

though standard operating procedure states they should. When the design of the lockout/tagout system is error-provocative, it is a near certainty that errors resulting in injuries and illnesses will occur. Although the design of the system may comply with the standards, the residual risk is unacceptable if it is error-provocative.

Ergonomic design practices offer another example of how an accepted design criteria for the workplace results in residual risk that may not be tolerable for some workers. A common ergonomic design practice is to develop designs that accommodate the 5th to 95th percentile target users. Examples include stature, reach, strength, etc. Typically, ergonomics design and operations standards that address the dimensions and capabilities of this 90% of the work population are considered acceptable. As a result, there will be some residual ergonomics risks, questionable in a given situation, with respect to those workers in the lower and upper fifth of the population.

Furthermore, consider OSHA's permissible exposure limits for hazardous substances or the guidelines issued by the American Conference of Governmental Industrial Hygienists. Although exposure limits are established, it is not presumed that all persons will be illness-free at those levels. Thus, in some companies, say their safety directors, the intent is to achieve exposure limits considerably less than world standards. These companies have set a goal to achieve superior, world-class safety records and have recognized that to do so they must operate at exposure levels lower than the standards. However, they also recognize that even at these improved levels, some small amount of residual risk remains.

## CONCLUSION

This chapter establishes a concept that should be an operational goal to be achieved in applying every element in Z10. That goal is to arrive at acceptable risk levels so that the risk of harm is at a practicable and tolerable minimum. To achieve that goal, understanding the concept of acceptable risk is necessary. Fewer incidents resulting in serious injury or illness or fatality will occur if attaining acceptable risk levels is a foundational concept when putting in place the processes required by Z10.

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3. In a smaller operation, the design and operation standard for acceptable risk to employees requires that if a hazard presents the potential for injury that may require medical treatment beyond first aid, the risk deriving from that hazard must be reduced.

4. In ANSI/RIA 15.06, the American national standard for Industrial Robots and Robot Systems-Safety Requirements, a provision requires that risk reduction measures be taken if a serious injury, defined as an injury that requires more than first aid, can be foreseen.

5. In ANSI/PMMI B155.1-2006, the American National Standard for Packaging Machinery and Packaging-Related Converting Machinery, the following definition is given:

Acceptable risk—risk that is accepted for a given task or hazard. For the purpose of this standard the terms “acceptable risk” and “tolerable risk” are considered synonymous.

This note follows the definition above: “The expression ‘acceptable risk’ refers to the level at which further risk reduction will not result in significant reduction in risk; or additional expenditure will not result in significant advantages of increased safety.”

## RELATING TO PRODUCT SAFETY

Safety professionals who are also involved in product liability prevention will recognize that strong similarities exist between the acceptable risk concept applied in an occupational setting and the reasonably safe legal concept applicable in product liability determinations.

Products must be designed so that they are not unreasonably dangerous. The term “unreasonably dangerous” implies that there may be some residual risk. Inherent in this aspect of the U.S. legal system—that the design of products may not be unreasonably dangerous but that some residual risk may exist—is the implication that some non-zero level of residual risk is acceptable.

## DESIGNING BEYOND STANDARDS

Many authors have written on the need, sometimes, to set design specifications exceeding the requirements of published standards to achieve acceptable risk levels. Complying with consensus or governmental standards will not necessarily achieve an acceptable risk level.

A learned colleague has frequently reminded us that complying with the National Electrical Safety Code or the applicable OSHA lockout/tagout standard will not necessarily ensure that a non-error-provocative lockout/tagout system has been put in place. Neither of those standards requires that disconnects be placed close to where the work is being done and thereby be conducive to employee use.

Workers may consider the inconvenience of traveling a distance to power disconnects excessive and a reason for them to not shut off the electric power, even

though standard operating lockout/tagout system is in place. Injuries and illnesses will be reduced with the standards, the risk

Ergonomic design practices are criteria for the workplace to accommodate some workers. A common design to accommodate the 5th percentile of the population for reach, strength, etc. Type of design to address the dimensions of the population considered acceptable. A design is questionable in a given population if it is in the upper fifth of the population.

Furthermore, consider the standards or the guidelines of the Industrial Hygienists. Although they state that all persons will be protected by their safety directors, the standards are world standards. These standards have safety records and have levels lower than the standards. Improved levels, some standards

## CONCLUSION

This chapter establishes a foundation in applying every element of risk that the risk of harm is acceptable. Understanding the concept of acceptable risk in serious injury or illness is a foundational concept.

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Nonetheless, it should not be assumed that a risk level as low as reasonably practicable will always be acceptable. On a few occasions, that will not be so. For instance, designing an air cooling system at a risk level that the designer considers to be as low as reasonably practicable and that uses Freon as the refrigerant is not acceptable. In the design of a steam-generating plant, an insulation system for steam piping that uses asbestos, although designed as low as reasonably practicable, is not acceptable.

## DEFINING ACCEPTABLE RISK

A sound and workable definition of acceptable risk must encompass hazards, risks, probability, severity, and economic considerations. Also, in the following definition, it is made clear that a risk level as low as reasonably practicable must also be tolerable:

Acceptable risk is that risk for which the probability of a hazards-related incident or exposure occurring and the severity of harm or damage that may result are as low as reasonably practicable, and tolerable in the situation being considered.

The risk assessment matrices shown in Chapter 8, "A Primer on Hazard Analysis and Risk Assessment," and the discussions of risk categories there will help in determining acceptable and tolerable risk levels.

## EXAMPLES OF SPECIFICALLY DEFINED RISK ACCEPTANCE LEVELS

In some organizations, risk levels that are acceptable or tolerable are defined in terms of degree of injury or damage to property. The following examples will give safety professionals a basis from which they can develop probability and severity levels, and thus risk levels, that are acceptable to the operations for which they give counsel:

1. NASA-STD-8719.7, the *Facilities System Safety Handbook*, defines acceptable risk as follows: Loss of life as a result of hazards in this facility is unlikely. Hazards may result in:

- No lost workday injuries or no restricted duty cases
- Loss of facility operational capability of less than 1 day
- Damage to equipment or property less than \$25,000

2. For a major manufacturer of heavy mobile equipment, if it may be reasonably assumed that a user of the equipment, a customer, can lose a day's work, the risk situation must be addressed through equipment redesign or by strengthening the operations manual, thus alerting users to the hazard's potential and providing appropriate instructions.





