ASME B31.3 Process Piping

Check out this website: EngineeringToolBox.com

Objectives

In this course, we will discuss:

- API 570 Piping Inspection Code
- Responsibilities
- What to Inspect
- Types of Inspections
- Inspection Practices
- Frequency and Extent of Inspection
- Remaining Life Calculation
- Repairs and Alterations
- Rerating

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
- Last edition was 21012

API 570 Piping Inspection Code

- Includes flammable and toxic services and excludes:
  - Water, steam, steam-condensate, boiler feed water and Category D fluid service
  - Piping systems that are an integral component of rotating or reciprocating mechanical devices
  - Piping or tubing with and OD ≤ NPS ½
  - Nonmetallic piping and polymeric or glass-lined piping
  - Plumbing
  - Fire heater and boiler internals are also excluded
- THESE CAN BE INCLUDED AT THE OWNER-USER'S DESCRETION.

Responsibilities

- Owner-User: 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

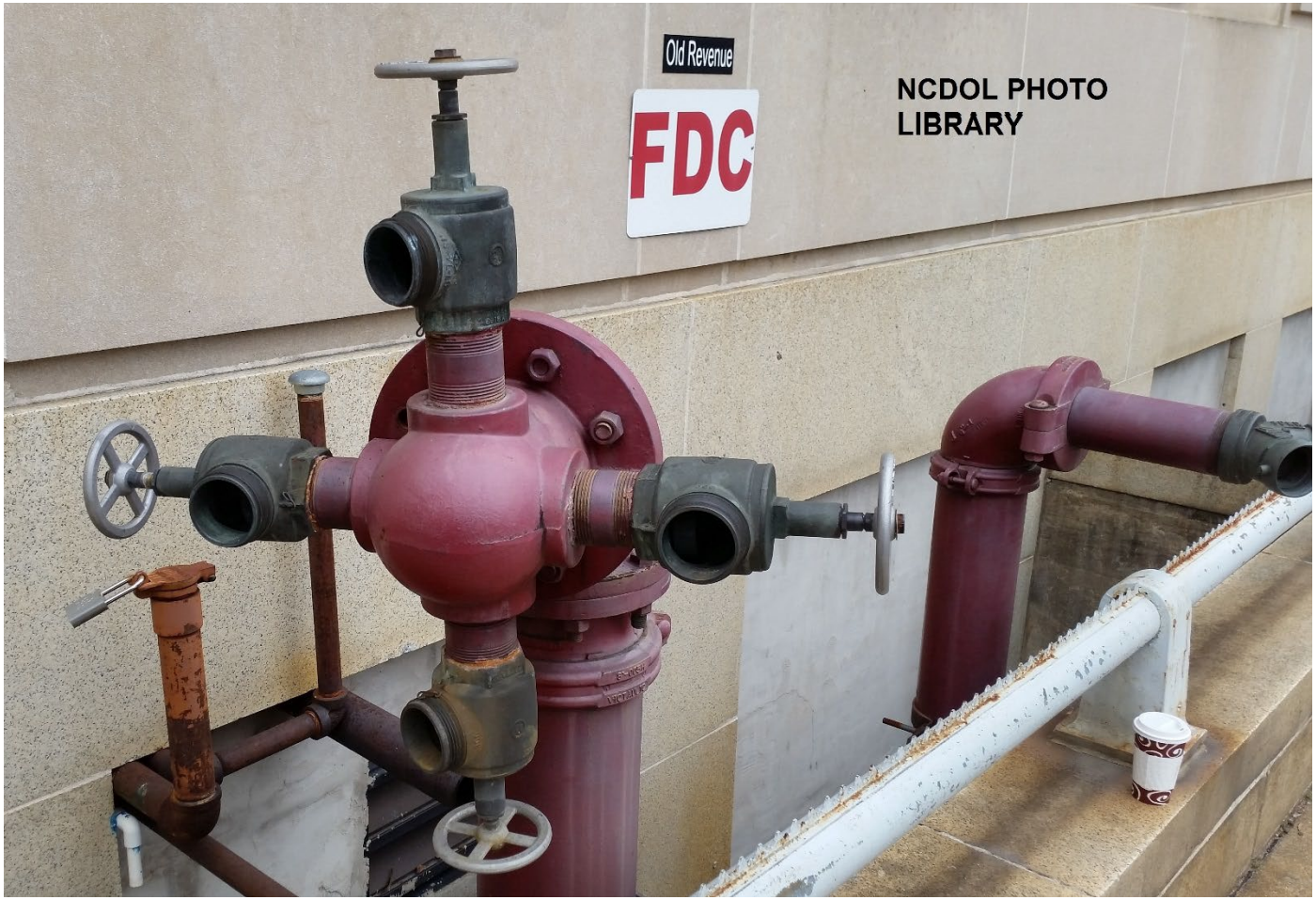
Responsibilities

- 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 determine that the inspection, examination and testing requirements of API 570 are met. Experience and education qualifications are specified in Appendix A of API 570.

