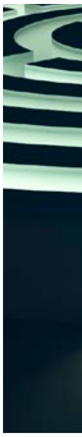

Business Risks

What Happens When Leaders Are Committed to Nonoptimal OSH Systems?

By Vladimir Ivensky

Conducting an OSH risk review is a common safety management practice, allowing to systematically recognize, evaluate, prioritize and control OSH risks for a particular industry, organization or project. OSH system deficiencies such as lack of leader commitment to safety, lack of management and employee participation in safety programs, nonexistent or not followed management of change procedures, inadequate hazard analysis and design for safety, flawed communication and reporting systems, and inadequate learning from prior events constitute significant OSH risks (Leveson, 2011). Engineering, management and PPE controls are applied to avoid or mitigate the risks to acceptable levels.

The aforementioned OSH risks are known and discussed in the OSH profession. This article reviews several less frequently discussed risks related to nonoptimal OSH models:

•Misbalanced OSH program. One program element (e.g., engineering controls, administrative controls or human factors) enjoys a priority over the others.

•Presumption that low occupational injury rates are directly correlated to a reduced risk of a serious injury or fatality.

•Impractical expectations for occupational injury rates (including from contractors) for the existing level of hazards and OSH controls.

•Confusion between occupational safety and system safety.

•Confusion between an intentional safety violation and an error.

•Presumption that employee commitment to safety would eliminate or significantly reduce errors.

•Lack of clarity on duty of safety care to other parties at multiemployer projects.

•Poor integration of OSH with operations and other functions, or OSH program does not fit the company's business model.

•Company leadership is committed to a nonoptimal OSH program and actively promotes it.

This noncomprehensive list of conceptual deficiencies provides an additional perspective on improving the effectiveness of OSH programs.

Leadership Commitment to a Nonoptimal OSH System as a Safety Risk

A company's senior management commitment to safety is a critically important element of any OSH program. ANSI/AIHA Z10-2012, Occupational Health and Safety Management Systems, states:

> Top management shall direct the organization to establish, implement and maintain an occupational health and safety management system in conformance with the requirements of this standard and that is appropriate for the nature and scale of the organization and its occupational health and safety risks.

The second part of the statement leaves significant flexibility to design an OSH management system appropriate to the nature and scale of a specific organization and its OSH risks.

While OSH professionals often question a specific executive's level of safety support (e.g., "Does s/he really support safety?"), company executives should make sure they are committed not just to safety in the abstract, but to an appropriately designed, effective and implementable OSH system, adequately recognizing, evaluating and controlling the OSH hazards and risks. Executives should ensure that they have satisfactory answers to the questions such as:

•Are the OSH strategy, model and system realistic, implementable, applicable and effective for the business?

•Can the existing OSH management system, budget and staffing deliver the stated goals and targets? How were those goals, targets and expectations formed?

•Does the OSH system fit a particular industry mix, scale of the organization, size of the projects, project hazards and project safety roles?

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•Is executive management aware of the legal OSH implications and regulatory requirements in sufficient detail?

•Is there agreement among the key stakeholders, including management, employees and OSH professionals on prioritization of the company's OSH hazards, effectiveness of controls and residual tolerable OSH risks?

Company executives are not safety professionals. In forming their OSH expectations, selecting OSH strategies and key performance indicators, defining the standard of OSH care, and choosing of particular OSH philosophies and management systems, executives rely on their own knowledge and experience in various fields, on their management teams, on existing industry practices and cultures, on internal corporate OSH departments, on outsourced consultants, or on the combination of these. OSH consultants have diverse educational backgrounds (e.g., engineering, psychology, biology, medicine, military, education, legal) and professional experiences and industries (e.g., manufacturing, construction, natural resources). OSH professionals can be influenced by or may specialize in a specific OSH area (e.g., ergonomics, management systems, leadership engagement, behavioral based safety, engineering controls, occupational health, regulatory compliance and audit, governance, assurance, training), perceiving a certain area or discipline as critical for the overall success of the program. In addition, OSH consulting companies may specialize in specific OSH products they developed and seek to promote and sell, or may be affected by a certain industry's practices and culture. Various industries have established a certain business culture, with safety playing a major role in some. For example, according to U.S. Chemical Safety and Hazard Investigation Board (Bresland, 2008):

•The hotel industry has a predominantly service culture.

•Wall Street has a financial results culture.

•The airline industry has a customer-focused culture and safety culture.

•The chemical manufacturing, oil refining and nuclear power industries have a predominantly safety culture.

The safety cultures in these industries, however, are not similar. For example, the airline industry is clearly focused on and emphasizes flight safety. The key performance indicator (KPI) in the airline industry is the absence of aviation mishaps and catastrophes. The number of OSHA-recordable back strains or rolled ankles among pilots, while an important consideration for pilots and company management, would be a poor KPI for an airline or a passenger selecting a flight for a vacation. Other high-hazard industries (e.g., chemical industry, oil and gas industry) balance their key OSH priorities between process safety and occupational safety, sometimes with elements of confusion between the two. Some high-hazard industries may presume a direct correlation between occupational safety (the low level of OSHA recordables), which constitute the main focus of their OSH efforts, and process safety (the absence of disasters). That correlation may not really exist and safety philosophy, confusing those two aspects, may result in skewed safety priorities and in misdirected efforts (Hopkins, 2000; Leveson, 2011; Manuele, 2013).

