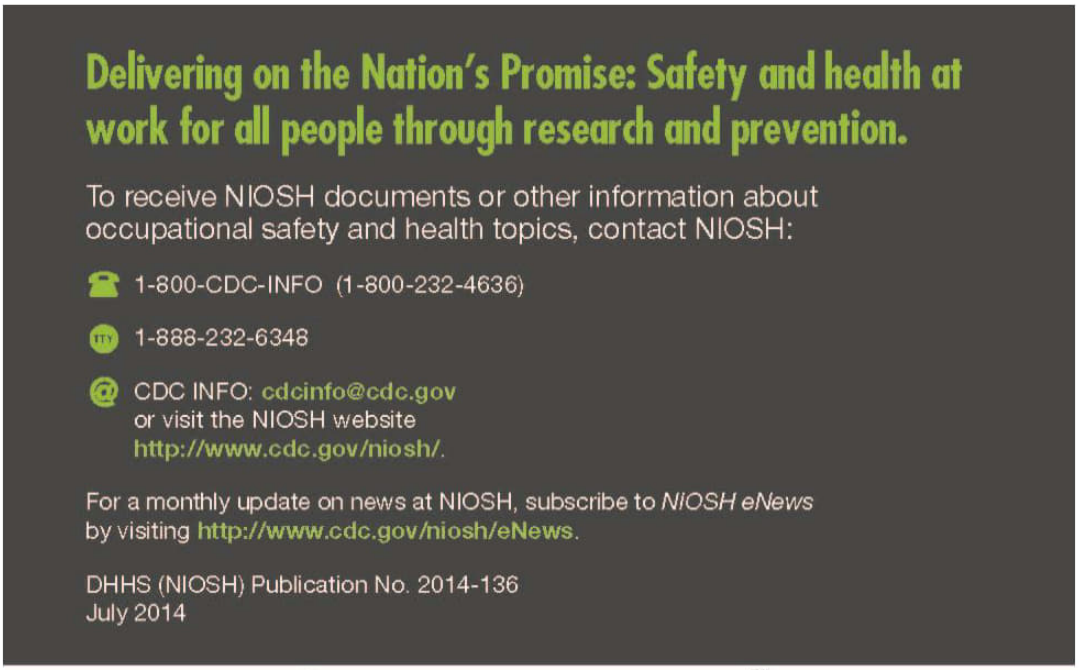
Module 2 : Managing Safety and Health Pages 72 -99



Health care providers can also be a resource on the health effects of toxic substances, proper medical and first aid treatment, and other health-related issues.

Lesson Summary

OSHA guarantees workers certain specific rights in addition to the general right to a safe workplace. Among these are the rights to receive proper training and information about previous, current, and expected hazards, and the right to file a complaint with OSHA or NIOSH without fear of retaliation. Workers may also participate in relevant OSHA inspections. Workers must report safety hazards to OSHA within 30 days and may do so online, in writing, of by telephone.

OSHA's standards provide protections to whistleblowers who report workplace safety violations. Workers cannot be transferred, denied a raise, have their hours reduced, be fired, or be punished in any other way because they exercised any right given to them under the OSH Act.

Module 2: Managing Safety and Health

Module Description

Employers are encouraged to develop and maintain a safety and health program that provides policies, procedures, and practices that protect employees from occupational safety and health hazards. In addition to preventing injuries, illnesses, and fatalities,

addressing safety and health issues in the workplace saves the employer money and adds value to the business.

This module begins with an overview of accident costs, direct and indirect. Then we explore the elements and processes of safety programs and worksite analysis. The job hazard analysis is commonly used for training workers as to how to perform a job in the safest manner possible. Hazard recognition and the hierarchy of hazard control are also discussed.

Next, the module explains how to understand accident causation and the various accident theories. If you learn the cause-and-effect relationship of accident causation and the human element, then you can reduce injuries and illnesses. The final lesson concludes with an overview of incident investigation techniques.

Module Learning Objectives

At the end of this module, students will be able to:

- Determine the direct cost of an accident
- Determine the indirect cost of an accident
- Describe the true cost of an accident related to human error factors
- Summarize the components of a safety program
- Explain how hazards are identified, prevented, and controlled
- Discuss safety training and program improvement
- Analyze worksites and tasks to identify hazards
- Explain the hierarchy of hazard control
- Understand accident causation theories
- Explain how unsafe behaviors contribute to accidents
- Understand the role of a safety management system in preventing accidents and incidents
- Identify incident investigation techniques to find a root cause of an event

Lesson 1: Accident Costs and Prevention

Lesson Focus

At the end of this lesson, students will be able to:

- Determine the direct and indirect costs of an accident
- Identify the components of a successful safety program
- Explain the importance of a workplace hazard analysis
- Recognize different types of hazards
- Explain the Hierarchy of Hazard Control
- Perform a risk analysis

Accident Costs

According to the 2016 Liberty Mutual Workplace Safety Index, the most disabling, nonfatal workplace injuries added nearly $59 billion to direct U.S. worker compensation costs. This translates into more than a billion dollars a week spent by businesses as a result of these injuries. Many accidents are expensive when considering lost time events. However, there are many more cost factors related to accidents that can be direct or indirect. To evaluate the total cost of the accident, you must combine both the direct and indirect costs.

These costs come out of the employer's profits. Depending on the company's profit margin, significant additional sales are required to offset the costs of a workplace injury.

Sales Needed to Recover the Cost of an Accident

Accident Cost	*Company Profit Margin* 1%	3%	5%
$1,000	$100,000	$33,000	$20,000
$5,000	500,000	167,000	100,000
$10,000	1,000,000	333,000	200,000
$25,000	2,500,000	833,000	500,000
$50,000	5,000,000	1,666,667	1,000,000
$100,000	10,000,000	3,333,000	2,000,000

SOURCE: MIOSHA CET #0182 / 12/09

Direct Costs of an Accident

The direct costs of an accident are directly associated with the event and are easily quantifiable. Most direct costs are paid by the insurance company of the employer. Examples of some of these costs are:

- Physical therapy
- Medical expenses
- Repair fees for damaged equipment
- Increases in workers' compensation premiums
- Continuation of pay
- Compensatory damages
- Costs for legal services

Indirect Costs of an Accident

The indirect costs of an accident are not paid through insurance and therefore are unrecoverable. While the direct costs are easy to quantify, the indirect costs are often unseen or impossible to quantify. The indirect costs of an accident are usually greater—sometimes much greater—than the direct costs. Some examples of indirect costs include:

- Wages paid to injured workers for absences not covered by worker's compensation
- Lost wages and work stoppages associated with the worker injuries
- Overtime due to the accident
- Administrative costs and time spent by safety personnel, clerical workers, and other employees after the injury
- Training for replacement workers
- Lost productivity due to the injury
- Low employee morale
- Accommodation for the injured employee within the organization
- Clean up and replacement costs of damaged material, machinery, and property
- Poor customer and community relations

Cost Estimate Calculator

The National Council on Compensation Insurance, Inc. (NCCI) collected statistics and data from insurance claims for policy periods 2015 through 2017. This data was incorporated by OSHA in the Safety Pays Cost Estimator for accidents. The NCCI data showed that the magnitude of indirect costs is inversely related to the severity of an accident. Using these numbers, OSHA created the **Safety Pays Cost Calculator**.

