



SAFETY IN CHEMICAL INDUSTRY

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Topics covered

- ✓ Inevitable place of Chemical Industry
- ✓ Need of Safety in Chemical Industry
- ✓ Statutory Provision
- ✓ Indian Standards
- ✓ MSDS
- ✓ PPE's in Chemical Industry
- ✓ Chemical Hazards & Control
- ✓ Process Hazards & Control
- ✓ Storage Hazards & control
- ✓ Safe Transportation of Chemicals
- ✓ Emergency Preparedness

Inevitable place of Chemical Industry

- ☑ Chemistry is the study of the principles governing various forms of matter and how do they inter-convert
- ☑ Chemical engineering applies these principles to convert raw materials into useful products.



Inevitable place of Chemical Industry

The safest and simplest way to avoid chemical hazards and their ill-effects is to avoid chemical industry itself.

But is it possible?

A place of chemical industry can be selected or shifted but it has to run somewhere on the earth and its place in our life has become *inevitable* because

Don't be like this guy



Inevitable place of Chemical Industry

- ☑ In homes we need cement, plaster, tiles, paint, plywood, glass, plastic, curtains, TV, tubes etc
- ☑ In kitchen we want gas, fuel, matches, heating appliances, metal or ceramic dishes et.
- ☑ For health we need drugs, pharmaceuticals, cosmetics, perfumes, talc etc.
- ☑ Agriculture needs fertilisers and pesticides.
- ☑ Construction requires minerals, metals, lime, cement, explosives etc

Contd.

Inevitable place of Chemical Industry

- ✓ **Transportation needs petrol, diesel, gas, paints, rubber etc**
- ✓ **Clothing requires dyes, colours, soaps, detergents and a variety of chemicals**
- ✓ **In offices we want paper, ink, adhesives, photo-copies, computer etc.**
- ✓ **Basic needs like air, water, food, clothing and shelter are the product of chemistry**
- ✓ **Our human body itself is an astounding chemical industry carrying wonderful chemical processes within it.**



Need of Safety In Chemical Industry

Therefore, it is not possible to avoid or prevent chemical industry and the only way remains for us is to run this industry *safely* by identifying, avoiding and controlling its hazards.

Need of Safety In Chemical Industry

- ☑ Study and identify chemical hazards using material safety data sheet (MSDS).
- ☑ Select safer technology
- ☑ Select safer sitting of chemical industry for minimum loss to men, material, environment etc
- ☑ Design and construct the factory with all safety precautions from the very beginning
- ☑ Workplace hazards inside the factory should be controlled by good engineering controls, safe work methods or operating procedure and using personal protective equipments

Contd.

Need of Safety In Chemical Industry

- ☑ All requisite safety devices, fittings, instruments, equipment, machines etc., must be provided and well maintained
- ☑ Workers must be properly trained for safe operation of the plant and their role in emergency planning and control
- ☑ Safe transportation and handling of hazardous chemicals within and out-side factory premises
- ☑ Safe disposal of hazardous wastes within and outside factory premises
- ☑ Well monitoring and control of hazardous substances at work places and of occupational ill-effects and diseases by pre and periodical medical examinations of the workers

Statutory Provisions

Factories Act 1948– Some of the Salient features

Sections	Scope
2 (cb)	Hazardous Process
7A & 7B	General duties of Occupier
11 to 20	Cleanliness, disposals of waste & effluents, ventilation & temperature, dust & fumes, overcrowding, lighting, drinking water, latrines, urinals & spittoons
Chapter - IV, Section 21 - 41	Provision of Hoist & lifts, lifting machines, revolving machinery, pressure plants, floors, stairs, means of access, excessive weights, precautions against dangerous fumes, use of portable electrical lights, explosive or inflammable dust, gas etc.
Chapter - IV A, Section 41 A - H	Hazardous Process provides for site appraisal committees, disclosure of Informations, health & safety policy, medical examination, health records, supervision, permissible limits of toxic chemicals (second schedule), safety committees
Chapter - V, Section 42 - 50	welfare provides washing facilities, cloak room, first aid, ambulance room, canteen, rest & lunch room.& crèche
Section 87 - 91	Dangerous operation, notice of Accidents, diseases, 87 A prohibits employments on account of serious hazards.
Section 96 A	Penalty for breach of Section 41 B, C or H

Statutory Provisions

Scope	Gujarat Factory Rules 1963	UP Factory Rules 1950
Pressure Plants	Rule 61	55 A
Protection of eyes	Rule 63	58
Material Safety Data Sheet		63C
Fire Safety	Rule 66 & 66A	61
Notice of Accidents	Rule 103 & 104	110
Reaction vessels & kettles	Rule 61 B	--
Fragile Roofs	68E	--
Ovens & Driers	Rule 68 G	62 A
Hazardous Chemicals	68 J	Uttar Pradesh Factories (Control of Industrial Major Accident Hazard Rules, 1996 - 2a
Disclosure of Informations	68 K to N, P & Q	63 D
Chemical Works	Schedule 19	Schedule 12
Solvent extraction Plants	Schedule 21	Schedule 20



Statutory Provisions

- ✓ Factory Acts & Rules
- ✓ Boiler Act 1923
- ✓ State Boiler Rules
- ✓ Indian Boiler Regulations 1950
- ✓ The petroleum Act & Rules
- ✓ The Explosive Act & Rules
- ✓ The Insecticide Act & Rules
- ✓ The poisonous Acts & Rules
- ✓ The Electricity Act & Rules
- ✓ Gas Cylinder Rules 1981
- ✓ Static & Mobile Pressure Vessels 1981
- ✓ Water & Air Pollution Control Acts & Rules
- ✓ Environment Protection Act 1986 & Rules
- ✓ Hazardous Waste Management Rules 1989
- ✓ MSIHC Rules 1989
- ✓ Chemical Accident Rules 1996
- ✓ Bio Medical Waste Rules 1998
- ✓ Building & Construction Act 1996.
- ✓ Radiation protection Rules
- ✓ Atomic Agency Act

Indian Standards

Some Example of BIS

Code For Safety	BIS Standards
Laboratory Safety	4209
Classifications of Dangerous Goods	1446
Classifications of Hazardous Chemicals	4607
LPG Installations	6044
Acetylene Cylinders	8433
Static Electricity	7689
Fire Safety of Buildings	3594
Plant lay out, Safe practice	8089 / 8091
Code For Occupational Safety & Health Audit	14489
OISD has published the Safety Standards for all refineries, LPG bottling Plants, Gas terminals, ONGC & GAIL installations.	OISD 105 TO 231

Material Safety Data Sheets





Material Safety Data Sheets – Legal Obligations

- ☑ Many countries have legislation that requires chemical producers or suppliers to prepare MSDS.
- ☑ Factories Act (41B) & Factory Rules (63 C) entrust to Occupiers of every Factory carrying a hazardous process to obtain or develop information in the form of MSDS.
- ☑ As per Schedule 9, Rule 17 of the MSIHC 1989 notification stipulates that every manufacturers, traders or suppliers of chemicals has to prepare MSDS in a prescribed format for each chemicals they deal.
- ☑ In India we follow 10-section MSDS
- ☑ However, International Labour Organization (ILO), the European Union (EU, formerly the European Communities, EC), the American National Standards Institute (ANSI), and the International Organization for Standardization (ISO) recognize 16-headings for MSDSs.

