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Defining Recognized and Generally Accepted Good Engineering Practices for Process Safety Management

In response to several high-profile hazardous material releases in the 1980s, including the Union Carbide disaster in Bhopal, India, in 1984, the U.S. Clean Air Act Amendments of 1990 directed the federal Occupational Safety and Health Administration (OSHA) and the U.S. Environmental Protection Agency (EPA) to develop regulations to prevent accidental chemical releases (OSHA, 1992). This directive led OSHA to develop the Process Safety Management of Highly Hazardous Chemicals regulation in 1992 (29 CFR 1910.119).¹ Process safety management (PSM) is a suite of risk management elements designed to minimize the risk of accidents associated with industrial processes using highly hazardous (toxic, reactive, flammable, or explosive) materials. Many industries are covered by PSM regulations, including petroleum refining, ammonia refrigeration, and chemical manufacturing (OSHA, 2017a). The California Division of Occupational Safety and Health (Cal/OSHA) promulgated a very similar PSM regulation for California the same year (8 CCR 5189). In response to the 2012 refinery accident in Richmond, California, Cal/OSHA promulgated a separate PSM regulation for petroleum refineries in 2017 (8 CCR 5189.1).

A novel feature of PSM regulations is their approach to referencing the best safety practices across a wide variety of specialized and complex process systems. Recognizing that it was infeasible to incorporate by reference all the specific individual safety standards that apply to the equipment and practices used in production processes involving highly hazardous materials, OSHA introduced the concept of *recognized and generally accepted good engineering practices* (RAGAGEP). As will be described in more detail, this term was created to refer to the best engineering practices for the given industry and system under consideration, which are typically documented in standards developed through a multistakeholder consensus process.

The intention behind introducing the term *RAGAGEP* in the PSM regulation was to ensure that production processes involving hazardous materials adhered to the best, most up-to-date safety

KEY FINDINGS

- The Occupational Safety and Health Administration’s original intention in introducing the term *recognized and generally accepted good engineering practices* (RAGAGEP) was to refer to the most current edition of whatever consensus standards and codes applied; however, the definition was expanded in response to protests from industry.
- From its inception, lack of clarity about the definition and interpretation of RAGAGEP has been a source of confusion and disagreement.
- Stakeholders noted that knowledge about RAGAGEP was not centralized within a facility but distributed across diverse subject-matter experts and resources.
- Approaches to documentation of process equipment compliance were mixed, and interview participants noted such challenges as unclear connections among manufacturers’ specifications, installation documentation, or both.
- A key concern among refinery operators is that California’s PSM regulation for petroleum refineries defines RAGAGEP to exclude standards, guidelines, or practices developed for internal use by the employer, despite the regulation allowing employers to use internal standards as long as they are more protective than RAGAGEP.
- Some participants were confident that their internally developed designs or procedures were more protective than RAGAGEP. However, there is no method that industry could be confident that government regulators would accept for demonstrating this level of protection.
- Refinery representatives said that the terms *should* or *should not* did not affect interpretations of RAGAGEP, but other participants said that this was an important controversy.

practices. According to Cal/OSHA officials, however, the specifics of what constitutes RAGAGEP and when and where they apply are often debated and have led to disagreements between industry and regulators. Such mismatched expectations have created friction between government and industry. Given that the PSM regulation is by far the most commonly cited regulation in OSHA violations to chemical facilities—and that the two sections of the PSM regulation referencing RAGAGEP are the most highly cited sections in PSM regulation violations (OSHA, 2017b)—uncertainty about the definition and intentions of RAGAGEP has important implications for safety at chemical facilities.²

In an attempt to reduce ambiguity and disagreement about the definition of RAGAGEP, Cal/OSHA asked the RAND Corporation to compile and review the ways in which RAGAGEP has been interpreted and to propose a definition that Cal/OSHA and the industries subject to the California PSM regulations could agree on. Cal/OSHA does not plan to revise

the PSM standard or take any other formal regulatory action in response to this study. Rather, it is seeking an interpretation of RAGAGEP that can be shared with and socialized in industry such that expectations for enforcement criteria and practices associated with RAGAGEP among government and industry are brought into better alignment.

Research Approach

Our approach involved pursuing multiple avenues.

Review of Reports About RAGAGEP

The majority of the literature referencing RAGAGEP is informal educational guidance from consultants and legal advisers about complying with the portions of PSM regulations that involve RAGAGEP. Most of this material is drawn directly from the regulations and associated regulatory documents (e.g., enforcement guidance memorandums). Most of this material

also pertains to the federal OSHA regulation, not all of which applies to the California PSM regulation. We also reviewed the materials documenting the development of the federal and California PSM regulations, consisting of draft regulation text and public comments and responses. These documents provide historical context about the intentions of the term *RAGAGEP* and the challenges involved in introducing it. We found nothing presenting any research or analysis related to *RAGAGEP*.