Judgments for arriving at an acceptable risk level are influenced by many factors, and the results vary considerably across industries. Even within a company, acceptable risk levels can vary substantially by location. A country's culture also plays an important role in risk acceptability, as has been experienced by our colleagues who work in companies with global operations. Risk acceptability is also time-dependent, in that what is acceptable today may not be acceptable tomorrow, next year, or the following decade.

Furthermore, safety professionals need to understand that decisions made with respect to risk acceptance or reduction may not always be based on logic. Sometimes, workers have perceptions about risk levels in a given situation that are unrealistically high. Although their perceptions may not be well founded, they have to be addressed in an attempt to diminish their fears. Companies have found that spending a little money to counter unreasonable perceptions of risk may be a good investment if employees are relieved of their fears and production slowdowns or interruptions are avoided.

## THE CONCLUSION TO OUR FAILED ATTEMPT

As we proceeded with our studies, we found that developing a distinct, perhaps statistical, universally applicable definition of acceptable risk that did not contain general and judgmentally interpretive terms is not possible. But, with a studied understanding of risk, and risk taking, and the concept of As Low as Reasonably Practicable (ALARP), I dare to offer a practical definition of acceptable risk that can be effectively applied when dealing with workplace hazards, risks, and deficiencies in safety and health management systems.

## DETERMINING ACCEPTABLE RISK LEVELS IS LARGELY JUDGMENTAL

In establishing a risk level, two judgmental estimates must be made: of the probability of a hazard-related incident or exposure occurring, and of the severity of harm or damage that may result. Rarely will precise incident or exposure probability data be available, and the differences in the estimates made by risk assessors of the severity of harm or damage that can occur in a given situation may be very large.

Some risk assessment systems include numerical categories for probability and severity levels and computations are made to arrive at a number that determines the risk level. Arriving at those numerical categories is entirely judgmental. Some of those numerical risk assessment systems are discussed in Chapter 10, "Three- and Four-Dimensional Numerical Risk-Scoring Systems."

Safety professionals must understand that risk assessment is as much art as science and that judgments—educated, to be sure—are made on incident or exposure probability and the severity of the incident or exposure outcome to arrive at a risk category. Also, they need to be able to work through the greatly differing views



residual risk. That risk is to be acceptable. An often quoted author on acceptable risk is William W. Lowrance, who wrote *Of Acceptable Risk: Science and the Determination of Safety*. One of his central themes is that attaining a risk-free environment, a zero risk level, is not possible. Lowrance writes:

Nothing can be absolutely free of risk. One can't think of anything that isn't, under some circumstance, able to cause harm. Because nothing can be absolutely free of risk, nothing can be said to be absolutely safe. There are degrees of risk, and consequently there are degrees of safety.

Recognizing that there are degrees of risk and safety, the logical and desirable outcome in applying the provisions in Z10 and improving safety and health management systems is to achieve the maximum degree of safety practicable.

### ATTAINING ACCEPTABLE RISK LEVELS: A CULTURAL VALUE

In organizations with advanced safety management systems, that idea—achieving minimum, practicable, and acceptable risk levels throughout all operations—is a cultural value. I suggest that safety and health professionals adopt the concept of attaining acceptable risk levels as a goal to be embedded in every risk reduction action proposed. In achieving that goal, it will be necessary to educate others on the beneficial effects of applying the concept.

Note that the standard's purpose identifies occupational fatalities, specifically, as a type of injury or illness to be reduced. That puts fatalities in a special category. It is obvious in this book that I emphasize giving particular attention to preventing incidents that result in serious injuries or illnesses, which encompass fatalities.

To repeat: My analyses indicate that many incidents resulting in serious consequences are unique and singular events and that they have multiple and complex causal factors having organizational, operational systems, technical, or cultural origins. Fewer incidents resulting in serious injury or illness or fatality will occur if attaining acceptable risk levels is a foundational concept and a cultural value when applying the processes required by Z10.

### A FAILED ATTEMPT AT DEFINING ACCEPTABLE RISK

How would I define acceptable risk? Not easily. Some time ago, I realized that it was common, during the question period following a speaker's presentation, for members of the audience to emphasize their opposition to the speaker's use of the term "acceptable risk." Some safety practitioners took strong positions as they expressed their beliefs that no risk was acceptable in the workplace. (Some still do.)

In recognition of the educational need those beliefs presented, I tried to develop a definition of acceptable risk that was precise, terse, and possibly numerical, which could be universally applicable to all risk situations. I failed. Bruce Main, president of design safety engineering, joined me in researching and authoring a paper titled

## Z10 IMPLIES THAT ACCEPTABLE RISK LEVELS ARE TO BE ATTAINED

The term "acceptable risk" does not appear in the "shall" requirements of Z10. But, by implication, the outcome of identifying and analyzing hazards, making risk assessments, and taking risk reduction measures is to attain acceptable risk levels. For example, this is how Section 5.1.2, Design Review and Management of Change, begins: "The organization shall establish and implement processes to identify, and take appropriate steps to prevent or otherwise control hazards and reduce potential risks." Hazards and risks are to be prevented or controlled—presumably to an acceptable level.

The term "acceptable level" appears in one place in the standard's "should" column (the advisory column), where advice is given on the hierarchy of controls process. The term also exists in Appendix E, which gives advice on Assessment and Prioritization. Section 5.1.1, Hierarchy of Controls, requires that "The organization shall implement and maintain a process for achieving feasible risk reduction." In the "should" column, the following appears:

Often, a combination of controls is most effective. In cases where the higher order of controls (elimination, substitution, and implementation of engineering controls) does not reduce the risk to an acceptable level, lower order controls may be necessary.

Appendix E contains a Hazard Analysis and Risk Assessment Guide. After the early steps in the Guide are taken, through which hazards are identified and analyzed and the risks are assessed, the decision makers are to make an acceptability determination. This is how Step 7 in the Guide reads: "The organization must then determine if the level of risk is acceptable or unacceptable."

