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POLLACHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

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Department of Computer Science and Engineering

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MX3089- INDUSTRIAL SAFETY

UNIT 1 SAFETY TERMINOLOGIES

What do mean by Industrial safety?

Industrial Safety is a multi-disciplinary approach to developing and ensuring compliance with regulatory agencies, safe working practices, and maintaining the health and well-being of those employed in a particular occupation or workplace.

Industrial safety means to create a safe environment for the worker in an industry from any hazards like fire, electrical, storage, floor, workplace, mentally and physically. Any industry must prioritize safety, and workplace safety initiatives foster a healthy environment and may raise employee morale. The best way to prevent any accident from repeating itself is to follow industrial safety rules and regulations. Over the course of time, we have developed Industrial safety training and services with live demonstrations to make your life safe.

Why is it Important?

- **To protect the industrial workers, machinery, facilities, structures, and the environment.**
- **For the safety of people in their workplaces.**
- **For protecting the environment against damage from industrial accidents.**
- **For protecting businesses against serious losses from damage to plants and machinery.**
- **For eliminating accidents causing work stoppage and production loss.**
- **For providing basic training in well-established techniques for engineering of safety systems.**

WHAT ARE CALLED A HAZARDS?

- A hazard is a dangerous phenomenon, substance, human activity or condition. It may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

6 types of safety hazards

Here are hazard types recognized by OSHA:

1. Work safety hazards

Work safety hazards are the most common risks in a workplace or work environment. They also can be specific to certain roles. For example, a construction professional may work with specialized machinery, creating unique safety concerns for that role.

Types of work safety hazards include:

- **Spills:** Spills can occur in any workplace so it's important to create a plan to prevent falls after a spill. To decrease the likelihood of a spill hazard, you can put out a caution sign to alert others so they should avoid the area.
- **Obstacles:** Tripping hazards occur when obstacles are in your path. They include blocked aisles, cords on the floor or poor equipment placement. To decrease the likelihood of a spill hazard, your company can create floor layouts and protocols to place objects where they pose the least threat of obstruction. Cords can be moved or covered to reduce tripping risk. You can also clearly mark stairs and steps using signs, floor paint and symbols.
- **Heights:** This hazard is more common in roles like painters or roofers that involve high elevations. To decrease the likelihood of a spill hazard, you can provide training for

professionals who work on ladders, roofs or scaffolds to help keep them safe in high places. Continuous awareness and attention to safety procedures can help prevent incidents while working at different heights.

- **Machines:** Some professionals work with machines or equipment with moving parts like forklifts, farming equipment or excavators. To decrease the likelihood of a spill hazard, you can provide training and updated safety standards to reduce their risk of contact.
- **Tools:** Professionals may work with tools such as chainsaws, electrical equipment or hammers that may pose safety hazards. Teaching them how to use these tools properly can help create a safer environment.
- **Electricity:** Electrical hazards may be caused by frayed cords, missing ground pins, improper wiring or contact with live wires. Only qualified workers should operate near live electrical equipment. To decrease the likelihood of a spill hazard, you may require professionals to receive training and complete certification programs to be aware of these hazards.

2. Chemical hazards

Chemical hazards occur when a professional is exposed to chemicals in either solid, liquid or gas form. This includes those who prepare, ship, manufacture, package or handle chemical products. OSHA's Hazard Communication Standard requires facilities to keep an inventory of all products. Some chemicals are safer than others but those exposed may react differently depending on the length of exposure and their chemical sensitivity.

Chemical hazards can include:

- Liquids like cleaning products, paints, acids and solvents

- Vapors, fumes and dust from welding, asbestos, exposure to solvents or dust from interior construction
- Gases like acetylene, propane, carbon monoxide and helium
- Flammable materials and fumes like gasoline, solvents and explosive chemicals
- Pesticides that can be sprayed, applied or ingested

To decrease the likelihood of a spill hazard, you can provide training and protective gear to help keep professionals safe from chemical exposure. They should be properly trained to handle chemicals and all chemical containers should have safety labels.

If your company uses or produces flammable materials, they should be clearly marked and properly stored. You can provide training to handle these materials, provide protective gear and instruct them on how to respond to a fire or other emergency.

Thoroughly washing exposed body parts and cleaning equipment can also help protect against these hazards.

3. Physical hazards

Physical or environmental hazards are risks from within the environment that can harm your body without necessarily touching it. These hazards occur more frequently in certain industries. For example, professionals who work outside may experience more weather-related exposure.

Physical hazards can include:

- **Noise:** Exposure to loud noises can be a risk in industries, such as construction or manufacturing, where employees work with loud machinery. To decrease the likelihood of a spill hazard, you can provide protective gear like earplugs and headphones to help reduce this risk.

- **Temperature:** Some people like landscapers, roofers and delivery drivers may work in extremely cold or hot temperatures. To decrease the likelihood of a spill hazard, you may create training programs to help professionals recognize the signs of exposure, dehydration and heatstroke.
- **Lighting:** Low lighting or direct sunlight can be a workplace risk. To decrease the likelihood of a spill hazard, your company can evaluate its lighting systems and windows to ensure professionals have proper lighting levels to perform their tasks.
- **Radiation:** In certain work environments, professionals may be at risk of radiation exposure. To decrease the likelihood of a spill hazard, you can reduce their risk by providing training, protective gear and radiation-detecting badges and instruments.

4. Ergonomic hazards

Ergonomic hazards can occur with physical motion or repetitive movements that put a strain on your body. Professionals can damage muscles, nerves, ligaments and tendons by performing the same motion repeatedly. This type of hazard is the hardest to anticipate since the risk may increase over time and use.

Ergonomic hazards can include:

- **Lifting:** Repetitive or heavy lifting can be a workplace hazard. To decrease the likelihood of a spill hazard, you can provide training and equipment, such as moving carts, to help prevent this hazard.
- **Sitting:** Sitting for a long time, such as at a computer or desk, can become an ergonomic risk. To decrease the likelihood of a spill hazard, you can teach professionals how to stretch properly and take breaks to reduce this risk. Your

company may consider providing standing desks or scheduled movement breaks.

- **Posture:** Poor posture can result from actions like stooping over an assembly line, poor posture while using a computer or standing too long. To decrease the likelihood of a spill hazard, you can provide ergonomic chairs and workstations to help team members maintain a healthy posture at work.

5. Biological hazards

Biological hazards are safety concerns associated with working with animals, people or infectious plant materials. These are more common in certain industries such as health care, education, emergency response, waste control and research. teaching.

Biological hazards may include:

- **Plant and insects:** Professionals who work outside, such as biologists and landscapers, may encounter poisonous plants, stinging insects or biting reptiles. To decrease the likelihood of a spill hazard, you can provide training and education programs to help employees know what to do in dangerous situations.
- **Blood and bodily fluids:** Certain roles, such as those in health care, child care or veterinary care, may expose employees to bodily fluids. To decrease the likelihood of a spill hazard, you can train them to learn the best practices for handling these materials safely. Companies can provide professionals with protective clothing and respiratory equipment to reduce contamination. Thoroughly washing exposed body parts can also help protect against infection.
- **Communicable diseases:** As with blood and bodily fluids, certain fields may expose professionals to bacteria and viruses that are airborne or communicable. To decrease the

likelihood of a spill hazard, companies can provide professionals with protective clothing and respiratory equipment to help reduce contamination.

- **Fungi and mold:** Professionals may be exposed to fungi and mold in health care, home renovations, demolition or other fields. To reduce risks, for example, from mold, you might institute mandatory training to identify mold and fungi and what to do when it's spotted. Protective clothing and respiratory equipment can help reduce exposure.
- **Animal and bird droppings:** Professionals exposed to these hazards may experience breathing difficulties or other symptoms. You can provide them with training, protective clothing and respiratory equipment to help reduce contamination.

6. Work organization hazards

Professionals can be impacted by hazards or stressors that cause stress (short-term effects) and strain (long-term effects). These hazards are associated with workplace issues such as workload, lack of control, negative culture, discrimination and more.

Work organization hazards include:

- Workload demands
- Workplace violence
- Lack of respect
- Lack of control
- Harassment
- Discrimination

Each hazard has the potential to impact others' mental and physical health. Steps you can take to help reduce these risks include awareness programs, training, open communication and feedback. If necessary, disciplinary measures may be required to protect others in your workplace.

Tips for managing workplace hazards

Managing workplace hazards can be a challenging task. However, some general guidelines or policies can help prevent workplace hazards. Here are some steps you can take regarding your company's policies on workplace hazards:

- **Policy updating:** It's important to ensure your work policies, safety guidelines and work instructions are updated and include the most relevant information possible.
- **Policy availability:** Safety policies and guidelines are most beneficial when they are accessible to all employees. Ensuring that your office has both digital and physical copies may help to prevent workplace issues.
- **Policy enforcement:** To ensure the effectiveness of policies, consider regularly reviewing policies and those who enforce them to verify their success.
- **Policy awareness:** Regular mandatory training can help remind employees of important policies that help ensure their safety. Rewarding employees for participation could also boost employee morale.

Leading and lagging indicators are qualifiers that assess a business's current state (lagging indicator) and predict future conditions (leading indicator), so companies can achieve accurate projections.

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What are leading & lagging indicators?

Leading and lagging indicators help enterprise leaders understand business conditions and trends. They are metrics that inform managers that they are on track to meet their enterprise goals and objectives.

Leading indicator

Leading indicators are sometimes described as inputs. They define what actions are necessary to achieve your goals with measurable outcomes. They “lead” to successfully meeting overall business objectives, which is why they are called “leading”.

Lagging indicator

If a leading indicator informs business leaders of how to produce desired results, a lagging indicator measures current production and performance. While a leading indicator is dynamic but difficult to measure, a lagging indicator is easy to measure but hard to change. They are opposites, and as such a lagging indicator is sometimes compared to an output metric.

How to use lagging indicators

Lagging indicators are always triggered by an event that has just occurred, and, in that sense, are a little more self-explanatory than leading indicators.

If you’re measuring the outcome of an event, product release, sales training program or what have you, you’re using lagging indicators to determine, in retrospect, who attended, what was produced, or how it was received by attendees.

What are TLVs?

TLVs are the maximum average airborne concentration of a hazardous material to which healthy adult workers can be exposed during an 8-hour workday and 40-hour workweek—over a working lifetime—without experiencing significant adverse health effects. A TLV has three components:

- **Time-weighted Average (TWA) concentration:** The concentration of a contaminant averaged over a workday (usually 8 hours long). It's measured in a workplace by sampling a worker's breathing zone for the whole workday. ACGIH recommends that the TWA should not be exceeded for up to an 8-hour workday during a 40-hour workweek.
- **Ceiling value:** A concentration of a toxic substance in air that ACGIH recommends should not be exceeded at any time during the workday. This value is often used in conjunction with the TWA.
- **Short-term Exposure Limit (STEL) value:** A TWA concentration over 15 minutes that ACGIH recommends not to exceed—even if the 8-hour TWA is within the standards. TWA-STELs are given for contaminants for which short-term hazards are known.

The four main routes of entry are inhalation, ingestion, injection, and absorption through the skin and eyes.

