Basics of Accident Prevention

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BASIC PRINCIPLES OF ACCIDENT PREVENTION

1.	Basic Philosophy of Industrial Accidents – Causation & Prevention
2	Types of Hazards
3	Role of Supervisor in Promoting Safety & Health .
4	Reporting & Classification of Accidents.
5	Hazard Identification & its Techniques.

1. BASIC PHILOSOPHY OF INDUSTRIAL ACCIDENTS – CAUSATION AND PREVENTION

1. INDUSTRIAL ACCIDENTS AND NEED FOR SAFETY

Industrialisation has brought within its wake several problems. One such is industrial accidents. With rapid advances in industrial processes, newer types of dangers to life, limb and health and being increasingly introduced. Mechanical, electrical, chemical and radiation hazards to set us on all sides. Yearly, several lakhs of employees are injured in factories due to accidents. Many more are disabled for life.

These accidents represent a social loss of great magnitude in the form of pain, loss of earning capacity and cost due to disturbance to economic efficiency. The painted suffering of the injured as well as the emotional loss to the victims of fatalities and accidents causing permanent disfigurements or disabilities are impossible to be summed up or evaluated. The economic costs are more tangible of being computed, though practically, no figures are available in terms of the total cost of accidents in our factories. To the management, it is the direct costs for meeting medical expenses, compensation or disablement benefits to the injured or their families and also the various other indirect costs due to the interference caused by accidents which are generally, taken economic cost is in terms of loss of productive capacity and the cost of maintenance of the injured and their families through social security schemes or through public or private charities.

2. DEFINITION OF ACCIDENT

Various definition of “Accident” can be found in literature. A broad and at the same time generally accepted definition for all purposes relating to safety of personnel is that an accident is an unplanned and unexpected event which causes or is likely to cause an injury.

3. CAUSE(S) OF ACCIDENTS

In 1932 , H W Heinrich, after careful study of 75,000 lost time accident cases from insurance files, found that 98% of the accidents were caused by either unsafe actions, or unsafe mechanical or physical conditions or both and that they could be prevented by correction of the unsafe acts and the conditions.

Analysis by the same author of 5,000 lost time accidents has shown that for every accidents resulting in an injury there are many other similar accidents that cause no injuries, whatever. It was estimated by him that in a unit group of 330 accidents of the same kind involving the same person and similar circumstances, 300 result in no injuries, 29 in minor injuries and 1 in a lost time injury. This is illustrated if figure 1.

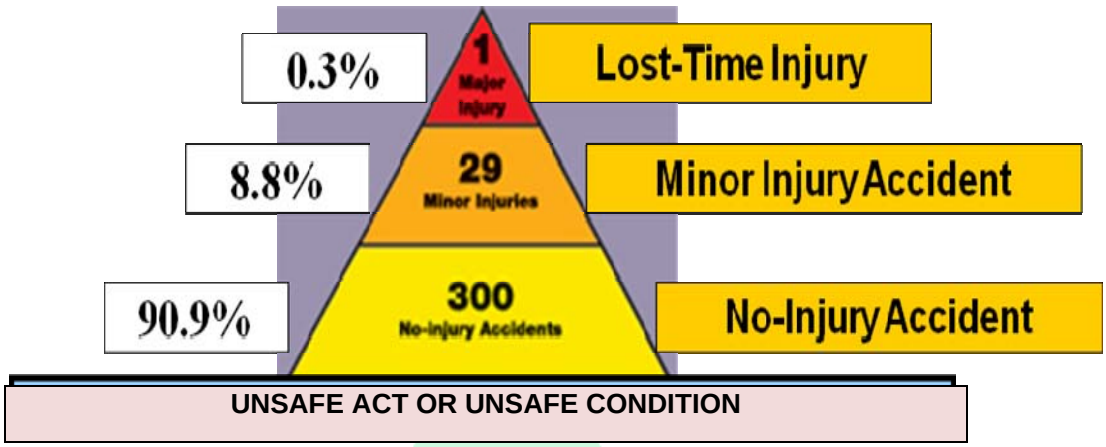


Fig. 1 – Foundation of a lost time injury

(iii) Theory of Accident Occurrence

The basic theory of accident occurrence may be briefly stated as :

i) A personal injury occurs only as the result of an accident;
ii) An accident occurs only as a result of an unsafe actions or exposure to an unsafe mechanical or physical condition or both;
iii) Unsafe actions or unsafe mechanical or physical conditions exists only because of faults on the part of persons; and
iv) Faults of persons are inherited or acquired from the environment and the reasons or causes for the faults are (a) Anatomical or physiological unsuitability, (b) Improper psychological characteristics, (c) lack of knowledge or skill and (d) Improper mechanical or physical environment.

Knowledge of the factors in the accident sequence guides and assists in selecting the point of attack in prevention work. It permits simplification without sacrifice of effectiveness. It also permits expansion of safety work into the underlying field of human behaviour or limitations and helps in organizing and introducing most suitable control measures.

(a) Unsafe Actions

i) Classification, causes and prevention

These are generally classified under the following heads :

a) Operating without authority, failure to secure or warn
b) Operating or working at higher than the specified speed;

c) Making safety devices in operative;
d) Using damaged equipment, hands instead of equipment; or equipment unsafely;
e) Unsafe loading, placing, mixing, combing, etc..;
f) Taking unsafe position or posture;
g) Working on moving or dangerous equipment;
h) Distracting, teasing, abusing, startling, etc. and
i) Failure to use safe attire or personal protective devices.

Very often one does not have to study the sub-causes for the unsafe actions of persons before remedial measures can be suggested for prevention of such actions. All that would be needed is proper instruction and follow-up. However, in many instances there is a need for finding the underlying reasons for unsafe acts and when these are discovered, they lead to the proper selection and application of effective measures in accident prevention. The reasons or sub-causes that give rise to unsafe actions have been classified by Heinrich, as stated earlier under the four broad hearings of anatomical or physiological unsuitability, improper psychological characteristics, lack of knowledge or skill, and improper mechanical or physical environment. To put it differently in the language of the ergonomist, faults on the part of persons which leads to unsafe actions of persons in a working environment are caused due to human limitations in respect of anatomical, physiological perceptual and psychological characteristics, skills, knowledge and capabilities as well as due to imperfections in the mechanical, physical or social environment. Clearly, human limitations in the context of interface between man and machine or man and his work environment are the ultimate causes of all accidents.

Personal characteristics such as age, job experience, visual functions, perception, motor ability, dexterity, reaction time, cardiovascular neuropsychiatry disorders and psychopathological conditions have bearing on incidence of accidents. Therefore, it is essential that adequate attention is paid to proper selection, training, placement, education and supervision of workers on the basis of the hazards in the jobs concerned. Further, engineering revision to make the work environment safer to the employees, the most effective way of controlling unsafe actions of persons, should be taken advantage of whenever possible.

Accident Proneness

In this connection it would be worthwhile to say a few words on the concept of 'accident proneness'. "Accident Proneness" can be defined in simple terms as a personal idiosyncrasy predisposing the individual who possesses it in a marked degree to a relatively high accident rate. This presupposes that there are only a few people who have many more accidents than the other. There has been lot of confusion in the use as well as interpretation of the word "Accident Proneness". Great injustice has also been caused to be done to employees due to adoption of a negative approach arising out of wrong convictions regarding accident proneness of individuals. Numerous studies carried out by research workers have failed to prove conclusively that any group of persons in a given sample can be separated as accident prone.