Interviews with Industry Representatives

We conducted a series of structured interviews with representatives of California facilities subject to the Cal/OSHA PSM regulation, consultants, labor representatives, and government regulators. The interviews covered experiences and opinions about such topics as what constitutes *RAGAGEP*, the sources of *RAGAGEP*, how safety is ensured when no *RAGAGEP* exist, and concerns about the interpretation of *RAGAGEP*. The interview protocol is presented in the appendix. We used the federal OSHA citation database to identify California facilities in the major industries subject to the PSM regulation that had received citations for violations of the PSM regulation. From those results, we randomly selected a sample of facilities, half of which had received citations for violating the sections of the PSM regulation that invoke *RAGAGEP* and half of which had received citations for violating other sections of the PSM regulation. We were unable to obtain contact information for most of these facilities, however. We therefore used a convenience sample that consisted of all the petroleum refineries in California, as well as various other organizations for which we could obtain relevant points of contact. Interviews were conducted virtually from October 2019 to October 2021. Interview findings were analyzed by extracting and summarizing key observations regarding *RAGAGEP*. Results of multiple interviews were integrated qualitatively to highlight the diversity of inputs and areas of agreement.

Review of Cal/OSHA Citations Involving RAGAGEP Violations

We reviewed a sample of Cal/OSHA citations for violations of the sections of the PSM regulation that invoke *RAGAGEP*. These citations had to be hand-scanned from Cal/OSHA paper files; because the research was conducted during the coronavirus disease 2019 pandemic, the files could only be accessed by Cal/OSHA staff, and even their access was limited. As a result, the sample consisted of only nine citations listing a total of 17 *RAGAGEP* violations. This was an exploratory analysis to determine the value of these violation records for the goals of the study.

Review of Analogous Regulations in Other Jurisdictions

Twenty-one states in the United States operate state plans in which they promulgate their own occupational safety and health regulations for private industry (OSHA, undated). All but two of them adopt the federal OSHA PSM regulation directly. Only California and Washington have promulgated their own PSM regulations, and those are both generally very similar and nearly identical to the federal OSHA PSM regulation with regard to *RAGAGEP*. California's special PSM regulation for petroleum refineries, however, differs substantially from the others with

Abbreviations

API	American Petroleum Institute
CalARP	California Accidental Release Prevention
Cal/OSHA	California Division of Occupational Safety and Health
CUPA	Certified Unified Program Agency
EPA	U.S. Environmental Protection Agency
IIAR	International Institute of Ammonia Refrigeration
OSHA	Occupational Safety and Health Administration
PSM	process safety management
RAGAGEP	recognized and generally accepted good engineering practices
VCS	voluntary consensus standard

regards to RAGAGEP. The differences are described in subsequent sections of this report.

In practice, some of these avenues were more productive than others. The following section on the origin and intention of RAGAGEP is drawn primarily from our review of reports about RAGAGEP. The subsequent section on challenges with the interpretation of RAGAGEP and recommended approaches for minimizing those challenges draws primarily from our interviews with industry representatives.

Origin and Intention of RAGAGEP

A challenge that OSHA faced in developing the PSM regulation is that there is a wide variety of process systems that handle hazardous materials, and safety practices and standards are generally quite specific to particular aspects of systems used in particular industries. Reconciling the diversity of process system environments with the specificity and details associated with each environment is a challenge. For example, one common approach used in safety regulations is to incorporate VCSs developed by independent standards development organizations. VCSs are developed by committees made up of representatives of a diverse variety of organizations having expertise or a stake in the associated market (e.g., researchers, manufacturers, end users, regulators, labor representatives, and

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legal professionals) and are generally considered to reflect state-of-the-art practices. But there are too many VCSs relevant to PSM to include them in a regulation that applies to PSM generally. An additional difficulty with this approach is that there are processes and equipment for which no applicable or up-to-date VCSs exist.

Recognizing these challenges, OSHA sought a way in developing the PSM regulation to refer to such best practices more generally than by incorporating individual VCSs by reference (Long et al., 2014). OSHA's intentions in this regard can be inferred from the originally proposed PSM regulation text, as described in the preamble to the PSM regulation (OSHA, 1992). One section of the original text required that "the employer document that the process equipment being used complies with applicable consensus codes and standards, where they exist; or be consistent with recognized and generally accepted engineering practices," and went on to list example organizations that develop VCSs. Another section similarly stated that "inspection and test procedures follow applicable codes and standards" and also listed examples of codes and standards that an employer could use to comply with this proposed provision. A third section stated that "the frequency of inspections and tests to be consistent with applicable codes and standards; or, more frequently if determined necessary by prior operating experience." It is clear from this proposed language that OSHA intended for the regulation to invoke the relevant VCSs with regard to process safety equipment, testing, and inspection for the specific industry and process under consideration.

Industry commenters, however, raised two concerns with this language (Long et al., 2014; OSHA, 1992). The first was that reference to specific standards development organizations and specific standards, despite the fact that such references were provided as examples only, was deemed too restrictive in that it would be too difficult for employers to determine which codes and standards were applicable to a given process, and hence such language could be interpreted to mean that employers were legally bound to adhere to all codes and standards of each organization listed. Even the phrase "applicable codes and standards" was opposed for the same reason.

The second concern was that, because some, mostly older, processes and equipment have no applicable or up-to-date standards, employers should be allowed to use their own internal standards or practices recommended by equipment manufacturers.