Considering some safety cultures' confusion on their key safety priorities, OSH consultants' willingness to sell their particular product and philosophy, corporate OSH departments' determination to satisfy company executives by promising results that may or may not be reasonably achievable, executives may find themselves supporting OSH management programs and systems that are not optimal or not able to meet expectations.

A mistake in selecting an effective OSH consultant or corporate OSH director can result in a nonoptimal safety model winning hearts and minds of a company's leadership.

Executive commitment to safety is critical. It is equally critical that this commitment is correctly targeted and directed, and that the OSH risks are properly recognized, evaluated, prioritized and controlled. When an influential and energetic CEO is actively engaged in safety within a conceptually, philosophically or technically deficient OSH system, setting unrealistic targets and failing to properly characterize, prioritize and control the risks, the result would be far from optimal.

Leadership commitment to a nonoptimal OSH model is, therefore, an OSH risk by itself, both for the company and the executive.

IN BRIEF

- **Executive commitment to safety is critical. It is equally critical that this commitment is correctly targeted and directed, and that the OSH risks are properly recognized, evaluated, prioritized and controlled.**
- **This article reviews leadership commitment to nonoptimal OSH systems as a business risk.**
- **It also discusses OSH system deficiencies such as misbalance between elements of a safety program, nonoptimal design of OSH organization, assumption that low incident rates are directly correlated to reduced fatality risks, impractical expectations of OSH system performance, confusion between intentional safety violation and error, assumption that no errors will be made if employees are committed to safety, confusion between occupational and system safety, lack of clarity on duty of safety care at multiemployer projects, and failure to prioritize risks.**

Assumption That Low Incident Rates Are Directly Correlated to Low Fatality Rates

While it may be anticipated that occupational injury rates are directly correlated with fatality rates, some industries and larger companies experience OSHA-recordable injury rates well below the U.S. national average, while their occupational fatality rates are above the U.S. national average (Figure 1). The opposite scenarios (relatively high injury rates with low fatality rates) also exist.

Figure 1 provides an example of negative correlation between OSHA total recordable incident rate per 100 full-time employees per year (TRIR) and occupational fatality rate per 100,000 full-time employees per year for four selected U.S. industries in 2014. While TRIR in the U.S. oil and gas extraction industry was the lowest of the four selected industries (2.0), the industry's fatality rate per 100,000 employees per year was the highest (15.6). Conversely, while TRIR in the U.S. education and health industry was the highest of the four selected industries (4.2) its fatality rate was the lowest (0.70).

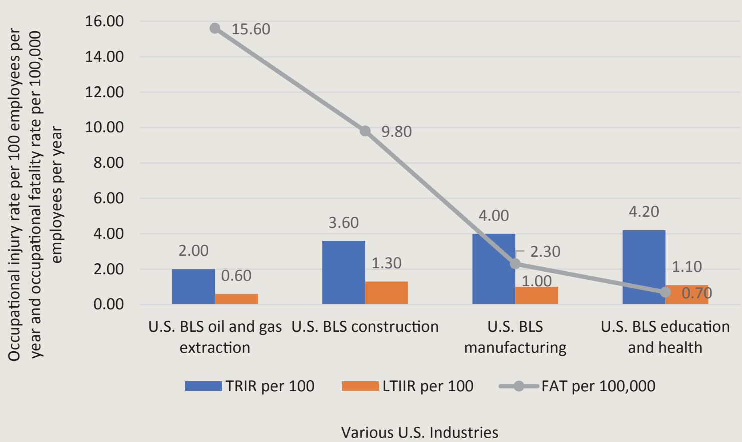
International Association of Oil and Gas Producers' (IOGP) website calls the organization the voice of the global upstream industry. IOGP members produce more than one-third of the world's oil and gas. They operate in all producing regions: the Americas, Africa, Europe, the Middle East, the Caspian, Asia and Australia. In 2014, IOGP had 76 members including major multinational oil and gas companies. Average IOGP lost-time injury rate (LTIR) in 2014 was 0.07 per 200,000 hours per year (in Figure 2, it is 0.34 per 1,000,000 hours) and average total OSHA-recordable incident rate (TRIR) was 0.33 per 200,000 hours per year. IOGP's LTIRs and TRIRs were exceptionally low in comparison with the U.S. BLS data for the oil and gas industry in the U.S. (Figure 1). IOGP's 2014 LTIR of 0.07 was 8.6 times lower than the U.S. BLS LTIR for the oil and gas extraction industry of 0.60. IOGP's 2014 TRIR of 0.33 was 6 times lower than the U.S. BLS TRIR for the oil and gas extraction industry of 2.00. However, 16 out of 22 IOGP companies with more than 50 million hours per year experienced occupational fatalities in 2014 (the best historical record year), despite their exceptionally low injury rates (the asterisks on Figure 2 indicate companies with fatalities).

Three out of five companies in the "top quadrangle" (best "safety performance") experienced fatalities in 2014. Figure 2 illustrates the point that low OSHA-recordable incident rates should never result in a complacency and could not be used as an indicator of decreased risk of serious injury or fatality incidents.