(b) Unsafe mechanical / Physical conditions

Unsafe mechanical or physical conditions are generally classified under the following heads :

a) Inadequately guarded;
b) Unguarded;
c) Defective condition, rough, sharp, slippery, decayed, corroded, frayed, cracked, etc.;
d) Unsafe design or construction;
e) Hazardous arrangement, process, etc. (Piling, storage, aisle space, exits, layout, overload, misalignment),
f) Unsafe illumination (Inadequate or unsuitable);

g) Unsafe a ventilation (inadequate or improperly distributed)
h) Unsafe dress or apparel, and
i) Unsafe methods, processes, planning etc.

4. PRINCIPLE OF ACCIDENT PREVENTION

Through in majority of the accidents, the direct cause is usually attributed by investigators to unsafe actions of persons, it should be emphasised that the most effective method of prevention of accidents by adopting engineering measures to remove the unsafe mechanical or physical conditions involved in the situations. Knowing or man and his environment on account of the limitations of the man in respect of his anatomical, physiological, psychological and perceptual characteristics, skills and abilities, the reduction in unsafe mechanical or physical conditions can will be appreciated. It is a plain fact that the more a process or an environment is kept free from unsafe mechanical or physical conditions, the lesser would be the chances for persons to run into accidents. Therefore, the part that 'engineering revision' (Removal of unsafe mechanical or physical conditions or amending unsafe processes or systems of work) can play in accident prevention cannot be over emphasised. Efforts to prevent accidents by methods giving emphasis on control of unsafe actions alone would not give encouraging results unless they are backed up with 'engineering' to the extent practicable.

Accident Prevention Methods

The well known prevention methods mentioned earlier can be summarised as :

i) Engineering revision;
ii) Personal adjustment; and
iii) Instrument, persuasion, and appeal;
iv) Discipline.

The important steps or procedures in application of these methods are detailed in chart 1.

The objective of accident prevention can be achieved only if the top management takes up the responsibility for safety. While the various duties and responsibilities for safety could be delegated the management's function itself of organising, planning directing and controlling for the ultimate objective of obtaining freedom from industrial accidents cannot be delegated. Safety, no doubt, is "everybody's business" but it requires management's sustained efforts to ensure that the accident prevention programme works successfully.

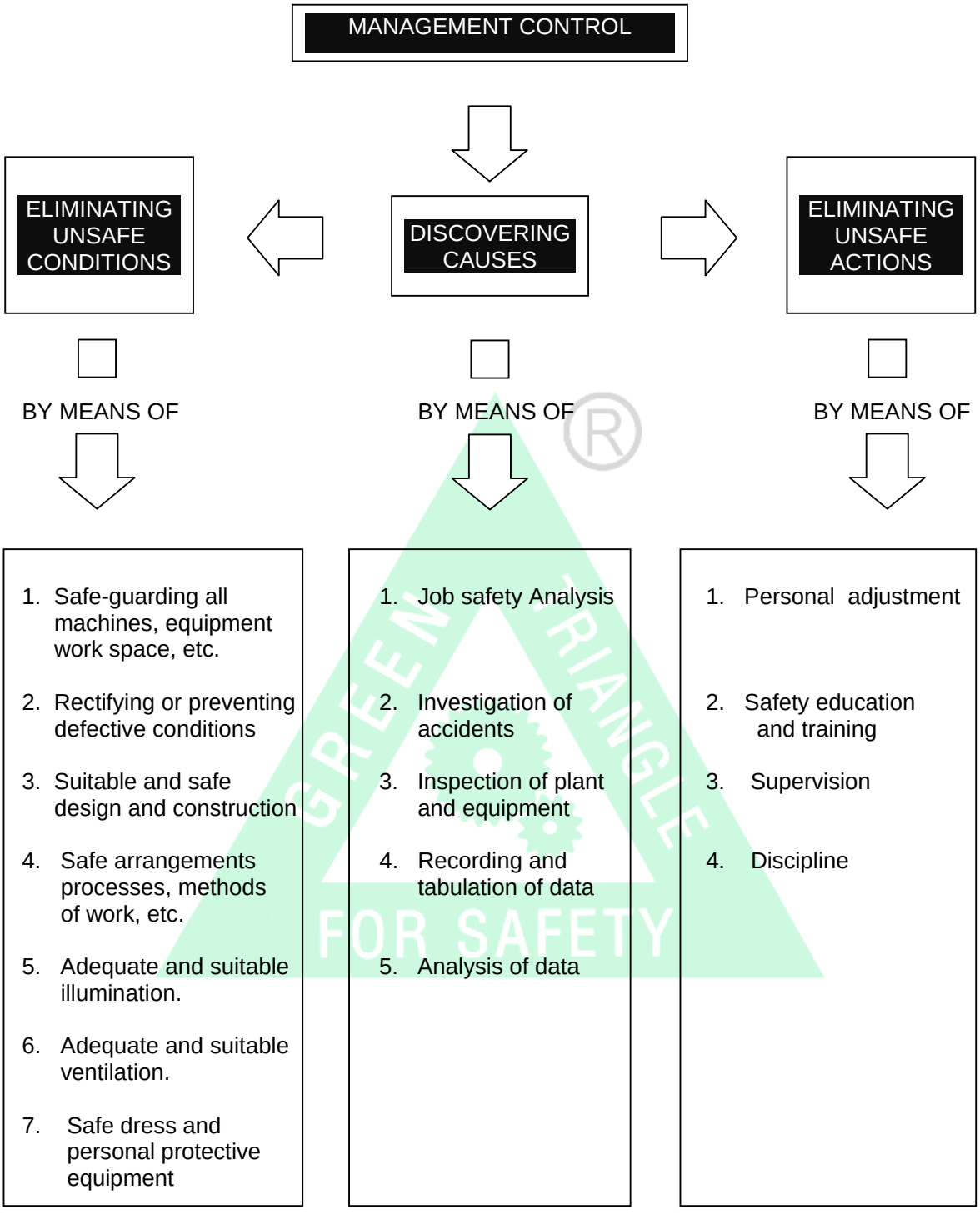

MANAGEMENT CONTROL
ELIMINATING UNSAFE CONDITIONS
DISCOVERING CAUSES
ELIMINATING UNSAFE ACTIONS
BY MEANS OF
BY MEANS OF
BY MEANS OF
1. Safe-guarding all machines, equipment work space, etc.
2. Rectifying or preventing defective conditions
3. Suitable and safe design and construction
4. Safe arrangements processes, methods of work, etc.
5. Adequate and suitable illumination.
6. Adequate and suitable ventilation.
7. Safe dress and personal protective equipment
1. Job safety Analysis
2. Investigation of accidents
3. Inspection of plant and equipment
4. Recording and tabulation of data
5. Analysis of data
1. Personal adjustment
2. Safety education and training
3. Supervision
4. Discipline

Chart 1

2 Types Of Hazards

Hazard: any condition that may result in the occurrence of or contribute to the severity of an accident.

-Suppose a belt and pulley drive is not guarded and it is running. If someone's finger gets caught in that belt then his finger may not only get injured but it may get amputated thereby increase the severity of the accident. This is Hazard.

There are lot of hazards prevailing in the workplace. Some of the hazards are listed below :

In this Physical Hazards and Chemical Hazards are covered in the later module (Industrial Hygiene & Occupational Health)

I. ELECTRICAL HAZARDS

INTRODUCTION

Accidents due to unsafe handling of electrical equipment, although contribute a very small percentage of the total compared with other agencies like machine tools, material handling equipment, hand tools, etc. have mostly a significant role to account for severe damage to person for property. Electrical energy, which acts like our friend and servant when safely used, may become our master and killer if adequate precaution is not taken in its use.

