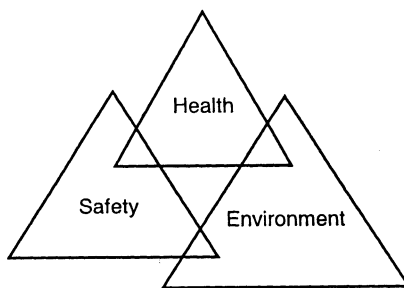


1

Safety, Health and Environment Management Systems

1.1 NEED FOR INTEGRATION OF SAFETY, HEALTH AND ENVIRONMENT (S, H & E)

Present-day industries are becoming more and more complex because they have to meet the requirement of increased production rate, high efficiency and optimisation. Huge investments are incurred. Any negligence at any stage from concept stage to design, erection, operation can result into disaster, loss of human lives and huge production losses, etc. Accordingly safety aspects deserve serious attention. Today safety is an integral part of any industry. Even if a single employee neglects safety aspect, it can lead to serious problem for everybody. It is, therefore, essential that foolproof safety systems be designed and incorporated, people trained adequately, checks and counterchecks made to ensure implementation of safety. As losses due to any accident can be surmountable, it is important that top management gets involved and shows full commitment towards implementation of safety. In present context it is not only sufficient to take care of safety but other two interrelated aspects, *viz.*, health (well-being of employees) and environment are also attached equal importance and consideration. All these three elements are interrelated and affect each other. For instance, if health of employees is not given due regard, it may lead to accidents. If industry pollutes the environment around work place, it will ultimately affect health of employees which may ultimately affect production. Each industry has certain obligations towards keeping good environment and also towards health of people. It is only if health and environment are in control that safety in industry can be ensured.



Showing Interrelationship and Interlinking between safety, health and environment.

Safety being a complex mechanism, necessary documentation has to be evolved, checklists prepared and system be designed to ensure implementation of all safe procedures and practices. The safety systems may have to be reviewed from time to time and updated. Necessary audits should be carried out. Safety head should report direct to top management and safety need not be compromised at any cost.

All employees should be made aware of keeping good health. Any conditions which can spoil health of employees should be corrected/eliminated. All employees should be subjected to

medical tests periodically to check their health. They should be trained to take care of their health by controlling their diet, doing regular exercises, yoga, pranayam, and adopting other naturopathy techniques. They should be encouraged to change their lifestyle to be in harmony with nature. Creating awareness of health will ultimately benefit industry because employees will remain alert and contribute their best to industry and boost productivity.

Many industries have a feeling that any money invested in checking pollution of environment is not productive for them. But in the long run, polluted environment will not only affect the performance of industry but life of everybody will become miserable due to poor health which in turn will affect safety. Realising this, standards have been prepared to enable industries to take care of and control the safety, health and environment ; all these three elements being interrelated. Throughout the world, people are concerned about safety, health and environment. With experience of several accidents in past, considerable public and governmental concern has been aroused for evolving appropriate strategy for identifying, assessing and controlling industrial accidents. Most of the industries being prone to safety hazards and environmental degradation, utmost precautions are needed to have full control over S, H & E.

1.2 COMMITMENT OF TOP MANAGEMENT IN SAFETY, HEALTH AND ENVIRONMENT POLICY

In the industries, Safety, Health and Environment management is considered as an integral part of overall management systems. Management's responsibilities include vision, establishing systems, setting the expectations, assessing performance, improving effectiveness, encouragement for doing things safely, prompt action for deficiencies, and allocating resources for responsible operation. The management should involve all employees, contractors, security personnel and business associates related to operation in the safety culture. Commitment of top management towards safety, health and environment is essential and this message should flow to all organisational levels.

Separate manuals for safety, fire, health and environment management need to be developed. The policy should be approved by the Board of Directors and be updated periodically and made available to all employees. The intentions and commitments on part of top management should be clearly specified.