Inhalation

Inhalation of chemicals occurs by absorption of chemicals via the respiratory tract (lungs). Once chemicals have entered into the respiratory tract, the chemicals can then be absorbed into the bloodstream for distribution throughout the body. Chemicals can be inhaled in the form of vapors, fumes, mists, aerosols and fine dust.

Ingestion

Print Page

Chemical exposure through ingestion occurs by absorption of chemicals through the digestive tract. Ingestion of chemicals can occur directly and indirectly. Direct ingestion can occur by accidently eating or drinking a chemical; with proper housekeeping and labeling, this is less likely to occur. A higher probability of receiving a chemical exposure can occur by way of indirect ingestion. This can occur when food or drink is brought into a chemical laboratory

Injection

Print Page

Chemical exposure via injection can occur when handling chemically contaminated items such as broken glass, plastic, pipettes, needles, razor blades, or other items capable of causing punctures, cuts, or abrasions to the skin. When this occurs, chemicals can be injected directly into the bloodstream and cause damage to tissue and organs. Due to direct injection into the

bloodstream, symptoms from chemical exposure may occur immediately.

Some chemicals can be absorbed by the eyes and skin, resulting in a chemical exposure. Most situations of this type of exposure result from a chemical spill or splash to unprotected eyes or skin. Once absorbed by these organs, the chemical can quickly find its way into the bloodstream and cause further damage, in addition to the immediate effects that can occur to the eyes and the skin.

WHAT IS THE HEALTH AND SAFETY POLICY INDUSTRY?

A health and safety policy is a document outlining an organisations commitment and approach to managing health and safety in the workplace. The policy is ultimately signed off by the person at the head of the organisation.

SAFETY & HEALTH GOALS

The following goals have been established for XYZ Manufacturing Company:

(1) Provide workers with a safe work environment.

(2) Conduct routine/regular workplace inspections.

(3) Provide Personal Protective Equipment.

(4) Develop and implement safe work procedures and rules.

(5) Provide on-going safety training

(6) Enforce safety rules and appropriate discipline.

(7) Provide on-going property conservation practices

safety policies for your workplace

- Incident reporting policy. ...
- Drug and alcohol policy. ...
- Safe driving policies. ...
- Personal protective equipment (PPE) policy. ...
- Lockout/tagout policy and procedures. ...
- Transitional duty policy.

WHAT IS A MATERIAL SAFETY DATA SHEET (MSDS)?

A material safety data sheet is a technical document which provides detailed and comprehensive information on a controlled product related to:

- health effects of exposure to the product

- hazard evaluation related to the product's handling, storage or use

- measure to protect workers at risk of exposure

- emergency procedures. T

he data sheet may be written, printed or otherwise expressed, and must meet the availability, design and content requirements of WHMIS legislation. The legislation provides for flexibility of design and wording but requires that a minimum number of categories of information be completed and that all hazardous ingredients meeting certain criteria be listed subject to exemptions granted under the Hazardous Materials Information Review Act.

The Purpose of the Data Sheet The data sheet is the second element of the WHMIS information delivery system and is intended to supplement the alert information provided on labels. The third element of the system is the education of employees in hazard information on controlled products, including instruction in the content and significance of information on the MSDS.

UNIT II

THE FACTORIES ACT, 1948

The Factories Act, 1948, sets the safety standards for workers employed in factories. It is applied to factories manufacturing goods, including weaving cloth, knitting of hosiery and other knitwear, clothing, and footwear production, dyeing and finishing textiles, manufacturing footwear, etc.

The Factories Act, 1948, regulates the working hours for all workers. According to the Act, a working week should not exceed 60 hours.

The objectives of this Act are to regulate the hours or working time in factories so that workers are not overworked or unduly exhausted. The Act's main objectives are also to protect workers' health and safety.

The Factories Act, 1948, regulates the hours of work and minimum wages

The Factories Act, 1948, mandates the payment of minimum wages to the workers by prescribing a fixed pay rate. An employer shall pay their employees at least the prescribed minimum wage rate. If an employee is paid less than minimum wage, the employer should pay that employee at least what the law requires. This Act reminds employers that any failure on their part to comply with its provisions will have serious legal consequences.

The Act requires employers to allow a weekly holiday to their workers. It further makes it obligatory for the employer to provide proper sanitary facilities and a clean potable water supply in the factory or workplace. Strict action will be taken against the employer if they fail in providing these facilities to the workers.

Employers are also required to set up first aid boxes in their factory, store first aid records, and ensure proper arrangements for transporting injured workers to a hospital or in-house medical facilities.

Apart from these, the Act has several relevant provisions defining the duty of an employer who has in-house medical facilities and the duty of a doctor who is an official medical officer at the factory. The Act also defines the procedure to be followed if a complaint of any kind is received by or made to the government's labour department.

The Factories Act, 1948, also provides for implementing some administrative measures regarding which subsequent governments have framed appropriate rules.

Some of these measures are as follows:

1. The Factory Act, 1948, has provisions for the constitution of a Child Labour Committee in every factory. This committee should consist of employers, workers, representatives from local authorities and a medical officer. The committee is responsible for regulating and controlling employment in the age group of 14 to 18 years at factories where more than 20 persons are employed.
2. An industrial dispute between the employer and worker(s) can be resolved by a Conciliation Officer appointed by the government. The authority of this officer is to conciliate and not to mediate.
3. The governments appoint labour officers to look after factory workers' interests; this officer is a government official. The labour officers must see that no violation of any provisions of the Factories Act, 1948, takes place at any factory in their territories.
4. The state governments or local authorities have set up welfare funds in every factory. This fund may be established for general or specific purposes depending upon entrepreneurs' or local authorities' initiatives.

Objectives of Factories Act, 1948

- To protect the health and safety of workers
- To ensure that factories adhere to global best practices in the factories
- To provide a fair and decent livelihood for all working-class people
- To reduce any social or industrial tensions

Provisions of Factories Act, 1948

Factories Act, 1948, limits work hours to 48 hours a week, and overtime work should not be more than nine hours a day. Factory Schedule Rules specify that a limited working day shall not exceed ten consecutive hours; this regulation does not apply during a public holiday or when an emergency requires immediate action and substantial loss has occurred.

The Factories Act, 1948, sets the safety standards for workers employed in factories. It is applied to manufacturing goods, including weaving, knitting of hosiery and other knitwear, clothing and footwear production, dyeing and finishing textiles, etc.

Period of application

The Factories Act was implemented in India following the general elections held in 1951 for the Legislative Assembly of States and Union Territories that fall under the Indian Union, with effect from June 15, 1951.

The Factories Act, 1948, was further amended in 1951, 1960, 1961, and 1972. In addition to this amendment, the Rules of 1951, 1960, and 1961 have been amended. The Factories Act was applied to the newly formed States in 1965 by the Chief Secretaries of these States.

It applies only to certain factories employing ten or more workers (including apprentices).

Introduction Hazardous materials

Hazardous materials are any material that has properties that may result in risk or injury to health and/or destruction of life or facilities. Many hazardous materials do not have a taste or an odor. Some can be detected because they cause physical reactions such as watering eyes or nausea. Some Hazardous Materials exist beneath the surface of the ground and have an oil or foam-like appearance. The substance can be identified from placards, labels or markings on the transporters.

Hazardous Material can be

Corrosive Hazmat Materials

They are strong enough to eat away at steel drums or human skin. Because they can eat through the containers they are carried in, they are of special concern during transportation. Example: car battery acids ·

Ignitable Hazmat Materials

present a fire hazard because they are flammable at relatively low temperatures. This causes a risk of explosion and the spreading of toxic gas over an area, as well as fire and smoke. Examples: paint removers, the chemical Benzene.

Reactive Materials

The can explode or release deadly fumes by mixing with water or reacting to heat or pressure. Examples: old weapons and ammunition, sodium metal, stannic chloride.

Radioactive Materials

include materials with both high and low radioactivity that can lead to dangerous side effects for thousands of years. Most of these materials are produced at nuclear power plants and by research facilities.

Toxic Hazardous Materials

consist of poisonous chemicals. People and animals exposed to these types of materials can develop severe health problems. Examples: lead, arsenic, mercury ·

Infectious Materials

These materials are also toxic wastes, but are in a separate category. They consist of materials infected with some type of germ, bacteria, or virus that could cause disease in humans or animals. These types of materials often come from hospitals. Examples: hypodermic needles, human and animal waste.

WHAT IS ISO 45001?

ISO 45001 is an international standard that specifies requirements for an **occupational health and safety (OH&S) management system**. It provides a framework for organizations to manage risks and improve OH&S performance.

The standard establishes criteria for an OH&S policy, objectives, planning, implementation, operation, auditing and review. Key elements include leadership commitment, worker participation, hazard identification and risk assessment, legal and regulatory compliance, emergency planning, incident investigation and continual improvement.

ISO 45001 utilizes the Plan-Do-Check-Act methodology to systematically manage health and safety risks. It applies to organizations of all sizes and can be integrated with other ISO management system standards.

Why is ISO 45001 important?

Implementing ISO 45001 provides **significant value to organizations looking to reduce workplace incidents and demonstrate OH&S commitment**. Benefits include:

- ISO 45001 provides an **internationallyrecognized** framework for managing occupational health and safety risks. It enables organizations to **systematically assess hazards and implement risk control measures**, leading to reduced workplace injuries, illnesses and incidents.
- Adopting the standard shows employees and external stakeholders that the organization is committed to worker health, safety and wellbeing. This **boosts reputation, morale and retention**.
- The standard requires complying with OH&S regulations, ensuring legal conformity. It also promotes **proactive risk management**, potentially lowering insurance premiums.
- By requiring emergency preparedness and response protocols, ISO 45001 **strengthens organizational resilience** against safety threats and crises.
- The framework of plan, do, check act means the OH&S system can continually improve and evolve, **enhancing long-term worker health and safety performance**.

In summary, ISO 45001 enables organizations to **better protect their workers and manage OH&S risks**, making it an essential standard worldwide.

Benefits

-
- Framework to **systematically manage** OH&S risks
- **Reduced** workplace incidents and injuries
- **Demonstrated commitment** to worker health and safety
- **Ensured compliance** with OH&S regulations
- Increased **organizational resilience**
- **Continual improvement** of OH&S performance

SAFETY AUDIT (AS PER IS 14489)

What is Safety Audit?

A Safety audit is an organized process which is used to gather information associated to a company's safety, reliability, effectiveness, and efficiency. An auditor will examine the, work environment, processes, the state of equipment, and other details to measure these qualities. In Safety audits the auditors will explore the company's safety documents to assess how they can refine their processes and safety management systems.

Safety Audit in Industries as per IS 14489?

IS 14489 is the Risk Management tool on Occupational Safety and Health Audit. This standard demonstrates Audit objectives, criteria and practices and provides instructions for establishing, conducting, planning and documenting of audits on occupational safety and health systems of an Organization.

Safety Audit and its types

There are three types of Safety audits.

1. Compliance Audit.

The compliance audit is conducted to inspect whether the Organization acts in accordance with all the related safety laws, safety standards, and other provisions.

It can be done by Government safety inspector or other external safety auditors. This depends on Country's safety rules, safety management system, etc.

2. Program Audit.

The safety auditor will inspect for the safety program execution that the Organization has planned or is a obligatory program put down by the Government or other parties.

