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A REVIEW ON INDUSTRIAL SAFETY

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ABSTRACT

Chance of hazards in the industry is more due to the various chemicals using in the industry, sometimes electricity also one of the cause for the industrial hazard. A safety committee has to be formed consisting of three to four management personnel being headed by the safety officer. Function of the safety committee will cover the total supervision starting from the incoming Raw Materials, their storage, the material under process and the whole manufacturing process up to the extent of finished goods in connection to safety, hazard and the measure to be taken to that effect. This review clearly demonstrated about the various hazards occurring in the industry and also the safety measures that should be taken during the handling of materials in the industry.

Keywords: Hazards, chemicals, fire, pollution.

INTRODUCTION

In the present Factories Act (Act No.LXIII1948) Drugs and Pharmaceutical Industries have been included in the list of Industries involving hazardous process as amended by Act No.20 of 1987. In the said provision occupier has been asked for compulsory disclosure of information regarding dangers including health hazards and the measures to overcome such hazards arising from the exposure to or handling of the materials or substances in the manufacture, transportation, storage and other processes to the workers employed in the factory. In Sub-section (1) information has been asked to include the quantity, specification and other characteristics of wastes and the manner of their disposal and to draw up an on-site emergency plan and detailed disaster control measures for the factory and make known to the workers employed therein and to the general public living in the vicinity of the factory.

A safety committee has to be formed consisting of three to four management personnel being headed by the safety officer. Function of the safety committee will cover the total supervision starting from the incoming Raw Materials, their storage, the material under process and the whole manufacturing process up to the extent of finished goods in connection to safety, hazard and the measure to be taken to that effect [1].

List of Raw Materials to be made with their chemical name, formula, quantity stored, whether toxic, poisonous or corrosive and the hazard and adverse effect which may be caused due to the mishandling and the instant effective measures needed to be taken in case of an accident. Brief details of manufacturing process with line diagram of vessels, location, chemical reactions involved with formula, temperature, pressure and exothermic/endothermic reactions in the respective vessels must be mentioned and the safety measure for operations like fencing of machinery, work on or near machinery in motion, restriction of young persons on dangerous machines, proper precaution about self-acting machines, precautionary measure for lifting machines, chains, ropes and lifting tackles and their proper maintenance are also to be stated clearly. If any plant is operated at a pressure above atmospheric pressure, effective measures should be taken to ensure that the safe working pressure of such a plant or machinery has been maintained. A chart may be enclosed stating the safety arrangement of vessels like safety valve details, pressure gauge details, rupture disc, stop valve, vent pipe etc., and the method of discharge of fumes/ gas of tank and the open air discharge if any. If any manufacturing process produces dust, gas fumes or vapor of such character and to such extent as to be likely to explode originated, all practical measures shall have to be taken to prevent any such explosion and to be stated clearly.

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Precautionary measures are to be taken by providing suitable fire fighting appliances in respective places and the other means if any so that effective measures can be taken in the event of fire. All the workers must be familiar with the means to escape in case of fire and to operate the extinguishers.

ON SITE PLAN AND SAFETY COMMITTEE

Members of the safety committee shall regularly supervise the plants and machineries. They shall check the valves, pumps, motors, connecting pipes, all acid, oil storage tanks, the generators and the electrical systems and the atmospheric hazardous conditions related to plants and chemical reaction. They shall put their remark in a log book for any breakage, leakage and disorder. They shall maintain accurate and up to date health records of the workmen in the factory who are exposed to any chemical, toxic or harmful substances which are manufactured, stored, handled transferred and such records are available to the workers. They shall arrange for medical examination of every workmen once in a year before assigning to a job and while continuing in such a job. They shall check the permissible limits of exposure of chemicals and toxic substances and keep the records in log book. They shall check the First Aid appliances whether or not during all working hours.

IMPLEMENTATION OF THE PLAN

The member of the safety committee shall meet the workmen concerned once in a month and discuss about their findings form records, the irregularities noticed and their way of rectification necessary for the safety of the plants, machines, hazard and health of the workmen. They shall have the power to stop the work of any machine, plant etc., if necessary on the ground of safety. They shall record their opinion and findings in a log book and inform the highest authority for immediate action. They shall conduct the safety training of the respective workmen and supervisors to deal in case of injuries.