For safety, separate committees need to be set up at management and shop-floor level. Management Safety Committee should be headed by unit head/location incharge. Workmen representative should be included in the committee. 50% of the members of each Shop-floor Safety Committee should be workmen. Management Safety Committee should review safety performance, audit reports, incident investigations, recommendations to the shop-floor committees, status of fire fighting and safety equipment and compliance of statutory rules/regulations. Shop-floor Safety Committee should deliberate hazards involved in operation, performance of safety systems, lessons learnt from past incidents/near-misses, training etc. and suggestions for improvement in safety standards.

Surprise safety checks, particularly at odd-hours, should be carried out and findings recorded. Punitive scheme may be devised for violation of safety procedures and non-compliance of Personal Protective Equipment. Safety promotional activities like display of safety posters/precautions and safety records at prominent locations, publication of safety newsletter bulletins, safety talk to contractors labourers, safety competition, etc. should be encouraged. Safety awareness survey should be carried out once a year and input provided to improve safety awareness.

1.3 ENSURING PARTICIPATION OF EMPLOYEES IN DEVELOPING S, H & E POLICY

Employees participation and involvement in development and implementation of the S, H & E Management system is essential. It must be remembered that a group decision is always considered to be a better decision than that of an individual, and is thus better implementable.

Plant manager should be given overall responsibility for the implementation of the Employee participation and to ensure that Process safety information, process hazard analysis reports, Incident investigation reports and Audit/Corrective action reports are made available to the affected employees or contract employees for proper dissemination of information.

Initial training on safety aspects to all has to be ensured. Structured training on safety, hazards and emergency response should also be imparted.

It should be ensured that no employee performs work for which he has not received appropriate training. Employees should be encouraged to look for and report potential hazards and to suggest ways to control and/or eliminate them.

Effective and continuing leadership at all level of participation is required. Each employee should be encouraged to observe all relevant S, H & E rules and regulations, actively participate in all promotional activities, report unsafe act and situation and active cooperation in mitigating the same.

Formal risk analysis should be conducted for all processes. One or more operation personnel familiar with the process being studied should be included in the HAZOP analysis. Hazardous processes and materials are identified in the Factories Act-1948, and specified as such by Risk Analysis for identifying : (a) The hazards of the process ; (b) Any previous incident with a likely potential for catastrophic consequences in the workplace ; (c) Engineering and administrative controls to provide early warning of releases ; (d) Consequences of failure of such controls ; (e) Facility siting ; (f) Human factors ; and (g) A qualitative evaluation of the range of possible safety and health effect of failure controls. •

Reliability of critical system and devices has to be ensured

Maintenance and inspection personnel should be involved in the implementation of mechanical integrity programme through normal work activities, including development of written maintenance procedure, training for process maintenance activities, inspection and testing, correction of deficiencies in equipment that are outside acceptable limits defined by the process safety information, and assisting in the implementation of the quality assurance programme. Maintenance personnel should also be trained on the potential hazards associated with the process and chemicals to which they may be exposed.

Operation & maintenance personnel should be involved in the development, review, modification, and use of operating procedures and they should operate and maintain processes in accordance with documented operating, inspection, testing and maintenance procedures.

Employees should be encouraged to support good health by cooperating with occupational health and hygiene physician in conducting various activities under occupational health monitoring, and maintaining healthy hygiene in workplace by observing and encouraging best practices.

A strong sense of environmental conscience needs to be developed amongst all the employees through educative and promotive programmes on regular basis. All employee should actively contribute towards sustainable development by safeguarding the workplace and the environment through compliance of relevant rules and regulations.

1.4 SAFETY, HEALTH AND ENVIRONMENT POLICY

S, H & E Policy as adopted by Indian Oil Corporation is reproduced below :

We are committed to conduct business with strong environment conscience ensuring sustainable development, safe workplaces and enrichment of quality of life of Employees, Customers and the Community. We believe that good S, H & E performance is an integral part of efficient and profitable business management. We shall :

- Establish and maintain good standard for safety of the people, the processes and the assets.