According to Manuele (2013):

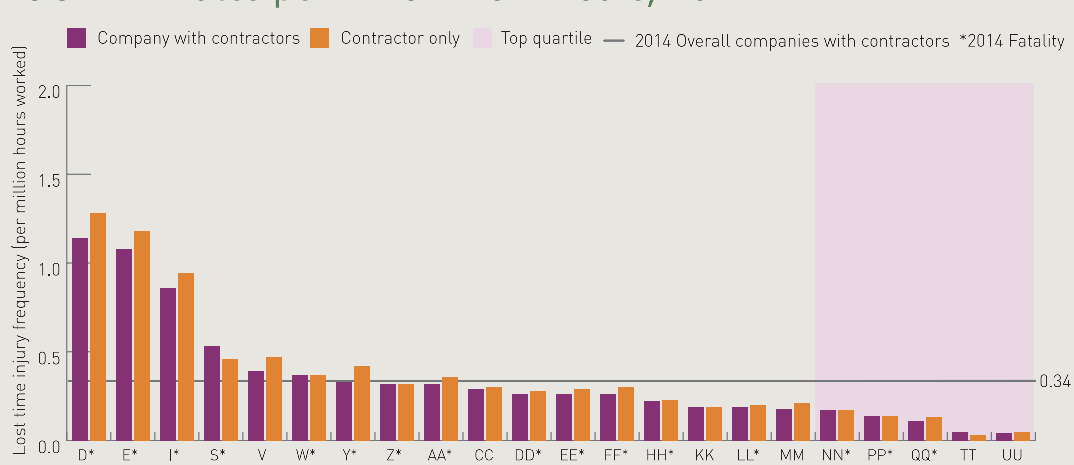
> It will take a major educational undertaking to convince management, and subsequently all personnel, that achieving low OSHA incident

FIGURE 1
Occupational Injury & Fatality Rates in Selected U.S. Industries



Note. *Data from Injuries, Illnesses and Fatalities, by Bureau of Labor Statistics, 2014.*

FIGURE 2
IOGP LTI Rates per Million Work Hours, 2014



Note. *Data must be divided by 5 to compare to the U.S. OSHA LTI rates, calculated per 200,000 hours. Asterisks indicate companies with fatalities. Figure reprinted from* Safety Performance Indicators—2014 Data, *by International Association of Oil and Gas Producers, 2015, London, U.K.: Author. Copyright IOGP 2015. Reprinted with permission.*

rates does not indicate that controls are adequate with respect to serious injury and fatality potentials. For more than 40 years, low OSHA incident rates have been overemphasized, resulting in competition within companies and among companies within an industry group. When achieving low OSHA incidence rates is deeply embedded within an entity's culture, uprooting and dislodging it will be a challenging, long-term effort. (Manuele, 2013)

Efforts to achieve low OSHA-recordable incident rates embrace significant elements of post-incident case management that do not contribute to incident prevention, but can be time and resource consuming. Building a safety strategy based on the assumption that achieving extremely low incident rate frequencies proportionately reduces the risk of an occupational fatality may lead to misdirected efforts and overlooked critical hazards.

Concentrating on achieving low incident rates via controlling high-frequency low-potential hazards may result in overlooking rare high-potential hazards, which may lead to serious incidents.

Impractical Safety Expectations

Many companies these days are targeting OSHA occupational injury rates so low that they may be problematic to achieve with realistic levels of OSH controls. The OSHA recordkeeping system (29 CFR 1904) was not designed for such a competition. Some OSHA-recordable occupational injuries (e.g., many musculoskeletal cases) can occur within a working environment and activities that are perfectly acceptable within any reasonable standard of care. The occupational injury cases can be associated with routine activities such as walking, bending or sitting, not violating any known best OSH management practices. Other injuries can be attributed to the actions of third parties, not controlled by the injured person's company, such as being rear-ended in traffic.

Succeeding in achieving zero harm expectations would require reaching absolute control over all occupational hazards and complete elimination of all OSH risks. Such zero risk conditions are not either theoretically or realistically achievable in many field environments. For example, a universally accepted job or task activity hazard analysis process (e.g., JSA, AHA) does not have an option for zero residual risk (i.e., risk can be low but cannot be zero).

The concept of tolerable risk, contradicting the concept of zero harm, is well illustrated by the principle of as low as reasonable practicable (ALARP), developed by the U.K.'s OSH regulatory agency, Health and Safety Executive (HSE, 2015). ALARP divides OSH risks into three categories. At the top end is intolerable risk: risk that cannot be accepted no matter how high the controllable costs might be. At the lower end is negligible risk: risk that is considered an acceptable residual risk. Tolerable risk is located between intolerable risk at the top and negligible risk at the bottom. This risk can be tolerated when cost-effective measures have been put in place. Anyone operating in the tolerable risk region must demonstrate that effective risk review has been conducted and that the cost-effective controls are in place that provide the lowest reasonably achievable risk possible. While the definitions of intolerable, tolerable and negligible risks are open for the interpretation, the ALARP approach contradicts the zero harm expectations as residual risks are tolerated in ALARP and the cost-benefit analy-

FIGURE 3

Incident Rate Reduction With Time & Efforts

Figure 3a: Total recordable incident rate (TRIR) reduction with time and efforts. Efforts (budget, safety program) are presented as a constant horizontal line.

