UNIT-4th & 5th PUSCP ①

Safety:- Safety is a property of a system that reflects the system's ability to operate, normally or abnormally, without danger of causing human injury or death and without damage to the system's environment.

Essential elements of safety program:→

* Having a safety and health policy
* setting a goal and developing objectives & committees
* Getting top management to provide visible leadership
* Getting employees involved.
* Assigning responsibilities.
* providing adequate Authority for enforcement & reward
* Giving & recieving Accountability
* providing periodic program evaluations.

Safety & Loss prevention→

Any organization has legal and moral obligation to save the health and welfare of its employes and general public.

All manufacturing processes are → come to extend to hazardous but in chemical process there are additional special hazard associated with the chemical used and the process condition

2.(a)

Safety and loss prevention in process design can be considered under the following broad categories:→

i) Identification and assesment of hazard
ii) Control of the hazard (eg→ contamination of the toxic materials and flammable materials).
iii) control of the hazard due to process variables such as temperature, pressure, flow by prevention of automatic control system.
iv) limitation of the losses.

Toxicity :⇒

The potential hazard will depend upon the inherent toxicity of the material and the frequency and duration of any exposure. It is usual to distinguish between the short term affect (acute) and long term effect (chronic)

A high toxic material that cause injury such as phosphene or chlorine would be classified as acute hazard whereas a meterial was only a print after a long exposure at low concentration. the inherent toxicity of a material is measured by a test on animal. It is usually expressed as lethal dose at which 50% of test animals are killed. The dose is expressed as the quantity in mg of the toxic substance per kg of body weight of the test animal.

⟶

Some LD 50 value :-

	Compound	mg/kg
i)	potassium cyanide	10
ii)	Tetra ethyl lead	35
iii)	Lead	100
iv)	DDT	150
v)	Aspirin	1500

In fixing permissible limits on concentration for the long term exposure of worker to toxic material. the exposure time must be consider together with the inherent toxicity of the material the threshold limiting value (TLV) is commonly used guide for controlling the long term exposure of worker to contaminated air. The TLV is defined as the concentration to which it is believed the average worker could be exposed to day by day, 8 hrs. a day, 5 days a week without suffering harm. It is expressed in ppm for gas and vapor and in mg/m^3 for the stand liquid material.

FLAMABILITY

Flamability is to describe material that will burn (bring) the hazard caused by the flammable material depend on the following factors.

(i) The flash point of the material.
(ii) The autoignition temperature of the material
(iii) Flamability limit of the material
(iv) Energy released during combustion.

EXPLOSION

(i) Detonation (super-sonic)
(ii) Deflagration (sub-super sonic)

An explosion is a sudden release of energy causing a pressure wave (blast wave). An explosion can occur without fire such as failure through high pressure of a steam boiler or an air receiver. When discussing the explosion of a flammable mixture it is necessary to distinguish between the detonation and deflagration. If a mixture detonate the reaction zone propogate with a super-sonic velocity (300 ms^{-1}) and the principle heating mechanism in the mixture is shock compression. In the flagration the combustion process is the same as in the normal burning of a gas mixture and combustion zone propogate at sub-sonic velocity and the pressure builder is very slow.

Whether detonation and deflagration occur in a air gas mixture depend on a number of factors including the concentration in gas mixture and ignition source.

CONFINED VAPOUR CLOUD EXPLOSION (CVCE)

A relatively small amount of flammable material. a few kg can lead to the explosion which release into the compact area.

UNCONFINED VAPOUR CLOUD EXPLOSION (UCVCE)

This type of explosion result from the release of a considerable amount of flammable gas or vapour into the atmosphere and its subsequent ignition such an explosion can cause extensive damage

BOILING LIQUID EXPANDING VAPOUR EXPLOSION (BLEVE)

Boiling liquid expanding vapour explosion occur when there is a sudden release of vapour containing liquid droplet due to the failure of a storage vessel exposed to fire.

DUST EXPLOSION

Finely divided combustible solids if immediately contact or mixed with the air can explode. several disaster explosion occur due to dust. (flammable)

Condition for dust explosion →

(i) A combustible dust

(ii) The dust is suspended in air at high concn

(iii) There is an oxidant

(iv) There is an ignition source

TEMPERATURE →

Excessively high temperature over and about that for which the equipment was designed can cause structural failure and initiate a disaster. High temperature can arise from loss of control of reactor and to heater and externaly from open fire. In the design of process where a high temperature is required a hazard protection against a high temperature is provided by -

- Provision of high temperature alarms interlock to shut down reactors feed by of heating source system
- Provision of emergency cooling system of reactor
- structural design of equipment to be distant the worst possible temperature selection of safe heating system for hazardous material.

NOISE →

Excessive noise is a hazard to health and safety. Long exposure to high noise level can cause permanent damage to hearing. The unit of sound measurement is the desibel define by the expression

sound level = $20 \log_{10}$ RMS (sound pr.) D.B

The subjective effect of sound depend upon frequency as well as intensity. Permanent damage to hearing can be cause at sound level 90 decibel and it is normal practice to provide ear protection in area where the level is about 80 decibel.

~~UNIT - II PLANT LAYOUT~~

PLANT LAYOUT.

The location of the plant can have a crucial effect on the overall profitability of a project and the scope for the future expansion. Many factor must be considered when selecting a suitable plant site. The principle factors are →

(i) location w.r.t the market area
(ii) Raw material suppy
(iii) Transportation facilities
(iv) availability of suitable land
(v) Environmental affect and waste disposal
(vi) local community consideration
(vii) climate
(viii) political and strategic consideration

The economic construction and operation of a process unit will depend on how wie the plant equipment specified on the process flow sheet. The principle factors to be consider are -

(i) economic consideration → construction and operation
(ii) The process requirement
(iii) convinence of maintenance
(iv) safety
(v) Future expansion
(vi) Modular construction

The following aspects are →

(i) Process requirement → All the required equipment have to be placed properly within process. Even the installation of the auxilary should be done in such a way that it will occupy the least space.

(ii) Cost → The cost of construction can be minimized by adopting a layout that give shortest run of connecting pipes between equipments and adopting the least amount of structural steel work.

(iii) operation → Equipment that need to have frequent operation should be located convinientty from control room. valves, sampling point and instrument should be located at convinient position and height.

(iv) Maintenance → Heat exchanger need to be sitted so that the tubes bundles can be easily withdrawn for cleaning and tube replacement. vessels that require frequent replacement of catalyst or packing should be located on the outside of the building equipment that require dismaintain for maintenance such as compressors and large pump should be placed under cover.

(v) Safety → Blast valve may be needed to isolate potentially hazardous equipment and confined the effect of an explosion. At least two escape roots for operator must be provided from each level in the process building.

(vi) Future expansion → Equipment should be located so that it can be convinienctly tied with any future. Expansion of the process space should be left on pipe. For future need service pipe oversize to allow for future.

(vii) Modular Construction → In recent year there has been a move to assemble section of the plant at the manufacturer side. These modules will include the equipment structural seal piping and instrument. The modules then transported to the plant site by road or sea.

HAZARD ANTICIPATION (पूर्वानुमान) (possibility)

In terms of health and safety hazard the following are the thumbs rules for hazard anticipation.