- Comply with all Rules and Regulations on Safety, Occupational Health and Environmental Protection.
- Plan, design, operate and maintain all facilities, processes and procedures to secure sustained Safety, Health and Environmental Protection.
- Remain trained, equipped and ready for effective and prompt response to accidents and emergencies.
- Welcome audit of our S, H & E conduct by external body, so that stakeholder confidence is safeguarded.
- Adopt and promote industry best practices to avert accidents and improve our S, H & E performance.
- Remain committed to be a leader in Safety, Occupational Health and Environment Protection through continuing improvement.
- Make efforts to preserve ecological balance and heritage.

1.5 FUNDAMENTALS OF SAFETY

Industrial work is full of hazards. It is necessary to take precautions with a view to ensure safety of the plants, machinery and the human beings.

Accidents in industry are very costly. Injuries to the workers cannot be compensated. An accident may lead to :

- (a) Injury or even death of a worker.
- (b) Damage to the plant and equipment.
- (c) Disruption of production schedules.
- (d) Lowers morale of personnel.
- (e) Prolonged absence of trained worker for treatment.

Accident may occur due to :

- (a) **Human Error.** Eighty-eight per cent accidents are caused due to UNSAFE PRACTICE, lack of foresight, wrong attitude etc.
 - (b) **Mechanical Failure.** Ten per cent accidents are caused due to plant condition, equipment or tool failure.
 - (c) **Acts of Nature.** Only two percent accidents are caused due to weather, flood or cyclone.
- It is necessary to eliminate unsafe acts and unsafe conditions to avoid accidents.

1.6 IMPORTANT POINTS FOR CONSIDERATION FOR SAFETY

- Prevention of accidents requires the wholehearted co-operation of all members of the organisation. A capable mentally alert employee will avoid accidents. An unsafe person is a liability to the company. Such person is danger to self, fellow workers, the public and to the general environment.
- Accident Do not “Just Happen” – Accidents are the result of unsafe acts or unsafe conditions or a combination of both.
- Unsafe Acts, which cause majority of accidents, include the following :
 - (a) *Operating without authority or warning* such as closing switches, operating valves without authority and proper line up, operating hoists and cranes without warning, failure to block or guard equipment against unexpected movement, failure to place caution boards or signal persons where needed.

- (b) *Operating or working unsafely* such as driving too fast, throwing material or tools at other workers, jumping from vehicles or platforms, or unnecessary haste.
- (c) *Making safety devices inoperative* such as using oversize fuses, blocking safety valves, defeating or bypassing interlocks.
- (d) *Using unsafe equipment or using equipment improperly* such as using dull cutting tools or mushroom-head chisels, pipe extensions on wrenches not designed for them, using excess leverage instead of hand force where required, wrong tool for the job, using hands instead of hand tools. Tools without proper insulation or defective tools.
- (e) *Unsafe loading, placing or mixing* such as overloading cranes and winches, carrying too heavy a load, leaving objects where they are likely to fall, improper packing, combining chemicals to form a dangerous mixture.
- (f) *Acquiring unsafe position or posture* such as walking under suspended loads or too close to openings, lifting while in awkward position, riding on running boards or other unsafe places on vehicles.
- (g) *Working on dangerous equipment* such as cleaning, oiling or adjusting moving machinery and working on live electrical equipment that could conveniently be de-energised.
- (h) *Distracting, teasing, startling* such as practical joking, horseplay quarrelling or annoying.
- (i) *Failure of use of personal Protective Equipment (PPE) or safe clothing* such as failure to use rubber gloves on energised equipment, and failure to use goggles, helmet, safety shoes, gas mask, respirator or gloves when necessary and wearing loose sleeves, neckties or jewellery near moving machinery.
- (j) Use of rings in fingers, carrying metallic pen, wristwatch, coins, keys in the pocket while working inside any panel, open tank, exposed equipment etc.
- (k) Use of jhoola while working at height.