Electrical hazards are generally of the following in nature :

a) Shock
b) Burn
c) Fire
d) Explosion
e) Arc-eye

a) Shock

When current passes through our body completing a closed circuit, excitation of our muscular and nervous systems occur and we perceive a shock. Shock is not always painful but usually so. Current of varying magnitude produces different type of injuries to human body. Ten mill amperes current is considered as the threshold limit for sensible shock. As the value increase, various physical repercussions start in our body. They are muscular contraction, unconsciousness, asphyxiation, temporary paralysis, haemorrhage – all accompanied with pain

which ranges from moderate to extreme in nature. At a current value of 50 mill-amperes or more, the victim may die (electrocution) when his heart stops functioning because of interference of rhythmic function or heart by passage of current.

Severity of Shock

Severity of shock depends upon the following features :

a) Amount of current
b) Duration of flow of current
c) Path of flow of current
d) Type of energy (AC/DC)
e) Frequency (in AC only)
f) Environmental condition

More amount of current means disastrous effect. Current flowing through our body in turn depends on the supply voltage and resistance of our body at the particular moment. According to Ohm's Law, I = V/R, which means that flow of current (I) will be more at a higher voltage (V) or at a lesser resistance ® of the victim's body. Human body resistance varies with a wide range being 25,000 to 6,00,000 Ohms with perfectly dry skin. Resistance comes down to 1,000 Ohms or even to 500 Ohms with wet skin when the victim receives severe shock.

Severity of injury is directly proportional to the duration of flow of current. If the current passes through the vital parts of a victim's body like brain, lungs, kidneys, etc. the effect will be more disastrous rather than when it flows through non-vital parts of his body.

With alternating current (AC) the effect of shock is always more than with direct current (DC). Shock with lower frequency of current is more dangerous than with higher frequency. 50 cycles per second (50 Hz) is considered as unsafe frequency. If current, at higher frequency is generated and used, as in the case of high frequency induction furnace, etc., it is considered relatively safe. At about 1,000 Hertz frequency, shock reduces considerably.

The person receiving shock will face severe injury if his surrounding atmosphere (environmental condition) is wet or humid or if the sweats or gets drenched with water when his body resistance will come down abruptly to a very low value.

b) Burns

The thermal effect of current causes burn injury. The heat developed due to passage of current is directly proportional to the square of the current, resistance of our body and the period of flow of the current. Sufficient amount of heat is thus development in no time and causes burn injury. Direct contact with line or exposure to high flash resulting from defective equipment causes such burn injury. Short-circuiting of cables, switches, etc. may produce such flash of explosive violence.

c) Fire

It occurs due to either of the following faults in electrical equipment.

a) Short-circuiting
b) Over loading
c) Loose connection

Short-circuiting occurs when, in the single phase circuit, phase line touches the natural line or in 3-phase circuit one phase touches the other as a result of failure of insulation of cables, wires, or conductors. Overloading means drawing of more current by any equipment than its rated capacity which occurs due to failure of insulation in the winding of any equipment. Loose

connection means formation of are at junction points of cable or at the terminal points of cables and fitting.

In all the above three fault conditions heat is generated in the conductor or wire which in turn heats up the insulating materials (PVC, rubber, etc.) of the conductor or wire to catch fire.

Basic causes of electrical fire are improper maintenance of ear thing system, use of oversize fuse and failure of insulation.

d) Explosion

Explosion in an electrical equipment occurs when fire due to short circuit originates in a confined space filled with oil like tank of oil circuit breaker or transformer, etc.

e) Arc-eye

Irritation of eyes occurs to an electric-arc welder who does not use protective glass for welding. Ultraviolet invisible rays from the are affects the eyes of the welder causing swelling, pain, etc. which automatically gets cured within two days or so. The use of a welding screen with proper shade number glass will be guard against such arc-eye.

ACCIDENT PREVENTION

Accidents due to shock, burn, fire explosion, etc. may be averted or severity reduced by the following two techniques.

1. Proper Maintenance

Any possible breakdown or fault should be anticipated by experienced personnel and adequate preventive measures should be taken before hand. A check-list should be prepared for periodic and special inspection of various installations. When doing preventive maintenance, the following points should be given emphasis.:

a) Checking of equipment earthing,

b) Checking of insulation of cable, wire, conductor, etc

c) Checking for loose connection of wires/cables and fittings.

Equipment earthing means connecting metal casing/parts of electrical equipment to good mass of earth under permanent moisture level through low resistive metallic path. Efficiency of earthing depends on the resistance of earth continuity conductor, earth electrode, contact resistance of the electrode with surrounding soil and specific resistance of the said soil. To ensure sound ear thing, system should be periodically inspected visually for broken earth conductor for maximum permissible earth loop resistance for a particular load.

Proper earthing takes care of accidents due to shock, burn, fire etc. by ensuring immediate discharge of current from the metal parts of a faulty equipment into the earth. It also helps the circuit protective device like fuse to work promptly by allowing sufficient amount of current to pass through it in case of a fault.

Insulation of wires or cables get damaged by mechanical agencies, chemical, oils, rodents or weathering effect. They are to be inspected visually for such damage and replaced in time to prevent accidents due to shock, fire etc. Insulation resistance test by instrument is recommended where visual inspection for insulation failure cannot detect such fault.

Various circuit protective devices like fuse, relays, release coils, etc. are required to be checked for protection of equipment against faulty condition which may otherwise lead to accidents causing fire.

2. Compliance with Safety Rules

Safety Rules are to be observed at the various stages of designing, fabricating, installing, operating and maintaining of electrical equipment. A few of the important safety rules are :

a) Follow Competency of Personal – Until a person is competent enough with full knowledge and experience of electrical work, he should not handle any electrical breakdown work.

b) Do Interlocking Design – Equipment should be designed, as far as possible, with interlocking arrangement in such a way that unless supply is cut off live parts is not made accessible and conversely until the live parts of an equipment is guarded accidental touching, the equipment cannot be energized.

c) Design for Low Voltage – Wherever possible, for portable equipment and other electrical apparatus, appliances, a low voltage supply should be used with separate bus bar.

d) Treat Unknown Circuit as Live – Until and unless or a line is definitely known as to be dead, it should be treated as a live circuit or live line.

e) Do Electrical Locking – When attending any breakdown with deadline, the control switch should be locked, fuse grip should be removed and the key of the lock should be retained with the person attending the breakdown.

f) Follow Work Permit System – For attending any electrical work, which is usually dangerous, Permit to Work System should be followed.

g) Use Standard Fittings and Accessories – Use of substandard fittings and unsafe accessories should be discouraged.

h) Wear/Use Personal Protective Equipment – Suitable PPE like non-conductive helmet, leather gloves, electrical safety shoes, etc. should be used as and when necessary.

i) Get Emergency Training – Persons working in electrical field should have training on fire fighting, emergency signalling, first aid, etc. in addition to his normal operational training.

j) Fencing of Live Conductors – Charged line running exposed without insulation should be installed at sufficient height (minimum 8.5 ft. from working level) and guarded against suitable barrier or fencing to prevent accidental touching.

k) Follow DO's and DONT's - For any special work or risk area, special safety instruction in the form of DO's and DONT's should be displayed e.g. in substation, receiving or sending ends of distribution lines.

l) Discourage for Makeshift Arrangement – Temporary wiring and work without proper accessories (e.g. plug earth connection) should be discouraged to avert accidents due to shock, fire, etc.

II) MECHANICAL HAZARDS

Industries engaged in manufacturing process use various types of machines, equipment, means of transport and other devices operated/moved manually or by power (electrical, electronic, hydraulic, etc.). Hazards encountered while operating or moving these machines, transport equipment, other devices, etc. are classified under mechanical hazards. Different types of mechanical hazards to which plant personal (usually at operative level or supervisory level) are exposed in course of their day-to-day activities are as follows :

TYPE OF MECHANICAL HAZARDS

(a) **Caught in between two moving/removing parts or one stationary and other moving/running part of general purpose machine tools**.

