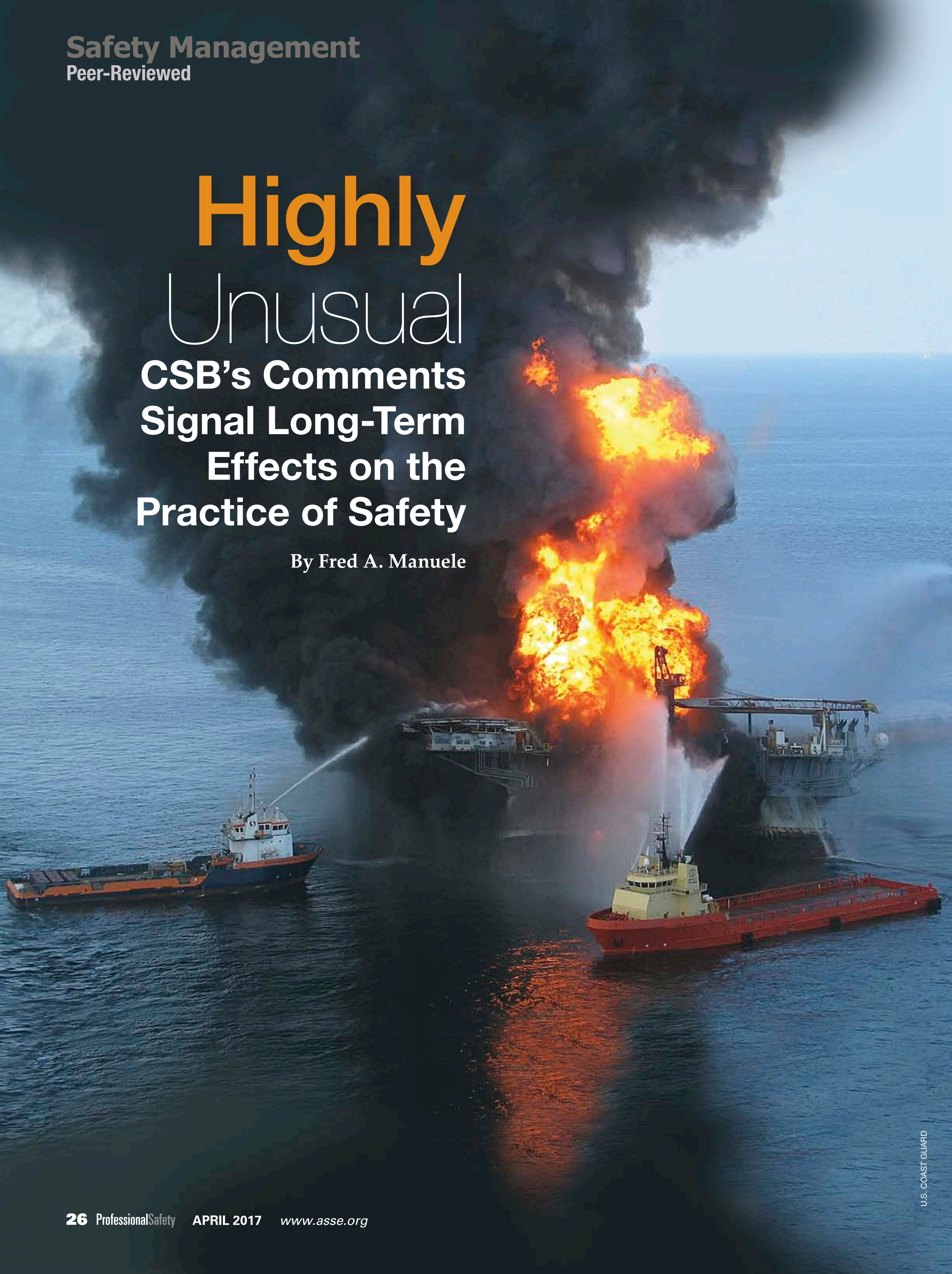

Highly Unusual

CSB's Comments Signal Long-Term Effects on the Practice of Safety

By Fred A. Manuele

U.S. COAST GUARD

CSB's report on the *Deepwater Horizon* incident contains several unusual comments pertaining to operations risk management that may have long-term effects on the practice of safety. CSB is a well-regarded governmental agency. This article calls attention of OSH professionals to these comments.

