

1 (a) Write briefly on the history and development of occupational safety and health in India.

The development of occupational safety and health in India from ancient period are as follows:-

> 2000 B.C : The ruler Hammurabi developed a "code of Hammurabi" for all the laws of the land at that time.

With respect to safety & health, the code contained

(i) the clauses dealing with injuries.

(ii) allowable fees for physicians.

(iii) damages assessed against those who injured others.

One of the clause from the said code, will show that how much Hammurabi was concerned for the proper handling of injuries - "If a man has caused the loss of a gentleman's eye, his own eye shall be caused to be lost".

> 1500 B.C : During the construction of a huge temple in his name, the King Ramses created an industrial medical service to care for the workers. They were required to bathe daily in the 'Nile' river and were given regular medical examinations. Sick workers were isolated.

3) As civilization progressed, so did safety & health development

4) In 1567 :- Various treatises were published i.e ;

(i) The pulmonary diseases on miners.

- (iii) Diseases of smelter workers.
- (iii) Diseases associated with the handling of an exposure to mercury.
- (iv) The need for ventilation in mines.
- (v) The various devices, that could be used to introduce fresh air into mines.

5) 18th Century : B. Ramazzini - related the occupational diseases

- i) to the handling of harmful materials
- ii) to the irregular movements of body.

6) The Industrial Revolution : changed the methods of Producing the goods for ever. These are :-

- i) Introduction of steam power to replace man & animal Power
- ii) Substitution of machines for people.
- iii) Introduction of new methods for converting the raw materials.
- iv) Organisation & specialization of work - resulting in a division of labour.

2(a) List the various acts and regulations promulgated by Indian Parliament related to occupational safety and health

The various acts & Regulations promulgated by Indian Parliament related to occupational safety and health are:

Indian Environmental Acts

1948 → Factories Act

1956 → River Boards Act

1974 → Water (Prevention & Control of Pollution Act)

1977 → Water Cess Act

1980 → Establishment of Department of Environment

1981 → The Air (Prevention and Control of Pollution Act)

1982 → Department of Environment forest & Wildlife establishment

1984 → Minimal National Standards (MNS)

1986 → Environmental protection Act

1987 → Air (Prevention & Control of pollution Amendment Act)

1988 → Water (Prevention & Control of pollution) Amendment Act

1989 → Hazardous Waste (Handling & Management rules)

1991 → Public liability Insurance Act

1992 → National Environmental Tribunal bill & Environmental Audit notification.

1993 → Ecomark notification

1994 → Environmental clearance notification

1999 → Environmental (siting for industrial project rules)

Regulations.

1. The factories act 1948, amended 1954, 1970, 1976, 1987.
2. The mines Act, 1952
3. The Dock Workers (Safety, Health & Welfare act, 1986)
4. The plantation Labour Act, 1951
5. The explosives Act, 1884.
6. The Petroleum Act, 1934
7. The Insecticide Act, 1968
8. The Indian Boilers Act, 1923
9. The Electricity Act, 1910
10. The Dangerous machines (Regulations) Act, 1983
11. The Indian Atomic Energy Act, 1962
12. The Radiological Protection Rules, 1971

2(b) State different principles of safety as per Heinrich. Also explain Heinrich's triangle of damage level relationship.