Machine tools operated in workshop like lathe, drill, grinder, milling machine, power saws, band-saws, shaping machine, planning machine or special purpose machine tools like reaming machine, cutter & tool grinder machine, slotting machine, etc. pose mechanical hazards if they are not adequately guarded at their dangerous parts

(b) **Contact with moving part(s) of machine**

Contact with exposed cutting tools of cutter of milling machine (horizontal vertical or universal), cutting tool (V-tool) of lathe machine, guiding abrasive wheel of grinder (surface grinder/cylindrical grinder) drill of drilling machine (pillar drill, radial drill) pose mechanical hazards.

(c) **Striking against/hit by flying objects or particles/dust from machine in motion**

Hit by grinding dust, or flying particles to eye poses mechanical hazards.

(d) **Fall of objects, from height**

Objects falling from height causing head injury or multiple injuries are source of mechanical hazards.

(e) **Hit by crane**
Hit by crane with or without materials under suspension or being carried therein poses technical hazards.

(f) Contact with vehicular traffic like truck & trailer, fork lift truck, earth movers, running conveyor belt, bucket conveyor, transporting/transferring materials from one place to other cause source of mechanical hazards.

(g) Hit by dropping object on feet or leg while handling materials

(h) Contact of hands with sharp/pointed/corroded/oily objects causing hand/palm injury during manual handling of materials poses mechanical hazard.

PREVENTION / ELIMINATION OF MECHANICAL HAZARDS

Depending upon the type of mechanical hazards exposed with duration of exposure, workers or operative personnel in the shop floor face chance of accident with different injuries like cut, crash, laceration, amputation, sprain, fracture, etc. All these hazards can be controlled or guarded by proper planning and implementing safe work procedure and work methods like :

a) adequately guarding all power operated machine tools against accidental contact with their dangerous parts (e.g. point of operation, transmission of machinery, etc.)
b) Using/wearing requisite type of personal protective equipment (like helmet, hand gloves, goggles) to minimise or guard against the ill-effect of hazard like fall of objects from overhead, eye injury due to flying objects/dust particles, etc.
c) Taking adequate care and attention while walking on shop floor as not to get struck by vehicle, crane or other means of transport.

Process of reducing/eliminating/contact of mechanical hazards is best done by applying hazard analysis techniques like Job Safety Analysis, Safety Audit and Plant Safety Inspection at the planning stage of production.

III) RADIOLOGICAL HAZARDS (RADIATION HAZARDS)

IONIZING RADIATION

Radiation can effect the people according to whether it comes from outside or from inside the body. In Industrial situation external radiations are common. The amount of tissue damage in exposed persons depend on the energy absorbed per unit mass of tissue and the nature of organic tissue itself. The blood forming organs and reproductive organs are more sensitive to radio active substances. Radiation absorbs by the tissue is measured in rads. One rad corresponds to hundred ergs and energy/ gram of tissue.

Alpha Particles

This is used in industries to monitor the thickness of paper, polythene films etc. These are high energy particles with very low penetrating capacity. The ill effects are mainly minor burns in the vicinity.

Beta rays

They was electrons of various energies and penetrate few millimetres into the tissue before they are absorbed. They cause some deep damage to the tissue.

Gamma rays & X-rays

They are electro-magnetic radiations of energies. They are used for metal inspections and welding checks. They have power of high penetration and are very dangerous. They cause burn, dermatitis locally and skin cancer, leukaemia and gene-mutation systematically.

Neutrons

They are uncharged particles with a wide range of energy and power of penetration. They cause remote and severe damage to the tissue.

Permissible doses of radiation

International Commission on Radiological Protection recommends –

(2) 3 Rems during any period of 13 consecutive weeks to the testes or ovaries, blood forming organs blood and lenses of eye at and age over 18 years.
(3) 235 rems of whole body radiation for persons occupationally exposed from 18 to 65 years of age.
(4) 60 years to the gonads by the age of 30 years.

PRINCIPLE OF PROTECTION AGAINST RADIATION

(a) Exposure must be minimized
(b) Shielding to be adopted.
(c) Change of radiation beam direction towards safe area.
(d) Adequate records for do this received.
(e) Medical examination with a special attention on blood.
(f) Technical protection measures, and follow up of regulations regarding storage, use, monitoring and disposal.

ULTRA-VIOLET RADIATION

Ultra Violet Radiation effect the skin causing burn, skin cancer and conjunctivitis. In welders it may cause “Arc eye”

Infra Red Radiations

Eye suffers more damaging effects due to this. They may cause fatigue and headache and cataract Glass blowers cataract is the commonest example.

Microwaves Radiation

Cornea and lens of eye are the most vulnerable structures because of the lack of heat dissipating blood vessels. Cataract and skin burns are similar to the infra red radiation. The frequency of more than 30 mega Hertz is dangerous.

Laser beams

A laser beam is a beam light energy of one length and uniform phase in which waves trouble together in step and in rhythm. Its application in cutting and welding operations, in photography and in medical use for photo coagulation of retina are well known. Organ affected is mostly they eye.

3 ROLE OF SUPERVISOR IN PROMOTING SAFETY AND HEALTH (WITH SPECIAL REFERENCE TO CHEMICAL INDUSTRY)

Growth of chemical industry in our country has been spectacular within the last two decades. The production of chemicals have also increased. Increased number of chemical manufacturing units and production of chemicals coupled with complex technologies, processes and use of hazardous chemicals have also increased the problem of Safety and Health hazards associated with their handling, use, etc. at work..

The protection of safety and health at work has been made more difficult by :-

i) variety and diversity of industries and the technologies employed therein; and

ii) spreading over the industry throughout the vast area including thickly populated metropolis and remote and grossly under development backward areas.

In spite of the severity of the problem posed by the massive expansion of chemical industries in the country and use of toxic and hazardous chemicals, the chemical safety did not receive the special attention it deserved.

The problem of danger to the health and well being of the community on account of chemical and other industry has become a pressing problem in the modern industrial society. While we cannot adopt a policy of not having any chemicals or other hazardous industry, merely because they pose a risk to the community, we have to reduce the element of risk by taking all necessary steps to control the hazards especially by providing competent supervision. This role in improving standard of health and safety performance.

1. ROLE OF SUPERVISOR

Supervisor is said to be an important link between management and workers. This concept proves more than true in case of health and safety drive. Management make provision for safety of the plant and people and the supervisors ensure that the workers utilize and work on the provisions made. He is in charge of people and equipment and is held responsible for people's proper behaviour. He works through them in achieving the task of quality production in time with health and safety of his people. Good supervision, therefore, is the starting point for an effective implementation of health and safety drive on the shop floor.

The supervisor carries the major responsibility for the health and safety of the workers under his jurisdiction. He is closest to them and the only one in a position to assure that they operate in a safe way. Health and Safety is an important part of his job and a thread that runs through all of it.

Unfortunately, the heath and safety part of his job has never been clearly defined. We urge safety efforts on him, what are the effective efforts, the pay-off efforts in which he should engage? What specifically should he do? What specific actions should he take in order to be best assured that he will genuinely control health and safety in his department?

2. RESPONSIBILITY

2.1 Safety

At the outset, the supervisor is not expected to become an occupational health and safety expert, he does not need to learn it as a specialization. Except in a limited way, chiefly through the exercise of common sense, the supervisor cannot be expected to design the danger out of process, determine the noxious qualities of materials processes in his department, overcome

operational limitation of equipment used in the handling of materials, or design safety equipment and clothing for operators. The supervisor need not be an expert in layout or colour coding. All these involving design are primarily the business of safety, health and industrial hygiene professionals.

