

Piping Inspection Code: In-service Inspection, Rating, Repair, and Alteration of Piping Systems

API 570
FIFTH EDITION, FEBRUARY 2024



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Piping Inspection Code: In-service Inspection, Rating, Repair, and Alteration of Piping Systems

1 Scope

1.1 General Application

1.1.1 Coverage

API 570 covers inspection, rating, repair, and alteration procedures for metallic piping systems and their associated pressure-relieving devices (PRDs) that have been placed in-service. This inspection code applies to all hydrocarbon and chemical process piping covered in 1.2.1 that have been placed in-service unless specifically designated as optional per 1.2.2. This publication does not cover inspection of specialty equipment including impulse tubing, sensory tubing or tubing associated with instrumentation, exchanger tubes, and control valves. However, this piping code could be used by owner-operators in other industries and other services at their discretion.

Process piping systems that have been decommissioned from service and abandoned in place are no longer covered by this in-service inspection code. However, abandoned in place piping may still need some amount of inspection and/or risk mitigation to ensure that it does not become a safety hazard due to continued deterioration. Process piping systems that are temporarily out of service or idled but have been mothballed (preserved for potential future use) are still covered by this code.

1.1.2 Intent

The intent of this code is to specify the in-service inspection and condition-monitoring program, as well as repair guidance that is needed to determine and maintain the ongoing integrity of piping systems. That program should provide reasonably accurate and timely assessments to determine if any changes in the condition of piping could possibly compromise continued safe operation. It is also the intent of this code that owner-operators shall respond to any inspection results that require corrective actions to ensure that the continued integrity of piping is consistent with appropriate risk analysis. API 570 is intended for use by organizations that maintain or have access to an authorized inspection agency, a repair organization, and piping engineers, inspectors, and examiners, all as defined in Section 3.

This code does not cover source inspection of newly fabricated pressure piping. Refer to API 588 for guidance on the surveillance of supplier vendors fabricating and/or repairing pressure piping that will be installed on-site. Owner-operators may engage the services of individuals qualified and certified in accordance with API 588 or this code.

However, inspections after new piping systems arrive on-site may still be needed at owner-operator option depending upon quality of shop inspection services and owner-operator specifications during fabrication.

1.1.3 Limitations

API 570 shall not be used as a substitute for the original construction requirements governing a piping system before it is placed in-service; nor shall it be used in conflict with any prevailing regulatory requirements. If the requirements of this code are more stringent than the regulatory requirements, then the requirements of this code shall govern.

1.2 Special Applications

1.2.1 Included Fluid Services

Except as provided in 1.2.2, API 570 applies to piping systems for process fluids that are hazardous to personnel, such as hydrocarbons, and similar flammable or toxic fluid services and processes.

The following are processes, services, and product state that are applicable:

- a) catalyst lines;
- b) hydrogen, natural gas, fuel gas, and flare systems;
- c) sour water and hazardous waste streams;
- d) hazardous fluid services;
- e) cryogenic fluids, such as liquid N₂, H₂, O₂, and air;
- f) gaseous He, H₂, O₂, and N₂ at pressures greater than 150 psig.

1.2.2 Optional Piping Systems and Fluid Services

The fluid services and classes of piping systems listed below are optional when applying requirements of API 570:

- a) hazardous fluid services below designated threshold limits, as defined by jurisdictional regulations;
- b) water (including fire protection systems), steam, steam-condensate, boiler feed water, and Category D fluid services as defined in ASME B31.3;
- c) other classes of piping that are exempted from the applicable process piping code.

1.3 Fitness-For-Service and Risk-based Inspection

This inspection code recognizes Fitness-For-Service concepts for evaluating in-service damage of pressure-containing piping components. API 579-1/ASME FFS-1 provides detailed Fitness-For-Service assessment procedures for specific types of damage that are referenced in this code.

This inspection code also recognizes risk-based inspection (RBI) concepts for determining inspection intervals or due dates and strategies. API 580 provides the basic minimum and recommended elements for developing, implementing, and maintaining an RBI program for fixed equipment, including piping. API 581 provides a set of methodologies for assessing risk (both probability of failure and consequence of failure) and for developing inspection plans.

2 Normative References

The following documents are referred to in the text in such a way that some or all their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document, including any addenda, applies.

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

API Recommended Practice 574, *Inspection Practices for Piping System Components*

API Recommended Practice 576, *Inspection of Pressure-relieving Devices*

API Recommended Practice 577, *Welding Processes, Inspection, and Metallurgy*

API Recommended Practice 578, *Material Verification Program for New and Existing Assets*

API Standard 579-1/ASME FFS-1 ¹, *Fitness-For-Service*

API Recommended Practice 580, *Elements of a Risk-based Inspection Program*

API Recommended Practice 583, *Corrosion Under Insulation and Fireproofing*

API Recommended Practice 584, *Integrity Operating Windows*

API Recommended Practice 585, *Pressure Equipment Integrity Incident Investigation*

API Standard 598, *Valve Inspection and Testing*

API Recommended Practice 751, *Safe Operation of Hydrofluoric Acid Alkylation Units*

API Recommended Practice 939-C, *Guidelines for Avoiding Sulfidation (Sulfidic) Corrosion Failures in Oil Refineries*

API Recommended Practice 2201, *Safe Hot Tapping Practices in the Petroleum and Petrochemical Industries*

