PRIA
INTERNATIONAL ACADEMY
Initiative in Education & Lifelong Learning

Certificate Programme

Occupational Health and Safety:

Legal and Operational Guide

Unit 4

Basics of Preventive Techniques

Units of Certificate in Occupational Health and Safety

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Introduction

An accident may be described as a result of a chain of events in which something has gone wrong. It has been shown that human intervention can prevent the injury or damage to which such a chain of events would otherwise lead. Assuming that events might lead to injury or damage because of factors in the workplace, one is led to conclude that the magnitude of the problem has to be determined on the basis of the existence and frequency of such factors.

The belief that accidents are caused and can be prevented makes it imperative for us to study those factors which are likely to favour the occurrence of accidents. The root causes of accidents can thus be isolated and necessary steps can be taken to prevent the recurrence of accidents. These root causes of accidents can be grouped as “immediate” and “contributing”. The immediate causes are unsafe acts by the worker and unsafe working conditions. Contributing causes could be management-related factors, the environment and the physical and mental condition of the worker. A combination of causes must converge in order to result in an accident.

Most theories of accident causation are conceptual in nature and, as such, are of limited use in preventing and controlling accidents. There is no one single theory that is considered right or correct and is universally accepted. These theories are nonetheless necessary, but not sufficient, for developing a frame of reference for understanding the occurrence of accidents.

Learning objectives

- After completing this Unit, you should be familiar with the following concepts and issues.
- Accident analysis
- Monitoring of accidents
- Reporting and investigation of accidents
- Prevention of accidents
- The role of safety audits and safety committees

4.1 What is an Accident?

4.1.1 Definition of Accident and a Work Related Accident

An accident is a sequence of parallel and consecutive events leading to a harmful consequence. For example, a falling object may cause injury if it hits someone. Accidents at work are usually limited to those which cause personal injuries.

A work related accident refers to an accident that occurs at the workplace, as a result of the work that a worker is engaged in. Accidents at the workplace are a form of occupational health hazard that impacts workers within an organisation. It impacts the individual physically and psychologically, and affects his or her productivity levels by making the individual insecure and uncertain about his or her surroundings especially at her/his workplace. Accidents also impact other employees within an organisation who may not have faced an accident as yet but might be apprehensive that they can face it in the future.

NOTE BANK

The cases of occupational related deaths across the world have been quite high and include men, women and children.

- Each day, an average of 6,000 people die as a result of work related accidents or diseases, totalling more than 2.2 million work related deaths a year.
- Each year, workers suffer approximately 270 million occupational accidents that lead to absences from work for 3 days or more.
- Approximately 4 per cent of the world's gross domestic product is lost with the cost of injury, death and disease through absence from work, sickness treatment, disability and survivor benefits.

A work related accident is therefore specific to the workplace and is a visible phenomenon across all the key sectors of an economy. Although the range and degree of impact caused by an accident varies from person to person, its overall impact is negative. The most negative or extreme impact of an accident on the individual is disability for life or death.

Accidents and injuries are not the same. In fact an injury is only one of the possible outcomes or results of an accident. The accident itself is a variation or interruption in the work process. The same type of accident may have a variety of consequences. The breaking of a link on a chain sling resulting in the fall of a load from a height, or the explosion of a pressure vessel may result in serious injury (even death) or may result in no injury at all. We can classify such accidents as “near-miss accidents” or “dangerous occurrences” (words used by law) where the event had the potential to cause injury but did not. Often, when the accident does not result in injury, we do not attach much importance to it.

4.1.2 Factors Causing Occupational Injuries or Accidents

A number of factors are responsible for an accident. When an accident occurs at the workplace, the main question that needs to be addressed is: Why and how did the accident occur? What led to the accident? This would entail a study of the factors which were responsible for causing the accident.

There are a number of causes for an accident. They can be divided into:

(1) Human factors, or unsafe acts;

(2) Environmental factors, or unsafe conditions, and

(3) Organisational factors; or management.

Human Factors

Early studies on industrial accidents stressed upon human factors causing accidents. Analysis of the reported cases of accidents showed that not everyone had accidents; a relatively small percentage of the population always seemed to have accidents. These people were considered prone to accidents and that is how the concept of “accident prone” came into being.

The initial studies that were undertaken showed that all people in a population face accidents. This however was incorrect because accidents are dependent upon an individual's job and the extent to which he or she is exposed to a particular hazard. There are people who are engaged in professions that are extremely tough and hazardous and they are repeatedly exposed to dangers or hazards resulting in accidents and injuries. These individuals are also more prone to accidents in comparison to other people whose working environments are more secure and safe. Later on, a number of investigations on accident proneness were conducted on industrial workers and transportation personnel. (Laitinen & Vahapassi, 1992, pp. 368-391)

Laitinen and Vahapassi (1992) put forth the reason that accidents occur when " a hazard is not seen, recognised, or understood as dangerous if one does not take responsibility for personal action, or if one does not know how to act or for other reasons does not decide to act. Even if the right decision is made, the muscular response may be incorrect, ineffectual, or too slow". (Laitinen & Vahapassi, 1992) For instance, bus drivers have been shown to have consistent individual differences in accident rates, and a psychological test has been developed to predict the accident behaviour of drivers.

Environmental Factors

Environmental factors refer to injuries from an outside agent as well as other factors in the physical working environment such as light, sound, temperature, etc. Coming in contact with a harmful object or substance can also cause injury. Sometimes the lack of energy, such as the lack of oxygen in the environment, becomes a health hazard. For example, mine workers, people working in underground tunnels, in bridge construction and in oil drilling work under extreme heat and suffocating conditions. This can cause a lack of oxygen, which can cause severe damage and result in accidental injury or death.

Organisational Factors

The social environment also has an impact on a worker's performance. Social environment refers to the relationship that an individual shares with his or her employer and fellow colleagues; spaces of informal interaction and bonding; and policies and systems present within the workplace. The organisation has a direct impact on an individual's overall growth and productivity. It is the management's responsibility to ensure that there are enough provisions within the workplace that create a safe and healthy work environment.

A management's strong concern for safety and skills in managing both material and human resources; a humanistic approach in dealing with employees, in which greater levels of informal worker-supervisor interaction are encouraged; and a more stable workforce and less turnover and absenteeism are considered to be essential factors for a successful safety programme performance.

When an accident occurs, it is imperative to study the causes that resulted in the accident. Once the causes have been identified, necessary steps should be taken to prevent the recurrence of an accident.

THINK TANK

- Do you know of an accident that has occurred in your workplace (or any other workplace)? What, in your opinion, could have been the cause of the accident? List the possible human, environmental and/or organisational factors that led to the accident.

The root causes of accidents can be categorised as immediate and contributing. Immediate causes could be the worker's unsafe acts and unsafe working conditions. Contributing causes refer to management-related factors, such as the environment and the physical and mental condition of the worker.

4.1.3 Theories of Accident Causation

There are several theories regarding the factors that cause accidents, which are conceptual in nature, and are of limited use in preventing and controlling accidents. There is nothing like a universally accepted theory of accident causation. Although these theories are necessary, they are not enough to understand the occurrence of accidents.

Preventing accidents is extremely difficult when the causes of accidents are still not understood. Many attempts have been made to develop a prediction theory for accident causation, but so far none has been universally accepted. Researchers from different fields of science and engineering have been trying to develop a theory of accident causation which will help to identify, isolate and ultimately remove the factors that contribute to or cause accidents.