The agency's final report on the explosion and fire that occurred April 20, 2010, at the Macondo *Deepwater Horizon* rig in the Gulf of Mexico was issued April 12, 2016. The incident resulted in 11 fatalities, 17 injuries and extensive environmental damage. CSB's comments may be signals indicating that, over time, organizations should revise their accountability levels and the content of their operations risk management systems that aim to protect people, property and the environment.

The report's executive summary sets forth CSB's responsibility: "CSB is an independent federal agency charged with investigating industrial chemical accidents. Its mission is to independently investigate significant chemical incidents and hazards and to effectively advocate for implementing its recommendations to protect workers, the public and the environment" (CSB, 2016a, p. 11).

While CSB investigates and reports on chemical incidents, safety professionals should consider as generic the sections of its report on the Macondo event addressed by this article.

According to the executive summary, "BP was the main operator/lease holder responsible for the well design and Transocean was the drilling contractor that owned and operated the *Deepwater Horizon* drilling rig" (CSB, 2016a, p. 6).

The executive summary of CSB's (2016a) report on the Macondo incident explains the report's four volumes:

> Volume 1 recounts a summary of events leading up to the Macondo explosions and fire. (p. 9)
>
> Volume 2 explores several technical findings related to the functioning of BOP [blow out preventer], a subsea system that was intended to mitigate or prevent a loss of well control. (p. 9)
>
> Volume 3 explores human and organizational factors associated with the incident, including aspects of the decision making by the well operations crew. (p. 10)
>
> Volume 4 delves into the role of the safety regulator in overseeing offshore oil and gas activities. (p. 10)

Comments in this article pertain to select sections in the executive summary, and volumes 3 and 4. These excerpts show the unusual nature of CSB's language.

Boards of Directors

The author is not aware of another governmental incident investigation report, or any other incident investigation report, that prominently implies that inadequacies at an organization's board-of-director level may contribute to the occurrence of a major incident. Volume 3, which explores human and organizational factors, makes many references to what a board of directors should do. These references are more precisely stated in the executive summary.

The following excerpts sufficiently demonstrate that CSB (2016a) believes that boards of directors have a responsibility to provide more extensive stewardship than they have in the past, and to hold the executive staff accountable with respect to the avoidance of major incidents.

> Corporate board of directors' oversight, shareholder activism, and U.S. Securities and Exchange Commission reporting requirements have the potential to influence an organization's focus on major accident risk. (p. 9)
>
> Post-Macondo industry and regulatory gaps in managing safety-critical elements, human factors, process safety indicators, corporate governance, workforce engagement, and major accident risk management and oversight need to be filled. (p. 9)
>
> [Volume 3] also addresses strategies for ensuring boards of directors remain focused on potential major accident events by examining corporate governance good practice. (p. 10)

To paraphrase, as they fulfill their corporate governance responsibilities, boards of directors are to focus on major incident potential and provide oversight to avoid the possible occurrence of such incidents. Few organizations operate this way. Yet, the logic of CSB's proposal is not easily refuted.

The author reviewed his own body of work to determine whether his writing states as precisely as CSB's report what the agency says with respect to corporate responsibility. It does not. The nearest the author's work comes is in *Advanced Safety Management: Focusing on Z10 and Serious Injury Prevention* (Manuele, 2014), which describes "a sociotechnical model for an operational risk management system" (see "A Sociotechnical Model" sidebar, p. 28). With respect to a board of directors and senior management, the model says:

IN BRIEF

- CSB's report on the *Deepwater Horizon* incident contains several unusual comments that may have long-term effects on the practice of safety. The author posits several potential long-term indicators.
- Corporate boards of directors may be held accountable when major incidents occur.
- Companies may be expected to have effective, realistic and continual risk assessment and risk reduction processes in place.
- Residual risks may be acceptable if they meet ALARP criteria.