As a result of these concerns, OSHA dropped reference to “applicable codes and standards” and to examples of standards development organizations and standards in the final version of the regulation (29 CFR 1910.119). OSHA also agreed that employers’ own internal standards are compliant with the regulation (OSHA, 1992). The final wording regarding requirements for process equipment (section 1910.119(d)(3)(ii)) and inspection and testing procedures (section 1910.119(j)(4)(ii)) is that they must follow “recognized and generally accepted good engineering practices.” Testing frequency must similarly “be consistent with applicable manufacturers’ recommendations and good engineering practices” (section 1910.119(j)(4)(iii)). Although the regulation itself does not define RAGAGEP, the discussion in the preamble described earlier and in Appendix C of the regulation (nonmandatory) indicates that OSHA’s intention is that RAGAGEP refers to applicable VCSs, engineering society technical reports, manufacturers’ recommendations, and employers’ internal standards. The final PSM regulation was issued in 1992 (29 CFR 1910.119).

The concept of RAGAGEP has seen limited adoption beyond the federal PSM standard. The text of California’s own PSM regulation (8 CCR 5189) is very similar to that of the federal regulation, and the references to RAGAGEP are nearly identical. The EPA included nearly identical references to RAGAGEP in its Risk Management Plan Rule (40 CFR 68), as did California in its Accidental Release Prevention (CalARP) program (19 CCR Ch. 4.5). Contra Costa County introduced its own accidental release ordinance in 1998 (Contra Costa Health Services, undated). The PSM regulations focus on the safety of workers within the facility, while the risk management and accidental release regulations focus on the safety of the communities in which the facilities are located.

The intention behind the use of RAGAGEP is laudable in that, in principle, it resolves some

important shortcomings of including external VCSs by reference:

- The number of different processes subject to the PSM regulation is large and evolving, making it difficult to incorporate a comprehensive list of specific, relevant VCSs by reference.
- Some processes and equipment have no applicable VCSs.
- When incorporating a VCS by reference, a government regulation must refer to a specific edition of a VCS; VCSs are typically revised on a three- to five-year cycle, meaning that, to stay aligned with best practices, regulations incorporating VCSs by reference must be updated on the same schedule, which can be resource-intensive, politically challenging, or both (Long et al., 2014).³

In summary, the concept of RAGAGEP is intended to ensure that process equipment and testing and inspection practices are selected and conducted according to the most up-to-date best practices.

In practice, however, the working definition of RAGAGEP has been unclear and problematic, in part stemming from OSHA’s own actions. In June 2015, OSHA issued a new interpretation of the PSM regulation that addressed RAGAGEP, as well as the usage of the term *should* (Galassi, 2015). The new interpretation held that, in the context of RAGAGEP, appropriate internal standards set by the employer “must either meet or exceed the protective requirements of published RAGAGEP where such RAGAGEP exist.” It also required that employers follow practices that RAGAGEP describe as those that should be followed or that employers determine and document that a chosen alternate approach is at least as protective. Similarly, following practices that RAGAGEP indicated should not be followed was “presumed to be violative” (Galassi, 2015).

OSHA issued this interpretation three months after a U.S. Supreme Court ruling reversed a long-standing requirement that changes to agency rules, including interpretive changes, must go through the Administrative Procedure Act public notice and comment process (Conn, 2016). Because of this ruling, OSHA was able to issue its new interpretation

without soliciting public comments. Industry protested OSHA's action because it felt that the changes were unfair and made without industry input. Industry sued OSHA and the case was settled (Conn, 2016). As part of the settlement agreement, OSHA issued a revised interpretation in May 2016 in which the offending language was reverted back to the interpretation that had been in place for many years: Internal standards no longer have to meet or exceed published RAGAGEP, and employers will not be cited for not following a practice described as one that should be followed (Galassi, 2016).

At the same time that the interpretation of the federal PSM regulation was being debated, California was in the process of issuing a new PSM regulation specifically for petroleum refineries. In response to the catastrophic Richmond refinery accident in 2012, California began developing a PSM regulation that addressed recommendations from the governor's Interagency Working Group on Refinery Safety that emerged from investigation of that incident (Cal/OSHA, 2018). The resulting regulation, 8 CCR 5189.1, which went into effect in 2017, introduced several important additions and changes to the general PSM regulation, including changes with regard to RAGAGEP. The new regulation introduced a definition of RAGAGEP, which restored the reference to examples of standards development organizations that had been dropped from the draft federal PSM regulation. More significantly, the definition states that "RAGAGEP does not include standards, guidelines or practices developed for internal use by the employer." Although this change restricts the scope of what is considered RAGAGEP, this restriction is to some extent counterbalanced by another change: The sections that refer to RAGAGEP include new text stating that employers are allowed to use RAGAGEP or more-protective internal practices. Thus, although internal practices are not considered RAGAGEP, they are allowed to be used as long as they are more protective than RAGAGEP.