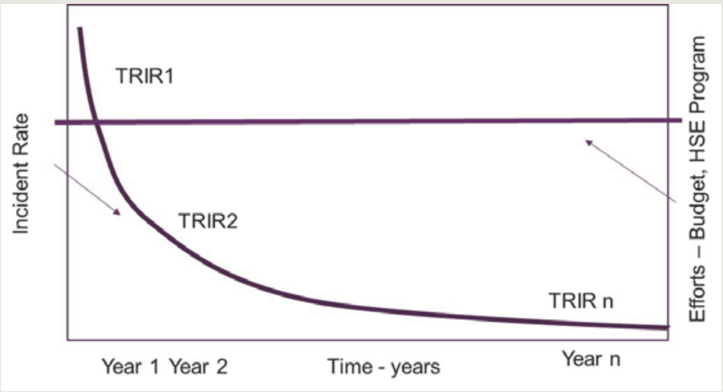


Figure 3b: Incident rate reduction with time and efforts. The efforts in this example are lower than in the case above, so the incident rate reduction is less impressive.

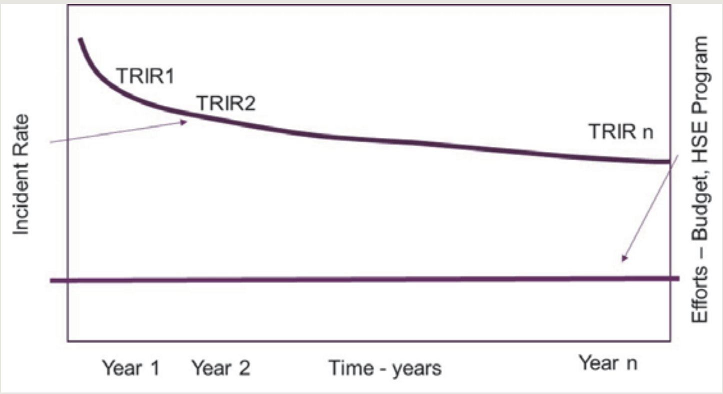


Figure 3c: Incident rate reduction with time and efforts. This example illustrates unrealistic expectations of safety performance of a subcontractor with some historic TRIR. The hiring contractor may expect an immediate drastic improvement of that contractor's safety performance without allowing sufficient time and control to achieve it.

sis on controls is, to some degree, "compromising on safety" while zero harm programs are declaring "no compromising on safety" as a core principle (Ivensky, 2016).

Zero harm expectations in some instances substitute scientific risk assessment and quantification with wishful thinking, relying predominantly on a highly safety-motivated workforce that would commit zero unsafe acts. Those philosophies often ignore the hierarchy of controls, overemphasizing the behavior-based safety aspects and sometimes confuse intentional safety violations and human errors (Ivensky, 2016).

When a subcontractor's safety performance is included in a prime contractor's or hiring contractor's zero harm programs, the above conditions are applied to the subcontractors. That creates an additional significant challenge as the level of control over the subcontractor's employees is typically lower than over the company's own employees and the level of the subcontractor's safety program maturity, while it may be acceptable by any common prequalification criteria, would rarely be perfect.

Illustrating these points are Figures 3a, 3b and 3c (p. 47). Applying a particular level of safety management control to a company (horizontal line) would result in continuous improvement of its safety performance and in reduction of occupational injury and illness rates over the years (a curve, demonstrating occupational injury rate improvements through the years). The real curve would fluctuate. More significant levels of OSH efforts (horizontal line) would, idealistically, result in better safety results (lower occupational injury and illness rates).

It is unprovable, however, to expect the results immediately, on day one of program implementation or on the day a new subcontractor is hired to work at a project (Figure 3c, p. 47).

Misbalance Between the Elements of a Safety Program

To implement an effective safety program, it is important to ensure that it is correctly designed and balanced. No elements of an OSH program should be underemphasized in favor of other elements. For example, technical and engineering safety components should not be downplayed in favor of cultural elements. Similarly, occupational health aspects should not be sacrificed in favor of occupational safety (Ivensky, 2017).

Emphasizing regulatory compliance would not guarantee a workplace free of hazards and incidents, as no regulation can envision numerous combinations of workplace circumstances that can lead to an incident. Properly designed management systems are necessary, but would not work without technical safety rules, technical knowledge, safety culture and safe behaviors. Safe behaviors will not be a solution in situations where hazards are not recognized or understood, or where no systematic approach exists for safety management. The effects of inevitable unintentional human errors must be eliminated by engineering controls and management systems.

It would be logical to assume that an optimal balance exists between the major elements of a safety program and overemphasizing or favoring any particular element may be detrimental to the overall success of a resulting safety program.

Confusion Between Intentional Violation & Error

Another common misconception of OSH programs is an assumption that "unsafe acts" occurring in the workplace constitute mostly conscious, intentional safety violations that can be modified by safety attitude, commitment and culture improvements, and by disciplinary actions.