3. Safety Management System Audit.

This is an overall audit, where the compliance and program will be conducted simultaneously, apart from inspecting the safety management system itself.

What is Safety Audit checklist?

A Safety Audit checklist is an instrument which will help to assess the safety conditions and practices in any workplace in compliance to usual safety standards and regulations. It lists the safety basis to be reached in order to address compliance gaps, and impart opportunities to enhance the workplace ambiance

Safety Audit Examples

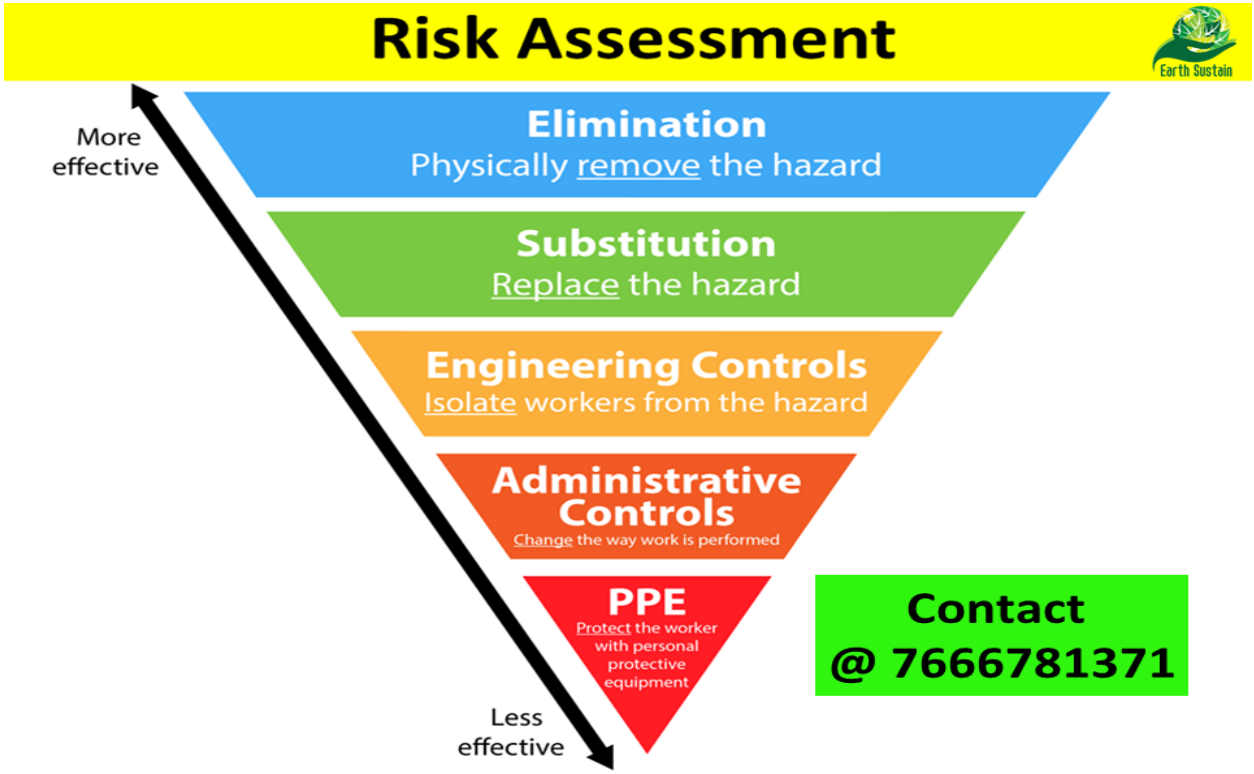
The following are few Examples of Safety Audit with their Safety Audit Checklist.

Chemical Storage Facility.

	Chemical Storage & Safety	Y	N	N/A	Comments
1	Chemical containers properly labeled, stored, & closed when not in use.				
2	Chemicals segregated and stored by compatibility.				
3	Peroxide formers dated at purchase and again upon opening.				
4	Peroxide formers disposed of within proper time frames.				
5	Secondary containment used where appropriate.				
6	Vacuum equipment trapped and/or filtered.				
7	Chemical storage areas free of ignition sources.				
8	Refrigerators/Freezers properly labeled.				
9	Refrigerators/Freezers properly rated if flammable liquids are stored within.				
10	Fume hoods and/or biosafety cabinets not used for general storage.				
11	Cryogenic materials stored properly and proper PPE available.				
12	Flammable liquids in containers over 4 L are in approved safety cans.				
13	Corrosive storage cabinet used if more than 10 gal of corrosives present.				
14	Chemicals purchased in amounts that can be used within a reasonable time.				
15	Chemical stocks purged of old, out-dated, and unusable chemicals.				
16	Chemical inventory up to date and copy sent to EH&S.				

A Step-by-Step Guide to Hazard Identification and Risk Assessment

Hazard analysis is the process of identifying hazards that have the potential to arise from a system or environment, documenting their unwanted consequences, and analyzing their underlying causes.



While exact processes may vary from company to company, here's what a typical hazard identification and risk identification look like:

Identify Hazards

Hazard identification is the first step in building a safety policy. It's imperative for organizations to understand and identify all the risks workers and the company faces throughout operations.

Evaluate Risks

Once hazards have been identified, the next step is evaluating the risks and conducting a comprehensive assessment. That way, hazards may be ranked based on severity and other factors so managers understand which ones require immediate attention or action.

Build and Implement a Safety Strategy

After ranking and assessing various risks, the next step is building and implementing a safety strategy. These strategies should be based on the prior identification, assessment, and analyses that the team conducted.

Monitor and Review

Safety is a continuous practice for organizations. This is why the last step of HIRA involves monitoring the effectiveness of your controls and reviewing your safety measures to ensure effectiveness. If the team finds any lapses or areas of improvement, corrective actions must be applied immediately. Steps involved in Hazard identification and risk assessment:

Step 1: Identification of the Hazard Hazard Identification is a critical step in Risk Analysis. Many aids are available, including experience, engineering codes, checklists, detailed process knowledge, equipment failure experience, hazard index techniques, What-if Analysis, Hazard and Operability (HAZOP) Studies, Failure Mode and Effects Analysis (FMEA), and Preliminary Hazard Analysis (PHA). In this phase all potential incidents are identified and tabulated. Site visit and study of

operations and documents like drawings, process write-up etc are used for hazard identification.

Step 2: Assessment of the Risk Consequence Estimation is the methodology used to determine the potential for damage or injury from specific incidents. A single incident can have many distinct incident outcomes. Likelihood assessment is the methodology used to estimate the frequency or probability of occurrence of an incident.

Estimates may be obtained from historical incident data on failure frequencies or from failure sequence models, such as fault trees and event trees. Risks arising from the hazards are evaluated for its tolerability to personnel, the facility and the environment. The acceptability of the estimated risk must then be judged based upon criteria appropriate to the particular situation.

Step 3: Elimination or Reduction of the Risk This involves identifying opportunities to reduce the likelihood and/or consequence of an accident Where deemed to be necessary.

Risk Assessment combines the consequences and likelihood of all incident outcomes from all selected incidents to provide a measure of risk. The risk of all selected incidents are individually estimated and summed to give an overall measure of risk.

Risk-reduction measures include those to prevent incidents to control incidents and to mitigate the effects. Preventive measures, such as using inherently safer designs and ensuring asset integrity, should be used wherever practicable. In many cases, the measures to control and mitigate hazards and risks are simple and obvious and involve modifications to conform to standard practice.

COMPONENTS OF RISK ASSESSMENT

The normal components of a risk assessment study are

¬ Hazard identification and specification

¬ Risk Review

¬ Recommendations on mitigation measures Failure case identification

The first stage in any risk assessment study is to identify the potential accidents that could result in the release of the hazardous material from its normal containment.

Chemical hazards are generally considered to be of three types

• Flammable • Reactive

• Toxic Where there is the potential for confined gas releases, there is also the potential for explosions. These often produce overpressures which can cause fatalities, both through direct action on the body or through building damage. Potential accidents associated with any plant, section of a terminal/plant or pipeline can be divided into two categories:

• There is a possibility of failure associated with each, mechanical component of the facility/terminal .There are generic failures and can be caused by such mechanisms as corrosion, vibration or external impact. A small event may escalate to a bigger event, by itself causing a larger failure.

• There is also a likelihood of failures caused by specific operating circumstances. The prime example of this is human error, however it can also include other accidents due, for example, to reaction runaway or the possibility of ignition of leaking tank gases due to hot work.

UNIT III SAFETY ACTIVITIES

TOOLBOX TALKS

Toolbox talks are informal group discussions that focus safety issues. Use toolbox talks daily to promote department safety culture and start health and safety discussions on job sites.

What is the aim of toolbox Talks?

The goal of a toolbox talk is to promote safety awareness and knowledge among workers, and to encourage workers to take an active role in their own safety and the safety of their colleagues.

Toolbox talk can be extremely informal with the crew supervisor leading a 5-minute refresher training on proper tool use with reminders to always leave the guards in place. A written handout isn't needed and the supervisor can use his knowledge to lead the discussion and encourage feedback from the crew members. The Importance of Toolbox Talks.

Having short but frequent Toolbox Talks can significantly reduce workplace incidents. A recent report found that companies that conduct Toolbox Talks daily had a 64% reduction in total incident rates than those that conducted their Toolbox Talk meetings on a monthly basis.

In addition to identifying immediate hazards for the day, an effective Toolbox Talk can:

1. Grow a positive safety culture within an organization.
2. Keep all workers alert.
3. Improve team communication and productivity.
4. Serve as a reminder of workers' duties and responsibilities.
5. Function as an updated record of hazards and action plan

The Purpose of Toolbox Talks

A toolbox talk, sometimes also referred to as tool box talk or tailgate safety meeting—is an industry best practice for reinforcing safety culture as it emphasizes the importance of safety in small, but consistent increments. Toolbox safety meetings are meant to supplement, not replace safety training and education as required by safety regulations in the United States.

“The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury.”

However, the state of California obligates supervisory employees to conduct “toolbox” or “tailgate” safety meetings, or equivalent, with their crews at least every 10 working days to emphasize safety. More than just a matter for compliance, performing 5-minute toolbox talks daily can significantly improve safety outcomes, champion worker health, and elevate the quality of work.

What are Toolbox Talk Topics?

Toolbox talk topics are safety agendas that should be discussed with workers prior to commencing work. It varies depending on the workers’ needs for the current or upcoming activities that would help expand their awareness of health and safety risks associated with their tasks. A toolbox talk topic should be short,

Construction Toolbox Talk

Construction workers are exposed to different health and safety hazards on site that, if not properly mitigated, may cause incidents, injuries, or fatalities. Use this construction

toolbox talk template to walk-through some of the most common fatal four in the construction industry. Discuss top causes of falls, electrocution, struck by objects, and caught between objects and share preventive tips on how to avoid these common incidents.

Slips Trips and Falls Toolbox Talk

Slips, Trips, and Falls are the common causes of accidents in the workplace and often the most overlooked hazard. Discuss with your team the most common types of slip injuries and have them point out any hazards on the jobsite. Get your team to suggest methods to prevent these measures.