ASME B16.34, *Valves—Flanged, Threaded, and Welding End*

ASME B31.3, *Process Piping*

ASME Boiler and Pressure Vessel Code, Section V: *Nondestructive Examination*

ASME Boiler and Pressure Vessel Code, Section IX: *Welding, Brazing, and Fusing Qualifications*

ASME PCC-1, *Guidelines for Pressure Boundary Bolted Flange Joint Assembly*

ASME PCC-2, *Repair of Pressure Equipment and Piping*

ASNT CP-189 ², *Standard for Qualification and Certification of Nondestructive Testing Personnel*

ASNT SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*

NACE SP0472 ³, *Methods and Controls to Prevent In-Service Environmental Cracking of Carbon Steel Weldments in Corrosive Petroleum Refining Environments*

NACE MR0103, *Petroleum, Petrochemical and Natural Gas Industries—Metallic Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments*

NFPA 704 ⁴, *Standard System for the Identification of the Hazards of Materials for Emergency Response*

¹ American Society of Mechanical Engineers, Two Park Avenue, New York, New York 10016, www.asme.org.

² American Society for Nondestructive Testing, 1201 Dublin Road, Suite #G04, Columbus, Ohio 43215, www.asnt.org.

³ NACE International (now Association for Materials Protection and Performance), 15835 Park Ten Place, Houston, Texas 77084, www.ampp.org.

⁴ National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02169, www.nfpa.org.

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

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

NOTE Definitions for terms delineated with asterisks are maintained by API 570. If another document plans to reference, see API Bulletin 590 for reference.

3.1.1

abandoned-in-place

Piping system, circuit, or contiguous sections thereof meeting all the following: has been decommissioned with no intention for future use; has been completely deinventoried/purged of hydrocarbon/chemicals; and is physically disconnected (i.e. air-gapped) from all energy sources and/or other piping/equipment but remains in place.

3.1.2

alloy material*

Any metallic material (including welding filler materials) that contains alloying elements, such as chromium, nickel, or molybdenum, which are intentionally added to enhance mechanical or physical properties and/or corrosion resistance.

NOTE 1 Alloys may be ferrous or nonferrous based.

NOTE 2 Carbon steels are not considered alloys for purposes of this code.

3.1.3

alteration

A physical change in any component that has design implications that affect the pressure-containing capability of a piping system beyond the scope described in existing data reports.

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

3.1.4

applicable construction code

The code, code section, or other recognized and generally accepted engineering standard or practice to which the piping system was built, or deemed by the owner-operator or the engineer to be most appropriate for the situation.

3.1.5

authorization

Approval/agreement to perform a specific activity (e.g. repair) prior to the activity being performed.

3.1.6

authorized inspection agency

Defined as any of the following:

- the inspection organization of the jurisdiction in which the piping system is used;
- the inspection organization of an insurance company licensed or registered to write insurance for piping systems;
- the inspection organization of an owner-operator of piping systems who maintains an inspection organization for their equipment only and not for piping systems intended for sale or resale;
- an independent inspection organization or individual under contract to and under the direction of an owner-operator and recognized or otherwise not prohibited by the jurisdiction in which the piping system is used; the owner-operator's inspection program shall provide the controls necessary when contract inspectors are used.

3.1.7**authorized piping inspector***

An employee of an owner-operator organization or authorized inspection agency (see 3.1.6) who is qualified and certified by examination under the provisions of Section 4 and Annex A and can perform the functions specified in API 570 where contracted or directed to do so.

3.1.8**auxiliary piping***

Instrument and machinery piping, typically small-bore secondary process piping that can be isolated from primary piping systems but is normally not isolated.

NOTE Examples include flush lines, seal oil lines, analyzer lines, balance lines, buffer gas lines, drains, and vents.

3.1.9**condition monitoring location****CML**

A designated area on piping systems where periodic examinations are conducted to directly assess and monitor the condition of the piping system using a variety of examination methods and techniques based on damage mechanism susceptibility.

NOTE 1 CMLs may contain one or more examination points and can be a single small area on a piping system [e.g. a 2 in. (50 mm) diameter spot] or plane through a section of a pipe where examination points exist in all four quadrants of the plane).

NOTE 2 CMLs now include, but are not limited to, what was previously called TML.

3.1.10**construction code**

The code or standard to which the piping system was originally built (e.g. ASME B31.3).

3.1.11**contact point***

The locations at which a pipe or component rests on or against a support or other object that may increase its susceptibility to external corrosion, fretting, wear, or deformation especially because of moisture and/or solids collecting at the interface of the pipe and supporting member.

3.1.12**corrosion allowance**

Additional material thickness available to allow for metal loss during the service life of the pipe component.

NOTE Corrosion allowance is not used in design strength calculations.

3.1.13**corrosion rate**

The rate of metal loss due to erosion, erosion/corrosion, and/or the chemical reaction(s) with the environment, either internal and/or external.

3.1.14**corrosion specialist**

A person acceptable to the owner-operator who is knowledgeable and experienced in the specific process chemistries, damage mechanisms, materials selection, corrosion mitigation methods, corrosion monitoring techniques, and their impact on piping systems.

3.1.15**corrosion under fireproofing****CUF**

Corrosion of piping, pressure vessels, and structural components resulting from water trapped under fireproofing.

3.1.16**corrosion under insulation****CUI**

External corrosion of piping, pressure vessels, and structural components resulting from water trapped under insulation.