This definition of RAGAGEP went beyond the short-lived federal OSHA interpretation, which had established that internal standards qualify as RAGAGEP only if they meet or exceed the protective requirements of published RAGAGEP to exclude internal standards and practices altogether. Industry

protested through the public comment process, with several commenters requesting that the exclusion of internal standards be removed. Their argument was that standards and codes are derived from industry experience and hence that internal standards are the basis of published RAGAGEP (California Occupational Safety and Health Standards Board, 2016). The American Petroleum Institute (API), for example, argued that RAGAGEP are broader than "established codes, standards, published technical reports or recommended practices" (California Occupational Safety and Health Standards Board, 2016, p. 91) and that "RAGAGEP [are] not based on established codes, standards, etc. as asserted; codes and standards are based upon RAGAGEP" (p. 91). Several commenters also protested the language that internal practices used in lieu of RAGAGEP be more protective than RAGAGEP and requested that the regulation be revised to say "equally or more protective." Cal/OSHA declined to make either of these changes in the final regulation.

The strong protest from industry about the definition of RAGAGEP in both the federal OSHA PSM regulation interpretation and the California refinery PSM regulation language demonstrates a fundamental disagreement between government and industry about the appropriate criteria for judging the safety of equipment, inspection and testing procedures and frequency, and repair methods.

Industry Views on the Definition of RAGAGEP

We conducted 14 interviews with representatives of different types of organizations with a stake in the interpretation of RAGAGEP in the California PSM standard. The distribution of interviews by stakeholder type is shown in Table 1. As described in the "Research Approach" section, we faced substantial challenges in obtaining contact information for nonrefinery industry facilities. As a result, our interview sample is biased toward refineries. However, because refineries are subject to a separate PSM regulation that has a restricted definition of RAGAGEP, feedback from refineries was of the most interest to Cal/OSHA.

TABLE 1
Distribution of Interviews by
Stakeholder Type

Group	Facilities Invited	Facilities Interviewed
Refinery	13	6
Other industry	4	1
CalARP CUPA	4	2
State government	1	1
Consultant	6	3
Legal	1	0
Labor	1	1
Total	30	14

NOTE: CUPA = Certified Unified Program Agency.

The consultants we interviewed assist facilities in complying with PSM regulations. One of the three consultants specializes in refineries, while the other two specialize in ammonia refrigeration. The non-refinery industry participant represented an ammonia refrigeration facility. CUPAs are local government entities that implement the CalARP program, which, as noted earlier, also adopted the RAGAGEP concept in its regulation.

We organize our findings by interview question (see the appendix for the interview protocol). In cases where there were differences between the responses of participants representing refineries and the responses of participants representing ammonia refrigeration, we highlight those differences.

Sources of RAGAGEP

What organizations typically provide RAGAGEP sources for your facility? Responses from refinery representatives fell into two categories. Three respondents noted that there are so many sources that it is impossible to enumerate them all. Responses included “lots” and “many, many, probably 30 or more.” Conversely, the other three respondents indicated that there are only a few sources: “Those listed in regulation are pretty much it. Maybe a few more,” and “It always comes back to the same set of documents.”

Ammonia refrigeration representatives were consistent in noting that nearly all RAGAGEP come from the International Institute of Ammonia Refrigeration (IIAR). The only other source noted was manufacturers’ recommendations. Other organizations that provide guidance on training and business practices were mentioned but not considered sources of PSM RAGAGEP.

Ammonia refrigeration facilities are less complex than refineries, and discussion revealed that IIAR had endeavored to align its standards with the references to RAGAGEP in the PSM regulation so that there would be a reasonably clear understanding within the industry about what constitutes RAGAGEP for different sections of the regulation. Refinery safety, on the other hand, is governed by several different standards development organizations. The greater number of organizations and inconsistencies among them, in terms of practices and norms for producing standards and other technical documentation, increases the complexity of RAGAGEP for refineries compared with ammonia refrigeration and other hazardous material industries.

Distribution of RAGAGEP Knowledge

Do you keep a comprehensive list of all the RAGAGEP that you use to comply with the PSM standard? Responses to this question were consistently that they do not. Refinery representatives stated that there are too many RAGAGEP and that they are too diverse for it to make sense to compile a single, comprehensive list. Rather, responsibility for awareness of RAGAGEP for different aspects of the process or facility is distributed among different subject-matter experts. Two separate respondents noted that “no one person knows it all.” Ammonia refrigeration representatives similarly said that facilities do not maintain such lists. Facility operators do not always employ PSM experts, and compliance is often outsourced to consultants. Although not raised in the interviews, having such knowledge about RAGAGEP distributed in such a way might make it difficult to meet the compliance audit requirement of the PSM regulation.

Documentation of Equipment Compliance

California PSM regulations 5189 section (d)(3)(B) and 5189.1 section (d)(7) require that employers document that equipment complies with RAGAGEP.

How do you document this? This question focused on the process equipment itself, as opposed to inspection and testing of that equipment. Responses to this question were mixed. Some participants weren't sure. Some indicated that this was challenging and that they weren't sure that they did it very well. Others pointed to equipment manufacturers' specifications and installation documentation. However, as one participant pointed out, the link between manufacturers' specifications, installation documentation, or both, and RAGAGEP is not always clear. They noted that most guidance generally does not require retrofitting older equipment as standards and codes evolve, although major upgrades to systems must meet current standards. As one participant noted, ensuring that upgrades adhere to RAGAGEP can be particularly challenging for inspectors because changes might not be visually obvious and these activities are not always well-documented, making it difficult for inspectors to know whether equipment is compliant. Similarly, compliance documentation can get lost when companies buy and sell facilities.

