Addressing Common PSM Audit Findings
Part 3 – Mechanical Integrity Issues[1]

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Introduction

This is Part 3 of a series addressing common process safety audit findings found in multiple industries. Part 1 addressed safe limits and operating limits [1] and Part 2 addressed operating procedures, training, and safe work [2]. Guidance on typical audit findings and how they can be avoided through appropriate understanding and implementation of the relevant regulatory requirements is provided.

As discussed in Part 1, process safety audits [3, 4] are conducted for two main reasons:

(1) Feedback on process safety program implementation and effectiveness to identify potential improvement opportunities for improved performance

(2) Compliance with process safety regulations such as OSHA's 29 CFR 1910:119 Process Safety Management (PSM) Standard and EPA's 40 CFR 68 Risk Management Program (RMP) Rule

If a facility has a process covered by these regulations, compliance audits must be conducted every 3 years.

MI [5,6] is intended to help ensure continued safe and reliable operation of equipment associated with a hazardous process, based on (1) documented design and process safety information (PSI), (2) maintenance practices associated with recognized and generally accepted good engineering practices (RAGAGEPs), such as American Petroleum Institute (API) recommended practices, and (3) the appropriate evaluation and management of process risks. Equipment malfunction or failure and loss of containment can lead to equipment downtime, process upsets, quality problems, and perhaps significant process safety incidents, including personnel injury, equipment damage, and environmental harm. This paper (1) addresses several of the most frequently observed audit findings related to MI and (2) provides guidance on how appropriate implementation of requirements for the PSM elements can improve compliance and ultimately contribute to safe operations and manufacturing excellence. Typical audit findings are shown in Tables 1a/b.

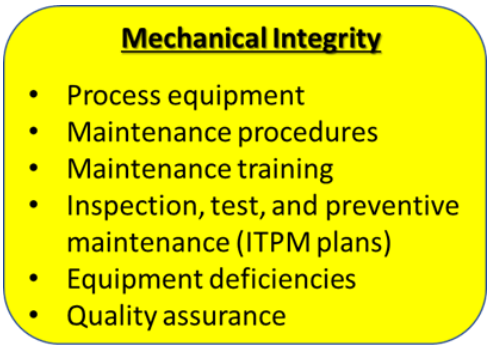
Requirements/Background

MI programs are implemented to protect against equipment failure or malfunction, such as failure of process vessels and piping, that can lead to the release of hazardous chemicals. Loss of containment can lead to exposure to toxic chemicals, fires and explosions, significant equipment damage, and environmental harm [7]. Equipment failure, even without loss of containment or other potential hazardous events, can also lead to process downtime, productivity issues, and supply chain disruptions. MI programs consist of several major parts, as shown in Figure 1. The OSHA MI regulatory requirements are shown in Table 2 (EPA's requirements are similar), and they have issued supplemental guidance on use of RAGAGEPs as part of PSM programs [8].

The scope of MI programs is typically very broad, encompassing most, if not all, equipment in a hazardous process that contains hazardous materials. For example, consider how much equipment may be installed at a chemical plant or refinery that must be properly maintained as part of the MI program. Process equipment included in the MI program is generally identified as part of the PSI documentation, which may

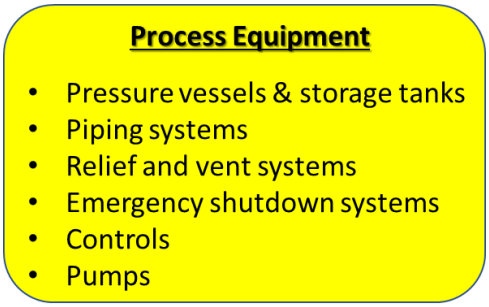
label equipment "PSM critical" or some other term to designate that the equipment (1) typically contains hazardous materials, (2) is a safeguard identified in the process hazard analysis (PHA), (3) is part of another safety system intended to help prevent or mitigate hazardous events, and/or (4) is covered by RAGAGEP requirements.