## RESIDUAL RISK

The language on residual risk in Appendix E, as in the following, clearly indicates that the intent is to achieve acceptable risk levels:

*Residual risk:* Risk can never be eliminated entirely, though it can be substantially reduced through application of the hierarchy of controls. Residual risk is defined as the remaining risk after controls have been implemented. It is the organization's responsibility to determine whether the residual risk is acceptable for each task and associated hazard. Where the residual risk is not acceptable, further actions must be taken to reduce risk.

## ZERO RISK LEVELS CANNOT BE ATTAINED

It is a given that a zero risk level cannot be attained if a facility or thing exists or an activity proceeds. Therefore, in all employment situations there will be some

residual risk. That risk is to be a risk is William W. Lowrance, *Determination of Safety*. One of the environments, a zero risk level, is

Nothing can be absolutely free of risk in some circumstance, able to cause harm; nothing can be said to be absolutely safe; there are degrees of safety.

Recognizing that there are degrees of risk, the outcome in applying the provisions of the management systems is to achieve the

## ATTAINING ACCEPTABLE RISK LEVELS

In organizations with advanced safety systems, a minimum, practicable, and acceptable level of risk is a cultural value. I suggest that safety is attained by attaining acceptable risk levels as a result of the action proposed. In achieving that, the beneficial effects of applying the

Note that the standard's purpose is to prevent a type of injury or illness to be reduced. It is obvious in this book that I emphasize incidents that result in serious injury.

To repeat: My analyses indicate that the consequences are unique and singular and the causal factors having organizational origins. Fewer incidents resulting in injury are attained by attaining acceptable risk levels as a result of applying the processes required by

## A FAILED ATTEMPT AT DEFINING ACCEPTABLE RISK

How would I define acceptable risk? It was common, during the question and answer session, for members of the audience to employ the term "acceptable risk." Some expressed their beliefs that no risk

In recognition of the educational need for a definition of acceptable risk that could be universally applicable to all of design safety engineering, joined

## CHAPTER 6

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# ACHIEVING ACCEPTABLE RISK LEVELS: THE OPERATIONAL GOAL

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### INTRODUCTION

The Occupational Health and Safety Management Systems Standard, ANSI/AIHA Z10-2005, tersely and clearly states its purpose in Section 1.2:

The primary purpose of this standard is to provide a management tool to reduce the risk of occupational injuries, illnesses, and fatalities.

Note the phrase “reduce the risk.” This question logically follows. What risk reduction level is to be achieved? Safety and health professionals understand that setting a goal to achieve a zero risk level may seem laudable, but doing so results in chasing a myth. No facility, thing or activity is risk-free.

This chapter will answer the question: What risk level is to be achieved? That answer will provide a basis for thought when considering and acting on occupational health and safety management system issues. In Z10, those issues are “defined as hazards, risks, management system deficiencies, and opportunities for improvement.”

When safety management systems are most effective, there is a commitment to ascertaining the facts about hazards and risks, regardless of any unpleasantness that may arise during the discovery process, and taking actions to achieve acceptable risk levels.

A safety culture is unsound if employees do not have opportunities to participate in every aspect of the occupational health and safety management system and if they do not have the mechanisms, time, and resources necessary to participate. Furthermore, if an employer does not take advantage of the knowledge, skills, and experience of the workers close to the hazards and risks, opportunities are missed to reduce injury and illness potential and to improve safety and health management systems. Too much cannot be made of the importance of concentrating on minimizing the hazards and risks at what James Reason calls "the sharp end," meaning where the work gets done.

In Section 4.0, the Planning section, Z10 provides a focus for all that is expected of management and employees. The planning process goal is to identify occupational health and safety management issues, which are defined as "hazards, risks, management system deficiencies, and opportunities for improvement." Consider this premise: The entirety of purpose of those responsible for safety, regardless of their titles, is to manage their endeavors with respect to hazards so that the risks deriving from those hazards are at an acceptable level.

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The safety director sought help. During our discussions, it was agreed that he would approach his boss to convince him that the organization would be well served if the opinions of the staff were solicited on the quality of the safety management system in place. He did so, and it worked.

A safety management system survey guide comparable to that just presented here was sent to the safety director. He worked up a version of it that fit the high-hazard operation with which he was involved. The survey guide was sent to a statistically adequate sampling of the staff—at all employment levels. Over 70% of the guide's recipients responded; they took the survey seriously.

When the safety director analyzed the results, he found that the same shortcomings in the safety management system were recorded, largely, by all levels of employment. And there were many shortcomings. However, most important, some of the staff members reporting directly to the senior executive who authorized the survey indicated that, for the department as a whole, safety was not a high-level value.

During a meeting I attended with the safety director, his boss, and other interested persons, the senior executive was well prepared with questions about how superior safety results had been achieved elsewhere. He was surprised by the results of the culture survey. He learned that every level of the organization had asserted they wanted safety to be given a higher status.

As the discussions proceeded, I asked the senior executive to draw an organizational chart showing the positions of all personnel who reported to him. He soon acknowledged that if the risks of injury and fatalities were to be reduced, he would have to provide strong leadership and hold the staff reporting to him accountable for results.

As this is written, the author has learned that the senior executive convened his staff and spelled out what he expected of them. A communication was issued throughout the organization setting forth the safety policy and the procedures to implement it. Safety is now an agenda item for several levels of management meetings, division heads are holding the staffs reporting to them accountable for results, and management is encouraging input and involvement from all levels of employees. Communication downward and upward has improved. Safety-related suggestions receive attention quicker than had formerly been the case.

## CONCLUSION

Management Leadership and Employee Participation is the most important section in Z10. Safety is culture-driven, and leaders create the culture. It is the responsibility of leadership to change the safety culture when it is deficient. Top administrators must take responsibility for risk management by remaining alert to the effects their decisions have on the work system. Leaders are responsible for establishing the conditions and the atmosphere that lead to their subordinates successes or failures.

As top management makes decisions directing the organization, its safety culture is established and that culture is translated into a *system of expected behavior*.