Unsafe conditions that may result in accident include the following :—

- (a) *Unguarded equipment* such as unshielded moving parts of machines, saws, compressor belts, etc., un-barricaded floor opening and excavations, and high voltage circuits which are unisolated, live, unguarded and without caution notice plates.
- (b) *Defective material or equipment* such as mushroomed chisels, split handles, poorly constructed scaffolding, damaged tools, electrical hand tools without proper insulation.
- (c) *Improper illumination* such as insufficient light or unsuitable location of lamps producing glare or objectionable shadows.
- (d) *Unsafe design and construction.* Structures like platforms, scaffoldings should have large safety factors and their construction and design in general should incorporate safety features. All anticipated hazards should be pointed out to workers.

1.7 GENERAL INSTRUCTIONS FOR SAFETY

(i) Responsibilities of Supervisors

Divisional heads, departmental heads, line engineers and other supervisors have the definite responsibility of ensuring the following :

- (a) Safe working conditions.
- (b) Necessary protective equipment and its use.
- (c) Properly maintained tools and equipment.
- (d) Properly planned work performed in a safe manner.

- (e) Application of the general and special safety instructions by their workmen.
- (f) Assignment of employees to jobs which they are capable of doing safely.
- (g) Immediate steps to correct any violation of safety rules observed or reported to them.

Supervisors will be held responsible for seeing that work under them is done in a safe manner. Each supervisor, should make certain that his men understand the following :

- (a) Work to be done.
- (b) Hazards that may be encountered.
- (c) Proper procedure for doing the work safely.

Frequent periodic inspections of construction, operation and maintenance equipment, materials, work areas, conditions and methods should be made by supervisors as a part of their routine duty. Such inspections are essential to prevent fires and accidents.

(ii) Responsibilities of individuals

- (1) An individual's definite responsibility is to act so as to provide
 - (a) Safety to himself
 - (b) Safety to his fellow employees
 - (c) Protection to the public
 - (d) Protection to the company property
 - (e) Protection to the general environment.
- (2) Every employee is expected to study the Safety Manual, familiarise with its contents and apply them. Ignorance of rules and regulations will result in accidents to self and co-workers.
- (3) Whenever in doubt regarding any rules and regulations, employees should consult their Engineer or Supervisor.
- (4) Before attempting any work under conditions that is considered to be unsafe, employees are required to call these conditions to the attention of the person-in-charge of work and seek his/her advice.
- (5) It will be the duty of every employee to report promptly to his/her Engineer or Supervisor any dangerous or improper condition of company apparatus or equipment, which comes to his/her notice.

(iii) Personal Conduct

- (1) Use of intoxicating liquor and drugs while on job is strictly prohibited. No employee should report for work while under the influence of liquor, and no Engineer or other Supervisor and Security on duty should knowingly permit a person to go to work while under the influence of liquor/drugs.
- (2) Practical joking and horseplay or gossiping while on the job is strictly prohibited.
- (3) No employee should distract the attention of another worker from his job unless he thinks that the worker is doing something, which is dangerous or risky either to self or equipment.
- (4) Any employee who endangers own or others' safety and lives by violating the foregoing requirements of personal conduct should be rendered liable to disciplinary action.
- (5) Security on duty should not allow any person under the effect of liquor/drugs to enter the company premises.

(iv) Personal Caution and Self Awareness

It is in workman's own interest to exercise utmost personal caution as indicated below so as to prevent accidents and injury.

- (1) Every employee should consider the result of each act and no chances should be taken that will endanger either workman's own or other employees' lives.
- (2) **Always Be Careful (ABC)** ; the workman should place himself in a safe position while working to avoid falling, stumbling, slipping or moving backwards against live parts.
- (3) The workman should satisfy regarding the safe working conditions before starting the work. The care exercised by others should be checked.

(v) *Physical Fitness*

- (1) Before and during employment, every employee should be given a physical examination and must be certified by the company's Medical Officer as being physically qualified for the work he/she is expected to do.
- (2) Any employee who is unable to perform duties due to illness or other disability should promptly report the condition to immediate supervisor.
- (3) After absence from work due to illness or injury, an employee may be required to pass a physical examination to determine fitness for duty.

(vi) *Reporting Hazardous Conditions or Practices*

- (1) All hazardous conditions should be reported to the Supervisor and engineer on duty.
- (2) Hazardous conditions should be eliminated as soon as they are discovered. Where a hazard cannot be removed, taking reasonable and proper precautions can prevent accidents.