Figure 1 – MI Program Requirements



Process equipment considered PSM critical is incorporated in the MI program via inspection or test procedures. Developing maintenance procedures and training mechanics and other maintenance personnel are therefore part of the MI program. Equipment specifically identified in the OSHA PSM standard that must be included is shown in Figure 2, but this should be considered a starting point based on the various types of equipment that may be present in a facility. A key part of the MI program is the documentation of the inspection, testing, and preventive maintenance (ITPM) plan, as shown in Table 3, which identifies the equipment included in the MI program and the inspection and testing requirements, based on RAGAGEPs, manufacturers' recommendations, PHA or other risk evaluation requirements, and/or required operating practices. Examples of RAGAGEPs are provided in Table 4.

Figure 2 – Required process equipment types



Common Issues Observed in PSM Audits

Following are examples of some of the common issues with MI that have been observed in PSM compliance audits:

1. General MI Program

Some facilities may have implemented preventive maintenance practices but have not developed fully documented MI programs as required by the regulations. In other cases, all the equipment associated

with the covered process may not have been identified and included in the MI program. Gaps in the program may be identified by review of the regulatory requirements, auditor review of facility PSI (e.g., equipment files, safe limits tables, safety system and emergency response equipment), and/or auditor knowledge of RAGAGEPs. In addition, auditor review of PHAs may help identify safeguards that have been credited for helping to prevent or mitigate the consequences of potentially hazardous scenarios, but which have not been included in the MI program.

Guidance: Ensure equipment associated with covered processes has been broadly reviewed for possible inclusion in the MI program, based on regulatory requirements, PSI documentation, PHA review, and RAGAGEP requirements. Consider identifying "PSM critical" equipment as part of the PSI equipment documentation, based on the potential consequences of equipment failure or malfunction. Document equipment types and the requirements for each in the ITPM plan (see below).

2. Maintenance Procedures

In many cases, maintenance procedures have not been developed and documented for equipment associated with the covered processes to ensure that ITPM activities are conducted appropriately and consistently by qualified personnel with proper documentation of the results. In some cases, procedures may be available from the manufacturer but have not been implemented in the procedures that have been developed. Maintenance procedures may also not be provided for common maintenance activities, such as equipment lubrication or calibration or to address RAGAGEPS requirements. Procedural gaps and lack of direction or training for maintenance personnel can result in ineffective inspection, testing, or other maintenance activities, leading to higher risk of equipment failure and hazardous incidents. Missing test activities can lead to poor evaluation and follow up on equipment needing attention. Missing or poorly documented historical test data can also prevent proper evaluation of reoccurring operating issues and remaining equipment life.

Guidance: Develop maintenance procedures for all required process equipment and work tasks based on manufacturer guidance and any related RAGAGEP requirements. Ensure procedures are specified for specific inspection and testing tasks and include requiring proper documentation.

3. Maintenance Training

Failure to provide training on an overview of the process and its hazards is a common finding. OSHA requirements are for maintenance personnel to be trained on the hazards related to equipment they are working on as well as the applicable MI procedures. This issue is more often observed with maintenance shops considered "central maintenance" facilities where all mechanics/technicians are part of one group and are dispersed throughout a large plant to different PSM-covered areas rather than being dedicated to a limited number of processes. Some of the reasons for this include (1) not receiving all required training when newly hired, (2) the plant added a new process area and failed to provide overview training to all maintenance personnel, or (3) personnel were operators in a particular part of the plant and changed position to maintenance technicians and were not subsequently trained on other areas in the facility

Training must also be provided on the maintenance procedures, safe work practices, and use of special tools or equipment, as needed. In some cases, specific tests or inspections require the use of certified inspectors per the RAGAGEP, and appropriate certifications must be obtained or qualified external inspectors brought in to conduct the activity. In addition, maintenance personnel should be trained on

emergency response plans and management of change (MOC) procedures. Although not required specifically by the MI element, proper documentation of the training provided should be maintained. Refresher and/or special skill training should also be provided as needed.

Guidance: Develop a maintenance training program to ensure training is provided in all required areas. Documentation, including verification of understanding, should be considered. Increasingly, trade or trade school training is being considered a prerequisite for being hired into maintenance roles. Based on required work activities, the development and training of internal certified inspectors should also be considered and addressed.