NOTE External chloride stress corrosion cracking (ECSCC) of austenitic and duplex stainless steel under insulation is also classified as CUI damage.

3.1.17**critical check valves***

Check valves that need to operate reliably to avoid the potential for hazardous events or substantial consequences should reverse flow occur.

3.1.18**cyclic service**

Refers to service conditions that may result in cyclic loading and produce fatigue damage or failure (e.g. cyclic loading from pressure, thermal, and/or mechanical loads).

NOTE 1 Other cyclic loads associated with vibration may arise from sources such as impact, turbulent flow vortices, resonance in compressors, and wind, or any combination thereof.

NOTE 2 API 579-1/ASME FFS-1—Section I.A.15 has a definition of cyclic service. A screening procedure to determine if a component is in cyclic service is provided in Part 14. A definition of “severe cyclic conditions” is in ASME B31.3—Section 300.2, Definitions.

3.1.19**damage mechanism**

Any type of deterioration encountered in the refining and chemical process industry that can result in flaws/defects that can affect the integrity of equipment.

EXAMPLE Corrosion, cracking, erosion, dents, and other mechanical, physical, or chemical impacts (see API 571 for a comprehensive list and description of damage mechanisms).

3.1.20**damage rate***

The rate of deterioration other than corrosion (i.e. rate of cracking, rate of HTHA, and creep rate).

3.1.21***deadleg**

Components of a piping system that normally have little or no significant flow.

3.1.22**decommissioned**

Termination of pressure piping from its service; pressure piping at this stage of its life cycle is permanently removed from service and either removed from the process unit or abandoned-in-place.

3.1.23**defect**

A discontinuity or discontinuities that by nature or accumulated effect render a part or product unable to meet minimum applicable acceptance standards or specifications (e.g. total crack length); the term designates rejectability.

3.1.24**deferral**

An approved and documented postponement of an inspection, test, or examination (see 7.13 and 7.14).

3.1.25**design pressure***

The pressure at the most severe condition of coincident internal or external pressure and temperature

(minimum or maximum) expected during service.

NOTE It is the same as the design pressure defined in ASME B31.3 and other code sections and is subject to the same rules relating to allowances for variations of pressure or temperature or both.

3.1.26

design temperature

The temperature used for the design of the piping system per the applicable construction code.

NOTE It is the same as the design temperature defined in ASME B31.3 and other code sections and is subject to the same rules relating to allowances for variations of pressure or temperature or both. Different components in the same piping system or circuit can have different design temperatures. In establishing this temperature, consideration should be given to process fluid temperatures, ambient temperatures, heating/cooling media temperatures, and insulation.

3.1.27

due date

The date established by the owner-operator and in accordance with this code, whereby an inspection, test, examination, or inspection recommendation falls due or is to be completed.

NOTE The date may be established by rule-based inspection methodologies (e.g. fixed intervals, retirement half-life interval, retirement date), risk-based methodologies (e.g. RBI target date), Fitness-For-Service analysis results, owner-operator inspection agency practices/procedures/guidelines, or any combination thereof.

3.1.28

examination point

recording point

measurement point

test point

A more specific location within a CML. CMLs may contain multiple examination points; for example, a piping component may be a CML and have multiple examination points (e.g. an examination point in all four quadrants of the CML of the piping component).

NOTE The term "test point" is no longer in use as "test" in this code refers to mechanical or physical tests, e.g. tensile tests or pressure tests.

3.1.29

examinations

A process by which an examiner or inspector investigates a component of the piping system using nondestructive examination (NDE) in accordance with approved NDE procedures (e.g. inspection of a CML and quality control of repair areas).

NOTE Examinations would be typically those actions conducted by NDE personnel, welding, or coating inspectors but may also be conducted by authorized piping inspectors.

3.1.30

examiner

A person who assists the inspector by performing specific NDE on piping system components and evaluates to the applicable acceptance criteria but does not evaluate the results of those examinations in accordance with API 570 unless specifically trained and authorized to do so by the owner-operator.

3.1.31

external inspection

A visual inspection performed from the outside of a piping system to find conditions that could impact the piping systems' ability to maintain pressure integrity or conditions that compromise the integrity of the supporting structures (e.g. stanchions, pipe supports, shoes, and hangers). The external inspection may be done while the piping is out of service and can be conducted at the same time as on-stream inspection.

NOTE External inspections are also intended to find conditions that compromise the integrity of the coating and insulation covering and attachments (e.g. instrument and small branch connections).

3.1.32**Fitness-For-Service evaluation**

An engineering methodology whereby flaws and other deterioration/damage contained within piping systems are assessed to determine the structural integrity of the piping for continued service (see API 579-1/ASME FFS-1).

3.1.33**fitting***

A piping component usually associated with a branch connection, a change in direction, or change in piping diameter.

NOTE Flanges are not considered fittings.

3.1.34**flammable materials***

As used in this code, includes all fluids that will support combustion.

NOTE 1 Refer to NFPA 704 for guidance on classifying fluids in 6.3.4.

NOTE 2 Some regulatory documents include separate definitions of flammables and combustibles based on their flash point. In this document, flammable is used to describe both, and the flash point, boiling point, autoignition temperature, or other properties are used in addition to better describe the hazard.

3.1.35**flash point***

The lowest temperature at which a flammable product emits enough vapor to form an ignitable mixture in air.

NOTE 1 For example, gasoline's flash point is about -45 °F (-43 °C), diesel's flash point varies from about 125 °F to 200 °F (52 °C to 93 °C).