The following chart will give the relationship between direct costs and indirect costs in a ratio that is used to calculate the total accident cost.

Direct Costs	Indirect Cost Ratio
$0-$2,999	4.5
$3000-$4,999	1.6
$5,000-$9,999	1.2
$10,000 or more	1.1

To use the cost estimate calculator, you need to know either the injury type or the workers compensation direct cost of an accident and the company's profit margin. However, if the profit margin is not known to the officer using the cost estimator, then OSHA will give a default 3% profit margin for calculation of the direct and indirect costs in relation to the additional sales needed to pay total cost of the accident.

As an example of this calculator, if you select an amputation from the entry type menu and give the company a profit margin of 10%, the calculator will give you the following information:

- Amputation: (1) Instance
- Direct Cost: $96,003
- Indirect Cost: $105,603
- Total Cost: $201,606
- Additional Sales needed to recuperate cost (Indirect Cost): $1,056,030
- Additional Sales needed to recuperate cost (Total Cost); $2,016,060

Therefore, this example illustrates that just one instance of an amputation has historically cost $96,003 in direct costs and $105,603 in indirect costs, yielding a total injury cost of $201,606.

When workers stay whole and healthy, the direct cost-savings to businesses include:

- Lower workers' compensation insurance costs
- Reduced medical expenditures
- Smaller expenditures for return-to-work programs
- Fewer faulty products
- Lower costs for job accommodations for injured workers

Here are some examples of how companies can "pay themselves" by preventing accidents and avoiding the associated costs:

RAM Construction paid itself $246,000. "It took several years, but we decreased our Experience Modification Rate (EMR) from a high of 1.43 to a low of 0.286. This reduction resulted in an average savings in workers' compensation costs of $82,000 per year for the last 3 years." (Safety Director, RAM Construction Services, Livonia, MI; MIOSHA CET #0182 / 12/09).

Kamminga and Roodvoets paid itself $211,000. "We developed a more visible and structured safety and health system. Our Experience Modification Rate (EMR) is now below 0.6, resulting in savings in our workers' compensation costs this year of more than $211,000. (Safety Director, Kamminga and Roodvoets, Grand Rapids, MI; MIOSHA CET #0182 / 12/09).

Safety Programs

Workplace injuries are preventable and a safety and health management system (SHMS) is the best way to prevent them. A safety program with a systematic approach integrates occupational safety and health objectives into the company's organizational structure. The results include:

- An effective system that supports the organization's philosophy
- Safety and health policies and goals that are clearly communicated
- Accountability for implementing the system
- Long-term solutions rather than one-time fixes
- Evaluation of results over time to promote continual improvement



- A system that positively impacts the company's bottom line

The components of a successful safety program include:

- Leadership from management
- Worker participation
- Hazard identification and assessment
- Hazard prevention and control
- Education and training
- Program evaluation and improvement
- Communication and coordination for host employers, contractors, and staffing agencies

Leadership from management

A committed management unit provides clearly defined objectives and goals for organizational safety. They finance the safety activities through purchases and resource allocations. Every level of management should value safety practices and accomplishments as much as they value regulatory compliance and water quality.

Leaders' commitment to safety ensures a company safety vision exists. This vision should be communicated regularly and widely, and it should align with and support company values and promote and communicate the concept of "safe production." Management leadership means that business owners, CEOs, managers, and supervisors at all levels are fully committed to continuously improving workplace safety and health performance. Safety leaders have the courage to demonstrate they value safety by working and communicating with team members to identify and limit hazardous situations even in the presence of other job pressures such as scheduling and costs.

Here are some steps managers can take to demonstrate their commitment to safety leadership:

- Writing or personally signing a clearly defined safety policy that acknowledges that safety and health are as important as productivity, water quality, regulatory compliance, and customer service
- Communicating the policy and values to all levels of the organization
- Visually setting examples of safety behavior and demonstrating actions consistent with a safety culture
- Allocating resources for safety and health
- Holding all levels of the organization accountable for safety performance

Worker Participation

Workers have much to gain from a successful safety and health program—and often the most to lose if the program fails. Workers often know the most about their jobs and are often those closest to potential hazards. Worker participation means that all workers, including contractors, subcontractors, and temporary staffing agency workers:

- Have opportunities to participate throughout the process of designing and implementing the safety program
- Have access to information they need to participate effectively in the program
- Are encouraged to participate in the program and feel comfortable reporting safety and health concerns

Workers are often best positioned to identify safety and health concerns and program deficiencies, such as emerging workplace hazards, unsafe conditions, close calls/near misses, and actual incidents. By encouraging reporting and following up promptly on all reports, employers can address issues before someone gets hurt or becomes ill.
By encouraging workers to participate in the program, leadership also signals that it values worker input into safety and health decisions. Management should acknowledge and provide positive reinforcement to workers who actively participate in the program. Maintain an open-door policy that invites workers to talk to managers about safety and health. Encourage workers to make suggestions about safety and health.

Hazard Identification and Assessment

A proactive, ongoing process to identify and assess hazards in order to fix them is a core element of any effective safety and health program. Failure to identify or recognize hazards is frequently one of the “root causes” of workplace injuries, illnesses, and incidents, and indicates that the safety and health program is ineffective. Hazard assessment can (and should!) lead to opportunities to improve program performance.

A hazard is any condition or action that can cause an organizational loss. An organizational loss can come in the form of an injury or illness, damaged equipment, or even worker turnover. When a loss occurs, the organization must determine the root cause of the loss and not just the symptoms. The assessment process must be structured, detailed, and deliver actionable measures to address the root cause. Hazard identification and assessment can be accomplished by:

- Worksite analysis of past, present, and predictive data from reports, instrumentation, and maintenance logs, as well as worker injury and illness records
- Worksite inspections for safety hazards
- Investigating each accident until the root cause is completely disclosed
- Identifying hazards that may arise outside of normal operating conditions, including emergencies and start-up or shut-down operations
- Characterizing the true composition of a hazard, giving a priority value to each component, and identifying appropriate hazard controls

Hazard Prevention and Control

Preventing and controlling hazards will protect workers from injury and illness, but will also give employees a clear sign that the company cares about their wellbeing. It is always preferable to eliminate hazards entirely, but when that is not possible other hazard controls are appropriate.