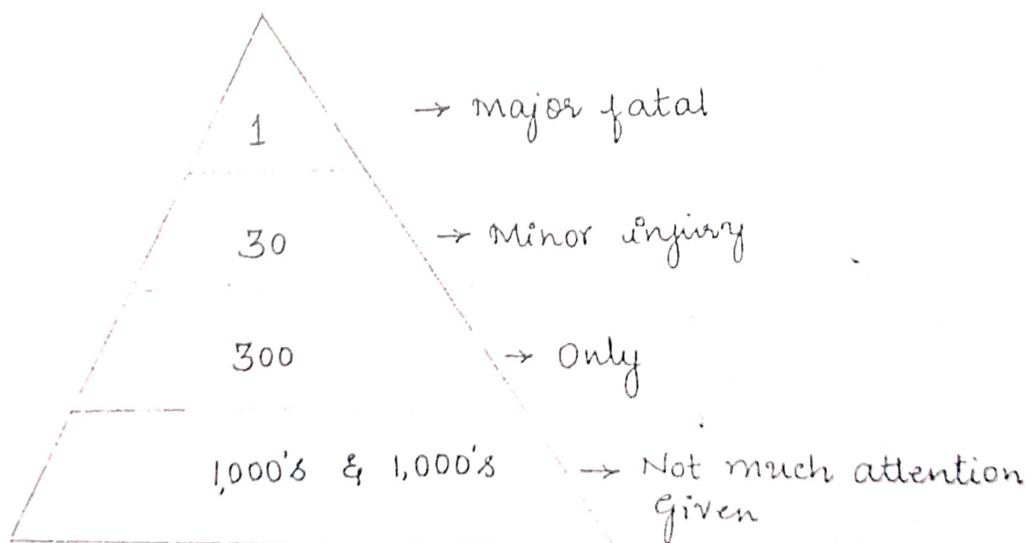
The four principles of safety as per Heinrich are:-

- 1) Hazard is an inherent part of human existence.
- 2) We cannot eliminate hazard but we can only contain, control & manage.
- 3) Accidents are not random happenings, but are patterned & have combination of causative factors.
- 4) All Accidents are caused either due to unsafe conditions or Unsafe acts or both.

Accidents by human error → 88%.

Accidents by Unsafe act → 10%.

Accidents by Nature → 2%.



3(a) Write briefly on 'Right to Know laws' and its advantages with respect to OSHA.

In recent years a great deal of time & money has been spent complying with hazard communication law better known as the Right-to-Know laws. Although there are many state & local laws, the oldest & best known is the OSHA Hazard Communication Standard enacted in 1983. This standard requires all companies & employers handling any hazardous substance in any form to assess the hazards associated with the substance in the work area & to inform workers of those hazards & to train them in safe handling procedures.

The Environmental Protection Agency (EPA) has also become involved with the Right-to-Know laws as a result of the Superfund amendments & Re-authorization act of 1986 (SARA-III), which requires companies to provide authorities with information concerning toxic chemical releases & other potential chemical hazards to the community.

SARA III also encourages emergency planning efforts in response to emergencies arising from chemical incidents.

All of the right-to-know laws have 3 primary objectives:-

- <1> The dangerous properties of materials used or produced in the workplace are determined.
- <2> Employees are to be trained in the recognition & safe handling of these materials.
- <3> The laws force companies to disclose the presence of hazard substance thereby making employees & others aware of possible dangers.

Compliance to OSHA hazard standard or SARA-III is expensive sometimes confusing & endless & steps should be taken to meet the requirements & do it on a cost-effective basis by using the following as building blocks :-

1. Hazard Determination :- the material safety data sheet (MSDS)
2. The Written program &
3. Training

M.S.D.S

An MSDS is a key for communication & compliance to right to know laws. Each M.S.D.S must identify particular material or mixture, its physical & chemical characteristics, any health hazard & other identifying criteria. Every company should develop an internal review process for MSDS forms received with orders to ensure that it contains the following minimum information

- 1> The chemical & common name of the hazardous substance & for a mixture the proportion of each chemical & its hazardous ingredients.
- 2> The hazards posed by the substance including potential for fire, explosion & reactivity.
- 3) Health hazards including symptoms of exposure & medical conditions aggravated by exposure.
- 4> Precautions for safe handling & use including procedures for cleaning up of spillages & leaks.

Written Program :-

All Employers use hazardous substance regardless of size, must comply with the written program requirement of OSHA's hazard communication std's.

This includes developing, implementing & maintaining a written hazard communication program. The program must describe the presence & location of hazardous substance in workplace, as well as identify the location & availability of the written program & where to find how to use MSDS labeling procedure & other matter related to Hazardous substance.