When safety management: ascertaining the facts about may arise during the disco risk levels.

A safety culture is unse in every aspect of the occ they do not have the mea Furthermore, if an employ and experience of the wo missed to reduce injury a management systems. Too on minimizing the hazards meaning where the work g

In Section 4.0, the Plan of management and emplo tional health and safety ma management system defini this premise: The entirety of their titles, is to manage th deriving from those hazard

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19. Are there organizational barriers that prevent effective communication on safety, up and down?
20. Have streamlining and downsizing conveyed a message that efficiency and being on schedule are paramount, and that safety considerations can be overlooked?
21. Is staffing adequate in your group so that work can be done safely?
22. Are you discouraged to report injuries?
23. Have technical and operational safety standards been at a sufficiently high level?
24. Has it been the practice to accept safety performance at a lesser level than the prescribed standard operation procedures?
25. Have known safety problems, over time, been relegated to a "not of concern" status and, thereby, become "acceptable risks"?
26. Has safety-related hardware or software become obsolete?
27. Are certain operations continued with the knowledge they are unduly hazardous?
28. Have budget constraints had a negative effect on safety decision making?
29. Has inadequate maintenance resulted in an accumulation of hazardous situations that have gone attended. (e.g., Is the detection equipment adequate, maintained, and operable? Are basic safety-related repairs unduly postponed?)
30. Has adequate attention been paid to "near miss" incidents that could, under other circumstances, result in a major accident?
31. Are safety personnel encouraged to be aggressive when expressing their views on hazards and risks, even though their views may differ from those held by others?
32. Has there been an overreliance on outside contractors (outsourcing) to do what they cannot do effectively with respect to safety?
33. Are purchasing and contracting procedures in place to limit bringing hazards into the workplace?

## A CASE STUDY

A safety director in a very large municipal organization with about 13,000 employees read an article this author wrote in which the necessity of having a positive safety culture to achieve superior performance levels was emphasized. That organization's work is considered high-hazard and fatalities and serious injuries often occur. The safety director had concluded that the senior executive in his organization, to whom he reported, was somewhat removed from the leadership necessary to further reduce fatalities and serious injuries, and that he did not hold the staff reporting to him accountable for their incident experience.

accumulation of latent technical conditions and operating practices has developed that could be the causal factors for low-probability incidents having severe consequences.

For such a self-analysis, a survey mechanism is necessary. An outline of a basic survey guide follows. For the survey mechanism to relate to the hazards and risks in a particular operation, it is necessary that management, assisted by a safety professional, add or delete items. Also, a scoring system for each item, compatible with practices in the organization, should be included in any revision of the guide so that a compilation of results can be made. In many situations, a simple "yes", "no", and "not applicable" scoring system will suffice. I must emphasize—this guide is not offered as a one-size-fits-all mechanism.

#### A Safety Management System Survey Guide

1. Is the safety management system in place in our organization effective?
2. Does management demonstrate by what it does that safety is a core value in our organization?
3. Is there a significant gap between what management says and what management does?
4. Has the staff reporting directly to the senior manager been held accountable, in reality, for a high level of safety decision making?
5. Is this a safe place to work?
6. Are you asked to effectively participate in safety discussions and meetings?
7. Are you asked to provide input on safety matters that affect you directly?
8. Is your input on safety matters respected and considered valuable?
9. Do you believe that some of the equipment you operate or the work methods you are required to follow are hazardous and overly risky?
10. Do you believe you are free to report hazardous conditions and practices without reprimand?
11. Are you encouraged to report hazardous conditions and practices?
12. Does your supervisor effectively give safety a high priority?
13. Is accident investigation of sufficient depth to identify the reality of causal factors (organizational, cultural, design and engineering, technical, procedural)?
14. Is there a broadly held belief that the unsafe acts of workers are the principle causes of accidents?
15. Is safety often relegated to a lower status and overlooked when there are production pressures?
16. Have you been given adequate training on hazards, risks, and safe operating procedures?
17. Does the organization's culture accept gradually escalating risk?
18. Does the organizational structure enhance or dissuade adequate safety decision making?

19. Are there organizational safety, up and down?
20. Have streamlining and being on schedule overlooked?
21. Is staffing adequate?
22. Are you discouraged?
23. Have technical and level?
24. Has it been the practice the prescribed standard?
25. Have known safety status and, thereby.
26. Has safety-related h
27. Are certain operati hazardous?
28. Have budget constr
29. Has inadequate main ations that have gon maintained, and op oned?)
30. Has adequate attent other circumstances?
31. Are safety personn views on hazards ar held by others?
32. Has there been an what they cannot d
33. Are purchasing and into the workplace?

#### A CASE STUDY

A safety director in a very ees read an article this au safety culture to achieve s nization's work is conside occur. The safety director tion, to whom he reported to further reduce fatalities reporting to him accountal

explore whether management system shortcomings have resulted in an accumulation of latent conditions and operating practices that have serious injury potential. It should also result in an assessment of the organization's safety culture. From the Columbia report:

- The physical cause of the loss of Columbia and its crew was a breach in the Thermal Protection System on the leading edge of the left wing. In our view, the NASA organizational culture had as much to do with this accident as the foam. At the most basic level, organizational culture defines the assumptions that employees make as they carry out their work. It is a powerful force that can persist through reorganizations and the change of key personnel. It can be a positive or a negative force.
- Leaders create culture. It is their responsibility to change it. Top administrators must take responsibility for risk, failure, and safety by remaining alert to the effects their decisions have on the system. Leaders are responsible for establishing the conditions that lead to their subordinates' successes or failures.
- At the time of the launch of [the shuttle], NASA retained too many negative (and also many positive) aspects of its traditional culture: "Flawed decision making, self-deception, introversion and a diminished curiosity about the world outside the perfect place."
- After the accident, Program managers stated privately and publicly that if engineers had a safety concern, they were obligated to communicate their concerns to management. Managers did not seem to understand that as leaders they had a corresponding and perhaps greater obligation to create viable routes for the engineering community to express their views and receive information.
- Safety personnel were present [at meetings] but passive and did not serve as a channel for the voicing of concerns or dissenting views. The silence of Program-level safety processes undermined oversight: when they did not speak up, safety personnel could not fulfill their stated mission to provide "checks and balances."
- Management decisions made during Columbia's final flight reflect missed opportunities, blocked or ineffective communications channels, flawed analysis, and ineffective leadership.