NOTE 2 An ignition source is required to cause ignition above the flash point, but below the autoignition temperature.

3.1.36**flaw***

An imperfection in a piping system detected by NDE that may or may not be a defect depending upon the applied acceptance criteria.

3.1.37**general corrosion**

Corrosion distributed approximately uniform over the surface of the metal.

3.1.38**hold point**

A point in the repair or alteration process beyond which work may not proceed until the required inspection or NDE has been performed.

3.1.39**idle**

Piping system, circuit, or contiguous sections that are not currently operating but remain connected to pressure vessels, electrical, or instrumentation (may be blinded or blocked in).

3.1.40**imperfection**

Flaws or other discontinuities noted during inspection or examination that may or may not exceed the applicable acceptance criteria.

3.1.41**indication**

A response or evidence resulting from the application of NDE that may be nonrelevant, flawed, or defective upon further analysis.

3.1.42**industry-qualified ultrasonic angle beam examiner**

A person who possesses an ultrasonic angle beam qualification from API (e.g. API QUTE/QUSE Detection and Sizing Tests) or an equivalent qualification approved by the owner-operator.

NOTE Rules for equivalency are defined in API 587.

3.1.43**injection point***

Injection points are locations where water, steam, chemicals, or process additives are introduced into a process stream at relatively low flow/volume rates as compared to the flow/volume rate of the parent stream.

NOTE 1 Corrosion inhibitors, neutralizers, process antifoulants, de-salter demulsifiers, oxygen scavengers, caustic, and water washes are most often recognized as requiring special attention in designing the point of injection. Process additives, chemicals, and water are injected into process streams to achieve specific process objectives.

NOTE 2 Injection points do not include locations where two process streams join (see 3.1.64, "mixing points").

EXAMPLE Chlorinating agents in reformers, water injection in overhead systems, polysulfide injection in catalytic cracking wet gas, antifoam injections, inhibitors, and neutralizers.

3.1.44**in-service**

The life-cycle stage of a piping system that begins after initial installation (where typically initial commissioning or placing into active service follows) and ends at decommissioning.

NOTE 1 Piping systems that are idle in an operating site and piping systems that are not currently in operation because of a process outage are still considered in-service piping systems.

NOTE 2 Does not include piping systems that are still under construction or in transport to the site prior to being placed in service or piping systems that have been retired.

NOTE 3 Installed spare piping is also considered in service, whereas spare piping that is not installed is not considered in service.

3.1.45**in-service inspection**

All inspection activities associated with in-service piping systems (after installation, but before it is decommissioned).

3.1.46**inspection**

The external, internal, or on-stream evaluation (or any combination of the three) of the condition of a piping system conducted by the authorized inspector or the designee in accordance with this code.

3.1.47**inspection code**

Shortened title for this code (API 570).

3.1.48**inspection plan**

A strategy defining how and when a piece of pressure equipment and associated components will be inspected, examined, repaired, and/or maintained.

3.1.49**inspector**

A shortened title for an authorized piping inspector qualified and certified in accordance with this code.

3.1.50 **integrity operating window** **IOW**

Established limits for process variables (parameters) that can affect the integrity of the equipment if the process operation deviates from the established limits for a predetermined length of time (includes critical, standard, and informational IOWs).

3.1.51 **intermittent service***

The condition of a piping system whereby it is not in continuous operating service (i.e. it operates at regular or irregular intervals rather than continuously).

NOTE Occasional turnarounds or other infrequent maintenance outages in an otherwise continuous process service does not constitute intermittent service.

3.1.52 **internal inspection**

An inspection performed from the inside of a piping system using visual and/or NDE techniques.

3.1.53 **jurisdiction**

A legally constituted governmental administration that may adopt rules relating to process piping systems.

3.1.54 **level bridle***

The piping assembly associated with a level gauge attached to a vessel.

3.1.55 **lining***

A nonmetallic or metallic material, installed on the interior of pipe, whose properties are better suited to resist damage from the process than the substrate material.

3.1.56 **localized corrosion**

Corrosion that is typically confined to a limited or isolated area(s) of the metal surface of a piping system.

3.1.57 **lockout/tagout*** **LOTO**

A safety procedure used to ensure that piping is properly isolated and cannot be energized or put back in-service prior to the completion of inspection, maintenance, or servicing work.

3.1.58 **major repair**

Any work not considered an alteration that removes and replaces a major part of the pressure boundary. If any of the restorative work results in a change to the design temperature, minimum allowable temperature (MAT), or maximum allowable working pressure (MAWP), the work shall be considered an alteration and the requirements for rerating shall be satisfied.

EXAMPLE Removal and replacement of large sections of piping systems.

3.1.59 **management of change** **MOC**

A documented management system for review and approval of changes (both physical and process) to

pipng systems prior to implementation of the change.

NOTE The MOC process includes involvement of inspection personnel that may need to alter inspection plans because of the change.

3.1.60

material verification program*

A documented quality assurance procedure used to assess alloy materials (including weldments and attachments where specified) to verify conformance with the selected or specified alloy material designated by the owner-operator.

NOTE This program may include a description of methods for alloy material testing, physical component marking, and program recordkeeping (see API 578).