According to Shappell (2000), human error (and not an intentional safety violation) has been implicated in 70% to 80% of all civil and military aviation incidents. Only a small percentage of human-factor-related incidents are caused by intentional safety violations: According to Reason (2000), "in aviation maintenance some 90% of quality lapses were judged as blameless." Therefore, a significant proportion of unsafe acts leading to an incident are not based on intentional violations of safety rules, but on errors.

It appears that the ABC (antecedent-behavior-consequence) models used in popular behavior-based safety programs are more applicable for managing the intentional safety violations and obvious slips or lapses (e.g., failure to buckle up in a car, failure to wear a hard hat) and less effective in controlling of human errors (e.g., rule-based mistakes, knowledge-based mistakes) in more complicated tasks. Human errors can be reduced but cannot be eliminated. Effective OSH and quality management systems with well-developed and implemented controls are required to mitigate and eliminate the effects of inevitable human errors.

Assumption That No Errors Will Be Made If Employees Support Safety

Probability of various types of human errors (human unreliability) are well studied (some examples are provided in Tables 1 and 2).

The nominal error rate in "completely familiar, well-designed, highly practiced routine task" is 4 out of 10,000. In the author's opinion, relying on safety commitment alone would not result in error-free performance, indicating the necessity of engineering controls and management systems able to mitigate the effects of a human error. When the task is associated, for example, with operating a safety-critical system, such as pushing a button for activating the railroad switching points while operating a train, any level of risk of human error becomes unacceptable, requiring additional engineering control to mitigate the effects of such an error.

In August 1999, a freight train was standing on a side line to enable the Indian Pacific passenger train to pass on the main line. As the Indian Pacific approached, one of the drivers from the freight train inadvertently pressed a button that activated the electrically operated points. He immediately recognized his error, but had no opportunity to undo his action. As a result, the

Indian Pacific was diverted from the main line and collided with the stationary freight train. (Western Australian Department of Transport, 1999, cited in Hobbs, 2003)

The incident report indicated that:

•The driver at the equipment room remembered opening the push button control box.

•The driver stated that he did not know why he pushed the points-reversing button.

•The driver stated he could not remember pushing the button.

Solutions such as a software requirement to confirm the request or automatic denial of the request, providing a signal that the rail is occupied by another train, would have eliminated the impact of a human error.

A good example of a knowledge-based technical error as a direct cause of a major aviation near-disaster is the Gimli Glider incident, well known in Canada. An Air Canada flight from Ottawa to Edmonton in July 1983 found itself without fuel halfway through the journey at an altitude of 41,000 ft. The amount of fuel that had been loaded was grossly miscalculated because of a confusion between the metric and imperial systems, as the metric system had recently replaced the imperial system in Air Canada. In addition, a fuel gauge on the plane was not operational. Astoundingly, the 68 passengers and eight crew members were saved by the pilots who managed to glide and land the Boeing 767 plane at the closed Air Force Base at Gimli, Manitoba.

The Gimli Glider incident was the subject of a detailed investigation, multiple articles, a movie, several TV shows and presents an extremely interesting and valuable case study for safety professionals. For the purpose of this article, the story points out that no observable safety behavior deficiencies (unsafe acts) would have been apparent to a regular safety observer: a ground crew would be wearing proper PPE, follow speed limits, utilize proper lifting techniques, place cones and use flaggers. The problem was mostly in the confusion between imperial and metric systems by the ground crew and by the pilots (i.e., knowledge-based errors were made). The critical safety failure act committed (deficient fueling of the plane) was not observable as "unsafe behavior" that is a usual target of behavioral safety program observers, but should have been detected through properly designed and integrated safety, quality and operation management systems. The investigation identified deficiencies in the safety management systems as the root cause of the incident.

Interestingly, the miscalculation of the fuel that expectedly should have led to a major aviation disaster was similar to common medication dosage errors that can seriously harm or kill a patient. One recent study's purpose was to identify causes of medical errors during a simulated prehospital pediatric emergency (Lammers, Byrwa & Fales, 2012). Two-person emergency medical services

TABLE 1

Nominal Rates of Human Unreliability for Generic Tasks

Task	Nominal error rate
Completely familiar, well-designed, highly practiced routine task	0.0004
Routine, highly practiced, rapid task requiring little skill	0.02
Fairly simple task performed rapidly or given scant attention	0.09
Complex task requiring high level of comprehension and skill	0.16
Totally unfamiliar task, performed at speed, with no real idea of likely consequences	0.55

Note. *Adapted from The Pathophysiology of Medication Errors: How and Where They Arise, by S.F. McDowell, H.S. Ferner and R.E. Ferner, 2009, British Journal of Clinical Pharmacology, 67(6), 605-613.*

TABLE 2

Nominal Error Rates of Activities in Healthcare

Task	Nominal error rate
Error of commission (e.g., misreading label)	0.003
Simple arithmetic errors with self-checking	0.03
Error of omission without reminders	0.01
Inspector fails to recognize an error	0.1
Error rate under very high stress when dangerous activities are occurring rapidly	0.25

Note. *Adapted from The Pathophysiology of Medication Errors: How and Where They Arise, by S.F. McDowell, H.S. Ferner and R.E. Ferner, 2009, British Journal of Clinical Pharmacology, 67(6), 605-613.*