## PROPOSING AN INTERNAL ANALYSIS OF THE SAFETY CULTURE

Assume that management responded favorably to a suggestion made by a safety professional that an internally conducted survey of the organization's safety culture would be beneficial. The purpose would be to gather the perceptions of all levels of employment on the quality of the safety management system in place. It should be understood that for those who participate in the exercise, their perceptions are their reality. The result of such an exercise will be a culture survey.

The self-analysis would provide data on the positive and negative effects of management leadership, the extent of employee participation, and whether an

A statement in the first bulleted item is significant in understanding the positive development of, or the deterioration in, a safety culture. Changes in a safety culture, for better or worse, do not occur quickly. Note that in the Texas City refinery: "Over the years, the working environment had eroded to one characterized by resistance to change, and lacking of trust, motivation, and a sense of purpose." The time factor is further recognized in the Executive Summary:

It is evident that [the causal factors] had been many years in the making and will require concerted and committed actions to address.

The excerpts that follow are taken from the body of the report. They relate specifically to inadequate participation by the hourly workforce, poor motivation, a safety culture that accepted high risk taking, and the failure of senior management to hold people accountable for following the "defined processes/procedures." I repeat: that all of these factors are acknowledged in an internally produced report by BP personnel:

- The principal gaps were the ad hoc nature of trending and analysis, and the lack of engagement of the hourly workforce in development of procedures and periodic self-assessments.
- When risks were identified, management and the workforce appeared to tolerate a high level of risk. The investigation team observed many examples of a high level of risk being accepted within the site.
- There was a failure by leadership to hold employees at all levels accountable for executing defined processes/procedures. A workplace environment characterized by poor motivation, unclear expectations around supervisory/management behaviors, no clear system of reward and consequences, and high distrust between leadership and the workforce, had developed over a number of years within the site. The working relationships between leadership and workers, and employees and contractors were poor.

To describe a positive safety culture that results from good management leadership and employee participation, start by turning the negatives of the foregoing into affirmatives.

### Columbia Space Vehicle Disaster, February 2003

The importance of a sound safety culture was made manifest when the factors surrounding the loss of a NASA space orbiter and its crew on February 1, 2003 were examined. The *Columbia Accident Investigation Report*, issued in August of that same year, is deeply disturbing. I recommend that you review the report in its entirety.

The highlights of the report provide a basis for review by operations managers and safety professionals to assess whether there have been similar shortcomings in past decision making with respect to safety in their operations. Such a review should

explore whether management's perception of latent conditions. It should also result in a Columbia report:

- The physical cause of the Thermal Protection System (TPS) failure on the NASA orbiter was the foam. At the time of the accident, that employees may not be able to persist through a positive or a negative situation.
- Leaders create a safety culture. Administrators must be alert to the effectiveness of the system for establishing and maintaining safety failures.
- At the time of the accident, there were also many positive factors, such as self-deception, in the perfect place.
- After the accident, the orbiter had a safety culture to management, and a corresponding engineering community.
- Safety personnel were not as a channel for Program-level safety up, safety personnel balances."
- Management decisions, blocked opportunities, blocked ineffective leadership.

### PROPOSING AN INTERVENTION

Assume that management is a professional that an intervention would be beneficial. The intervention of employment on the job should be understood that for their reality. The result of the intervention is the reality.

The self-analysis of management leadership is the reality.

## CASES: INADEQUATE MANAGEMENT LEADERSHIP AND EMPLOYEE PARTICIPATION

Data follow with respect to two situations in which deterioration in safety management leadership and employee participation resulted in catastrophic incidents. Negative safety decision making resulted in a deteriorating safety culture, failure to adequately involve employees in the safety process, and poor communication.

A positive safety culture results from management leadership and direction that produce the opposite of what is described in the following cases. I suggest that readers ask whether similar situations ever occur in the operations to which they give counsel.

### Catastrophe in Texas City, March 2005

On March 23, 2005, at a BP Products North America-owned and -operated refinery, a fire and explosion resulted in 15 deaths, 170 injuries, and extensive property damage. An investigation team led by BP employee J. Mogford released a report titled *Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report, Texas City, Texas, USA*. The 192 page report may be accessed at the website listed in the end-of-chapter references.

The report's Executive Summary highlights its content. As you read the following excerpts from the summary, keep the safety culture, management leadership, accountability, and employee participation implications in mind:

[The] underlying causes are identified as follows:

- Over the years, the working environment had eroded to one characterized by resistance to change, and lacking of trust, motivation, and a sense of purpose. Coupled with unclear expectations around supervisory and management behaviors this meant that rules were not consistently followed, rigor was lacking and individuals felt disempowered from suggesting or initiating improvements. Process safety, operations performance and systematic risk reduction priorities had not been set and consistently reinforced by management.
- Many changes in a complex organization had led to the lack of clear accountabilities and poor communication, which together resulted in confusion in the workforce over roles and responsibilities.
- A poor level of hazard awareness and understanding of process safety on the site resulted in people accepting levels of risk that are considerably higher than comparable installations. One consequence was that temporary office trailers were placed within 150 feet of a blowdown stack which vented heavier than air hydrocarbons to the atmosphere without questioning the established industry practice.
- Given the poor vertical communication and performance management process, there was neither adequate early warning system of problems, nor any independent means of understanding the deteriorating standards in the plant.



- A large proportion of incidents resulting in severe injury occur in unusual and nonroutine work, in nonproduction activities, and where sources of high energy are present. Also, they occur in what may be called at-plant construction operations. (At-plant construction encompasses work such as this: A motor is to be replaced. It weighs 800 pounds, and sits on a platform 15 feet above the floor. The work is to be done by in-house personnel.)
- Causal factors for low-probability/high-consequence events are seldom represented in the analytical data on accidents that occur frequently. (Some ergonomics-related incidents are the exception.)
- Many incidents resulting in serious injury are unique and singular events, having multiple and complex causal factors that may have technical, operational systems, or cultural origins.