3.1.61

maximum allowable working pressure

MAWP

The maximum gauge pressure permitted for the piping system in its operating position for a designated temperature. This pressure is based on calculations using the minimum (or average pitted) thickness for all critical piping elements (exclusive of thickness designated for corrosion) and adjusted for applicable static head pressure and nonpressure loads (e.g. wind and seismic). The MAWP may refer to either the original design or a rerated MAWP obtained through a Fitness-For-Service assessment.

NOTE MAWP is the same as the design pressure, as defined in ASME B31.3 and other code sections and is subject to the same rules relating to allowances for variations of pressure or temperature or both.

3.1.62

minimum alert thickness*

flag thickness

A thickness greater than the required thickness that provides for early warning from which the future service life of the piping is managed through further inspection and remaining life assessment.

3.1.63

minimum design metal temperature/minimum allowable temperature

MDMT/MAT

The lowest permissible metal temperature for a given material at a specified thickness based on its resistance to brittle fracture.

NOTE In the case of MAT, it may be a single temperature, or an envelope of allowable operating temperatures as a function of pressure. It is generally the minimum temperature at which a significant load can be applied to a piping system as defined in the applicable construction code. It might be also obtained through a Fitness-For-Service evaluation.

3.1.64

minimum required thickness*

required thickness

t_{min}

The minimum thickness without corrosion allowance for each component of a piping system based on the appropriate design code calculations and code allowable stress that consider internal and external pressure, temperature, mechanical and structural loadings, including the effects of static head.

NOTE Minimum required thicknesses may also be reassessed using Fitness-For-Service analysis in accordance with API 579-1/ASME FFS-1.

3.1.65**mixing point***

Mixing points are locations in a process piping system where two or more streams meet.

NOTE The difference in streams may be composition, temperature, or any other parameter that may cause deterioration and may require additional design considerations, operating limits, inspection, and/or process monitoring.

3.1.66**non-conformance***

An aspect of quality of an item that is not in accordance with the requirements of this code and/or any other specified codes, standards, or other requirements.

NOTE A non-conformance does not necessarily mean that the item is defective or that the item is not suitable for continued service.

3.1.67**non-pressure boundary**

Components and attachments of, or the portion of piping that does not contain the process pressure.

EXAMPLE Clips, shoes, repads, supports, wear plates, nonstiffening insulation support rings, etc.

3.1.68**off-site piping***

Piping systems not included within the plot boundary limits of a process unit, such as a hydrocracker, an ethylene cracker, or a crude unit.

EXAMPLE Tank farm piping and interconnecting piperack piping outside the limits of the process unit.

3.1.69**on-site piping***

Piping systems included within the plot limits of process units, such as a hydrocracker, an ethylene cracker, or a crude unit.

3.1.70**on-stream inspection**

An inspection performed from the outside of piping systems while they are in-service using NDE procedures to establish the suitability of the pressure boundary for continued operation (see 5.5.3).

3.1.71**overdue inspection**

Inspections for in-service piping that remain in operation and have not been performed by the due date documented in the inspection plan and have not been deferred by a documented deferral process (see 7.13).

3.1.72**overwater piping***

Piping located where leakage would result in discharge into streams, rivers, bays, etc., resulting in a potential environmental incident.

3.1.73**owner-operator**

An owner or operator of piping systems who exercises control over the operation, engineering, inspection, repair, alteration, maintenance, pressure testing, and rerating of those piping systems.

3.1.74**pipe***

A pressure-tight cylinder used to convey, distribute, mix, separate, discharge, meter, control, or snub fluid flows,

or to transmit a fluid pressure and that is ordinarily designated “pipe” in applicable material specifications.

NOTE 1 Materials designated as “tube” or “tubing” in the specifications are treated as pipe in this code when intended for pressure service external to fired heaters.

NOTE 2 See API 530 for piping internal to fired heaters.

3.1.75

piperack piping*

Process piping supported by consecutive stanchions or sleepers (including straddle racks and extensions).

3.1.76

pipe spool*

A section of piping with a flange or other connecting fitting, such as a union, on both ends that allows the removal of the section from the system.

3.1.77

piping circuit*

A subsection of piping systems that includes piping and components that are exposed to a process environment of similar corrosivity and expected damage mechanisms and is of similar design conditions and construction material whereby the expected type and rate of damage can reasonably be expected to be the same.

NOTE 1 Complex process units or piping systems are divided into piping circuits to manage the necessary inspections, data analysis, and recordkeeping.

NOTE 2 When establishing the boundary of a particular piping circuit, it may be sized to provide a practical package for recordkeeping and performing field inspection.

3.1.78

piping engineer*

One or more persons or organizations acceptable to the owner-operator who are knowledgeable and experienced in the engineering disciplines associated with evaluating mechanical and material characteristics affecting the integrity and reliability of piping components and systems.

NOTE The piping engineer, by consulting with appropriate specialists, should be regarded as a composite of all entities necessary to properly address piping design requirements.

3.1.79

piping system*

An assembly of interconnected pipes that typically are subject to the same (or nearly the same) process fluid composition or operating conditions, or both.

NOTE Piping systems also include pipe-supporting elements (e.g. springs, hangers, guides, etc.) but do not include support structures, such as structural frames, vertical and horizontal structural members, and foundations.

3.1.80

pitting*

Localized corrosion of a metal surface in a small area that takes the form of cavities called pits, which can be highly localized as a single pit or widespread within a specific area on a metal surface.

NOTE Pitting can be highly localized (including a single pit) or widespread on a metal surface.