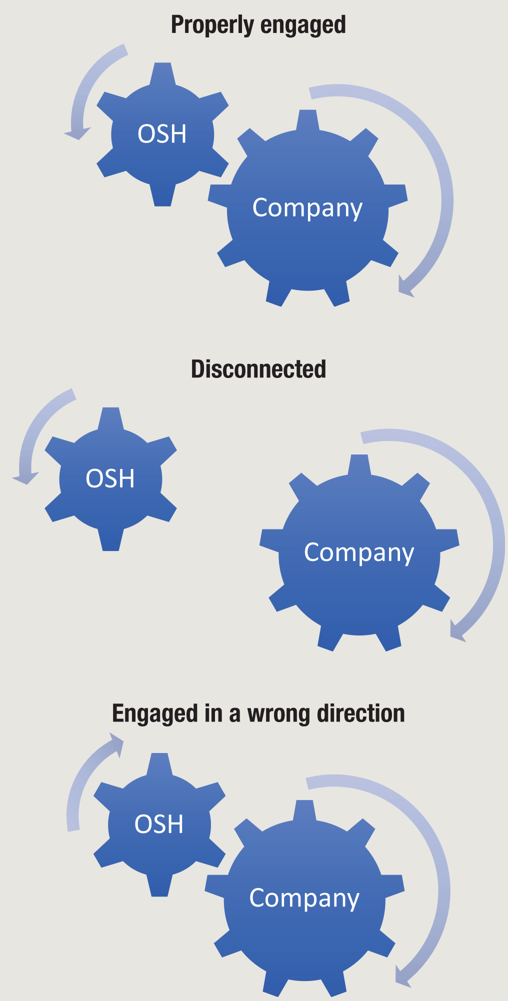
TABLE 3

Error-Producing Conditions & Increased Risks of Errors

Error-producing condition	Error risk increase
Unfamiliarity with a situation that is potentially important, but that only occurs inherently or that is novel	17
Shortage of time available for error detection and correction	11
Low signal-to-noise ratio	10
Mismatch between an operator's model of the world and that imagined by a designer	8
No obvious means of reversing an unintended action	8
Channel capacity overload, particularly one caused by simultaneous presentation of nonredundant information	8
A need to unlearn a technique and apply one that requires the application of an opposing philosophy	6
Ambiguity in the required performance standards	5

Note. *Adapted from The Validation of Three Human Reliability Quantification Techniques—THERP, HEART and JHEDI: Part I—Technique Descriptions and Validation Issues, by B. Kirwan, 1996, Applied Ergonomics, 27(6), 359-373.*

FIGURE 4
Corporate OSH Function's Interaction With a Company



crews from five geographically diverse agencies participated in a validated simulation of an infant with altered mental status, seizures and respiratory arrest using their own equipment and drugs. A scoring protocol was used to identify errors and root causes. Forty-five crews completed the study. Clinically important themes that emerged from the data included oxygen delivery, equipment organization and use, glucose measurement, drug administration and inappropriate cardiopulmonary resuscitation. Delay in delivery of supplemental oxygen resulted from two different automaticity errors and a 54% failure rate in using an oropharyngeal airway. Most crews struggled to locate essential pediatric equipment. Three found broken or inoperable bag/valve/masks, resulting in delayed ventilation. Some mistrusted their injection gun device; others used it incorrectly. Only 51% of crews measured blood glucose; some discovered that glucometers were not stored in their sealed pediatric bags. The error rate for diazepam dosing was 47%; for midazolam, it was a staggering 60%.

Underlying causes of dosing errors were found in four domains: cognitive, procedural, affective and teamwork, and they included incorrect estimates of weight, incorrect use of the pediatric emergency tape, faulty recollection of doses, difficulty with calculations under stress, mg/kg to mg to mL conversion errors (similar to those in the Gimli Glider incident), inaccurate measurement of volumes, use of the wrong end of prefilled syringes and failure to crosscheck doses with partners.

Again, a typical safety observer would not be able to notice any "unsafe behavior," as all necessary safety protocols (e.g., bloodborne pathogens exposure prevention) would be followed. Only an expert in a particular field (aviation, fueling, medical) would be able to notice the errors. Such a professional would be acting as a part of an integrated safety/quality/technology/engineering system's team.

Commitment to safety or lack of thereof was not listed as a contributing factor to drug dosage errors at hospitals or in the Gimli Glider incident. However, medication dosage error can be potentially lethal to a patient as a pilot's error can be lethal to both the pilot and passengers. Occupational safety is historically concentrating more on occupational hazards to an employee (e.g., bloodborne pathogen exposure prevention in medicine, safe working conditions for the plane fueling crew) than on comprehensive system risks, including human error prevention and mitigation within a technological process (comprehensive system safety).

While the errors that humans make may appear random, many of these errors occur in systematic and predictable ways (Henriksen & Dayton, 2006). For example, specific "error-producing conditions" are known, studied and have specific error-increasing rates (Table 3, p. 49). Eliminating error-producing conditions would logically result in the reduced error frequencies.

According to Leveson (2011):

> Human error is a symptom of a safety problem, not a cause. Telling people not to make mistakes, firing operators who make them or trying to train people not to make mistakes that arise from the design of the system is futile. Human error can be thought of as a symptom of a system that needs to be redesigned.

