Process Safety Management: Inspection for Mechanical Integrity

Presented by:
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Inspection for Mechanical Integrity – Applying Industry Standards to meet inspection requirements, most specifically those developed by the American Petroleum Institute (API)
Process Safety Management

- Process Safety Management (or PSM) is a program based on OSHA’s Hazard Communications Standard
- The PSM standard applies to companies that deal with:
  - Any of more than 130 specific toxic and reactive chemicals in listed quantities
  - Flammable liquids and gases in quantities of 10,000 pounds or more
- Was required to start by May 26, 1994 and fully implemented (in terms of evaluation) by May 26, 1997
The owner/operator of a facility determines site applications through the performance of a Process Hazard Analysis (PHA), and compiling written process safety information. From the point of view of the process and associated information, this should include:
Information on the hazards of the highly hazardous chemicals in the process shall consist of at least the following:

- Toxicity,
- Permissible exposure limits,
- Physical data,
- Reactivity data,
- Corrosivity data, and
- Thermal and chemical stability data, and hazardous effects of inadvertent mixing of different materials.
Application

Information on the technology of the process must include at least the following:
• A block flow diagram or simplified process flow diagram,
• Process chemistry,
• Maximum intended inventory,
• Safe upper and lower limits for such items as temperatures, pressures, flows or compositions, and
• An evaluation of the consequences of deviations, including those affecting the safety and health of employees.
Information on the equipment in the process must include the following:

- Materials of construction,
- Piping and instrument diagrams (P&IDs),
- Electrical classification,
- Relief system design and design basis,
- Ventilation system design,
- Design codes and standards employed,
- Material and energy balances for processes built after May 26, 1992, and
- Safety systems (e.g., interlocks, detection, or suppression systems).
Mechanical Integrity

• PSM is really a mechanical integrity program
• PSM mechanical integrity requirements apply to the following equipment:
  • Pressure vessels and storage tanks;
  • Piping systems (including piping components such as valves);
  • Relief and vent systems and devices;
  • Emergency shutdown systems;
  • Controls (including monitoring devices and sensors, alarms, and interlocks); and
  • Pumps.
• Inspection and testing must be performed on process equipment, using procedures that follow recognized and generally accepted good engineering practices.
• The frequency of inspections and tests of process equipment must conform with manufacturers’ recommendations and good engineering practices, or more frequently if determined to be necessary by prior operating experience.
The petroleum industry began developing formal standards for inspection in the late 1980’s, releasing the first standard, API 653 in 1992.

The primary inspection standards applied include:
• API 653 for the inspection of bulk storage tanks
• API 570 for the evaluation of piping
• API 510 for the evaluation of pressure vessels

These standards have been widely applied outside of the petroleum industry, to industry in general, especially the chemical and utility sectors.
Primarily applies to field erected tank, though can be used for factory fabricated tanks.

The standard establishes inspection requirements, visual inspection checklists, applicable non-destructive testing, and a means to determine inspection intervals.

Provides the for determination of inspection intervals based on corrosion rates and minimum remaining thicknesses.
Typical Application includes bulk storage of:

- Fuel oil, gasoline or other petroleum products
- Process chemicals including solvents, acids or caustics
- Waste products from the process
- Waste water prior to or after treatment, or also as a treatment process vessel
- Clean or potable water
Inspections typically include:
• Visual inspection per a defined checklist
• Non destructive testing of the tank, including:
  • Ultrasonic thickness gauging of the shell, floor and appurtenances such as nozzles,
  • Magnetic Flux Leakage Floor Scanning: a means to evaluate a large percentage of the floor area for localized corrosion, especially on the soil side
  • Leak testing of floor lap welds by vacuum box testing
  • Magnetic Particle or Dye Penetrant testing as necessary
  • Settlement surveys to evaluate orientation and foundation conditions
Data from the report is complied and evaluated in accord with the standard. Thickness data is used to establish corrosion rates and compute inspection intervals in reference to the minimum remaining thicknesses (MRT) as defined in the standard.
Inspection Intervals:
• In-service (external) – every 5 years or half corrosion rate life, whichever is less
• Out-of-service (comprehensive internal and external) – every 20 years or corrosion rate life to the floor MRT
Developed to provide a standard for the inspection of product piping in bulk storage facilities (tank farms), refineries and chemical facilities

Extended widely to various processes, power generation facilities and transmission and distribution piping

Standard implements focused inspection to identify and evaluate for specific modes and areas of failure: early “risk-based” inspection.
API 570 – Piping

Implements various forms of visual and non-destructive testing, focusing on likely points of failure. These areas include:

- Soil-air interfaces (the transition point from underground to above ground piping)
- Corrosion under insulation (CUI)
- Dead-leg corrosion
- Etc.
Classifies piping by “risk” with those lines generating the highest potential of creating an immediate emergency receiving the most frequent inspection.