Electrical Safety Toolbox Talk

Electrocutions account for one of the most common injuries seen on construction sites. Discussing this topic during your toolbox talk help remind every worker about the hazards of electricity and the preventive measures when getting in contact with it. Remind your team of the Do's and Don'ts of electrical safety, discuss lock out tag out procedures, list all major hazards, and ask the team to identify any pre-shift or pre-start issues.

PPE Safety Toolbox Talk

Personal Protective Equipment (PPE) is used to reduce employees' exposure to hazards. Observe hand safety by discussing the relevance of PPE to keep them safe prior to commencing work. A toolbox talk can be used to inform employees about the guidelines and conditions of PPE and record faulty equipment for repair or replacement. Download this PPE toolbox checklist.

Working at Heights Toolbox Talk

It is always best to avoid working at heights. But when necessary, all employees must fully understand hazards and the preventive measures before commencing work. During your toolbox talk, it is important for employees to discuss all appropriate safety measures in place including fall protection equipment and fall hazards.

Confined Space Safety Toolbox Talk

Working in a confined space exposes workers to various deadly gases as well as oxygen deficiency. Only highly trained personnel should enter a confined space workplace. During your Toolbox Talk, discuss all hazards present for the particular confined space, agree as a team what to do during ordinary work as well as in the event of an incident.

Accident Reporting Toolbox Talk

Employees have the first and primary responsibility in accident reporting. Should you get involved with any injury, first aid, and incident or near miss, you are expected to report directly to your supervisor or safety department immediately. During your toolbox talk, empower your employees to report incidents effectively by answering the following questions: “What do I report?”, “Who do I report it to?”, “When do I report?”. Use an accident and incident reporting checklist to assist your employees in proper documentation of accidents in the workplace.

Asbestos Awareness Toolbox Talk

Asbestos known as a hidden killer can put both employees and businesses at risk. This topic is very important, especially in the construction industry. Create awareness in asbestos by using this as a topic for toolbox talks. During your toolbox talk, discuss

different types of asbestos-containing materials that they may come in contact with.

COSHH Toolbox Talk

Workplaces have the potential to produce hazardous substances, whether that be from cleaning chemicals to dust and gases. Make your team aware of these hazardous substances to prevent negative health risks. During your toolbox talk, have a discussion on areas of their tasks that involves hazardous substances, how these can harm them, and how you can all reduce the risks of harm occurring. Use a COSHH Assessment tool to prevent injuries or any adverse health effects from harmful chemicals.

Excavation Toolbox Talk

Excavation sites are open to many potential accidents. Industries involved in building sites should ensure worker safety by using this as a topic in their toolbox talks. During your team's toolbox talk, it would be a good idea to go through the general requirements for excavation safety. Use an excavation safety checklist to perform worksite and equipment inspections and ensure utilities, barriers, walkways, and warning systems are in place.

Fire Extinguisher Toolbox Talk

In the event of fire incidents, employers expect their employees to use fire extinguishers. Using this as a topic for toolbox talk help employees get details in terms of its location as well as roles during fire emergencies. Discuss with your employees the different types of fire and the right extinguisher to use. Use a fire

extinguisher inspection checklist to identify defects on tags seals on fire extinguishers and ensure safe for use.

Fire Safety Toolbox Talk

Raise awareness on fire risks and discuss with your team the different types of fire safety issues that may occur in the workplace. You can discuss fire prevention methods to mitigate fire risks and avoid injuries, and accidents. Check out fire safety checklists that can help solidify your fire safety plans.

First Aid Toolbox Talk

Discuss this topic amongst your team to ensure everyone is knowledgeable on first aid arrangements in place. During your toolbox talk, cover where first aid equipment and supplies are stored, emergency contacts in case of a serious injury, and objectives to administer when providing first aid to an injured person until professional help arrives. Use a first-aid checklist to ensure that all supplies in the kit are complete and up to date to provide better medical care in the events of accidents or injuries.

Housekeeping Toolbox Talk

Workplace housekeeping contributes to providing a safe workplace. A disorderly work environment not only lowers morale but also may result in employee injuries or worst-case scenario, death. To avoid this, you can conduct safety talks and cover general housekeeping rules and best practices. During your toolbox talk, you can also discuss the effects of poor housekeeping practices to emphasize the importance of proper housekeeping. Use a housekeeping checklist to eliminate workplace hazards and ensure cleanliness and organization in the workplace.

Manual Handling Toolbox Talk

One of the most common injuries across industries relates to pain, strain, and injuries to the back. This is caused by using poor techniques in manual handling (e.g., twisting, turning, lifting, carrying materials, or digging). During your toolbox talks, discuss and demonstrate the best practices for manual handling. Use a manual handling risk assessment to identify and evaluate risk factors of manual handling in your workplace.

Integrated Risk Management

Discover the transformative benefits of integrated risk management, particularly why and how embracing the holistic approach of identifying, assessing, and mitigating risks can help ensure the company's business success and longevity.

Ladder Safety Training

Discover what ladder safety training is, why it's important, its key principles, and the best practices for implementing an effective safety

What is a Safety Committee?

A safety committee includes employees from different departments in the organization who are responsible for identifying potential workplace hazards, developing strategies to mitigate or eliminate them, and promoting a safety culture throughout the workplace.

A safety committee's specific responsibilities and structure varies depending on the organization and industry, but its aim is creating a safer work environment for employees. Most organizations allow the executive committee to form the safety committee after a successful executive board meeting.

Safety committees, sometimes overseen by the corporate governance committee, are crucial, as they provide the following benefits:

- Promote a safety culture by identifying potential hazards before accidents or injuries occur.
- Identify potential hazards within the workplace through regular inspection and reviewing incident reports.
- Develop safety policies and implement the procedures within the organization.
- Improve communication by providing a forum for employees to discuss safety concerns and make suggestions for improving workplace safety.

Safety committees ensure a safe and healthy workplace environment, ultimately improving the overall health and well-being of employees.

Safety Committee Responsibilities

A safety committee's responsibilities help to maintain a safe and healthy work environment for all employees. Although the specific responsibilities differ depending on the organization, the following are the general key responsibilities of a safety committee.

1. Develop a Safe Work Environment

The safety committee conducts regular workplace safety inspections to identify potential hazards. This includes inspecting equipment, facilities, and work processes to ensure they meet safety standards.

Also, the committee performs employee safety training, like how to properly use safety equipment, emergency procedures, and best practices for avoiding workplace hazards.

The safety committee also monitors safety performance within the organization by identifying trends and patterns in safety incidents and recommending improvements to safety policies and procedures.

2. Craft Safety and Wellness Programs

The safety committee should assess the workplace to identify potential hazards and risks through safety audits, incident reports, and employee feedback. Based on the assessment, the committee members should develop wellness initiatives and safety programs promoting employee health and well-being, such as exercise classes, mental health support services, and healthy eating programs.

Then, to ensure the safety and wellness programs are effective, the safety committee should solicit employee feedback, involve employees in developing safety policies and wellness initiatives, and encourage participation in the programs.

3. Organize and Lead Safety Training

Committee members need to identify the specific training needs based on the nature of the work and the potential hazards and risks. Once the committee has identified the training needs, they develop a comprehensive training plan. The plan should include each training session's objectives, content, and delivery methods.

The safety committee also selects a qualified, experienced trainer to lead the training sessions. The trainer should have the expertise to deliver the training content effectively and engage participants.

To conduct the training, the safety committee should prepare all the necessary training materials, such as handouts, visual aids, and demonstration equipment. The materials should be clear, concise, and easy to understand.

4. Conduct Workplace Safety and Inspection Checks

Workplace safety checks identify potential hazards and risks and ensure the workplace meets safety standards. The committee members should review the relevant regulations and guidelines that apply to the workplace. This strategy will help the committee understand workplace safety requirements and identify the areas that need inspection.

The safety committee should also systematically inspect each work area during the safety check. Committee members should look for hazards such as loose wires, equipment, machinery, and tripping or sharp objects.

How to Join a Safety Committee

If you want to join a safety committee, express your interest to your supervisor or human resources department. They can provide you with information about the committee and how to join. Then, check the eligibility criteria, such as years of experience in the organization. There may be board term limits that only allow you to serve on the safety committee for a certain period of time.

Who is a Safety Officer?

A safety officer is someone who is in charge of the organization's internal well-being, which includes employees, employers, and those who are associated with that organisation in terms of safety and health. A Safety Officer, in simple terms, is someone who is responsible for the safety and health of a factory, warehouse, or manufacturing facility, or organisation.

Safety Officer – Roles and Responsibilities:

A Safety Officer Job is crucial as it entails protecting all members of the organisation from risks, infections, accidents, injuries, etc. As a Safety Officer, he or she will be in charge of ensuring compliance with occupational health and safety rules, with the primary purpose of ensuring a safe working environment and preventing injuries and accidents. Furthermore, a safety officer would advise a company's personnel on a variety of health-related matters, such as wearing face masks while working in a group, handling machinery, dealing with immediate danger, fire, and providing fire alert, planning safety evacuating strategies, etc. The term 'evacuation' refers to a plan to get out of a dangerous situation or one that poses a threat to people and property. Clear instructions and suggestions included in an evacuation plan

offered by a safety professional give confidence to employees while working in an organization.

A Safety Professional's Role in an organisation:

A Safety Officer would read and verify existing processes and policies prior to actually updating them to meet the company's current requirements. A safety specialist would identify, analyse, and conduct risk assessments to determine the outcome of any suspected hazard, including probabilities, scenarios, and procedures involved in the installation, execution, and other processes inside a company. They (a safety professional) would arrange seminars and webinars on safety and hazard-related issues to help employees and management members understand their roles and the consequences of taking risks or putting themselves in dangerous situations.

A safety professional would enforce regulations and provide procedures, controls, and processes to help the company reduce or eliminate risks. It's a safety professional that investigates mishaps, accidents, and near-misses in order to prevent similar occurrences in the future. In addition, a safety representative within an organisation would always report or raise complaints to management about safety incidents, near misses, hazard likelihood, and situation risks, and conduct regular follow-ups on steps made to mitigate or control those hazards.

A safety expert at any location plays a crucial role in ensuring that the organisation follows the law and conducts internal audits on a regular basis. This again would help in safety auditing, as audits of worksites are conducted for the purpose of health, safety, and fire hazard identification. During these surveys, compliance with applicable building and fire rules is assessed, as well as the detection of dangerous hazards. In this part of the audit, a safety officer is required.

Despite the fact that time management is one of the most challenging aspects of a safety professional's job, they make every effort to finish tasks on time, prioritising the most dangerous tasks first.

A Safety Professional's Role in a Warehouse:

Do you have any idea what a warehouse safety professional does? The work of a safety officer is crucial in environments such as warehouses. Following the recruitment process, a safety officer will give instructions and monitor the training of a new joiner. They will inspect the system of work by evaluating machinery, safety measures, and warehousing operations to see if staff are handling tools in warehouses properly and safely.

