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A Guide to the Legal Framework of the PSM Standard for Engineers

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Compliance with the Process Safety Management (PSM) Standard is challenging for even the most sophisticated operators because of the broad scope and highly technical nature of the 14 PSM elements. This article provides guidance on how to comply with the three elements most frequently cited by OSHA—process safety information, process hazards analysis, and mechanical integrity—and the consequences of a failure to do so. © 2013 American Institute of Chemical Engineers Process Saf Prog 33: 152–155, 2014

Keywords: acceptable limits; audit; citation; compliance; corrective action; coverage; deficiency; fine; flammable; General Duty Clause; highly hazardous chemical; inspection; timely manner; training; mechanical integrity; National Emphasis Program; non-serious; performance based; process; process safety information; process hazards analysis; RAGAGEP; serious; violation; and willful

INTRODUCTION

The Process Safety Management (PSM) Standard is a U.S. regulation that was issued by the Secretary of Labor in 1992. Its enactment was motivated by a series of chemical disasters in the 1980s and early 1990s, including the 1984 Bhopal, India gas leak disaster, which resulted in more than 2,000 fatalities, and deadly chemical explosions in the U.S. facilities of Phillips 66, ARCO and BASF [1].

The primary purpose of the PSM Standard is to prevent, or minimize the consequences of, the release of highly hazardous chemicals into locations that could expose people to serious bodily injury and deadly harm. To achieve its purpose, the Standard requires regulated facilities to implement a "PSM program," which is a systematic approach to proactively review chemical processes and identify, evaluate, and prevent or mitigate chemical releases. PSM programs must contain 14 components (referred to as "elements"): (1) employee participation, (2) process safety information (PSI), (3) process hazard analysis, (4) operating procedures, (5) training, (6) contractors, (7) pre-startup safety review, (8) mechanical integrity, (9) hot work permit, (10) management of change, (11) incident investigation, (12) emergency planning and response, (13) compliance audits, and (14) trade secrets [2].

Compliance with the PSM Standard is challenging for even the most sophisticated operators because of the broad scope and highly technical nature of these 14 elements. This article focuses on the elements of the PSM program—specifically PSI, process hazard analysis, and mechanical integrity—that have resulted in the majority of OSHA citations under the Petroleum Refinery (>50%) and Chemical (>60%) PSM National Emphasis Programs [3,4].

The goal of this article is to provide in-house engineers with guidance on how to comply with these elements and when to consult external resources, such as engineering and/or legal PSM experts. The number of citations issued by OSHA in connection with the National Emphasis Programs demonstrates that there is still considerable misunderstanding of the PSM Standard, which is now over 20 years old. Consultation and collaboration with external PSM experts can facilitate the creation and maintenance of a robust, compliant PSM program. It can also be beneficial when addressing PSM violations identified through audits (1st, 2nd, and 3rd party) and OSHA inspections to ensure efficient and effective corrective action. Finally, it can be beneficial during due diligence performed in connection with mergers and acquisitions. External PSM expertise can help identify PSM violations and quantify corrective action prior to closing, which can substantially impact purchase price and/or the scope of indemnification rights under a purchase agreement.

PERFORMANCE BASED

The PSM Standard is "performance-based," which means that the regulator, in this case the Secretary of Labor, dictates "what to do" (e.g., to implement a PSM program that contains the 14 elements), and the operators determine "how to do it" (e.g., through the adoption of internal policies, external standards, or a hybrid/combination approach) based on their knowledge, industry practice, facility needs and conditions, and economic considerations. A site's PSM program can be a single document or series of documents; the only requirement being that it contains all 14 elements.

Operators should consider consulting PSM experts to determine whether a site's PSM program appropriately incorporates all 14 elements. In addition, they should consider consulting PSM experts to review the content of any existing PSM programs because OSHA can issue citations for a site's failure to follow its own PSM program, even when the site's program is arguably more stringent than industry practice. For example, OSHA recently cited a petroleum refinery for allowing the wall of a flare line to fall below minimum acceptable thickness identified in its internal inspection manual [5]. In short, operators must not only develop compliant PSM programs but they must be understood, implemented, and followed.