My studies reveal that very often, over time, there had been an accumulation of shortcomings in safety and health management decision making that reflected adversely on management leadership and the safety culture. Other writers have reported similar findings.

Incidents that result in serious injuries are often low-probability events that result from what James Reason refers to as an accumulation of latent technical conditions and operating practices that are built into a system and shape an organization's culture. He discusses the long-term impact of a continuum of less-than-adequate management leadership and decision making in *Managing the Risks of Organizational Accidents*:

Latent conditions, such as poor design, gaps in supervision, undetected manufacturing defects or maintenance failures, unworkable procedures, clumsy automation, shortfalls in training, less than adequate tools and equipment, may be present for many years before they combine with local circumstances and active failures to penetrate the system's layers of defenses.

They arise from strategic and other top-level decisions made by governments, regulators, manufacturers, designers and organizational managers. The impact of these decisions spreads throughout the organization, shaping a distinctive corporate culture and creating error-producing factors within the individual workplaces.

As the impact of less-than-adequate decision making by management spreads throughout the organization, employees at all levels respond to the negative safety culture that develops and risky work practices become common. Such a situation, once recognized, presents a challenge to safety professionals in that giving advice to reduce the probability of incidents occurring that result in serious injuries must become a principle goal.

While not easy to do, safety professionals must prepare the data that may convince management to recognize the possible systemic causal factors which have accumulated and to take action to reduce them. Thus, to achieve a significant reduction in the potential for low-probability/severe-consequence incidents occurring, a different mind-set and change in culture have to be achieved. All this relates to Management Leadership and Employee Participation.

## CASES: INADEQUATE MANAGEMENT LEADERSHIP AND EMPLOYEE PARTICIPATION

Data follow with respect to management leadership and employee participation. Negative safety decision making to adequately involve employees.

A positive safety culture can produce the opposite of what readers ask whether similar safety give counsel.

### Catastrophe in Texas City

On March 23, 2005, at a BP Petroleum Refinery, a fire and explosion resulted in 15 deaths and 180 injuries. An investigation team led by the U.S. Chemical Safety and Hazard Investigation Board (CSHIB) released its *Fatal Accident Investigation Report* for Texas City, Texas, USA. The report is available in the end-of-chapter references.

The report's Executive Summary includes excerpts from the summary of accountability, and employee participation.

[The] underlying causes are:

- Over the years, the workforce experienced resistance to change. 27% of the workforce was new hires. Coupled with unclear expectations, this meant that rule violations were common. Individuals felt disempowered to report safety concerns. Safety operations had not been set and consistent.
- Many changes in a complex process and poor communication over roles and responsibilities.
- A poor level of hazard awareness at the site resulted in people at a comparable installation were placed within 15 feet of air hydrocarbons to the practice.
- Given the poor vertical communication, there was neither adequate means of understanding the incident.

Defining responsibilities and establishing accountabilities is an important step. It must be done for safety and health management systems to be effective and to provide a basis for performance and accountability reviews.

### EMPLOYEE PARTICIPATION, SECTION 3.2

Not only are employees to assume responsibility for aspects of health and safety over which they have control, but they are also to have opportunity to participate in every aspect of the occupational health and safety management system. And they are to have the mechanisms, time, and resources necessary to participate.

A statement made in Z10's advisory column next to employee participation is close to one I have often made and which I believe to be fundamentally true. If an employer does not take advantage of the knowledge, skills, and experience of the workers close to the hazards and risks, opportunities to improve safety management systems and reduce injury and illness potential may be missed.

Employers improve their prevention efforts if they recognize the insight and creativity of their workers. The task of reducing risk is well served if the culture makes it clear that worker's knowledge is valued and respected and that they are to participate in ownership of the safety management system.

Two examples of outstanding contributions to risk reduction made by hourly workers come to mind. At a plant manufacturing heavy machinery, the innovations of tool and die makers in redesigning work situations to reduce ergonomics risks were so creative that visitors were often shown their inventions as a matter of pride. In a space industry company, it became standard practice for the design engineers to seek the opinions of hourly workers before proceeding to manufacture what had been designed. They learned through experience that the suggestions made by hourly workers avoided risks, particularly human factors design errors, and resulted in improved efficiency during the production process.

This section of Z10 also requires that employers provide employees with relative occupational health and safety information, and identify and remove obstacles or barriers to employee participation. Examples given in the advisory column on obstacles or barriers to meaningful employee participation are lack of response to suggestions for risk reduction and reprisals for bringing hazards to the attention of supervisors. Both of these examples define a negative safety culture.

Appendix C, Employee Participation, is an excellent reference. It covers these topics: Encouraging employee participation; Example methods for establishing a participative culture; Examples of employee participation; Time and Resources; and Communications.

### RELATING MANAGEMENT LEADERSHIP TO SERIOUS INJURY PREVENTION

Analyses I made resulting from reviews of over 1,200 incident investigation reports indicates that:

from operations or from products sold, and damage to the environmental is an organizational value.

2. Bear the signature of the senior executive or manager.
3. Be appropriate to the nature of the organization's operations and their scope.
4. Be current, reviewed at least annually, and prominently displayed.
5. State a commitment to comply with all applicable legislation and standards.
6. Affirm that issued safety, health, and environmental policies are to be followed.
7. Make clear that employees are to actively participate in all elements of the safety and health management system.
8. Pledge to a continual improvement process to further reduce risks.

If additional examples of policy statements are desired, they may be found in the safety, health, and environmental reports issued by Bayer at <http://www.bayerUSA.com>; DuPont at <http://www.dupont.com>; Intel at <http://www.intel.com>; and Johnson & Johnson at <http://www.jnj.com>.

### RESPONSIBILITY AND AUTHORITY, SECTION 3.1.3

This section of Z10 requires that management define roles, assign responsibilities and authority, provide the necessary resources (financial and human), and, I emphasize, establish accountability. If a management accountability system for safety, health, and environmental results is not in place, management commitment to attaining superior results is questionable. Accountability without consequences is not accountability.