If a safety professional notices something hazardous in the workplace, they will rectify it and guide them in the right way. They provide and inspect personal protective equipment (PPE) for employees such as gloves, masks, helmets, safety belts, aprons, and so on. They will ensure that there are no fire accidents because there are increased chances for such accidents in warehouses, especially in storage areas, and they will undertake frequent fire safety audits to ensure that this does not happen. They would counsel and supervise staff on material segregation, treatment, and storage, as well as proper handling and disposal processes, depending on the type of the materials (chemicals, biological materials, and so on). They ensure that healthcare waste management rules and strategies are followed, as well as assist in the protection of staff from hazards. This aids in legal compliance as well.

A Safety Professional's Role in the Manufacturing Industry:

A safety specialist would advise employees, whether new or experienced, to follow safety protocols and use PPE when

working within factories to reduce the risk of injury. ETP inspections would be performed by them. A safety expert would recommend periodic maintenance to assist reduce reactive maintenance, equipment failure, accidents, and illness. A safety personnel would also ensure that "energy isolation" was implemented in the workplace. This process assists workers in safely disconnecting power sources prior to commencing work, thus preventing unexpected energy releases. In this context, the term "isolation" refers to the process of disconnecting or making equipment safe to work on by disconnecting all energy sources from the workplace. Furthermore, safety experts would advise industries on 'waste management,' as improperly treated chemical and biological waste from industries can pose a hazard to people and the environment.

A Safety Professional's Role in the construction field:

Construction safety officials will inspect for potential hazards, such as malfunctioning or sharp tools, and advise on how to remove them from the project site, thus promoting safe work practices. A construction safety specialist will also implement or enforce standards based on specific environmental conditions and risks to protect people during a project, as well as to conduct frequent site inspections.

In addition, safety professionals conduct mock drills on a regular basis to assist employees during an emergency. Furthermore, safety professionals train and inspect those who "work at height" or "in a confined place." Also, people who undertake 'hot work,' such as cutting, brazing, or welding, will receive detailed instructions and assistance from safety personnel. Internal safety audits would be carried out by safety people. A safety officer would also ensure that staff are adequately trained, give clear instructions, and supervise those who are involved in 'lifting and rigging.'

A safety professional's Role in the hospitality industry:

The hospitality sector is one of the most important and profitable in the world, particularly in the Middle East. A safety officers' domain knowledge and expertise would be crucial in preserving the company's reputation, whether it be a resort, hotel, or another establishment, as well as avoiding prosecution and lawsuits. Safety professionals play an important role in assisting their employers in implementing good changes in the workplace and instilling a safety culture at all levels. Thus, management will gain confidence when safety professionals are recruited among the personnel.

What is a safety incentive program?

A safety incentive program is a reward-based initiative used to encourage employees to meet and exceed safety standards in the workplace. Safety incentive programs promote existing safety protocols and highlight effective safety processes performed by employees. These programs reward employees with both tangible and intangible prizes once team members meet specified safety goals.

Safety incentive programs can last for a certain amount of time or work as ongoing motivational tools to promote caution and responsibility on the job. Some industries that may use safety incentive programs include:

- Manufacturing
- Warehousing
- Hazardous material production and disposal
- Construction
- Petroleum refining and extraction
- Industrial services
- Scientific research and testing

Related: How To Become a Safety Director

What are the benefits of safety incentive programs?

Safety incentive programs can help reduce injuries and accidents in the workplace. By recognizing employees who maintain and exceed company protocols, an incentive program can positively reinforce safety standards and policies.

Instituting a safety incentive program can also keep safety measures relevant. A rewards initiative can help you refocus on important measures that impact employees in their daily tasks. Since employers are required to comply with standards maintained and enforced by the Occupational Safety and Health Administartion (OSHA), safety incentive programs can be used to highlight certain areas of OSHA regulations to encourage employees to follow these practices. Incentivizing the standards that relate to the equipment and type of work employees perform benefits everyone in the workplace.

Tips for a successful safety incentive program

Here are some ideas to help you initiate a safety incentive program at your workplace:

- **Consider using outside safety consultants.** Hiring a consulting firm can help you assess your safety needs and plan for ways to encourage employees to prioritize safety. Firms that specialize in safety consulting may provide the clearest picture of your company culture.
- **Use incentives that aren't monetary-based.** Using cash prizes can prove challenging both from budget concerns and employee tax liabilities. Consider using gift cards as an alternative.

- **Offer both rewards and recognition.** Employees can benefit from praise and tangible rewards. Consider giving both as part of your program.
- **Create incentives that target your most-needed areas.** Analyze your workplace culture and determine what safety measures need the most focus. Look for ways to encourage team members who would benefit the most from improved safety standards.
- **Set high standards for safety incentives.** Because safety should already be a part of daily work requirements, an incentive program works most effectively to reward behaviors that exceed expectations. Consider making goals team related so employees work together to surpass safety protocols.
- **Use a safety incentive program to complement, not replace a safety program.** Safety incentives should be used in addition to a policy that is already in place for employees. An incentive recognizes the high standards that guide employee safety in the workplace.
- **Make reporting a priority.** Even during a safety incentive, make it clear to employees that the top priority is still to identify safety hazards and report any accidents that occur at the workplace. Consider adding leveled rewards based on the lowest number of incidents but still allowing for reporting of any occurrences.
- **Reward employees on a regular and timely basis.** When starting a safety incentive initiative, it's important to give rewards regularly over a predetermined period. Breaking measures into monthly or quarterly initiatives can help maintain interest in a safety incentive program.

1. Time off bonuses

One way to encourage safety in the workplace is to offer time off as a prize for extended periods of incident-free workdays. This

could be a half-day off bonus, passes to leave work early or bonus vacation days. Decide what works best for your workplace culture and daily workload. Before awarding time off bonuses, consider outlining how you will account for time off, who will process the requests and if there will be a specified period when employees must use their reward.

2. Gift card prizes

Choosing the right gift card prize can motivate employees in a safety incentive program. Consider giving gift cards to businesses that most employees can use such as restaurants, grocery stores or online retail vendors. You may even choose to scale amounts based on the goals and length of your initiative. You could offer one amount of gift card reward for reaching the first safety milestone and increase the gift card value for reaching the next goal.

3. Extra break time

Another thoughtful reward can be offering employees extra break time for meeting safety initiative goals. Breaks can also act as safety measures to ensure team members are well-rested and focused when they continue their work. You can offer break time as a general reward for the team or as a specific prize for individuals.

4. Pro-safety merchandise

Consider rewarding individual employees with safety-related company merchandise after they meet specific milestones. You could start with a coffee mug with a logo that announces the employee's excellent adherence to safety measures. The next step up could be a t-shirt prize. Choose products that are both useful and appealing to most employees.

5. Raffles

One way to reward team members for safety initiatives is through a raffle system. Every time employees meet a safety goal either individually or as a group, pass out raffle tickets. You can offer raffle chances to reward employees throughout the duration of the incentive program or do a raffle drawing once you've reached the end of the initiative. Include several large items as a motivation to reach safety goals and earn raffle tickets. In this type of program, everyone has a chance to win a big prize.

What is Mock drill?

The mock drill is a simulated exercise or practice run that imitates a real-time emergency, preparing the individuals & organization to evaluate the potential weakness, improving the response time and readiness to handle emergency crises during fires, hazardous chemical release, medical emergencies and natural disasters.

Types of Mock Drill & Its Examples

- **Fire Drill:** It simulates a fire emergency and allows the participants to practice safe evacuation and familiarize themselves with firefighting equipment usage.
- **Hazmat Evacuation Drill:** It ensures the employees leave the premises quickly and safely when gas leaks, smoke, chemical spills, or other hazards chemical exposure.
- **Medical Emergency Drill:** It simulates medical emergencies like cardiac arrest, choking, or severe injuries and prepares employees to provide first aid, use medical equipment, and swiftly contact emergency services.
- **Earthquake Drill:** It teaches the “drop, cover, and hold on” technique and evacuation procedures during earthquakes
- **Workplace Safety Drill:** This is conducted to understand general safety procedures, such as handling hazardous materials, machinery operation, or emergency shutdowns, to prevent accidents or injuries.

Importance of Mock drills in workplace safety

Mork drills are not just a practice they are opportunities to fine-tune the emergency response.

Consider the following scenario: The organization set up the simulated fire scenario in a designated area and used a smoke machine to simulate smoke. When the smoke is released, a fire alarm system is activated to signal the start of the drill, prompting employees to respond as they would during a real fire emergency. By hearing the instructions from the fire marshals, employees follow the established fire emergency

procedures, and they evacuate the building using designated evacuation routes and move quickly and safely to the pre-determined assembly points.

The above scenario underlines the importance of conducting mock drills in your workplace. By conducting mock drills, your employee knows their designated exits, the assembly points, and what procedures to follow in case of emergencies. It also,

- Familiarizes individuals with emergency procedures.
- It helps to find out the weak spots
- It improves coordination between your workers
- It boosts decision-making skills of your employees

Benefits of Mock Drill practice at work

- Take the least possible time for a safe evacuation.
- Minimize your property damage & maximize your business continuity.
- It helps to identify the area using the nearest safe exit to be safe during natural disasters.
- It reduces financial costs and the period of overall relief.
- **Human error assessment and reduction technique** (**HEART**) is a technique used in the field of human reliability assessment (HRA), for the purposes of evaluating the probability of a human error occurring throughout the completion of a specific task. From such analyses measures can then be taken to reduce the likelihood of errors occurring within a system and therefore lead to an improvement in the overall levels of safety. There exist three primary reasons for conducting an HRA: error

identification, error quantification, and error reduction. As there exist a number of techniques used for such purposes, they can be split into one of two classifications: first-generation techniques and second generation techniques. First generation techniques work on the basis of the simple dichotomy of 'fits/doesn't fit' in the matching of the error situation in context with related error identification and quantification and second generation techniques are more theory based in their assessment and quantification of errors. HRA techniques have been used in a range of industries including healthcare, engineering, nuclear, transportation, and business sectors. Each technique has varying uses within different disciplines.

- HEART method is based upon the principle that every time a task is performed there is a possibility of failure and that the probability of this is affected by one or more Error Producing Conditions (EPCs) – for instance: distraction, tiredness, cramped conditions etc. – to varying degrees. Factors which have a significant effect on performance are of greatest interest. These conditions can then be applied to a "best-case-scenario" estimate of the failure probability under ideal conditions to then obtain a final error chance. This figure assists in communication of error chances with the wider risk analysis or safety case. By forcing consideration of the EPCs potentially affecting a given procedure, HEART also has the indirect effect of providing a range of suggestions as to how the reliability may therefore be improved (from an ergonomic standpoint) and hence minimising risk.
- Background[edit]

- HEART was developed by Williams in 1986.[1] It is a first generation HRA technique, yet it is dissimilar to many of its contemporaries in that it remains to be widely used throughout the UK. The method essentially takes into consideration all factors which may negatively affect

performance of a task in which human reliability is considered to be dependent, and each of these factors is then independently quantified to obtain an overall Human Error Probability (HEP), the collective product of the factors.