Tips for implementing hazard prevention and controls are as follows:

- Identify what controls are available for each type of hazard
- Select the proper controls by doing a detailed hazard assessment
- Develop, maintain, and update a hazard control plan
- Select controls that are applicable for all aspects of the organization and conditions
- Implement the selected hazard controls with a priority on elimination and substitution of hazards
- Follow up on all hazard controls for each task to make sure they are protective enough

Assess and understand the hazards you have identified and the types of incidents that could result from worker exposure to those hazards. Use this information to determine which controls to implement and to set priorities for implementing them. To ensure that control measures remain effective, track progress in implementing controls, inspect controls once they are installed, and follow routine preventive maintenance practices.

Education and Training

Education and training can be thought of as a tool that binds each step together to keep hazard control efforts cohesive. The role of education and training must be a factor in helping both management and workers maintain an overall culture of safety. Effective education and training for employers, managers, supervisors, and workers means they:

- Have the knowledge and skills needed to work safely and avoid creating hazards that could place themselves or others at risk
- Can demonstrate awareness and understanding of workplace hazards and how to identify, report, and control them
- Have received specialized training when their work involves unique hazards

General workers should have safety awareness training with regular operations or maintenance training. However, if they work in a specialized area that exposes them to unique hazards, then training must be applicable to those hazards. Effective training can be done peer-to-peer, in formal classrooms, online, or at the worksite. Provide opportunities for workers to ask questions and offer feedback during and after the training. As the program evolves, institute a more formal process for determining the training needs of workers responsible for developing, implementing, and maintaining the program.

Program Evaluation and Improvement

Any safety program must be continually analyzed and improved in order to stay current and effective. Periodically step back and evaluate what works and what does not, and whether you are on track to achieve your program goals. Evaluate the program initially to verify that it has been implemented as intended, and then on a regular basis once it is established. Whenever you identify opportunities to improve the program, make the



adjustments and monitor how well it performs as a result. Share the results of your monitoring and evaluation within the workplace to help drive further improvement.

Consider assessing risk by multiplying together the probability a negative event will occur and the severity of the outcome if an event occurs.

The probability of an accident occurring can be broken down into 5 categories:

- Remote
- Unlikely
- Occasional
- Probable
- Frequent

Severity refers to the consequence of an accident when it does occur:

- Minor
- Marginal
- Serious
- Catastrophic

You can assign numbers 1-5 to the probabilities and 1-4 to the severity, and by multiplying those numbers together you find your R-value or risk assessment value. For example, if your risk assessment tells you that a task is probable (4) and would have serious consequences (3) then the R-value will be 4x3=12.

Establish and follow procedures to collect, analyze, and review performance data in order to determine the probability and severity of an accident. You should consider both leading and lagging indicators.

Leading indicators reflect the potential for injuries and illnesses that have not yet occurred. These include things like the level of worker participation in safety training, the number of hazards and close calls reported, the number and frequency of inspections, and the number of hazards identified during inspections.

Lagging indicators generally track worker exposures and injuries that have already occurred. These include the number and severity of injuries and illnesses that have occurred, the results of worker exposure monitoring, and the amount paid to workers' compensation claims.

Communication and Coordination for Host Employers, Contractors, and Staffing Agencies

Most employers occasionally have other employers' workers present in their workplace, including janitorial staff, temporary clerical support, or specialized service workers such as electricians or mechanics. These workers, like those you employ, can be exposed to safety or health hazards present in your workplace.



The host company must take responsibility for all workers, including contract and staffing agency workers. Employers must establish mechanisms to coordinate their efforts and communicate information to ensure that all workers on site and their representatives can participate in efforts to prevent and control injuries and illnesses, and that workers are afforded equal protection against hazards.

Many public sector organizations are not under the jurisdiction of federal OSHA or even a state OSHA, but the contract companies are under an occupational safety agency that will regulate and cite them for violations. However, local government officials have a moral obligation to make sure that workers of all types who do business with them are protected from hazards.

Outline the procedures and processes for coordinating safety and health responsibilities, as well as and the procedures for communicating between the host employer and contractor, subcontractor, or temporary staffing agency. Document these in writing. To keep the workers safe, the company should:

- Communicate with all outside contractors the importance of worker safety
- Coordinate with supervisors, owners, and workers throughout the project to make sure the worksite is safe
- Hold all workers and agencies accountable for operating a safe worksite
- Verify that the bids and contracts specify that safe work practices are a must for working with the company

A safety culture will protect the workers from injury and illness because the company places a value on the lives of the workers. This is a deposit into the “good will” bank of the worker and will be rewarded with loyalty. A deep commitment to a safety culture will lead to worker retention and organizational benefits far beyond regulatory compliance.

Worksite Analysis

Hazard prevention and control comes from all levels of the organization, including the chief executive officer and extended all the way down to the workers themselves. A safety management system depends not only on individual responsibility but also on a system that can prevent hazards across all work activities.

What is a JHA?

One of the most common systems for identifying and preventing hazards on a jobsite is through a Job Hazard Analysis (JHA). A JHA helps workers identify the specific hazards associated with the different steps of a task. Unlike a standard operating procedure (SOP), which only shows employees how to perform the task, a JHA includes additional information about the hazards associated with each component of a job. It is common to develop a JHA by starting with the SOP to get the steps outlined in chronological order. The safety committee, which should include a selection of the working crew, can dissect the steps to see if and where a hazard may present itself.

Once the hazard or hazards are identified, then the workers will look to the hierarchy of hazard control to see if they can either eliminate the hazard, substitute it, engineer a



control, use existing or new work rules as an administrative control, or as a last resort wear personal protective equipment during that step. Once the proper controls have been determined, a JHA worksheet should be filled out and kept for the review of the employees prior to performing the task. Some JHAs can be done in advance for jobs that are routine, while others are done onsite right before beginning the task. However, even JHAs that are done prior should be revisited by the work team before any work begins. If there is any doubt as to the steps, hazards, or hazard controls, then the work should not proceed until all questions have been answered.