The supervisor is concerned with applications of the measures, with the effect on the employee of the process, materials, and so forth. He must see that the workers are properly trained in the safe use of the machinery, equipment and controls in the safe execution of whatever processes and operations their job require, and in the safe activity and movement within the work area. He must recognize that training cannot step short of the firm establishment of work habits which represent the safest as well as the most efficient method of production. If the supervisor feels that production cannot proceed without hazard to the employees, he must recommend changes in the machinery or method or both for considerations. Beyond this point he has little control over the physical equipment because he is usually not in a position or lacks the engineering skill to redesign or modify the equipment. He is responsible for having the condition corrected but is rarely able to do it himself. However, he does inspect, suggest, and recommend. Above all, he must perceive the hazard before he can have anything done about it. The inspection of the department for physical and chemical hazards is of paramount importance, and it is an activity for which he has or can develop the required skill.

Safety and health must be interwoven into the operating activity as thoroughly as possible by the supervisor so that it is not regarded by the workers as something separate and not a part of his regular job. Workers must be made to realise that it is an integral part of efficient and economical working.

The supervisors safety efforts should be directed to three major areas ;

i) the workers

ii) the work method

iii) the work area

i) The Worker

Ensure that all workers :

- know the correct and safe way of doing the job
- understand the dangers they are exposed to
- understand the purpose and functioning of the various safeguards to control the process hazards
- know and report faults immediately before they develop into major hazards.
- know their role and participate in the emergency drill
- understand the purpose and use the proper protective clothing and equipment.

Take action to control the danger :

- Train, explain and gain acceptance of safety instruction.

To prevent recurrence :

- Stop, correct, retrain and follow up.

ii) The Work Method

Ensure that :

- prescribed safe operating procedures for machinery and equipment and work permit systems are followed
- Storage and handling of chemicals is safely done
- Local exhaust system function properly
- Rules about hazardous substances (toxic, flammable and corrosive) are observed.
- Take action to control danger
- Watch for dangerous working practices.

To prevent recurrence :

- Eliminate, guard, warn and report the dangers

iii) The work Area

Ensure that

- All work places are safe
- Access to work station is safe
- Fire exits and fire fighting equipment is in good condition
- Handrails and covers are in good condition

2.2 Health

Every employer has legal and moral responsibilities for the health of his employees, and this responsibility is shared by all members of the management and supervisory team. A healthy work force will always perform better.

A supervisor should :

i) Know the legal requirements in relation to :

- Processes
- Work Methods
- Employee safety and health training
- The handling and disposal of dangerous materials
- Medical examinations for certain categories of employees
- Procedures for monitoring health hazards.

ii) Recognise the four main sources of occupational disease:

- Physical hazards (such as pressure variation, vibration, heat, cold, infra red and ultra violet rays, etc.)

- Chemical hazards (where chemicals, gases, metals may damage the eyes, skin, lungs, and other internal organs, or bones)

- Biological hazards (these include bacteria, moulds, fungi and viruses derived from animals and their bi-products)

- Stress denotes the effect of mental and emotional pressure.

iii) Identity the hazards which are most likely to affect your own employees.

(a) The environment at work

If people have to work in a noisy or dusty atmosphere or with certain chemicals, the supervisor should learn all he can about effects of these hazards, and how to identify the early symptoms in an employee who is beginning to be affected. He must make sure that workers are using all the safeguards provided, and if a new hazard emerges, or a new safeguard becomes available, bring these to the attention of your manager.

(b) The individual at work

Some individuals are more at risk than others. They may be older, less agile, or suffer from some inherent weakness or impairment. It is necessary for the supervisor to know his staff well enough to avoid exposing them to situation in which his weakness would put them at greater risk.

One hazard which affects individuals very differently is stress. People vary greatly in their ability to cope with this, and very often a small amount of stress at work added to psychological pressures outside the work situation can produce sever symptoms. A supervisor needs to be able to recognize the danger signs, and ease off the pressure. A private chat, in which the individual releases his tensions by taking about them, is often the best answer.

The supervisors would normally do this, but in some cases the Personnel Department or a union representative can often help.

3. PRINCIPLES OF MANAGEMENT

In order to manage health and safety in his section effectively, the supervisor must use the principles of management. The five phases of management apply to safety and health also, and are discussed below.

3.1 Planning

The safety and health program is only as effective as the formal plan designed to implement it.

Planning safety and health covers the planning of :

- Safety and health training
- Operator training
- Safety procedures and systems (e.g. permit to work and “Isolation” keys for maintenance)
- The inclusion of safety and health in the induction programme
- Fire Drills
- Supply and use of protective equipment.

3.2 Organising

- Making clear that every employee has a responsibility for health and safety
- Setting up safe systems (e.g. isolation switches and permit to work systems during maintenance.)

3.3 Leading

- Motivating employees to the health and safety conscious.
- Taking corrective action when employees place themselves or others at risk.
- Setting a good example in tidiness, care, work methods.
- Noticing and praising employees who demonstrate health and safety consciousness.

3.4 Co-ordinating

Co-ordinating the work of the team with other teams, and team members amongst themselves in such a way that hazards do not occur (e.g. during maintenance or on shift charge over).

Co-ordinating the health and safety programme with other departments and with the safety officer and occupational health specialist.

3.5 Controlling

- Plant Inspections
- Investigation of accidents (Major, minor & fatal)
- Looking at statistics and interpreting them for Medical checks.
- Checking on sickness absence.

In addition, a supervisor should :

- set a positive attitude and good example by his own conduct and dress.
- develop trust and confidence amongst his people
- be alert for dangerous practices – supervisors are the people who really know what is going on
- train his new and old employees on health and safety aspects.
- deal promptly and firmly with matters under his control but don't take management's responsibility on his own shoulders. If he has any worries about safety and health in his section, he should not keep them to himself but tell the manager.
- use foresight –see where potentially hazardous situations exist
- prevent accidents by taking proper and timely action
- be an effective communicator – give opportunity to ask questions and clarify what is expected of them in matters of safety and health.
- be a motivator – encourage and invite the employee to come up with suggestions which would improve the operating procedures without increasing the hazards. This might harness employees apparently strongest motivation, the motivation of personal achievement.

4. CONCLUSION

It is essential that the supervisor does not overlook new hazards when a change of procedure is to be adopted, when he has an emergency storage problem or when he handles a new equipment. Even when the job is static, it is always a good practice to continuously analyse it.

A supervisor who preservers in his health and safety programme and is alive to his role and responsibilities will find it rewarding and will pay-off for his company and himself in the long run.

4 ACCIDENT REPORTING AND CLASSIFICATION OF ACCIDENTS

The principal factors related to causation of accidents are :

a) agency;
b) unsafe mechanical or physical condition,
c) unsafe act,
d) unsafe personal factor
e) type of accident,
f) nature of injury, and
g) location of injury

Measuring safety performance and classification

1 Use of rates

Industrial accidents and occupational disease cause much suffering and loss of life and are a heavy financial burden on industry and on social security schemes. In order to take practical steps towards reducing their number by the establishment and application of safety and health measures, its very useful to have detailed statistics showing the causes and types of accidents, the industries or occupations in which they occur and the severity of the resultant injuries or occupational disease. The compilation of employment injury statistics is the first step towards prevention of occupational risks, this factor was recognized in the International Labour Organization Prevention of Industrial Accidents recommendation, 1929. Employment injury statistics provide essential information for Government department dealing with labour, industrial organisations and other agencies dealing with occupational safety and health and also for managements.

2 Method for Computation of Frequency Rate and Severity Rate for Industrial Injuries and Classification of Industrial Accidents (IS : 3786 – 1983)

This Indian Standard (First Revision) was adopted by the Indian Standard Institution on 30th September, 1983, after the draft finalized by the Industrial Safety Advisory Committee had been approved by the Executive Committee.