- HEART methodology[edit]
- 1. The first stage of the process is to identify the full range of sub-tasks that a system operator would be required to complete within a given task.
- 2. Once this task description has been constructed a nominal human unreliability score for the particular task is then determined, usually by consulting local experts. Based around this calculated point, a 5th – 95th percentile confidence range is established.
- 3. The EPCs, which are apparent in the given situation and highly probable to have a negative effect on the outcome, are then considered and the extent to which each EPC applies to the task in question is discussed and agreed, again with local experts. As an EPC should never be considered beneficial to a task, it is calculated using the following formula:
- **Calculated Effect = ((Max Effect – 1) × Proportion of Effect) + 1**
- 4. A final estimate of the HEP is then calculated, in determination of which the identified EPC's play a large part.

The **on-site emergency plan** deals with measures to prevent and control. emergencies within the factory and not affecting outside public or environment.

The **off-site emergency plan** will deal with measures to prevent and control. Emergencies affecting public and the environment outside the premises.

SAFETY POSTERS

Provide a Safety Message Quickly

Sharing safety concepts and best practices that workers have already heard, or been exposed to, is the best way to reinforce great safety habits on the job.

Noise Hazards

Noise hazards in the workplace

What is noise and how does it cause hearing loss?

Noise is any unwanted sound that doesn't happen in a natural environment. Noise can include sounds coming from machinery, highway traffic, and industrial, commercial and residential sources.

Noise is caused by pressure changes in the air created by vibrations, which are transferred to the ear by sound waves. The sound waves are then converted to electrical signals by delicate hair cells called cilia, found in the inner ear, or cochlea. These signals are transmitted to the brain and interpreted as sound.

Exposure to loud noise breaks down the cilia and large groups of the cells often get torn away. When the cilia become damaged they do not grow back and this can cause **permanent hearing loss**.

You can prevent noise-induced hearing loss by eliminating or reducing hazardous noise exposure in your workplace.

How do I know if my workplace has hazardous noise?

If you need to raise your voice to be heard, then the noise level is high enough to cause hearing loss. Hazardous noise is any sound that's frequency (e.g., high pitch), intensity (loudness), and duration (length of time) can cause permanent hearing loss.

You can use a simple test to find out if your workplace has hazardous noise. For this basic check you do not need any special equipment, you just need to ask the following questions:

- Is the noise too loud?
    - Is noise very noticeable or aggravating?
    - Do you have to shout when talking to a person standing one metre away?
    - Do you have to shout to be heard for at least part of the day?

    - Do you have temporary hearing loss after working a shift that goes back to normal by the next day?
    - Do you have ringing in the ears at the end of a work shift?
- Where is the noise coming from?
    - Are vibrating or noisy tools being used during the course of a work day (e.g., power saws, blowers, hammers)?>
    - Can certain machines be identified that cause noise (e.g., woodworking or forging machines)?
    - Is the work environment noisy (e.g., demolition, foundries, mining)?
    - Are there explosive sound sources, also called impact noise (e.g., metal hitting metal)?
- Are you being exposed to noise?
    - Do you work in the area close to the identified noise sources?

These questions will usually give you enough information to determine whether you need to reduce noise exposure in the workplace.

This chart provides a range of common sources of noise to help you identify levels that might be dangerous. Sound levels are measured in decibels (dB). Exposure limits are generally measured on a dB(A) scale, which measures sound pressure levels (e.g., the loudness of sounds in air heard by the human ear).

PARTICULATE MATTER

PM stands for particulate matter (also called particle pollution): the term for a mixture of solid particles and liquid droplets found in the air.

Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope.

What is an example of particulate matter?

Particles are defined by their diameter for air quality regulatory purposes. Those with a diameter of 10 microns or less (PM10) are inhalable into the lungs and can induce adverse health effects.
Fine particulate matter is defined as particles that are 2.5 microns or less in diameter (PM2. 5).

WORK-RELATED MUSCULOSKELETAL DISORDERS (WMSDS) are multi-factorial in nature. Epidemiological studies have found an association between WMSDs and heavy load lifting, forceful exertion, awkward posture, repetition, and whole body vibration. WMSDs result in disability, lost work time, and increased production costs.
The complications of poor posture include back pain, spinal dysfunction, joint degeneration, rounded shoulders and a potbelly.
Suggestions to improve your posture include regular exercise and stretching, ergonomic furniture and paying attention to the way your body feels.

POSTURAL PROBLEMS DURING A VARIETY OF ACTIVITIES

At Long Island Spine Rehabilitation Medicine, we routinely treat patients who have injured themselves because of their poor posture at their jobs:

- Working at computers for long hours
- Working at construction or loading docks
- Working in the military
- Doing repetitive tasks in factory settings
- Working as police, firefighters, and first responders
- Working in cleaning and maintenance jobs
- Driving long distances or in stop-and-go traffic
- Teaching through lectures that require standing
- Teaching or caring for young children who require lifting
- Working at healthcare facilities where lifting patients is necessary
- Working in retail stores which necessitates standing for long periods
- Working in landscaping: lifting, pushing, bending, reaching

We also treat many patients whose poor posture while doing any of the following has resulted in temporary or ongoing pain:

- Sitting in classrooms
- Playing golf, tennis, football, or other sports
- Painting houses or artistic creations
- Sculpting, playing musical instruments, or dancing
- Readers or watching TV
- Napping or sleeping

WHICH SYSTEMS ARE NEGATIVELY IMPACTED BY BAD POSTURE?

Though the scope of bad posture injury is wide, problems caused by improper posture primarily affect three body systems:

- Skeletal system, including the spine and the rest of the bones and joints
- Neural system, including the brain, spinal cord, and all nerves and peripheral receptors outside the spinal cord
- Myofascial system, including the muscles, tendons, and connective tissues

What are REBA and RULA?

REBA and RULA are two of the most common methods used to assess risk levels related to body injuries. Rapid Entire Body Assessment (REBA) is a tool used in ergonomic evaluations to identify certain levels of risk that workers may be exposed to.

REBA focuses on body posture and movement, analyzing physical stress points, and determining the risk of musculoskeletal disorders.

With REBA, executives can quickly identify risk factors in a work environment and develop interventions to mitigate those risks. This tool is best used for assessing tasks that involve prolonged sitting, standing, and repetitive motions.

Rapid Upper Limb Assessment (RULA) is another ergonomic evaluation tool that analyzes the level of risk associated with upper limb movements.

This tool focuses on identifying potential risks that may contribute to musculoskeletal disorders such as carpal tunnel syndrome and tendinitis.

Similar to REBA, RULA assesses body posture and movement but focuses on upper limb movements specifically. This tool is best used for assessing tasks that involve repetitive, high force, or awkward postures.

The Importance of Implementing REBA and RULA

These assessments are designed to identify high-risk postures and movements that could lead to musculoskeletal disorders (MSDs).

By identifying these risks, organizations can develop strategies to mitigate them, thereby reducing the likelihood of workplace injuries.

Implementing REBA and RULA assessments helps organizations to design workstations that meet the needs of their employees. These assessments provide detailed information about the specific risk factors associated with different tasks.

This information can be used to design custom-made workstations that are tailored to the specific needs of employees. As a result, employees are more likely to be comfortable, and they are less likely to suffer from MSDs.

Thirdly, REBA and RULA assessments help organizations to identify potential causes of injuries and provide recommendations to prevent these injuries from occurring.

By identifying the root causes of injuries, organizations can develop strategies to minimize the risks of injuries.

This makes it easier to implement preventative measures that reduce the risk of injuries and increase the overall safety of the workplace.

Implementing these assessments shows that organizations are committed to the safety and well-being of their employees. In today's competitive job market, workers are looking for employers that prioritize their safety and health.

By implementing REBA and RULA assessments, organizations can demonstrate that they are committed to creating a safe and healthy work environment.

Finally, organizations that implement ergonomic assessments often see a significant reduction in workplace injuries and related costs.

By identifying and mitigating ergonomic risks, organizations can reduce the number of injuries, lost time, and medical costs associated with workplace injuries.

As a result, organizations can improve their bottom line and enhance their reputation among employees and customers.

What are Electrical Hazards?

Electrical hazards refer to the potential dangers and risks that are associated with electrical systems. These hazards can cause dangers such as burns, electrocution, arc flash, electric shock, and other serious injuries. In extreme cases, they can even lead to fires or explosions, posing a threat to life, property, and the overall safety of a place and its occupants.

Why It's Important to Know About These Hazards

Working around electricity can be very safe on the job site when workers properly identify and control hazards. But, inadequate training, lack of experience, and failure to recognize potential hazards could result in electric shock or death.

The construction industry is most in danger from electrical hazards, accounting for 52% of all electrical fatalities in the US workplace. Most of these incidents and fatalities were caused by direct worker contact with overhead power lines and contact with machines, tools, and hand-carried metallic objects. So how do we protect ourselves against these dangers?

One of the best ways to protect yourself against these dangers is through awareness. Knowing the potential risks associated with electricity allows you to take precautions to prevent electrical accidents and fatalities. Having this knowledge can also help you spot the signs of electrical hazards immediately for prompt action, thereby contributing to the overall safety of the workplace.

Causes of Electrical Hazards

Electrical hazards, while dangerous, can be prevented when you're aware of the factors that contribute to them. Here's a list of the most common causes of electrical hazards to watch out for:

- **Insufficient insulation** – Over time, electrical insulation can deteriorate due to wear and tear, rodents, or exposure to moisture. This degradation can lead to exposed wires and increase the risk of electric shock or short circuits.
- **Circuit breaker failure** – If the circuit breaker fails to trip during an overload, it loses its protective functioning, further increasing the risk of electrical hazards.

- **Damaged electrical appliances** – Loose connections, frayed wires, or cracked insulation can result in electrical malfunctions.
- **Improper use of extension cords** – Practices like daisy chaining and overloading can cause overheating and ignite electrical fires.
- **Inadequate maintenance** – Failing to regularly inspect electrical systems, ignoring warning signs, or bypassing safety procedures can trigger severe electrical hazards over time.

Preventative Steps and Safe Work

Preventative steps

There are various ways of protecting people from the hazards caused by electricity, including insulation, guarding, grounding, and electrical protective devices. Laboratory users can significantly reduce electrical hazards by following some basic precautions:

- Inspect wiring of equipment before each use. Replace damaged or frayed electrical cords immediately.
- Use safe work practices every time electrical equipment is used.
- Know the location and how to operate shut-off switches and/or circuit breaker panels. Use these devices to shut off equipment in the event of a fire or electrocution.
- Limit the use of extension cords. Use only for temporary operations and then only for short periods of time. In all other cases, request installation of a new electrical outlet.
- Multi-plug adapters must have circuit breakers or fuses.
- Place exposed electrical conductors (such as those sometimes used with electrophoresis devices) behind shields.

Minimize the potential for water or chemical spills on or near electrical equipment. Cranes are primarily used to transport and hoist heavy materials from one location to another.

Table of Contents

Types of cranes at construction site

There are various types of cranes used at construction sites, each with its unique features and capabilities. Here are some of the most common types of cranes used in construction:

1. Tower cranes: These are tall, stationary cranes that are typically used in the construction of high-rise buildings. They have a long horizontal arm (jib). The jib of a tower crane is typically not raised or lowered. Instead, the trolley on the jib moves in and out to position the load. The crane can also rotate (slew) to position the load in a different location around its base. Some tower cranes have a luffing jib that can be angled up or down

2. Mobile cranes: These cranes are mounted on wheeled vehicles or tracks and can be easily moved around the construction site. They are typically used for heavy lifting tasks and have a telescopic boom that can extend to great heights.