The Domino Theory

According to W.H. Heinrich (1931), who developed the Domino Theory, 88 per cent of all accidents are caused by unsafe acts by people, 10 per cent by unsafe actions and 2 per cent by “acts of God”. He proposed a “five-factor accident sequence” in which each factor would actuate the next step in the manner of toppling dominoes lined up in a row. The sequence of accident factors is as follows: ancestry and social environment; worker’s fault; unsafe act together with mechanical and physical hazard; accident; damage or injury. The removal of one factor could prevent the accident and resultant injury; with the key domino to be removed from the sequence being the third. Although Heinrich provided no data for his theory, it nonetheless represents a useful point to start the discussion and a foundation for future research.

Multiple Causation Theory

It is an outgrowth of the Domino Theory, but it postulates that for a single accident there may be many contributory factors and causes, and that certain combinations of these give rise to accidents. According to this theory, the contributory factors can be grouped into behavioural (pertaining to the worker, such as improper attitude, lack of knowledge, lack of skills and inadequate physical and mental conditions) and environmental (improper guarding of hazardous work elements and degradation of equipment). The major contribution of this theory is to bring out the fact that rarely, if ever, is an accident the result of a single cause or act.

The Pure Chance Theory

According to the pure chance theory, every one of any given set of workers has an equal chance of being involved in an accident. It further implies that there is no single discernible pattern of events that leads to an accident. In this theory, all accidents are treated as corresponding to Heinrich's acts of God, and it is held that there exist no interventions to prevent them.

Biased Liability Theory

This theory is based on the view that once a worker is involved in an accident, the chances of the same worker becoming involved in future accidents are either increased or decreased as compared to the rest of workers. This theory contributes very little, if anything at all, towards developing preventive actions for avoiding accidents.

Accident Proneness Theory

This theory maintains that within a given set of workers, there exists a subset of workers who are more liable to be involved in accidents. Researchers have not been able to prove this theory conclusively, because most of the research work has been poorly conducted and most of the findings are contradictory and inconclusive.

The Energy Transfer Theory

A worker incurs injury or equipment suffers damage through a change of energy, and that for every change of energy there is a source, a path and a receiver. This theory is useful for determining injury causation and evaluating energy hazards and control methodology. Controlling the energy transfer at the source can be achieved by the elimination of the source, changes made to the design or specification of elements of the work station and preventive maintenance. The path of energy transfer can be modified by enclosing the path, installing barriers, installing absorbers and positioning isolators. The receiver of energy transfer can be assisted by limitation of exposure and personal protective equipment.

The "Symptoms versus Causes" Theory

The "symptoms versus causes" theory is not so much a theory as an admonition. Usually, when investigating accidents, we tend to fasten upon the obvious causes of the accident to the neglect of the root causes. Unsafe acts and unsafe conditions are the symptoms, the proximate causes, and not the root causes. (Raouf, 1998, pp. 56.6- 56.7)

4.2 Accident Analysis

The purpose of this Section is to provide a guide for calculating the magnitude of the accident problem; it is not a description of the magnitude itself. In dealing with occupational accidents, the magnitude of the problem can be estimated in different ways, depending on one's need to estimate how big the problem has been or how big it will be in the future. (Some people may say that this distinction is an unnecessary one, since knowledge of the current extent of the problem will serve to indicate what is to be expected in the future.) The magnitude of the problem as well as its types differs from country to country, from industry to industry and from workplace to workplace.

When dealing with accidents in the workplace, one can estimate the magnitude of the problem retrospectively by comparing the number of accidents (incidence rate) with the severity of the accidents (lost work days). However, if one wants to estimate the magnitude of the problem prospectively, it is done by evaluating the presence of risk factors in the workplace, i.e., factors that might lead to accidents.

A sufficiently complete and accurate view can be gained by means of a comprehensive reporting and record-keeping system. Analyses of well prepared accident reports can give a picture of the basic relationships essential to understanding the causes of the accidents, and enable a determination of risk factors.

4.2.1 Risk Assessment

Risk measurement must be made on the basis of information regarding the number and seriousness of injuries that have occurred in the past that yield a retrospective measurement. The risk of injury to individuals may be described by the following two types of data.

Measurement of risk provides a calculated frequency of injuries and a measurement of the seriousness of the injury. This could be described as the number of lost work-day cases (or fatalities) per number of workers (e.g., in Denmark, the risk of dying in an occupational accident is 3 fatalities per 100,000 employees).

Type of risk or element of danger assessment provides not only an indication of the sources of exposure and other harmful factors, which may cause an accident, but also provides an indication of the circumstances leading to the injury or damage. Work performed at a height, for example, will involve the risk of falling, with the possibility of serious injury. Similarly, work with cutting tools involves the risk of cuts from contact with sharp components, and working with noisy machines for a long period of time may result in hearing damage.

People usually use a good deal of common sense about many types of risks. For example, if you work at a height, you may fall; if it is slippery underfoot, then you may slip; and if there are sharp objects nearby, you may cut yourself. But many types of risk, which are not apparent, may be overlooked. With regard to these, the worker must be informed of the risk (e.g., that noise causes hearing damage, that some solvents cause brain damage and that certain chemicals cause acute poisoning on inhalation). Our knowledge of types of risk, from the most to the least conspicuous, whether gained through everyday experience or through research efforts, is based on past events.

However, it is one thing to know what has happened, and another to assess what will happen in the future. It should be noted that the very knowledge of the sources of exposure and other potentially harmful factors, as well as knowledge of the factors that can either heighten or reduce risk, can provide a basis for recognising the risk.

Factors Determining Risk

- The following factors are of greatest relevance in determining risks.
- Factors which determine the presence or absence (or potential) of risks of any sort;
- Factors which either increase or minimise the probability of these risks resulting in accidents or injuries; and
- Factors affecting the seriousness of accidents associated with these risks.

To clarify the first point, it is necessary to identify the causes of the accident, namely sources of exposure and other harmful factors; the latter two points constitute the factors which influence the measurement of risk.

The primary factors in the working environment, which are the direct causes of harm, either by way of occupational diseases or occupational accidents, are as follows.

Exposure sources and occupational disorders: The concept of injuries due to exposure sources is often linked to the concept of disease (or disorder), because a disease can be viewed as caused by exposure to one or several agents over a short (acute exposure) or long (chronic exposure) period of time. Chronic exposure agents are usually not directly harmful, but take effect after a relatively constant and extended period of exposure, whereas acute exposures are almost instantaneously harmful. The intensity, damage and period of action are of importance to the development of the injury, which may often be a matter of a combination of the effects of several different agents. This fact makes it difficult to point out and determine the exposure sources because (among other reasons) mono-causal correlations between specific disorders and specific exposure sources are almost never found. Examples of exposure sources, which may result in an injury in the form of a disease, are:

- chemical exposure (solvents, cleaning agents, degreasing agents, etc),
- physical exposure (noise, radiation, heat, cold, inadequate lighting, lack of oxygen, etc),
- physiological exposure (heavy loads, bad work postures or repetitive work),
- biological exposure (viruses, bacteria, flour, animal blood or leather, etc), and
- psychological exposure (work in isolation, threat of violence, changing working hours, unusual job demands, etc).