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A Sociotechnical Model for an Operational Risk Management System

The board of directors and senior management establish a culture for continual improvement that requires defining, achieving and maintaining acceptable risk levels in all operations.

Management leadership, commitment, involvement and the accountability system establish that the performance level to be achieved is in accord with the culture established by the board.

To achieve acceptable risk levels, management establishes policies, standards, procedures and processes with respect to:

Providing adequate resources

Risk assessment, prioritization and management
- Applying a hierarchy of controls

Prevention through design
- Inherently safer design
- Resiliency, reliability and maintainability

Competency and adequacy of staff
- Capability—skill levels
- Sufficiency in numbers

Maintenance for system integrity

Management of change/prejob planning

Procurement—safety specifications

Risk-related systems
- Organization of work
- Training—motivation
- Employee participation
- Information—communication
- Permits
- Inspections
- Incident investigation and analysis
- Providing PPE

Third-party services
- Relationships with suppliers
- Safety of contractors—on premises

Emergency planning and management

Compliance/compliance assurance reviews

Performance measurement: Evaluations are made and reports are prepared for management review to support continual improvement and to ensure that acceptable risk levels are maintained.

> The board of directors and senior management establish a culture for continual improvement that requires defining, achieving and maintaining acceptable risk levels in all operations.
>
> Management leadership, commitment, involvement and the accountability system establish that the performance level to be achieved is in accord with the culture established by the board to achieve acceptable risk levels. (p. 110)

Note that the preceding excerpt does not reference a board of directors as having specifically defined responsibility to, as it provides governance, focus on major incident potential and provide oversight to avoid the possible occurrence of such incidents. The author does not know of a resource that does so.

What could result from the positions taken by CSB? Transitions in the practice of safety occur slowly. But, look ahead 5 to 10 years and CSB's influence may be substantively felt. OSH professionals should be attentive to opportunities to provide the necessary advice that may affect the guidance a board of directors is expected to provide as well as the organizational culture created by the board and senior management.

Organizational Culture

The section titled "Culture for Safety: Focus and Response" in Volume 3 of the CSB (2016b) report addresses organizational culture. CSB places extensive emphasis on the influence that an organization's culture can have on avoiding major incidents. That a government entity gives such importance to culture is most unusual and surprising. Three excerpts from Volume 3 speak to this point.

> "A strong safety culture cannot eliminate all accidents, especially in technologically complex and dynamic industries such as deepwater drilling. There is always a risk that an accident will happen. Strong safety cultures can reduce the likelihood of accidents and the severity of accidents should they occur." (Sutcliffe, 2011, as cited in CSB, 2016b, p. 236)
>
> A culture that truly promotes safety extends beyond workers' perceptions, espoused values and documented policies. . . . A culture for safety is characterized not only by goals, policies and procedures, but by the *company's commitment to them and what it actually does* [Emphasis added]. (p. 240)
>
> Thus, a company's most senior leadership, starting at the board of directors, plays the pivotal role in influencing a culture that robustly promotes process safety. Cases show that actual practices repeated by a group over time, when enforced and verified by an authoritative entity, can lead to a culture change (Hopkins, p. 1). Institutional actions offer deep insight into a corporate culture: "critical controls to prevent a major incident are just another way of describing important organizational practices" (Wilkinson, 2016, as cited in CSB, 2016b, p. 242).

How significant to read that CSB agrees that "a company's most senior leadership, starting at the board of directors, plays the pivotal role in influencing a culture" and that this subject is of such importance as to be included in its report.

OSH professionals should agree that management creates and owns the culture, and that an organization's culture is a prominent determinant with respect to the occurrence of incidents. Rarely can an organization's culture be developed from the bottom up.

The author has written extensively about this subject. The following excerpt from Chapter 7 of *On the Practice of Safety*, titled "Superior Safety Performance: A Reflection of an Organization's Culture," is an example.