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PSM COVERAGE

The threshold inquiry for PSM compliance is to determine what areas of a facility must be covered by a PSM program. Under the PSM Standard, a PSM program must cover any "process" that involves "highly hazardous chemicals." The Standard broadly defines "process" as any activity involving a highly hazardous chemical, such as the use, storage, manufacturing, or handling of a chemical. This broad definition includes all vessels interconnected within an activity, as well as vessels that are separated from an activity but could be involved in a hazardous release [6].

The PSM Standard defines "highly hazardous chemicals" in two ways. First, it lists 137 chemicals in Appendix A to the Standard as "high hazardous chemicals" when they are present at a facility in excess of certain threshold quantities (TQ). OSHA has determined that these chemicals have a potential for catastrophic release—that is, a major uncontrolled emission, fire, or explosion that puts employees in serious danger—when present above their TQs. Second, the Standard defines highly hazardous chemicals as flammable gases (as defined by 29 C.F.R. 1910.1200) and flammable liquids (with a flashpoint below 100°F) that are on site in one location in a quantity of 10,000 pounds or more. This definition, however, excludes hydrocarbon fuels used solely for workplace consumption, and flammable liquids stored in atmospheric tanks or transferred that are kept below their normal boiling point without chilling or refrigeration [7].

The reasonable interpretation of these definitions is that all equipment involved in, or that could have an impact on, any activity related to highly hazardous chemicals must be covered by the PSM program unless it falls under a limited exception [8]. Operators should consider consulting PSM experts in connection with defining the boundaries of PSM coverage. An expert's demarcation of what activities constitute "process" and what chemicals rise to the level of "highly hazardous" will help a facility develop and maintain an effective, compliant PSM program. OSHA has recently issued citations related to the improper delineation of the boundaries of PSM coverage [9]. OSHA cited a petroleum refinery for its failure to inspect a ventilation system for a control room on the basis that it was "process equipment" involved in the "handling" of chemicals.

Where a majority of processes at a facility are PSM covered, operators should consider applying PSM requirements to the non-covered processes as well to avoid, among other things, having two different process safety programs in place at the same facility. Indeed, many PSM elements may already be applied facility-wide (e.g., management of change, pre-startup safety review, hot work permits, contractor safety, emergency planning and response, and incident investigation).

PROCESS SAFETY INFORMATION

PSI is critical data regarding the highly hazardous chemicals, technology, and equipment involved in the chemical process. The PSI element of the PSM Standard requires operators to have the following types of PSI in a complete, accurate, up-to-date and accessible format: (1) information pertaining to chemical hazards, which shall consist of, at a minimum, toxicity information, permissible exposure limits, physical data, reactivity data, corrosivity data, thermal and chemical stability data, and hazardous effects of inadvertent mixing of different materials that could foreseeably occur [10]; (2) information pertaining to the technology, which shall consist of, at a minimum, block flow or process flow diagrams similar to exemplar diagrams contained in Appendix B to the Standard, process chemistry, maximum intended inventory, safe upper and lower limits for temperatures, pressures, flows or compositions, and an evaluation of the consequences of deviations, including those affecting the safety and health of employees[1]; and (3) information pertaining to equipment, which shall include 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 the Standard was enacted (May 26, 1992), and safety systems (e.g., interlocks, detection, or suppression systems) [11].

The amount of information needed to meet the PSI element can be considerable. There is no requirement that all PSI be compiled in a single document, or that it be located in a single file. Where it is contained in various documents and/or locations, good practice is to compile an index of the PSI and/or locations.

Compliant PSI—including P&IDs, electrical classifications, equipment files, and relief system documentation—is essential to the safe operation of a facility. P&IDs are critical because they depict the connectivity of equipment and the instrumentation used to control the equipment. They are also required to, among other things, conduct effective process hazards analysis (discussed below) and relief system evaluation. Electrical classifications are critical because improperly classified electrical equipment can become a source of ignition and can cause an explosion. Equipment files are critical because operators must be able to document that all equipment complies with current recognized and generally accepted good engineering practices (RAGAGEP), or is designed, maintained, inspected, tested, and operating in a safe manner. Relief system documentation is critical because relief systems are the last line of defense for protecting equipment from scenarios that can cause catastrophic equipment failure and explosions, fires, and toxicity impacts. OSHA has recently issued citations for incomplete and inaccurate PSI [12]. OSHA cited a manufacturer of insulation paneling because its PSI did not contain specific corrosivity data ("process safety information did not include corrosivity data for resistance of Type 321 Stainless Steel . . . to n-Pentane").