Alternatives to RAGAGEP

In instances where (a) no RAGAGEP exist, (b) facilities use equipment designed and constructed in accordance with codes, standards, or practices that are no longer in general use, or (c) facilities

use equipment or practices more protective than existing RAGAGEP, how do you determine and document that the equipment is designed, constructed, installed, maintained, inspected, tested, and operating in a safe manner? Under the conditions listed in this question, the California PSM regulations allow facility operators to use practices other than RAGAGEP. Ammonia refrigeration representatives felt that this question was largely moot, because it is exceedingly rare for any of these conditions to apply. Refinery representatives said that it is similarly unusual to not have applicable RAGAGEP. In situations in which operators deviated from RAGAGEP, the approach used to demonstrate safety depends on the details. For inspection or testing frequency, for example, demonstrating that a deviation is more protective than RAGAGEP is relatively straightforward—more frequent inspection or testing is more protective. The case for deviations in system design is more challenging. Four respondents noted that demonstrating safety in such situations requires delving into the details of the process and applying sound engineering principles focusing on safety and reliability. Some participants were confident that their internally developed designs or procedures were more protective than RAGAGEP. However, participants consistently noted that there is no agreed-upon method for demonstrating the safety of alternatives to RAGAGEP that industry could be confident that government regulators would accept. Given that RAGAGEP reflect the best practices for ensuring safety, it is not surprising that it is challenging to demonstrate that an alternative approach is more protective than RAGAGEP.

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Interpretation of *Should* in RAGAGEP

How do you interpret portions of RAGAGEP that are preceded by the terms *should* or *should not*? The protest and rapid rescindment of federal OSHA's interpretation that made following actions preceded by the word *should* (referred to here as *shoulds*) mandatory and following actions preceded by *should not* (referred to here as *should nots*) violative, as described earlier, exemplify the disagreement on this issue. The California PSM regulations are silent on this point. Responses to this question were mixed. Refinery representatives uniformly presented this as a non-issue; they evaluate *shoulds* or *should nots* and decide what is most appropriate. All other participants, on the other hand, characterized this as an important controversy. Four participants stated that Cal/OSHA treats the term *should* as being nearly equivalent to *shall*. One stated that if a *should* makes the process safer, it must be followed. Three others stated that Cal/OSHA requires facilities to comply with *shoulds* or else document why they chose an alternative approach and how the chosen alternative is at least as protective as the *should*.⁴

Complicating this issue is the fact that standards development organizations differ in their relative use of *should* and *shall*. Two participants noted that API standards, which are core RAGAGEP for refineries, use the term *should* very liberally, while other organizations, such as the National Fire Protection Association, do not use *should*. Two participants noted that IIAR has largely removed *should* from its standards as part of a deliberate effort to eliminate uncertainty around this issue.

Internal Standards

One of the major changes implemented in the refinery PSM standard is that it includes a definition of RAGAGEP that explicitly excludes “standards, guidelines or practices developed for internal use by the employer/owner/operator.” What are the implications of this revision? This question applies only to petroleum refinery operations. One of the challenges that both industry and government face in interpreting RAGAGEP in the federal PSM standard and in the general California PSM standard

is that RAGAGEP is not explicitly defined. When California developed the separate PSM regulation for petroleum refineries in 2017, it included a definition of RAGAGEP. However, instead of adopting the long-standing working definition, it restricted the definition to exclude standards, guidelines, or practices developed for internal use by the employer (typically referred to as *internal standards* for brevity). At the same time, the regulation introduced additional new language stating that employers are allowed to use internal standards as long as they are more protective than RAGAGEP.

This internal standards issue appears to be the most contentious aspect associated with RAGAGEP. Four of the six refinery representatives felt strongly that excluding internal standards was ill-advised and problematic. Participants emphasized that industry is innovative and that there are instances in which internal standards surpass existing RAGAGEP and are safer. One said that allowing internal standards provides more flexibility—that a company might have expertise and knowledge that exceeds VCSs. This view was supported by another participant, who was confident that internal standards were as safe as RAGAGEP and was willing to have Cal/OSHA conduct testing to confirm this. When asked whether the option to use more-protective internal standards in place of RAGAGEP provided the flexibility to continue to use internal standards, the participants claimed it did not but provided no clear explanation. Even when probed about whether the issue was one of safety, cost, capability, liability, or something else, participants did not elaborate.

Three participants that are not representatives of refineries but deal primarily with refineries had a different take. They noted that the revised definition should not be an issue because facilities are still allowed to use internal standards; they just can't call them RAGAGEP. One went on to speculate that industry opposes the change because using an internal standard in place of RAGAGEP requires that the facility justify why it uses it and demonstrate that it is more protective than RAGAGEP. Another participant worried about the possibility that, because internal standards are not transparent and have not been vetted by the community outside a single company, the standards could be manipulated and might not be as

safe as claimed. He went on to note that he could not understand why industry was so upset about internal standards not qualifying as RAGAGEP when it could still use internal standards but just could not call them RAGAGEP. He noted that “industry has created this debate, but it’s not clear what the debate is.”