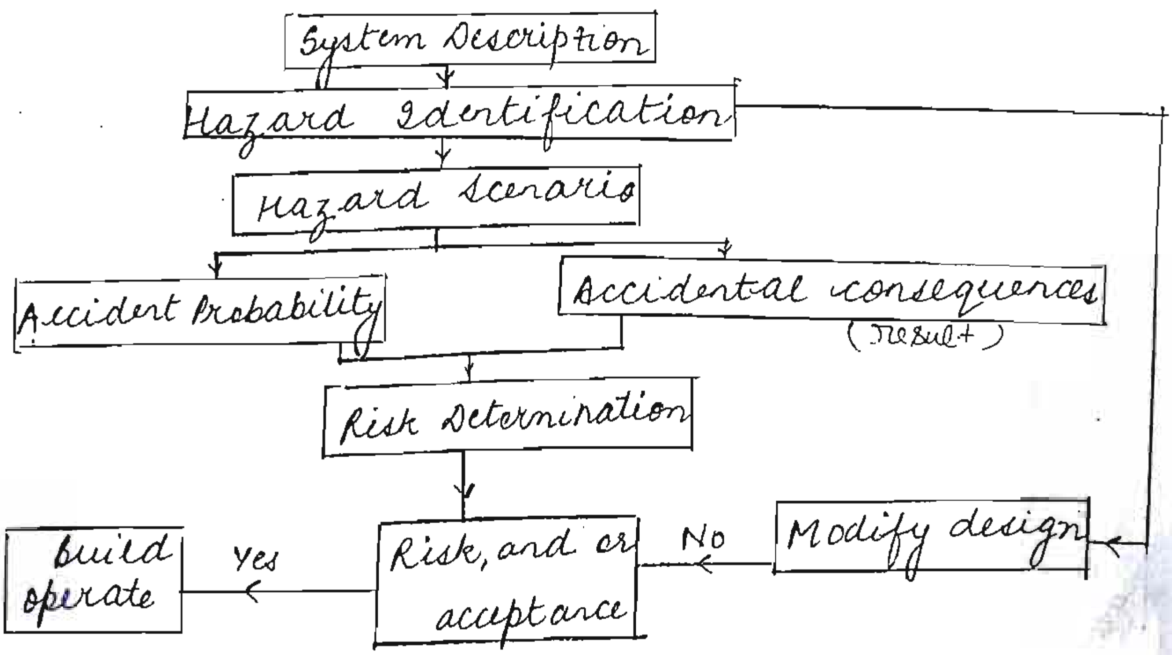
1. open process is more hazardous than the closed process
2. A manual process is more hazardous than the automatic operation
3. A high temperature or high pressure system is more hazardous as compared to low pressure and temperature process.
4. ~~A~~ gaseous ~~is~~ ~~was~~ more hazardous than liquid and it is more hazardous than a solid.
5. organic solvent are more hazardous than the aqueous system.
6. A flammable liquid or gas with a low flash point and low auto-ignition point or temperature.
7. A compressed gas is more hazardous.

जोखिम की पहचान

HAZARD IDENTIFICATION →

Any process or operation involving chemical that may cause body injury (चोट) or cause a health risk by inhalation, injection or skin contact should be classified as a potential hazard so every process involving chemical should be examined to identify hazard. Hazard are everywhere, unforturately a hazard is not always identifying until an accident occur. It is necessary to identify hazard and reduce the risk well in advance of an accident. Hazard identification and risk assesment are sometime combined to a general category called Hazard Evaluation. Risk assesment sometimes called the Hazard Evaluation/Analysis.

PROCEDURE FOR HAZARD IDENTIFICATION AND RISK ASSESMENT.



HAZARD AND OPERATABILITY STUDY (HAZOP)

The hazard and operatability study a formal procedure used to identify hazard in chemical process facility. This process is very effective in identifying hazards. However this approach provides little information on risk and consequences. As a result this approach tends to "gold plate" in a process design, resulting a large number of hazard being identified. The full hazop study is completed by committe composed of a experienced plant and lab people. A complete hazop study will require a large investment in time and effort by the people involved.

STORAGE OF CHEMICALS:

chemical storage requirement depend on the type or properties of chemicals, quantity of storage, operational and environmental conditions. The following general precautions should be of taken when storing chemicals.

1. Chemicals should be stored in appropriate (good) containers
2. All storage container should be labelled (लेबल) to indicate the identify of the chemicals.
3. Volatile liquid should be store in a cool place away from sunlight or heat source.
4. Different classes of hazards chemical should be separated

STORAGE OF CORROSIVE CHEMICALS

1. Acids should be store in plastic or other suitable container. The main stock of concentrate acid and basis should be store as near to the floor level as possible.

2. Protective gloves, safety glasses, face shield and aprons should be wear

3. Provision for safety showers and eye wash fountain must be available

4. If a small amount of a strong corrosive chemical is spilled, use a neutralising agent to neutralise it and flush with water or use an absorbent to absorb it and dispose of in plastic bags.

STORAGE OF FLAMMABLE MATERIAL (ज्वलनशील)

1. Flammable liquid should be kept (रखना) in steel cabinets away from any heat source.

2. Flammable chemicals should not be kept in an open
3. Flammable liquids should not be store in refrigerator (फ्रिज)

4. No smoking at or near the storage area.

5. Fire fighting equipment should be available at the storage area.

6. Amount of flammable liquid in working area should be kept to a minimum.

7. Flammable liquid should be handle in area free of ignition source.

8. If there is a spillage of flammable liquids then turn off ignition and heat source.

9. If the spilled liquid is volatile, let it evaporate and be exhausted by the ventilation system.
10. If the spilled is not volatile, use sand to absorb the spillage. बिखरा हुआ उड़नेवाला

STORAGE OF REACTIVE CHEMICALS

1. It should be store at isolated, cool, dry area and away from direct sunlight.
2. Open flamed and other sources of heat must be kept away from reactive chemicals.
3. Shock, friction and all forms of impact must be avoided.
4. Incompactible material should not be stored with each other.
5. Chemical which rarely absorb moisture or react violently with air must be kept in tightly sealed container or decicators.
6. Quantity of reactive material store or used should be kept minimum.
7. Safety glasses or goggles and gloves must be worn during handling
8. All spillage must be cleared up immediately.

STORAGE OF TOXIC CHEMICALS
विषैला

1. Toxic chemicals should be stored in proper containers
2. Highly toxic chemicals should be stored in double containment and kept in a locked cupboard.

शेरब धाम

3. Minimum amount of toxic chemicals should be kept for current use.

4. Toxic chemicals should not be stored on high shelves where there is a risk of droping when taking down for use.

5. Suitable types of personal protective equipment should be used.

6. Appropriate decontamination procedure should be followed when handling spillage.

PERMISIBLE EXPOSURE LEVEL (PEL)

When excessing risk of exposure to contamination in working environment the result of air sampling or concentration measurement are compared with their PEL.

Two types of PEL are specified in the factories order are-

(i) LONG TERM → PEL long term is the Maximum Time Weight Average (TWA) concentration of a toxic substances to which a person may be exposed over an eight hour per day or a 40 hours one week.

