

SAFETY DESIGN REVIEWS: SECTION 5.1.3 OF Z10

Requirements for design review and management of change are addressed jointly in Section 5.1.3 of Z10. Although the subjects are interrelated, each has its own importance and uniqueness. Comments on the management of change concept and how to institute the management of change process are the focus of Chapter 19. Only the design review requirements of Z10 are addressed in this chapter.

Although the term *design review* appears in the title of Section 5.1.3, the “shall” requirement and the advisory comments indicate that much more than a design review is expected. The standard states that “The organization shall establish a process to identify, and take appropriate steps to prevent or otherwise control hazards at the design and redesign stages to reduce potential risks to an acceptable level.”

A design review is one part of that process. For a design review to occur, there must be a design to review. As Bruce Main writes in *Risk Assessment: Challenges and Opportunities*: “A design review evaluates a design against the design criteria or requirements.” (p. 27)

In the advisory column, E5.1.3 says: “The design review should consider all aspects including design, procurement, construction, operation, maintenance, and decommissioning.” And E5.1.3.1 says: “The design process typically includes consideration of some or all of the following life cycle phases: Concept design stage; Preliminary design; Detailed design; Build or purchase process; Commissioning, installing and debugging processes; Production and maintenance operations; and Decommissioning activity.”

To do as Z10 implies, systems must be in place to avoid, eliminate, reduce, or control hazards and the risks that derive from them:

- As early as possible and as often as needed in every aspect of the design and redesign processes
- In all phases of operations

What needs to be agreed upon in an organization is a well-understood concept, a way of thinking that is translated into a system that effectively addresses hazards and risks in the design and redesign processes, a way of thinking that is applied universally by all who are involved in the design processes.

I hold to the premise that over time, the level of safety achieved will relate directly to whether acceptable risk levels are achieved or not achieved in the design and redesign processes. This premise relates to the design of facilities, hardware, equipment, tooling, operations layout, the work environment, the work methods, and products. *Design*, as the term is used here, encompasses all processes applied in devising a system to achieve results.

Methods used to avoid bringing hazards and risks into the workplace will be discussed here broadly, with the hope that safety professionals can adopt from the materials presented to their advantage. To assist in applying the Z10 design provisions, this chapter includes:

- A review of safety through design and prevention through design concepts and procedures
- Comments on how some safety professionals are engaged in activities that lessen the probability of hazards and risks being brought into the workplace
- An edited composite of procedures in place in several companies to achieve hazard avoidance and control in the design process, and procedures to be followed before modified equipment is released for operation
- A general checklist as a reference from which a specifically tailored checklist can be developed for use in design reviews, and for equipment acceptance
- A company's equipment design philosophy, a model

SAFETY THROUGH DESIGN AND PREVENTION THROUGH DESIGN

If the design review requirements of the Z10 standard are to be met, "to reduce potential risks to an acceptable level," the focus in the design and redesign processes has to be on hazards and the risks that derive from them. In the advisory column following E5.1.3F, the instruction given is: "See Appendix F: Risk Assessment for more information on risk assessment methodologies to consider when assessing risks during design reviews and managing hazards and risks associated with operational change." Appendix F is a good reference, as is Chapter 11, "A Primer on Hazard Analysis and Risk Assessment" in this book. There is no appendix in Z10 on safety in the design and redesign processes.

Activities undertaken by the National Safety Council and the National Institute for Occupational Safety and Health that encourage addressing hazards and risks in the design and redesign processes are related directly to Z10's design requirements.

NATIONAL SAFETY COUNCIL

The book *Safety Through Design* was a creation of the Institute For Safety Through Design, an entity at the National Safety Council. The Institute's vision was to achieve a future in which "Safety, health, and environmental considerations are integrated into the design and development of systems meant for human use." (p. xi) An advisory committee, the members of which were drawn from industry, organized labor, academia, and others interested in the cause, agreed on the following definition.

Safety Through Design: The integration of hazard analysis and risk assessment methods early in the design and engineering stages and taking the actions necessary so that risks of injury or damage are at an acceptable level. (p. 3)

That definition serves well in understanding and developing the design requirements in Z10. The theme of safety through design is that if decisions affecting safety, health, and the environment are integrated into the early stages of the design and redesign processes:

- Productivity will be improved.
- Operating costs will be reduced.
- Expensive retrofitting to correct design shortcomings will be avoided.
- Significant reductions will be achieved in injuries, illnesses, and damage to the environment, and their attendant costs. (p. 3)

Effectiveness and economics were addressed in the following citation: "Hazards and the risks that derive from them are most effectively and economically avoided, eliminated, or controlled if they are considered early in the design process, and where necessary as the design progresses." (p. 11)

All of the foregoing derives from the following premises. Risks of injury derive from hazards. If hazards are avoided, eliminated, reduced, or controlled in the design process and acceptable risk levels are achieved, the potential for harm or damage and operational waste is diminished. These premises tie in neatly with the reference in Z10 to addressing occupational health and safety management system issues, which are defined "as hazards, risks, management system deficiencies, and opportunities for improvement". (Section 4.0 – Planning).

Item C in Z10's Section 3.1.3 – Responsibility and Authority – indicates that the occupational health and safety management system should be integrated into an organization's other business systems and processes. There are seven chapters in Part II of *Safety Through Design* that are good resources for those who attempt to integrate the Z10 design requirements into other business processes.

In accord with an initially established sundown provision, the operations of the Institute for Safety through Design were discontinued in 2005.

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

In 2006, several of the participants in the activities of the Institute For Safety Through Design, and others, received an e-mail from an executive at the National Institute for Occupational Safety and Health (NIOSH) encouraging our participation in a major initiative promoting Prevention through Design. One aspect of the NIOSH initiative was to develop and approve a broad generic voluntary consensus standard on Prevention through Design that is aligned with international design activities and practice.

I volunteered to lead that endeavor. On September 1, 2011, the American National Standards Institute (ANSI) approved the standard ANSI/ASSE Z590.3-2011, *Prevention Through Design: Guidelines for Addressing Occupational Hazards and Risks in the Design and Redesign Processes*.

By its charter, activities at NIOSH are limited to occupational safety and health hazards and risks and are the focus of Z590.3. But, by intent, the terminology in Z590.3 was kept broad enough so that the guidelines could additionally be applicable to all hazard-based fields: product safety, environmental controls, property damage that could result in business interruption, and so on. In the standard, the definition of prevention through design is, of necessity, applicable to work-related hazards and risks only.