> **Culture Defined & Its Significance**
>
> If an entity wants to achieve superior safety results, safety must become a core value within the organization's culture. Safety is culture-driven. Where safety is a core value within a company, senior management is personally and visibly involved and holds employees at all levels accountable for results.
>
> Senior executives display by what they do that safety is a subject to be taken very seriously. An organization's culture determines the level of safety to be

obtained. What the board of directors or senior management decides is acceptable for the avoidance, elimination and control of hazards is a reflection of its culture. Management attains, as a derivation of its culture, the hazards-related incident experience it establishes as tolerable. For personnel in an organization, "tolerable" is their interpretation of what management does. (Manuele, 2013, p. 126)

Another example is the following excerpt from Chapter 8 of *Advanced Safety Management: Focusing on Z10 and Serious Injury Prevention,* titled "Management Leadership and Employee Participation: Section 3.0 of Z10."

Safety is culture driven, and management establishes the culture. Management owns the culture. An organization's safety culture is represented by the reality of application of its goals, performance measures, and sense of responsibility to its employees, to its customers, and to its community—all of which are translated into a *system of expected performance*. Over the long term, the injury experience attained is a direct reflection of an organization's safety culture. Strong emphasis is given to the phrase *a system of expected performance* because it defines what the staff believes that management, in reality, wants done. Although organizations may issue safety policies, manuals and standard operating procedures, the staff's perception of what is expected of them and the performance for which they will be measured—its *system of expected performance*—may differ from what is written. (Manuele, 2014, p. 142)

An organization will achieve major improvements in safety only if a culture change takes place—only if significant changes occur in an organization's *system of expected performance*.

Risk Assessment, Risk Reduction & ALARP

Volume 3 (CSB, 2016b) consists of comments made by a prestigious government agency that promote making risk assessments and establishing realistic risk reduction goals. Note particularly, the agency says that the outcome of those activities should achieve risk levels that are as low as reasonably practicable (ALARP). Although the term ALARP often appears in safety-related literature and in some standards, it is most unusual for a federal agency to adopt the concept implied by ALARP as a risk level to be achieved—and sufficient—in risk management.

It should be understood that, while conducting a risk assessment in itself does not guarantee that the risks will be managed, the act of conducting a risk assessment provides an organization the opportunity to identify and control those risks. Consider the following excerpts from Volume 3 (CSB, 2016b).

Companies need an effective, and realistic, risk reduction goal because they cannot eliminate every risk completely—absolute safety is not possible. The question then becomes, when are efforts to reduce the level of residual risk sufficient? This challenge led to reducing risk to a level as low as is reasonably practicable, or ALARP, an important concept to explore in risk reduction practices. (p. 170)

ALARP is also defined as "efforts to reduce risk [that are] continued until the incremental sacrifice (in terms of cost, time, effort or other expenditure of resources) is grossly disproportionate to the incremental risk reduction achieved" (CCPS, 2007, p. xxxvii). In practice, these efforts by the company are twofold. First, they are the initial identification and implementation of physical, operational/human, and organizational safety barriers to reduce the risk of a major accident as determined by a hazard analysis. Second, they are adherence to safety management systems intended to ensure strong barriers throughout the lifetime of an operation. The success of these systems hinges on the risk management approach and corporate oversight of that approach to create a strong and supportive culture. (p. 171)

While an initial effort to address risk levels is necessary, the efforts should be continual and in response to various factors such as new technology developments, updated industry standards or lessons learned from an incident. (p. 171)

What does all this mean? Safety professionals should understand that absolute safety is not attainable. No matter how extensive the consideration of hazards and risks in the design and operation phases, residual risk will always exist. The residual risk should be as low as is reasonably practicable and acceptable, and risk must be continuously assessed as situations change. This is a strong statement, especially for a government entity to imply that reducing risks to a level as low as is reasonably practicable is tolerable and acceptable.

ALARP seems to be an adaptation from ALARA, which is as low as reasonably achievable. Use of the ALARA concept as a guideline originated in the atomic energy field.