Operators should consider consulting PSM experts to determine whether a site's PSI is compliant and, if not, how to close the compliance gap. Common errors include assuming that all chemical hazard information is located on material safety data sheets; however, many do not contain complete information regarding reactivity, corrosivity, stability, and the hazardous effects of inadvertent mixing. This gap can be addressed by creating hazardous chemical interaction matrices.

PROCESS HAZARD ANALYSIS

Process hazard analysis (PHA) is an organized set of assessments designed to identify and analyze the significance of potential hazards associated with the processing or handling of highly hazardous chemicals. PHAs help facilities determine how to control such hazards. The PHA element of the PSM Standard requires operators to have conducted all initial PHAs by May 26, 1997, and to conduct follow-up PHAs at regular intervals not to exceed 5 years [13]. In order to conduct an effective PHA, all PSI should be complete, accurate, and up-to-date. Any deficiencies in PSI must be identified in the PHA and listed as a recommendation.

In addition, PHAs must be conducted by a team that includes individuals with expertise in engineering and process operations using one of the following methodologies: What-If, Checklist, What-If/Checklist, Hazard and Operability Study, Failure Mode and Effects Analysis, Fault Tree Analysis, or an appropriate equivalent method [14]. A popular new methodology being used is the Layer of Protection Analysis (LOPA).

[1]Where original technical information no longer exists, operators may develop such information in conjunction with process hazard analysis.

LOPA is used to identify safety integrity level requirements for safety instrumented systems as well as to provide better quantification of the frequencies of scenarios identified in PHAs.

PHAs must address the hazards of the process, any previous incidents with potentially catastrophic consequences, engineering and administrative controls, and the consequences of failure of the controls. PHAs must also address facility siting, human factors and failure of controls [15]. Although many companies use checklists to address facility siting issues during PHAs, good practice is to also conduct separate site-wide facility studies focused on occupied buildings according to industry standards such as API 752.

Upon their completion, PHAs may contain recommendations, which must be resolved (i.e., accepted, rejected, or withdrawn) in "a timely manner." Corrective action pursuant to recommendations must be completed "as soon as possible" [16] Although the PSM Standard does not define these terms, government publications indicate, for example, that OSHA expects employers to complete corrective action within a one or two year timeframe absent unusual circumstances [17]. In order to obtain consistent results from PHAs across a facility or an entire company, it is important to establish a preferred PHA methodology and other supporting tools such as risk ranking matrices, and recommendation tracking software.

Operators should consider consulting PSM experts to help determine whether PHAs are being conducted in compliance with the Standard. OSHA has recently issued citations for failure to properly conduct PHAs [18]. OSHA cited a manufacturer of chemicals and plastic products for failing to address hazards of the process, administrative controls, facility siting, and human factors in its PHAs. PSM experts can also elucidate unfixed compliance terms like "a timely manner" and "as soon as possible" to assist a facility's compliance effort. OSHA has recently issued citations for failure to address recommendations within an appropriate time-scale [19]. OSHA cited an environmental services company that incinerates hazardous wastes and other materials for failing to complete certain PHA recommendations for over 5 years. OSHA has also recently cited companies for failure to complete corrective actions in shorter time periods [20].

MECHANICAL INTEGRITY

Mechanical Integrity (MI) is the system of assuring that process equipment is in satisfactory condition to safely and reliably perform its intended design function and operate properly within the limits of established PSI. Process equipment is equipment that can control, prevent, or mitigate catastrophic chemical releases. It includes pressure vessels, storage tanks, piping systems (including piping components such as valves), relief and vent systems and devices, emergency shutdown systems, controls (including monitoring devices, sensors, alarms, and interlocks), pumps, and utility systems [21].