(vii) *Accident Reports, Records and Investigation*

- (1) Accident records are essential to the prevention of accidents. They show the type of accidents most frequently encountered where they occur and their relative severity. A study of these records will emphasise common hazards, and prompt a better understanding of the causes of accidents and most effective methods for preventing them.
- (2) All accidents which result in injury or not or however small the accident may be shall be promptly reported to Engineer or Supervisor and operation Engineer on duty. Many near misses/near accidents, which are not reported, recur with serious injuries.
- (3) All accidents to the public involving company personnel, equipment or property should be reported promptly.
- (4) Accidents should be investigated to determine the cause and what steps are needed to prevent a recurrence. It shall be the responsibility of the person-in-charge of the job to get a complete, detailed story of the accident as soon as possible after it occurs.
- (5) Accidents, whether they result in personal injury or not, should be promptly investigated by the Divisional Head.

1.8 CREATING AWARENESS ABOUT PROCESS SAFETY

Process safety is defined as the operation of facilities that handle, use, process or store hazardous materials in a manner free from episodic or catastrophic incidents. Knowledge of chemicals, process and plants is one of the prime assets and is required for developing other modules of the management system—process hazard analysis, operating procedures, training emergency preparedness plans etc.

Complete and accurate written information is required to be compiled for the following three categories :

Process Chemicals. Hazardous/non-Hazardous category of chemicals shall be defined. Data for all process chemicals (raw materials, intermediates, products and chemicals) pertaining to process chemicals shall help in assessing fire and explosion characteristics, reactive hazards, safety and health hazards to workers and the corrosion and erosion effects on the process equipment. For each process chemical, information in respect of (Physical properties, Boiling point, Vapour Pressure, Melting/Freezing point, Vapour Density and Specific Gravity) is required.

In addition information on fire and explosion hazards : (Flash point, Auto-ignition Temperature, Explosive limits and Burning rate) ; Reactive hazards [The tendency of the material to react violently when subjected to heat or the presence of other process chemicals, water, air (oxygen) or other possible contaminates] ; Hazardous combustion/decomposition products ; Health Hazard Data, [Personal exposure hazard properties (long term and short time), Information on toxicity of the material and exposure limit values such as Threshold Limit Value (TLV), Short Term Exposure Limit (STEL), Permissible Exposure Limit (PEL), Lethal Dose 50 (LD₅₀) etc.] also need to be maintained.

Process Technology. Process technology information should include : (a) Written process descriptions, (b) Process chemistry, (c) Process Flow Diagrams (PFD), (d) Safe operating limits of process parameters like pressure, temperature, flow rate etc. and the consequences or results of deviation that could occur if operating beyond the established process limit, (e) Maximum inventory level for process chemicals, and (f) Material and energy balances.

A process flow diagram (PFD) shows major process equipment, valve on pipelines. Flow rates, pressures, temperature and stream composition may be indicated for better clarity. Process flow diagrams (PFD) are more elaborate than block flow diagrams.

Piping and Instrument Diagrams (P & IDs) are the detailed representation of the plant. Each and every piece of equipment, pipelines, valves and instrument along with their interconnection are shown and are most appropriate to show relationship between equipment and instrument.

Process Equipment. Process equipment includes columns, vessels, heat exchangers, reactors, pumps and compressors, valves, piping, drilling rigs and work-over rigs, cross country pipelines, tanks, loading and un-loading facilities and other equipment that contains process chemicals. Design data of process equipment should be documented and should include the following : (a) Materials of construction, (b) Design specifications, (c) Codes, standards and industry accepted engineering practices used for design and fabrication, (d) Electrical classification.

Planning for Safety. First concern of any management in industry is to do business profitably. It is important for management to understand that safety, health programming and care for environment embraces profitable ways of operating effectiveness to achieve corporate goals. All these three aspects need to be integrated into total management programmes and objectives. Safety, health and environment are valuable and efficient business tools today.