As defined in Title 10, Section 20.1003, of the *Code of Federal Regulations* (10 CFR 20.1003), ALARA is an acronym for "as low as (is) reasonably achievable," which means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical, consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest. (NRC, 2017)

The implication that decision makers are to "[make] every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical" provides conceptual guidance when striving to achieve acceptable risk levels in all classes of operations.

ALARP has become the more frequently used term for operations outside the atomic energy arena. Concepts embodied in the terms ALARA and ALARP apply to the design of products, facilities, equipment, work systems and methods, and environmental controls, as well as in operations risk management.

Transitions in the practice of safety occur slowly. But, look ahead 5 to 10 years and CSB's influence may be substantively felt.

In the real world, benefits represented by the amount of risk reduction to be achieved and the associated costs become important factors. Tradeoffs are frequent and necessary. An appropriate goal in the decision-making process is for the residual risk to be as low as reasonably achievable. Paraphrasing the terms of the NRC definition of ALARA helps explain the process:

1) Reasonable efforts must be made to identify, evaluate, and eliminate or control hazards so that the risks deriving from those hazards are acceptable.

2) In the design and redesign processes for physical systems and work methods, risk levels for injuries and illnesses, and property and environmental damage must be as far below what would be achieved by applying current standards and guidelines as is economically practicable.

3) For items 1 and 2, decision makers must consider:

•purpose of the undertaking;

•state of the technology;

•costs of improvements in relation to benefits to be attained;

•whether the expenditures to reduce risk in a given situation could be applied elsewhere with greater benefit.

Spending an inordinate amount of money to reduce the risk only a little through costly engineering and redesign is inappropriate, particularly if that money could be better spent otherwise (such as for an exercise facility). The author leans a bit more toward ALARA as it is applied than ALARP as it is applied.

To the credit of the authors of ANSI/ASSE Z10-2012, Occupational Health and Safety Management Systems, the standard includes a provision requiring that risk assessments be conducted (ANSI/ASSE, 2012, p. 15).

If present terminology holds, ISO 45001, the forthcoming international standard for safety management systems, will include a provision requiring that risk assessments be made.

Making risk assessments is the core of ANSI/ASSE Z590.3-2011(R2016), Prevention Through Design: Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes. In that standard, the ALARP concept is embodied within its definition of acceptable risk:

> Acceptable risk: That risk for which the probability of an incident or exposure occurring and the severity of harm or damage that may result are as low as reasonably practicable (ALARP) in the setting being considered. (ANSI/ASSE, 2016, p. 12)

Similarities exist in the definition of ALARP in the CSB report as compared to the definition set forth in Z590.3, the latter of which follows.

> ALARP: That level of risk which can be further lowered only by an increase in resource expenditure that is disproportionate in relation to the resulting decrease in risk. (ANSI/ASSE, 2016)

That safety professionals will be expected to have sufficient knowledge and capability to make and give counsel on risk assessments has evolved over the past 40 years, albeit somewhat slowly.

Leading & Lagging Indicators

CSB makes much of leading indicators. Why? Both BP and Transocean had good OSHA-type incident rates. CSB makes the case, as have others, that having good incident rates does not necessarily indicate that an organization's risks related to serious injury and fatality potential are well controlled. CSB encourages organizations to have a set of metrics that relate to the performance level desired for the key processes, operating discipline, and layers of protection that relate to identified hazards and risks.

What CSB writes about leading indicators is refreshing. Consider the following two excerpts from Volume 3:

> •Indicators should measure the health of the company's safety management system and the *specific barriers in place to prevent or mitigate major accident hazards* [Emphasis added] (CSB, 2012). (CSB, 2016b, p. 152)

> •The selected indicators should be actionable in terms of the necessary actions to improve some specific aspect of safety performance. (CSB, 2016b, p. 153).

To prevent or mitigate major incident hazards, organization management must know the major hazards. To accomplish this, hazard analyses and risk assessments must be conducted. Results of the risk assessments would include determining the "actionable items" that are "to improve some specific aspect of safety performance" and to achieve risk levels as low as reasonably practicable.