Job Hazard Analysis Form

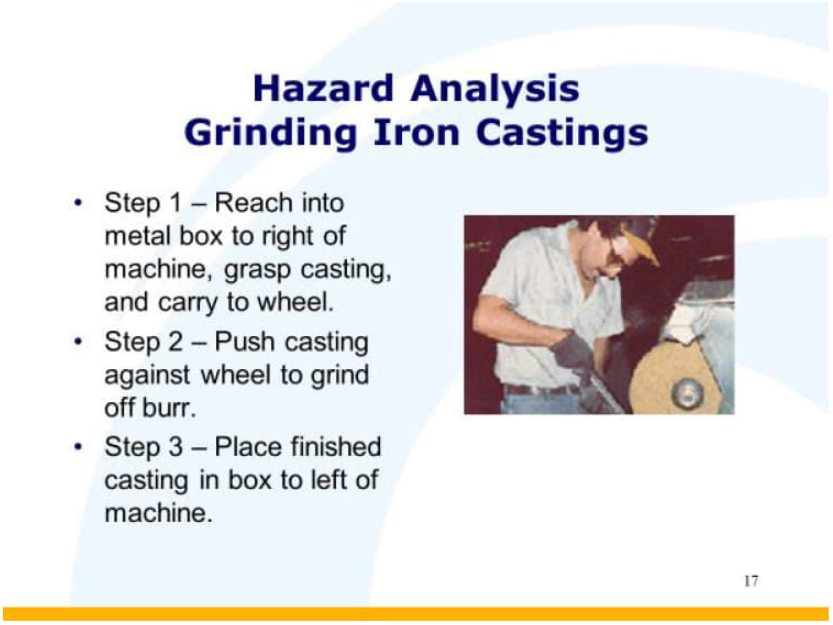
JOB TITLE: DATE OF ANALYSIS:

JOB LOCATION:

STEP	HAZARD	NEW PROCEDURE OR PROTECTION

Sample JHA

This job involves a worker grinding iron castings to remove burrs left by a previous operation. To accomplish this, he reaches into metal box to the right of the grinder to get a 15-pound casting. He then carries it to a grinding wheel and grinds off the burrs. He does this 20 to 30 times per hour. Let's consider step 1 of the following task.



The JHA for step 1 of this process would include the following:

In the "Step" column:

- Reach into metal box to right of machine, grasp casting, and carry it to the wheel

In the "Hazard" column:

- Picking up the casting, an employee could drop it onto his/her foot. The casting's weight could cause a serious injury to the foot or toes
- Contact with sharp burrs and edges of castings could cause severe lacerations
- Strains to the lower back from reaching, twisting, and lifting 15-pound castings

In the "New Procedure or Protection" column:

- Remove castings from the box and place on a table next to the grinder
- Wear steel-toed shoes with arch protection
- Change to protective gloves to allow a better grip

- Use a device to pick up the castings

Hazard Recognition

A hazard is anything that can injure or hurt an individual. The presence of hazards in a workplace does not necessarily mean injuries or accidents will occur. An accident requires both the presence of a hazard and exposure to the hazard in order to occur. A JHA should identify whether the hazard itself or the exposure to the hazard is the primary concern. For example, in a trenching or excavation operation, a cave-in is possible even when no workers are present. Only when workers are present would it be considered an accident because only then are workers exposed to it.

Hazard recognition should be first and foremost taught to the front-line supervisors who have control over the work conditions affecting both them and the workers they supervise. Hazard recognition must also be taught at the level of each worker as they become employed at the facility. Some hazards, such as working at heights, are fairly obvious, but there are also hazards that may not be as obvious. Workers may be exposed to an odorless toxic fume, for example, meaning they would not be aware that they are being poisoned. This is a common hazard in confined spaces.

Hazard Types

Hazard types help classify hazards according to what negative effects they might have on workers. Examples of hazard types are:

- Ergonomics
- Caught-in
- Contact-with
- Chemical exposure
- Flammable liquids
- Laceration
- Falls to below
- Falls to the same level
- Mechanical hazards
- Engulfment

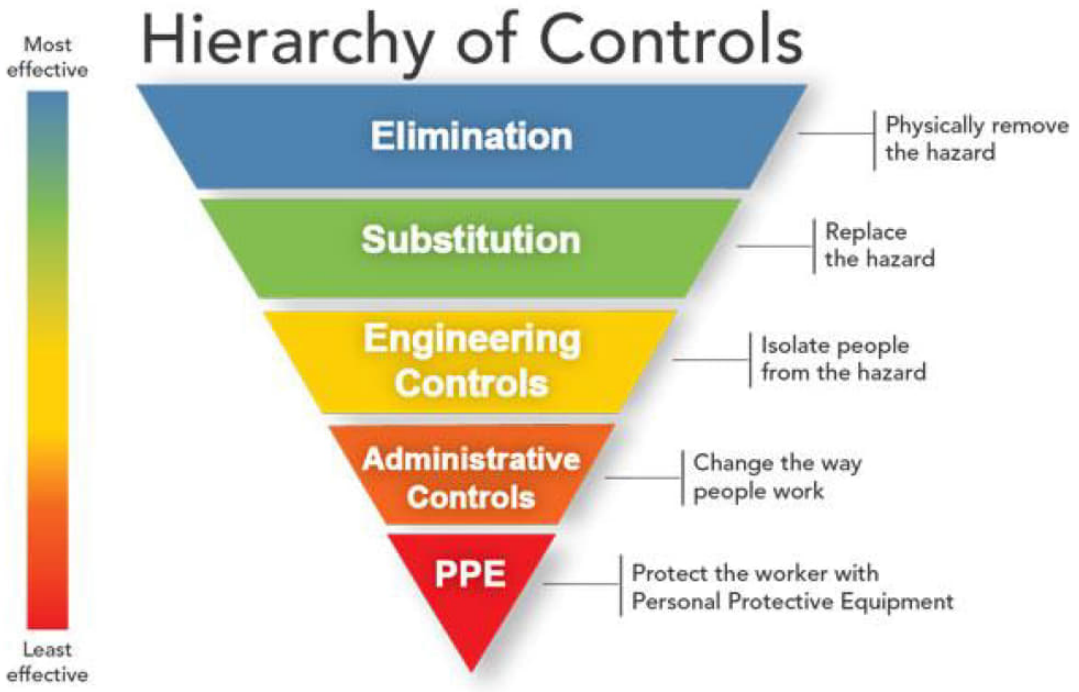
There are many more hazard types that are job specific, so the worker must be trained to recognize these hazards from the first day of work. Once the hazards are identified, the next stage is to learn how to control them and prevent them from injuring workers.

Hierarchy of Hazard Controls

Controlling exposures to occupational hazards is the fundamental method of protecting workers. Traditionally, a hierarchy of controls has been used as a means of determining how to implement feasible and effective control solutions.