(ii) SHORT TERM (PEL) → It is the maximum TWA concn to which person may be exposed over a period of 15 minutes during the work day.

BIOLOGICAL MONITORING

→ The primary objective of the biological monitoring is to be ensured that the current or past exposure of the worker is not harmful to his health by detecting excessive exposure before obvious health effect occur.

→ It is useful to accessing overall exposure of a worker to a chemical.

This can be done by monitoring →

1. The amount of a chemicals that has been absorbed by the worker.
2. The health effect of the absorbed chemical on the worker.

Biological monitoring involves measuring the level of an appropriate determinant in biological samples of usually blood or urine collected from the worker at the specified time.

The BTLV (Biological Threshold Limit Value) represent the maximum concn of the toxic substance in biological sample which could not be associated with significant risk to the worker health. All results exceeding the BTLV verified by a repeat test. As soon as possible if the repeat test is higher than the recommended BTLV, worker should be removed from further exposure.

HAZARD IDENTIFICATION ANALYSIS

(i). FAULT TREE ANALYSIS
(ii) EVENT TREE ANALYSIS

FAULT TREE ANALYSIS

A fault tree analysis (FTA) is a top down, detective failure analysis in which an undesired state of system is analysed using boolean logic to combined a series of lower level events.

This analysis method is mainly used in the field of safety engineering to understand how system can fail. To identify the best ways to reduce risk or to determine event rates of a safety accident or a particular level failure. FTA is used in the aerospace nuclear power chemical and process, pharmaceutical, petroleum chemicals and other high hazard industries.

Some symbols used in FTA are grouped as event, gates and transfer symbols.

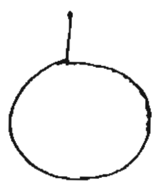
EVENT SYMBOLS

Event symbols are used for primary events and intermediate events.

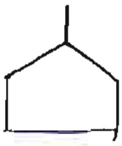
- Primary events are not further developed on the fault tree. intermediate events are found at the output of a gate.

1. BASIC ~~GAT~~EVENTS :

Failure or error in a system component or element.

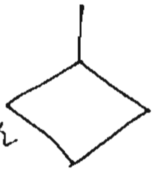


2. <u>External Event</u> →



Normally expected to occur.

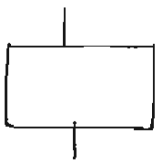
3. <u>Undeveloped event</u> →



An event about which insufficient information is available or which is of no consequence.

4. <u>Conditional event</u> → A condition that restrict or affect logic gates

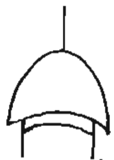
5. <u>Intermediate event</u> → An intermediate event gate can be used immediatly about a primary event to provide more room to type the event description.



GATE SYMBOLS

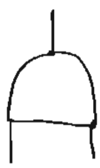
Gate symbol describes the relationship between input and output events. The symbols are derived from Boolean Algebra or Boolean logic symbols.

(i) <u>OR GATE</u>



The output occur if any input occur

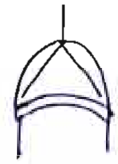
(ii) <u>AND GATE</u>



The output occur only if all input occur

(iii) EXCLUSIVE OR GATE

The output occur if exactly one input occur



(iv) PRIORITY AND GATE

The output occur if the input occur under an enabling condition specified by a conditioning event

TRANSFER SYMBOL:

The transfer symbol are used to correct the input and outputs of related fault tree such as the fault tree of a subsystem to a system.

(i) transfer in

(ii) transfer out

FTA ANALYSIS

It involves fine steps.

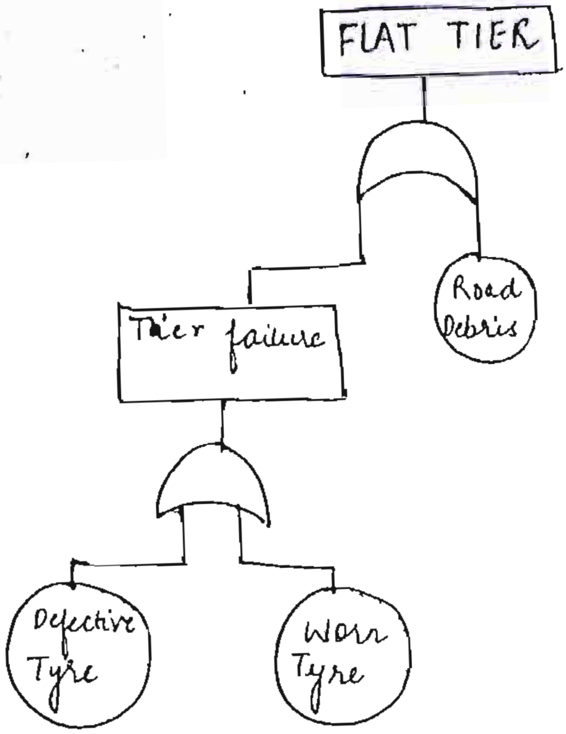
(i) Define the undesired event to study →
Definition of the undesired event can be very hard to catch. Although some of the events are very easy and obvious to observe. An engineer with a wide knowledge of the design of the system or a system analyst with an engineering background is are best person who can help and number the undesired event.
undesired events are used then to make the FTA, one event for one FTA, No two events will be used to make the one FTA.

2. Obtain an understanding of the system →
Once the undesired even is selected, all cause with probabilities of affecting the undesired event or zero or more are studied and analysed.

3. Construct the fault tree →
After selecting the undesired event and having analysed the system so that we know all the causing effect. We can now construct a fault tree. Fault tree is based on AND and OR gates which defines the major characteristic of the fault tree.

4. Evaluate the fault tree →
After the fault tree has been assembled for a specified undesired event it is evaluated and analysed for any possible improvement or in other words study the risk management and find ways for system impro--vement.

5. Control the hazard identified →
This step is very specific and differ largely from one system to another, but the main point will always be that. After identifying the hazard all possible methods are used to descrease the probability of occurence.



(2) EVENT TREE METHOD

Event tree begin with an initiating event and work toward a final result. This approach is very inductive. The method provide information on how a failure can occur and the probability of occurence.

When an accident occur in a plant various safety system come into play to prevent the accident from propogating these safety system either fail or succed. The event tree approach include the effect of an event initiating followed by the impact of the safety system. The typical steps in event methods are →

(i) Identifying an initiating event of interest.
(ii) Identify the safety function design to deal with the initiating event.
(iii) construct the event tree.
(iv) Describe the resulting accident event sequence.

UNIT-4 TOXICOLOGY

Due to the quantity and variety of chemical used by the chemical process industry chemical engineer must be knowledge about.

(i) The way toxicant enter biological organism
(ii) The way toxicant are eliminated from biological organism.
(iii) The effect of toxicant on biological organism and
(iv) Method to prevent or reduce the entry of toxicant into the biological organism.

HOW TOXICANT ENTER INTO BIOLOGICAL ORGANISM →

The path of chemical agent through the bodies is well defined after the toxicant enter the organism. It moves into the blood stream and is eventually eliminated or it is transported to the target organ. For corrosive chemicals the damage to the organism can occur without absorption or transported through the blood stream.