Harmful factors and occupational accidents: The concept of harmful factors (not including exposure sources) is linked to occupational accidents, because this is where damages occur and workers are exposed to the type of actions that cause instant injury. This type of action is easily identified, because the damage or injury is immediately recognised when it occurs. The difficulty attached to this type of injury is the unexpected contact with the harmful factor. Examples of factors, which may result in a person being injured by an accident, are often linked to different energy forms, sources or activity, such as,

- Energy that involves cutting, dividing or planing, usually in connection with such types of sharp objects as knives, saws and edged tools;
- Energy that involves pressing and compressing, usually in connection with different shaping means such as presses and clamping tools;
- The conversion of kinetic energy into potential energy, e.g., when something hits or falls against a worker;
- The conversion of potential energy in a person into kinetic energy, such as occurs in falls from one level to another;
- Heat and cold, electricity, sound, light, radiation and vibration;
- Toxic and corrosive substances;

- Energy exposing the body to excessive stress in such actions, e.g., as the moving of heavy loads or twisting of the body; and
- Mental and psychological stress such as the threat of violence.

4.2.2 Analysis of Individual Accidents

Jorgensen (1998) put forth two primary purposes behind analysing individual accidents.

First, the analysis of an accident helps to determine the cause of an accident. Once the cause of the accident or the risk-causing factors are known, safety measures can be introduced within the workplace in order to reduce the degree of accidents caused. Depending upon the type of organisation and the nature of work which the organisation undertakes, the safety measures can either be technical or organisational.

Second, developing knowledge of the accident further contributes to analysing accidents at the enterprise level and at the more comprehensive (e.g., organisation-wide or national) levels. In this connection, it is important to assemble the following information.

- Identity of the workplace and the work itself (that is, information relating to the sector or the trade in which the workplace is positioned), and the work processes and the technology that characterise the work;
- The nature and the seriousness of the accident;
- Factors causing the accident, such as exposure sources, the way in which the accident occurred and the specific working situation causing the accident; and
- General conditions at the workplace and the working situation (comprising the factors mentioned in the foregoing paragraph) (Jorgensen, 1998, pp. 56.4-56.5).

Accidents should be tabulated on the basis of different departments and sections and one should initially look at those sections where the rate of accidents is high, or where the accidents have been extremely severe. Accidents many a times are also repeated. In order to trace the causes and patterns for an accident's reoccurrence, it is important to categorise them in various ways, e.g., part of the body, kind of injury, type of work/machines/trades, agency (part of equipment or machine that caused injury). Such categorisation helps in tracing the pattern of accidents and it helps in making fool proof arguments about the accidents, focusing on the aspect that accidents are not random occurrences but the result of systematic faults.

Types of Analyses

Jorgensen (1998) further describes five primary types of analyses of accidents, with each having a distinct purpose.

Analyses and identification of where and which types of accidents occur: The goal is to determine the incidence of the injuries, as associated, for example, with sectors, trade groups, enterprises, work processes and types of technology.

Analyses with respect to monitoring developments in the incidence of accidents: The purpose is to be warned of changes, both positive and negative. Measuring the effect of preventive initiatives may be the result of such analyses, and increases in new types of accidents within a specified area will constitute warning of new risk elements.

Analyses to prioritise initiatives that call for high degrees of risk measurement, which in turn involve calculating the frequency and seriousness of accidents: The goal is to establish a basis for prioritisation to determine where it is more important to carry out preventive measures as compared to other areas.

Analyses to determine how the accidents occurred and, especially, to establish both direct and underlying causes: This information is then applied to the selection, elaboration and implementation of concrete corrective action and preventive initiatives.

Analyses for elucidation of special areas which have otherwise attracted attention (a sort of rediscovery or control analyses): Examples include analyses of incidences of a special injury risk or the discovery of a hitherto unrecognised risk identified in the course of examining an already known risk.

These types of analyses can be carried out at several different levels, ranging from the individual enterprise to the national level. Analyses at several levels will be necessary for preventive measures. Analyses involving the incident rates of general accidents, monitoring, warning and prioritisation will be carried out chiefly at higher levels, whereas analyses describing direct and underlying accident causes will be conducted at lower levels. The results of the analyses will accordingly be more specific at the individual level and more general at the higher level (Jorgensen, 1998, p. 56.5)

NOTE BANK

Hazard and Operability Study (HAZOP)

- Should be carried out to determine deviations from normal operations in the installation, and operational malfunctions which could lead to uncontrolled events.
- Should be carried out for new plants at the design stage and for existing plants before significant modifications are implemented or for other operational or legal reasons.
- Should systematically question every critical part of the design, its intention, deviations from this intention and possible hazardous conditions.
- Should be performed by a multidisciplinary expert group, and should always include workers familiar with the installation.

Phases of the Analysis

Jorgensen observes that irrespective of the level from which an analysis starts, it will usually have the following phases.

- Identification of where the accidents occur at the general level selected;
- Specification of where the accidents occur at a more specific level within the general level;

- Determination of the goals in view of the incidence (or frequency) and seriousness of the accidents;
- Description of exposure sources or other harmful factors that is, the direct causes of damage and injury;
- Examination of the underlying causal relation and causal development.

(Jorgensen, 1998, p. 56.5)

Accident Consequence Analysis

As the final step of a hazard analysis, an accident consequence analysis should be carried out to determine the consequences of a potential major accident on the installation, the workers, the neighbourhood and the environment. This should contain:

1) A description of the potential accident (tank rupture, rupture of a pipe, failure of a safety valve, fire);
2) An estimation of the quantity of material released (toxic, flammable, explosive);
3) Where appropriate, a calculation of the dispersion of the material released (gas or evaporating liquid); and
4) An assessment of the harmful effects (toxic, heat radiation, blast wave). .

The techniques for accident consequence analysis should include physical models for the dispersion of pollutants in the atmosphere, propagation of blast waves, thermal radiation and so on, depending on the type of hazardous substance present in the major hazard installation. The results should be used to determine which protective measures, such as fire-fighting systems, alarm systems or pressure-relief systems, are necessary.

THINK TANK

- Does your organisation have a sufficiently complete and accurate comprehensive reporting and record-keeping system for workplace accidents? If it does, you can share the salient features of the system with your classmates. If it does not, what in your opinion should be the basic elements of the accident report and record system?
- Discuss the phases of an accident analysis. Try and give examples from your industry setting.

4.3 Monitoring of Hazards

The basic objective of monitoring is to protect workers against any ill effects from hazardous substances, work organisation or work processes. Monitoring by itself is not control. It is a system to monitor hazards and the effects of hazards to make provisions for necessary correction. It is a way of checking that control measures are functioning properly. Monitoring may suggest the need for new control mechanisms. Basically monitoring can be of two types:

1) Environmental Monitoring
2) Medical and Biological Monitoring

4.3.1 Environmental Monitoring

It is a process of measurement and evaluation of hazardous material and processes. Measurement of exposure in terms of level of dust, chemical fumes, noise, vibrations, heat, radiation, etc, is the basis of environmental monitoring. The fundamental goals of any occupational health programme should be the reduction of occupational diseases by the elimination of exposure to toxic substances and hazardous physical agents or by controlling them to levels believed to be safe. To fulfil these objectives:

i. Potentially toxic substances in the workplace environment should be identified;

ii. Should be quantified on an individual level;

iii. Should call for control of exposure levels with appropriate methods, and there should be an appropriate mechanism for monitoring the functioning of the control mechanism. All these elements are part of the environmental monitoring system.

Criteria of a Good Environmental Monitoring Programme

(i) The programme should start with a statement of the aims to identify the levels of hazards where certain actions are contemplated.

(ii) All results generated by the programme should be available to workers and to their representatives and preferably a system should be evolved on the basis of which information generated will flow automatically.