Material Safety Data Sheets

What is MSDS :

- ☑ A Material Safety Data Sheet (MSDS) is designed to provide both workers and emergency personnel with the proper procedures for handling or working with a particular substance.
- ☑ MSDS's include information such as physical props. (melting point, boiling point, flash point etc.), toxicity, health effects, first aid, reactivity, storage, disposal, PPE, and spill/leak procedures.
- ☑ These are of particular use if a spill or other accident occurs.

Material Safety Data Sheets

MSDS are meant for :

- ⇒ **Employees who may be occupationally exposed to a hazard at work.**
- ⇒ **Employees who need to know the proper methods for storage assessment etc.**
- ⇒ **Emergency responders such as fire fighters, hazardous material crews, emergency medical technicians, and emergency room personnel etc.**

Material Safety Data Sheets

MSDS Applications :

MSDS enables users to take the necessary measures relating to :

- ⇒ Protection of human health & safety at work place.
- ⇒ Protection of the environment

MSDS enables the employer to determine if any chemical agents are present in the workplace and to assess any risk from its use.

Material Safety Data Sheets

Who Prepares it :

Responsible body of the marketing of the substance or preparation
Manufacturer / importer / distributor

Who receives it :

Downstream users of the substance or preparation

How :

Free of Charge, Paper or electronic format

When :

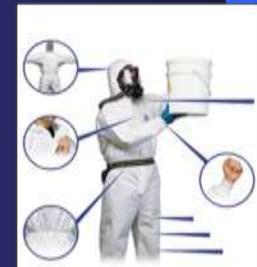
Before or during the first supply of the substance or preparation

- ⇒ Mandatory updating : When new information on the classification are available
- ⇒ Language : that of the downstream users
- ⇒ It must report the preparation date and the date of last updates.

Material Safety Data Sheets

	Indian Factory Rules - 10 Point MSDS	European Union - 16 Point MSDS
Section 1.	Chemical Identity	Chemical Product & Company Information
Section 2	Physical & Chemical Data	Composition/Information on Ingredients
Section 3	Fire & Explosion Hazard Data	Hazards Identification
Section 4	Reactivity Data	First Aid Measures
Section 5	Health Hazard Data	Fire Fighting Measures
Section 6	Preventive Measures	Accidental Release Measures
Section 7	Emergency & First Aid Measures	Handling and Storage
Section 8	Additional Information / References	Exposure Controls/Personal Protection
Section 9	Manufacturer / Supplier Data	Physical and Chemical Properties
Section 10	Disclaimer	Stability and Reactivity
Section 11		Toxicological Information
Section 12		Ecological Information
Section 13		Disposal Considerations
Section 14		Transport Information
Section 15		Regulatory Information
Section 16		Other Information

Head to Toe Protection for Chemical Industries





PPE Standard & Requirement

- ☑ Personal protection equipment is important. So important, that in 1994, OSHA (the Occupational Safety and Health Administration) established 29 CFR 1910.132-138, the "Personal Protection Equipment" standard.

- ☑ Briefly stated, this standard requires that employers must establish and administer an effective PPE (Personal Protection Equipment) program for employees and that employees be trained in the proper use of PPE.

- ☑ In the Factories Act 1948, there are specific provisions for providing the personal protective equipment to workers who are exposed to unsafe and unhealthy environment.

- ☑ It is also the intention of the law that these personal protective equipments shall be of such type and made of such materials that they withstand to such specific hazards for which they are actually being used.

- ☑ Quality of personal protective equipment shall be as per the provision in Rule 68-B of Gujarat Factories Rules 1963 & 63 D Under UP Factory Rules under the Factories Act 1948

How Do We Control Hazards

To control hazardous and unsafe conditions and work practices, use the most effective control methods feasible at your work place. Try to reduce employee exposure by implementing effective controls that do not primarily rely on individual employee behavior. Follow a system of strategies, called the "Hierarchy of Controls," which prioritizes control methods that try to remove or reduce the hazard:

Hierarchy of Controls (most to least effective)

Eliminate/reduce the hazard	Engineering Controls
Reduce the hazard	<ul style="list-style-type: none">• Work Practice Controls• Administrative Controls
Put barrier between worker and hazard if needed	Personal Protective Equipment (PPE)

PRODUCT	APPLICATION	BIS STANDARD	EN STANDARD	IMAGE
Safety Goggles	Eye Protection		ANSI Z87.1 EN166	
Face Shield	Face Protection	IS:8521(Part 1 and 2)	ANSI Z87.1 EN166	
Helmet	Head Protection	IS: 2925-1984	EN397	
Ear Plug/Muff	Ear Protection	IS: 9167-1979 IS: 6229-1980	EN352-1/2/3	
Respirators	Respiratory Protection	IS: 9473-1980	CFR-29 EN 149 / 148	
Gloves	Hand Protection		EN374.2003	
Aprons and Clothing	Body Protection	IS: 12257-1984 IS: 3322-1965	EN343	
Safety Shoe	Foot Protection	IS: 1989 (Part-1 & 2)-1986	EN344	
Breathing Apparatus	Confined Space and Emergency	IS: 10245 (Part 2 & 4)- 1982	NFPA1981:	
Supplied Airline	Continuous fresh air supply	IS: 10245 (Part 3)- 1982		

Head Protection

- Parts of a Hard Hat:



- **Class A** designed to:

- Protect you from falling objects; and
- Protect you from electrical shocks up to 2,200 volts.

- **Class B** are designed to:

- Protect you from falling objects; and
- Protect you from electrical shocks up to 20,000 volts.

- **Class C** are designed to :

- Protect you from falling objects;
- DO NOT protect you from electrical shocks; and
- DO NOT protect you from corrosive substances

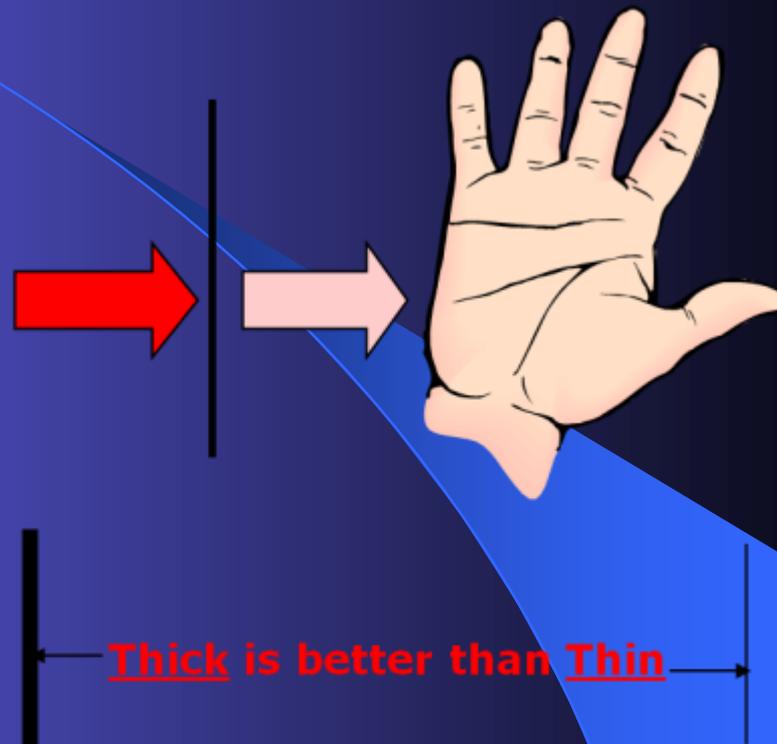
Chemical Resistance Gloves Facts

Chemical-resistant gloves are not totally “chemical-proof”

Solvents will eventually penetrate the gloves over time.