Efficient production is the aim of industries to maximise profits. Efficient production requires facilities, equipment, materials, and personnel. It is the duty of management to supply these but in the process certain support services are also needed. All these support services have safety, health and environment aspects. Incorporating them into support services allows us to involve safety, health and environment at a function level, as an integral part of the operation. These three important functions thus need to be built into support services, organisational and personnel functions and then these need to be continually audited to ensure adequacy of controls. The company's involvement in safety, health and environment is essential.

The impact of industry on the environment comes in the form of noise, hazardous resistances, oil spills, ionising, nonionising radiation or thermal energy, polluting air, water or soil. These

sources must be identified and controlled, and the various programmes needed for this must be established and used.

Proper planning and organisation are essential for any effective safety, health and environment programme. Planning aspect involves appropriateness of programme, fixing responsibility and accountability of senior management, delegation of duties, identification of key personnel to carry out plan job descriptions prescribing relationships between management, staff and line personnel, means of measuring responsibilities, support of management, plans for identifying/controlling/auditing hazards, monitoring, information system, training, resources, and defining objectives.

Medical Services. Occupational health programme needs to be provided by management to deal constructively with the health of employees in relation to their work. Apart from curative medicine, health programme should also include prevention and maintenance of health.

With increasing use of synthetic chemicals in industry, it has become essential to make use of services of full time industrial hygienists.

Periodic health examination to detect underlying, potentially correctable diseases for early treatment is nowadays essential. All employees need to be trained, educated and motivated to use good health and safety practices both on and off the job.

Industrial hygienist must carry out work site inspection and monitor to detect and appraise health hazards, and make appropriate recommendations for corrective measures.

To reduce absenteeism during an epidemic, employees should be offered inoculations on company premises.

Special programme to tackle emotional problems, alcoholism, drug abuse, etc. should also be organised.

A great emphasis needs to be given on prevention and research programmes for keeping people healthy. Preventive medicine starts with health education, lectures/films, periodical examination, and health counselling services. Companies can provide facilities for employee physical conditioning programmes (gyms, tracks, athletic fields, swimming pools, yoga and meditation classes) for improved health and morale of employees which result in lower absenteeism and higher production. Wellness is not merely an absence of disease but the active pursuit of good health through improvement in lifestyle. If people are well, they are on the job and productive. Strategies directed to lifestyle improvement have been found to be more advantageous than efficient health care systems.

1.9 ACCIDENT CAUSATION

Accidents are preventable and an accident can be prevented if we understand the underlying causes of accidents in order to prevent future accidents. An accident can occur by any unplanned and uncontrolled event caused by human, situational or environmental factors, or any combination of these factors which interrupts the work process and which has potential to result in minor or major injury, illness, damage or undesired event. Any hazard can result in an accident and thus safety programmes are hazard control programmes.

An accident can occur by the unsafe act of a person or by existence of a mechanical or physical hazard. The motives or reasons that permit the occurrence of unsafe acts of persons provide a guide to the selection of appropriate corrective measures :

- Human error is often main reason for accidents. The three situations for human errors are
 - overload (mismatch between load and capacity of person at the time of action).
 - incorrect response by the person to a situation (insufficient training, fatigue, anxiety or other reasons could be responsible for this).
 - improper activity.

The basic reasons for operators to choose to perform the job unsafely are—priority system, pressure for meeting production deadlines, and peer influences.

The three interacting components in accident situation are men, machinery, and environment changes in any of three components or their interrelationships can alter the probability of occurrence of an accident.

1.10 HAZARD IDENTIFICATION

If hazards are identified, chances of occurrence of accident can be minimised. What is hazard—It is a workplace condition which exists or can be caused in combination with other variables, which has the potential for accidents, serious injuries, disease, and/or property damage. With hazard identification, the safety programmes and records can be improved. Examination of accident and injury records often points the way to where the efforts should be focussed.

Hazard identification analysis is a very careful study of all the components of a work system in order to detect problems, to understand the relationship between the system and the problem in order to eliminate the problem and its potential consequences.