3. Rough terrain cranes: As the name suggests, these cranes are designed for use on rough and uneven terrain. They have large, wide wheels and are often used in off-road construction sites.

4. Crawler cranes: These cranes have tracks instead of wheels and can be used on soft ground or in areas where a wheeled vehicle might get stuck. They are typically used for heavy lifting tasks and have a wide range of motion.

5. Overhead cranes: These cranes are mounted on rails or beams and are used to move heavy loads horizontally along the length of the rail. They are commonly used in manufacturing and warehouse environments.

6. Gantry cranes: These cranes are similar to overhead cranes, but they have legs that support them instead of being mounted on rails or beams. They are often used in shipyards or to move containers.

Each type of crane has its own advantages and disadvantages, and the choice of crane will depend on the specific requirements of the construction site and the lifting task at hand.

General parts of crane

Here are some of the general parts of a crane:

1. Boom: This is the long, horizontal arm of the crane that is used to lift and move heavy loads. The boom can be fixed or telescopic, allowing it to extend or retract to different lengths.

2. Hook: This is the device at the end of the boom that is used to attach and lift loads. The hook can be attached to different types of lifting equipment, such as chains or slings.A crane typically has two hooks: a main hook and an auxiliary hook. The main hook is the primary hook used for lifting heavy loads, while the auxiliary hook is a smaller hook used for lighter loads or for assisting with lifting tasks. The auxiliary hook is often used to attach rigging equipment, such as slings or chains, to the load being lifted. Having two hooks allows the crane operator to perform more efficient and versatile lifting tasks, using the appropriate hook for the specific load being lifted.

3. Jib: Some cranes have a smaller, secondary arm called a jib that is attached to the end of the main boom. The jib can be used to extend the reach of the crane or to lift loads at an angle. To use Jib 3rd party inspection certificate is required

4. Counterweight: A counterweight is often used to balance the weight of the load being lifted and to provide stability to the crane. It is typically a large weight that is attached to the opposite end of the crane from the load.

5. Cab: The cab is the enclosed area where the crane operator sits and controls the crane's movements. The cab is usually located near the top of the crane and provides a clear view of the construction site.

- **TOXIC GAS**
- Every manufacturing industry, from oil and gas to chemical production, deals with various types of toxic gas. Maintaining healthy levels of these dangerous gases is essential to protect the wellbeing of employees and warehouse workers.

Common Types of Harmful Gases

Gas detection experts have defined a toxic gas as "one which is capable of causing damage to living tissues, impairment of the central nervous system, severe illness or, in extreme cases, death when it is ingested, inhaled, or absorbed by the skin or eyes." Technically, gases are generally considered toxic if the median lethal concentration is greater than 200 parts per million (ppm).

Depending on your industry, you may come into contact with numerous harmful gases on a daily basis. Examine the health effects of the following five common toxic gases:

1. Hydrogen Sulfide
2. Carbon Monoxide
3. Nitrogen Oxides
4. Ozone
5. Solvents

1) Hydrogen Sulfide

Primarily identified by its "rotten egg" smell, hydrogen sulfide (H2S) is found in a number of manufacturing processes and chemical substances. Products such as pesticides, plastics, pharmaceuticals, landfills, and even breweries emit hydrogen sulfide as a byproduct. The toxicity levels of hydrogen sulfide emissions are dangerously high, especially if not disposed of properly. Inhalation of high concentrations of H2S can result in irritation, unconsciousness, memory loss, or in severe cases, instant death.

Severity Level: OSHA currently recommends a 10-minute ceiling level of 10 ppm for workers. In addition, 100 ppm of H2S exposure has been proven to have immediate lethal consequences, making it highly toxic, even at these low concentration levels.

Pro Tip: Install an **H2S gas detector** to monitor specific levels of H2S concentration in your vicinity, no matter what other gases may be present.

2) Carbon Monoxide

Generally found in industrial processes as a source of energy and reducing agent, carbon monoxide (CO) is a tasteless, odorless, and colorless gas. When materials are burned improperly, the emissions of carbon monoxide are highly poisonous, especially in crowded areas where human exposures can't be monitored. Health effects such as nausea, restlessness, and euphoria may be experienced with repeated exposure causing eventual death.

Severity Level: OSHA currently recommends 50 ppm for workers during an 8-hour time period, and maritime workers may need extra attention if the CO concentration is greater than 100 ppm. Concentration levels beyond 200 ppm are considered highly dangerous.

3) Nitrogen Oxides

Nitrogen oxides encompass seven different gases, with nitric oxide and nitrogen dioxide being the two most common forms. Found in a number of consumer and industrial environments, nitrogen oxides are the main contributor of air pollution and reduced air quality. Nitric oxide is often emitted from vehicles, agricultural processes or as a byproduct of combustible fossil fuels, and nitrogen dioxide has been used in the production of rocket fuels and explosives. According to the **CDC**, health effects vary from eye, skin, and respiratory tract irritation to acutely lethal circumstances.

Severity Level: Health officials are constantly trying to find ways to limit exposure to nitrogen oxides. The current permissible limit for nitric oxide is 25 ppm within an 8-hour work shift, with 100 ppm being immediately lethal. Comparatively, nitrogen dioxide has a 5 ppm permissible limit and 20 ppm lethal concentration limit.

4) Ozone

Especially toxic to plant life and humans, ozone is a gas made up of three oxygen atoms (O3) and is usually seen as widespread smog across cityscapes. While it may occur naturally in the upper atmosphere of the stratosphere, chemical reactions resulting from vehicle exhausts or gasoline vapors contribute to large ozone concentrations at ground level. Health problems such as decreased lung function, respiratory infection, UV overexposure (i.e. sunburns) or skin cancer in humans make it a toxic substance that must be monitored continually.

Severity Level: According to OSHA, ozone levels should never exceed the following average: 0.10 ppm (parts per million) for 8 hours per day exposure. While the level of work may contribute to the actual level, extreme caution must be administered when working near ozone for an extended period of time.

5) Solvents

In addition to being highly flammable, the properties of organic solvents are highly toxic. **Organic solvents** are carbon-based substances capable of dissolving or dispersing one or more other substances. Solvents usually found in kerosene, gasoline, paint strippers, and degreasers are highly flammable and at high concentrations, can affect your central nervous system. Other side effects such as dizziness, drowsiness, lack of concentration, confusion, headaches, coma, and death can be experienced during long term exposure of solvents.

Severity Level: Due to the various forms of solvents used on a daily basis, OSHA has published individual guidelines for every toxic chemical gas that has been identified. Review the standards of the toxic gases you may encounter to protect your long term health.

-

JOB SAFETY ANALYSIS

Job Safety Analysis (JSA) is a systematic procedure that breaks each job/task into key training sequences, identifies safety elements of each job/task step and coaches the employee on how to avoid potential safety hazards. Another commonly used term for this process is called a Job Hazard Analysis or JHA.

Job Safety Analysis (JSA) is a procedure that helps integrate accepted safety and health practices into a particular task or job operation. In JSA, the ultimate goal is to identify potential hazards in every step of a process and recommend the safest way to execute the job. JSA is a written procedure developed to understand, review, minimize or eliminate hazards associated with work processes. A Job Safety Analysis (JSA) must be conducted at the job site before the commencement of a job, or when there has been any modification done to the existing job process. JSA can also include risk assessment to evaluate the hazard occurance probability while also detailing the severity of its consequences, and the effectiveness of the control and preventive measures implemented.

What are the benefits of doing a job safety analysis?

JSA is a written work procedure. While the written Job Safety Analysis serves as a document that can be showcased to OSHA, the documented records of JSA will also help the organization in many ways as it helps create a safe work environment. Simply put, job safety analysis is beneficial to the organization as it:

- Helps identify undetected hazards.
- Increases job knowledge of the participants.
- Improves safety and health awareness.
- Enhances communication between supervisors and workers.
- Promotes better acceptance of revised safe work procedures.

- Helps complete comprehensive incident investigations.
- Can be used as a standard for all safety and health inspections or observations.
- Serves as teaching material during job training or considered a briefing guide for sporadic jobs or processes.

What are the four basic steps in job safety analysis?

Job Safety Analysis can be broken down into four stages that helps perform the analysis effectively. JSA is performed in stages as it helps complete every portion of the analysis easily and document the findings meticulously. **The four basic stages in conducting a job safety analysis (JSA) are:**

- While all jobs should undergo JSA, it is cumbersome and time consuming. JSA is also necessary to be performed when there is a change or revision in equipment, process, environment, or raw materials. Hence, it is advisable to select the job for analysis in the order of priority based on the following factors:

    - Frequency and severity of accidents can help determine the starting point of the analysis
    - Potential for illness or injury that involves hazardous conditions or materials
    - New jobs that present a higher risk to workers
    - Modifications in job procedures
    - Non-routine jobs
    -

PRELIMINARY HAZARD ANALYSIS-

Preliminary Hazard Analysis (PHA) is a semi-quantitative analysis performed to identify, early in the design and definition stages of a system, all potential hazards and hazardous events that can cause an accident, classify identified hazardous events according to their severity and

identify the required hazard controls and their respective follow-up actions.

To that is it good for and when should a PHA be used?

The **PHA** is suitable as an **initial risk study** at an early stage of a project and its results are used to

(i) compare main concepts, to
(ii) focus on the important **risk** issues, and as
(iii) input for **analysis of** more detailed **risks** .

It is also used as an initial step in a detailed **risk analysis** of a system concept or an existing system. Therefore, the purpose of the **PHA** is then to identify those **hazardous events that should be subject to further and more detailed risk analysis**.

In **PHA** is the precursor, in many cases, of the **Hazard Log** (Registry **Threats)**. In addition, the **PHA will** not discriminate between threats related to **security** or threats related to **availability** . Therefore, whether a risk generates, for example, an **out of service** or a **degraded mode,** or a **security** problem, they will be recorded in the **PHA**.

Building a PHA - Step 1 of 4 - PHA Prerequisites

The first step in starting a **PHA development** is to establish the **PHA** team , typically consisting of a leader with skills and experience, a person responsible for recording and filling in the evolutions of the group analysis, and team members, typically a group of 2 6 people, with **knowledge of the system being analyzed, the environment in which it operates and the processes that will be affected** .

Not surprisingly, the number of team members to participate will depend on the complexity of the system and also on the objectives of the analysis.

The second step is to define and describe the system to be analyzed. That is, be clear about the limits of the system have a clear description of the system operational and environmental conditions to to consider. Continuing with the definition of the

system, it is important to be clear about thes inputs, functions that I develop and outputs of the system.
The presentation of the definition of the system should also be , if possible, at the block level, dividing the system into parts that can be managed by the analysts.
Finally, it is important as always to use the **feedback from the experience of the organizations** . In this way, it is considered a robust and level process, one that is capable of collecting information on **risks from previous and similar systems** , for example, from accident databases, either its own or external to the organization.

What is fault tree analysis?

Fault tree analysis (FTA), sometimes known as event tree analysis, is a method of identifying the possible causes of a system failure. A fault tree is used to graphically illustrate the different potential causes of a failure in the form of a diagram. By using FTA, you can determine what factors contributed to an event (known as a failure), and the probability of it occurring. Once the major causes are identified and addressed, FTA can help maintenance teams prioritize corrective actions.