The thicker the glove, the more resistant it is to solvents.

Solvents will also break down (swell, crack or weaken) the glove material over time.



Chemical Resistance Gloves

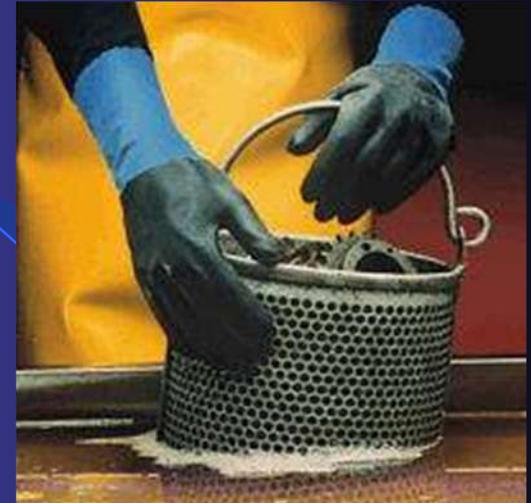
- Chemical glove selection

No single glove material will protect against all solvents.

You must select gloves according to the type of solvent.

Good chemical gloves are made of Viton[®], butyl, nitrile, neoprene, PVC or a combination of these.

[Link to chemical glove selection guide](#)



Types of Respirators

Air-purifying half-face respirator – solvent is captured in an activated charcoal cartridge



Air-purifying full-face respirator – same as above, but also provides protection from solvent eye irritation



Powered air purifying respirator (PAPR)- air is pulled through cartridges by a battery-operated fan. Reduces breathing resistance.



Air-line Respirator – fresh air is supplied by a hose from a compressor. The most protective type typically used for high levels or confined space work.



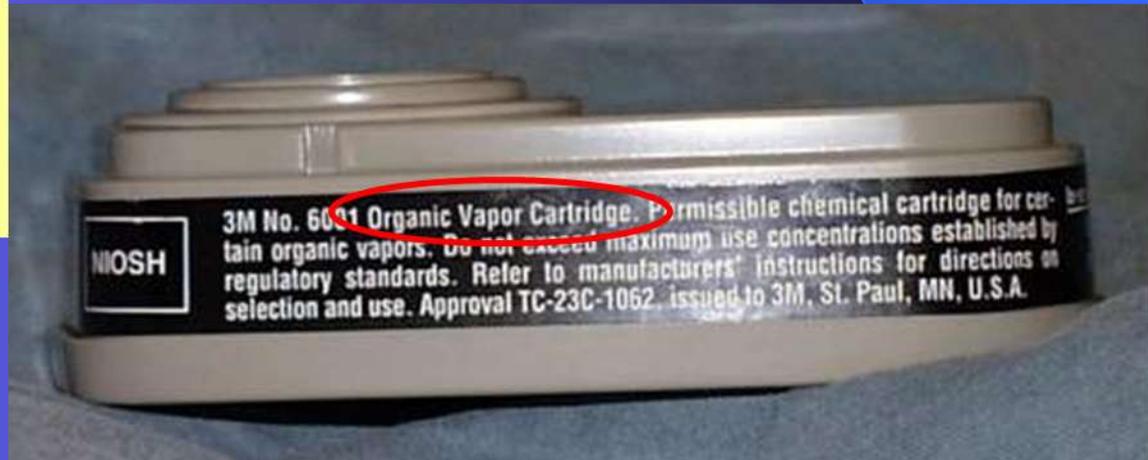
Organic Vapor - Cartridge

“Organic vapor” cartridges are the only type that capture solvent vapors.

Cartridges for solvents will absorb only so much solvent until breakthrough occurs.

Cartridges are not suitable for some solvents since they are not trapped inside the cartridge. (includes methanol and methylene chloride)

Cartridges should be selected and changed regularly according to manufacturers recommendations.



Safety Shoes

There are many types of footwear that are designed to protect your feet.



Steel toe footwear protects your toes from falling objects and from being crushed.



Latex/Rubber footwear resists chemicals and provides extra traction on slippery surfaces



Butyl footwear protects against most ketones, aldehydes, alcohols, acids, salts, and alkalis.



Vinyl footwear resists solvents, acids, alkalis, salts, water & grease

Safety Shoes

There are many types of footwear that are designed to protect your feet.



Electrostatic dissipating footwear conducts static electricity to floors that are grounded.



Electrical hazard footwear are insulated with tough rubber to prevent shocks and burns from electricity.



Disposable footwear includes shower slippers, clear polyethylene and non-woven booties used in dust free work areas.

PPES – In Short

The Personal Protective Equipment (PPE) Rule says you must

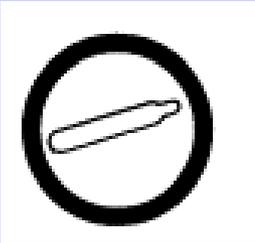
- ☑ Do a Hazard Assessment for PPE and document it
- ☑ Select and provide appropriate PPE to your employees
- ☑ Provide training to your employees and document it
- ☑ Make sure your employees use their PPE properly
- ☑ Make sure PPE is in safe and good condition

Defective equipment can be worse than no PPE at all.

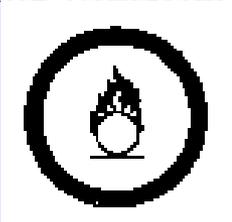
Chemical Hazards & Control



Chemical Hazard & Controls

Class & Symbols	Characteristics	Precautions
<p>Compressed Gas</p> 	<ul style="list-style-type: none"> • Gas inside cylinder is under pressure • The cylinder may explode if heated or damaged • Sudden release of high pressure gas streams may puncture skin and cause fatal embolism 	<ul style="list-style-type: none"> • Transport and handle with care • Make sure cylinders are properly secured • Store away from sources of heat or fire • Use proper regulator
<p>Flammable & Combustible Material</p> 	<ul style="list-style-type: none"> • May burn or explode when exposed to heat, sparks or flames • Flammable: burns readily at room temperature • Combustible: burns when heated 	<ul style="list-style-type: none"> • Store away from (oxidizing materials) • Store away from sources of heat, sparks and flame • Do not smoke near these materials

Chemical Hazard & Controls

Class & Symbols	Characteristics	Precautions
<p>Oxidizing Material</p> 	<ul style="list-style-type: none"> • Can cause other materials to burn or explode by providing oxygen • May burn skin and eyes on contact 	<ul style="list-style-type: none"> • Store away from (flammable and combustible) materials • Store away from sources of heat and ignition • Wear the recommended protective equipment and clothing
<p>Poisonous & Infectious Material, Materials causing immediate & serious toxic effects</p> 	<ul style="list-style-type: none"> • May cause immediate death or serious injury if inhaled, swallowed, or absorbed through the skin 	<ul style="list-style-type: none"> • Avoid inhaling gas or vapours • Avoid skin and eye contact • Wear the recommended protective equipment and clothing • Do not eat, drink or smoke near these materials • Wash hands after handling