Toxicant enter into biological organism by the following routes →

(i) Ingestion → By mouth into the stomach.
(ii) Inhalation → By mouth or nose to lungs
(iii) Injection → By drugs into the skin (veins)
(iv) Dermal absorption → through skin membrane

(ii) The target or test organism
(iii) The effect or response to be monitored
(iv) The dose range.
(v) The period of test.

The toxicant must be identified with respect to its chemical composition and its physical state. For studies determining the effect on specific organs such as the lungs, kidneys or liver.

Dose unit depend upon the method of delivery for substance delivered directly into the organism. The dosage measuring in mg of agent/kg of body weight. For gases substance the dosage measured in either ppm or mg of agent/cubic metre (mg/m3). The period of test is depend on whether long or short term effect. Acute toxicity is the effect of a single exposure or a series of exposure closed together in a short period of time. Chronic toxicity is the effect of multiple exposure occuring over a long period of time. Chronic toxicity studies difficult to perform due to the time involve. Most toxicological study depend upon acute exposure.

CONTROL METHOD OF TOXIC SUBSTANCES

This require the application of appropriate technique for reducing work place exposure. Design control method is a very important and relative task. During the design process the designer may pay particular attention to ensure the newly ~~oriented~~ designed control technique provides the desired control and the new control technique itself does not create another hazard. sometime even more hazardous than the original problem.

→ chemical plant controlled technique.

TYPE AND EXPLAINATION	TYPICAL TECHNIQUES
(1) Substitution: use chemical and equipment which are less hazardous	(1) Use mechanical pump seal versuses packing (2) use welded pipe versuses flanged section (3) use solvent that are less toxic (4) Use water as a heat transfer fluid instead of hot soil.
(2) Attention: use chemical under condition which make them less hazardous	(1) Reduce process temperature and pressure

(2) operate at condition where reaction run away is not possible

(3) Dissolve hazardous metals in safe solvent

(3) Isolation :
isolate equipment and source of hazard

(i) Place control room away from operator

(2) barricate control rooms and tank

(4) Intesification:

(i) change from large batch reactor to smaller continuous reactor

(2) Improve control to reduce inventory of hazardous intermediate chemicals.

(5) Enclosures :
enclosed room or equipment and place under negative pressure

(i) Enclosed hazardous operations like sample point

(2) use analyser and instrument to observe inside equipment.

(3) Shield high temperature surfaces.

(6) Local ventilation:
exhaust ~~and~~ that contain hazardous substances

(i) use properly designed hood

(ii) use hood for charging and discharging

(iii) use local exhaust at sample points

(iv) keep exhaust system under -ve pressure.

(7) Dilution ventilation	(i) Design worker rooms with good ventilation and special area or enclosures for contaminated clothing (2) Design ventilation to isolate operation from rooms and offices.
(8) Wet methods : Use wet methods to minimize contamination with dust	(1). clear vessels chemically versus sand blasting (2) Use water spray for clearing
(9) Good house keeping keep toxics and dust containment away	(1) Provide water and steam connection for area washing (2) Provide lines for flushing and clearing.
(10) Personal protection As last writ of defence	(i) Wear appropriate respirators. (ii) Wear appropriate respirators safety glasses and protective equipment, face shield. (iii) Use apron, dress shields and space suits

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VENTILATION

For environmental control of air borne toxic material the most common method of choice is ventilation due to the following reasons →

(i) Ventilation can quickly remove dangerous concentration of flammable and toxic material

(ii) Ventilation can be highly localized reducing the quantity of air moved and the equipment size.

(iii) Ventilation equipment is readily available and can be easily installed.

(iv) Ventilation equipment can be added to an existing facilities.

(v) The major disadvantages of ventilation is the operating cost.

- It is based on two principle →

(i) Dilute the contaminant below the target concentration

(ii) Remove the contaminant before worker are expose.

→ Ventilation system are composed of fan and duct. The fans produced a small pressure drop that moves the air. There are two types of ventilation technique.

(i) Local and dilution technique

(1) LOCAL VENTILATION :

The most common example of local ventilation is the hood. A hood is a device that either completely enclosed the source of contaminent and moves the air in such in fashion to carry the containinant to an exhaust device. There are several types of hoods -

(i) The enclosed hood

(ii) Exterior hood.

Enclosed Hood → Completely contain the source of containinent

Exterior Hood → continuously wrong containinants into an exhaust from some distance away.

"The receiving hood is an exterior hood that uses the discharge motion of the containinant for collection".

"The push-pull hood uses a steam of air from a supply to push containinent to word an exhaust system The most common example of enclosed hood is the laboratory hood - the fresh air is from to the window area of the hood and removed out of top through a duct. The air flow profile with in the hood are highly depending upon the location of the window.

Another type of laboratory hood is the bypass hood. For this design, by pass air is supplied through a drill at the top of the hood. this ensure the availability of fresh air to sweep out containinent in the hood. The bypass air is a supplied is reduced by the sash open.

Advantage of enclosed hood →

i) Completely eliminate exposure to worker

ii) Require minimum air flow.

iii) provide a containinant device in the event of fire or exclusion

(iv) A slide door on hood provide a shield to the worker.

Disadvantage →

(i) A limit work space.

(ii) Can only be used for small batch scale, pilot plant equipment.

DILUTION VENTILATION →

It is contaminent can not be placed in a hood and must be used in an open area or room, dilution ventilation is necessary. Unlike hood ventilation where the air flow prevent worker exposure, dilution ventilation is alway expose the worker. But in concent diluted by fresh air. Dilution ventilation is always require more air flow then local ventilation.

The following restriction should be consider before implementing dilution ventilation.

(i) The contaminant must not high toxic.

(ii) The contaminant must be evolved at a uniform rate

(iii) The worker must remaining suitable distance from the source to ensure proper dilution of the contaminant.

(iv) Scrubbing system must not be required to treat the air prior to exhaust into the environment.

RESPIRATORS →

Respirators are routerly found in chemical laboratories and plants, respirators should only be used.

(i) On a temporary basis, until regular control methods can be implemented.

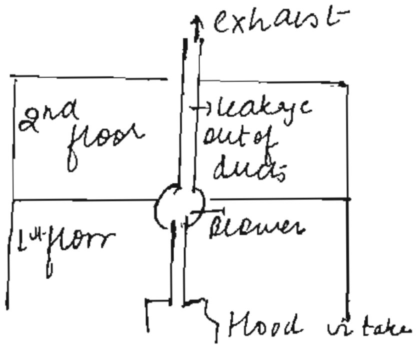
(ii) An emergency equipment to ensure worker, safety in the event of accident

(iii) As a last in the event that environmental control technique are unable to provide satisfactory protection.

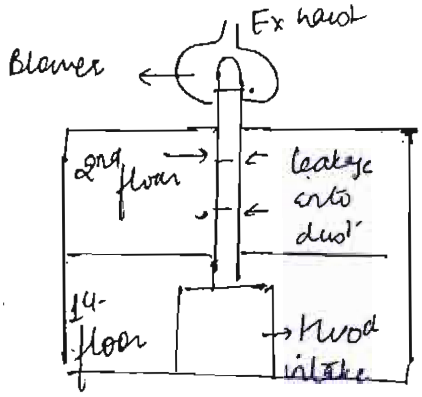
(iv) Respirator always compromise worker ability. A worker with a respirator is unable to perform or response as well as a worker without one.