Who uses fault tree analysis?

Fault tree analysis is used by system designers, process designers, project managers, and engineers in manufacturing. These personnel often use FTA alongside the Kaizen methodology and root cause analysis to prevent or solve system failures.

How is fault tree analysis performed?

FTA uses a fault tree analysis diagram to show the different events or conditions that could lead to an undesired outcome, like equipment failure. T

The FTA process consists of three main steps:

- Create a fault tree diagram
- Identify failure events, initiating events, and contributing factors from your diagram
- Evaluate relationships between failures and initiating events (or contributing factors)

The symbols used on a fault tree diagram are called events, conditions, or states. These can occur at any point in time during system operation. Lines connect the symbols together to show how one event may lead to another until we reach the end of our line, an undesired event (known as a fault). The faults represent things that go wrong within your system. Below is an example of how these diagrams can look:

In this fault tree diagram example, we see an illustration of a pump or motor assembly not having any flow. This event is the main failure, and below it, we can see the initiating events: Mechanical failure and electrical failure. To the right of the fault tree diagram, below electrical failure, we can see further events and failures, one being a motor failure and the other being a fuse failure. Below the fuse failure, we see that a circuit overload event is occurring and, below it, two different basic events: Wire shorted and/or a power surge.

What are fault tree analysis symbols?

Every industry uses the same set of symbols and naming conventions for fault trees. The fault tree illustrates the link and flow between different activities and is read from top to bottom. Events and gateways (known as gates) are the two categories under which the activities fall.

Event symbols

Events occur when a system or process fails. The types of events that appear in fault trees have been detailed below.

Below are definitions of each event type illustrated above:

- Top event (TE): These types of events are at the top of the fault tree and prompt an investigation into the system failure. It has a single input but no relative outputs because it is the start of the failure.
- Intermediate events (IE): These events are generally caused by one or more events. It has both an input and output. Another event may cause its failure, and most likely causes further failures down the fault tree.
- Basic events (BE): These types of events are generally the root cause of the top event. They sit at the bottom of the fault tree.
- Underdeveloped events (UE): These events don’t have enough information and are placed as a subtree.
- Transfer events (TE): These types of events happen when a fault tree is too long to fit on paper. Larger parts of the tree are hidden with a symbol and expand in a separate tree. There are two types: Transfer-out and transfer-in events. Transfer-out has a triangle and output to the right, and transfer-in events have input on the top of the triangle.
- Conditional events (CE): These events happen as conditions for a type of gate called an inhibit gate.
- House events (HE): These types of events are used to turn an event off and on. If the event is set to 0 means it will not occur, but if it is set to 1 it means that it will occur. House events are

used to allow parts of the fault tree to be included or not included.

Gate symbols

Gates represent the various ways that failures can occur in an asset or system. Sometimes a single event can cause a top-level failure (or catastrophic failure). Sometimes a combination of different events can cause a top-level failure event. The types of gates in FTA are detailed below.

Below are definitions of each gate type illustrated above:

- AND gate: This type of gate is connected to output events. The events only occur if the input events to the gate occur.
- Priority AND gate: This gate occurs if all the input events happen in a specific order.
- OR gate: This type of gate may have one or more inputs, and an output event will occur if one or more of the input events happen.
- XOR gate: This gate is slightly less common. An output happens only if one input element occurs.
- k/N or VOTING gate: This gate is similar to OR gate visually. There will be a number of input events ‘N’ and one output event ‘k.’ The output event occurs when the number of input events occurs. The exact number of inputs needs to be met to trigger this gate.
- INHIBIT gate: This type of gate will have an output event when all input and conditional events occur.

Event Tree Analysis

Overview

Event Tree Analysis (ETA) uses the same logical and mathematical techniques as Fault Tree Analysis. However, whereas a fault tree analyzes how an undesirable top event may occur, an event tree considers the impact of the failure of a particular component or item in the system, and works out the effect such a failure will have on the overall system risk or reliability. Event trees use an inductive approach, whereas fault trees are deductive. Event trees were developed for the nuclear industry. They are much less widely used in the process industries.

The initiating event in an event tree will usually fall into one of the following four categories:

- Failures or unsafe conditions in individual items of equipment;
- Human error;
- Utility failures; and
- External events (such as hurricanes or earthquakes).

The sketch shows an event tree for a situation in which the pressure in a vessel rises.

Event Tree Example

The tree starts with the event “High Pressure in the Vessel”. The reasons for the occurrence of this event are not explained. There are four layers of protection, each of which has a chance of either success or failure. At the first junction the normal control system acts. If it brings the pressure to a safe state then there is no need to continue with the development of the tree. Therefore the

“Success” lines are dashed, showing that they do not need to be considered.

Event tree analysis is an example of inductive analysis. It uses the same logical and mathematical techniques as Fault Tree Analysis. However, whereas a fault tree analyzes how an undesirable top event may occur, an event tree considers the impact of the failure of a particular component or item in the system, and works out the effect such a failure will have on the overall system risk or reliability. Event trees use an inductive approach, whereas fault trees are deductive.

What Does Checklist Analysis Mean?

Checklist analysis (CLA) is a technique that can be used to identify and manage risk. The checklist is developed by listing items, steps, or tasks and is then analyzed against criteria to determine if the procedure is completed correctly. The checklists should be developed using historical information or knowledge gained from similar projects in the past.

Safeopedia Explains Checklist Analysis

Checklist analysis is generally used in tandem with other methods of risk identification to ensure that the process is as thorough as possible. The following steps describe the method of conducting checklist analysis:

- Start with defining the activity for which the analysis is to be done. Section the activity into its major components to be analyzed.
- Define the issues that the analysis should address (i.e. safety problems, environmental impact).
- Develop the checklists related to the issues defined.
- Work through the checklist. If there is a risk of potential problems, come up with appropriate mitigating measures.

- Finally, evaluate the recommendations and incorporate them to improve the activity defined at the start of the analysis.

Root cause analysis (RCA) is the process of discovering the root causes of problems in order to identify appropriate solutions. RCA assumes that it is much more effective to systematically prevent and solve for underlying issues rather than just treating ad hoc symptoms and putting out fires. Root cause analysis can be performed with a collection of principles, techniques, and methodologies that can all be leveraged to identify the root causes of an event or trend. Looking beyond superficial cause and effect, RCA can show where processes or systems failed or caused an issue in the first place.

Core principles

There are a few core principles that guide effective root cause analysis, some of which should already be apparent. Not only will these help the analysis quality, these will also help the analyst gain trust and buy-in from stakeholders, clients, or patients.

- Focus on correcting and remedying root causes rather than just symptoms.
- Don’t ignore the importance of treating symptoms for short term relief.
- Realize there can be, and often are, multiple root causes.
- Focus on HOW and WHY something happened, not WHO was responsible.
- Be methodical and find concrete cause-effect evidence to back up root cause claims.
- Provide enough information to inform a corrective course of action.

- Consider how a root cause can be prevented (or replicated) in the future.

As the above principles illustrate: when we analyze deep issues and causes, it's important to take a comprehensive and holistic approach. In addition to discovering the root cause, we should strive to provide context and information that will result in an action or a decision. Remember: good analysis is actionable analysis.

Benefits and goals of root cause analysis

The first goal of root cause analysis is to discover the root cause of a problem or event. **The second goal** is to fully understand how to fix, compensate, or learn from any underlying issues within the root cause. **The third goal** is to apply what we learn from this analysis to systematically prevent future issues or to repeat successes. Analysis is only as good as what we do with that analysis, so the third goal of RCA is important. We can use RCA to also modify core process and system issues in a way that prevents future problems. Instead of just treating the symptoms of a football player's concussion, for example, root cause analysis might suggest wearing a helmet to reduce the risk of future concussions. Treating the individual symptoms may feel productive. Solving a large number of problems looks like something is getting done. But if we don't actually diagnose the real root cause of a problem we'll likely have the same exact problem over and over. Instead of a news editor just fixing every single omitted Oxford comma, she will prevent further issues by training her writers to use commas properly in all future assignments.

WHAT –IF ANALYSIS

What-if analysis, using a cross-functional team, questions and discusses the potential hazards and their effects on the systems.

Methods as What-if analysis and Structured What-if Risk Assessment can be powerful tools in identifying, assessing, and communicating risk within an organization.

- What –If Analysis is a structured brainstorming method of determining what things can go wrong and judging the likelihood and consequences of those situations occurring. The answers to these questions form the basis for making judgments regarding the acceptability of those risks and determining a recommended course of action for those risks judged to be unacceptable.
- An experienced review team can effectively and productively discern major issues concerning a process or system. Lead by an energetic and focused facilitator, each member of the review team participates in assessing what can go wrong based on their past experiences and knowledge of similar situations.
- Using an operating procedure and/or Piping and Instrument Diagram (P&ID), the team reviews the operation or process step utilizing a form similar to one illustrated in Figure C-1. Team members usually include operating and maintenance personnel, design and/or operating engineers, specific skills as needed (chemist, structural engineer, radiation expert, etc.) and a safety representative. At each step in the procedure or process, What-If questions are asked and answers generated. To minimize the chances that potential problems are not overlooked, moving to recommendations is held until all of the potential hazards are identified.

The review team then makes judgments regarding the likelihood and severity of the “What-If” answers. If the risk

indicated by those judgments is unacceptable then a recommendation is made by the team for further action. The completed analysis is then summarized and prioritized, and responsibilities are assigned.

- ***"What-If" Hazard Analysis***

Division:	**Desc. of Operation:**	**By:** **Date:**

What If?	**Answer**	**Likeli-hood**	**Conse-quences**	**Recommendations**

Figure C-1. What-If Analysis Form

Hazard Identification and Assessment

One of the "root causes" of workplace injuries, illnesses, and incidents is the failure to identify or recognize hazards that are present, or that could have been anticipated. A critical element of

any effective safety and health program is a proactive, ongoing process to identify and assess such hazards.

To identify and assess hazards, employers and workers:

- Collect and review information about the hazards present or likely to be present in the workplace.
- Conduct initial and periodic workplace inspections of the workplace to identify new or recurring hazards.
- Investigate injuries, illnesses, incidents, and close calls/near misses to determine the underlying hazards, their causes, and safety and health program shortcomings.
- Group similar incidents and identify trends in injuries, illnesses, and hazards reported.
- Consider hazards associated with emergency or non routine situations.
- Determine the severity and likelihood of incidents that could result for each hazard identified, and use this information to prioritize corrective actions.
  Some hazards, such as housekeeping and tripping hazards, can and should be fixed as they are found. Fixing hazards on the spot emphasizes the importance of safety and health and takes advantage of a safety leadership opportunity. To learn more about fixing other hazards identified using the processes described here, see "Hazard Prevention and Control."

Action item 1: Collect existing information about workplace hazards

Action item 2: Inspect the workplace for safety hazards

Action item 3: Identify health hazards

Action item 4: Conduct incident investigations

Action item 5: Identify hazards associated with emergency and nonroutine situations

Action item 6: Characterize the nature of identified hazards, identify interim control measures, and prioritize the hazards for control