Training :-

Training is required by OSHA's hazard communication standard & other OSHA's std's & generally by other

right to know laws.

It is left to the description of individual companies to decide what training programs to introduce. The net result of this policy is to yield excellent well thought inexpensive training program which have been developed internally & therefore they are well trained to the need of individual companies. The training should be approach in a general fashion on the first day of the employment & then for specific assignment at the time of assignment & then annually. Training programs should include, lectures, group discussion & prepare presentations each of which can be supplemented by the use of slides or videos which are produced in house or purchased from outside. The choice are numerous but the goal is the same i.e. the safe handling of substances by employees.

3(b) Categorize types of accidents and their related causes.

The nature of accidents may vary from industry to industry. An employee may be caught in a machine while working on it. or he may fall against a machine or he may fall from a height while engaged on a particular task, or explosives used carelessly may explode.

These accidents may result in disablement or death. Depending upon the severity of the injury, the accidents may be typed as.

Major Accidents & Minor Accidents

An accident which result in a death or prolonged disability to the victim is a major one. A scratch or cut, which does not seriously disable one is a minor accident.

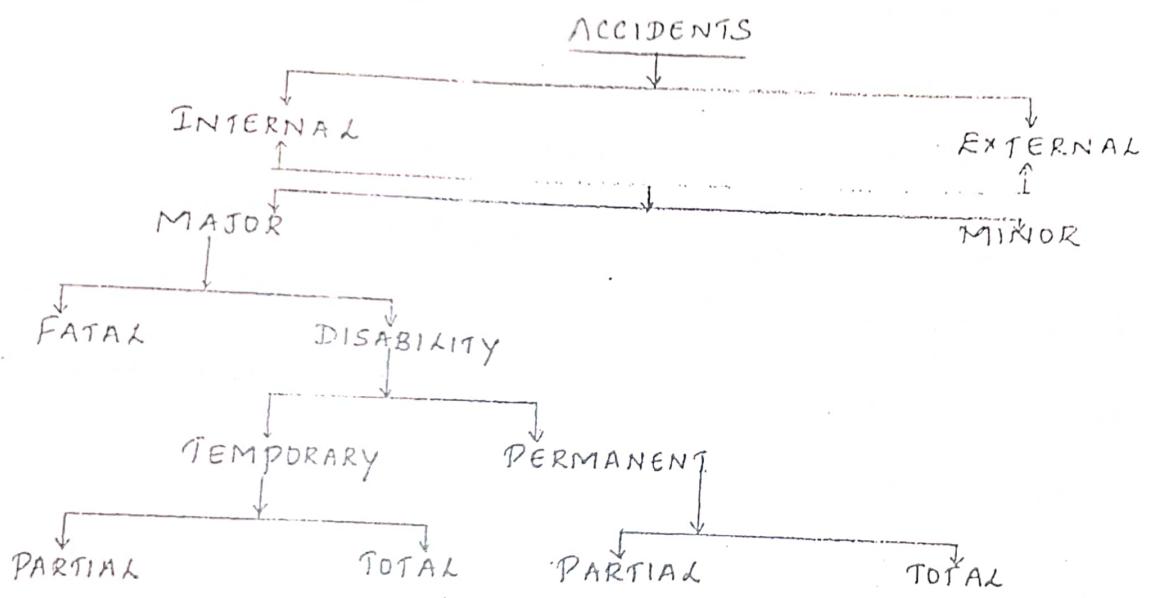
An accident may be Internal or External. If a worker falls or an object falls on him, it may not show signs of injury, but they may have fractured a bone or strained a muscle or nerve which is an internal injury. A deep scratch on the leg or shoulder may show sign of injury, which is an external injury.

A worker may be disabled by injury for a day

or week or month or a few months. If he recovers from such disability, his disability is temporary, but if the injury is such that he will never recover fully, his disability is permanent one.

A disability may be partial or total. An accident may be fatal or non-fatal.