Types and areas of deterioration

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

Remember API 570 doesn't cover eveything



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External Inspection Checklist

- Leaks
  - Process
  - Steam Tracing
  - Existing Clamps
- 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
  - Bottom-out springs
  - Brace distorsion/breakage
  - Loose brackets
  - Side plates/rollers
  - Counter balance condition
  - Support corrosion

External Inspection Checklist

- Corrosion
  - Bolting support points under clamps
  - Coating/painting deterioration
  - Soil-to-air interface
  - Insulation interfaces
  - Biological growth
- Insulation
  - Damage/penetrations
  - Missing jacketing/insulation
  - Sealing deterioration
  - Bulging
  - Banding (broken/missing)

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Types of Inspections

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

Types of Inspections

- Internal visual inspection is not normally used for most piping systems
- May be used for very large diameter piping
- May use remote viewing
- Usually performed with scheduled maintenance or when an opportunity presents itself

Types of Inspections

- Thickness is measured via ultrasonic thickness gauging (UT) or radiography
  - UT for pipe > NPS 1
  - Radiography for ≤ NPS 1
- Minimum thickness should be determined and recorded
- Locations of Thickness Measurements Location (TMLs) should be recorded on the drawing and marked on the pipe to permits repetitive measurements

Thickness Measurement Locations

- Always include the following:
  - Measurements in all four quadrants of pipes and fittings
  - Include inside and outside radius of elbows and tees where corrosion/erosion could increase rate of metal loss
  - Include areas of corrosion under insulation, soil/air interfaces, and other areas of localized or general corrosion

Thickness Measurement Locations

- There are NO specific guidelines for the number of TMLs conducted in API 570

- Conduct more inspections when there is:
  - Higher potential for an emergency in the event of a leak
  - Higher expected or experienced corrosion rates
  - Higher potential for localized corrosion
  - Complex fittings, branches, dead legs, inspection points, and like fittings
  - Higher potential for corrosion under insulation (CUI)

External Visual Inspection

- Performed to determine the condition of the outside of the piping, insulation system, painting and coating systems, and associated hardware

- Check for:
  - Misalignment, vibration, leakage
  - Cracked or broken hangars, bottomed-out spring support, support shoes displaced from members
  - Bellows expansion, deformation, misalignment, or displacement
  - Components that are unsuitable for long-term use

External Visual Inspection

- Vibrating or swaying pipe
- Supplementary inspection should be specified when needed to assess the condition of piping.
  - Thermography for hot spots
  - 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 rerating
- Valves: TMLs are not normally required on valves due to their greater wall thickness, but valve thickness should generally be checked when removed for service.
- Welds: Not required to meet the radiographic acceptance criteria for new construction random radiography

Inspection Practices

- Defects resulting from environmental cracking shall be assessed by the piping engineer
- Defects from original weld fabrication should be inspected using one or more of the following:
  - Inspector judgment
  - Certified welding inspector judgement
  - Piping engineer judgement
  - Engineering fitness-for-service analysis

Inspection Practices: Flange Joints

- Potential causes of leaks in a flange joint include:
  - Uneven bolt tightening
  - Imprpooer flange alignment
  - Excessive external moments from piping
  - Imprpoer gasket placement
  - Improper, dirty or damaged flange facing finish
  - Improper gasket type or size
  - Pre-compressed gasket
  - Thermal shock
  - Bolt relaxation
  - Differential expansion between bolts and flanges

Frequency and Extent of Inspection

- Inspection strategy based on likelihood and consequence of failure
- API 570 has 3 classes for defining consequence of failure
- Owner/user may come up with a more extensive classification that addresses the consequence of failure

API 570 Classes for Consequence of Failure

- Class 1: Greatest hazard (safety or environmental) should a leak occur
- Class 2: Includes services that are not Class 1 or Class 3
- 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

Inspection Intervals

- Considerations for setting inspection intervals:
  - Corrosion rate and remaining life calculations
  - Piping service classification
  - Applicable jurisdictional requirements
  - Judgement based on operating conditions, previous inspection history, current inspection results, and conditions that may warrant supplemental inspections

Inspection Intervals

- Inspection Intervals should not exceed ½ the calculated remaining life or that shown in the following table:

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

Table 6-1 from API 570

CUI Inspection Intervals

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

	Areas with Damaged Insulation	Suspect Ares 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

t_{actual} = The actual minimum thickness

Corrosion rate is determined based on thickness measurements.

Remaining Life Calculation

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

Where:

$t_{initial}$ = 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
- With unknown materials, use the lowest grade of material and joint efficiency in the applicable code
- To calculate 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

- Based on pressure, mechanical, and structural considerations using the correct design parameters and stress allowable by code

- When high potential consequences are present, engineers should consider increasing the required minimum thickness above the calculated minimum thickness
  - Unknown or unanticipated loads
  - Undiscovered metal loss
  - Resistance to abuse-

Assessment of Inspection Findings

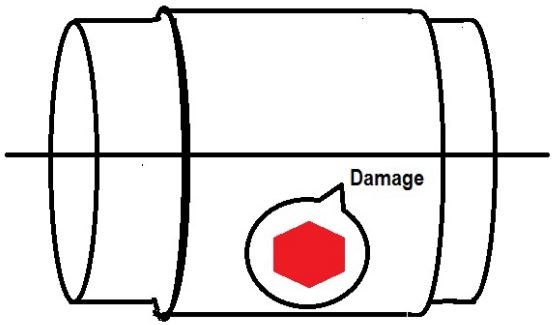
- Pressure containing components with degradation that could affect the load carrying capability shall be evaluated for continued service.
- Fitness-for-service techniques, such as those documented in API RP 579 and ASME B31G may be used for this evaluation
- Local wall thinning below the required minimum 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 shouldn't 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

- Verify that the materials are consistent with the selected or specified construction materials
- Qualifications and procedures follow ASME B31.3 or the original piping construction code
- Some exceptions are provided for weld preheat and Pre-weld heat Treat
- Examinations should follow ASME B31.3 or the original piping construction code

Leak Testing

- Normally required after major repair or alteration
- The inspector may determine whether to pressure test considering practicality and necessity
- Final closure joints may be exempted from pressure testing depending on the design, radiographic or ultrasonic examination, and additional requirements

Rerating

- Piping may be rerated. Requirements include:
  - Calculations must e performed by the piping engineer to 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

Summary

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Thank You For Attending!

Final Questions?

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(1-800-625-2267)

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