There are several methods for hazard identification, each having its own contribution for specific tasks and hazard analysis. Most commonly used methods are :

(i) **Preliminary hazard analysis.** It serves as a guide for more in-depth analysis as more information becomes available. It focuses on what is already known about the product, process, or change to be made. It consists of formulating a list of hazards and asking simple questions in the form of what-if.... ?

(ii) **Failure mode and effects analysis.** It is adopted for safety analysis from reliability analysis of complex system. System is broken down into all its components and systematic evaluation of how components might fail, and what the effects of these failures might be, is done. This analysis requires a criticality rating for each failure mode depending on the degree of hazard posed by the failure. This method has demerit of not examining the linkage of components and the potential of human errors.

(iii) **Hazard and operability review (HAZOP).** Adopted widely by chemical plants to identify operation problems, HAZOP uses brainstorming techniques, encouraging involvement and innovation, and generates ideas for solutions.

(iv) **Fault tree analysis.** A deductive reasoning technique which assumes an undesirable event and proceeds in a logical manner to examine events or combinations of events which must precede the occurrence of the top event. It provides a graphic model that displays the various combinations of equipment faults and/or failures that can cause the top event. Such analysis is possible with complete and comprehensive understanding of the system/plant operation and various equipment failure modes.

Hazard control

Fig. 1.1 shows the elements involved in an effective hazard control system.

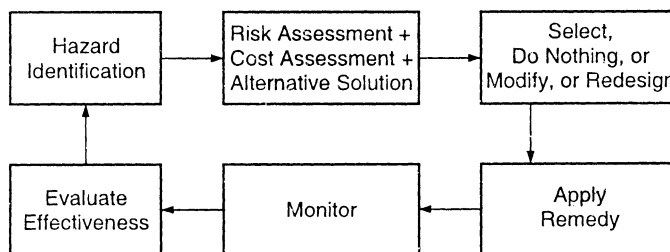


Fig. 1.1

Safety Programmes

The three phases of safety programme are

- (i) **Safety awareness.** Educational on job instructional training, behaviour, ergonomics, job safety analysis techniques.
- (ii) **Safety implementation.** By all concerned.
- (iii) **Safety programme preservation.** To maintain enthusiasm and energy levels which do not deteriorate with time.

1.11 ACHIEVING SAFE ENGINEERING DESIGNS AND PROCESSES

There are certain capabilities and limitations of both men and machines. Having understood these thoroughly, we can devise successful combinations of men and machines to perform appropriately to obtain safe designs and processes.

Characteristics of Men and Machines

Men excel in

- Learn by past experience and alter the course of action
- Ability to apply originality in problem solving by perceiving alternatives and deciding best option
- Ability to react to unexpected low-probability events
- Ability to improvise and adopt flexible procedures
- Ability to exercise judgement where events cannot be completely defined
- Ability to memorise lots of information for long periods and recall them at appropriate times
- Sensitivity to an extremely wide variety of stimuli
- Ability to perform fine manipulation

Machines excel in

- Ability to operate in hostile environments and do repetitive works untiringly
- Insensitivity to extraneous factors
- To do many things at a time
- Sensitivity to infrared and radiowave signals
- Ability to store and recall large amounts of information in short time periods
- Ability to respond quickly to control signals
- Perform routine, repetitive, precise and hard jobs
- Exertion of large force smoothly and with precision
- Performance of complex and rapid computation with high accuracy

1.12 INDUSTRIAL SAFETY PRACTICES

If accidents occur in an industry, it is indication of poor safety involvement of management. If safety programmes are operated in positive manner, accidents are bound to be prevented. Safety matters need to be analysed, appraised and considered within the routine of business management. Safety should appear as an integral part of the corporate system. While machinery safeguarding, safety devices, and personal protection equipment are essential for safety, human performance factor also deserves serious attention. Ergonomic factors which affect human performance should be thoroughly analysed and workers be given total information and knowledge about their role and how they have to perform their task. They must be very clear about the process and how they have to react under emergency situations.

The development and application of safety standards, codes and regulations enhances safety in workplace.