4. ITPM Plans

Findings related to development and implementation of ITPM plans often include:

- No ITPM plan
- Incomplete or incorrect ITPM plan (missing equipment types or relevant RAGAGEPs)
- Inspection not done or not done on the required frequency
- Inspection not done using approved maintenance procedure
- Inspection not done by trained maintenance personnel or qualified/certified inspectors
- Poor documentation of inspection results
- No review and/or follow up of inspection results, including corrective actions or program adjustments

Common findings for different types of equipment are provided in Tables 5 through 9.

Guidance: Document an ITPM plan, using approved tests and inspections, to maintain required equipment. The elements of an effective ITPM plan are provided in Table 3, and an example is shown in Figure 3. In addition, have a process for identifying when RAGAGEP requirements have been changed and for evaluating the needed updates, if any, to the ITPM plan and MI program.

Figure 3– Example of an ITPM Plan

Equipment/ Item	Inspection	Frequency	Basis	Procedure
Reactor 101	External visual	2 yrs (5 yrs)	ABC Chemical Procedure XYZ (API 510)	Work Instruction PV-I-001
Reactor 101	Internal visual	10 yrs	ABC Chemical Procedure XYZ and API 510	Work Instruction PV-I-002
Hi-hi interlock R-101	Functional test	2 yrs	ABC Chemical Procedure XYZ	Work Instruction INST-I-001
Pump 101 discharge piping	UTT	10 yrs	API 570 for corrosion life > 20 yrs	Work Instruction PIP-I-002
Pump 101 discharge pumping	Visual	3 yrs	Plant experience (See PHA 96-03 page A-27)	Work Instruction PIP-I-001

5. Equipment Deficiencies

Many sites have not developed a formal program to (1) review equipment deficiencies and (2) ensure proper steps are taken to respond to issues such as leaks, failed inspections, reaching minimum allowed thickness (Tmin), operating beyond operating or safe limits, failed welds, etc. These situations must be managed to ensure the integrity of the equipment and safety of personnel. The equipment deficiency program should consider if equipment must be (1) shut down until fixed, (2) run at lower operating rates (temporarily or permanently), (3) possibly bypassed until repair or a replacement part is obtained (typically temporarily), or (4) replaced. The program should also ensure that the proper risk assessments are made, documentation is provided, and appropriate authorization is received. Fitness-for-service evaluations, based on historical operating and inspection data, may need to be conducted, especially if frequent problems have occurred.

Guidance: Document an equipment deficiency program for responding to equipment operating or inspection deficiencies, which should include proper documentation of the path forward (e.g., bypass authorization procedures, temporary MOC for modified, equipment shutdown/repairs), review, and authorization to proceed.

6. Quality Assurance

Many sites have no quality assurance (QA) program in place as required by the MI element. Some may have corporate directives that direct the site to establish a QA program or provide additional guidance on specific practices, but this is often observed to be only partly implemented or not specific to site needs and practices. Documentation that appropriate checks and inspections are being conducted during equipment fabrication and installation is often not available or incomplete. Material verification programs are not provided, may not be documented, or are inconsistent or ineffective. A wide range of approaches has been observed related to the availability and organization of equipment spare parts from typical warehousing controls to specialized spare parts programs. Lack of correct spare parts can lead to imperfect maintenance and operating decisions when equipment failures occur.

Guidance: Document a QA program for equipment fabrication or receipt that includes inspection, verification, and installation procedures and maintains appropriate spare parts inventories and controls.

Summary

The scope and requirements related to effective MI programs are complex and detailed, such that MI is often one of the elements with the most audit findings. In particular, lack of detailed knowledge of relevant RAGAGEPs can lead to poor design of ITPM plans and therefore poor implementation of MI requirements. If the MI program has faults, as identified in an audit, it is very likely that at least some of the following issues will be observed:

- Some PSI equipment documentation may be missing or poorly organized, impacting MI program scope and effectiveness
- Not all required process and facility equipment has been included in the MI program
- Maintenance procedures have not been developed
- Effective maintenance training has not been provided
- Inspections and test are not being conducted or conducted at the right frequency
- Poor documentation is maintained
- Equipment deficiencies are not properly evaluated or followed up on

- QA program is not developed

We hope that the information provided in this paper will help you better evaluate this important part of your PSM program for improved regulatory compliance and continued safe and reliable operation.