Chemical Hazard & Controls

Class & Symbols	Characteristics	Precautions
<p>Corrosive Materials</p> 	<ul style="list-style-type: none"> • Will burn eyes and skin on contact • Will burn tissues of respiratory tract if inhaled 	<ul style="list-style-type: none"> • Store acids and bases in separate areas • Avoid inhaling these materials • Avoid contact with skin and eyes • Wear the recommended protective equipment and clothing
<p>Dangerously Reactive Material</p> 	<ul style="list-style-type: none"> • May be unstable, reacting dangerously to jarring, compression, heat or exposure to light • May burn, explode or produce dangerous gases when mixed with incompatible materials 	<ul style="list-style-type: none"> • Store away from heat • Avoid shock and friction • Wear the recommended protective equipment and clothing

Routes of Chemical Exposure

- Inhalation – breathing (e.g., powders, fumes)
- Absorption – skin or mucus membranes
- Ingestion – entry through mouth
- Injection – through skin by foreign body
- *Acute Exposure (short term): eye irritation, nausea,*
- *dizziness, skin rash, burns, headache*
- *Chronic Exposure (long term): long-term illness*

Examples of Toxic Effects



Chemical Hygiene Plan

A written document addressing:

- ✓ Standard operating procedures (SOP)
- ✓ Exposure control measures
- ✓ Fume hood & protective equipment
- ✓ Information & training
- ✓ Chemicals that require prior planning & approval
- ✓ Work with particularly hazardous substance
- ✓ Medical consultations and examinations

Chemical Incompatibility Matrix

	Acids (Inorganic)	Acids (Organic)	Acids (Oxidizing)	Bases (Alkalis)	Oxidizers	Poisons (Inorganic)	Poisons (Organic)	Solvents (Organic)	Water Resistance
Acids (Inorganic)		Red		Red		Red	Red	Red	Red
Acids (Organic)	Red		Red	Red	Red	Red	Red	White	Red
Acids (Oxidizing)		Red		Red		Red	Red	Red	Red
Bases (Alkalis)	Red	Red	Red			White	Red	Red	Red
Oxidizers		Red	White			White	Red	Red	Red
Poisons (Inorganic)	Red	Red	Red	White	White	White	Red	Red	Red
Poisons (Organic)	Red	Red	Red	Red	Red	Red	White	White	White
Solvents (Organic)	Red	White	Red	Red	Red	Red	White	White	White
Water Resistance	Red	Red	Red	Red	Red	Red	White	White	White

Red -
Incompatible
&
White - OK

Process Hazards & Control

Types of Processes & Operations:-

Generally in a chemical plant processes are classified as batch processes or continuous processes or their combination.

- Batch Process – Relatively more manpower is required & are exposed to hazards more frequently.
- Continuous Process – Carried out in a closed vessel or circuit and poses relatively less or no chemical exposure.

Process Hazards & Control

Many processes are operated at high pressure and high temperature for which automatic warning, monitoring & controlling devices are desired.

- Flammable, explosives & solvent distillation processes should be carried out under inert atmosphere or vacuum .
- Toxic processes should be connected with appropriate scrubbers and neutralisers.
- Study all unit processes and unit operations with complete reaction documents i.e. all reaction data of intermittent behaviour as well as escaping behaviour out of the controlled parameters.

Process Hazards & Control

- This requires precise laboratory study and much details of side reactions, unwanted runaway reaction, generation of any flammable or toxic vapour, fumes, gas etc. or generation of abnormal pressure, temperature at any stage of the process.
- Based on above all necessary safety measures must be kept ready and provided to keep the reaction in control and to control if the reaction is going out of control.
- Processes involving exothermic & high pressure reactions, toxic substances, highly flammables etc. are difficult to control and needs much attention.
- Controls such as automated high pressure & temperature trip and alarm devices, safety valves, inert blanketing, earthing & bonding etc to be provided for such processes.

Hazard Control

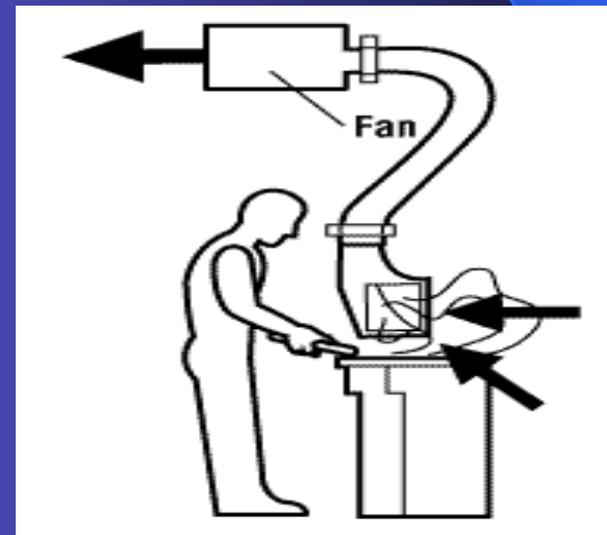
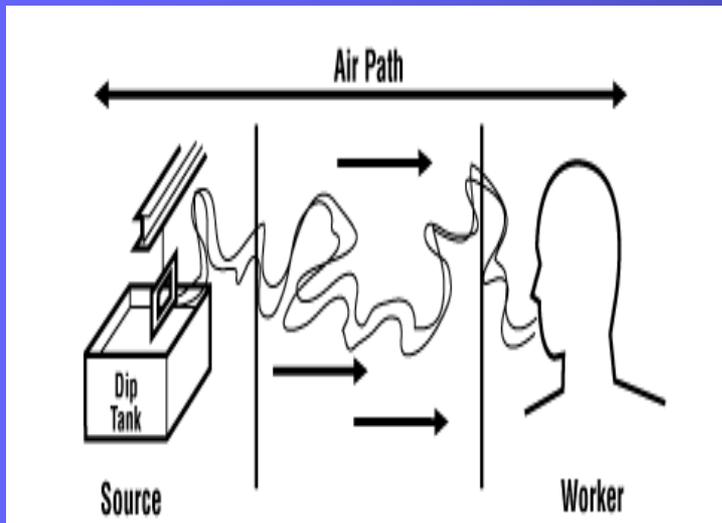
A control program consists of all steps necessary to protect workers from exposure to a substance or system

- Selecting an appropriate control is not always easy. It often involves doing a Risk assessment to evaluate and prioritize the hazards and risks using following methods.
 - What-If,
 - Hazard and Operability Study (HAZOP),
 - Failure Mode and Effects Analysis (FMEA),
 - Fault Tree Analysis etc.

Hazard Control

Controls are usually placed:

- At the source (where the hazard "comes from")
- Along the path (where the hazard "travels")
- At the worker



Preferred ways to Control Hazard

Preference	Control	Example
1.	Eliminate	Removing the hazard, eg taking a hazardous piece of equipment out of service.
2.	Substitute	Replacing a hazardous substance or process with a less hazardous one, eg substituting a hazardous substance with a non-hazardous substance.
3.	Isolation	Restricting access to plant and equipment or in the case of substances locking them away under strict controls.
4.	Engineering	Redesign a process or piece of equipment to make it less hazardous. Isolating the hazard from the person at risk, eg using a guard or barrier.
5.	Administrative	Adopting standard operating procedures (SOPs) or safe work practices or providing appropriate training, instruction or information.
6.	Personal Protective Equipment	The provision and use of personal protective equipment could include using gloves, glasses, earmuffs, aprons, safety footwear, dust masks.