The MI element of the PSM Standard requires operators to establish and implement an MI program to maintain the ongoing integrity of process equipment [20]. A critical first step in developing an MI program is to identify the process equipment and instrumentation that needs to be included. A good practice is to look at the PHAs to determine if failure of equipment could result in the release of hazardous chemicals. Also, any safeguards listed for PHA scenarios should be included.

Additionally, MI requires written procedures by which an operator shall: (1) conduct MI training; (2) perform inspections and testing of process equipment following RAGAGEP; and (3) correct deficiencies in process equipment that are outside of acceptable limits (defined by the PSI, or RAGAGEP) before any further use, or in a timely manner while necessary means are taken to assure the safe operation of the equipment during an interim period [21].

The term RAGAGEP includes "national consensus" codes and standards like those published by National Fire Protection Association, American Society for Testing and Materials, American National Standards Institute, and American Petroleum Institute [22]. Examples of deficiencies outside of "acceptable limits" include equipment that was not designed, fabricated, constructed or installed per RAGAGEP; equipment with mechanical defects that interfere with its capability to function as intended; a degradation in the equipment exceeding acceptable limits (including retirement thickness); operating equipment outside its normal limits; equipment leaks; and by-passed equipment [23]. For example, equipment that is operated below retirement thickness is outside acceptable limits until it is repaired or replaced to meet PSI requirements or it is determined fit-for-service "as is" under API 579, which establishes a new acceptable limit.

Individuals who perform inspections and testing may need to have certifications, such as for inspecting pressure vessels and welding. Also, the testing and inspections can be costly, particularly if equipment must be taken out of service to perform the test or inspection. Implementing risk-based inspection programs such as outlined in API 580/581 may allow resources to be more effectively utilized.

Operators should consider consulting PSM experts concerning MI to help determine whether the scope of an existing MI program is adequate, whether inspections are being properly conducted, and whether deficiencies are being addressed in compliance with the Standard. OSHA has recently issued citations for an MI program's failure to correct process equipment deficiencies in a safe and timely manner [24]. OSHA cited a chemical company for operating with compromised rupture discs in relief systems.

PSM VIOLATIONS

Deficient PSI, PHAs, and/or MI violate the PSM Standard, which could result in an OSHA citation. There are three categories of PSM violations: (1) serious; (2) non-serious; and (3) willful [25]. A violation is "serious" if death or serious physical harm (i.e., a substantial impairment to bodily function) could result from the violation [26]. Conversely, a violation is "non-serious" if death or serious physical harm could not result from the violation [27]. OSHA assesses civil penalties of up to $7,000 for every serious and non-serious violation. A "willful violation" is one that is committed with either intentional disregard or plain indifference to the requirements of the PSM Standard [28]. OSHA assesses civil penalties between $5,000 and $70,000 for every willful violation. Willful violations that cause death to an employee are subject to criminal sanctions, including imprisonment of up to 1 year [29].

The severity of each OSHA penalty is determined by the gravity of the violation. Two factors largely determine the gravity of a violation: (1) the severity of the injury that could occur from the violation (i.e., high, medium, or low); and (2) the probability that the injury could result from the violation (i.e., greater probability and lesser probability) [30]. Other factors OSHA may consider include the size of the operator, the operator's good faith, and the prior history of violations at the site [31]. These factors, however, are not defenses to the underlying violations.

When confronted with a potential PSM violation (e.g., inadequate PSI, PHAs, and/or MI), OSHA may issue a citation under the PSM Standard or, in the alternative, under the OSHA General Duty Clause in the event that the PSM Standard does not apply. The General Duty Clause is a "catchall provision" that imposes an independent duty on operators to provide a safe work environment. Specifically, it requires an operator to provide a place of employment that is free from "recognized hazards" that are currently "causing, or are likely to cause [should they occur] death or serious physical harm to . . . employees" [32]. A hazard is "recognized" where: (a) the employer has identified it; (b) it is known in the industry; or (c) it is blatantly obvious [33]. Penalties under the General Duty Clause are the same as those issued under the PSM Standard.

CONCLUSION

Personnel who collaborate with PSM experts will understand the complexities of today's PSM standard. This understanding will make their facilities better equipped to maintain PSM compliance, help avoid costly OSHA citations, better control cost of corrective action, and foster a safe and reliable work environment for all employees.

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