The various types of accidents can be summarized as below



Accidents result from a variety of causes :-

Motor vehicle accidents :- Motor vehicle accidents are the leading cause of accidental deaths. They include deaths resulting from accidents involving mechanically or electrically powered vehicles (excluding rail vehicles) that occur on or off the road.

Falls :- This category includes all deaths from falls except

those associated with transport vehicles. For example, a person who is killed as the result of falling while boarding a bus or train would not be included in this category.

Poisoning :- The poisoning category is divided into two subcategories :

- 1) poisoning by solids and liquids, and
- 2) poisoning by gases & vapors.

The first category includes death that result from the ingestion of drugs, medicine, widely recognized solid and liquid poisons, mushrooms, and shellfish. It does not include poisoning from spoiled food or salmonella.

The second category includes death caused by incomplete combustion (for example, gas vapors from an oven or unlit pilot light) or from carbon monoxide (for example, exhaust fumes from an automobile).

In a typical year, there are approximately 6,000 deaths in the first category & 1,000 in the second.

Drowning : This category includes work-related & non-work related drownings but excludes those associated with floods or other natural disasters.

Fire-related Injuries :- This category includes deaths from burns, asphyxiation, falls & those that result from falling objects in a fire.

Suffocation :- This category includes deaths from the ingestion of an object that blocks the air passages. In many such deaths, the ingested object is food.

Firearms :- This category includes deaths that result when recreational activities involving firearms or household accidents involving firearms result in death. For example, a person killed in the home while cleaning a firearm would be included in this category.

Others :- This category includes deaths resulting from medical complications arising out of mistakes made by health care professionals, air transport injuries, interaction with machinery, mechanical suffocation, & the impact of falling objects.

Work Injuries By type of Accident

Work injuries can be classified by the type of accident from which they resulted.

The most common causes of work injuries are:-

- Overexertion
- Impact accidents
- Falls
- Bodily reaction (to chemicals)
- Compression

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- Motor Vehicle accidents
 - Exposure to radiation / caustics
 - Rubbing or abrasions
 - Exposure to extreme temperatures.

4 (a) Suggest an accident investigation plan and state its advantages.

Accidents occur when hazards escape detection during preventive measures, such as a job or process safety analysis. When hazards are not obvious, or as the result of combinations of circumstances that were difficult to foresee. A thorough accident investigation may identify previously overlooked physical, environmental, or process hazards, the need for new or more extensive safety training, or unsafe work practices.

The primary focus of any accident investigation should be the determination of the facts surrounding the incident and the lessons that can be learned to prevent future similar occurrences. The focus of the investigation should never be to place blame. The process should be positive & thought of as an opportunity for improvement.

Most accidents in the workplace result from unsafe work behaviours. According to the latest research, they represent the direct cause for about 95% of all workplace accidents. Hazardous conditions represent the direct cause for only about 3%. "Acts of God" account for the remaining 2%. All these statistics imply that management system weaknesses account for fully 98% of all workplace accidents. Effective accident investigation identifies these root causes and recommends strategies to eliminate management system weaknesses.

4 (b) Briefly discuss the methods adopted for acquiring accident facts.

Methods adopted for acquiring accident facts are:-

Accident Investigation plan:

- (i) Isolate the accident scene
- (ii) Record all evidence
- (iii) photograph and/or videotape of the scene
- (iv) Identify the witnesses
- (v) Interview witnesses.

(i) Isolate the Accident Scene

As soon as emergency procedures are completed, and the injuries have been removed, the accident scene should be isolated, until all evidence has been collected, observed as recorded. This is to prevent disturbance & destroying of vital evidence.

The purpose of isolating the scene is to maintain as closely as possible the conditions that existed at the time of the accidents.

(ii) Record all evidences

It is important to make a permanent record of all persistent evidence as quickly as possible. This is required to be done for 3 reasons.

a) Certain type of evidence may be perishable,

b) The larger an accident scene is isolated, the more likely it is that evidence will be disturbed, knowingly or unknowingly.

c) If the isolated scene contains a crucial piece of equipment or a critical component in a large process, pressure will be quickly developed to get it back in operation.