Respirator can be used improperly and can be damaged to the extent that they do not provide the needed protection

OSHA and NIOSH have developed standard for using respirator. Including fit, testing, periodic. instruction, specified used application. Training and record keeping. All industrial uses of respirators are legaly bound to understand and fulfill the OSHA's requirements.



(Positive pressure



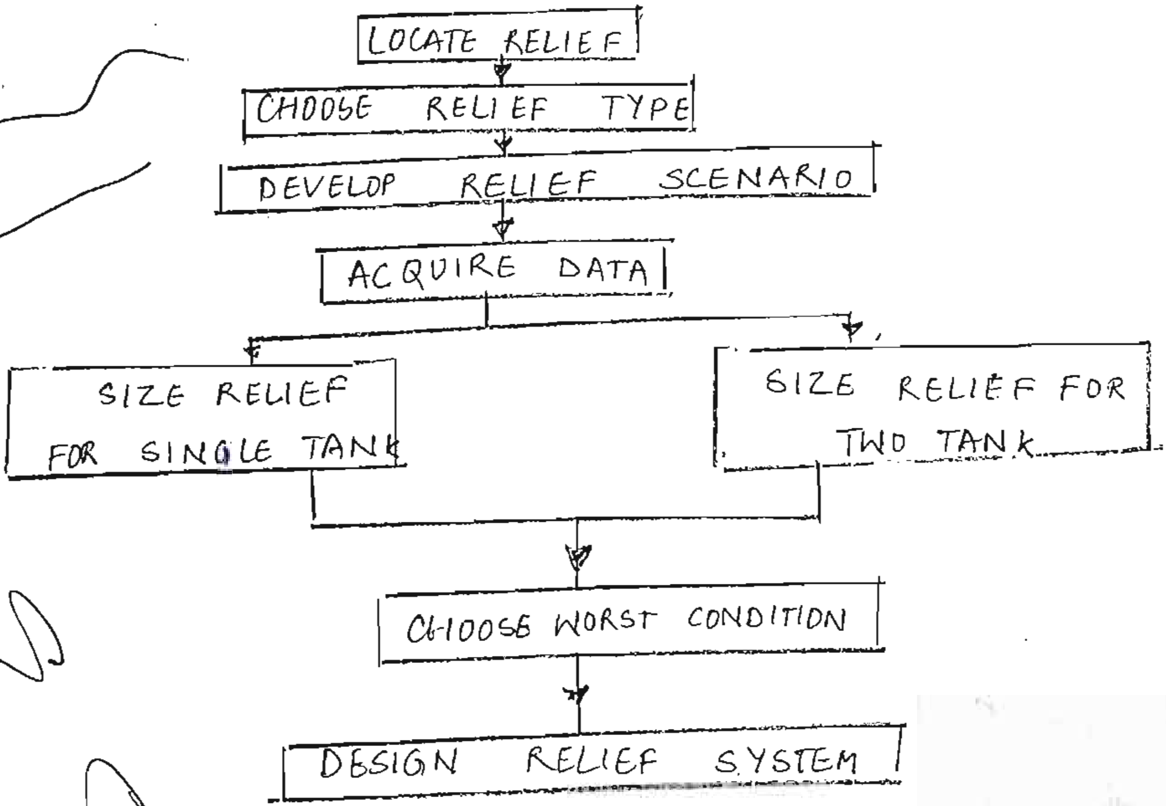
Negative pressure

UNIT IV RELIEF SYSTEM

Despite many safety precautions within chemical plants, equipment failure or operator error may occur and cause increase in process pressure beyond safe level. If pressure rise is too high, then may exceed the maximum strength of pipe line and vessels. This can result the rupturing the process equipment causing release of toxic and flammable material.

We can prevent this by controlling the process and second by installing relief system to relieve liquid or gases before excessive pressure develop.

METHOD FOR SAFE INSTALLATION OF RELIEF SYSTEM



RELIEF SYSTEM : TYPE AND LOCATION OF RELIEF

Relief concept → Pressure relief system are required for the following reasons -

(i) To protect personel from the danger of over pressuring equipment

(ii) To minimise chemical losses during pressure upsets

(iii) To prevent damage to equipment

(iv) To prevent damage to adjoining properties

(v) To fulfill the governmental regulations.

(vi) Location of Relief →

The procedure for specifying the location of relief system require the review of every unit operation in the process and every process operating step.

The engineer must anticipate the problem which may occur/result in increased pressure. Pressure relief device are installed at every point identified as potentially hazardous that is at point where upset condition create pressure which may exceed the maximum allowable working pressure.

RELIEF TYPE

Specific type of relief device are chosen for specific application such as for liquid, gases, solid and corrosive material. They may be vented to the atmosphere or vented to containment systems.

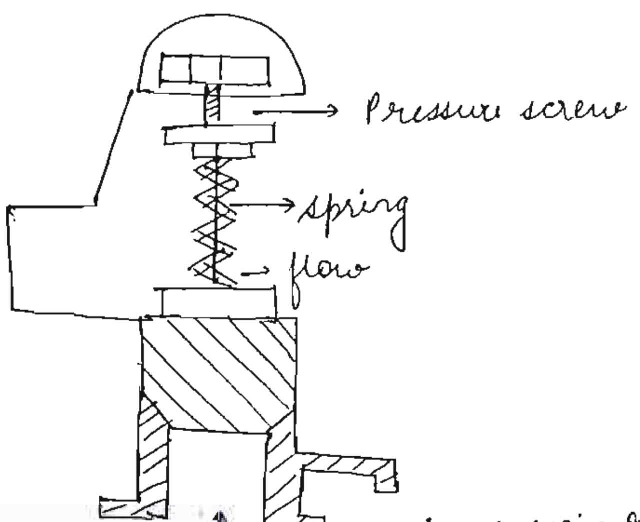
In engineering terms the types of relief device specified on the basis of the details of the relief system, process condition and physical property of the relief fluid. there are two general categories of relief devices -

(i) spring operated
(ii) Rupture dish.

And two major type of spring operated valve.
(i) Conventional
(ii) Balanced Bellows.

CONVENTIAL RELIEF SYSTEM

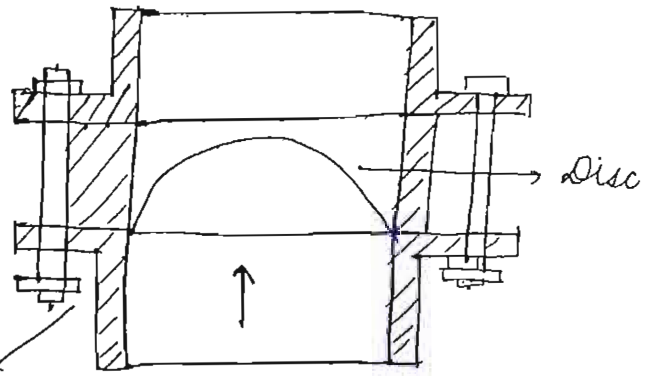
The convential relief is affected by the back pressure. This type of valve is accepted only when back pressure are minimum because the set pressure increase as the back pressure increase.