One representation of this hierarchy is as follows:





The idea behind this hierarchy is that the control methods at the top of graphic are potentially more effective and protective than those at the bottom. Following this hierarchy normally leads to the implementation of inherently safer systems, where the risk of illness or injury has been substantially reduced.

The following are the levels of the hierarchy of controls:

- **Eliminating the hazard** is the primary way to protect workers. If workers do not have any exposure to that hazard because it is not present, then they will not be injured or harmed.
- **Substituting one substance or process for another** is a secondary way to protect workers from injury or illness. For example, if there is work with the gas chlorine and the workplace decides to go to liquid bleach, that substitution would protect the workers from exposure to a hazardous gas.
- **Engineering controls** create a physical barrier between the worker and the hazard point. This physical barrier is not something that can easily be removed or bypassed without worker intervention. An example of engineering control is a machine guard on a table saw. If workers want to use the table saw without the machine guard, they would have to physically take off that guard and then operate the machinery.
- **Administrative controls** are work rules set by the employer to protect workers from injuries or illnesses. A work rule, policy, or procedure, along with the employer's safety culture, are company norms that will translate into tangibly better outcomes. An example of an administrative control is to have workers read the procedure on how to safely do a task. This procedure would be detailed,

identify the hazards, and help the worker select the appropriate control for that hazard.

- **Personal Protective Equipment (PPE)** is the very last line of defense for worker safety and health because even when using PPE, they are still exposed to that hazard. If the worker must still be exposed to a hazard even after other controls are implemented, then PPE should be selected for protection. Personal protective equipment must be accompanied with a PPE hazard assessment that identifies the right protective equipment to match the hazard that the workers are exposed to. For instance, disposable gloves can be worn to protect against biological hazards. If a worker is cleaning up a bloodborne pathogen spill from human fluids, then he or she would use gloves. The PPE hazard assessment would tell him or her what types to use, such as latex gloves, nitrile gloves, or even thicker gloves depending on whether there is also a needlestick hazard.

Risk Analysis

Risk analysis is a way to understand the nature and complexity of a hazardous condition. A proper risk analysis is done through assessing the risk involved for the workers when confronted with a hazard. Usually, risk analysis includes the probability of the hazard creating an accident and the likelihood that the incident will result in an injury or illness of a certain severity. Therefore, risk is calculated by multiplying the probability an event will happen by the expected severity.

Probability is often divided into five levels: improbable, remote, occasional, probable, and frequent. In most risk analyses, each probability category can be assigned a number between 1 and 5.

The severity factors also are delineated into levels, this time four of them: negligible, marginal, critical, and catastrophic. Similar to the probability factor, numbers between 1 and 4 are assigned to the severity factors.

Using this system, an assessment can be performed that yields a specific number to describe the risk level and classify the hazard. Combined with the human error factor, the probability and severity may both increase any hazard that has a high risk.

Frequency of Occurrence-Probability	Catastrophic (Fatality) (4)	Critical (OSHA Recordable) (3)	Marginal (First-Aid) (2)	Negligible (Near Miss) (1)
Frequent (5)				
Probable (4)				
Occasional (3)				
Remote (2)				
Improbable (1)				

Case Study

A worker in a laboratory is using acid without any hand protection. The probability of a chemical burn is high enough to warrant the top level of likelihood of an event occurring,

which is a 5. The consequence of a chemical burn will yield a severity of 3. Calculating the risk of this use of acid in a laboratory without hand protection therefore yields a risk factor of 15. Using the maximum scale of 20 (the highest probability of 5 multiplied by the highest severity of 4) shows that this action by the worker is a high-risk activity. In this example, the use of chemicals without proper personal protective equipment has an element of behavioral deficiency. This at-risk behavior can be identified through a behavioral-based safety inspection and coached.

Lesson Summary

There are many cost factors related to accidents that can be direct or indirect. The direct costs of an accident are directly associated with the event and are easily quantifiable. Most direct costs are paid by the insurance company of the employer. The indirect costs of an accident are not paid through the insurance and therefore are unrecoverable.

The components of a safety program include:

- Management leadership
- Worker participation
- Hazard identification and assessment
- Hazard prevention and control
- Education and training
- Program evaluation and improvement
- Communication and coordination for host employers, contractors, and staffing agencies

A hazard is anything that can injure or hurt an individual. Hazard identification is primary to understanding how an accident can happen. Hazard types are ways to classify what specifically the hazard is to the worker.

One of the most common ways for workers to visualize hazards prior to undertaking a job is through a Job Hazard Analysis (JHA). A JHA identifies the steps required to perform a task, the hazards associated with each step, and the controls necessary to mitigate the hazards.

Once hazards are identified, they must be controlled to prevent illness or injury. The hierarchy of hazard controls ranks these in order of preference, from complete elimination of the hazard (most preferred) through substitution of the hazardous material or task, engineering controls, administrative controls, and finally wearing personal protective equipment (PPE – the control of last resort).

For individual hazards, an employer may need to perform a risk analysis to determine the risk associated with those hazards. Risk is calculated by assigning numbers between 1 and 5 to the probability level and numbers between 1 and 4 to the severity.

Lesson 2: Accident Causation and Investigation

Lesson Focus

At the end of this lesson, students will be able to:

- Understanding Accident Causation
- Accident Theories
- Incident Investigation Techniques
- Behavior-Based Safety Programs

Understanding Accident Causation

OSHA strongly encourages employers to investigate all workplace accidents, both those that cause harm and the "close calls" that could have caused harm under slightly different circumstances. Investigating a worksite accident—a fatality, injury, illness, or close call—provides employers and workers the opportunity to identify hazards in their operations and shortcomings in their safety and health programs. Most importantly, it enables employers and workers to identify and implement the corrective actions necessary to prevent future incidents. Accident investigations that focus on identifying and correcting root causes, not on finding fault or blame, also improve workplace morale and increase productivity by demonstrating an employer's commitment to a safe and healthful workplace.

To understand accident causation, investigations rely on the idea that most accidents are caused by human error. Therefore, if you learn the cause-and-effect relationship of accident causation and the human element, then you can reduce injuries and illnesses. Though there are additional factors to consider, the human element is a leading cause of accidents.

Note: Though there are some definitions that create a distinction between "accidents" and "incidents," for the purposes of this training the two words will be used interchangeably.

Accident Theories

A variety of theories have been developed over the years to help us understand how accidents happen. The following are brief introductions to these theories.

Single Factor Theory

The Single Factor Theory for accident investigation is the most basic of the accident causation models. The single factor theory assumes that one event is solely responsible for an accident. It is akin to the "pilot error syndrome" that states that the cause of an airplane accident was solely an error caused by the pilot. In modern accident causation models, the single factor theory has little to no value.