Very little literature exists on leading indicators that direct safety practitioners to perform hazard analyses and risk assessments so that major incident potentials can be identified. The author identified one such document. Comments on this document appear in *On the Practice of Safety* (Manuele, 2013), in the chapter, "Measurement of Safety Performance."

> In 2006, the Health and Safety Executive in the U.K. published *Developing Process Safety Indicators: A Step-by-Step Guide for Chemical and Major Hazard Industries*. The approach taken in this guide with respect to leading and lagging indicators differs from any other approach discovered in this author's research.
>
> The guide introduces the idea of "dual assurance" in which leading and lagging indicators are set in a "structured and systematic way." Acting in concert, they serve as "system guardians providing dual assurance to confirm that the risk control system is operating as intended or providing a warning that problems are starting to develop."
>
> In this system, leading indicators are related directly to lagging indicators. And that makes good practical sense. Since the purpose of an operational risk management system is to reduce in so far as is practicable the occurrence of what are called lagging indicators, then energies expended on managing leading indicators that relate directly to lagging indicators is properly directed. (p. 550)

Although the guide applies to the chemical and major hazard industries, the author recommends it to all safety practitioners involved in performance measurement, and leading and lagging indicators because its thought processes are worthy of consideration.

Incident Barriers

That the CSB report pleads for appropriate barriers to be in place to prevent major incidents is significant and provides safety practitioners an opportunity for reflection. This subject needs greater recognition in the safety practitioner community.

A previously cited excerpt from Volume 3 is repeated here because it has bearing on the discussion of barriers that follows.

> Indicators should measure the health of the company's safety management system and the *specific barriers in place to prevent or mitigate major accident hazards* [Emphasis added] (CSB, 2012). (CSB, 2016b, p. 152)

Hollnagel's (2004) comments on barriers are significant in relation to having "specific barriers in place to prevent or mitigate major accident hazards."

> A barrier is, generally speaking, an obstacle, an obstruction, or a hindrance that may either: 1) prevent an event from taking place, or 2) thwart or lessen the impact of the consequences if it happens nonetheless. In the former case the purpose of the barrier is to make it impossible for a specific action or event to occur. In the latter case the barrier serves, for instance, to slow down uncontrolled releases of matter and energy, to limit the reach of the consequences, or to weaken them in other ways.
>
> Barriers are important for the understanding and prevention of accidents in two different, but related, ways. Firstly, the very fact that an accident has taken place usually means that one or more barriers have failed—either because they did not serve their purpose adequately or because they were missing or dysfunctional.
>
> The search for barriers that have failed must therefore be an important part of accident analysis. Secondly, once the aetiology of an accident has been determined and a satisfactory explanation has been found, barriers can be used to prevent the same or similar accidents from taking place in the future. In order to facilitate this, the consideration of barrier functions must be a natural part of system design. (p. 68) *[Note: As used here,* aetiology *is the study of causation.]*

Hollnagel (2004, p. 79) references Haddon's concept and strategies concerning the avoidance of unwanted energy releases.

William Haddon, the first director of the National Highway Safety Bureau, proposed that his energy release theory was applicable in preventing incidents and reducing the severity of injury or damage if an incident occurred. Its concept is that unwanted transfers of energy can be harmful (and wasteful) and that an organization should take a systematic approach in the design and operating processes to limit their possibility. Part of this approach consists of providing physical or procedural barriers to prevent contact by persons or property and to direct an energy flow into wanted channels. Haddon's barrier concepts are soundly based.

Haddon (1970) states that "the concern here is the reduction of damage produced by energy transfer." But he also says that "the type of categorization here is similar to those useful for dealing systematically with other environmental problems and their ecology." Excerpts from Haddon (1970) follow. Note that all of the strategies relate to facility design or work methods design.