Concerns About the Interpretation of RAGAGEP

What concerns and suggestions do you have about the interpretation of the term RAGAGEP and its application in California’s PSM standards? Overall, experiences and opinions about RAGAGEP varied considerably across the interview participants. Some had no concerns and were, in fact, pleased with the concept of RAGAGEP and how it is defined and enforced. One refinery participant stated, “whoever came up with RAGAGEP was a genius—it keeps the regulation evergreen,” and “RAGAGEP is not a part of the regulation I lose sleep over.” One ammonia refrigeration representative similarly valued the inherent ability of RAGAGEP to remain current and also appreciated the performance-based nature of RAGAGEP.

Other interview participants, however, noted various issues with the definition and enforcement of RAGAGEP and provided several suggestions for changes. We have summarized these concerns and suggestions here.

The internal standards issue emerged as the one of most concern. Four different refinery industry representatives emphasized that excluding internal standards from the definition of RAGAGEP was too restrictive and recommended revising the definition to allow internal standards to qualify as RAGAGEP, as federal OSHA does. Three other participants with expertise in refineries but who are not in the industry reiterated that tension around the internal standards issue is a problem. One simply acknowledged this without making a suggestion, while another supported the exclusion of external standards. The third took more of a middle ground, stating that “interpreting standards too rigidly can stifle innovation, so we need to be careful to allow alternative practices if they are demonstrated safe.”

A closely related concern raised by one interview participant is that the portions of the Cal/OSHA refinery PSM regulation allowing alternative practices that are more protective than RAGAGEP should be changed to be “equally as protective as or more protective than RAGAGEP.” This concern echoes multiple public comments to the same effect that were submitted when the regulation was being drafted.

Another set of suggestions had to do with the types of materials that constitute RAGAGEP. Two interview participants wanted Cal/OSHA to create a comprehensive and exclusive list of source organizations for RAGAGEP. One specifically wanted regional and foreign sources to be excluded. In both cases, their request stems from a concern that they might be cited for not adhering to some unexpected document that Cal/OSHA inspectors decide is RAGAGEP. By defining the organizations that qualify as sources of RAGAGEP, facilities said that they could better ensure compliance. These two participants and one other also offered suggestions about the types of documents that should qualify as RAGAGEP. One said that RAGAGEP must come from recognized standards development organizations only, which stemmed from their facility having been cited for not following a recommendation from a private risk management firm. A second participant went a step further in suggesting that RAGAGEP should be limited to community-vetted documents, such as codes, standards, and technical reports, and that recommended practices and other such nonconsensus materials be excluded. The third went furthest in suggesting that RAGAGEP be restricted to standards only and that other document types be excluded.

Three other participants provided their thoughts on the quality of different RAGAGEP sources. They emphasized that the leading standards development organizations for refining and ammonia refrigeration, API and IIAR, respectively, do not faithfully adhere to best practices in the development of VCSs. In both cases, participants claimed that standards development committees are unbalanced, though in different ways. Two participants claimed that API committees are dominated by production industry representatives (technology users), while the other claimed that IIAR committees are dominated by technology suppliers.

In both cases, the argument is that the committees are dominated by the most powerful stakeholder type and that the voices of other stakeholders are marginalized, resulting in standards that favor the interests of the powerful over other stakeholders. For example, one ammonia refrigeration representative claimed that recommended frequencies of inspections and part replacements are greater than necessary because standards are dominated by technology suppliers endeavoring to protect their warranties, protect against liability, and sell more spare parts.

Although both organizations ostensibly adhere to the best practices for standards development promoted by the American National Standards Institute, one participant emphasized that these practices can be “gamed” and that API, in particular, appeared to deliberately stack committees with industry representatives.

Another concern raised in two interviews is that the refinery PSM regulation (and hence RAGAGEP requirements) apply too broadly. They suggested that the regulation apply to process equipment only and that other components of an operation, such as off-site tank farms and facility siting, not be covered.

In the realm of enforcement, multiple interview participants expressed frustration over Cal/OSHA enforcing *shoulds*. At the same time, several others expressed no such concern and were comfortable treating *shoulds* as optional. This mixed response might suggest that enforcement is inconsistent.

Another more general enforcement concern that some participants raised is that the standards and practices encompassed in RAGAGEP are performance-based and hence do not necessarily spell out in detail how they are to be met. In some situations, this requires a facility to act based on its interpretation of how best to adhere to RAGAGEP. If its interpretation is inconsistent with Cal/OSHA’s interpretation, the facility is at risk of being cited for a violation, which puts industry at a disadvantage. These participants wanted more detailed guidance from Cal/OSHA on how to meet certain aspects of RAGAGEP. This was not a consensus view, however; other participants had a very positive view of the nonprescriptive nature of RAGAGEP and the ability for facilities to take a situation-specific approach to meeting them.