H.W. Heinrich's Domino Theory

In 1931, industrial safety pioneer H.W. Heinrich proposed a theory referred to as the axioms of industrial safety, a series of ten principles designed to protect workers. The first axiom dealt with accident causation, stating "the occurrence of an injury invariably results from a completed sequence of factors, the last one of these being the accident itself." A lineup of dominoes is the image most often used to demonstrate this principle, which eventually became known as the domino theory.

In all the domino theories, there are 3 phases that are influencers of an accident. These phases are:

- Pre-contact phase, prior to the event happening
- Contact phase, which refers to the event as it's happening
- Post-contact phase, which refers to after the release of unplanned energy, the product downtime, or the injury or illness

In a later model of the domino theory, managerial influence and managerial error dominoes were added. In the later model, loss was organizational loss as opposed to just an accident. An example of organizational loss could be property damage, loss of public trust, as well as an illness or injury.

A criticism of the domino theory holds that more dimensional approaches were required because an accident might have multiple factors and causes that don't operate in a linear fashion.

Multiple Factor Theory

The multiple factor theory looks at not just the 3 phases in the domino theory of pre-contact -- contact -- post contact, but also other factors that influence an accident. Multiple factor theories analyze things such as management, the machines, the media, and the man. The role of management would be to create the organizational structures, the policy, and procedures that ensure safety. The machinery includes the design, shape, size, and the type of equipment or materials being used. The role of media can be described as an environmental factor that might influence worker or manager behavior, while the factor of the man includes gender, age, mentality, fatigue factors, height, weight, etc.

In analyzing all these factors, it becomes apparent that your model does not include just the influencers. Unlike previous theories, management's role is more concrete in the multiple factor theories. Strong management that respects the role of occupational safety will support and lead the safety effort of the organization.

Human Factor Theory

The human factor theory states that every accident is caused by human error. This theory analyzes the factors that lead to human error, such as overload, inappropriate activities, and inappropriate responses.

Overload doesn't always mean that the worker is overburdened, but the job itself may have excess stressors such as noise, heat, or unclear instructions. Workers can often feel overloaded when given too many tasks at a time or work instructions do not clearly define the goals. Front-line supervisors are charged with making sure that the workers understand the steps of each task.

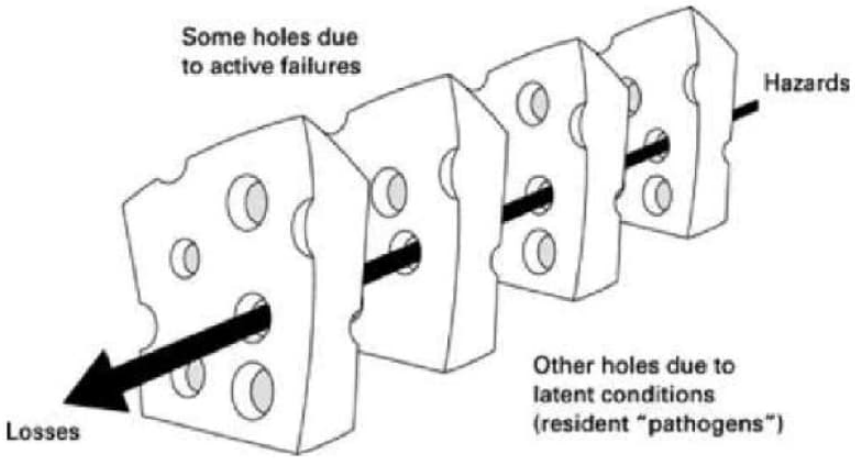
There are two types of failures that cause human errors: active failures and latent failures. An active failure is usually caused by the worker or person engaged in an activity. The actions give an immediate consequence, which is the direct cause of the accident. Latent failures lay the foundation of an active failure due to such issues as:

- Ineffective training
- Poor engineering of the equipment or location
- Poor or inadequate supervision
- Ineffective communication
- Unclear roles for the worker

James Reason's Swiss Cheese Theory

In recent years, a professor from Manchester University in the United Kingdom, James Reason, developed an accident causation model based on the analogy of holes in Swiss cheese. In his analysis of an accident, he uses a visualization of a complete system with no holes. In a complete system, management is involved, employees are motivated, there is a safety management system in place, and a safety culture exists in the organization.

Fig. (1): The Swiss Cheese Model by James Reason published in 2000. Adopted from Perneger BMC Health ServicesResearch 2005 5:71.



https://www.researchgate.net/figure/Fig-1-The-Swiss-Cheese-Model-by-James-Reason-published-in-2000-Adopted-from-Perneger_fig1_324280519

A breakdown of any one of these components creates a hole similar to the hole in a slice of Swiss cheese. As more holes develop, the system becomes less effective and more dysfunctional. Eventually, the holes in each system will line up and allow a release an accident to occur. This model combines the linear nature of the domino theory with the complexity of the multiple factor theory.

For example, an employee handling caustic chemicals may wear gloves, but if the walkway isn't clear he can still trip. If the walkway is clear and he does not trip, the container the chemical is in might be defective and rupture. If the container does not rupture, the chemical may still emit fumes that could impair the worker. The key is to provide a sufficient number of layers of protection and monitor each layer for deficiencies so that they can be corrected.

How to Use Accident Theories

With the possible exception of the single-factor theory, all of these accident theories could potentially be useful in determining how and why an accident occurred. Most accidents involve some sort of domino-like sequence, even if the time elapsed was very short. Virtually all accidents result from the intersection of multiple factors, and on construction sites in particular accidents are often the result of too many "holes" in the layers of protection. The important thing is for employers and employees alike to consider the causes of accidents and take concrete steps to prevent the same accidents from happening again in the future. Every accident should be a learning opportunity!

Accident Investigation Techniques

The following are some of the common techniques used to investigate accidents.

Root Cause Analysis

A root cause analysis is a detailed procedure used by safety professionals to look beyond the initial reactions, which may be informed more by emotion than careful thought, to assign blame for an incident.

A root cause analysis must be conducted to determine all factors and variables responsible for an accident. Most of these types of analysis will require a team of trained professionals who are familiar with accident causation models, as well as good investigators and critical thinkers. There are many types of root cause analysis, but they all seek to do the same thing: address the source cause of any accident.

The 5 Whys

The 5 Whys is an accident investigation technique often used by safety professionals to conduct a root cause analysis. It uses quantifiable questions that build on one another

to get closer and closer to that cause. Although this technique is called the 5 Whys, it often takes more questions than that to get to the root cause.

Here is an example of how the 5 Whys can be used to investigate an accident:

A worker receives a laceration from touching an unguarded blade on a handfed ripsaw. Using the 5 Whys technique for questioning, the investigator can begin with these questions:

Q: Why did the worker receive a laceration?
A: Because he touched unguarded blade.