> A major class of ecologic phenomena involves the transfer of energy in such ways and amounts, and at such rapid rates, that inanimate or animate structures are damaged.
>
> Several strategies, in one mix or another, are available for reducing the human and economic losses that make this class of phenomena of social concern. In their logical sequence, they are as follows:
>
> •Prevent the marshaling of the form of energy.
> •Reduce the amount of energy marshaled.
> •Prevent the release of the energy.
> •Modify the rate or spatial distribution of release of the energy from its source.
> •Separate, in space or time, the energy being released from that which is susceptible to harm or damage.
> •Separate, by interposing a material barrier, the energy released from that which is susceptible to harm or damage.
> •Modify appropriately the contact surface, subsurface, or basic structure, as in eliminating, rounding, and softening corners, edges, and points with which people can, and therefore sooner or later do, come in contact.
> •Strengthen the structure, living or nonliving, that might otherwise be damaged by the energy transfer.
> •Move rapidly in detection and evaluation of damage that has occurred or is occurring, and counter its continuation or extension.
> •After the emergency period following the damaging energy exchange, stabilize the process. (p. 229)

All hazards are not addressed by the unwanted energy release concept. Examples are the potential for asphyxiation from entering a confined space filled with gas, or inhalation of asbestos fibers. But all hazards are encompassed within a goal that is to avoid *both* unwanted energy releases *and* exposures to hazardous environments.

Many improvements made in the interior and exterior design of automobiles to reduce the occurrence of incidents and their potential severity relate to Haddon's principles.

Hollnagel (2004) also refers to management oversight and risk tree (MORT) as an indication of a treatment and a resource with respect to barriers.

> MORT proposed a distinction between several different types of barriers. These were: 1) physical barriers; 2) equipment design; 3) warning devices; 4) procedures/work processes; 5) knowledge and skills; and 6) supervision.

> Finally, the MORT barrier analysis discussed how barriers might be unable to achieve their purpose, either because they failed as such or for other reasons. (p. 80)

ANSI/ASSE Z10-2012, Occupational Health and Safety Management Systems, is an additional and valuable resource with respect to barriers. In its planning section, safety and health issues are defined as "hazards, risks and management system deficiencies" (ANSI/ASSE, 2012, p. 9).

How significant to read that CSB agrees that "a company's most senior leadership, starting at the board of directors, plays the pivotal role in influencing a culture."

Barriers are defined here in the widest possible scope. Hollnagel's (2004) comments on MORT are a good reference for what barriers may include. Barriers include all aspects of operations that relate to hazards and the risks that derive from them, and the relative management systems that should be in place to achieve acceptable (i.e., as low as reasonably practicable) risk levels.

If appropriate barriers and controls exist and the management systems pertaining to them have no deficiencies, then damaging incidents are less likely to occur. Having appropriate and well-managed barriers and controls in place is critical for every aspect of operational risk management.

Management of Change

Following is an excerpt from Volume 3 (CSB, 2016b).

> Experience shows that changes in the operating environment, systems, procedures, equipment, organization, and management personnel and practices represent some of the biggest challenges to effectively managing major hazard risks. Poorly managed change frequently results in serious failures, many of which are precursors to major accidents (or higher costs as well). A vital component of change management is an assessment of how those technical changes may influence human performance. (p. 102)

OSH practitioners should closely examine the preceding excerpt. It is loaded. Although the comments are within a report on an offshore disaster, they pertain to a broad range of operations.

Studies of incident investigation reports show that "poorly managed change frequently results in serious failures, many of which are precursors to major accidents (or higher costs as well)" is too often the case. CSB (2016b) says "a missed opportunity" was an important factor in the Macondo event (p. 103).

If safety practitioners believe their responsibilities include a focus on serious injury and fatality prevention, it is to their advantage to review for adequacy the management of change practices in the organizations they advise. If effective management of change processes are in place, fewer incidents resulting in serious injuries or fatalities would occur.

Recognizing Practical Limitations

In its report, CSB (2016b) boldly suggests that designers of systems and writers of standard operating procedures may not be able to achieve perfection.