Prevention through design: Addressing occupational safety and health needs in the design and redesign process to prevent or minimize the work-related hazards and risks associated with the construction, manufacture, use, maintenance, retrofitting, and disposal of facilities, processes, materials, and equipment. (p. 10)

The content of the Z590.3 standard is closely related to Z10's design provisions. Prevention through design is addressed in Chapter 16.

THE SAFETY DESIGN REVIEW PROCESS

A safety design review process will not be effective until the participants on the review team have acquired knowledge of hazards and risks and have agreed on the risk assessment methods and risk assessment matrix to be used. Chapter 11, "A Primer on Hazard Analysis and Risk Assessment," serves as a base for the education of team members. Also, a safety design review process can be employed successfully only if senior management has been convinced of its value.

Paul Adams has had considerable experience in design reviews. He was asked to describe the process for integrating safety into the design process as it is implemented in a major manufacturing company with which he has been affiliated. His comments appear here with his permission.

The Safety Design Review Process

Formal safety design reviews may sound like tedious exercises, but they are effective processes for delivering inherently safer designs. Design reviews are systematic processes for carefully reviewing design attributes, applications, misapplications, energy control systems, and human interactions. Safety design reviews aim to identify hazards and hazardous conditions that are foreseeable throughout the lifecycle of a product, process or facility, and to develop mitigation strategies.

In most cases, a safety design review is best conducted by a team of stakeholders and at least one objective, disinterested engineer. Typical participants include representatives from Engineering, Production, Maintenance, and Health and Safety. Both the system designer(s) and the review team share responsibility for the safety of the final design.

Safety design reviews should be approached as important problem-solving events. A spirit of cooperation, and even fun, can be maintained by restricting criticism to constructive debate on specific design features. Although the focus should always be on safety, review teams frequently identify additional opportunities to reduce costs and improve productivity. Constructability and maintainability issues often surface, and these alone can pay huge dividends for the comparatively short time invested in reviewing a project. While it is the role of the facilitator to assure that these topics do not derail or compromise the safety focus, such opportunities should obviously be captured as value-added by-products. Review sessions also provide excellent learning opportunities for both novice and experienced engineers, as collective knowledge and experience are openly shared and questioned.

A common approach for conducting a formal design safety review is to methodically work through a Design Safety Checklist. Some organizations use a generic checklist, supplemented with additional checklists for specific disciplines, such as electrical or chemical systems. For each system element, reviewers address the various forms of energy present and the steps taken to control unwanted or hazardous release. A typical design safety review meeting proceeds as follows:

1. Project manager distributes drawings and copies of checklists, or they can be projected on large screens.
2. Review team chooses a facilitator, often a disinterested engineer; i.e., an engineer not assigned to or intimately familiar with the project.
3. Project engineer/manager describes the project and its scope, and answers general questions about major areas of concern.
4. Project engineer/manager keeps notes; a.k.a. design punch list.
5. Facilitator leads a methodical review using a generic checklist, with team members asking detailed questions to ensure thorough consideration of hazards and their control. Checklist items and sections that are not applicable are so noted. Both production and maintenance tasks should be considered.

6. Additional discipline checklists are reviewed as appropriate.
7. A marked-up copy of the checklists, along with signatures of the participants, is retained with project documents in accord with records retention policy.

In the event an organization does not have a design safety review checklist, a systematic review can still be performed. A suggested method is to carefully review layout and assembly drawings, considering each form of energy separately, including the potential hazard exposure, and possible scenarios and consequences of unintended release of this energy form.

For example, review the drawing considering all uses and possible exposures to electrical energy, then pneumatic systems, hydraulic systems, chemical processes, mechanical kinetic and potential energy, thermal and radiation energy, etc. For each form of energy, work systematically through the layout or assembly drawing using a geographical approach, such as starting at the beginning of a production line and moving through it to its end. Again, it is important to consider both production and maintenance activities.

The development of simulation software has added a new dimension to the design safety review process. Modern computer assisted design software systems convert two-dimensional drawings to three-dimensional images that can be moved and reoriented with ease to show different viewing perspectives. When used in design reviews, this provides a powerful means of illustrating designs for those who have difficulty visualizing workstations and processes from traditional two dimensional drawings. In addition, some software products enable engineers to place humanoid figures into scaled three-dimensional depictions of proposed workstations, and have figures of various body sizes move through simulated work tasks. It also allows reviewers to more effectively consider ergonomic issues and risk factors; i.e., potential for strains and cumulative trauma disorders resulting from the expenditure of "human energy" in awkward postures.

Specific deliverables from a design review typically include:

- A set of marked-up drawings and specifications.
- A list of design modifications requiring attention prior to release for bid or construction/fabrication.
- A list of specific items to be checked during installation and the final walk-down or post-fabrication inspection. (There are often items identified as potentially problematic that cannot be adequately assessed at the time of the review due to lack of detailed knowledge.)
- Assignments for resolving specific details or making design corrections.

Following the review, it is the responsibility of the project engineer/manager to ensure that all issues raised during the design safety review are resolved and appropriate revisions are completed. Verification through a post-construction/

fabrication inspection should be completed prior to release of the process, facility or system.

That's what a design safety review is all about. Done well, such reviews diminish the likelihood of bringing hazards and risks into the workplace. Having the right facilitator is important in the design review process.

In one company, it is standard practice to engage a consultant facilitator to lead safety design reviews to assure that the views of one or two people do not dominate and that all participants are given an opportunity to be heard.

EMPHASIZING CONSIDERATION OF THE WORK METHODS IN THE DESIGN PROCESS

Much has been made in this book of the need to design work methods and procedures so that they are not error-provocative or overly stressful. Considerations of hazards and risks in the design process should not be limited to the facility, equipment, and processes (i.e., to the hardware). They should also focus on the hazards and risks in the work methods prescribed, taking into consideration:

- The capabilities and limitations of the workers so that the risks of injury and damage are at as low as reasonably practicable
- The benefits of not creating work situations that are error-provocative

In a paper entitled "The Titanic and Risk Management," Roy Brander wrote this: "Safe design of the procedure is as important as design of the artifact." (Item 30) His point is important. It fits closely with my observation that, too often, inadequate attention is given to avoiding hazards in work methods, the result being that what workers are expected to do is inherently risky.