(iii) A clear cut action plan must be formulated beforehand on the basis of which the control mechanism would be applied if monitoring reveals “hazardous conditions” in the work environment,

(iv) The “action level” should be jointly formulated beforehand.

No union should agree to any environmental monitoring programme unless specified control actions flow from it. Whenever there is a possibility of exposure to toxic agents, an initial estimation should be made to find out whether the level exceeds the significant level. Usually it is far less than the standard threshold limit values (TLVs) laid down by government authorities. This “significance level” is known as the “action level”. If the “dose” of exposure exceeds this level, action is called for in the form of environmental and/or biological monitoring of the workplace.

Sampling and Monitoring Techniques

(i) *Grab sampling*: Taking an air sample for analysis. Important points to note: when and from which areas the samples were taken, whether the sample taken falls nearer the “breathing zone”.

(ii) *Fixed point monitoring*: This shows total exposure, but not how it varies through the day.

(iii) *Continuous eight-hour monitoring*: This gives total exposure for a day, as well as variations in concentration during the day.

(iv) *Personal monitoring*: This is probably the best method of environmental monitoring where monitoring is done on the “person”. A personal monitor is fitted on the person so that it gives a true picture of the exposure.

Biological and Medical Monitoring

Estimation of dose, i.e., "exposure" is done through the help of environment monitoring mechanisms and the response is measured or assessed through biological and medical monitoring. It is monitoring not of the working environment but of the worker's person.

- If employees are exposed above the "action level", medical monitoring should be called for.
- Where the control of hazards is not quite effective and where workers are advised to wear Personal Protective Equipment (PPE), medical monitoring is a must.
- It is also advisable to institute a medical monitoring system where the exposure from multiple substances is common. Routine medical monitoring of workers provides a safeguard against the pitfalls and inaccuracies of environment monitoring.

4.3.2 Biological Monitoring

This is a method of identifying and quantifying a substance in vivo, or inside one's body. It could be the measurement of the actual substance, or its metabolites or of enzymes affected by it, blood, urine, hair, etc, or even exhaled air. Biological monitoring systems actually monitor the pre-clinical changes inside the body long before the development of overt signs and symptoms of a disease process (tests need to be done even after symptoms become apparent). There are many types of biological tests like blood tests, immunological tests, liver function tests, etc. The basic objective of biological tests is to detect the earliest changes at a stage when it is reversible. Therefore, many of these tests could be used as "predictors" of future disease processes. Based on this understanding, the concept of "Biological Limit Value" has been developed.

The following points need to be remembered when conducting biological tests.

1. The range of the normal value
2. Quality control of the test
3. Interpretation of abnormal results
4. Reporting of the data obtained.

Biological monitoring of some chemical agents are part of statutory requirements in most countries, e.g. blood test for lead, etc.

4.3.3 Medical Monitoring

Medical monitoring deals with the “clinical symptoms” of a disease. The fundamental objective of medical monitoring is to detect the “earliest deviation in a physiological system” so that corrective measures could be employed effectively. It also includes the proper assessment of the state of health. A pre-tested questionnaire is usually employed with or without some specific questions on known symptoms of the hazards, followed by a clinical examination of the person, aided with some simple tests like lung function tests, hearing tests, eye tests, etc. Checking the medical record could be a part of the medical monitoring system.

Medical monitoring includes:

1. Pre-employment check-up
2. Return to work check-up
3. Periodical medical examinations, both general and specific
4. Medical surveillance

Refusal of work on the ground that a person is found to be suffering from the following conditions is not acceptable.

1. Diabetes
2. Hypertension
3. High cholesterol levels in the blood
4. Defective eye sight (correctable)
5. Defective hearing (correctable)
6. Pregnancy

Medical monitoring provides scope for protection at an individual level whereas environmental monitoring provides group protection. Environmental monitoring works at the “level of exposure” whereas medical monitoring deals with the “effect of exposure”.

So medical monitoring could be considered a “second line of defence”. It does not replace the importance of environmental monitoring. In fact, medical monitoring without environmental monitoring is least effective and can hardly be recommended.

Periodic Specific Medical Examination

Special attention is given to workers exposed to known specific hazardous substances, e.g., asbestos, mercury, lead, etc. Specific periodic examination includes specific tests which can determine the earliest impact of toxic agents on specific target organs.

Medical Surveillance

It is a comprehensive way of looking at the problem, where agents, environmental factors and hosts (workers) are taken into consideration. The interaction between the host and the environment and the earliest deviation from the normal is monitored

through all sorts of biological and medical tests with a well-designed plan sketched beforehand.

THINK TANK

- What is environmental monitoring?
- What do biological and medical monitoring measure?

4.4 Reporting and Investigation of Accidents

As soon as a worker is injured, she/he must report to her/his supervisor and go to the dispensary/first aid centre. If she/he is quite badly injured, and cannot go on her/his own to the first aid centre, she/he is accompanied by one of her /his co-workers or the supervisor. If it is a serious injury and the worker's limb is fractured or she/he is badly burnt or unconscious, she/he would be taken on a stretcher or by ambulance if one is available.

At the first aid centre, she/he is given treatment, either by the trained attendant or the doctor, if on duty. This may include cleaning and disinfecting an injury, removing a burr from the eye, or dressing a wound, if it is a simple injury. If it is a more complex injury, where specialist treatment or surgery is needed, the preliminary treatment given is to prepare the patient for such future treatment. Blood transfusions, oxygen to assist breathing, etc, may be given. The injured person is then sent to the nearest hospital with which the factory has such an arrangement.

The supervisor at the scene of the accident writes up a preliminary report, normally known as an Accident Intimation Slip. This includes the personal details of the injured person, her/his activity at the time of the accident, and a preliminary assessment of the reasons for the accident. At the first aid centre, the attendant doctor records the nature of the injury, the part of the body injured and brief details of treatment given. Normally three copies of this form are prepared: one goes to the worker's departmental head, one remains with the first aid centre, and the third goes to the department which will report the accident to the factory inspector. This department may be the time office, personnel department or safety department. The safety department normally visits the spot of the accident, investigates the accident and records its findings on the Accident Information Slip. On this basis, the report to the factory inspector is prepared and sent. Normally, only injurious or fatal accidents are recorded and investigated. The non-injury or "near-miss accidents" are most often not recorded and not investigated at all. It is important that these also be investigated.

Most accidents, especially serious ones, when they occur create some furore among workers, and also among some management departments. The investigation is then followed up with recommendations on how to prevent similar accidents from reoccurring. This may be by modifications or the introduction of safety devices in the machine, by a change in work procedures or the institution of more serious fault-finding inspection and preventive maintenance. If the furore has already died down, these recommendations simply remain on paper. The pressure to ensure them on a sustained basis does not exist and since it requires additional resources, in terms of people, time and money, the newly recommended procedure or inspection system is often simply set aside.

It is only workers and unions who have a direct interest in improving working conditions. Further, at a particular work location, it is the worker with her/his deep and intimate experience and knowledge of working there who is capable of understanding the causes of the accident, the problems and suggesting solutions. It is this expertise which must be brought forward to improve working conditions.

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Investigation of Accidents

If the information about an accident is received directly from the workplace, the following questions should be asked:

- *Who is giving the information (name and role of the job)?*
- *What was the place where the accident happened?*
- *Who is the victim?*
- *Who is the employer of the victim?*
- *When did the accident happen?*
- *Can you give a short description of the accident?*
- *What were the consequences of the accident?*
- *Where is the victim now?*
- *Have the police been informed?*
- *Is there any additional information?*
- At the same time the following decisions may have to be taken with regard to the workplace.