The rates and effects of human errors (not safety violations) would most likely not significantly depend on employees' commitment to safety, but on employee and management competence, the correct design of the management system, the absence of error-producing conditions and the effectiveness of controls. That would ensure that human errors are minimized, avoided or detected and mitigated before they become safety and health hazards or causes of incidents.

Confusion Between Occupational Safety & System Safety

Leveson (2011) notes that most industries separate the different problems of occupational safety and system safety.

> Confusion between these two very different problems and solutions can lead to overemphasis on only one type of safety, usually occupational or personal safety, while thinking that the other types of accidents or losses will also be prevented—

which they will not. Because personal safety metrics (such as days away from work) can more easily be defined and collected than process or system safety metrics, management is fooled into thinking system safety is improving when it is not and may even be deteriorating.

According to HSE (2005):

> The majority of major hazard sites [in high-hazard industries] still tend to focus on occupational safety rather than on process safety and those sites that do consider human factors issues rarely focus on those aspects that are relevant to the control of major hazards. For example, sites consider the personal safety of those carrying out maintenance, rather than how human errors in maintenance operations could be an initiator of major accidents. This imbalance runs throughout the safety management system, as displayed in priorities, goals, the allocation of resources and safety indicators.

The same point is included in the conclusion of the Baker Panel Report (BP U.S. Refineries Independent Safety Review Panel, 2007):

> [The company] uses the [comprehensive list of causes (CLC)] for both personal safety accidents and process safety accidents. As a result, the checklist CLC approach may tend to bias the analysis toward looking at human error as opposed to engineering and management issues. In the Panel's opinion, the causal factors involved in occupational or personal safety incidents and process safety incidents typically are very different. The use of personal safety incident hypotheticals as the only examples in some of the [company] training materials that the Panel reviewed may inadvertently reinforce this bias. The human error analysis, which focuses investigators' efforts on personal safety aspects of incidents rather than all aspects of an incident, may introduce additional bias in the analysis toward finding behavioral root causes.

Lack of Clarity on Duty of Safety Care at Multiemployer Projects

Lack of clarity on a company's statutory and project-specific roles and responsibilities, holds a risk of creating a duty of safety care and safety liabilities where it can or should be avoided or a risk of a failure to recognize and mitigate the existing duty of safety care to other project parties.

Certain conditions can contribute to those risks:

•confusion in recognizing own project-specific safety role and responsibilities (e.g., prime contractor, construction manager at risk, construction manager as agent, engineer/architect, lower-tier subcontractor), creating additional safety liabilities or failure to recognize and mitigate the existing liabilities;

•confusion between statutory, common law, contractual and control-generated safety duties applicable to a party at a multiemployer project;

•acting as a controlling employer when not needed;

•failure to intervene in unsafe situations when needed (Ivensky, 2015).

Safety Organization Design Is Not Optimal

Correct OSH program selection, design and integration with the company are critical for the overall success of both the OSH program and the company. Figure 4 illustrates a corporate OSH function's possible interactions with a company. A correctly designed and integrated OSH department would help a company move in a right direction. A disengaged OSH department would operate in its own world, not connected to the company, providing close to zero value. An OSH department designed in a way that does not fit the company's business model would be attempting to move the company in a wrong direction, creating a negative value for the business.

While designing the OSH system, the risk of poor scaling should be recognized and avoided. Table 4 illustrates the scaling of OSH systems.

Attempts to adopt a one-size-fits-all approach and failure to scale the OSH models would constitute an OSH risk. A related risk is interpreting the popular everyone-is-responsible-for-safety philosophy to mean that no one is actually responsible (diffusion of responsibility). Declared shared responsibility for safety holds a risk of an interpretation that actually no one is responsible. The proverb "Too many cooks spoil the broth" indicates that if too many people are responsible for a task it will not be done well. The

TABLE 4
The Scaling of OSH Systems

	Large project model	**Small project model**
Corporate OSH organization	•Relies on professional safety organization at the project level. •Provides leadership and strategic direction. Provides support to offices.	•Have no project safety organization to rely upon. •Provides company-wide safety support to projects and offices. •Serves as program safety manager on all major contracts.
Projects: number, order of magnitude	10^1	10^{3-4}
Professional project safety organization	Can be numerous full-time safety professionals per major project	•No dedicated project safety organization •No full-time project safety professionals
Project safety roles	Typically a prime contractor or controlling employer	Various safety roles, such as: 1) prime contractor 2) construction manager at risk 3) construction manager as agent 4) engineer/architect to any project party 5) lower tier contractor with subcontractor(s) 6) lower tire contractor without subcontractor(s)
OSH training and direction provided	Strategy, leadership, management system	Strategy, leadership, management system, technical safety training

Russian equivalent of that proverb has a direct safety connotation: "Seven nannies have a child without an eye." It is important that roles and responsibilities for OSH are clearly assigned and go well beyond general declarations and slogans. Employees, for example, should not be asked to recognize and control hazards they have no information, training or means to recognize and control.

