ASME B31.3 Process Piping

Charles Becht IV, PhD, PE
Don Frikken, PE
Instructors

18. In-Service Piping

- API 570 Piping Inspection Code
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API 570 Piping Inspection Code

- For inspection, repair, alteration, and rerating of in-service metallic piping systems
- Applicable to piping systems constructed in accordance with ASME B31.3
- First Edition, June 1993
- Second Edition, October 1998
  - Addendum 1, February 2000
  - Addendum 2, December 2001

API 570 Piping Inspection Code

API 570 includes flammable and toxic services. It excludes specific requirements for:

- Water, steam, steam-condensate, boiler feed water and Category D fluid service
- Piping systems that are an integral part or component of rotating or reciprocating mechanical devices
- Piping or tubing with an OD ≤ NPS 1/2
- Nonmetallic piping and polymeric or glass-lined piping
- Plumbing
- fired heater and boiler internals are also excluded

The excluded piping can be included at the owner-user's option.

Responsibilities

Owner-user:

Has overall responsibility for compliance with API 570 and developing, documenting, implementing, and executing the inspection, repair, alteration, and rerating

Piping Engineer:

Responsible to the owner-user for design, engineering review, analysis, and evaluation of piping systems

Repair Organization:

Responsible to owner-user for providing materials, equipment, quality control, and workmanship to maintain and repair the piping system in accordance with API 570

Inspector:

Responsible to owner-user for determining that the inspection, examination and testing requirements of API 570 are met. Qualifications in terms of experience and education are specified in Appendix A of API 570

What to Inspect

API 570 directs attention to the following types and areas of deterioration

- Injection points
- Dead legs
- Corrosion under insulation (CUI)
- Soil-to-air interfaces
- Service specific and local corrosion
- Erosion and corrosion/erosion
- Environmental cracking
- Corrosion beneath linings and deposits
- Fatigue cracking
- Creep cracking
- Brittle fracture
- Freeze damage

What to Inspect

API 570 doesn't cover everything.

External Inspection Checklist

(API 570 Appendix D)

- Leaks
  - Process
  - Steam Tracing
  - Existing Clamps (temporary repairs)
- Misalignment
  - Piping misalignment/restricted movement
  - Expansion joint misalignment
- Vibration
  - Excessive overhung weight
  - Inadequate support
  - Thin, small-bore, or alloy piping
  - Threaded connections
  - Loose supports causing metal wear

External Inspection Checklist

- Supports
  - Shoes off support
  - Hanger distortion or breakage
  - Bottomed-out springs
  - Brace distortion/breakage
  - Loose brackets
  - Slide plates/rollers
  - Counter balance condition
  - Support corrosion
- Corrosion
  - Bolting support points under clamps
  - Coating/painting deterioration
  - Soil-to-air interface
  - Insulation interfaces
  - Biological growth

External Inspection Checklist

- Insulation
  - Damage/penetrations
  - Missing jacketing/insulation
  - Sealing deterioration
  - Bulging
  - Banding (broken/missing)

Types of Inspection

- Internal visual
- Thickness measurement
- External visual
- Vibrating piping
- Supplemental

Types of Inspection

- Internal visual inspection is not normally used for most piping systems
- But may be scheduled for very large diameter piping
- Or may be performed using remote viewing technique
- Should be performed when given the opportunity like at disconnected flange joints

Types of Inspection

- Thickness is measured via UT or radiography
- At least the minimum thickness should be determined and recorded
- The locations of TMLs should be recorded on a drawing and marked on the pipe to permit repetitive measurements at the same TMLs
- Generally should include measurements in each of the four quadrants of pipe and fittings
- Generally should include inside and outside radius of elbows and tees where corrosion/erosion could increase rate of metal loss
- Also required in areas of continuing corrosion under insulation, soil/air interfaces, and other areas of localized or general corrosion