3.1.81

positive material identification

PMI

A physical evaluation or test of a material performed to confirm that the material, which has been or will be placed into service, is consistent with what is specified by the owner-operator.

NOTE These evaluations or tests can provide qualitative or quantitative information that is sufficient to verify the nominal alloy composition (see API 578).

3.1.82**postweld heat treatment****PWHT**

Treatment that consists of heating an entire weldment or section of fabricated piping to a specified elevated temperature after completion of welding in order to relieve the effects of welding heat, such as to reduce residual stresses, reduce hardness, stabilize chemistry, and/or slightly modify properties.

NOTE See ASME B31.3, paragraph 331.

3.1.83**pressure boundary**

The portion of the piping that contains the pressure-retaining piping elements joined or assembled into pressure tight fluid-containing piping systems.

NOTE 1 Pressure boundary components include pipe, tubing, fittings, flanges, gaskets, bolting, valves, and other devices, such as expansion joints and flexible joints.

NOTE 2 Also see non-pressure boundary definition.

3.1.84**pressure design thickness***

Minimum allowed pipe wall thickness needed to hold the design pressure at the design temperature.

NOTE 1 Pressure design thickness is determined using the rating code formula, including needed reinforcement thickness.

NOTE 2 Pressure design thickness does not include thickness for structural loads, corrosion allowance, or mill tolerances and therefore should not be used as the sole determinant of structural integrity for typical process piping (see 7.6).

3.1.85**primary process piping***

Process piping in normal, active service that cannot be valved off, or, if it were valved off, would significantly affect unit operability.

NOTE Primary process piping typically does not include small-bore or auxiliary process piping (see also 3.1.96, "secondary process piping").

3.1.86**procedure**

A document that specifies or describes how an activity is to be performed. A procedure may include methods to be employed, equipment or materials to be used, qualifications of personnel involved, and sequence of work.

3.1.87**process piping***

Hydrocarbon or chemical piping located at or associated with a refinery or manufacturing facility.

NOTE Process piping includes piperack, tank farm, and process unit piping but excludes utility piping (e.g. steam, water, air, nitrogen, etc.).

3.1.88**quality assurance**

All planned, systematic, and preventative actions specified to determine if materials, equipment, or services will meet specified requirements so that the piping will perform satisfactorily in-service.

NOTE 1 Quality assurance plans will specify the necessary quality control activities and examinations.

NOTE 2 The contents of a quality assurance inspection management system for piping systems are outlined in 4.3.1.

3.1.89**quality control**

Those physical activities that are conducted to check conformance with specifications in accordance with the quality assurance plan.

3.1.90**rating***

The work process of making calculations to establish pressures and temperatures appropriate for a piping system, including design pressure/temperature, MAWP, structural minimums, required thicknesses, etc.

3.1.91**renewal***

Activity that discards an existing component, fitting, or portion of a piping circuit and replaces it with new or existing spare materials of the same or better qualities as the original piping components.

3.1.92**repair**

The work necessary to restore a piping system to a condition suitable for safe operation at the design conditions.

NOTE 1 Any welding, cutting, or grinding operation on a pressure-containing piping component not specifically considered an alteration is considered a repair.

NOTE 2 Repairs can be temporary or permanent (see Section 8).

3.1.93**repair organization**

An organization that is qualified to make the repair by meeting the criteria of 4.3.2 of API 570.

3.1.94**rerating**

A change in either the design temperature rating, design pressure rating, or the MAWP of a piping system.

NOTE A rerating may consist of an increase, a decrease, or a combination of both. Derating below original design conditions is a means to provide increased corrosion allowance.

3.1.95**risk-based inspection****RBI**

A risk assessment and management process that considers both the probability of failure and the consequence of failure due to material deterioration. See 5.2.

3.1.96**scanning nondestructive examination**

Examination methods designed to find the thinnest spot or all flaws in a specified area of pressure piping, such as profile radiography (RT) of nozzles, scanning ultrasonic testing (UT) techniques, and/or other suitable NDE techniques that will reveal the scope and extent of localized corrosion or other deterioration.

3.1.97**secondary process piping***

Process piping located downstream of a block valve that can be valved off without significantly affecting the process unit operability.

NOTE Often, secondary process piping is small-bore piping (SBP).

3.1.98**small-bore piping*****SBP**

Pipe or pipe components that are less than or equal to nominal pipe size (NPS) 2.

3.1.99**soil-to-air interface*****SAI**

An area in which external corrosion may occur or be accelerated on partially buried pipe or buried pipe near where it egresses from the soil.

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 at least 12 in. (305 mm) below to 6 in. (150 mm) above the soil surface. Pipe running parallel with the soil surface that contacts the soil is included.

3.1.100**structural minimum thickness***

Minimum required thickness without corrosion allowance based on the mechanical loads other than pressure that result in longitudinal stress (see 7.6).

NOTE The thickness is either determined from a standard chart or engineering calculations. It does not include thickness for corrosion allowance or mill tolerances.

3.1.101**tank farm piping***

Process piping inside tank farm dikes or directly associated with a tank farm.

3.1.102**temporary repair**

Repairs made to piping systems to restore sufficient integrity to continue safe operation until permanent repairs are conducted.

NOTE Injection fittings on valves to seal fugitive [leak detection and repair (LDAR)] emissions from valve stem seal are not considered to be "temporary repairs" as described in 8.1.4.1 and 8.1.5 in this code.