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References

1 J.A. Klein and J.R. Thompson, "Addressing Common PSM Audit Findings: Part 1, Operating/Safe Limits Tables," Chemical Processing, (add when known)

2 J.R. Thompson and J.A. Klein, ""Addressing Common PSM Audit Findings: Part 2, Procedures, Safe Work Practices, and Training," Chemical Processing, (add when known)

3 Center for Chemical Process Safety, Guidelines for Auditing Process Safety Management Systems, 2nd Edition, John Wiley & Sons, 2011

4 Center for Chemical Process Safety, Guidelines for Risk Based Process Safety, John Wiley & Sons, 2007.

5 Center for Chemical Process Safety, Guidelines for Asset Integrity Management, Wiley-AIChE, 2016

6 Center for Chemical Process Safety, Dealing with Aging Process Facilities and Infrastructure, Wiley-AIChE, 2018

7 J.A. Klein and S. Dean, "Develop a Loss-of-Containment Reduction Program," CEP, p. 35-40, June, 2020

8 OSHA, RAGAGEP in Process Safety Management Enforcement, www.osha.gov/laws-regs/standardinterpretations/2016-05-11-0, 2016

Table 1a – Typical MI Audit Findings

Requirement	Audit Findings	Recommendations
1910.119(j)(1) Application. Paragraphs (j)(2) through (j)(6) of this section apply to the following process equipment: (i) Pressure vessels and storage tanks; (ii) Piping systems (including piping components such as valves); (iii) Relief and vent systems and devices; (iv) Emergency shutdown systems; (v) Controls (including monitoring devices and sensors, alarms, and interlocks); and pumps.	**MI-1:** Not all equipment in the PSM processes is accounted for in the site's maintenance program.	**MI-1-R:** Consider (1) validating all equipment in the PSM-covered processes, (2) establishing equipment records in maintenance software, as needed, and (3) assigning preventive maintenance (PM) tasks to ensure all equipment will be maintained per the applicable RAGAGEP.
1910.119(j)(2) Written procedures. The employer shall establish and implement written procedures to maintain the ongoing integrity of process equipment.	**MI-2:** No maintenance procedures are developed for maintenance tasks in the PSM-covered processes.	**MI-2-R:** Consider developing maintenance procedures for all maintenance tasks being performed in the PSM-covered processes.
1910.119(j)(3) Training for process maintenance activities. The employer shall train each employee involved in maintaining the ongoing integrity of process equipment in an overview of that process and its hazards and in the procedures applicable to the employee's job tasks to assure that the employee can perform the job tasks in a safe manner.	**MI-3:** Maintenance personnel have not received training on overviews of the PSM-covered processes and their hazards. .	**MI-3-R:** Consider providing training on overviews of the PSM processes and their hazards to all maintenance personnel. Also, once procedures are developed, ensure training on them is provided to maintenance personnel who will perform these job tasks.