HOW SOME SAFETY PROFESSIONALS ARE ENGAGED IN THE DESIGN PROCESS

To obtain information on how safety professionals are involved in activities to avoid bringing hazards and risks into the workplace, a request for comments on the subject was made through an Internet safety server. These are some of the responses—the most unfortunate first. As they are reviewed, safety professionals may want to assess their place in the design process and look for hints on how they can improve their positions.

- From an industrial hygienist: If the engineers would only let me into the design process, I know that many of the health hazards I deal with could be better controlled, we wouldn't need to do so much testing, and our operations would be more productive because we would reduce the amount of time employees spend on testing and on the use of personal protective equipment.

- We don't have any forms or established procedures for our getting into what engineers are designing, and there is no formal method for engineering to notify us of a project. We do get copies of the engineering weekly reports, and we read those carefully. Then, we invite ourselves into the discussion.

- There was a lot of resistance by engineering to our getting into what they were designing because they had not recognized that we could be an asset. It took us a long time and quite a few money-saving successes to get it ingrained into their procedures that it was to their benefit to refer capital expenditure requests to us for our input. We don't have a written procedure, but it gets done.

- Almost all of our engineering is done by outside firms. I haven't been successful in convincing the few engineers we have left that I can help them write specifications that will save them money. But I have convinced the manager of my plant that I am to have sign-off authority for new installations.

My sign-off reviews can be embarrassing to the people who laid out the specs and I have to be diplomatic in how I do what I need to do. But the plant manager gives me support now. He has been educated.

- This from a construction safety professional: I request to see all drawings at the 10% level while changes are still easily incorporated. I get a schedule of all construction plans and visit contractor lay down areas to inspect materials being used on the job. I attempt to educate quality assurance personnel on what to look for as safety indicators.

I visit the engineering department and the contracting department on a daily basis when I'm in town. Yes, it is time consuming but it saves money and lives as well as equipment. It took maximum effort on my part to get where I am.

- In my company, it's in the capital expenditure procedure manual that all funding requests will receive a safety review. Managers have the same responsibility for safety as they do for productivity and quality, and when they approve the capital expenditure request, they are also signing off for safety. But, my name appears on the capital expenditure distribution list among the management people who have to sign off as approving the request. This isn't as burdensome as it was in the beginning because I have educated a fairly stable engineering and management staff on what it takes to get my approval.

- Through our successes in ergonomics, engineering recognized our contributions not only for safety, but also for productivity. They now invite us into the design process in the idea stage. They make it plain that they look to us to see that they don't mess up. We learned the hard way over a lot of years that it is expensive to correct hazards that are in the machines and equipment we buy. We had to do some costly equipment modifications for employee safety and health, and for environmental situations after the installations were completed and in operation. Our engineers aren't easy on us. But that's okay. We had to accept the criticism from them that our ergonomics checklists were so general that they weren't helpful.

- Our Facility Safety Manual includes extensive procedures for documented reviews for safety, health, environmental, and ergonomic standards before budget approval is obtained on a new project, and for equipment reviews before the equipment is released to normal production.

As you will see from what I'm mailing to you, we are deep into specifications, and the signature of a safety specialist is required in the project and budget review procedures.

Involvement of safety professionals in the design processes, specification writing, purchasing, and sign-off processes varies from nothing at all to being required to be participants by written procedures. In all but one of the cases cited, there is some involvement by safety professionals—and that came about because safety professionals took the initiative and proved their value.

At the Professional Development Conference held by the American Society of Safety Engineers in 2012, I was among about 40 others attending a late afternoon session—a typical number for a presentation late in the day. A later session, for which the subject was risk assessments, began at 4:30 P.M. and extended into the happy hour. The presenters were long-time associates. I thought it appropriate to caution them not to expect a large audience. But surprise, surprise. Well before starting time it became aware that the attendance figure would be huge.

When the attendees were asked for a show of hands on how many were doing risk assessments in the design and redesign processes, over half responded favorably. That represents substantial progress in relation to the case some 20 years ago.

A GOOD PLACE TO START

Safety professionals who are not involved in the design processes should consider ergonomics as fertile ground in which to get started. It is well established that successfully applied ergonomics initiatives result not only in risk reduction, but also in improved productivity, lower costs, and waste reduction. Furthermore, musculoskeletal injuries are a large segment of the spectrum of injuries and illnesses in all organizations. Since they are costly, reducing their frequency and severity will show notable results.

Ergonomists know how to write specifications that result in designing the workplace and the work methods to fit the capabilities and limitations of workers. A company that established detailed ergonomics design criteria was DaimlerChrysler. How their design criteria were used demonstrates that there can be a close relationship between establishing safety design parameters and including safety specifications in purchasing documents. The version of the ergonomics design criteria available on the Internet was last updated in May 2006, and it is still presented as a DaimlerChrysler document. This is how the DaimlerChrysler ergonomic design criteria were introduced.

This document attempts to integrate new technology around the human infrastructure by providing uniform ergonomic design criteria for DaimlerChrysler's manufacturing, assembly, power train and components operations, as well as

part distribution centers. These criteria supply distinct specifications for the Corporation, to be used by all DaimlerChrysler engineers, designers for the vendors, suppliers, contractors etc. providing new or refurbished/rebuilt materials, services, tools, processes, facilities, task designs, packaging and product components to DaimlerChrysler.

In effect, the Ergonomic Design Criteria used internally at DaimlerChrysler also became the ergonomic specifications that vendors and suppliers had to meet. In a section of the criteria entitled "Supplier Roles and Responsibilities," it is made clear that all suppliers were to "make all reasonable efforts to implement all of the criteria and requirements" of the ergonomic design criteria. If a requirement was to be compromised, the supplier was to so inform DaimlerChrysler and the matter would be resolved by a DaimlerChrysler ergonomics representative. DaimlerChrysler's Ergonomic Design Criteria are available at <http://www.docstoc.com/docs/25321410/150-Ergonomic-Design-Criteria>. The criteria can be downloaded for personal or business use. Taking into consideration what is now known about ergonomic design specifications, it is incomprehensible that employers continue to purchase equipment that is not ergonomically designed.

An adaptation of how another company developed extensive "General Design and Purchasing Guidelines" that serve both as design requirements to be met by its engineering staff and as the company's purchasing specifications appears as an addendum to the chapter on Procurement. My searching revealed that most companies consider their design and purchasing criteria to be proprietary and not distributable. But one such document that includes general design parameters is in the public domain and can be cited here.