Types of Inspection

- No specific numeric guidelines for number of thickness measurement locations (TMLs) provided in API 570
- More TMLs should be provided when there is
  - Higher potential for creating a safety or environmental emergency in the event of a leak
  - Higher expected or experienced corrosion rates
  - Higher potential for localized corrosion
  - More complexity in terms of fittings, branches, dead legs, injection points, and other similar items
  - Higher potential for CUI
- Ultrasonic thickness measurement preferred for pipe larger than NPS 1
- Radiography preferred for pipes NPS 1 and smaller

Types of Inspection

External visual inspection is performed to determine the condition of the outside of the piping, insulation system, painting and coating systems, and associated hardware; and to check for signs of misalignment, vibration, and leakage. Some specific things to check:

- Cracked or broken hangers, "bottoming out" of spring supports, support shoes displaced from support members
- Bellows expansion for unusual deformations, misalignment, or displacements that may exceed design
- Any components in the service that may be unsuitable for long-term operation

Types of Inspection

- Vibrating or swaying piping should be reported to the inspector or piping engineer for assessment.
- Supplementary inspection should be specified when needed to assess the condition of piping. Examples are
  - Thermography to check for hot spots in refractory lined systems
  - Acoustic emission testing
  - Acoustic leak detection
  - Ultrasonic or radiographic examination for detecting localized corrosion.

Inspection Practices

- Pressure testing not normally conducted except for alterations, major repairs, and sometimes with rerating.
- TMLs are not normally required on valves, due to their greater wall thickness, but valve thicknesses should generally be checked when removed for service

Inspection Practices

- Welds are not required to meet the radiographic acceptance criteria for new construction random radiography
- Defects resulting from environmental cracking shall be assessed by the piping engineer
- Defects resulting from original weld fabrication should be investigated using one or more of the following
  - Inspector judgment
  - Certified welding inspector judgment
  - Piping engineer judgment
  - Engineering fitness-for-service analysis

Inspection Practices

Potential causes of leaks in a flange joint include:

- Uneven bolt tightening
- Improper flange alignment
- Excessive external moments from piping
- Improper gasket placement
- Improper, dirty or damaged flange facing finish
- Improper gasket type or size
- Using a gasket that has already been compressed
- Thermal shock
- Bolt relaxation
- Differential expansion between bolts and flange

Frequency and Extent of Inspection

- An inspection strategy based on
  - likelihood and
  - consequence of failure

  is referred to as risk-based inspection.
- For the purposes of defining consequence of failure, API 570 defines 3 service classes.
- The owner/user may devise a more extensive classification scheme that more accurately assesses consequence

Frequency and Extent of Inspection

Class 1 - greatest hazard (safety or environmental) should a leak occur

Hydrofluoric acid, anhydrous hydrogen sulfide, piping over or adjacent to water and piping over public throughways, pressurized services that rapidly vaporize during release, that could result in vapor cloud explosions, etc.

Class 2 - includes services that are not Class 1 or Class 3

Hydrogen, fuel gas, natural gas, hydrocarbons that slowly vaporize during release, on-site strong acids and caustics

Class 3 - flammable services that do not significantly vaporize when they leak and are not located in high-activity areas. Also, services potentially harmful to human tissue that are located in remote areas

Off-site acids and caustics, on-site hydrocarbons that will not significantly vaporize during release

Inspection Intervals

- Considerations in setting inspection intervals
  - Corrosion rate and remaining life calculations (Interval can affect MAWP)
  - Piping service classification
  - Applicable jurisdictional requirements
  - Judgment based on operating conditions, previous inspection history, current inspection results, and conditions that may warrant supplemental inspections
- Inspection intervals should not exceed 1/2 the calculated remaining life or that shown in the following table

Inspection Intervals

Recommended Maximum Inspection Intervals (Years)

Type of Circuit	Thickness Measured	External Visual
Class 1	5	5
Class 2	10	5
Class 3	10	10
Injection Points	3	By Class
Soil-to-air interfaces		By Class

(Table 6-1 from API 570)

Extent of CUI Inspections

API 570 recommends that a percentage of the areas with potential for corrosion under insulation be inspected

	Areas with Damaged Insulation	Suspect Areas with Susceptible Temperature Ranges
Class 1	75%	50%
Class 2	50%	33%
Class 3	25%	10%

(Table 6-2 from API 570)

Remaining Life Calculation

Remaining Life = (t_{actual} – t_{reqd}) / Corrosion Rate

Where:

t_{actual} = The actual minimum thickness determined at the time of inspection

t_{reqd} = The required minimum thickness

Corrosion rate is determined based on thickness measurements.