The risk parameters include:
• High-hazard chemicals in terms of danger to personnel and/or environment
• Likelihood of reaching waterways or public throughways
The available inspection data (including ultrasonic thickness, pitting depth and other visual inspection results) are evaluated for corrosion rate, and compared to calculated minimum thicknesses based on pressure capacity and/or likely perforation time frame.
Inspection interval determinations are based on:

- Corrosion rate and remaining life calculations
- Piping service classifications
- Applicable jurisdictional regulations and requirements
- Judgment of the inspector, engineer, corrosion specialist and owner.
This standard further extends the concept of risk-based inspection to allow for focusing of the inspection effort. In additional, the standard extends beyond API: ASME and API join to provide a general standard for non-fired pressure vessels. The API 510 Standard is also an ANSI standard.

Based on this standard, the inspector and engineer are given more tools to evaluate maximum allowable working pressure (MAWP) and other pressure vessel design parameters.
Primarily intended to inspect vessels designed to applicable standard, such as the ASME Boiler & Pressure Vessel Code, but can be extended to non-standard vessels.

Examples of vessels might include:
• Steam storage tanks such as for feed water, de-aerator and condensate tanks. High-temperature hot water may also be affected.
• Pressurized chemical tanks such as ammonia.
• Hydraulic vessels.
Air storage tanks, while not generally defined as under PSM requirements, are increasingly being included in facility inspection programs.

This may include:

• Air-start and instrumentation vessels
• Air service vessels such as those used to power tools
Implements the generation of an inspection plan that is to include:

- Defining the types of inspection required, e.g. external, internal
- Identify the next inspection date for each inspection type
- Describe the inspection and NDT techniques
- Describe the extent and location of inspection and NDT
- Describe the surface cleaning requirements for inspections and examinations
- Describe the requirements for any needed pressure, e.g. type of test, test pressure and duration
- Describe any required repairs
The results of ultrasonic thickness data, pressure tests and visual inspection are calculated for corrosion rate and compared the required thickness for the MAWP of the vessel and heads. The intervals shall not exceed one half of the remaining life of the vessel or 10-years, whichever is less.

Risk Based Inspection (RBI) techniques for inspection and remaining life can also be applied at the discretion of the inspector, pressure vessel engineer and owner.

Local regulations for pressure vessels may apply and affect inspection intervals.
Preparring for an inspection

The ability to complete an inspection safely and accurately, especially and internal inspection, can be effected by many factors

Proper preparation is essential!
A team experienced in cleaning above ground storage tanks, including having knowledge of the material stored, best performs the tank cleaning. Many times this is a tank-cleaning contractor. The cleaning not only requires the removal of all product, but the removal of all sludge, scale, or other material that might prevent the inspector from seeing the metal or non-metallic material that is the tank. This may mean that the tank floor and lower shell should be sand blasted or high pressure water-blasted. Note that a high-pressure water blast is typically performed at 10,000 PSI or over, and not with the typical equipment available from the local home or rental center. Remember: You can’t inspect what you can’t see!
Please strongly consider having the cleaning reviewed by a Certified Marine Chemist or other qualified Industrial Safety professional. These professionals can provide review of the cleaning results, increase the likelihood of a safe project completion, and note any special site or equipment requirements. This is especially important for tanks storing something other than light distillate petroleum products.
While the PCA Engineering field team will complete their own Confined Space Entry Permit, we will abide by your requirements, as well. As the owner/operator of the confined space, OSHA dictates that your program designate the responsibility of the entrant, attendant, supervisor and rescue personnel.

- When retaining a repair company, please ensure that the firm and their site supervisor are qualified to meet API 650, 653 and ASME Section VIII standards. All work must be completed to meet these standards in order to provide your facility the best service and meet regulatory obligations.
In addition to the regulation, the following documents provide guidance and reference materials:

- OSHA 3132 – Process Safety Management
- OSHA 3133 – Process Safety Management Guidelines for Compliance
- API 653 – Tank Inspection, Repair, Alteration and Reconstruction
- API/ANSI 510 – Pressure Vessel Inspection Code: In-Service Inspection Rating, Repair, and Alteration
- API 570 - Inspection, Repair, Alteration, and Re-Rating of In-Service Piping Systems
Thanks for Your Attention and Interest!

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