Conventional spring operated valve

RUPTURE DISH →

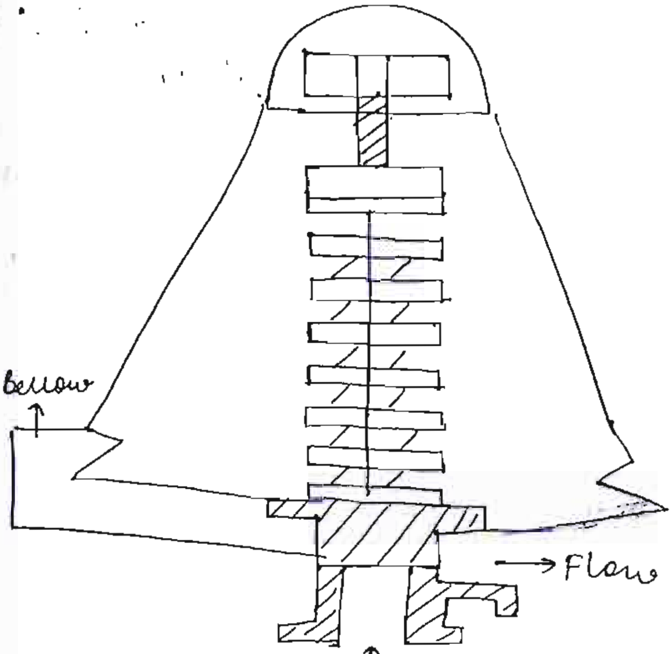
Rupture dish are specially designed to rupture at a specified relief set pressure. They usually consist of calibrated sheet of metal designed to rupture at a well specified pressure. They are also used along in series or in parallel to spring loaded relief device. They can be made from variety of material.



Rupture disk and assembly.

BALANCED BELLOW RELIEF SYSTEM

The balanced bellow design is used for process situation where substantial back pressure are present. This type of valve keep atmosphere pressure on the discharge side of the relief Therefore, the relief pressure, regardless of the process back pressure. on ~~the discharge side~~ The flow rate, however is affected by the magnitude of the back pressure.



Balanced Bellows

There are three subcategory types of spring loaded pressure relief -

(i) The relief valve for liquid service →
The relief valve begins to open at the ~~set~~ rise pressure. This valve reaches full capacity when the pressure reaches 25% over pressure. The valve close as the pressure return to the set pressure

(ii) The safety valve for steam, gas and vapour service.
safety valve open when the pressure exceed the set pressure. This is accompained by using a discharge nozzle that direct high velocity material towards the valve seat. After blown down of the excess pressure the valve reset at approximate 4% below the set pressure. The valve has a 4% blow down.

LEAK TESTING

To see there is any leakage in containers and vessels and to find where the leaks are so corrective action can be taken. There are several method for leak testing depending on the situation. Sometimes leakage of fluid may be tested by pressuring them into air and submerging them in water. To see where air bubbles come out to indicate a leak. If submerging in water is not possible then pressurisation with air followed by covering the area to be tested with a soap solution is done to see if soap bubbles formed, which indicate a leak.

There are some standards to check leakage.

(i) BSEN 13184/2001 → leak testing; pressure change method.

(ii) BSEN 13185/2001 → pressure gas method

(iii) BSEN 13192/2002 → calibration of reference leak for gases.

In shell and tube heat exchanger, eddy current testing is sometime done in the tubes to find location on tubes where there may be leak or damage which may eventually developed a leak.

(iii) The safety relief valve is used for liquid and vapour service, safety relief valve function as relief valve for liquid and a safety valve for vapour.

LEAKAGE →

A leak is a hole or other opening usually undesired in a container or fluid containing system such as a tank through which the content of the container can escape or outside matter can enter the container. the entry or exit or exchange of matter through the leak is called the leakage.

LEAK TYPE AND POSSIBLE CAUSES →

Type of leak opening include a puncture or other corrosion holes, very tiny pin hole leak, crack or micro crack, inade-quate sealing between components or parts join together. When there is a puncture the size and shape of the leak opening may not be so obvious since leak opening are often so irregular, leak are sometimes size by the leakage rate, as in volume of fluid leaked per time rather than the size of the opening.

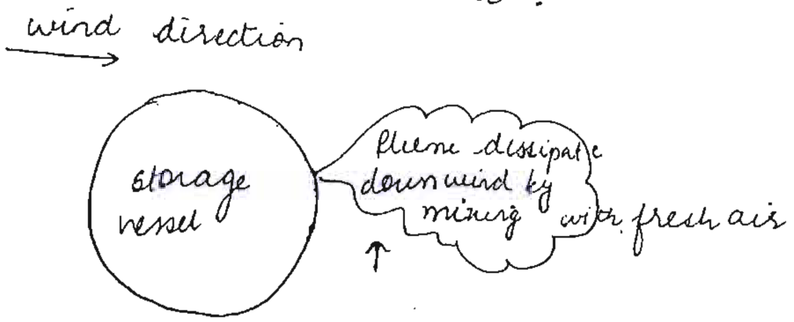
GAS LEAK →

for eg- in natural gas lines allow flammable and potentially explosive gas to leak out, resulting in a hazardous situation.

TOXIC RELEASE AND DISPERSION

During an accident all on requirement, equipment can release toxic material very quickly and insufficient enough quantity to spread in dangerous cloud throughout a plant site and the total community. There are three steps in utilising a toxic release model.

1. Identify the design basis:
   What process situation can lead to release.
2. Develop a source model - to describe how material are released and the rate of release.
3. Use the dispersion model - to describe how material spread throughout the accident area.



Factories Act 1948

The Factories Act 1948 was an Act of Parliament passed in UK and adopted in India.

It was passed with the intention of safeguarding the health of workers. It extended the age limits for the medical examination of persons entering factory employment, while also including male workers in the regulations for providing seats and issuing extensive new building regulations.

Objectives:

1. To ensure adequate safety measures and to promote the health and welfare of the workers employed in factories.
2. To prevent haphazard growth of factories through the provisions related to the approval of plans before the creation of a factory
3. To provideBasic minimum requirements for ensuring safety, health and welfare of workers.
4. To regulate the working condition in factories, regulate the working hours, leave, holidays, overtime, employment of children, women and young persons
5. Regulates working condition in factories.