Evidence can be recorded in a variety of ways, including written notes, sketches, photography, videotape, dictated observations & diagrams.

(iii) Photograph and/or videotape of the scene

Modern photographic & videotaping technology has simplified the task of observing and recording evidence using a digital camera in conjunction with computer. Photographs of accident scenes can be viewed immediately and transmitted instantly to numerous different locations.

(iv) Identify witness

Compile a witness list in 3 categories

a) Primary witness - are eyewitness to the accident

b) Secondary witness - are witness, who did not actually see the accident happen, but were in the scene vicinity and arrived on the scene immediately or very shortly after the accident.

c) Tertiary witness - are witness who were not present at the time of accident nor afterward, but still have some

relevant evidence to present (i.e an employee, who had complained earlier about a problem with the machine involved in the accident.

(v) Interview witness

Every witness on the list should be interviewed. Preferably in the order of Primary, Secondary & Tertiary Interviews shall be conducted at the accident scene, immediately after preparation of list of witness, immediately after occurrence of accident.

5
(a) List and explain various models available for accident causation.

The various models available for accident causation are:

- 1) The Domino theory - Heinrich's theory
- 2) The Human factors theory
- 3) The Accident / Incident theory (Petersen model)
- 4) The Epidemiological theory
- 5) The Systems theory
- 6) The Combination theory

Heinrich's theory (axioms) :-

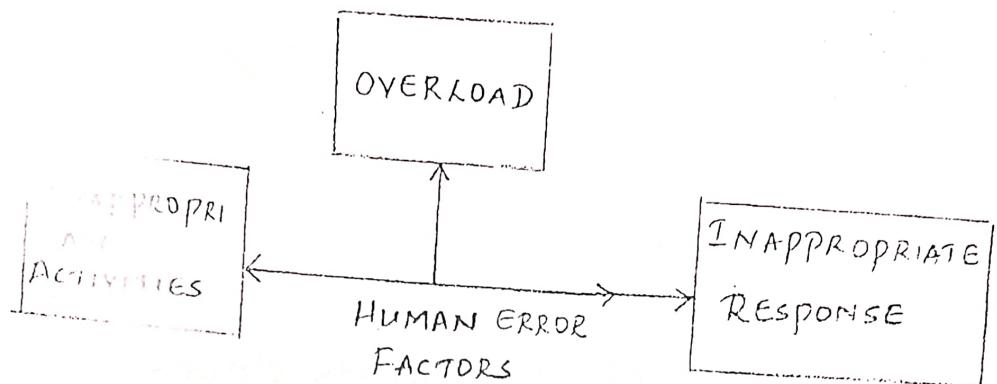
1. Injuries result from a completed series of factors, one of which is the accident itself.
2. An accident can occur only as the result of an unsafe act by a person and/or a physical or mechanical hazard.
3. Most accidents are the result of unsafe behaviours by people.
4. An unsafe act by a person or an unsafe condition does not always immediately result in an accident / injury.
5. The reasons why people commit unsafe acts can serve as helpful guides in selecting corrective actions.
6. The severity of an accident is largely fortuitous & the accident that caused it is largely preventable.

7. The best accident prevention techniques are analogous with the best quality and productivity techniques.
8. Management should assume responsibility for safety since it is in the best position to get results.
9. The supervisor is the key person in the prevention of industrial accidents.
10. In addition to the direct costs of an accident (i.e compensation, liability claims, medical costs, and hospital expenses) there are also hidden or indirect costs.