MILITARY RESOURCES: DESIGN REQUIREMENTS

In a draft of MIL-STD-882E, an appendix contained suggested design guidelines that were not included in the final version. Nevertheless, they are quite good, and a brief version is given here. They promote thinking about and giving guidance on writing design specifications to fit the needs of a particular entity.

Example General Safety Design Requirements

1. Hazardous material use is to be eliminated or minimized. After considering material selection and substitution of lesser hazardous materials, the remaining risks are to be reduced in the design process.
2. Hazardous substances, components, and operations are to be isolated from other activities, areas, personnel, and incompatible materials.
3. Equipment is to be located so that access during operations, servicing, repair, or adjustment minimizes personnel exposure to hazards (e.g., hazardous substances, high voltage, electromagnetic radiation, and cutting and puncturing surfaces).
4. Power sources, controls, and critical components of redundant subsystems are to be protected by physical separation or shielding, or by other acceptable methods.

5. For hazards that cannot be eliminated, consideration is to be given to safety devices that will minimize mishap risk (e.g., interlocks, redundancy, fail safe design, system protection, fire suppression, and protective measures such as clothing, equipment, devices, and procedures).
6. Provisions for the disposal of systems are to be considered in the design process.
7. Warning signals are to be standardized within like types of systems: they are to be designed to minimize the probability of incorrect personnel reaction to them.
8. Warning and cautionary notes are to be provided in assembly, operation, and maintenance instructions; and distinctive markings are to be provided on hazardous components, equipment, and facilities to ensure personnel and equipment protection when no alternate design approach can eliminate a hazard. Use standard warning and cautionary notations where multiple applications occur. Standardize notations in accordance with commonly accepted commercial practice. Warnings, cautions, or other written advisories are not to be used as the only risk reduction method for hazards assigned Catastrophic or Critical mishap severity categories.
9. If safety critical tasks require personnel to have specific proficiency, a certification process for that proficiency should be used.
10. In the design process, specific consideration should be given to the minimization of injury or damage to equipment or the environment as a result of a mishap.
11. Inadequate or overly restrictive safety requirements are not to be included in the system design specifications.
12. Acceptable risk is mishap risk that is as low as reasonably practicable (ALARP) within the constraints of operational effectiveness, time, and cost.

Although the foregoing outline doesn't cover much space, it represents an extensive body of knowledge. The outline is basic, and right on.

In the *Air Force System Safety Handbook* developed by the Air Force Safety Agency at Kirtland Air Force Base in New Mexico, a section opens with this statement:

As an accident avoidance measure, one develops strategies for energy control similar to those listed below.

The controls shown are an adaptation of Haddon's unwanted energy release theory, which is discussed later in this chapter. The controls listed in the *Air Force System Safety Handbook* are worthy of consideration.

- a. Prevent the accumulation by setting limits on noise, temperature, pressure, speed, voltage, loads, quantities of chemicals, amount of light, storage of combustibles, height of ladders, etc.
- b. Prevent the release through engineering design, containment vessels, gas inerting, insulation, safety belts, lockouts, etc.

- c. Modify the release of energy by using shock absorbers, safety valves, rupture discs, blowout panels, less incline on the ramps, etc.
- d. Separate assets from energy (in either time or space) by moving people away from hot furnace, limiting the exposure time, picking up with tongs, etc.
- e. Provide blocking or attenuation barriers, such as eye protection, gloves, respiratory protection, sound absorption, ear protectors, welding shields, fire doors, sunglasses, machine guards, tiger cages, etc.
- f. Raise the damage or injury threshold by improving the design (strength, size), immunizing against disease, warming up by exercise, getting calluses on your hands, etc.
- g. And by establishing contingency response such as early detection of energy release, first aid, emergency showers, general disaster plans, recovery of system operation procedures, etc. (p. 65)

A General Design Safety Checklist appears later in this chapter. Also, several other design guidelines and checklists that can be adapted for design purposes appear in this book.

A SAFETY DESIGN REVIEW AND OPERATIONS REQUIREMENTS GUIDE

A composite is provided here of the procedures in place in three companies for design reviews and for a safety sign-off before new or modified equipment can be released into normal operations. Those procedures serve to avoid bringing hazards and risks into the workplace. In a way, these requirements represent culture statements: Managements have decided that hazards and risks are to be dealt with as equipment is designed and before it can be placed in operation. This composite presents a basis for thought as safety professionals pursue having similar concepts and procedures adopted.

REQUIREMENTS: EQUIPMENT AND PROCESS DESIGN SAFETY REVIEWS

A. Purpose

To establish procedures to ensure that hazards are analyzed and that risks are at an acceptable level when considering new, redesigned, and relocated equipment or processes.

B. Scope

These procedures apply to all equipment and processes that may present risks of injury to people or damage to property or the environment. They pertain to the design or redesign of all new, transferred, and relocated equipment and processes. For all aspects of these procedures, documentation shall be appropriate to the activity.

Safety, as the term is used here, encompasses risks of injury or damage to personnel (employees and the public), property, and the environment.

C. Responsibilities

Location Manager. The responsibility for safety rests with the location manager in the operations for which he or she has authority.

Project Manager. The project manager is responsible for assuring that:

- Corporate safety requirements are met
- Safety documentation to accompany capital expenditure requests is prepared
- Preliminary and subsequent design safety reviews are conducted
- Appropriate coordination and communication take place with outside design and engineering firms to assure that specifications are met
- Proper consideration is given to any safety problems identified by the staff during their visits to vendors and design and engineering firms prior to delivery of equipment

Design Engineers. Principal responsibility of the design engineers is to design inherently safer equipment and processes. Whether employees or contractors, design engineers shall assure that the considerations necessary for safety have been given in the design process. They will provide the Project Manager and the Safety Review Team documentation including:

- Detailed equipment design drawings
- Equipment installation, operation, preventive maintenance, and test instructions
- Details of and documentation for codes and design specifications
- Requirements and information needed to establish regulatory permitting and/or registrations

Safety Review Team. This team will conduct preliminary and subsequent design safety reviews for equipment and processes, or have design reviews made by outside consultants for particular needs. In addition to the Project Manager, members will include the project design engineers, production and maintenance personnel, the facilities engineer, selected disinterested engineers, the safety professional, and others (financial, purchasing) as needed. The Safety Review Team will also be responsible for:

- Arranging and conducting safety walk-downs of new projects
- Determining when visits are to be made at vendor design and engineering locations, and selecting the personnel with the necessary skills to make the visit

Safety Professional. The safety professional will:

- Serve as a member of the Safety Review Team and assist in identifying and evaluating hazards in the design process and provide counsel as to their avoidance, elimination, or control
- Visit design engineering firms and other vendors, when so requested by the Safety Review Team, to assure that safety problems are identified and corrected prior to shipment of equipment

Equipment Acceptance – Safety Review Form

Dept. _____ Control No. _____

Equipment description _____

This form must be completed prior to equipment being released to normal production. It is applicable to:

1. All newly installed equipment or processes
2. Changes made in the use of equipment or processes
3. Modifications of existing equipment or processes

Preliminary approval indicates that the equipment is ready for initial production trials, but needs additional work for safety as listed in a memo attachment titled "Safety items needing attention." Final approval indicates that the preliminary findings have been addressed satisfactorily and that the equipment can be released to normal production.

	<u>Preliminary</u>	<u>Final</u>
Signed: _____	_____	_____
Engineer-in-charge	Date	Date
Signed: _____	_____	_____
Dept. Mgr. or Supervisor.	Date	Date
Signed: _____	_____	_____
Safety Manager	Date	Date

The original copy of this form shall be retained by the Department Manager or supervisor. The Engineer-in-charge and the Safety Manager will retain copies. The company's file retention policy shall apply.

FIGURE 15.1 Safety Design Reviews

- Be a signatory on Equipment Acceptance-Safety Review Form [Figure 15.1] prior to newly installed or altered equipment or processes being released to normal production.

Department Managers and Supervisory Personnel. Department managers and supervisors will give support to the project manager for the activities that come under their jurisdiction. They will be signatories, along with engineering personnel and the safety professional, on sign-off forms before newly installed or altered equipment is released for normal operation.

D. Initial Capital Expenditure Safety Review

Capital expenditure requests at financial levels requiring divisional or corporate approval are to be accompanied by a Preliminary Safety Review Form, which is to be completed by the Safety Review Team. Comments would be included in the form, giving assurance that the hazards and risks identified can be dealt with properly.

For new or altered equipment or processes at a financial level not requiring divisional or corporate approval, formal Preliminary Safety Reviews are to be made at the discretion of the Safety Review Team.

E. Design Reviews

When designs have been completed and drawings and specifications are available, the Safety Review Team will hold one or more design review meetings to:

- Identify hazards not given appropriate attention, and recommend solutions to attain acceptable risk levels
- Assure that corporate safety requirements are being met
- Avoid the cost of risk-reduction retrofitting as the project moves forward
- Assure compliance with applicable regulations, codes, and standards

F. Safety Walk-Downs

When a project reaches completion at approximately a 70% level, the Safety Review Team will arrange and conduct a safety walk-down to provide an opportunity to:

- Assure that specifications have been met
- Determine that hazards identified in the preliminary safety review and the subsequent design review have been addressed properly
- Identify hazards that may have inadvertently been built into the project, and to arrange for the necessary action to be taken

Similarly, a final safety walk-down will be arranged as the project nears completion.

H. Equipment and Process Release Requirements

For newly purchased, redesigned, or relocated equipment or processes—before release for normal production:

- Task analyses shall be made to identify hazards and risks, and the hazards identified are to be dealt with properly.
- Any revisions necessary in the written job procedures shall be made.
- Retraining, as required, shall be given.
- An Equipment Acceptance-Safety Review Form shall be completed, the signatories to which shall be the engineer in charge, the department manager or supervisor, and the safety professional.

I. Design Reviews at Vendor and Design Engineering Locations

When considered advantageous by the Safety Review Team, arrangements will be made for personnel with the appropriate skills to visit vendors and design engineering firms to:

- Assure that vendors are building equipment to specifications
- Determine whether hazards exist that were not identified in the design review process, or by the vendor or design engineering firm that need attention
- Avoid the high cost of retrofitting for safety matters during installation, testing, and debugging

For these reviews, a specifically tailored Vendor/Design Engineering Review Form is to be created from sections of the General Design Safety Checklist that relate to the task. Reports are to be made available to the Safety Review Team and the Project Manager.

EQUIPMENT ACCEPTANCE: SAFETY REVIEW FORMS

Drafting equipment acceptance safety review forms specific to every piece of equipment or process would be a mammoth undertaking. Nevertheless, industry-specific safety review checklists do exist, and they should be used where applicable.

The example of an equipment acceptance review form shown in Figure 15.1 assumes the existence of a General Design Safety Checklist that can serve as a reference basis for the review process. Also, the example presumes that there will be two levels of review: a preliminary review to identify items needing attention, and a final sign-off.

PRELIMINARY SAFETY DESIGN REVIEW FORMS

A Preliminary Safety Design Review goes by several names. In one company its purpose is to meet "Fitness for Use Criteria." In another company it is referred to as a "Hazards Screening Analysis." A Preliminary Safety Review Form is a list of subjects pertaining to equipment, facilities, or processes that aids the reviewers in identifying hazards and risks that must be addressed. Completion of the form produces, in effect, an early design review. The review team indicates whether a subject needs further consideration.

No single list can be suitable for all needs. In drafting such a list, a safety professional should use a general design safety checklist as a reference and include some, all, or more than the subjects listed in Table 15.1.

GENERAL DESIGN SAFETY CHECKLIST

A detailed, specifically referenced design checklist covering all workplace safety needs would fill thousands of pages. The design safety checklist presented here is a brief composite taken from several sources. Some safety professionals will view it as

TABLE 15.1 Topics To Be Considered: Preliminary Design Safety Review

Ergonomics	Material handling
Machine guarding	Illumination needs
Fire protection	Means of egress
Walking and working surfaces	Confined spaces
Use of hoists, cranes, etc.	Work at heights
Electrical potentials	Lockout/tagout
Confined spaces	Temperature extremes
Hazardous or toxic materials	Noise or vibration
Personal protective equipment	Nonionization emitters
Environmental concerns	Sanitation

excessive; others will find that it does not address all their needs. Those who use it as a reference should be aware that there are many subject-specific and industry-specific checklists to which they should also refer. For example:

- The *Guidelines For Hazard Evaluation Procedures, 2nd Edition*, issued by the Center for Chemical Process Safety, includes a checklist-questionnaire for chemical operations that fills 45 pages.
- The checklist in Addendum B at the conclusion of Chapter 11, "A Primer on Hazard Analysis and Risk Assessment," is adapted from ISO 14121, *Safety of Machinery—Principles of risk assessment*, a standard issued by the International Organization for Standardization. It is to serve as a guide for those who design and manufacture equipment and machinery that goes into European workplaces.