Table 1b – Typical MI Audit Findings - continued

Requirement	Audit Findings	Recommendations
1910.119(j)(4) Inspection and testing. (i) Inspections and tests shall be performed on process equipment. (ii) Inspection and testing procedures shall follow recognized and generally accepted good engineering practices. (iii) The frequency of inspections and tests of process equipment shall be consistent with applicable manufacturer's recommendations and good engineering practices, and more frequently if determined to be necessary by prior operating experience. The employer shall document each inspection and test that has been performed on process equipment. The documentation shall identify the date of the inspection or test, the name of the person who performed the inspection or test, the serial number or other identifier of the equipment on which the inspection or test was performed, a description of the inspection or test performed, and the results of the inspection or test.	**MI-4:** Several inspections are overdue within the PSM units per the ITPM plans. RAGAGEPs have not been reviewed and the proper interval has not been applied per the RAGAGEP that applies to the equipment.	**MI-4-R:** Consider validating equipment inspection and test requirements/frequencies in maintenance software to ensure all equipment is accounted for and receiving the proper inspections and tests per the equipment RAGAGEP requirement. Update the ITPM plan accordingly.
[1910.119(j)(5)]. Equipment deficiencies. The employer shall correct deficiencies in equipment that are outside acceptable limits (defined by the process safety information in paragraph (d)) before further use or in a safe and timely manner when necessary means are taken to assure safe operation.	**MI-5:** The site does not have an active equipment deficiency program.	**MI-5-R:** Consider developing an equipment deficiency program to properly manage equipment deficiencies when they are identified, including equipment issues and past-due ITPM activities.
[1910.119(j)(6)]. Quality assurance. (i) In the construction of new plants and equipment, the employer shall assure that equipment as it is fabricated is suitable for the process application for which they will be used. (ii) Appropriate checks and inspections shall be performed to assure that equipment is installed properly and consistent with design specifications and the manufacturer's instructions. (iii) The employer shall assure that maintenance materials, spare parts and equipment are suitable for the process application for which they will be used.	**MI-6:** The site does not have an active quality assurance (QA) program as part of the MI program.	**MI-6-R:** Consider developing a QA program to ensure quality assurance is applied to newly fabricated equipment to ensure (1) its suitability for the process, (2) appropriate checks and inspections are being performed, and (3) it is installed correctly and meets design specification. Ensure maintenance materials, spare parts, and equipment are suitable for the process application for which they will be used.

Table 2 – OSHA 29 CFR 1910.119 (PSM) Requirements for Mechanical Integrity

1910.119(j)(1) Application. Paragraphs (j)(2) through (j)(6) of this section apply to the following process equipment: (vi) Pressure vessels and storage tanks; (vii) Piping systems (including piping components such as valves); (viii) Relief and vent systems and devices; (ix) Emergency shutdown systems; (x) Controls (including monitoring devices and sensors, alarms, and interlocks); and (xi) Pumps.
1910.119(j)(2) Written procedures. The employer shall establish and implement written procedures to maintain the ongoing integrity of process equipment.
1910.119(j)(3) Training for process maintenance activities. The employer shall train each employee involved in maintaining the ongoing integrity of process equipment in an overview of that process and its hazards and in the procedures applicable to the employee's job tasks to assure that the employee can perform the job tasks in a safe manner.
1910.119(j)(4) Inspection and testing. (ii) Inspections and tests shall be performed on process equipment. (ii) Inspection and testing procedures shall follow recognized and generally accepted good engineering practices. (iv) The frequency of inspections and tests of process equipment shall be consistent with applicable manufacturer's recommendations and good engineering practices, and more frequently if determined to be necessary by prior operating experience. The employer shall document each inspection and test that has been performed on process equipment. The documentation shall identify the date of the inspection or test, the name of the person who performed the inspection or test, the serial number or other identifier of the equipment on which the inspection or test was performed, a description of the inspection or test performed, and the results of the inspection or test.
[1910.119(j)(5)]. Equipment deficiencies. The employer shall correct deficiencies in equipment that are outside acceptable limits (defined by the process safety information in paragraph (d)) before further use or in a safe and timely manner when necessary means are taken to assure safe operation.
[1910.119(j)(6)]. Quality assurance. (i) In the construction of new plants and equipment, the employer shall assure that equipment as it is fabricated is suitable for the process application for which they will be used. (ii) Appropriate checks and inspections shall be performed to assure that equipment is installed properly and consistent with design specifications and the manufacturer's instructions. (iii) The employer shall assure that maintenance materials, spare parts and equipment are suitable for the process application for which they will be used.

Table 3 – Elements of an Effective ITPM Program (adapted from [5,7])

Equipment / Item – Specific equipment items or general equipment classes (based on function, design, and type). The general equipment classes include equipment items in the same or similar service, where the ITPM tasks are substantially the same.

Inspection – Tasks that have been determined by the applicable codes and standards, manufacturers' recommendations, industry practice, and/or the equipment's performance history.

Frequency – The interval within which the ITPM task is to be completed. The interval is generally based on the shortest time specified in the applicable codes and standards or manufacturers' recommendations, and/or on industry practices. The interval provided is intended to be the initial interval assigned to the equipment. Previous and future experience or inspection data may require that the interval be adjusted for specific pieces of equipment.