Extra detail

Under the legislation, young persons under the age of eighteen became subject to medical examination not only on entry to the place of work, but annually thereafter. Certificates of fitness were also made a requirement for young people employed in the loading, unloading and coaling of ships and other kinds of work in ships on harbour or wet dock, engineering construction and building operations as well as for factory employees

SALIENT FEATURES OF MINES ACT,1952 RULES & REGULATION

- every mine shall be under a sole manager with prescribed qualifications. the owner, agent and manager of every mine shall each be responsible to see that all operations are conducted in accordance with the provisions of this Act
- Drinking water in every mine provided and maintained at suitable points with sufficient supply of cool and wholesome drinking water
- provision of readily accessible first-aid boxes or cupboards with prescribed contents during all working hours
- No work for more than forty-eight hours in any week or for more than nine hours in any day
- Equipment for fire-fighting – (1) a sufficient supply of sand or in combustible dust or sufficient portable fire extinguishers shall be provided at every entrance to a mine,
- Precautions against dust – minimising of emissions of dust and suppression of dust which enters the air at any work place below ground or on surface
- of certain machinery belowground. – (1) No internal combustion engine or steam boiler shall be used belowground in a mine
- Danger from surface water – No workings shall be made in any mine vertically below (a) any part of any river, canal, lake, tank or other surface reservoir

Bhopal Gas Tragedy

The **Bhopal disaster**, also referred to as the **Bhopal gas tragedy**, was a gas leak incident in India, considered the world's worstindustrial disaster. It occurred on the night of 2–3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh. Over 500,000 people were exposed to methyl isocyanate (MIC) gas and other chemicals

The official immediate death toll was 2,259. The government of Madhya Pradesh confirmed a total of 3,787 deaths related to the gas release. Others estimate 8,000 died within two weeks and another 8,000 or more have since died from gas-related diseases

Contributing factors

Factors leading to the magnitude of the gas leak mainly included problems such as;

- storing MIC in large tanks and filling beyond recommended levels.
- poor maintenance after the plant ceased MIC production at the end of 1984,
- failure of several safety systems due to poor maintenance,
- and safety systems being switched off to save money— including the MIC tank refrigeration system which could have mitigated the disaster severity.

Other factors identified by the inquiry included:

- use of a more dangerous pesticide manufacturing method,
- large-scale MIC storage,
- plant location close to a densely populated area,
- undersized safety devices, and
- the dependence on manual operations.
- Plant management deficiencies were also identified – lack of skilled operators,
- reduction of safety management, insufficient maintenance, and inadequate emergency action plans.

DETAIL OF WHAT AND WHY HAPPPENED

In the early morning hours of December 3, 1984 a rolling wind carried a poisonious grey cloud past the walk of the Union Carbide C plant in Bhopal, Madhya Pradesh , India. An estimated 8,000 or more people died (over three times the officially announced total)About 300,000 more would suffer agonising injuries from the disastrous effects of the massive poisoning. Forty tons of toxic gases were released from Carbide's Bhopal plant and spread throughout the city. The cause was the contamination of Methyl Isocyanate (MIC) storage tank No. 610 with water carrying catalytic material. The result was a nightmare that still has no end. Residents awoke to clouds of suffocating gas and began a desperate flight through the dark streets. No alarm ever sounded a warning and no evacuation plan was prepared. When victims arrived at hospitals breathless and blind, do doctors did not know how to treat them since Carbide had not provided emergency information.. This is the Hiroshima of chemical industry.

MIC in gaseous form is heavier than air and has a tendency to settle down. In this form it is subject to wind dispersal. The geographical characteristics of the area would control the dispersal. At 11 PM on December 2, 1984 the pressure in the tank started building up till the safety valve opened. At that time, the carbaryl plant was stated to be working. The escaping MIC was released into the atmosphere. The leakage was between 12.45 am and 1.30 am. A gentle wind slowly moved the deadly cloud over an area of about 40 sq. km, thus causing a vast destruction of life.

WORKSMEN'S COMPENSATION ACT

Workers' compensation act is a form of insurance providing wage replacement and medical benefits to employees injured in the course of employment in exchange for mandatory relinquishment of the employee's right to sue his or her employer for the tort of negligence. The tradeoff between assured, limited coverage and lack of recourse outside the worker compensation system is known as "the compensation bargain".

Statutory compensation law

Statutory compensation law provides advantages to employees and employers. A schedule is drawn out to state the amount and forms of compensation to which an employee is entitled, if he/she has sustained the stipulated kinds of injuries. Employers can buy insurance against such occurrences. However, the specific form of the statutory compensation scheme may provide detriments.

Statutes often award a set amount based on the types of injury. These payments are based on the ability of the worker to find employment in a partial capacity: a worker who has lost an arm can still find work as a prop[illegible] fully able [illegible] difficulty in finding work suiting disability.

When employers are required to put injured staff on "light-duties" the employer may simply state that no light duty work exists, and sack the worker as unable to fulfill specified duties. When new forms of workplace injury are discovered, for instance: stress, repetitive strain injury, silicosis; the law often lags behind actual injury and offers no suitable compensation, forcing the employer and employee back to the courts (although in common-law jurisdictions these are usually one-off instances). Finally, caps on the value of disabilities may not reflect the total cost of providing for a disabled worker. The government may legislate the value of total spinal incapacity at far below the amount required to keep a worker in reasonable living conditions for the remainder of his life.

DISASTER MANAGEMENT:

It is a systematic process (i.e based on the key management principle of planning, organising and leading which include coordinating & controlling)

AIM:- is to reduce the negative impact or consequences of adverse event (i.e, disaster cannot always be prevented, but the adverse effect can be minimised)

It is a system with many component :-

1) Hazard
2) Emergency :- "Is a situation generated by the real or imminent occurrence of an event that requires immediate attention"
3) Disaster
4) Risk
5) Vulnerability :- "Is the extent to which a community's structure, service or environment is likely to be damaged or disrupted by the impact of hazard.

Emergency Mangement: is the generic name of an interdisciplinary field dealing with the strategic organization management processes used to protect critical assets of an organization from hazard risk that can causes event like disaster or catastrophes & to ensure the continuance of the organization within their planned lifetime.

Q) distinguis b/w

Emergency	Disaster
Emergency is a situation in which the community is capable of coping. It is a situation generated by real or imminent occurrence of an event that require immediate attention & that require immediate attention of emergency resources	Disaster :- is a situation in which the community is incapable of coping. It is a natural or human caused event which causes intense negative impacts on people, goods service & enviornment exceeding ~~that~~ the affected community's capability to response; therefore the ~~com~~ community seek the assistance of govornment & international agencies

PRINCPLE OF EMERGENCY MANAGEMENT:

1) Comprehensive: emmergency manager consider & take into account all hazard, all phase, all stakeholder & all impacts relevant to disaster.

2) Progressive: Emergy manger anticipate future disaster & take preventative & preparatory measures to build disaster-resistant & disaster-resilent communities.

3) <u>Risk driven</u> :- emergency managers use sound risk management principles (hazard identification, risk analysis & impact analysis) in assigning priorities & resources

4) <u>Integrated</u> :- emergency manager ensure unity of effort among all levels of government & all element of community.

5) <u>Collaborative</u> :- Emergency manager create & sustain broad & sincere relationship among individual & organization to encourage trust, advocate a team atmosphere & facilitate communication

6) ~~Coordinated~~ flexible - emergency Manager use creative & innovative approaches in solving disaster challenge

7) ~~Flexible~~ Coordinated :- emergency manager synchronize the activities of all relevant stake holder to achive a common purpose

DISASTER: A serious disruption in the functioning of community or a society causing wide spread material, economic, social or environment losses which exceed the ability of the affected society to cope using its own resources

- **Hazard:** Hazard is defined as a dangerous condition or event that threat or have the potential for causing injury to life or damage to property or the environment".
- **Natural Hazard:** hazard which are caused because of natural phenomena (hazard with meteorological, geological or even biological origin)

Manmade hazard:- are hazard which are due to human negligence. Manmade hazard are associated with industries or energy generation facilities & include explosions, waste, pollution etc

- **Types** — **Hazards**

Types	Hazards
1) Geological Hazard	Earth quake, Tsunami, Volcanic erruption, Dam burst, landslide, Mine fire.
2) Water & Climatic Hazard	Tropical Cyclone, Floods, Hailstorm, Hurricane, Sea erosion.
3) Environmental Hazard	Environmental pollution, Deforestation, Pest infection
4) Biological	Human \ Animal Epidemics, Pest attack, Weapons of Mass Destruction.