This General Design Safety Checklist is presented intentionally as a list of questions without the boxes and lines for separation that are typically found in checklists. Also, the response that would be placed to the right of a design checklist in which users would enter check marks for "yes," "no," or "not applicable" has been eliminated.

GENERAL DESIGN SAFETY CHECKLIST

Preface

This checklist begins with a preface that brings attention to Haddon's unwanted energy release theory. That theory is: For all injuries or illnesses, property damage, and environmental damage, an unwanted and harmful transfer of energy or exposure to a harmful environment is a factor.

William Haddon espoused the theory that unwanted transfers of energy can be harmful (and wasteful) and that a systematic approach to limiting their possibility should be taken. Thus, it is proposed that a systematic approach be taken in the design process to limit harmful transfers of energy and exposures to harmful environments.

The questions in Section A, "Introduction: Basic Considerations," relate to Haddon's theory and are presented as general concepts to be considered when using the checklist, for which "yes" or "no" answers are to be obtained. They emphasize that the two distinct aspects of risk are to be considered in the design process:

- Avoiding, eliminating, or reducing the *probability* of a hazard-related incident or exposure occurring
- Reducing the severity of harm or damage if an incident or exposure occurs

A. Introduction: Basic Considerations

1. Can production of hazardous materials or energy be eliminated?
2. Will the amount of the hazardous materials or energy be limited?
3. Can less-hazardous materials be substituted?

4. Can hazardous material or energy buildup be prevented?
5. Can the release of hazardous materials or energy be slowed down?
6. Can unwanted energy release be separated in space or time from that which is susceptible to harm or damage?
7. Can barriers be interposed to separate the unwanted energy release from that which is susceptible to harm or damage?
8. Will surfaces with which people come in contact be modified to reduce the risk of injury?

B. Designing for Those with Disabilities

1. Do the designs take into consideration the requirements of the Americans with Disabilities Act (ADA)?
2. Are reasonable accommodations made for the disabled?

C. Confined Spaces

1. Have confined spaces been eliminated by design where practicable?
2. Are any confined spaces to be permit required? 1910.146(c)(1)
3. Have confined spaces been designed for easy of ingress, prompt egress, and where practicable, elimination of hazardous atmospheres?
4. Can confined spaces be designed with multiple, large accesses?
5. Are accesses provided with platforms that will support all required personnel and equipment?
6. Will access ports be large enough to permit entry when personnel are using personal protective equipment?
7. Will pipes or ducts limit entry to access ports?
8. Are locations of ladders and scaffolds in the space identified?
9. Are fall protection needs fulfilled (such as anchorage points)?
10. Can the necessary equipment be moved through accesses?
11. Does the design provide for isolation of the confined space from hazardous energy (i.e., electrical, chemical, etc.)?
12. Does the design provide for isolation by valve blocking, spools, double blocks and bleeds, flanges, and flushing connections?
13. Can spaces be designed so that maintenance and inspection can be performed from outside or by self-cleaning systems?

D. Electrical Safety

1. Overall, will the electrical system meet OSHA/NEC standards?
2. Will the system be sufficiently flexible to allow for future expansion?
3. Will emergency power be provided for critical systems?

4. Is grounding adequate?
5. Are ground fault interrupter circuits to be installed where needed? 1910.304(f)(7)
6. Are grounding connections to piping and conduits eliminated to prevent accumulation of static electricity?
7. Is grounding provided for lightning protection on all structures?
8. Are accommodations made for special-purpose or hazardous locations? 1910.307
9. Is the design adequate where there may be combustible gases or vapors?
10. Is high-voltage equipment isolated by enclosures such as vaults, security fences, and lockable doors and gates?
11. Are nonisolated conductors such as busbars on switchboards or high-voltage equipment connections that are located in accessible areas protected to minimize hazards for maintenance and inspection personnel?
12. Where injury to an operator may occur if motors were to restart after power failure, are provisions made to prevent automatic restarting upon restoration of power? 1910.262(c)(1)
13. Are electrical disconnect switches lockable, readily accessible, and labeled? 1910.303(f)
14. Are breakers/fuses sized properly? 1910.303(b)
15. Has the polarity of all circuits been checked? 1910.403(a)(2)
16. Do electrical cabinets and boxes have appropriate clearances? 1910.303(g) and (h)
17. Are exposed live electrical parts operating at 50 volts or more guarded against accidental contact by approved cabinets or enclosures, by location, or by limiting access to qualified persons? 1910.303(g)(2)(i)
18. Are rooms or enclosures containing live parts or conductors operating at over 600 volts, nominal, designed to be kept locked, or provisions made to be under the observation of a qualified person at all times? 1910.303(h)(2)
19. Are the electrical wiring and equipment located in hazardous (classified) locations intrinsically safe, approved for the hazardous location, or safe for the hazardous location? 1910.307(b)(1-3)

E. Emergency Safety Systems: Means of Egress

1. Are means of egress adequate in number, remote from each other, properly designated, marked, lighted, and easily recognized?
2. Has emergency lighting been provided for means of egress, and elsewhere where needed?
3. Does the design contemplate emergency lighting where workers may have to remain to shut down equipment?
4. Do means of egress exit directly to the street or open space?
5. Are doors, passageways, or stairways that do not lead to an exit marked by signs reading "not an exit" or by a sign indicating actual use?
6. Does the design provide internal refuge areas for workers who cannot escape?

7. Will reliable emergency power be provided for critical and life support systems?
8. Will emergency safety showers and eyewash stations be adequate and placed properly?
9. Will adequate first-aid stations, spill carts, and emergency stations be provided?