> The operator cannot write a drilling program that foresees all circumstances and covers every detail for the drilling contractor to follow. Therefore, the operator and drilling contractor must actively work to bridge the gap between work-as-imagined in the drilling program as defined by well designers, managers, or even regulatory authorities and work-as-done by the well operations crew. (p. 84)

> Gaps between work-as-imagined . . . and work-as-done . . . must be continually identified, managed and minimized by building a resilient process that can sustain desirable operations during both expected and unexpected conditions. (p. 84)

While the preceding excerpts refer to drilling and contractors, their premise applies to all types of operations. To expect designers and writers of standard operating procedures to achieve perfection and be able to envision all possible hazards denies their humanity. Gaps typically exist between work-as-imagined and work-as-done.

Why is this significant? Safety practitioners should realize that variation from what is prescribed is a norm. When an incident occurs and it is learned that an employee did not follow the standard operating procedure, a five-why process should be applied to determine the reason for that person's actions. It may be that what was done seemed logical to the employee and the supervisor as they made revisions in the work process.

Incident Investigation

The following excerpt from Volume 3 is titled "Expanding Beyond Immediate Causes and Implementing Change." Safety professionals should take note of the sound concepts it presents.

> The broadest learning impact can be achieved when investigations extend beyond the immediate technical causes of an incident. Addressing deficient safety management systems and inadequate organizational practices can result in findings that go beyond the immediate chain events that preceded any one incident. As examples in this chapter show, while the immediate causes of a well control incident might vary, the safety management systems and organizational findings can be similar. . . . There is the danger of concentrating on the exact mechanism of the previous incident rather than identifying broad lessons. (p. 127)

Regulatory Recommendations

Volume 4 is titled "Regulatory Oversight of U.S. Offshore Oil and Gas Operations: A Call for More Robust and Proactive Requirements." The document fulfills CSB's responsibilities as described in the following excerpt.

> The CSB's preventive mission as a federal agency is to reduce chemical hazards as broadly as possible (e.g., through recommendations that will effect national preventive changes). The CSB, therefore, focuses its recommendation efforts on changing national legislation, regulation,

> voluntary consensus standards and industry recommended practices. As a result of an investigation or study, the CSB may issue "proposed rules or orders" to regulators such as the EPA Administrator and the Secretary of Labor "to prevent or minimize the consequences of any release of substances that may cause death, injury or other serious adverse effects on human health or substantial property damage as the result of an accidental release" [42 U.S.C. 7412(r)(6)(c)(ii)]. (CSB, 2016c, p. 12)

CSB (2016a, pp. 12-23) summarizes "Key Investigative Findings and Conclusions," including those pertaining to regulatory attributes. The following excerpts from Volume 4 reflect what CSB (2016c) continues to stress.

> For example, key findings in Volumes 3 and 4 of the Macondo Report show that the U.S. offshore regulator lacks effective use of key process safety indicators and guidance addressing corporate boards of directors and human factors focused on major accident prevention. The CSB report analysis shows that addressing these significant gaps could help reduce the risk of similar incidents. (p. 12)

Under the heading "Continual Risk Reduction to Levels As Low As Reasonably Practicable (ALARP)," CSB (2016c) says:

> The intention of a goal-based, risk-reduction regulatory framework is to eliminate or sufficiently minimize the risks in an operation. Although risk can never be completely eliminated, any such framework must continually strive toward this goal. With major accident hazards, the key question becomes: Is there anything more that can be done to reduce the risk? ALARP is a standard familiar to industry in other global offshore regimes, and even in other high-hazard industries in the U.S. (p. 14)

As part of the agency's investigative approach, CSB may examine the strengths and weaknesses of regulations that other countries have adopted. CSB reviewed regulatory requirements in the U.K., Australia and Norway, and found that U.S. requirements have gaps that CSB hopes will be eliminated as they are revised (p. 17).

Conclusion

CSB's report on the *Deepwater Horizon* incident is fascinating for the positions it takes. The writers of the report indirectly advance the state of the art in safety management. Safety practitioners will benefit by asking what they can learn from the executive summary and four volumes that make up the CSB report. **PS**

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