According to Heinrich, there are five factors in the sequence of events leading up to an accident. These factors can be summarized as follows:

1. Ancestry and social environment
2. Fault of person
3. unsafe act / mechanical or physical hazard
4. Accident
5. Injury

The Human Factors Theory



OVERLOAD

INAPPROPRIATE
RESPONSE

INAPPROPRIATE
ACTIVITIES

→ Environmental factors (noise, distractions)

→ Detecting a hazard
But not correcting it

→ Performing tasks without the requisite training

→ Internal factors (personal problems, emotional stress)

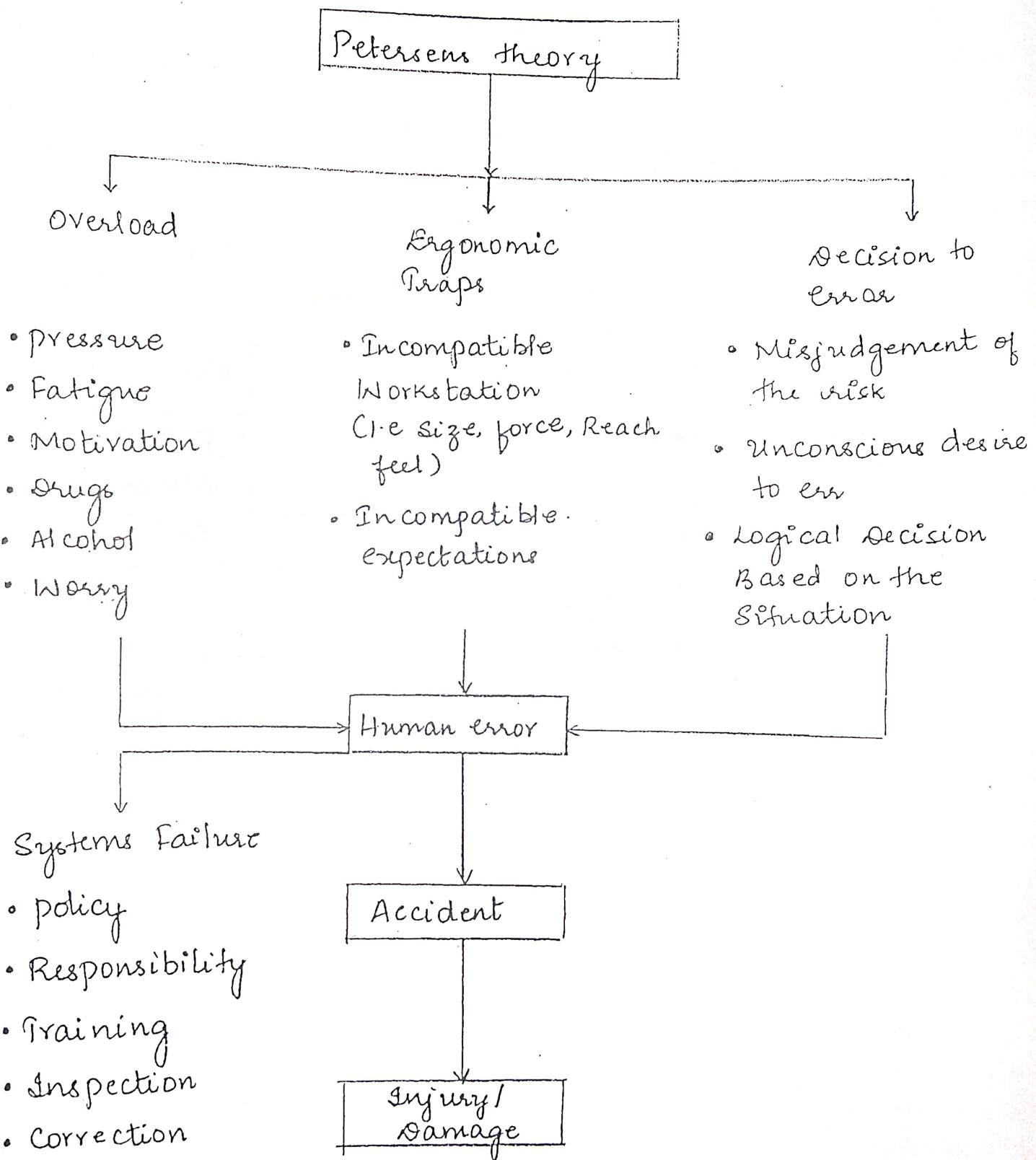
→ Removing safeguards from machines & equipment