F. Environmental Considerations (Some are Operational, Beyond Design)

1. Have waste products been identified and a means of disposal established?
2. Will provisions be made for responding to chemical spills (containment, cleanup, disposal)?
3. Is there an existing spill control plan for chemicals?
4. Have all waste streams been identified?
5. Are adequate pre-treatment facilities provided for process waste streams?
6. Will an adequate storage area be available for wastes held prior to treatment or disposal?
7. Will waste storage areas have adequate isolation, or containment for spills?
8. Will hazardous wastes be disposed of at approved treatment, storage, and disposal facilities?
9. Is special equipment or specially trained personnel provided for treatment operations?
10. Has the acquisition of permits been addressed for the treatment or disposal of waste streams?
11. Have state or local requirements for permitting been evaluated and factored into the project?
12. Can the facility meet regulations for reporting spills or the storage of chemicals?
13. Have adequate provisions been made for cleaning the process equipment?
14. Have provisions been made for a catastrophic release of chemicals?
15. Have provisions been made for any necessary demolition and the resulting waste?
16. Have requirements for remediation at the site prior to construction been addressed?
17. Will all practicable measures for waste minimization be implemented?
18. Have the processes that generate air pollution been evaluated for minimization potential?
19. Will adequate air pollution controls be installed (scrubbers, fume hoods, dust collectors)?
20. Have handling and cleaning of air pollution control systems been addressed?
21. Have the processes that generate wastewater been evaluated for reduction potential?

22. Will indoor spills be protected from reaching drains?
23. Will outdoor spills be protected from reaching stormwater drains and sewer manholes?
24. Are adequate water disposal systems available?
25. Will pre-treatment methods be necessary and provided?
26. Will the discharges of domestic and industrial wastewater be in accord with regulations?

G. Ergonomics: Workstation and Work Methods Design

1. Generally, have material-handling designs considered worker capabilities and limitations, to accommodate the employee population at the 95% level?
2. Do material-handling designs promote the use of mechanical material-handling equipment such as conveyors, cranes, hoists, scissor jacks, and drum carts?
3. Do design layouts reduce in so far as practicable:
 - a. constant lifting
 - b. twisting and turning of the back when moving an object
 - c. crouching, crawling, and kneeling
 - d. lifting objects from floor level
 - e. static muscle loading
 - f. finger pinch grips
 - g. work with elbows raised above waist level
 - h. twisting motions of hands, wrists, or elbows
 - i. hyperextension or hyperflexion of wrists
 - j. repetitive motion
 - k. awkward postures
4. Are workstations designed to provide:
 - a. adequate support for the back and legs?
 - b. adjustable work surfaces that are easily manipulated?
 - c. delivery bins and tables to accommodate height and reach limitations?
 - d. work platforms that elevate and descend, as needed?
 - e. powered assists and suspension devices to reduce the use of force?
5. Has adequate attention been given to:
 - a. lighting (to Illuminating Engineering Society requirements),
 - b. heat,
 - c. cold,
 - d. noise, and
 - e. vibration?
6. Does the design accommodate the hazards inherent in servicing, maintenance, and inspection?

7. Will there be adequate clearance and ready access to equipment for servicing?
8. Will controls be efficiently located in a logical and sequential order?
9. Will indicators be easy to read, either by themselves or in combination with others?

H. Fall Avoidance

1. Overall, has the design reduced the need for ladders and stairs insofar as practicable?
2. Where works at heights is to be done, has adequate consideration been given to providing work platforms or fixed ladders?
3. Are parapets or guardrails provided at roof edges?
4. Is equipment designed to avoid fall hazards during maintenance, inspection, and cleaning?
5. Does the design provide for fall arrest measures, such as anchorage points and fall restraining systems?

I. Fire Protection

1. Overall, in the design, will national and local fire codes and insurance requirements be met?
2. Will fire pumps, water tanks/ponds, and fire hydrants be adequate?
3. Will risers and post valves be accessible, and protected from damage?
4. Will small hose standpipes be adequate?
5. Will sufficient hose racks be provided?
6. Will special fire suppression systems be provided?
7. Has containment of fire suppression water been addressed?
8. Will there be adequate external fire zones?
9. Will emergency vehicle access be adequate?
10. Will flame arresters be installed where needed on equipment vents?
11. Will fire extinguishers be of appropriate types, adequate, and mounted for easy access?
12. Will the design for location of flammables be appropriate?
13. For flammables, will storage rooms and cabinets meet national fire codes and insurance requirements?
14. For flammable liquid dispensing, will grounding, bonding, and ventilation be adequate?
15. Will fire sensors, pull stations, and alarms be adequate?
16. Are flooding systems designed to provide a pre-discharge alarm which can be perceived above ambient light or noise levels before the system discharges, giving workers time to exit from the discharge area?
17. Has the project been reviewed by insurance personnel?

J. Hazardous and Toxic Materials

1. In the design process, have all materials in this category been identified?
2. Have the physical properties of the individual chemicals been identified?
3. Have the most conservative exposure limits been established as the design criteria?
4. Has a determination been made to use intrinsically safe equipment?
5. Have Material Safety Data Sheets been obtained for all materials?
6. Are the reactive properties known for chemicals that will be combined or mixed?
7. Have measures been taken to eliminate, substitute for, or reduce the quantities of hazardous chemicals?
8. Does the design emphasize closed process systems?
9. Will the design properly address all occupational illness potentials and reduce the need for monitoring, testing, and personal protective equipment insofar as is practicable?
10. Are storage facilities designed to separate hazardous from nonhazardous substances?
11. Does the design consider the chemical compatibility issues?
12. Have adequate provisions been made for chemical release, fire, explosion, or reaction?
13. Have provisions been made to contain water used in hazardous release control?
14. Are ventilation systems adequate to handle an emergency release?
15. Is the storage of hazardous chemicals belowground avoided?
16. Is storage tank location such as to reduce facility damage or damage to the public in a catastrophic event insofar as is practicable?
17. Are adequate storage tank dikes provided?
18. Will emergency ventilation be provided for accidental releases?
19. For extraordinary releases, will special ventilation, relief, and deluge systems be provided?
20. Will the normal use of chemicals allow operating without personal protective equipment?
21. Will the design of bulk loading/unloading facilities contain anticipated leaks and spills?

K. Lockout/Tagout: Energy Controls

1. In the design process, has adequate attention been given to lockout/tagout requirements to prevent hazardous releases from these energy sources:
 - a. electrical,
 - b. mechanical,
 - c. hydraulic,

- d. pneumatic,
 - e. chemical,
 - f. thermal,
 - g. nonionizing radiation, or
 - h. ionizing radiation?
2. Are lockout/tagout devices adequate in design and number, readily accessible, and operable?
 3. Are lockout/tagout devices standard throughout the facility?