Workers, their representatives and unions must provide sustained follow up to ensure that the recommendations are implemented by:

a) Investigating accidents thoroughly;

b) Analysing all accidents so as to discover patterns, if any, in their occurrence;

c) Making recommendations to managements; and

d) Follow up to ensure the implementation of preventive measures recommended by both the management and themselves.

Investigating Accidents

In addition to the investigation undertaken by the management, it is also necessary that workers' representatives take up this task. This investigation should be thorough and in-depth and should especially look at aspects which the management would not normally bother with. For example, factors like age, job stress, workload, equipment failure, imbalanced work allocation, effects of productivity drives and incentive systems, job and skill levels, shift systems, training, experience in that task etc.

In the first place, access to information regarding the occurrence of the accidents is required. Find out the internal accident reporting procedures in your factory as well as those responsible for sending the reports to the factory inspector. Also, check who maintains the register prescribed under the relevant Act. All these departments will be good sources of information. Another good source of information is the inspection reports made by the factory inspector. See the register maintained in the factory. However, certain cases may go unreported or the facts suppressed. The union or the safety committee therefore needs to build up its own reporting structure within the factory. Once the workers are informed and come to know that there is a worker's committee keen on pursuing these problems, they will readily come forward with information. The members of the safety committee (who are normally from different departments) or other selected safety representatives are the right people to do such a job. A network of this kind will be a good check on the management's reporting system.

Accident Analysis

Tabulate the accidents that have occurred according to the departments/sections and look initially at those sections where the number of accidents is high, or where more serious accidents have occurred. Many times the same type of accident is repeated. To identify common causes and patterns in accident occurrence, it is useful and necessary to categorise them in various ways, e.g., part of the body, kind of injury, type of work/machines/trades, agency (part of equipment or machine that caused injury). With such a grouping, the pattern of accidents may be clearly seen and foolproof arguments may be made to the management that these accidents are not random occurrences but the result of systemic faults.

Making Recommendations to Management

For a particular accident, find out what went wrong, i.e., was it failure of equipment, machine, wrong work procedure, inadequate levels of skill or training of workers, workplace at heights, etc. Use the causes so found to formulate recommendations, which can then be placed before management either through the safety committee or in the form of demands. These may be in the form of design change, installation of safety features, new work procedures, better training, less work load, improved inspection, etc.

The injured worker and her/his colleagues are the best placed to give practical suggestions for change and improvement. Consult them and use their ideas as a basis for recommendations.

Also check the recommendations that the management representatives are making. Keep track of them, get copies of their reports and pursue the matter with management so that these recommendations are implemented.

Another demand is to ask for worker's representation on the investigation committees appointed by the management. This will give the worker time off for this task as well as access to information and records.

In case, the representative finds herself/himself in a minority, she/he can always make a separate report through the union.

Follow up for Implementation

The recommendations made by management as well as by the workers and their representatives must be followed up if they are not to remain merely on paper. For this, the safety committee members must keep track of the preventive measures made and keep raising the issue of the progress of the implementation of these recommendations in the safety committee.

4.5 Accident Prevention and Control

Accident prevention has traditionally been based on learning from accidents and near accidents (near misses). By investigating every accident we learn about the causes and take action towards mitigating those causes. The problem is that we have not been able to develop, in the absence of sufficiently good theories, investigation methods that bring up all the relevant factors for prevention. An investigation may give a fairly good picture about the causes. However, this picture is usually relevant only for the specific case investigated. There may be conditions and factors that contributed to the accident which the investigators do not recognise or understand. Generalising all accident situations bears a degree of risk.

4.5.1 Principles of Workplace Safety

Questions of accident prevention cannot be solved in isolation, but in the context of their relationship with production and the working environment. Hence, the following principles for accident prevention can be derived.

1. Accident prevention must be built into production planning with the goal of avoiding disruptions.

2. The ultimate goal is to achieve a production flow that has no hindrance as far as possible. This results not only in reliability and the elimination of defects, but also in the workers' well-being, labour saving methods and job safety.

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What is Job Safety?

Job safety involves the interrelationship between people and work; materials, equipment and machinery; the environment; and economic considerations such as productivity. Ideally, work should be healthy, not cause harm and not be unreasonably difficult. For economic reasons, as high a level of productivity as possible must be achieved.

The following principles are important in understanding how accident prevention concepts relate to disruption-free production.

1. Accident prevention is sometimes considered a social burden instead of a major part of disruption prevention. Disruption prevention is a better motivator than accident prevention because improved production is expected to result from disruption prevention.

2. Measures to ensure workplace safety must be integrated into the measures used to ensure disruption-free production. For example, the instructions on hazards must be an integral part of the general directions governing the flow of production at the workplace.

Some of the practices commonly used in the workplace to achieve job safety and which are necessary for disruption-free production include, but are not limited to, the following.

- Workers and supervisors must be informed and aware of the dangers and potential hazards (e.g., through education);
- Workers must be motivated to function safely (behaviour modification);
- Workers must be able to function safely. This is accomplished through certification procedures, training and education.

The personal working environment should be safe and healthy through the use of:

- Administrative or engineering controls,
- Substitution of less hazardous materials or conditions, or

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Emergency planning

Emergency planning should be regarded by works management and the competent authorities as an essential feature of a major hazard control system.

Emergency plans should be clear and well defined, and available for use quickly and effectively in the event of a major accident. On-site and off-site plans should be coordinated for maximum efficacy. In industrial areas where available emergency equipment and manpower are limited, works management should attempt to make provisions for mutual assistance, between neighbouring industrial activities in the event of a major accident.

- By the use of personal protective equipment (PPE).

Equipment, machinery and objects must function safely for their intended use, with operating controls designed to human capabilities.

Provisions should be made for appropriate emergency response in order to limit the consequences of accidents, incidents and injuries.

The different paths of accident prevention for ensuring workplace safety are as follows.

1. Eliminate the hazard or danger so that injury or damage is no longer possible.
2. Provide for separation between the worker (or equipment) and the hazard (equal to elimination of the hazard). The danger remains, but an injury (or damage) is not possible since we make sure that the workers' natural zones of influence (equipment) and object (hazard or danger) do not intersect.
3. Provide shielding, such as fireproofing, protective clothing and respirators to minimise the hazard. The hazard still exists, but the possibility of an injury or damage is reduced.
4. Adapt to the hazard by providing measures such as warning systems, monitoring equipment, and information about dangers, motivation for safe behaviour, training and education.

4.5.2 Controlling Exposures

Exposure sources or other harmful factors are to a great extent governed by the nature of the processes, technologies, products and equipment to be found in the workplace, but may also be governed by the way in which the work is organised. From the point of view of measurable risk, it should be recognised that control of the probability of exposures and the seriousness of injuries to workers often depends on the following three factors.

Elimination/Substitution Safety Measures

Workplace hazards in the form of exposure sources or other harmful factors may be eliminated or mitigated by substitution (e.g., a less harmful chemical may replace a toxic chemical in a process). It should be noted that this is not always possible, as exposure sources and other harmful factors will always be present in human surroundings (not least with respect to human working conditions).

Technical Safety Measures

These measures, often called engineering controls, consist of separating persons from harmful factors by encapsulating the harmful elements, or installing barriers between the workers and the factors which may cause injury. Examples of these measures include, but are not limited to, automation, remote control, use of ancillary equipment and machine protection (guarding).