Basis – The applicable codes and standards, manufacturers' recommendations, and equipment performance histories used to establish the appropriate ITPM tasks and their corresponding frequencies.

Procedure(s) – Allows a company to document site-specific procedure(s) or vendor-supplied documentation (e.g., equipment manual, checklists) associated with the required task.

Inspection Personnel Qualification (if needed) – Normally lists any certifications or training required by the applicable code or standard. When there is no applicable code or standard, the general knowledge required for the task is listed such as mechanic, technician, operator, etc.

Table 4 – Examples of RAGAGEPs (not complete list)

- **ANSI/NB-23** — National Board Inspection Code. Used as the basis for ITPM tasks and frequencies for boilers, pressure vessels, and pressure relief devices (i.e., pressure safety valves and rupture disks).
- **ANSI Z358.1** — American National Standards Institute Z358.1. Used as the basis for ITPM tasks and frequencies for safety showers and eyewash stations.
- **API 510** — American Petroleum Institute Standard 510. Used as the basis for ITPM tasks and frequencies for pressure vessels and associated relief valves.
- **API 570** — American Petroleum Institute Standard 570. Used as the basis for ITPM tasks and frequencies for piping systems.
- **API RP 573** — American Petroleum Institute Recommended Practice 573. Used as the basis for ITPM tasks and frequencies for fired boilers and heaters.
- **API RP 576** — American Petroleum Institute Recommended Practice 576. Used as the basis for ITPM tasks and frequencies for pressure relief devices (i.e., pressure safety valves and rupture disks).
- **API RP 583** – Guidelines for a Material Verification Program (MVP) for New and Existing Assets.
- **API 653** — American Petroleum Institute Standard 653. Used as the basis for ITPM tasks and frequencies for atmospheric storage tanks.
- **API RP 2003** — American Petroleum Institute Recommended Practice 2003. Used as the basis for ITPM tasks and frequencies for grounding and bonding equipment.
- **API RP 2028** — American Petroleum Institute Recommended Practice 2028. Used as the basis for ITPM tasks and frequencies for flame arresters in piping systems.
- **API RP 2210** — American Petroleum Institute Recommended Practice 2210. Used as the basis for ITPM tasks and frequencies for flame arresters on tank vents.
- **ASME B31.3** – American Society of Mechanical Engineers. Used a basis for process piping.
- **ASNT SNT-TC-1A** — American Society of Nondestructive Testing Recommended Practice SNT-TC-1A. Used as the basis for personnel qualification and certification in nondestructive testing.
- **ISA 91.00.01** — ANSI/ISA Standard 91.00.01. Used as the basis for ITPM tasks for emergency shutdown systems and controls that are critical to maintain safety.
- **ISA RP 92** — ANSI/ISA recommended practice used as the basis for ITPM tasks associated with fixed vapor detectors.
- **NFPA** — Various National Fire Protection Association codes. Used as the basis for ITPM tasks and frequencies for life safety, fire protection, and electrical equipment.

Table 5 – Common Areas of Audit Findings for Atmospheric Storage Tanks

Atmospheric storage tanks are typically inspected per *Tank Inspection, Repair, Alteration, and Reconstruction,* API Standard 653, Fifth Edition, November 2014, Addendum 1, April 2018. Below are the most common findings annotated during a review of atmospheric storage tank records:

1. No monthly API 653 inspections are being performed.
2. Thickness readings are only performed on the shell and roof of installed tanks of 10 years or more – No data available on the bottoms of the tanks. This leads to retirement dates only being monitored on the shell. In many cases inspections are incomplete since the tank's bottoms were not inspected.
3. Red flagged condition monitoring locations (CMLs) are not being reexamined per recommended interval (established by calculation).
4. Tanks placed in risk based inspection (RBI) status without a proper analysis per *Risk-based Inspection*, API Recommended Practice 580, Third Edition, February 2016. Many tanks are placed in RBI status prior to the first 10 year internal inspection. This is not a recommended practice.
5. Recommendations by API inspectors for major repairs are not performed prior to tanks being placed back into service.
6. Overdue external, internal, and thickness inspections without proper deferrals in place.