Q: Why did the worker touch the unguarded blade?
A: Because the guard was not placed on the saw.

Q: Why was the guard not on the saw?
A: Because the worker believed he could work faster without the guard.

Q: Why did the worker believe it is better to work faster and not safer?
A: Because the worker gets paid on a quota basis.

Q: Why is management placing a greater importance on production quotas over safety?
A: Because management receives a bonus for achieving production quotas.

In this brief example, the use of production quotas indirectly led to the worker valuing speed over safety. There may be many other factors related to why the worker received a laceration in the scenario, such as:

- Poor organizational safety culture
- Untrained worker
- Management and supervisors have unfair expectations of production quotas
- Workers fear retribution for slowing down production to address safety concerns
- Upper management has condoned and/or rewarded production goals over safety concerns

When conducting a 5 Whys accident analysis, the investigator will dig deeper to uncover an accident's cause. This new revelation may lead the organization to address gaps in their safety management system. The 5 Whys is an accident investigation technique often used by safety professionals to conduct a root cause analysis. It uses quantifiable questions that build on one another to get closer and closer to that cause. Although this technique is called the 5 Whys, it often takes more questions than that to get to the root cause.



Behavior-Based Safety (BBS) Programs

There is a safety and health tool known as a behavior-based safety (BBS) program that picks at-risk behaviors and monitors workers to understand why they are behaving in that way. There are a number of behaviors that can cause a worker to perform work unsafely or below expectations. These performance traps or snares will reveal themselves in a BBS observation. To correct these behaviors, the coach must be able to identify them and must know how to help the worker overcome them.

The following are common human performance snares and ways to overcome them.

Time Constraints

One of the most common human performance snares arises when workers feel that they have a time constraint forcing them to cut corners. There are many actual time pressures related to jobs, such as due dates, daily schedules, quotas, and frontline supervision time crunches.

Some time pressures are legitimate and cannot be easily adjusted. In an emergency situation, for example, an employee might have to make important decisions rapidly. In such a situation, employees tend to rely on habit strength, meaning they resort to the methods they have used most frequently in the past. As part of a behavior-based safety program, workers will be trained to habitually use safe behaviors, leading them to that habit strength in times of emergencies.

However, in some cases workers use time constraints to avoid safe behaviors that may require more effort or attention than they want to give. In these situations, a coaching session with workers should include tools that can help deal with time constraints. The coach can perform a self-check or arrange a peer-check to see if there was truly a time constraint to performing the task. A pre-job briefing would help workers see the whole job and visualize how long it will take ahead of time. A careful consideration of the worker's attitude at the time of the job could also reveal whether they are placing an unreasonable amount of time pressure on themselves. Be sure to consider whether policy and procedure were followed for the employee performing the task, or bypassed.

Interruptions or Distractions

In some cases, an at-risk behavior is caused because the worker is distracted or interrupted during the task. In order to successfully coach this individual, there must be an assessment of what the distraction was and where it came from. Distractions might arise from the worker him/herself, or from external sources (like another employee's phone ringing).

The first step in dealing with interruptions or distractions is to remove them, or to remove the employee from the distraction area. The employee should perform a system check prior to resuming the task to make sure all conditions are still safe for operations. It may also be a good idea to have the worker seek assistance from a coworker before resuming work in order to assess the situation for any more distractions or interrupting

factors. Ultimately all distractions should be removed so that the worker can focus on how to perform a task safely.

Multitasking

The term multitasking implies that someone can do more than one task at the exact same time. It is nearly impossible for workers to multitask in the purest sense of the word. Workers can, however, try to switch rapidly from one task to the next in order to multitask. This can become a very dangerous pattern of behavior that can lead to mistakes in one or more of the processes the worker is trying to do at the same time. The worker should prioritize a list of tasks he/she needs to accomplish first. Once a task is accomplished then the next task in line should be tackled. If the worker feels that they have too many tasks that are due at the same time, then instead of attempting to multitask they should speak to their manager about delegating or adjusting some of the responsibilities.

Overconfidence

When a worker is overconfident, he/she will be more likely to take risks and injure him/herself or others. In some instances, the worker will feel that they do not need to be checked because they have performed the work correctly in the past. However, this is not always the case and even the best worker can forget steps in the procedure.

To help workers overcome the feeling of overconfidence (that they are too skilled to make a mistake), the coaches or supervisors should ask them how they would feel if they did not get all the steps correct and there was an incident. Pointing out the possibility of something going wrong may help get them to rethink their own abilities. Additionally, a coaching session may include a self-check during which they are asked to question or challenge their own expectations.

The supervisor should routinely reinforce expectations of policies and procedures with individual workers.

Vague Guidance

Some workers develop at-risk behaviors because they only received vague guidance about the task. It is possible that the supervisor himself/herself might not have a good understanding of the task at hand. Vague guidance can lead to dangerous work practices and lost productivity.

Workers should be encouraged to ask questions if they’re unsure of any guidance given by the supervisor. The supervisor should have a good understanding of the job and ensure that all workers understand each task that has been assigned to them. In some cases, the supervisor might even require retraining on how to perform tasks that they are responsible for delegating.

Overnight Shift Work

It is not uncommon to observe a decrease in worker performance during overnight shift work. Experienced nightshift workers learn how to adapt to the schedule. However, new workers will need time to adjust to this lifestyle change. During this adjustment period, the chances of at-risk behavior due to drowsiness or other related factors go up. Therefore, at home, the late shift worker should be encouraged to create systems to keep them from getting fatigued, such as using blackout curtains and shutting off all electronic devices during the sleep hours. When coaching a worker who is showing at-risk behavior during the night shift, consider the simple things that lead to fatigue. It must be your common goal to have a worker assimilate to the new schedule when they are new on a job. In some cases, the shift supervisor should monitor the new hire and coach them on how to get better sleep after the job is complete. Additionally, some coaching from coworkers might help.

Some other behaviors related to late-night work can lead to lazy turnovers during the day shift when the workers feel fatigued in the final hours of the work shift and become labored. Therefore, final checks must be done before the day shift workers come to take over the process. To combat this issue, it may be necessary to have a more detailed shift turnover between the lead operators. Another tool that can be used to combat this issue is to have a detailed checklist of each shift, regardless of if it's day or night. The checklist will serve as a reminder of what is required for each shift.

Peer Pressure

Just like in school, the social impact from peers in the workforce is very important to monitor. This impact can be both good and bad depending on the individuals involved. When a workforce is very tightknit and the safety culture values low risk, then many workers will encourage each other to maintain safe behaviors.