In the Introduction to Z10, it is made clear that it was drafted to be compatible with other business processes. That thought is reinforced in Section 3.1.3. Management is to provide the leadership and assume responsibility for "integrating the occupational health and safety management system into the organization's other business systems and processes." Doing so is a goal worthy of achievement. It will interweave safety and health processes into, and be supportive of, the organization's endeavors.

While management has leadership responsibilities for safety, so too do employees. As the standard indicates, "Employees shall assume responsibility for aspects of health and safety over which they have control."

Appendix B, Roles and Responsibilities, is an excellent reference from which excerpts may be taken to "define roles, assign responsibilities, establish accountabilities, and delegate authority" as suitable to an entity's needs. The data cover the following employment categories: President, Chief Executive Officer, Owner; Executive Officers, Vice Presidents, and other Senior Leadership; Directors, Managers, and Department Heads; Supervisors; Employees; and Health and Safety Department.

Defining responsibilities and  
It must be done for safety and  
provide a basis for performance

### EMPLOYEE PARTICIPATION

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participative culture; Examples  
and Communications.

### RELATING MANAGEMENT PREVENTION

Analyses I made resulting from  
indicates that:

In their bid to make profit under deflationary pressures, those companies have been restructuring their operations and trying to cut costs, and are compelled to continue using facilities and equipment that normally would have been replaced and renewed years ago, thereby raising the risk of accidents. Hama said. Also because of job cuts, the firms do not have sufficient numbers of workers who can repair and keep the old equipment in proper condition, she said.

The operation of Japan's manufacturing industries was once looked upon as a global standard, but the fact that major companies that are supposed to symbolize that standard have been hit by serious accidents shows deflation has damaged the nation's industrial base. Hama observed.

There are other references in the OECD report indicating that the effects of pressures to maintain high profit levels and reduce costs may be among the root causal factors for incidents that have low probability but serious consequences. In such cases, safety is compromised and the safety culture deteriorates. Although the OECD report pertains to the chemical process industries, similar observations may be made with respect to the negative impact of bottom-line pressures in other industries.

Later in this chapter, comments are made on a catastrophe in which the management acknowledged in its own internally prepared report that its safety culture, over time, had been allowed to deteriorate. In Chapter 14, "Lean Concepts: Opportunities for Safety Professionals," reference is made to safety levels being diminished as lean concepts are applied. In discussions with several safety directors, it has been readily established that everyone is expected to do more with less and that bottom-line pressures weigh heavily.

It is appropriate to acknowledge then that when the business environment results in management decision making that negatively impacts on the safety culture, convincing management that safety should be one of the organization's core values will not be easily achieved. However, the safety professional has an obligation to be professional, factual, and complete in the recommendations that he or she makes to keep risks at an acceptable level.

### **POLICY STATEMENT, SECTION 3.1.2**

Z10 states that "The organization's top management shall establish a documented occupational health and safety policy." Three sample policy statements are provided in the standard's Annex A. They are good references. An organization's policy statement should be specially tailored to reflect top management's beliefs and written in the language that the issuer would normally use. The policy statement also has to be believable. In drafting a policy statement, considering the following may be helpful. The policy statement should:

1. Clearly state management's position on safety, health, and the environment, and indicate that avoiding injury and illness to employees and to the public

Proof of management's wanting to know about problems is demonstrated by the actions they take to eliminate or control hazards and risks.

Sutton's statement describes a necessity for superior results to be achieved. And safety professionals should be working toward influencing management that it is in their best interest to put processes in place to uncover, confront, and address hazards and the risks that derive from them. Never the less, realism with respect to the management practices in some companies must be acknowledged, as is discussed in the next section. Unfortunately, what R. B. Whittingham wrote in the Preface to *The Blame Machine: Why Human Error Causes Accidents* speaks to what is sometimes actuality:

Organizations, and sometimes whole industries, become unwilling to look closely at the system faults which caused the error. Instead the attention is focused on the individual who made the error and blame is brought into the equation.

You will not find a statement in this book indicating that the role of the safety professional in favorably influencing an organization's culture is easily fulfilled. Yet, the endeavor remains worthwhile and attaining positive results, perhaps in small steps, can be rewarding.

## THE BUSINESS ENVIRONMENT

It is possible that the prevailing business environment makes it more difficult for safety professionals in some organizations to favorably influence their safety culture. Consider this excerpt from a 2005 report by the International Organization for Economic Cooperation and Development (OECD) based in Paris:

The concept of "drift" as defined by Rasmussen as "the systematic organisational performance deteriorating under competitive pressure, resulting in operation outside the design envelope where preconditions for safe operation are being systematically violated" was generally agreed as being a far too common occurrence in the current business environment.

This OECD report also includes comments taken from *The Japan Times* that are attributed to Norika Hama, a professor of international economics at Doshisha University Business School, at the February 27, 2004, Economic and Structural Reforms in Japan and Germany Symposium (jointly sponsored by the Japanese-German Center of Berlin and Japan's Keizai Koho Center.):

### Japan Times article

Another offshoot of deflation that is particularly worrying, she said, has manifested itself in a series of major accidents that have hit the plants of Japan's industrial giants in recent years. The examples cited by Hama included a fire that destroyed a tire factory of Bridgestone Corp. in Kuroiso, Tochigi Prefecture and a fire and explosion at Nippon Steel Corp.'s Nagoya ironworks, both of which happened last September.

In their bid to make profit under restructuring their operations and using facilities and equipment 20 years ago, thereby raising the risk, the firms do not have sufficient equipment in proper condition.

The operation of Japan's manufacturing standard, but the fact that major standard have been hit by serious industrial base, Hama observed.

There are other references in the measures to maintain high profit level factors for incidents that have cases, safety is compromised. OECD report pertains to the changes be made with respect to the industries.

Later in this chapter, comment acknowledged in its own time, had been allowed to determine for Safety Professionals." as lean concepts are applied. It has been readily established that bottom-line pressures weigh heavily.

It is appropriate to acknowledge in management decision making convincing management that safety will not be easily achieved. However, be professional, factual, and committed to keep risks at an acceptable level.