Organisational Safety Measures

Organisational safety measures, also known as administrative controls, include separating persons from harmful factors either by means of special working methods or by separation in time or space. Examples of these controls include, but are not limited to, reduced exposure time, preventive maintenance programmes, encapsulating the individual workers with personal protective equipment, and expedient organisation of work.

4.5.3 Controlling Human Conduct

It is often not possible to isolate all hazards using the above measures for control. It is commonly supposed that accident prevention analysis ends here, because it is believed that workers will then be able to take care of themselves by acting “according to the rules”. This means that safety and risk will at some point depend on factors which control human conduct, namely whether the individual person has the knowledge, the skills, the opportunity and the will to act so as to ensure safety in the workplace.

Knowledge

Workers must first be aware of the types of risk, potential hazards and elements of danger that may be found in the workplace. This usually requires education, training and job experience. The risks also need to be identified, analysed, recorded and described in a readily understandable manner so that workers know when they are in a specific risk situation and the consequences that are liable to follow from their actions.

The Opportunity to Act

It must be possible for the workers to act safely. It is necessary for workers to be able to make use of the available technical and organisational as well as physical and psychological opportunities for action. Positive support for the safety programme must be forthcoming from the management, supervisors and the surroundings, including concerns about risk taking, designing and following working methods with safety in view, the safe use of proper tools, clearly defining tasks, establishing and following safe procedures, and providing clear instructions on how equipment and materials are to be handled safely.

The Will to Act Safely

Technical and organisational factors are important with respect to the workers' readiness to behave in ways that will ensure workplace safety, but social and cultural factors are equally important. Risks will arise if, for example, safe conduct is difficult or time consuming, or if the management or colleagues do not desire it, or is not appreciated by them. The management must be clearly interested in safety, taking steps to prioritise it and displaying a positive attitude towards the need for safe conduct.

Information on the causes of accidents serves the following purposes.

- It can demonstrate where something is wrong and what needs to be changed.

- It indicates the types of harmful factors that cause accidents (or near accidents) and also describes the situations that result in damage and injuries.
- It identifies and describes the underlying circumstances that determine the presence of potential hazards and risky situations and that will result in optimum safety by their being altered or eliminated.

Information of a general sort can be obtained by a thorough analysis of the damage or injuries and the circumstances under which they occurred. Information obtained from other similar accidents may point out more general factors of importance, thus disclosing causal relationships which are not immediately visible. However, as very detailed and specific information can be obtained by analysing an individual accident, this information may help uncover the specific circumstances which should be addressed. Often, analysis of the individual accident will provide information which is not possible to obtain from the general analysis, whereas the general analysis may point out factors which the specific analysis does not elucidate. Data from both of these kinds of analyses are important to help disclose obvious and direct causal relations at the individual level

4.5.4 Control at Source

Workers/unions can fight for establishing proper controls. There are three broad strategies to control hazards:

- Engineering controls
- Administrative controls
- Personal protective equipment

Engineering Controls

These are the most effective and permanent ways to control health hazards. The three types of engineering control techniques that can be used are given below.

(i) *Substitution*: The most positive of all controls. If a material, machine, or process is dangerous, the best thing is to substitute a new material, machine or process that is less hazardous.

(ii) *Ventilation/Exhausts*: The movement of air to keep air contaminants (dusts, mists, gases, fumes or vapours) from reaching the breathing zone of the workers. These are of two kinds – general or local exhaust ventilation. General ventilation is designed to move air through the entire workshop. Air is continually sucked out by fans in the ceiling or walls. Fresh air is pulled in through inlets. General ventilation may make the workplace more comfortable but it will not make it any safer if toxic dust, fumes or gases are present. No general ventilation system can protect you from breathing contaminated air.

Local exhaust ventilation is designed to remove toxic dust, fumes, and gases at the point where they are generated. If engineered properly, it will capture the contaminant before it can escape and enter the workers' breathing zone. A local exhaust system consists of a hood close to the site to suck in the contaminated air, ducts to carry it away, a fan, and an air cleaning device to purify the air before it is vented outside.

(iii) *Isolation*: A hazard can be isolated by using a barrier or establishing a safe distance from it. This is an effective control method, especially for noise.

Administrative Controls

Administrative controls do not eliminate hazards, but limit workers' exposure to a hazard. Some examples are:

- Rescheduling the work to a time when fewer workers will be exposed;
- Extending rest periods (can be used to control exposures to excessive heat or cold);
- Job rotation;

- Proper manning levels so as to control leakages in time.

Personal Protective Equipment and Clothing

These are the least effective methods of fighting hazards. Besides being uncomfortable and interfering with work performance, they can create their own health and safety hazards. These should be acceptable only when it has been proven that engineering controls are not feasible.

The objective of a Personal Protective Equipment (PPE) Programme is to protect employees from the risk of injury by creating a barrier against workplace hazards. Personal protective equipment is not a substitute for good engineering or administrative controls or good work practices, but should be used in conjunction with other practices to ensure the safety and health of employees. Personal protective equipment will be provided, used, and maintained when it has been determined that its use is required and that such use will lessen the likelihood of occupational injury and/or illness.

PPE constitutes the last line of defence. It does not reduce or eliminate the hazard, but merely sets up a barrier against it. Unless these are constantly maintained in good condition, they can create a false sense of security.

There are two types of PPE

- Respiratory
- Non-Respiratory

Respiratory PPE are:

1. Air supplying type

➢ An air respirator connected to the compressed air line or to a blower.

- A self-contained breathing apparatus where a cylinder of air or oxygen is carried on one's back.

2. Air purifying type

- A mechanical filter which traps dust; canister/cartridge type which protects against chemicals by having an antidote in the container.

Non-Respiratory PPE is classified according to the part of the body that it protects.

1. Head

- Helmet: against falling objects
- Caps: against heat, sparks, chips, splashes

2. Ears

- Ear muffs: to reduce noise

3. Eyes and Face

- Safety goggles: to protect eyes
- Face shields: to protect against dust, splashes of liquid, flying particles and harmful radiation

4. Hand and Arm

- Full sleeved shirt or separate sleeves for welders, fettlers, etc.
- Gloves: made of cotton, leather, or rubber to protect against sharp objects, heat, chips, corrosive chemicals and irritants

5. Body Protection

- Uniform Aprons: cotton, rubber or leather protects against heat and chemical splashes, lead aprons protect against radiation.

- Shirt should be half open T-shirt type with half sleeves as otherwise open cuffs or shirt ends could get entangled in machines.

6. Foot and Leg

   - Safety boots /shoes
   - Leg guards to protect against the splash of molten metal, hot liquid, falling of objects on the toes or foot, and to protect the sole from sharp objects.

7. Safety Belt: To arrest the fall of a person from a height and into pits. Belts must be used whenever a person is working at a height or at deeper levels such as in sewers, especially on construction and maintenance sites.

8. Barrier Cream: Sets up a barrier between the skin and the offending agent, controlling the incidence of dermatitis. There is a set of two creams, one acting as a barrier and the other a cleansing cream.

4.6 Safety Audits

Safety audits are conducted to verify the existence and implementation of elements of occupational safety and health system and to ascertain the system's ability to achieve defined safety objectives.

A safety audit subjects each area of a company's activity to a systematic critical examination with the objective of minimising loss. Every component of the total system is included, like the layout and construction of the plant, operating procedures, emergency plans, personal protection standards, accident records, etc. It is conducted by appropriately qualified personnel, including safety professionals. A formal report and action plan is then prepared and monitored.

Various methods for assessing the results of a company's safety practices include injury, frequency, and duration of accidents and estimation of financial loss. These methods have one thing in common; they are quantitative rather than qualitative.