Storage Hazards & Controls

Storage vessels are used to contain chemicals in bulk. Storage tanks to contain 10 tonnes to 10000 tonnes material are constructed. Oil refineries, petrochemical plants or fertilizers plants have even bigger tanks also.

If such tanks leaks, breaks or caught in fire, a great hazard is possible. When a fire, explosion or gas leak takes place from a bulk quantity, tremendous efforts are required to control the situation and save loss to people, property and environment.

Therefore safety of storage tanks needs highest attention.

Control for Storage Hazards

- The important & first step is the proper selection of **construction of material** for the vessel depending on the type of chemical to be stored or processed, chemistry of that chemical in relation to the material of vessel, type of use, durability required.
- After proper selection of material of construction, vessel are to be constructed according to the applicable **design standards**.
- A **notice** indicating the name of the chemical stored, tank capacity and some imp. Properties (e.g. Sp. Gravity, B.P., Flash point. LEL-UEL, TLV) should be displayed on or near the tank. It should be easily & clearly visible & in the language understood by the workers.

Control for Storage Hazards

- **DYKE OR BUND**-This should be sound, safe & leak proof and to be made as per the standards. Partition walls to be provided in a dyke to segregate the chemicals of different flash points.
- **SEPARATION DISTANCE**-Minimum safe distance between tanks, building and a source of ignition to be kept.
- **VENT PIPES**-Vent pipes should have, wire mesh, flame arrestor or breather valve according to the nature of chemical stored. If toxic or corrosive material is stored, vent is connected with an appropriate scrubber.

Control for Storage Hazards

- Vent cooler/ Condenser to be provided as per the properties of chemical stored.
- In transferring pressurized gases like chlorine, ammonia, LPG, open vent is not possible and it is connected as return line in closed circuit and vent is closed after filling up the tank.
- **Overflow Safety-** For the overfilling safety, a safe overflow pipe to be provided. High (safe) level alarm & feed pump trip devices to be interlocked to avoid overfilling of tanks.

Control for Storage Hazards

- **Filling ratio-** A tank should not be filled beyond its filling ratio (Rf). It is defined as the ratio of the weight of the material (Liquid or gas) to the weight of the water that the tank will hold at 15 deg.C.
- **Level Indicator-** The qty. of the material stored should be externally visible. Level indicators are to be selected as per the type of contents to be stored.
- **Pressure Relief Devices-** If pressure inside a tank rises, it may burst the tank and may create fire, explosion or toxic hazard. To avoid such situation a Pressure Relief Device is necessary. Safety valve, Ruptured Disc, Relief valve, Fusible plug and PVRV (Pressure & Vacuum relief valve) are to be selected as per requirement.

Control for Storage Hazards

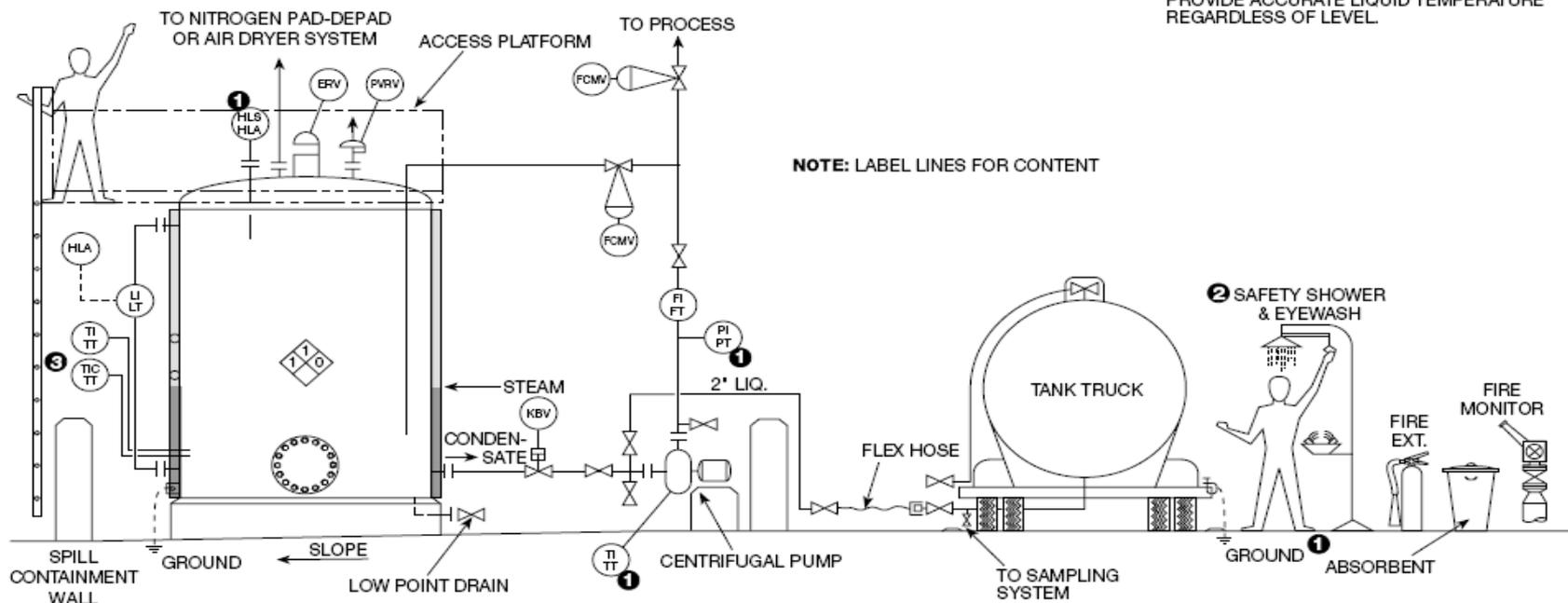
- **Flameproof Fitting**-Electric fittings like motors starters, switches, lamps etc. near the storage tanks containing flammable material should be of approved flameproof types.
- **Earthing & Bonding**-Tanks & piping containing flammable material should have double earthings. Resistance (<10 ohm) should be measured & recorded. Pipe joints/ flanges should have copper bonding to maintain electric continuity. The filling (Inlet) pipe should be extended up to bottom to avoid free fall & static charge due to material flow.
- **Flange-guards**-These are useful to divert the leakage downwards.

Control for Storage Hazards

- Appropriate PPE's should be worn by workers to protect themselves in case of any accidental discharge or exposure.
- **Fire Fighting Equipment**-Appropriate fire fighting equipments are to placed near the storage as per applicable standards. Training & maintenance of these eqpt. is most essential.
- **Water sprinklers & Foam injection systems**-These systems are to provided to cool the tanks & prevent the fire to spread from one tank to another tank. Water can be used as scrubbing medium for water soluble gases.
- **Emergency shower & Eye washer** at storage of hazardous materials.