Table 6 – Common Areas of Audit Findings for Pressure Vessels

Pressure vessels are typically inspected per *Pressure Vessel Inspection Code: In-service Inspection, Rating, Repair, and Alteration*, API 510, Tenth Edition, May 2014, Addendum 1, May 2017, Addendum 2, March 2018. Below are the most common findings annotated during a review of pressure vessel records:

1. Overdue external inspections.
2. Overdue internal inspections.
3. Thickness data on file but calculation never performed to determine remaining life or next inspection interval .
4. Red flagged CMLs are not being reexamined per recommended interval (by calculation).
5. The use of nonqualified personnel inspecting pressure vessels (e.g., non API 510 certified individuals without proper training).
6. Pressure vessels placed in RBI status without a proper analysis per *Risk-based Inspection*, API Recommended Practice 580, Third Edition, February 2016. Many pressure vessels are placed in RBI status at commissioning, with no baseline thickness readings. This is not a recommended practice.
7. The same pressure vessel is inspected multiple times when the inspections should be alternated for comparison of multiple in-kind pressure vessels in the same service.
8. Overdue external, internal, and thickness inspections without proper deferrals in place.

Table 7 – Common Areas of Audit Findings for Piping Systems

Piping circuits are typically inspected per *Piping Inspection Code: In-service Inspection, Rating, Repair, and Alteration of Piping Systems*, API 570, Fourth Edition, February 2016. Below are the most common findings annotated during a review of piping circuit records:

1. Piping is not properly classified per Table 1 in *Piping Inspection Code: In-service Inspection, Rating, Repair, and Alteration of Piping Systems*, API 570, Fourth Edition, February 2016. Therefore, piping inspection intervals may be set at 10 years for all piping circuits, which does not align when Class 1 and 2 piping circuits are present.
2. Piping circuits in the PSM process units are not accounted for in the site test and inspection plan. Those not accounted for are considered overdue.
3. Overdue external and thickness inspections without proper deferrals in place.
4. Injection points not receiving 3-year thickness inspections.
5. Deadleg piping is not identified and not receiving proper inspections.
6. Small bore piping is not being inspected.
7. Thickness data on file but calculation never performed to determine remaining life or next inspection interval.
8. Buried process piping not included in the test and inspection plan, including surface-to-air interfaces.
9. Piping circuits over water not receiving inspection.
10. Expansion joints and hoses not in the test and inspection plan.

Table 8 – Common Areas of Audit Findings for Pressure Safety Valves

Pressure safety valves (PSVs) are typically inspected per (1) *Pressure Vessel Inspection Code: In-service Inspection, Rating, Repair, and Alteration*, API 510, Tenth Edition, May 2014, Addendum 1, May 2017, Addendum 2, March 2018, (2) *Pressure-Relieving Devices*, API Recommended Practice 576, Fourth Edition, April 2017, and (3) National Board Inspection Code (NBIC). Below are the most common findings observed during a review of PSVs:

1. Overdue inspections and tests without a proper deferral in place.
2. Process PSVs in dirty service have set intervals greater than the recommended 5-year interval.
3. PSVs in clean service have set intervals greater than the recommended 10-year interval.
4. PSVs not passing “as received” pop test are put back into service without review of the cause or adjustment to the inspection interval.
5. PSVs being tracked by location number instead of serial number on the valve. The site would not have data on what valve has been in the location and for how long.
6. PSVs in service that are not accounted for in the site’s test and inspection program.

Table 9 – Common Areas of Audit Findings for Safety Instrumented Systems (SISs)

SISs are typically inspected per guideline ANSI-ISA-S84.01 - *Application of Safety Instrumented Systems for the Process Industries*. Below are the most common findings annotated during a review of SIS preventive maintenance (PM) records:

1. SIS PM not being performed.
2. PM task packages are developed with the tasks to be performed in sequential order with a pass/fail of 100% of all tasks pertained in the package. However, the following are annotated deficiencies:
    a. Tasks are skipped or not performed, therefore 100% of the test was not performed but signed off by management as being a fully passing test.
    b. Items failed and are not repaired/corrected prior to moving on to the next task in the package but signed off by management as being a fully passing test.
    c. Calibrations are not being performed prior to the PM task.