Type	Hazards
Chemical, Industrial	Chemical disasters, Oilspills
Nuclear Accidents	Industrial disasters, Nuclear

Risk → Risk is "a measure of expected losses due to a hazard event occuring in a given area over specific time period. Risk is a function of probability of particular hazardous event and the losses each would causes"

The level of risk depend on

→ Nature of Hazard

→ Vulnerability of elements which are affected

→ Economic value of those element.

DISASTER RISK REDUCTION CAN TAKE PLACE IN FOLLOWING Ways

1) Preparedness →

This protective process embraces which enable governments, communities & individual to respond rapidly to disaster situation to cope with them effectively. Preparedness include the formulation of viable emergency plans, the development of warning systems the maintenance of inventories & the training of personnel It may also embrace search & rescue measures as well as evacuation plans for area that may be at risk from a recurring disaster.

Preparedness therefore encompasses those measures taken before a disaster event which are aimed at minimising loss of life, disruption of critical services & damage when the disaster occur.

DISASTER MANAGEMENT CYCLE:

Disaster Risk Management include sum total of all activities, programmes & measures which can be taken up before, during & after a disaster with the purpose to avoid disaster, reduce its impact or recover from its losses. The 3 key stages of activities that are taken up within disaster risk management are

Before Disaster (pre disaster).

Activities taken to reduce human & property losses caused by a potential hazard for exp:- carrying out awareness campaigns, strengthening the existing weak structures, preparation of the disaster management plans at household & community levels etc. Such risk reduction measure take under this stage are termed as mitigation & preparedness activities

2) During a disaster (disaster occurrence) :-

Initatives taken to ensure that the needs & provision of victims are met & suffering is minimized. Activities taken under this stage are called emergency response activities

3) After a disaster (post ~~Hazard~~ Disaster) :-

Initiative taken in response to a disaster with a purpose to achieve early recovery & rehabilitation after a disaster strikes. These are called as response & recovery activities

Occupational Health & Saftey (OHS) legislation

Section 15 of the Alberta Occupational Health & Saftey (OHS) Regulation require an employer to ensure that procedures are established to minimize worker exposure to "harmaful substances" at work sites.

- A harmful substance is defined in section 1 of Regulation as "a substance that, because of its properties, application
- or presence, creates or could create a danger, including a chemical or biological hazard, to the health & saftey of worker exposed to it".

Worker must be provided with training on procedures developed by employer & apply that training at work site.

- Part 2 of the Alberta (OHS) code require an employer
- to asses hazard at work site. Hazard that are identified must be eliminated or controlled.

If there may be emergencies at work site that involve fire or explosion, the employer must develop an emergency response plan that includes the element specified in part 7 of OSH code

Specific health & saftey requirement for fire & explosion hazard can be found in Part-10 of OHS code
· At work site no person may:—

1) Work or enter a work area where the LEL is greater than 20% except for ~~component~~ competent workers responding to emergency

2) Smoke or use of open flame in area of work site where a flammable material is stored, handled or processed.

3) Mix, clean with or use a flammable or combustion liquid at temp above in flash point in an open vessel if there is a potential ignition source nearby

4) Use a flammable or combustion liquid at temp above its flash point for washing or cleaning except in cleaning equipment specially designed and manufacturing for this purpose.

Sto

Handling and Storage of flammable Materials at the Work site :

What are flammable materials

flammable materials are substance that can ignite easily & burn rapidly. They can be common material that are at most work sites in gas, liquid & solid forms. Some examples of flammable material are :-

GASES: Natural gas, propane, butane, methane, hydrogen sulphide flammable gas are usually gases with a low explosive limit of less than 13% in air, or have a flammable range in air of at least 12%.

LIQUID: Gasoline, many solvent such as acetone, alchols & toulene, paint & adhesive, cleaners, wax, polishes.

- flammable liquid have flash point below 37.8°c (100°F)

SOLIDS : Some type of coal, pyrophoric metal (metal that can burn in contact with air, water or such as sodium & potassium) (FeS, uranium) Solid wastes that are soaked with flammable liquid (paper, spill clean up product), gun powder, dust & ignitable fibres.

Storage of flammable materials:

flammable material must not be stored near exits, electric equipment or heating equipment. They should always be stored in a seperate, well-ventilated storage area, away from potential source of ignition.

1) Portable Storage container for flammable liquid

When flammable liquid are transferred from their original container or from bulk storage such as drum or tank, it is Important that proper type of portable contain be used.

Storage of "portable quantities" are usually made of metal or plastic, are vapour-proof & have

→ welded seams
→ spark or flame arrestors
→ pressure release valve or spring closing lids with spout cover.

2) Storage Cabinets

When individual container of flammable liquid are not in use & are stored inside building, they should be stored in cabinet. Storage cabinet should met the requirement of standard ULC/ORD C 1275

National fire Protection ass. guidelines -

→ Up to 500L of flammable liquid may be stored in cabinet, however no more than half of total volume (up to 250L) can be flammable liquid.

3) <u>Storage tank & Rooms</u> →

At some work sites, there are many different types of flammable material or large volumes of particular materials used. At these sites, flammable material may be stored in large container (drum or tank) or they may be specified flammable material storage room.

~~→ Do not sto~~

<u>In general</u>

1) Do not store other type of chemicals beside bulk storage container for flammable material or in storage room for these product

2) Bulk storage container should be located away from potential ignition source such as heat, spark etc.

3) Do not store ~~coppto~~ compressed gas beside flammable material container.

4) Smoke should never be allowed near flammable material storage area

5) flammable gases:

When storing flammable gas in work place

→ store flammable gas cylinder in a seperate well ventilated room.

→ ensure that cylinder are properly secured so that they cannot fall over & valves are protected from damage

→ always use correct fitting & valves for specific cylinder, do not mix & match fitting.

Handeling flammable materials →

FIRE PREVENTION

To prevent fires, flammable ~~gas~~ material must be properly managed in the work place. These are 3 main ways to prevent fires.

1) limit the amount of flammable & combustible material

   a) keep only what you need on-site

   b) Purchase material in smallest volume necessary

   c) At work location, keep only those chemicals that are needed for present task

d) do not let hazardous waste accumulate at work site

e) Store ~~chemical~~ product, including wastes, used at worksite in proper container

f) keep flammable material seperate from other processes & storage area.

2) Provide proper ventilation to ensure flammable vapour do not accumulate.

a) Install properly designed ventilation in storage area

b) Ensure that processes that are use or make flammable material do not exhaust back in work site

c) Ventilation system must be properly maintained

3) Control ignition sources

a) Ground & bond all work & ignition proof equipment

b) Ensure that there is no smoking in work areas where flammable materials are stored or used

c) Use intrinsically safe & non-sparking tools.