This standard was originally issued in 1966 with the following objectives in view:-

(a) to help in evaluating the relative need for taking accident prevention measures in different departments of an establishment;

(b) to help in making an appraisal of the progress of accident prevention campaign and making people safety conscious;

(c) to provide encouragement when methods used for the prevention of accidents are successful; and

(d) to enable comparisons to be made.

(A) SCOPE

This standard prescribes basic methods of recording and classifying industrial accidents. It also includes details of work injury and gives the methods for computation

of frequency, severity and incident rate of work injuries in industrial premises. This would enable adoption of a uniform system of recording events associated with injuries and the determination of corrective action.

(B) TERMINOLOGY

For the purpose of this standard, the following definitions shall apply :
Accident – An unintended occurrence arising out of and in the course of employment of a person resulting in injury.

Death – Fatality resulting from an accident.

Disabling Injury (Lost Time Injury) An injury causing disablement extending beyond the day of shift on which the accident occurred.

Note – An ideal system of accident statistics would take into account every occurrence causing injury however slight. Unfortunately, this is impracticable because the record of trivial injuries varies not only according to the number of sustained but also according to the strictness with which a firm insists on this being reported. On the other hand, if an accident keeps a man away from work for a day or more, his absence is bound to be noticed. In other words, the 'one day', or 'one shift' accident has been chosen because it is a standard unit which cannot vary to a great extent from firm to firm or from year to year. This is, therefore, used for practical purpose as it is the nearest accurate figure to the ideal and is a very simple standard to use.

Non-disabling injury – An injury which requires medical treatment only, without causing any disablement whether or temporary or permanent nature.

Reportable Disabling Injury (Reportable Lost Time Injury) – An injury causing death or disablement to an extent as prescribed by the relevant statute.

Days of Disablement (Lost time) – In the case of disablement of a temporary nature, the number of days on which the injured person was partially disabled as defined in 2.7. In the case of death or disablement of a permanent nature whether its partial or total disablement as defined in 2.7 and 2.8 man-days lost means the charges in days of earning capacity lost due to such permanent disability or death as specified in Appendix B of IS 3786. In other cases the day on which the injury occurred or the day the injured person returned to work are not to be included as man-days lost; but all intervening calendar days (including Sundays or, days off, or days of plant shut down) are to be included. If after resumption of work, the person injured is again disabled for any period arsing out of the injury which caused his earlier disablement, the period of such subsequent disablement is also to be included in the man-days lost.

Partial Disablement – This is of two types: Disablement of a temporary nature which reduces the earning capacity of an employed person in any employment in which the he has engaged at the time of the accident resulting in the disablement; and disablement of a permanent nature, which reduces his earning capacity in every employment which he was capable of undertaking at the time.

Total Disablement – Disablement, whether of a temporary or permanent nature, which incapacitates a workman for all work which he was capable of performing at the time of the accident resulting in such disablement, provided that permanent total disablement total disablement shall be deemed to result from every type of injury specified in Part A of Appendix or from any combination of injuries specified in Part B of Appendix A where

the aggregate percentage of the loss of earning capacity, as specified in that part against those injuries, amounts to one hundred percent.

Man-hours worked – The total number of employment hours worked by all employees working in the industrial premises. It includes managerial, supervisory, professional technical, clerical and other works including contractors' labour.

(C) CALCULATION OF MAN-HOURS WORKED

Man-hours worked shall be calculated from the pay roll or time clock recorded including overtime. When this is not feasible, the same shall be estimated by multiplying the total man-days worked for the period covered by the number of hours worked per day. The total number of man-days for a period is the sum of the number of men at work on each day of the period. If the daily hours vary from department to department and the result added together. When actual non-hours are not used, the basis on which the estimates are made shall be indicated.

3. ASSESSMENT OF WORK INJURY

3.1 Basis of Assessment

General – Through investigation of all factors relating to the occurrence of each reported injury is essential. Determination as to whether or not the injury should be considered a work injury under the provisions of this standard shall be based on the evidence collected during investigations.

Evidence – The evidence to be considered in determining whether or not the reported injury should be considered a work injury may include, but not necessarily be limited to, the following :-

a) Facts resulting from investigation of the injured employee's work activities and working environment to which the injury might be related;

b) Statements (written it possible) of the injured employee, fellow employees, witness and supervisors;

c) Medical reports acceptable to the authority classifying the work injury; and

d) Facts concerning the injury employee's work activity for other employees, and other off-the-job activities, injuries and illnesses.

3.2 Assessment of Special Cases

General – Before inclusion in the record special cases should be assessed. Clauses 5.2.2 to 5.2.15 are intended to assist in such assessment but these provisions/ rules should not be used to exclude a genuine work injury from the record.

Inguinal Hernia – An inguinal hernia shall be considered a work injury only if it is precipitated by an impact, sudden effort, or severe strain and meets, after investigation, all of the following conditions :

a) there is clear evidence of an accidental event or an accident, such as a slip, trip or fall, sudden effort or over-exertion;

b) the immediate pain was so acute that the injured employee was forced to stop work long enough to draw the attention of his foreman or fellow employees, or the attention of a physician was secured within 12 hours.

Back Injury – A back injury or strain shall after investigation, be considered a work injury if :

a) There is clear evidence of an accident event or an incident such as slip, trip or fall, sudden effort or over-exertion, or blow on the back ; and

b) A medical practitioner, authorised to treat the case, is satisfied after a complete review of the circumstances of the accident or incident that the injury could have arisen out of the accident or incident.

Aggravation of Pre-existing Condition – If aggravation of pre-existing physical deficiency arises out of or in the course of employment, the resulting disability shall be considered a work injury and shall be classified according to the ultimate extent of the injury except that if the injury is an inguinal hernia or a back injury, the requirement of 5.2.2 or 5.2.3 shall apply.

Aggravation of Minor Injury – If a minor injury is aggravated because of diagnosis or treatment, either professional or non-professional, or if infection or other symptoms develop later, either on the job or off-the-job the injury shall be classified according to its ultimate extent.

Cardiovascular Diseases – This term is used to cover the following groups.:-

a) Rheumatic heart disease,
b) Hypertensive disease,
c) Ischemic disease,
d) Heat disease secondary or pulmonary disease,
e) Cerebrovascular disease,
f) Diseases of arteries, arterials and capillaries, and
g) Disease of veins and lymph vessels.

Cardiovascular diseases shall not be recorded as work injuries unless:

a) the symptoms were so severe during working hours that the attention of a supervisor was drawn to them; and
b) a medical practitioner, authorised to treat the case, satisfied after a thorough investigation, of the circumstances, that the disease or aggravation of the disease was work caused.

Miscellaneous – The category includes the following :-

a) Purposely inflicted injuries – An injury purposely inflicted by the employee or another person shall be considered a work injury if it arises out of or in the course of employment;
b) Skylarking – An injury inflicted by or arising out of skylarking during employment shall be considered a work injury.

Other Disabilities – The following are examples of injuries which shall be considered work injuries if they arise out of or in the course of employment :-

a) Animal and insect bites;
b) Skin irritations and infections;
c) Muscular disability;
d) Injuries arising from exposure to extreme temperature (hot or cold); and
e) Loss of hearing, sight, taste, feel or sense of smell.

4. COMPUTATION OF FREQUENCY, SEVERITY AND INCIDENCE RATES

4.1 Frequency Rate – The frequency rate shall be calculated both for lost time injury, reportable lost time injury as follow :-

$$FA = \frac{\text{Number of Lost time injury} \times 1,000,000}{\text{Man hours – worked}}$$

$$FB = \frac{\text{Number of reportable lost time injury} \times 1,000,000}{\text{Man hours worked}}$$

Note 1: If the injury does not cause loss of time in the period in which it occurs but in a subsequent period, the injury should be included in the frequency rate of the period in which the loss of time begins.