Failure to Prioritize Risks

Improperly selected priorities, strategy and tactics not shared by key stakeholders, disagreements on perceived safety risks and ways to control them, and OSH communication gaps can damage the safety culture and OSH program effectiveness. Attempts to control all hazards and risks, regardless of their priority, and spreading available safety resources wide and shallow may not result in the reduced risks of serious injuries and fatalities. This approach may be counterproductive as available safety resources may be distracted, managing frequent low-severity safety issues while less-frequent, less-obvious significant hazards may be overlooked.

History of aviation knows multiple cases of catastrophes resulted from the pilots being distracted by flashing indicators (faulty or not) and preoccupied with the attempts to solve a particular problem (real or immediate) while forgetting to pilot a plane. The ability to sort the incoming information and recognize the correct priorities is critically important in any safety-sensitive occupation, as well as in safety management.

High-efficiency OSH programs should be able to prioritize tasks based on their importance to the ultimate goal: eliminating catastrophes and serious injuries and fatalities, thereby keeping people alive and missions successful.

Conclusion

Leadership commitment to nonoptimal OSH systems is a business risk. Several less frequently discussed risks are related to nonoptimal OSH models, such as a misbalance between elements of a safety program, nonoptimal design of OSH organization, the incorrect assumption that low OSHA-recordable incident rates are directly correlated to reduced serious injury and fatality risks, impractical expectations of OSH system performance, confusion between an intentional safety violation and an error, assumption that no errors will be made if employees are committed to safety, confusion between occupational safety and system safety, lack of clarity on duty of safety care at multiemployer projects, and failure to prioritize risks. This noncomprehensive list and discussion of conceptual deficiencies provides additional perspective on improving the effectiveness of OSH programs. **PS**

References

Anderson, M. (2006). Behavioral safety and major accident hazards: Magic bullet or shot in the dark? Merseyside, U.K.: Health and Safety Executive.

ANSI/ASSE. (2017). Occupational health and safety management systems [ANSI/ASSE Z10-2012 (R2017)]. Retrieved from www.asse.org/ansi/asse-z10-2012-r2017-occupational-health-and-safety-management-systems

BP U.S. Refineries Independent Safety Review Panel. (2007, Jan.). The report of the BP U.S. Refineries Independent Safety Review Panel (Baker Panel Report). Retrieved from www.csb.gov/assets/1/19/Baker_panel_report1.pdf

Bresland, J. (2008, Dec. 4). The Chemical Safety Board's view of safety culture (Presentation). Retrieved from www.nrc.gov/about-nrc/regulatory/enforcement/john-bresland-us-chem-safetybd.pdf

Bureau of Labor Statistics (BLS). (2014). Injuries, illnesses and fatalities. Retrieved from www.bls.gov/iif/oshsum.htm

Health and Safety Executive (HSE). (2005). Inspectors toolkit: Human factors in the management of major accident hazards, introduction to human factors. Retrieved from www.hse.gov.uk/humanfactors/topics/toolkitintro.pdf

HSE. (2015, June 20). ALARP "at a glance." Retrieved from www.hse.gov.uk/risk/theory/alarpglance.htm

Henriksen, K. & Dayton, E. (2006). Organizational silence and hidden threats to patient safety. *Health Services Research, 41*(4 Pt 2), 1539-1554.

Hobbs, A. (2003). Error "molecules" and their implications for system safety. *Proceedings of the Sixth International Australian Aviation Psychology Symposium, Sydney, Australia*.

Hopkins, A. (2000). *Lessons from Longford: The Esso gas plant explosion*. Sydney, Australia: CCH Australia.

International Association of Oil and Gas Producers (IOGP). (2015). Safety performance indicators—2014 data. London, U.K.: Author.

Ivensky, V. (2015, July). Statutory duty of safety care to subcontractors: U.S., Canadian and U.K. perspectives. *Professional Safety, 60*(7), 38-45.

Ivensky, V. (2016, July). Safety expectations: Finding a common denominator. *Professional Safety, 61*(7), 38-43.

Ivensky, V. (2017, Jan.). Optimizing safety: Engineering, systems, human factors: Part 1. *Professional Safety, 62*(1), 36-45.

Kirwan, B. (1996). The validation of three human reliability quantification techniques—THERP, HEART and JHEDI: Part I—Technique descriptions and validation issues. *Applied Ergonomics, 27*(6), 359-373.

Lammers, R.B., Byrwa, M. & Fales, W. (2012). Root causes of errors in a simulated prehospital pediatric emergency. *Academic Emergency Medicine, 19*(1), 37-47.

Leveson, N. (2011, May 17). Risk management in the oil and gas industry. Testimony before the U.S. Senate Committee on Energy and Natural Resources. MIT. Retrieved from http://energy.mit.edu/news/risk-management-in-the-oil-and-gas-industry

Manuele, F. (2013, May). Preventing serious injuries and fatalities: Time for sociotechnical model for an operational risk management system. *Professional Safety, 58*(5), 51-59.

McDowell, S.F., Ferner, H.S. & Ferner, R.E. (2009). The pathophysiology of medication errors: How and where they arise. *British Journal of Clinical Pharmacology, 67*(6), 605-613.

Reason, J. (2000). Human error: Models and management. *BMJ, 320*(7237), 768-770.

Shappell, S.W. (2000). The Human Factors Analysis and Classification System—HFACS. Springfield, VA: U.S. Department of Transportation, Federal Aviation Administration.