Control for Storage Hazards

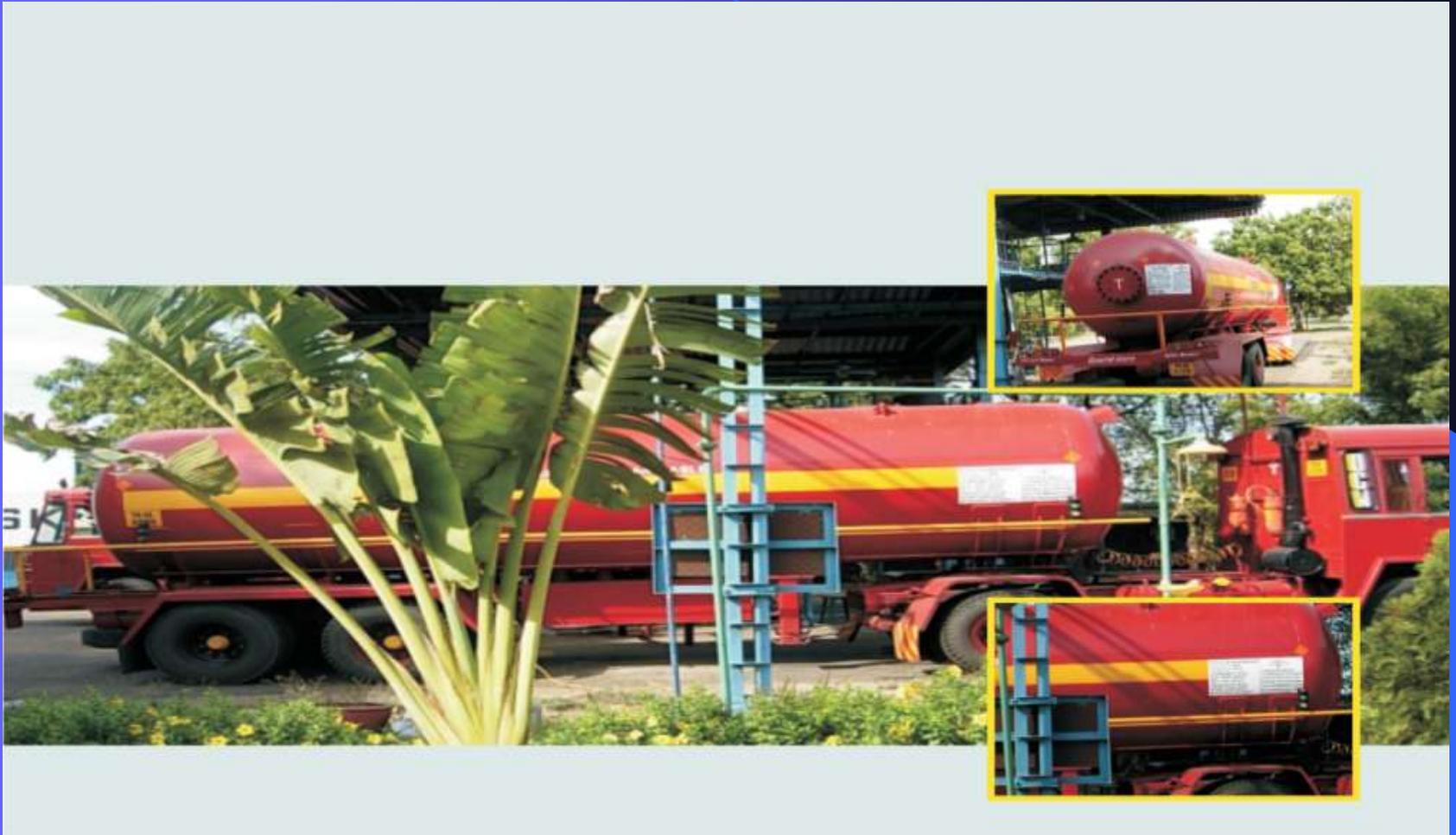
- ❶ PUMP TO BE TURNED OFF BY:
HIGH LEVEL IN TANK
HIGH TEMPERATURE
LOW PUMP DISCHARGE PRESSURE
LOW PUMP DISCHARGE FLOW
LOSS OF ELECTRICAL GROUND
- ❷ SAFETY SHOWER MUST BE LOCATED
TO BE QUICKLY ACCESSIBLE FROM ALL
PRODUCT HANDLING AREAS.
- ❸ POSITION TEMPERATURE SENSORS TO
PROVIDE ACCURATE LIQUID TEMPERATURE
REGARDLESS OF LEVEL.



LEGEND

PCV = pressure control valve, ERV = emergency relief valve, VRV = vacuum relief valve, HLS = high level switch, HLA = high level alarm, LI - level indicator, LT = level transmitter, EBV = emergency block valve, TI = temperature indicator, TT = temperature transmitter, EBV = emergency block valve, FI = flow indicator, FT = flow transmitter, PI = pressure indicator, PT = pressure transmitter.

Safety in Chemicals Transportation



Overview

- ☑ The rapid increase in the transportation of hazardous chemicals has enhanced the accident potential during transit.
- ☑ In transit, the goods would subject to impact, vibration, compression and other adverse effects and exposure to harmful environment.
- ☑ The other factors such as improper packing of the contents, poor storage may also lead to release of chemicals to the environment resulting in emergencies like fire, explosion, toxic release, etc.
- ☑ Apart from pollution of land, water and air, such emergencies have potential to cause injuries and death, property damage and environmental degradation.
- ☑ Availability of information on the hazards and control measures at the time of emergency is vital for minimizing the effect of such accidents.

- ☑ The Central Motor Vehicles Rules-1989
- ☑ The classification of chemical hazards as recommended by the UN Committee of Experts on the Transport of Dangerous Goods.

Definition of Dangerous Goods

When transporting **Hazardous Chemicals** which are classified to be **“Dangerous for transport”** into one of the total 9 classes based on the UN Classification Criteria,

these Hazardous Chemicals are called **“Dangerous Goods”**.

Dangerous Goods are Substances and Cargo, which, based on their

- nature,
- properties, and behavior as well as
- conditions,

may cause, during the transport, a **Hazard** in particular to

- the public safety ,
- the health of the people,
- the damages and loss of the infrastructure and equipment, also
- the negative effects and contamination to the environment

1	EXPLOSIVES	
2.1	FLAMMABLE GASES	
2.2	NON-FLAMMABLE NON-TOXIC GASES	
2.2	OXIDIZING GAS	
5.1	(NITROUS OXIDE & OXYGEN ONLY)	
2.3	TOXIC GASES	
3	FLAMMABLE LIQUIDS	
4.1	FLAMMABLE SOLIDS (and other reactive substances)	
4.2	SUBSTANCES LIABLE TO SPONTANEOUS COMBUSTION	
4.3	SUBSTANCES THAT IN CONTACT WITH WATER EMIT FLAMMABLE GASES	
5.1	OXIDIZING SUBSTANCES	
5.2	ORGANIC PEROXIDES	
6.1	TOXIC SUBSTANCES	
6.2	INFECTIOUS SUBSTANCES	
7	RADIOACTIVE MATERIAL (CATEGORY I)	
7	RADIOACTIVE MATERIAL (CATEGORY II or III)	
8	CORROSIVE SUBSTANCES	
9	MISCELLANEOUS DANGEROUS GOODS AND ARTICLES	
	MIXED CLASS LABEL FOR ROAD AND RAIL TRANSPORT	
	SUBSIDIARY RISK LABEL TO BE USED WITH ELEVATED TEMPERATURE SUBSTANCES	