Remaining Life Calculation

Corrosion Rate = (t_{init} – t_{actual}) / Time

Where:

t_{init} = Initial thickness (long-term corrosion rate) or thickness measured in a previous inspection (short-term corrosion rate)

t_{actual} = The actual minimum thickness determined at the time of inspection

Time is between thickness measurements.

Maximum Allowable Working Pressure

- Calculated in accordance with applicable code
- If the material is unknown, use the lowest grade of material and joint efficiency in the applicable code
- To calculate the MAWP, use the current thickness minus two times the anticipated corrosion that will occur between the current time and the next inspection time

Required Minimum Thickness

- The required minimum thickness shall be based on
  - Pressure
  - Mechanical, and
  - Structural considerations

  using the appropriate design formulae and code allowable stress
- For services with high potential consequences, the piping engineer should consider increasing the required minimum thickness above the calculated minimum thickness to provide for
  - Unanticipated or unknown loadings
  - Undiscovered metal loss, or
  - Resistance to abuse

Assessment of Inspection Findings

- Pressure containing components found to have degradation that could affect their load carrying capability (pressure loads and other applicable loads including weight, wind and thermal expansion) shall be evaluated for continued service.
- Fitness-for-service techniques, such as those documented in API RP 579 and ASME B31G, may be used for this evaluation.
- Local wall thinning below the required minimum thickness might be found to be acceptable using this approach.

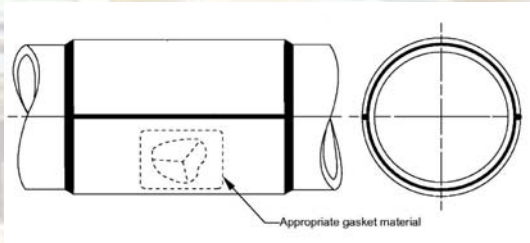
Repairs and Alterations

- Can be made by the owner or user, or by contractors acceptable to them
- Must be authorized by the inspector
- Alterations must also have approval of the piping engineer
- Repairs of cracks that occurred in-service should not be made without prior consultation with the piping engineer in order to identify and correct the cause of the cracking

Temporary Repairs

Temporary repairs, including on-stream repairs are permitted. These include

- Full encirclement welded split sleeve
- Box-type enclosures designed by the piping engineer
- Fillet welding a split coupling or plate patch over an area of local corrosion
- Bolted leak clamps (design must consider pressure thrust)



Temporary Repairs

- Repair of piping with longitudinal cracks should not be commenced unless the piping engineer determines that the crack will not propagate from under the sleeve or enclosure.
- Temporary repairs shall be replaced with permanent repairs at the next available maintenance opportunity

Fabrication and Examination

- The inspector shall verify that the materials are consistent with the selected or specified construction materials
- Qualifications and procedures are generally required to be in accordance with ASME B31.3, or the code to which the piping was originally constructed
- Some exceptions are provided for weld preheat and PWHT
- Examinations are required to be in accordance with ASME B31.3, or the code to which the piping was originally constructed

Leak Testing

- Normally required after alterations or major repairs
- The decision as to whether or not to pressure test is by the inspector, considering practicality and necessity
- Final closure joints may be exempted from pressure testing, conditional on design, radiographic or ultrasonic examination, and additional requirements

Rerating

Piping may be rerated. Requirements include:

- Calculations must be performed by the piping engineer that demonstrate that the pipe is acceptable for the new conditions
- If the prior leak test was not sufficient for the new conditions, a new leak test is required
- Current inspection records must verify that it is acceptable for the new service
- Piping flexibility must be adequate for the new conditions