3.1.103**testing**

Within this document, testing generally refers to either pressure testing, whether performed hydrostatically, pneumatically, or a combination hydrostatic/pneumatic, or mechanical testing to determine data such as material hardness, strength, and notch toughness.

NOTE Testing does not refer to NDE using techniques such as liquid penetrant (PT), magnetic particle (MT), etc.

3.1.104**utility piping***

Non-process piping associated with a process unit (e.g. steam, air, water, nitrogen).

3.2 Acronyms and Abbreviations

For the purposes of this document, the following acronyms and abbreviations apply.

BPVC *Boiler and Pressure Vessel Code*

CCV critical check valve

CML condition monitoring location

CPD	continuing professional development
CUF	corrosion under fireproofing
CUI	corrosion under insulation
EMAT	electromagnetic acoustic transducer
ECSCC	external chloride stress corrosion cracking
HF	hydrofluoric
	NOTE Generally referred to as HF acid.
ID	inside diameter
IDMS	Inspection Data Management System
IOW	integrity operating window
ISO	inspection isometric drawing
LDAR	leak detection and repair (of fugitive emissions)
LT	long term
MAT	minimum allowable temperature
MAWP	maximum allowable working pressure
MDMT	minimum design metal temperature
MOC	management of change
MT	magnetic particle examination technique
NDE	nondestructive examination
NPS	nominal pipe size
	NOTE The term is typically followed, when appropriate, by the specific size designation number without an inch unit.
	EXAMPLE NPS 24 refers to a nominal pipe size of 24 in.
OD	outside diameter
PEC	pulsed eddy current
PMI	positive material identification
PQR	procedure qualification record
PRD	pressure-relieving device
PT	liquid penetrant examination technique
PWHT	postweld heat treatment
RBI	risk-based inspection
RT	radiographic examination (method) or radiography

SAI	soil-to-air interface
SBP	small-bore piping
ST	short term
SMYS	specified minimum yield strength
TML	thickness monitoring location
UT	ultrasonic examination technique
WPS	welding procedure specification

4 Owner-Operator Inspection Organization

4.1 General

An owner-operator of piping systems shall have a defined program for piping system inspections, inspection frequencies, and maintenance and is responsible for the function of an authorized inspection agency in accordance with the provisions of API 570. The owner-operator shall be responsible for the activities relating to the rating, repair, and alteration of its piping systems. See definition of “authorized inspection agency” in 3.1.6.

4.2 Authorized Piping Inspector Qualification and Certification

Authorized piping inspectors shall have education and experience in accordance with Annex A of this inspection code. Authorized piping inspectors shall be certified in accordance with the provisions of Annex A. Whenever the term “inspector” is used in this code, it refers to an “authorized piping inspector.”

4.3 Responsibilities

4.3.1 Owner-Operator Organization

4.3.1.1 Systems and Procedures

An owner-operator organization is responsible for developing, documenting, implementing, executing, and assessing piping inspection systems and inspection procedures that will meet the requirements of this inspection code. These systems and procedures will be contained in a quality assurance inspection/repair management system and shall include the following:

- a) organization and reporting structure for inspection personnel;
- b) documenting and maintaining inspection and quality control procedures;
- c) documenting and reporting inspection and test results;
- d) developing and documenting inspection plans;
- e) developing and documenting risk-based assessments;
- f) developing and documenting the appropriate inspection intervals;
- g) corrective action for inspection and test results;
- h) internal auditing for compliance with the quality assurance inspection manual;

- i) review and approval of drawings, design calculations, and specifications for repairs, alterations, reratings, and Fitness-For-Service assessments;
- j) ensuring that all jurisdictional requirements for piping inspection, repairs, alterations, and rerating are continuously met;
- k) reporting to the authorized piping inspector any process changes that could affect piping integrity;
- l) training requirements for inspection personnel regarding inspection tools, techniques, and technical knowledge base;
- m) controls necessary so that only qualified welders and procedures are used for all repairs and alterations;
- n) controls necessary so that only qualified NDE personnel and procedures are utilized;
- o) controls necessary so that only materials conforming to the applicable construction code are utilized for repairs and alterations;
- p) controls necessary so that all inspection measurement and test equipment are properly maintained and calibrated;
- q) controls necessary so that the work of contract inspection or repair organizations meet the same inspection requirements as the owner-operator organization and this inspection code;
- r) internal auditing requirements for the quality control system for PRDs;
- s) requirements and work process to increase the confidence that inspectors have an annual vision test and are capable of reading standard J-1 letters on standard Jaeger test type charts for near vision;
- t) controls necessary to prevent external covering or insulation of cold wall piping or headers that might cause overheating and rupture;
- u) controls necessary to ensure that temporary facilities are managed and removed at the appropriate times.

4.3.1.2 Inspection Organization Audits

Each owner-operator organization shall be audited periodically to determine if they are meeting the requirements of an authorized inspection agency as defined in this inspection code. The audit team should consist of people experienced and competent in the application of this code. The audit team should typically be from another owner-operator plant site, company central office, or from a third-party organization experienced and competent in refining and/or petrochemical process plant inspection programs or a combination of third-party and other owner-operator sites.

The following key elements of an inspection program should be assessed by the audit team:

- a) the requirements and principles of this inspection code are being met;
- b) owner-operator responsibilities are being properly executed;
- c) documented inspection plans are in place for covered piping systems;
- d) intervals and extent of inspections are adequate for covered piping systems;
- e) general types of inspections and surveillance are being adequately applied;
- f) inspection data analysis, evaluation, and recording are adequate;
- g) repairs, reratings, and alterations comply with this code.