In some cases, however, there may be a "bad apple" among the workers. If this bad apple has some social impact on the workers, then more workers will undertake at-risk behaviors as a result. Is important for the front-line supervisor to be an agent of change and not be the bad influence themselves. The assessment of at-risk behaviors may lead to modeling from an agent of influence in that group. It may be the front-line supervisor or perhaps someone who's been there for considerable numbers for years.

Some behaviors that commonly result from peer pressure include:

- Taking shortcuts with safety
- Ineffective or misleading communication
- Inadequate use of procedures
- Dereliction of rules
- Inadequate job briefings
- Not using peer checks
- Inadequate self-checks



In these instances, there may be a need to take progressive disciplinary action, especially in cases of workers who are being pressured into poor behavior. The influencer must be identified and put on notice until the behavior changes. The management team should consider separating the work team or unit across two different locations or divisions in the company.

A positive way to encourage new peer pressure that reinforces safe behavior is to offer mentoring and coaching opportunities for all at-risk workers. Peer mentoring can help the workers see that it is possible for someone at their level to have a positive strong influence. This will also indicate to the worker that the organization cares for them and is willing to work with them to improve behaviors.

Change

Some workers are averse to change and become more prone to at-risk behaviors when changes are implemented. Even when change is inevitable, workers need to feel that they are part of the system in order to be more comfortable with the idea of change and understand that it may be in their own best interests. In some cases, it is better to inform workers of the change well in advance and give them all scenarios related to the change before any actions are taken.

A change analysis should be conducted before major changes are implemented. A change analysis is a detailed process that is utilized to determine what domino effects will result from changing a major element of their system. This analysis is performed through the entire organization and utilizes systematic steps to analyze all repercussions of the change. For instance, if a company wants to change from using gas chorine to liquid bleach, then a change analysis is in order. The release of gas chlorine into the atmosphere can create adverse effects for the whole community and not just the workplace. However, liquid chlorine bleach is not as harmful to a community if released into the atmosphere. The change analysis would incorporate all necessary parts, equipment, training, and regulatory requirements prior to the occurrence of such a major change in the system.

Physical Environment

There may be some performance issues due to the actual layout of the workspace. Things like poor lighting, ventilation problems, or even the layout of machines can lead to problematic or dangerous behaviors. Many workplaces conduct worksite analyses to make sure that there are no environmental factors adversely impacting any part of the job.

Workers will be the first ones to see if there are any physical and environmental problems that are leading them to at-risk behaviors. They will work around them as best as possible through whatever means available to them.

A third-party audit is an excellent way to analyze the work environment to ensure that there are no physical issues that would lead the workers to adopt at-risk behaviors. When the assessment is complete, a third-party auditor will have a final report with

recommendations. Once recommendations have been read and understood, the organization should start making all the required changes to the physical environment promptly.

Mental Stress

Mental stress is produced by many things in the work environment, though workers may also bring stresses from home. It may be tempting to trust that workers will separate their work and home lives, but realistically some workers will exhibit at-risk behaviors because of home stresses.

Mental stress can produce severe outcomes when they are coupled with at-risk behavior in the workplace. Some jobs are not forgiving when it comes to any form of deviation from safe practices. In such cases, workers will not only hurt themselves and their coworkers, but their behavior might even adversely affect the community or the environment. Mental stress coupled with fatigue can also be a deadly combination for employees and their coworkers. Distractions as well as worker harassment may be an outcome of mental stress. Some workers internalize stress in such a way that they become pressurized with emotions until there is a breaking point.

A workplace should have areas where workers can release mental stresses to prevent at-risk behaviors. Another strategy is to provide an employee assistance program for workers, which gives them the chance to talk about any stresses that are happening in their lives to a psychologist or other mental health professional. These mental health professionals are trained to help workers cope with stress.

Additionally, when at-risk behavior is observed and mental stress is determined to be the culprit, then the coaching should be sympathetic. When dealing with situations when workers are under stress, understanding the source of stress is important. The best approach is to try and eliminate the source of stress in the work atmosphere. Clearly communicating all expectations of the organization to have stress free workers and environments is of the utmost importance. Workers who demonstrate severe stress levels should have increased supervision and coaching. If stress cannot be eliminated, then a management approach must be taken.

Stress-limiting activities include:

- Workplace sponsored teambuilding activities
- Calisthenics and yoga
- Wellness programs
- Sponsoring of a community event
- Collaborating with a nonprofit organization to perform activities such as feeding the homeless, reading books to children, or helping with literacy programs

Understanding common human performance snares will enable the steering committee or assigned coaches to give the workers a better understanding of how to combat some at-risk behaviors which will help them perform their jobs in a better way.

Lesson Summary

To understand accident causation, investigations rely on the idea that most accidents are caused by human error. Therefore, if you learn the cause-and-effect relationship of accident causation and the human element, then you can reduce injuries and illnesses. Though there are additional factors to consider, the human element is a leading cause of accidents.

Theories of accident causation include:

- Single factor theory, which traces the cause of an accident back to a single factor. This is unrealistic and the single factor theory is rarely used.
- H.W. Heinrich's domino theory, which analyzes an accident as a chain of three phases: pre-contact, contact, and post-contact. According to Heinrich, by removing one of the "dominos" in this sequence, accidents and their negative effects can be prevented.
- The multiple factor theory holds that there are more than Heinrich's three phases to consider when investigating an accident – that there are multiple factors that contribute to the cause.
- The human factor theory traces all accidents back to human error.
- James Reason's Swiss cheese theory uses the holes in slices of Swiss cheese to explain accident causation. The holes represent breakdowns in safety, and when enough holes line up an accident can occur.

Commonly used accident investigation techniques include root cause analysis and the 5 Whys. A root cause analysis is a detailed procedure used by safety professionals to look beyond the initial reactions, which may be informed more by emotion than careful thought, to assign blame for an incident.

A behavior-based safety (BBS) program picks at-risk behaviors and monitors workers to understand why they behave in those ways. Some common human performance snares include time constraints, distractions, multitasking, overconfidence, vague guidance, and peer pressure.

Module 3: OSHA Focus Four Hazards

Module Description

Construction safety is one of OSHA's top concerns. Construction is among the most dangerous industries in the country and construction inspections comprise 60% of OSHA's total inspections. In 2019, preliminary data from the Bureau of Labor Statistics indicate that there were 1,061 fatal on-the-job injuries to construction workers – more than in any other single industry sector and nearly one out of every five work-related deaths in the U.S. that year. Also, in 2018, private industry construction workers had a fatal occupational injury rate nearly three times that of all workers in the United States.



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