L. Machine Guarding

1. Overall, do the designs prevent workers' hands, arms, and other body parts from making contact with dangerous moving parts? 1910.212(a)(3)
2. Have the requirements of all applicable machine guarding standards of the American National Standards Institute been identified and met?
3. Are safeguards firmly secured and not easily removed? 1910.212(a)(2)
4. Do safeguards ensure that no object will fall into moving parts? 1910(a)(1)
5. Do safeguards permit safe, comfortable, and relatively easy operation of the machine? 1910.212(a)(2)
6. Can the machine be lubricated without removing safeguards? 1910.212(a)(2)
7. Does the design include a system that requires shutting down machinery before safeguards are removed?
8. Are fixed machines anchored soundly?
9. Are in-running nip points guarded properly? 1910.212(a)(1)
10. Will the design address point-of-operation exposure properly? 1910.212(a)(3)
11. Are all reciprocating parts guarded properly? 1910.212(a)(3)(iv)
12. Are all rotating parts guarded properly? 1910.212(a)(3)(iv)
13. Are all shear points guarded properly? 1910.212(a)(3)(iv)
14. Are exposed set screws, keyways, collars, etc. guarded properly? 1910.212(a)(3)(iv)
15. Does the design eliminate the potential for flying chips? 1910.212(a)(i)
16. Has the potential for sparking been eliminated? 1910.212(a)(i)
17. If robots are to be used, are they designed to ANSI/RIA R15.06-1999; the American National Standard for Industrial Robots and Robot Systems safety requirements?

M. Noise Control

1. In the design process, have maximum noise levels been established that are to be stipulated in specifications for new equipment?
2. Is emphasis given to controlling noise levels through engineering measures?

3. Are the size or shape of rooms and proposed layout of equipment, workstations, and break areas to be evaluated for noise levels?
4. Will workers be separated from noise by the greatest practicable distance?
5. Will barriers be installed between noise sources and workers?
6. Are enclosed control rooms to be provided for operators in areas where the noise is above trigger levels?
7. Are lower-noise-level processes to be selected where feasible?
8. Have equipment and workstations been located so that the greatest sources of noise are not facing operators?

N. Pressure Vessels

1. Will all pressure vessels be designed to ASME and insurance company requirements?
2. Will pressure vessels containing flammables or combustibles meet OSHA 1910.106 and NFC standards?
3. Will pressure relief valves be:
 - a. correctly sized and set,
 - b. suitable for intended use, and
 - c. directed to discharge safely?

O. Ventilation

1. Have all sources of emission been identified and their hazards characterized?
2. Have ways to reduce personnel interaction with the emission sources (location, work practices) been considered in the design process?
3. Have assessments been made with respect to incompatible emission streams (cyanides and acids, etc.)?
4. Has consideration been given to weather conditions and seasonal variations?
5. Will the design requirements of the ANSI Z9 series, the ACGIH ventilation manual, ASHRAE guidelines, and NFPA 45 and 90 met?
6. Will local ventilation effectively capture contaminants at the point of discharge?
7. Will room static pressures be progressively more negative as the operation becomes "dirtier"?
8. Will the ventilation system provide a margin of safety if a system fails?
9. Will emergency power and lighting be provided on critical units?
10. Will the ventilation equipment be remote and/or "quiet"?
11. Will spray booths and degreasers meet OSHA standards?
12. Will laboratory or contaminated air be totally exhausted?
13. If contaminated air is cleaned and reused, will it meet good safety requirements?
14. Will the makeup air to hoods be clean and adequate?

15. Have flow patterns been established to prevent exposure to personnel?
16. Does the design provide for proper gauging and alarm systems with respect to a sudden pressure drop?
17. Are ventilation controls easily accessible to operators?

P. Walking and Working Surfaces, Floor and Wall Openings, Fixed Stairs and Ladders

1. Will aisles, loading docks, and through doorways have enough clearance to allow safe turns where material-handling equipment is used? 1910.22(b)(1)
2. In the aisles, are people and vehicles adequately separated?
3. Are permanent aisles to be marked with lines on the floor? 1910.22(b)(2)
4. Does the design provide for floors, aisles, and passageways being free from obstruction? 1910.22(b)(1)
5. Has a logistics study been made to provide a safe and efficient flow of people and materials?
6. Will the construction texture of walking surfaces be nonslip?
7. Will the floors be designed to stay dry?
8. Will water and process flows be designed to keep off the walkway?
9. Will the floors be sloped and drained?
10. Will utilities and other obstructions be routed off the walking surfaces?
11. Will the design allow future utility expansion, with added facilities not having to be above and thereby cross floors, and be obstructive?
12. Will designs for floor and wall openings meet the requirements of OSHA 1910.23?
13. Do the designs for fixed stairs and ladders meet the requirements of OSHA 1910.23, .24, and .27?

RESOURCES

Appendix L in Z10 provides guidelines on audits. Design review and management of change are mentioned briefly as subjects to be considered when audits are made. In Appendix O, "Bibliography and References," several resources are listed under the caption "Design Review and Management of Change."

Entering "Safety Design Reviews" into a search engine will bring up several publications relating to systems design that individual safety professionals—depending on their fields of interest—may find interesting.

Bruce W. Main is the president of design safety engineering, inc. He is a practitioner in risk assessment and design reviews. His book *Risk Assessment: basics and Benchmarks* contains a chapter entitled "Design Reviews." He addresses:

- Purpose of a Design Review
- Types of Design Reviews

- Timing of a Design Review
- Design Review Mechanics
- The Decision Making Process
- Separating Analysis and Review
- Types of Safety Analyses for Design Reviews
- Practical Considerations.

Safety professionals who are interested in honing their knowledge and skills with respect to risk assessment and safety design reviews will find this book interesting.

Chapter 18 in this book, "Lean Concepts: Emphasizing the Design Process," includes a discussion on how a company merged lean concepts and environmental, safety, and health needs into its design process. In that process, design reviews are made at several stages as the design progresses.

CONCLUSION

I have been a strong proponent of addressing the hazards and risks that derive from them early in the design process. And I recommend that safety professionals move toward including the design review element in Z10 in the safety management systems they influence. I stand by the premise that:

- Hazards and the risks that derive from them are most effectively and economically avoided, eliminated, reduced, or controlled if they are considered early in the design process, and where necessary, as the design progresses.
- Risks of injury, illness, or damage are reduced significantly if processes are in place to avoid bringing hazards and risks into the workplace.

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