Safety audit on the other hand gives a reasonable indication of how well a company's safety programme is working in all its aspects; how hazards are being recognised and controlled, how unsafe acts are being eliminated, how accidents are being avoided. To achieve this, the analysis of accidents is not the only parameter taken into consideration.

4.6.1 Who Conducts the Safety Audit?

Safety audits are normally conducted by those personnel who are not the part of the plant which is being audited. The team must have members with a wide variety of experience like safety professionals, people with experience in the field of design, operation and maintenance.

4.6.2 Frequency of Audits

Safety audits should ideally be conducted every two or three years in a normal plant and at least once a year in plants which deal with hazardous materials.

4.6.3 Types of Audit

The safety audit system currently being practised in India can be classified in two categories: Internal Audits and External Audits.

Internal Audit

Plant safety inspection is regularly carried out either by officers of the safety department, members of safety committees or other concerned people drawn from other departments. The internal audit specifically refers to those audits which are carried out by technical teams who are not part of the local plant management. Within this category, two patterns are noticed:

In the first pattern, the team consists of technical personnel from the technical services/safety departments functioning at the corporate level. In the case of Indian companies, these may be from the company's headquarters while in the case of multinationals such teams would normally come from the corporate headquarters of the parent company.

In the second pattern, more common in multi-unit companies, a team of multi-disciplinary senior technical managers of other units would constitute the audit team of a particular unit.

Internal audit teams are constrained by the fact that their experience is usually limited to their particular plant. Further, their knowledge of statutory and non-statutory provisions may be limited. The advantages are that in-company auditors are familiar with the specific technology in use, company practices and work culture particularly in relation to the company's safety standards and programmes.

External Audit

In external audits, the team is an independent, third party.

The main benefit of an external audit is that the report is relatively free from bias and gives an independent professional certificate about the safety status of the plant. However, the recommendations may be more general in nature and may not deal with the particulars and constraints of implementation. Further, the audit team's knowledge about what is going on in a particular plant will be limited, and may be incomplete.

4.6.4 Objectives of a Safety Audit

The major objective is to determine the effectiveness of the company's safety and loss prevention measures. This should cover the physical examination and qualitative assessment of all facts related to the safety of each and every activity. These activities should include research and development, design, occupational health and hygiene, environmental control, product and public safety (including storage, package, labelling and transportation) as well as those associated directly with production and technical operation, maintenance, clearance certificates, emergency procedures, job descriptions and operating instructions, training, housekeeping and personnel attitudes.

Some important objectives are:

- To identify potential of fire, accident and health hazards
- To study existing measures, procedures and systems for controlling these hazards
- To recommend changes to improve effectiveness of existing procedures, organisation and programmes.

Authorisation

It is an essential requirement of an audit system that it should have approval at the policy-making level. As well as the audit system, its objectives shall also be meaningful to workers and line management, who should not only understand and accept it but also be prepared to adjust their own safety and loss prevention activities in accordance with information about the deficiencies and trends revealed in audit. Audits may also result in suggestions needing policy decisions and proposals for capital expenditure. It is therefore important that senior managers are also involved in the formal audit system and have committed resources – manpower and money to implement the changes agreed upon. It is also essential that an appropriate member of the board and senior management is directly involved in the review of the audit report leading to an action plan and subsequent formal reviews of progress on the plan. The effective participation of workers in any safety audit is also important, because the maximum loss in case of any mishap is borne by the workers. Besides, it is the workers who will actually put the recommendations made in the audit report in to practice.

4.6.5 Scope of Safety Audit

The safety audit is necessarily very wide ranging in scope and covers all aspects of a company's operations.

The following would be the broad areas of examination for the audit of a chemical complex:

1. Fire prevention and protection
2. Process safety
3. Safety in the storage and transportation of hazardous chemicals

4. Chemical hazards and their control, comprising ventilation and exhaust systems, work environment monitoring, personal protective equipment, emergency showers/fountains and medical help, etc.
5. Pollution control
6. Review of procedures -operating, maintenance, start up and shut down, permits to work.
7. General hazards and their control, comprising machine guarding, material handling, working surfaces and means to access, electric hazards, housekeeping
8. Safety management
9. Emergency preparedness, including evacuation plan and medical facilities.

Each of these areas comprise of a number of elements. For example, the areas of safety management would include:

1. Safety policy
2. Involvement of top management
3. Assignment of responsibility and accountability
4. Safety department
5. Safety committee and other schemes of workers' participation
6. Establishment of safe operating procedures
7. Safety manual
8. Safety training of management, supervisors and workers
9. Safety inspection
10. Accident reporting, investigation and analysis

11. Safety records

12. Safety promotion and publicity

13. Medical department – first aid, periodical medical examination, etc.

4.6.6 Methodology

The following are the stages/steps in conducting a safety audit:

1. Collection of preliminary information on the safety programme by questionnaire to assess the existing system

2. Planning the audit exercise including the timeframe, special focus areas, collection and study of relevant standards.

3. Field visit of the audit team

a) Pre-audit meeting with the chief executive and all departmental heads, safety committee members and workers' representatives to explain the objectives and methodology and also to obtain their support. The chief executive should issue a clear directive to all personnel in the plant regarding co-operation with the audit team.

b) Inspection of all production areas, following the product flow.

c) Inspection of all supporting services like substation, captive power station, boiler and compressor houses, stores, maintenance workshops.

d) Discussion with managers, supervisors, workers and safety committee members.

e) Study of records and key documents.

f) Study of activities, records and discussion with personnel of fire, safety and medical department.

g) Discussion with chief executive highlighting the broad findings and preliminary conclusions of the audit.

4. Analysis of the data collected and report writing.

5. Submission of draft report and discussion with the plant management and workers.

6. Presentation of the final report with recommendations.

7. Preparation of an action plan for the implementation of the audit report's recommendations.

8. Follow-up by the top management as well as workers to ensure implementation.

Pre-audit

Prior to the conduct of the audit, it is essential that the team to have all relevant information related to the plant available with them for study in advance. This helps in selecting the areas to focus in the audit, identifying and studying relevant standards, and the preparation of a detailed checklist.

Information on these aspects can be asked for from the organisation through a pre-audit questionnaire, which would cover:

a) Details of the plant and equipment;

b) Details of sections, employees' strength, etc;

c) Summary of accidents and fire records of the plant for the previous 3-4 years;

d) Details of safety, fire fighting, medical, management; and

e) Emergency plans.

While most of the above mentioned elements will be common to all types of plants, in the case of certain industries, particularly the chemical process industry, greater details regarding the process safety system, chemicals used, their quality, etc., should be solicited.

Pre-audit questionnaires are sent in advance and are to be received before the field visit commences.

Checklist

In addition to the questionnaire, the audit team should also prepare a detailed checklist of the points which require checking and inspection, as well as of further details/clarifications needed on the information received through the questionnaire.

This checklist consists of a series of points under relevant reporting heads. It is also useful if a summary of the expected standard against each point is mentioned as a ready reference for the auditor while checking. The checklist requires systematic preparation in order to be a useful aid to the auditor. Generally these checklists remain with the auditor and are not given to the company under audit.

Standards

In order to avoid controversy and carry conviction it is desirable that the safety audit inspection be carried out with reference to the criteria and standards. It also helps in increasing the acceptability of the recommendations and in getting approval for the necessary budgetary and manpower allocation where needed. Further it also helps in planning for the successful implementation of the recommendations.