→ misjudging the degree of risk involved with a given task

→ Situational factors (unclear instructions, Risk level)

→ Ignoring safety

Petersens model



Epidemiological theory

Predisposition characteristics

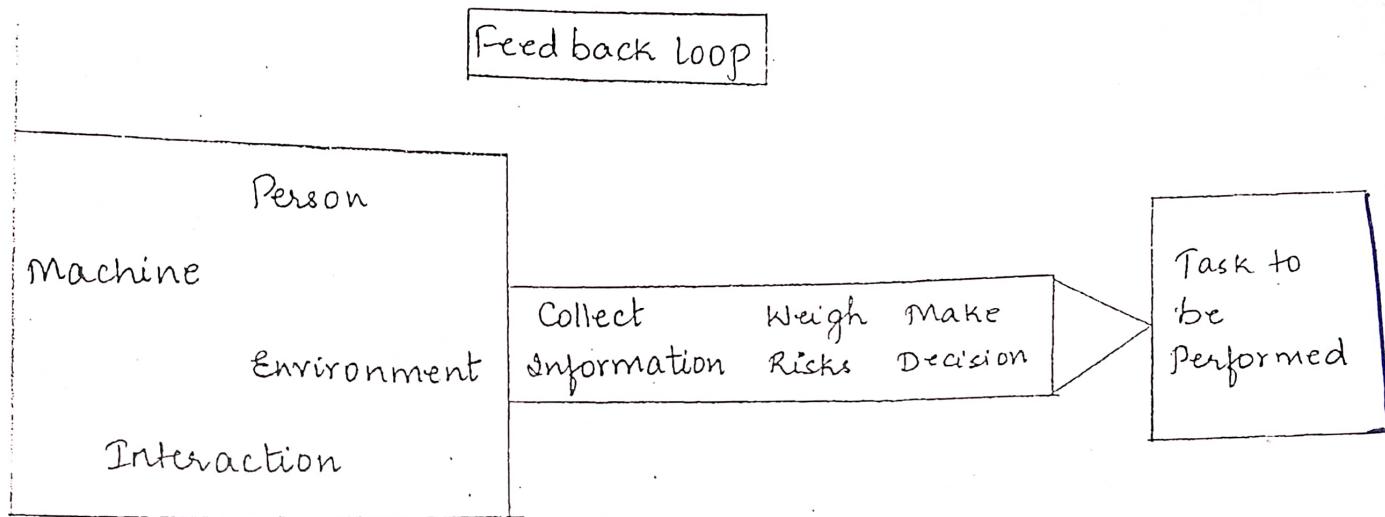
- Susceptibility of People
- Perceptions
- Environmental factors

Situational characteristics

- Risk assessment by individuals
- Peer pressure
- Priorities of the supervisor
- Attitude

Can cause or
Prevent accident
Conditions

Systems theory model



Factors to be considered

- Job requirements
- Worker's Ability & Limitations
- Gain if the task is successful
- Loss if the task is attempted but fails
- Loss if the task is not attempted

The Combination theory

- Degree of difference between any theory and reality
- Avoid applying one theory to all accidents
- No theory is common for all accidents
- The cause of an accident cannot be accurately explained by any model.
- The combination theory combines parts of several different theories.

5b State the requirements of health & basic safety measures as per Factories Act

The requirements of health & basic safety measures as per Factories Act are:-

1. To ensure cleanliness of the workplace.
2. Make effective arrangement for treatment & disposal of waste & effluent.
3. Make suitable & effective provisions for adequate ventilation.
4. Maintain Temperatures to secure reasonable comfort for workers.
5. To remove any dust or fumes from the workplace which may be injurious to workers.
6. To prevent overcrowding by maintaining a specific cubic area for each worker.
7. To provide sufficient & suitable light.
8. Make suitable arrangements to provide clean drinking water conveniently situated for all workers
9. Provide suitable latrines & urinals to specified standard.
10. To provide required personnel protective equipment.