The Central Motor Vehicle Rules-1989

- Rule-129. Transportation of goods of dangerous or hazardous nature to human life
- Subrule-129-A. Every goods carriage carrying goods of dangerous or hazardous nature to human life shall be fitted with a spark arrester
- Rule 130. Manner of display of class labels
- Rule 131. Responsibility of the consignor for safe transport of dangerous or hazardous goods.
- Rule 132. Responsibility of the transporter or owner of goods carriage
- Rule133. Responsibility of the driver
- Rule134. Emergency information panel
- Rule135. Driver to be instructed
- Rule136. Driver to report to the police station about accident
- Rule 137. Class labels (Table-I)

Rule-131- . Responsibility of the consignor

The consignor has to ensure the following points :

- The goods carriage has a valid registration to carry the hazardous goods.
- The vehicle is equipped with necessary First-aid, Safety equipments and Antidotes as may be necessary.
- The transporter or owner of the goods carriage has full and adequate information about the dangerous or hazardous goods being transported.
- The driver of the goods carriage is to be trained in handling the dangers posed during transport of such goods.
- Every consignor shall supply to the owner of the goods carriage full and adequate information about the dangerous or hazardous goods, being transported as to enable such owner and its driver to:
 - (a) comply with the requirements of rules 129 to 137
 - (b) to make aware of the risks created by such goods to health or safety of any person.



Rule 132. Responsibility of the transporter or owner of goods carriage

It shall be the responsibility of the owner or transporter to ensure the following:-

- The goods carriage has valid registration and permit and is safe for the transportation of the said goods.
- The vehicle is equipped with necessary First-Aid, Safety equipment, tool box and antidotes as may be the necessity to contain any accident.
- The owner or transporter should satisfy himself that the information given by the consignor is full and accurate in all respects as specified in rule 137.
- The owner or transporter should ensure that the driver being deputed for transportation is trained to handle and transport such hazardous materials and has information as annexure V of rule 132.
- The owner of the goods carriage carrying dangerous or hazardous goods and the consignor of such goods shall lay down the route for each trip or permitted otherwise by police authorities.
- The owner of the goods carriage should ensure that the driver holds a driving license as per provisions of the Central Motor Vehicle Rules.

Rule 133. Responsibility of the driver

- It is the responsibility of the driver to keep all information provided to him in writing i.e., in the form TREM CARD (Transport Emergency Card). This is to be kept in the drivers cabin and should be available at all times (Rule 133). Driver will also ensure that parked vehicle is safe from fire, explosion or any other risk. As per Rule the driver should have the ability to read and write at least one Indian language specified in the Constitution and English language.
- The driver should have successfully passed a course connected with the transport of hazardous goods.
- The owner of every goods carriage transporting dangerous or hazardous goods shall ensure the satisfaction of the consignor that the driver of the goods carriage has received adequate instructions and training to enable him to understand the nature of the goods being transported, by him. (Rule 135)
- The driver of a goods carriage transporting any dangerous or hazardous goods shall, on the occurrence of an accident involving any dangerous or hazardous goods transported by his carriage, report forthwith to the nearest police station and also inform the owner of the goods carriage or the transporter regarding the accident. (Rule 136)

HAZARDOUS CHEMICAL



HAZCHEM Scale

FOR FIRE OR SPILLAGE

1	JETS	FOG In the absence of fog equipment, a fine spray may be used
2	FOG	
3	FOAM	DRY AGENT Water must not be allowed to some in contact with the substance at risk
4	DRY AGENT	

HAZCHEM Scale

Full body protective
Clothing with BA

Breathing apparatus
plus protective
clothing

Can be violently
or explosively
reactive

P	V	FULL	DILUTE
R		FULL	
S	V	BA	CONTAIN
S		BA for FIRE only	
T		BA	CONTAIN
T		BA for FIRE only	
W	V	FULL	CONTAIN
X		FULL	
Y	V	BA	CONTAIN
Y		BA for FIRE only	
Z		BA	CONTAIN
Z		BA for FIRE only	



Wherever practicable, diluted
substances should be contained
and prevented from entering
drains and water courses

Prevent by any means
available, spillage from
entering drains or
water course

Notes for Guidance
FOG : In the absence of fog equipment a fire spray may be used.
DRY AGENT : Water must not be allowed to come into contact with the substances at risk.
V : Can be violently or even explosively reactive
FULL : Full body protective clothing with BA.
BA : Breathing apparatus plus protective gloves.
DILUTE : May be washed to drain with large quantities of water
CONTAIN : Prevent by any means available, the spillage from entering drains or water course.

E CONSIDER EVACUATION



Emergency procedures in the event of a Tanker / Truck accident

- If possible drive out of populated areas.
- Identify the cargo, refer labels, TREM Card, instructions.
- In case of a major leak of highly inflammable gas/ vapors, do not start the engine.
- Stop pilferage of the leaked substance, it can be dangerous.
- Secure the accident area and divert traffic.
- Remove affected persons for first aid.



Emergency procedures in the event of a Tanker / Truck accident

- In the event of electrical fire, isolate the battery of the vehicle.
- In case of fire, inform nearest Fire Station, avoid inhalation of fumes, use gas masks if required.
- In case of leaks, see if it can be arrested easily.
- Contain small spills by covering with sand.
- Avoid direct contact with skin, wash with water and use necessary protective clothing like PVC apron.
- In case of contact with eyes or skin wash with plenty of water. For any major contamination, remove clothing immediately.

On- site emergency:

The emergency situation arising within the plant premises is called on-site emergency.

The effects of the disaster are within the plant and the management of such disaster and its effect are called on-site emergency management plan.

Off-site emergency:

The emergency situation arising in plant escalates and spreads beyond the compounded wall is called Off-site emergency.

Disaster, which can effect more then few kilometers like toxic dispersion, vapour cloud explosion, flash fire, BLEVE are the typical examples.

Each organization is assigned with specific jobs or responsibilities during emergency situations.



(Institutional Framework – Emergency Preparedness "

"Chemical Accident (Emergency Planning, Preparedness and Response) Rules, 1996" , notified under the EPA Act 1986,
The Manufacture, Storage and Import of Hazardous Chemical (MSIHC) Rules, 1989/2000
The Hazardous Wastes (Management & Handling) Rules, 1989, as **amended in 2000**,
the Biomedical Wastes (Management & Handling) Rules, 1998/2000 and
the Batteries (Management & Handling) Rules, 2001

EMERGENCY PREPAREDNESS

➤ Chemical Accidents (Emergency Planning, Preparedness and Response)

Rules, 1996 :