The owner-operator shall receive a report of the audit team's scope and findings. After review of the report, non-conformances should be prioritized, and corrective actions implemented. Other suggestions for improvement are at the discretion of the owner-operator. Each organization should establish a system for tracking and completion of audit findings. This information should also be reviewed during subsequent audits.

4.3.1.3 MOC

The owner-operator is also responsible for implementing an effective MOC process that will review and control changes to the process and assets (e.g. piping and piping components). An effective MOC process is vital to the success of any piping integrity management program so the inspection group can:

- a) address issues concerning the adequacy of the piping design and current condition of the proposed changes;
- b) anticipate changes in corrosion or other types of damage and their effects on the adequacy on the pressure piping and update the inspection plan and records to account for those changes.

The MOC process shall include the appropriate materials/corrosion experience and expertise to effectively forecast what changes might affect piping integrity. The inspection group shall be involved in the approval process for changes that may affect piping integrity. Changes to pipe components, supports, and the process shall be included in the MOC process to ensure its effectiveness.

4.3.1.4 IOWs

The owner-operator should implement and maintain an effective program for creating, establishing, and monitoring IOWs. IOWs are implemented to avoid process parameter exceedances that may have an unanticipated impact on pressure equipment integrity. Future inspection plans and intervals have historically been based on prior measured corrosion rates resulting from past operating conditions. Without an effective IOW and process control program, there often is no warning of changing operating conditions that could affect the integrity of equipment or validation of the current inspection plan. Deviations from and changes of trends within established IOW limits should be brought to the attention of inspection/engineering personnel so they may modify or create new inspection plans depending upon the seriousness of the exceedance.

IOWs should be established for process parameters (both physical and chemical) that could impact equipment integrity if not properly controlled. Examples of the process parameters include temperatures, pressures, fluid velocities, pH, flow rates, chemical or water injection rates, levels of corrosive constituents, chemical composition, etc. IOWs for key process parameters may have both upper and lower limits established, as needed. Particular attention to monitoring IOWs should also be provided during start-ups, shutdowns, and significant process upsets. See API 584 for more information on issues that may assist in the development of an IOW program.

4.3.1.5 Pressure Equipment Integrity Incident Investigations

The owner-operator should investigate pressure equipment integrity incidents and near-misses (near-leaks) to determine causes (root, contributing, and direct), which may result in updates to the associated inspection program, IOW, Corrosion Control Document, etc. If pressure equipment integrity incidents and near-misses are recognized and investigated, and the causes are identified, then future leaks and failures of pressure equipment can be minimized or prevented. API 585 covers pressure equipment integrity incident investigations and provides owner-operator with guidelines for developing, implementing, sustaining, and enhancing an investigation program for pressure equipment integrity incidents.

4.3.1.6 Corrosion Control Document

The owner-operator should assess piping systems, as identified in the owner-operator's piping inspection programs, for credible damage mechanisms. API 970 provides guidance to address this and may be used.

The Corrosion Control Documents or alternate document identifying all credible damage mechanisms should be available to all stakeholders (e.g. inspector, mechanical integrity engineering, and process engineers) who have a role in fixed equipment integrity.

4.3.2 Repair Organization

The repair organization is responsible to the owner-operator and shall provide the materials, equipment, quality control, and workmanship necessary to maintain and repair the piping or PRD in accordance with the requirements of this inspection code. The repair organization shall meet one of the following criteria:

- a) the holder of a valid ASME Certificate of Authorization that authorizes the use of an appropriate ASME code symbol stamp;
- b) the holder of another recognized code of construction certificate that authorizes the use of an appropriate construction code symbol stamp;
- c) the holder of a valid R-stamp issued by the National Board for repair of pressure vessels;
- d) the holder of a valid VR-stamp issued by the National Board for repair and servicing of relief valves;
- e) an owner-operator of pressure piping and/or relief valves who repairs their own equipment in accordance with this code;
- f) a repair contractor whose qualifications are acceptable to the pressure piping owner-operator;
- g) an individual or organization authorized by the legal jurisdiction to repair pressure piping or service PRDs.

4.3.3 Personnel

4.3.3.1 Piping Engineer

The piping engineer is responsible to the owner-operator for activities involving design, engineering review, rating, analysis, or evaluation of piping systems and PRDs covered by API 570 as specified in this code.

4.3.3.2 Authorized Piping Inspector

When inspections, repairs, or alterations are being conducted on piping systems, the designated authorized piping inspector shall be responsible to the owner-operator for:

- a) determining that the requirements of API 570 on inspection, examination, quality assurance, and testing are met;
- b) being directly involved in the inspection activities, which in most cases will require field activities to ensure that procedures are followed;
- c) extending the scope of the inspection (with appropriate consultation with engineers/specialists), where justified depending upon the findings of the inspection;
- d) notifying the owner-operator in a timely manner and making appropriate repair or other mitigative recommendations, where non-conformances are discovered.

The inspector shall be knowledgeable with piping system damage mechanisms listed in API 571, as well as the content of API 574, API 576, API 577, API 578, API 583, API 584, API 585, and API 588, and be knowledgeable in API 580 where RBI is in use, where these are applicable or in use by the owner-operator. The inspector shall be able to use the guidance contained in these documents to meet the requirements and/or expectations in this code.