Basic safety measures - As per Factories Act

1. Severeley guarding all parts of dangerous machinery.
2. Precautions for working on Machinery.
3. Emergency devices for cutting off Power.
4. To maintain hoists & lifts.
5. Lifting machines, chains, ropes & other lifting tackle must be maintained in good condition
6. Test pressurized Vessels regularly
7. Ensure walking surfaces are of sound construction
8. Provide Personnel protective equipments (PPE)
9. Measures to remove gas & dust before entering Confined places.
10. Measures to prevent fire

i(a) Explain the roles and responsibilities of various stakeholders in occupational health & safety.

The role of Management

The saying "safety begins at the top". clearly states that the essential concern for successful safety work in industrial undertaking Safety Engineers, foreman and other supervising staff members can never achieve good results. If top management does not take the lead in promoting and maintaining high standards for safety. the role of the management must manifest all that have do with the working environment & people in the undertaking. Management has to organise production process efficiently combining a max of production with the minimum of loss & should treat safety not as an extra but as part of the processes itself. The management concern for safety must be attested to:-

- (i) provision and maintenance of safe working conditions in technological processes and manufacturing operations.
- (ii) provision and maintenance of normal temp & clear air in work rooms.
- (iii) carrying out good practical measures to promote safety & industrial hygiene
- (iv) cultivating workers, operating engineers & other technical staff the correct working habili & safety working methods by adequate vocational training regular

instructions courses briefing & through other means.

(v) provision for workers with necessary working clothes and personal protective equipments (PPE)

organisationally, the management (director/ chief engineer) delegates the responsibility for safety activities in the undertaking, further down to foremen in product departments. The enforcement of safety measures depend to a greater extent on the foremen who for the workers represent the management. He has to see that the intention and orders of the management are carried out by exercising his authority and influence.

The Safety Engineer has a special status, when the work to be done calls for an extraordinary Precautions, such work should not start until he has given his permission. As a rule, he has to provide the department with written permit indicating the precautions to be taken and to supervise it clearly, while it is going.

High standard of safety can never be achieved without a thorough instructions & training of safety and health risks, hygienic care, clothing, maintenance and care of machine tools, materials and equipment inside the undertaking.

3(b) Write briefly on the precautionary measures to be taken for accidents prevention.

There are several ways by which the accidents can be prevented. The National Safety Council U.S.A said that accident prevention depends on the three 'E's etc Engineering, Education & Enforcement.

- a) Improved engineering could prevent accidents
 - b) The employees should be educated in safe procedures and safety rules.
 - c) Safety rules could be established.
- a) Engineering

The engineering aspects of a safety program involve making design improvements to both products & process. By altering the design of a product, the processes required to manufacture it can be simplified & as a result make less dangerous & less hazardous.

b) Education : The education aspect of a safety program ensures that employees know how to work safely. Safety education typically covers that, when, where, why and how of safety.

c) Enforcement : The enforcement aspect of a safety program involves, making sure that employees abide by safety policies, values, regulations, practices & procedures. Supervisors & fellow employees play a

Key role in the enforcement aspects of modern safety program.

Widely used accident prevention techniques includes:

- (i) Failure minimisation
- (ii) Fail-safe design - by proper planning & design including structural design at the grass root level.
- (iii) personal protective equipments: supply and maintenance of proper protective equipments such as noise control, light, helmets etc at work place.
- (iv) Timed Replacement - proper repair and maintenance of the factories, equipment, plants etc
- (v) Isolation
- (vi) Screening
- (vii) By proper selection and placement of employee, safety training to new employee in safe practices & procedures
- (viii) By installing the concept of safety in the workers & the management through safety conscious programme i.e safety weeks, safety slogans, safety campaigns, safety quizzes.
- (ix) Regular review of all written suggestions of work to ensure.
- (x) Regular feedback to all concerned - possibly by safety commitments & Job contact training sessions following any changes in existing safe systems of work.

(xi) By Regular supervision, checking & inspection of the various processes relating to Industrial Complexes or factories.