Note 2 : If an injury causes intermittent loss of time, it should only be included in the frequency rate once, that is, when the first loss of time occurs.

Eg1 :

In a factory the no. of reportable accidents in a year are 8, total man hours worked in that year are 2 million, the FR is :

Solution :

$$FR = \frac{\text{Number of reportable lost time injury} \times 1,000,000}{\text{Man hours worked}}$$

$$FR = \frac{8 \times 1,000,000}{2,000,000}$$

FR = 4

Note 3 : Severity Rate – The severity rate shall be calculated from man-days lost both for lost time injury and reportable lost time injury as follows :-

$$SA = \frac{\text{Man-days lost due to lost time injury} \times 1,000,000}{\text{Man-hours worked}}$$

$$SB = \frac{\text{Man-days lost due to reportable lost time injury} \times 1,000,000}{\text{Man-hours worked}}$$

Note : Since severity rate SB is based on the lost time injuries reportable to the statutory authorities, it should be used for official purpose only. In all other cases severity rate SA should be used for comparison purposes.

Example 2 :

In a factory the no. of man-days lost due to reportable accidents are 100, total man-hours worked in that year are 2 million, the Severity Index is

Solution :

$$SI = \frac{\text{Man-days lost due to reportable lost time injury} \times 1,000,000}{\text{Man-hours worked}}$$

$$SI = \frac{100 \times 1,000,000}{2,000,000}$$

SI = 50.

Calculation of man-days lost under 6.2 shall be based on the following :-

a) Man-days lost due to temporary total disability ;

b) Man-days lost according to schedule of charges for death and permanent disabilities as given in Appendix A. In case of multiple injury, the sum of schedule charges shall not be taken to exceed 6 000 man-days.

c) Days lost due to injury in previous periods, that is, if any accident which occurred in time in the period of still causing loss of time in the period under review, such loss of time is also to be included in the period under review;

d) In the case of intermittent of time, each period should be included in the severity rate for the period in which the time is lost; and

e) If any injury is treatment as a lost time injury in one statistical period and subsequently turns out to be a permanent disability; the man-days charged to the injury shall be started from the Schedule charge for the injury when permanent disability becomes known.

4.2 Incidence Rates

General incidence rate is the ratio of the number of injuries to the number of persons during the period under review. It is expressed as the number of injuries per 1000 persons employed.

The incidence rate may be calculated both for lost time injuries and reportable lost-time injuries as follows :-

$$\text{Lost time injury incidence rate} = \frac{\text{No. of lost time injuries} \times 1,000}{\text{Average number of persons employed}}$$

$$\text{Reportable lost time injury Incidence rate} = \frac{\text{No. of reportable lost time injuries} \times 1{,}000}{\text{Average number of persons employed}}$$

Note : Since reportable lost-time injury incidence rate is based on the lost time injuries reportable to the statutory authorities, it should be used for official purpose only. In all other cases, lost time injury incidence rate should be used.

Statistical Period – Rates for any period, that is months and which have not already been included in earlier calculations.

An injury which occurred in a previous period and which did not cause lost time at the time of occurrence, but caused lost time in the current period, shall be included as a lost-time injury in the current period.

When calculating duration rates, the time lost for the period shall include time lost in the current period caused by injuries which occurred in previous period.

Reporting Of Near Miss & Learning Lessons

Any accident causing physical injury whether major or minor is usually reported, since in most of such cases, medical assistance is sought. Near-miss accidents being no injury incidents, there is nothing to record other than "event just missed or very close to result in a serious injury or damage". Hence, there is very little chance of such incidents getting reported. Such incidents unlikely get any serious attention, and are very large in number, i.e. as per Henreich Theory, in a unit group of 330 similar type of incidents with the same person, such number of incidents (i.e. near-miss) will be 300 in comparison with the one major and 29 minor incidents. Basic philosophy of accident prevention states that cause of injurious accident (i.e. incident which results in injury) and cause of non-injurious accident (i.e. incident which does not result in injury) are the same. Hence, any number of near-miss accidents will be equally helpful to reveal the factors which something went wrong resulted in the near-miss and under slightly changed condition it could have resulted in injurious accident. This lesson is very much useful towards accident prevention approach.

Circulation of near-miss accident report will caution people working around. Line of thinking of person involved in the incident and just saved from injury likely to be in one direction. Others can think freshly with different views. These views or conclusions may suggest some measures for prevention of accident. Accident prevention measure based on conclusion with very few cases of reported accidents will serve limited purpose since data is not sufficient. Large amount of useful information behind near-miss accident cases remains unattended.

Often people hesitate to report near-miss cases. There is a tendency to cover-up or hide near-miss which is harmful for accident prevention programme. This might be due to wrong accident reporting and investigation procedure which is more inclined to blame person rather than to look for real causes. People should be encouraged to share their experiences freely with others for common benefit.

5. TECHNIQUES OF IDENTIFICATION OF HAZARDS

INTRODUCTION

A situation, condition or activity which has the capacity to result in an accident or injury is termed as a 'Hazard'. Elimination or control of hazardous situations calls for the deployment of systematic and established techniques, development of special skills and above all team effort by employees and management. Identification and appraisal of hazards and evaluation of the severity of accident problem is one of the basic functions in the process of rendering the work methods and environment safe in industry. Hazard identification helps in correcting accident provocative situations in every stage of a product's manufacturing cycle, from design to dispatch. It also looks beyond to ensure user's safety during its use in its life time. It is obvious that before hazards can be controlled, they must be discovered. There are a number of ways to discover hazards in work situations: Monitoring – Observation and data collection – is a core activity almost in all the hazards identification techniques. Safety surveys, plant safety inspections, accident investigation, job safety analysis, etc. are useful techniques for identification and control of hazards in industry.

Hazard Analysis

Hazard analysis is systematic process aimed at acquiring specific information about hazards and failures pertinent to a given system. It involves two analytical methods namely, inductive method and deductive method.

Inductive Method

The inductive analytical method uses observable data to predict what can happen. It postulates how the component parts of a system will contribute to the success or failure of the system as a whole. Inductive analysis considers a systems operation from the standpoint of its components, their failure in a particular operating conditions, and the effect of that failure on the system. The inductive method forms the basis for such analysis as Failure Mode and Effect Analysis (FMEA) and construction hazard analysis (CHA).

In failure mode and Effect Analysis, the failure or malfunction of each component is considered, including the mode of failure. The effects of the hazard that led to the failure are traced through the system and the ultimate effect on the task performance is evaluated. However, because only one failure is considered at a time, some possibilities may be overlooked.

Once the inductive analysis is completed and the critical failures that require further investigation are detected, then the fault tree analysis will facilitate an inspection.

Job Safety Analysis (JSA) is an inductive method used for hazard identification and analysis. JSA is discussed later in this paper.

Deductive Method

If inductive analysis tells us what can happen, deductive analysis tells us how. It postulates the failure of the entire system and then identifies how the components could contribute to the failure. Deductive methods use a combined – events analysis, often in the form of trees. The positive tree calls for stating the requirements for success.

Fault trees are reverse images of positive trees and show ways troubles can occur. An undesired event is selected. All the possible happenings that can contribute to the event are diagrammed in the form of a tree. The branches of the tree are continued until independent event. The fault tree requires rigorous, through analysis; all known sources of failure must be listed. The fault tree is a graphic model of the various parallel and sequential combinations of system component faults that my result in a single selected system fault.

What is a Job Safety Analysis?

It is an organised look at what, in your work activities and workplace, could cause harm to people. This will allow you to weigh up whether you have taken adequate precautions or should do more to avoid harm. The important things you need to decide are whether a hazard is significant and whether you have covered it by satisfactory precautions so that the risk is acceptably low.