## POLICY STATEMENT, SECTION

Z10 states that "The organization's occupational health and safety policy provided in the standard's Annex A. The policy statement should be specific and written in the language that the organization also has to be believable. In addition, it may be helpful. The policy statement

1. Clearly state management's commitment and indicate that avoiding

In a large majority of organizations, an advanced safety culture does not exist. Then, the principle role of the safety and health professional is to influence management to move toward achieving a superior culture. The possibility of being successful in that endeavor is enhanced if the safety professional attains the status of an integral member of the business team. That will result from giving well-supported, substantial, and convincing risk reduction advice that serves the business interests. Admittedly, convincing management that safety should be one of the organization's core values may not be easily achieved.

## ABSOLUTES FOR MANAGEMENT TO ATTAIN SUPERIOR RESULTS

During a review of statements made in annual reports on safety, health, and environmental controls issued by five companies that consistently achieve outstanding results, a pattern became evident that defines the absolutes necessary to attain such results:

- Safety considerations are incorporated within the company's culture, within its expressed vision, values, beliefs, core values, and *system of expected behavior*.
- The board of directors and senior management lead the safety initiative and make clear by their actions that safety is a fundamental within the organization's culture.
- There is a passion for, and a sense of urgency to generate, superior safety results.
- Safety considerations permeate all business decision making, from the concept stage for the design of facilities and equipment, through their disposal.
- An effective performance measurement system is in place.
- All levels of personnel are held accountable for results.

Whatever the size of an organization—10 employees or 100,000—the foregoing principles apply to achieving superior results. Safety is culture-driven, and the board of directors and senior management define the culture and the system of expected behavior. When a passion for superior results exists, management will insist that its hazard and risk problems be identified and resolved.

Robert I. Sutton is a professor of management science and engineering at Stanford University and a prolific author on management practices. A statement he makes in one paper (<http://www.bobsutton.typepad.com>) relates well to what companies with superior results want done with respect to hazards and risks:

Last week, I was talking to an executive from a big software company about the virtues of evidence-based management. I argued that, when you dig into how some of the best companies operate, you see that there is a commitment to finding, facing, and acting on the facts—no matter how unpleasant those facts might be.

For superior results to be achieved, management must establish open communication so that knowledge about hazards and risks flows upward to decision makers.



- Comments on the specific elements in Section 3.0:
  - Policy Statement, Section 3.12
  - Responsibility and Authority, Section 3.1.3
  - Employee Participation, Section 3.2
- Relates management leadership to serious injury prevention
- Describes cases of inadequate management leadership and employee participation that resulted in catastrophes
- Proposes that an internal analysis of the safety culture be made, gives an outline for such an analysis, and comments on a case study

## THE SIGNIFICANCE OF ORGANIZATIONAL CULTURE

As top management makes decisions directing the organization, the outcomes of those decisions establish its safety culture. Safety is culture-driven, and management establishes the culture. An organization's culture consists of its values, beliefs, legends, rituals, mission, goals, performance measures, and sense of responsibility to its employees, to its customers, and to its community—all of which translate into a *system of expected behavior*. The injury and illness experience that results is a direct reflection of an organization's safety culture.

I give strong emphasis to the phrase "*a system of expected behavior*" because it defines what a staff believes, in reality, management wants done. Although organizations issue safety policies, manuals, and standard operating procedures, their staffs' perception of what is expected of them and the performance by which they will be measured—the *system of expected behavior*—may differ from what is officially documented. Colleagues remind me of having written years ago that what management does, rather than what management says, defines the actuality of an organization's safety culture and its commitment or noncommitment to safety, and that often a difference exists between what management says and what management does.

To achieve superior results, only top management can provide the leadership and direction needed to "establish, implement and maintain an occupational health and safety management system." Major improvements in safety will be achieved only if a change in culture takes place—only if major changes occur in the *system of expected behavior*.

## THE ROLE OF SAFETY AND HEALTH PROFESSIONALS WITH RESPECT TO THE SAFETY CULTURE

What is the safety and health professional's role with respect to the safety culture? In an organization where safety is a core value and management at all levels walks-the-talk and demonstrates by its actions that it expects the safety culture to be superior, the role of the safety and health professional is easier as he or she gives advice that supports and maintains the culture.

In a large majority of organizations, the principle role of management is to move toward successful in that endeavor. It is an integral member of a well-supported, substantial business interests. Admittedly, the organization's core values

## ABSOLUTES FOR MANA

During a review of statements of environmental controls issued by various companies, a pattern became evident in the results:

- Safety considerations are expressed vision, values
- The board of directors make clear by their actions the organization's culture.
- There is a passion for superior results.
- Safety considerations are a stage for the design of products.
- An effective performance measurement system.
- All levels of personnel are involved.

Whatever the size of an organization, the same principles apply to achieving superior results. The actions of directors and senior management define the behavior. When a passion for safety is evident, its hazard and risk problems are solved.

Robert I. Sutton is a professor at Stanford University and a past president of the Society for the Advancement of Management. He makes in one paper (<http://www.sloan-society.org/papers/sutton.htm>) the case for companies with superior results.

Last week, I was talking about the virtues of evidence-based management. One of the best companies operating in the world is acting on the facts—

For superior results to be achieved, the organization must have a clear vision so that knowledge about

## CHAPTER 5

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# MANAGEMENT LEADERSHIP AND EMPLOYEE PARTICIPATION — SECTION 3.0

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### INTRODUCTION

In Chapter 1, this author stated that Section 3.0, “Management Leadership and Employee Participation,” is the most important section in the Occupational Health and Safety Management Systems Standard. Having superior management leadership is an absolute requirement—a sine qua non—if the goal is to achieve superior results. In Section 3.1.1, Z10 asserts that “Top management shall direct the organization to establish, implement and maintain an occupational health and safety management system.” With respect to this very important section of Z10, this chapter:

- Discusses the significance of management direction with respect to an organization’s safety culture
- Comments on the role of safety professionals with respect to the safety culture
- Sets forth the absolutes needed in management leadership to attain stellar results
- Acknowledges the impact that the current business environment may have on achieving or maintaining a superior safety culture

*Advanced Safety Management Focusing on Z10 and Serious Injury Prevention.* by Fred A. Manuele  
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