➤ Provides for Constitution of – Central Crisis Group

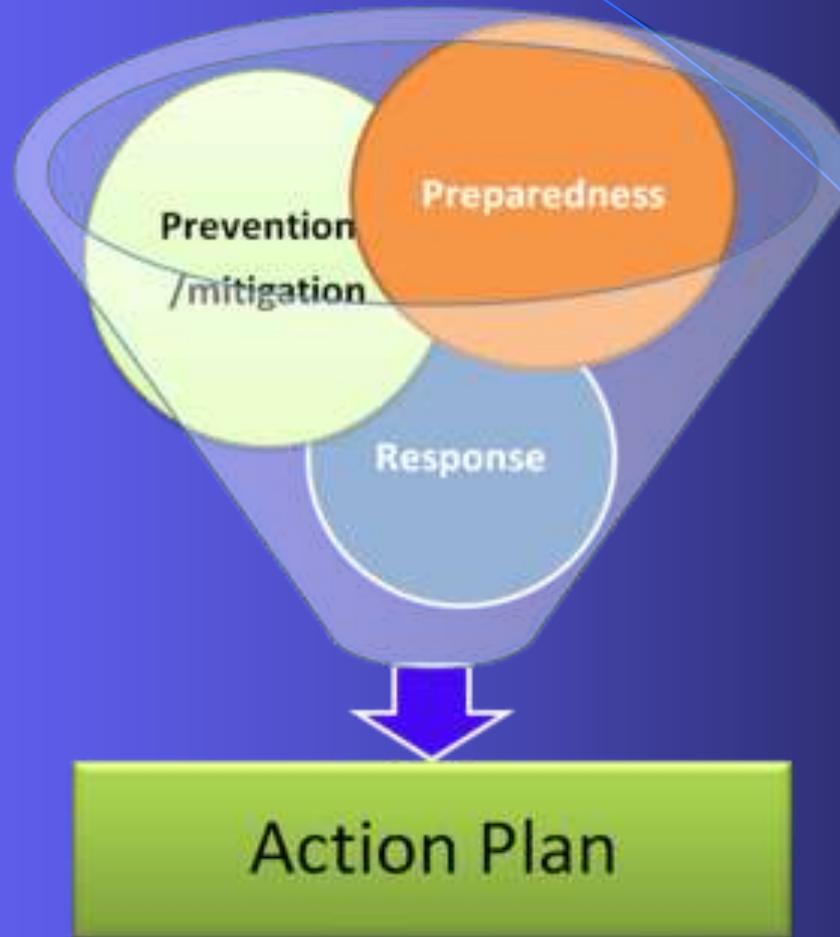
State Crisis Group

District Crisis Group

Local Crisis Group

➤ Lays down functions and responsibilities of these crisis groups

EMERGENCY PREPAREDNESS



Preparedness :

includes planning, prevention and mitigation

i.e. Risk assessment (HAZOP, FEMA, FTA, ETA, consequence assessment, probability estimation, etc. audits; on-site and off-site emergency plans, ISO's, OSHAS, compliance of the laws, engineering modifications

Formal education in the area of safety, risk assessment, medical, fire fighting, for cadre development

Regular drills, participation of all stake holders are base of exercises

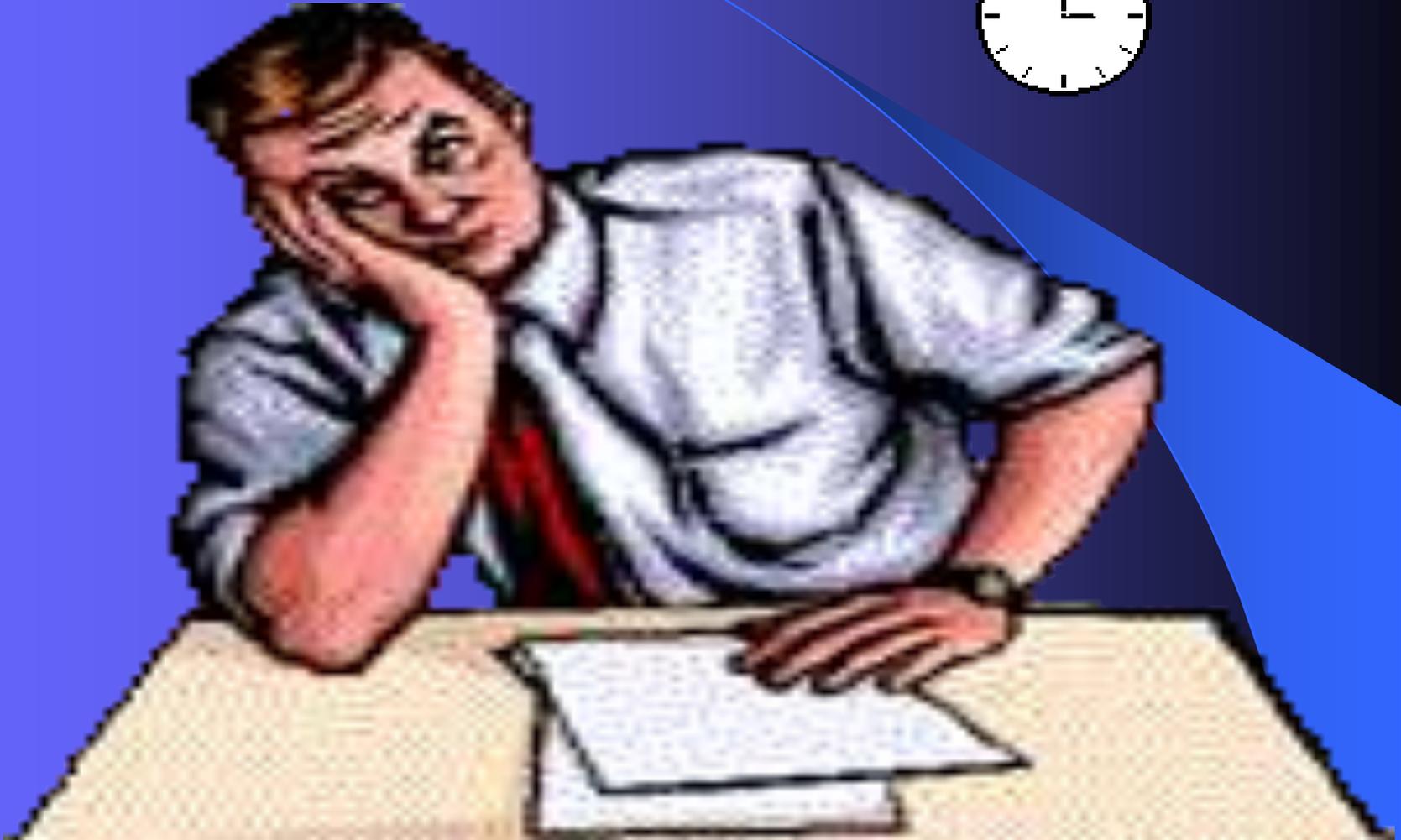
- **Planning:**
 - ✓ On-site and Off Site emergency management plans.
 - ✓ Risk assessment should make a base for plans
 - ✓ Reach to all important stake holders by using some common platform
- **Prevention:**
 - ✓ Compliance of laws and rules, by doing risk assessment after assessing the consequences and probability by using HAZOP, FEMA, ETA, FTA and computer model for consequence analysis
- **Mitigation**
 - ✓ Change in process, chemicals, instrumentation, machine, training of human beings, community and civil administration involvement
- **Training**
 - ✓ Planning, Prevention and mitigation

CONCLUSIONS

- We learn best through our own experiences in different phases of our life.
- Mistakes could be catastrophic in a chemical plant, but it is a great opportunity to learn and design a safer plant in the future.
- We must learn from previous incidents and develop new procedures, practices and management systems.
- These incidents have much learning which reveal many hidden facts about safety and provide efficient tools for prevention of similar incidents in the future.
- Best practices within the industries must be shared to have safer environment & “Zero Tolerance”



Any Questions ?





*Thank You
Friend*