Job Safety Analysis should assess the risk that may be present in all work activities, and may identify particular areas for more detailed 'specific' assessments.

Why is Job Safety Analysis Necessary?

All employers have duty of care to individuals, staff, contractors or third parties in the workplace. Failure to take reasonable steps to ensure their health and safety could result in legal action being taken against the employer for negligence or specific action being brought under local Occupational Health & Safety legislation.

A Job Safety Analysis must be undertaken to identify risks to health and safety and control measures must be taken to manager those risks.

Evidence is required to be kept in the form of reports which document the identified hazards and controls and regular updates must be produced which document the actions being taken to implement those controls.

Who Should Perform a Job Safety Analysis?

Essentially, individuals who are familiar with the working area and working practices should be involved with the Job Safety Analysis process. All peripatetic workers (workers who work away from a principal base) should be able to assess their own work activities. Assessors are responsible for developing a Job Safety Analysis plan for their area of responsibility, and completing assessment in accordance with this plan.

How often should a JSA be done?

Job Safety Analysis should be undertaken at least once a year provided that no changes in working practices or environment have occurred during this time.

When changes have been made - even small changes - a new Job Safety Analysis must be performed to check whether risks to health and safety have changed.

How Job Safety Analysis is Performed

There are Eight steps to performing a satisfactory Job Safety Analysis

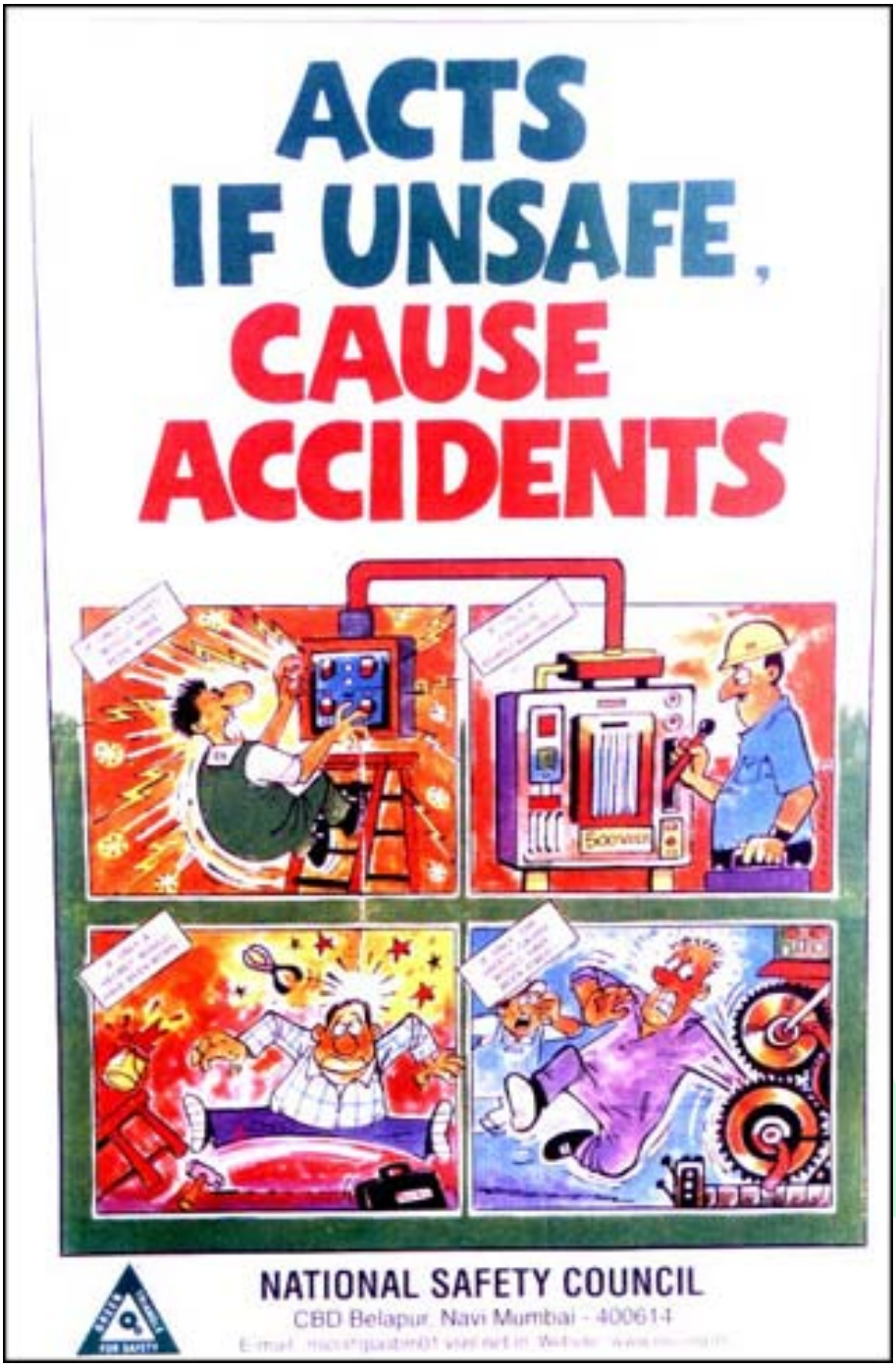
1. Focus for assessment	A risk assessment is not a theoretical exercise. However, much work can be done on paper from the knowledge you, your employees or their representatives have of the workplace. A tour of the workplace will be needed to confirm, amend or add detail to your initial views.
2. Identify activities	To identify all potential safety hazards in the workplace, you should first look at all activities that are carried out. Don't just look at routine daily operations - consider all possible activities, including occasional maintenance and visits to the workplace by third patties.
3. Identify hazards	Make a list of all hazards that are likely to occur for each activity. Ignore the trivial and concentrate on significant hazards. Consider hazards that may not be associated with particular activities - e.g. fire.
4. Who is at risk	Decide who (e.g. employees, contractors, visitors etc) might be in danger in the workplace, and note their location in relation to first aid resources and evacuation routes.
5. Evaluate risk	Evaluate the risks arising from the hazards and decide whether your existing safety control measures are adequate or whether more should be done to get rid of the hazard or to control the risks.
6. Review controls	Look at the existing control measures that you have in place for each identified risk and assess whether it is adequate and whether more could be done to improve their implementation. Consider whether new controls need to be introduced.
7. Record Decisions	**Produce a JOB SAFETY ANALYSIS report**, recording your findings and details of the action you took as a result. Tell your employees about your findings by distributing or publishing your report. Prepare an emergency plan. Inform, instruct and train employees in Health & Safety procedures, including first aid.
8. Review Regularly	Keep the assessment under review and revise it when necessary. Any material change in processes equipment or manpower should prompt you to consider the need for a new job safety analysis

It is important that you carry out your job safety analysis in a practical and systematic way. It must take the whole of the workplace into account, including outdoor locations and any rooms and areas which are rarely used. If your workplace is small you may be

able to assess the workplace as a whole. In larger buildings, you will often find it helpful to divide the workplace into rooms or a series of assessment areas using natural boundaries, e.g. process areas, offices, stores, workshops as well as corridors, stairways and external routes.

Applicable Hazard Identification Techniques with respect to the state of operation

Project Phase	Selected HI Techniques
Research and Development	What-If Analysis
Conceptual Design	Preliminary Hazard Analysis
Pilot Plant Operation	HAZOP Analysis
Detailed Engineering	Fault Tree and Event Tree Analysis
Construction/Start-Up	Checklist Analysis and Safety Review
Routine Operation	HAZOP Analysis
Plant Expansion	Relative Ranking and HAZOP Analysis
Incident Investigation	FMEA and HRA
Decommissioning	What-If/Checklist Analysis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