Summary and Recommendations

Given the great diversity and complexity of industrial processes, it is clear that the greatest expertise in designing and operating systems safely lies within industry-specific communities (technology suppliers, technology users, consultants, researchers, labor representatives, and other stakeholders). To facilitate community-wide consistency and quality and to ensure the safety of workers and neighboring populations, these communities work together to develop standards, codes, and other technical documentation that guide the design and operation of industrial processes. Occupational safety and health agencies charged with regulating these industries recognize this expertise and routinely incorporate industry-specific VCSs by reference into safety and health regulations. A distinguishing characteristic of PSM regulations is that they focus on particular materials (highly hazardous materials) rather than particular industries. This characteristic makes it infeasible to incorporate by reference all relevant VCSs into a single regulation.

OSHA recognized this challenge when developing the first PSM regulation and took the innovative approach of introducing the concept of RAGAGEP. Our analysis shows that OSHA’s intention in introducing RAGAGEP was for the term to act as a synonym for “the most current edition of whatever standards and codes apply.” In fact, the original wording referred to recognized and generally accepted good

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engineering practices only where no relevant standards and codes existed. This intended meaning, however, met with immediate resistance from industry. Through the public comment and response phase of the regulation development process, the intended meaning of the term expanded to include relevant standards and codes, engineering society technical reports, manufacturers' recommendations, and employers' internal standards. Although the intended meaning can be reasonably inferred from the rule-making documents, RAGAGEP was not defined in the regulation. Cal/OSHA adopted the federal PSM regulation the same year, seemingly with little debate.

Limited data suggest that there is a long-standing disagreement between government and industry about the definition of RAGAGEP. Beyond the adamant pushback from industry over the wording of the originally proposed OSHA regulation, 23 years after introducing RAGAGEP, OSHA attempted to restrict its definition in a formal interpretation letter. This effort met with immediate protest from industry and was reversed less than a year later. The motivation for attempting this change and why OSHA waited so long to attempt it are unknown, but the fact that the attempt occurred seems to support such a long-standing disagreement. At the same time, in response to a refinery fire, Cal/OSHA began developing a new PSM regulation specifically for petroleum refineries. Not having an analogous federal standard to adopt, California was forging new territory. Cal/OSHA confronted the disagreement about the definition of RAGAGEP directly by including a definition in the proposed regulation that explicitly excluded internal standards, although it allowed facilities to use more-protective internal standards instead of RAGAGEP. Industry once again protested, but Cal/OSHA prevailed, and the defini-

tion stands. Cal/OSHA confirms that disagreement over the definition of RAGAGEP persists.

Drawing on the historical context and evolution of RAGAGEP and on findings from our structured interviews, we have developed recommendations for mitigating the disagreement over the definition of RAGAGEP. Cal/OSHA has no intention of revising the PSM regulations or issuing any sort of formal interpretation documents. Given these constraints, options for addressing the disagreement are limited. Furthermore, the options that exist are not necessarily circumstances over which Cal/OSHA has much influence.

Recommendations

Develop a Definitive List of Organizations That Qualify as Sources of RAGAGEP

This proposal would be relatively straightforward to implement and contribute to resolving uncertainty about what counts as RAGAGEP. Working with the various industries subject to the California PSM regulations, Cal/OSHA could identify which standards development and engineering organizations develop standards governing equipment and equipment inspection and testing. With appropriate stakeholder input, selection criteria could be developed, and Cal/OSHA could identify qualifying organizations. The goal is not to be overly exclusive but rather comprehensive and definitive. Given the concerns expressed by commenters on the original OSHA PSM regulation that identifying organizations could be construed as a requirement that facilities comply with all standards from each listed organization, care would need to be taken to clarify that this is not the case and that the list merely represents the universe of organizations from which RAGAGEP must be selected.

Limited data suggest that there is a long-standing disagreement between government and industry about the definition of RAGAGEP.

Indicate What Types of Documents Qualify as RAGAGEP

This would similarly address uncertainty about what counts as RAGAGEP. Suggestions raised by interview respondents spanned from any guidance produced by a recognized standards development organization to bona fide consensus standards only. The former encompasses documents that are not standards (e.g., technical reports) whose development might not follow open, transparent, and consensus-based practices for standards development. A challenge with implementing this recommendation is that there is no consistent hierarchy of document types among standards development organizations. Establishing particular document types might require delving into each organization's product slate to certify document types at the individual organization level.

Eliminate the Word *Should* from RAGAGEP

Our analysis shows that the fact that some RAGAGEP indicate that certain actions *should* or *should not* be followed has created controversy about what is required for compliance. Although *should* nominally indicates that an action is recommended but optional, overuse of *should* renders RAGAGEP less enforceable. In the extreme, if RAGAGEP were entirely composed of *shoulds*, it would become entirely optional and there would be nothing to enforce. As noted earlier, Cal/OSHA has taken the stance that facilities must adhere to *shoulds* or document why they have not and how what they are doing instead is as safe as the *should*. Taken at face value, this might seem unfair, as industry claims. But the issue stems from the prolific use of *should* in API RAGAGEP, which Cal/OSHA has indicated leaves too much discretion to facility operators.