Some Audit Elements for Management Systems

1. Safety Health and Environment Policy
2. Safety and Health Organisational Set-up
3. Education and Training

4. Communication/Motivation/Promotion of Safety
5. Safety Inspections
6. Accident Reporting, Investigation and Implementation of Recommendations
7. Maintenance of Accident Statistics and Its Utilisation
8. Safety Audits
9. Personal Protective Equipments
10. Process/Plant Modification Procedure (including technology change)
11. Safe Operating Procedures
12. Work Permit Systems
13. Fire Fighting Systems
14. Health and Safety Improvement Plan Targets
15. Prevention of Occupational Diseases
16. Work Environment Monitoring System
17. Medical Examination
18. Material Safety Data Sheets
19. Emergency Preparedness Plans (On Site/ Off Site)
20. Hazardous Waste Treatment and Disposal
21. Transportation of Hazardous Materials
22. Hazard Identification
23. Contractor Safety Systems

24. New Equipment Review/Inspection

Some Audit Elements for Technical Aspects

1. Building and Structures
2. Operational Safety and Procedures
3. Process In-Built Safety
4. Handling and Storage of Chemicals

i. Manual Handling

ii. Lifting Appliances

iii. Lifting Tackles

iv. Material Handling Procedures

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2. Operational Safety and Procedures
3. Process In-Built Safety
4. Handling and Storage of Chemicals
   i. Manual Handling
   ii. Lifting Appliances
   iii. Lifting Tackles
   iv. Material Handling Procedures

4.6.7 Safety Committees

A safety committee is basically a forum in which the employer and the employee jointly participate in decision making in matters related to safety, health and environment in the workplace.

The purpose of the safety committee is to contribute to mutual understanding between management and labour by encouraging safety and health promotion in the workplace (ILO, 1983). The safety committee is the outcome of many years of struggle by trade unions for their right to participate effectively in the process of decision making for matters related to workplace safety and health. In many countries, safety committees are formed voluntarily while in some, the formation of such committees in industrial establishments is a compulsory legal requirement.

In a review of the functioning of the safety committees, certain aspects have been considered of utmost importance in the success or failure of such committees (ILO, 1983). Those aspects are issues related to whether:

a) the members of the safety committees feel that it is backed by the employer;

b) the safety committee is provided with suitable infrastructural facilities for holding meetings, secretarial assistance and other related facilities;

c) the committee is constituted of important members of management such as the chairman of the committee;

d) the committee meets regularly, for instance, at least once a month;

e) each meeting has agenda to discuss the safety and health scenario of the factory since the last meeting;

The management representatives in the committee will consist of the chairman who holds a senior managerial position in the organisation, a safety officer, a factory medical officer, and one representative each from the production, purchase and maintenance departments. The workers' representatives will be elected from among

the workers. The committee's duration will be for two years and will hold at least one meeting in every quarter of a year, and minutes of the proceedings are to be recorded. The committee will have the right to ask and seek all relevant information concerning the safety and health of the workers.

Functions of the Safety Committee:

a) assist and co-operate with the management for fulfilling the aims and objectives of the organisation;

b) deal with all matters related to health, safety and environment and to work out practical solutions to the problems encountered;

c) create safety awareness among all the workers by undertaking educational, training and promotional activities;

d) review reports (safety audit, etc.), surveys, plans related to safety, occupational health and environment for implementation of recommendations;

e) carry out health and safety surveys, identify causes of accidents and look into complaints regarding safety and health hazards; and

f) review the implementation of the recommendations made by the committee.

Summary

In this chapter, we understood the meaning of an accident and what an accident at the workplace is. We have learnt the various ways to avoid occurrence of accidents in the future by accident analysis and monitoring hazards. We have also looked at how to avoid accidents from becoming a disaster by accident prevention and control and reporting and investigating an accident, and the purpose of a safety audit.

Glossary of Terms

- **Accident:** An accident is something that goes wrong unexpectedly. Physical examples include an unavoidable collision (including a person or object falling by chance). The term is also loosely applied to mean any undesirable outcome, even if it could have been avoided, such as getting injured by touching something sharp, hot, electrically live, ingesting poisons, or other injuries caused by lack of ordinary precautions.
- **Acute exposures:** Are single, non-repetitive exposures for not more than 8 hours (Up to 14 days for humans).
- **Biological Limit Values (BLV):** They are the reference values for the biological indicators associated with global exposure to chemical agents. The BLV are applicable for occupational exposures of eight hours per day five days a week. The extension of the BLV to periods that differ from the reference period should be carried out taking into account the pharmacokinetic and pharmacodynamic data of the agent in question. In general, the BLV represent the most probable levels of the biological indicators in healthy workers subjected to overall exposure to chemical agents.

- **Breathing zone:** Area of a room in which occupants breathe as they stand, sit, or lie down. Technically, it is the two-foot sphere around each person's mouth, from which all your breathing air is drawn.

- **Grab sampling:** To collect a sample directly into a sampling device over a period of time. It is the rapid collection of whole-air samples into a suitable container, such as an evacuated canister or a polytetrafluoroethylene (PTFE) bag.

- **Hazard and operability studies**: Hazard and operability (Hazop) studies is a formal critical examination of any new installation (equipment). The hazard potential associated with the design of the installation and the process of operation is studied. This study includes possible hazards due to the malfunctioning or incorrect operation of individual items as well as the composite installation.

- **Injury:** Means damage or harm to the physical structure of the body and those diseases or infections naturally resulting from the damage or harm. The term also includes occupational diseases.

- **Monitoring:** Continuous or repeated observation, measurement, and evaluation of health and/or environmental or technical data for defined purposes, according to prearranged schedules in space and time, using comparable methods for sensing and data collection. Evaluation requires comparison with appropriate reference values based on the knowledge of the probable relationship between ambient exposures and adverse effects. Biological monitoring and environmental monitoring are narrower terms.

- **Risk:** Is the potential harm that may arise from some present process or from some future event. In everyday usage, "risk" is often used synonymously with "probability", but in professional risk assessments, risk combines the probability of a negative event occurring with how harmful that event would be. Risk = probability of an accident/"event" (e.g., events per year) times its consequence (e.g. lost money, or deaths, per event).

- **Safety audit:** Verifying the existence and implementation of elements of occupational safety and health system and for verifying the system's ability to achieve defined safety objectives.

- **Safety inspection**: A routine, scheduled inspection of a unit or department, which may be carried out by personnel within the unit, possibly accompanied by some one from outside. The inspection would check maintenance standards, employee involvement, and work practices and check that the work is carried out in accordance with the rules.

- **Safety sampling**: A specific application of safety inspection/tour designed for measuring, by random sampling, the accident potential by counting safety defects. Trained observers record the number of safety defects detected while touring specific locations by a prescribed route. Typically tours last only 15 minutes and are conducted at weekly intervals. The count of defects is used to portray trends in the safety situation.

- **Safety survey**: A safety survey is a detailed examination of a narrower field of activity, e.g. major key areas revealed by the safety audit, individual plants, procedures or specific problems common to a work as a whole. These too are followed by a formal report action plan and monitoring.

- **Safety tour**: An unscheduled examination of a work area, carried out by anyone or a range of personnel from the works manager to safety committee members to ensure that standards are maintained at an acceptable level and that obvious hazards are removed.

- **Threshold limit values (TLV):** Time-weighted average concentration of an air pollutant at the workplace for a conventional eight-hour workday and a 40-hour work week, to which nearly all workers may be repeatedly exposed without adverse health effects. TLV is a legally mandated safety limit.

Recommended Reading

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