The simplest way to resolve this controversy is to draft standards as definitive documents that use the word *shall*. This does not necessarily preclude retaining *shoulds* in nonmandatory (also referred to as *informative* or *nonnormative*) appendices, an approach that many standards development organizations, including API, take. In a well-designed standard, the *shalls* describe the essential, performance-based elements of the standard, while the *shoulds*

delve into more-prescriptive approaches for attaining the stated performance requirements. Though helpful, *shoulds* are intended to be optional, and facilities may choose other approaches to meet the standard requirements.

A major challenge with implementing this recommendation is that RAGAGEP are owned and managed by independent organizations over which Cal/OSHA has no authority. This barrier might be surmountable, however. Interview participants noted that, in an effort to eliminate ambiguity, IAR has intentionally moved toward more-definitive standards over time. Upon implementation of the first recommendation and when a definitive list of organizations that qualify as sources of RAGAGEP is established, Cal/OSHA might be able to work with these organizations to encourage them to better delineate definitive portions of RAGAGEP in future editions that are devoid of *shoulds*.

Develop Clear Guidance for How to Evaluate the Protectiveness of Internal Standards

Although internal standards do not qualify as RAGAGEP, facilities are still allowed to use them as long as they are demonstrated and documented to be more protective than RAGAGEP.⁵ One interpretation of industry's opposition to excluding internal standards from RAGAGEP is that demonstrating and documenting that an internal standard is more protective than RAGAGEP is burdensome. Given that RAGAGEP comprise standards and codes published by known standards development organizations using best practices for consensus-based standards development, demonstrating that an internal standard is more protective than RAGAGEP might be challenging. This challenge is compounded by the fact that many refineries in California have changed ownership multiple times. Internal standards thus reflect multiple owners' requirements at different times in the history of process equipment. However, published standards evolve over time via new learning from all stakeholders, including technology users. An individual facility's experience with an alternative approach might indeed be ahead of the curve, and subsequent revisions of a published standard might adopt this approach.

Objectively evaluating the relative protectiveness of alternative standards for process system equipment and operation would be a substantial undertaking. It would involve developing performance metrics, measurement methods, and protocols and dedicating the time and resources to pursue them. But if a functional evaluation framework could be devised and implemented, it would provide industry with a mechanism to determine when it is appropriate (i.e., compliant) to use internal standards instead of RAGAGEP, which it appears eager to do.

Conclusion

The concept of RAGAGEP is an innovative approach to overcoming challenges with incorporating technical standards into the PSM regulation. It introduced its own challenges, however, in the form of disagreement and uncertainty about the types of materials that RAGAGEP include and how they are enforced. Our analysis explored the context and working experiences associated with RAGAGEP and elucidated stakeholders' key concerns. From those concerns, we developed four recommendations that Cal/OSHA can pursue to help better align industry and government interpretations and expectations.

APPENDIX

Interview Protocol

1. What organizations typically provide RAGAGEP sources for your facility?
2. Do you keep a comprehensive list of all the RAGAGEP that you use to comply with the PSM standard?
3. 5189 section (d)(3)(B) and 5189.1 section (d)(7) require that employers document that equipment complies with RAGAGEP. How do you document this?
4. In instances where (a) no RAGAGEP exist, (b) facilities use equipment designed and constructed in accordance with codes, standards, or practices that are no longer in general use, or (c) facilities use equipment or practices more protective than existing RAGAGEP, how do you determine and document that that equipment is designed, constructed, installed, maintained, inspected, tested, and operating in a safe manner?
5. How do you interpret portions of RAGAGEP that are preceded by the terms should or should not?
6. One of the major changes implemented in the refinery PSM standard is that it includes a definition of RAGAGEP, which explicitly excludes "standards, guidelines or practices developed for internal use by the employer." What are the implications of this revision?
7. What concerns do you have about the definition or interpretation of RAGAGEP and its application in California's process safety management standards and what would you suggest to resolve these concerns?

Notes

- ¹ Although OSHA refers to 29 CFR part 1910.119 as a *standard*, we use the term *regulation* to distinguish government regulations from nongovernmental voluntary consensus standards (VCSs).
- ² For example, RAGAGEP violations were central to the 2019 Philadelphia Energy Solutions oil refinery explosion, which was among the worst refinery disasters in U.S. history (Marsh JLT Specialty, 2020; OSHA, 2019).
- ³ For example, the Mine Act, which is the primary safety regulation for mining in the United States, still refers to the 1968 edition of the National Electrical Code (30 CFR Chapter 1).
- ⁴ Cal/OSHA confirmed that this is correct.
- ⁵ Technically this applies to petroleum refineries only. However, petroleum refining appears to be the only industry interested in using internal standards; ammonia refrigeration and possibly other industries do not seem to use internal standards.

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About This Report

This research was sponsored by the Process Safety Management (PSM) Unit of the California Division of Occupational Safety and Health (Cal/OSHA), California Department of Industrial Relations. The research was prompted by ongoing disagreement between industry and government regulators over the definition of the term *recognized and generally accepted good engineering practices* (RAGAGEP), a key element in PSM regulations. The findings are intended to help better align industry and government interpretations and expectations associated with RAGAGEP. In addition to Cal/OSHA, California businesses in the industries subject to PSM regulations, labor organizations, and standards development organizations would likely find value in the results of this research.

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