DETAILS OF WORKERS EDUCATION IN SAFETY

The members of safety committee shall conduct training of all persons through audio visual aids, class room lectures, orientation training, seminars and workshop participation etc. Such training shall be impaired by internal trainers and external experts if needed. New knowledge will be rapidly published with regards to what hazards, where located, how to control, why to control and who is responsible. Every person will be trained to learn to go on doing what has never been done before for safety.

DETAILS OF EVERY INCIDENCE OF FIRE, EXPLOSION AND POISONING OR ANY ACCIDENT IN THE FACTORY

The safety officer is the in-charge of the central control room in which the key persons have been provided who shall be responsible for co-ordination and supervision of all action plan in the event of fire, explosion, poisoning and toxic release and any accident in the factory shall be assisted by at least three deputies so that one is always available at all times of the day or night.

Numbers of chemical substances when exposed to the high-temperature environment of an actual fire, many substances that are ordinarily harmless become quite dangerous. They may vaporize, explode or burst into flame. Chemicals rank among the more dangerous hazards which cause severe injuries and death to fire fighters and other fire victims.

A substance is considered to be a hazardous material when it is one of the following: flammable, explosive, corrosive, toxic, radioactive or if it readily decomposes to oxygen at elevated temperatures.

The following examples typify the manner in which a chemical mixture may be hazardous:

1. The chemical product is toxic. Depending on the nature of the substance, its concentration and the manner in which it is treated by the body, the product of a chemical reaction may cause sickness or even death. For example, if the acid found in some commercial rust removers or toilet bowl cleaners is mixed with laundry bleach or swimming pool disinfectant, a highly toxic gas evolves. The gas is chlorine. A few deep breaths of even a moderate concentration, such as 1,000 parts per million in air, can be fatal.
2. The chemical product is explosive or flammable. A number of oxygenated substances, such as nitrates, chlorates and perchlorates, are potentially explosive when mixed with certain organic materials. Some mixtures of this type are spontaneously explosive. Others detonate when tickled by a feather.
3. The chemical reaction occurs with the simultaneous release of heat. The evolved heat from a chemical reaction may be absorbed by the components of the reaction or by nearby materials. As the heat is absorbed, the temperature of these materials may rise to the point where their self-ignition becomes possible. For example, when concentrated nitric acid is spilled onto sawdust, the resulting chemical reaction between these two substances causes a considerable amount of heat to be evolved. The evolved heat is frequently sufficient to cause the sawdust to ignite spontaneously.

CLASSES OF FIRE

Class A fire

Class A fires result from the combustion of ordinary cellulosic materials which leave embers or coals. Common examples of a Class A fire are those involving wood, paper and certain textiles. Water is generally an effective extinguishing on Class A fires.

Class B fire

Class B fires result from the combustion of flammable liquids and flammable gases. Examples of materials that can cause a Class B fire are gasoline, kerosene, greases, kerosene, greases, oils, methane and hydrogen. Carbon dioxide and foam are considered effective fire extinguish of Class B fires.

Class C fire

Class C fires result from the combustion of materials occurring in or originating from live electrical circuits. Carbon dioxide is a common extinguishing used on fires that originate from electrical discharges.

Class D fire

Class D fires result from the combustion of certain metals which possess unique chemical properties, such as reactivity with water and carbon dioxide. Metals that can cause a Class D fire include titanium, magnesium, zirconium and sodium. Class D fires are extinguished with special extinguishes which usually contain graphite [2].

IDENTIFICATION OF HAZARDOUS MATERIALS

The U.S. Department of Transportation (DOT) developed a labeling system that tends to identify the relative hazards of some 1,400 dangerous materials. Abbreviation of the name of the item or even its quantity is strictly forbidden by DOT regulation. When a package is exempt from labeling, the words "No Label Required" must follow the description of the item on the shipping papers.

The DOT requires that one or more labels be attached to the container of the hazardous materials by its shipper. The selection of the appropriate label is dependent on the classification of the specific hazard. This classification system is summarized in the following table.

Organic compounds are associated with a number of collective hazards. Most of them are flammable. Organic compounds melt and boil at relatively lower temperatures than most inorganic substances. They easily volatilize at room temperatures and possess relatively low specific heats and ignition temperatures. These physical properties account for the ease with which organic substances burn.

The ignition of a mixture of an organic vapor and air is generally possible with a very small flame or spark. The accompanying heat of combustion is usually so great that virtually anything nearby is raised to its ignition temperature and also bursts into flame. The ignition of methane, ethane and propane, for example, releases 213, 368 and 526 Kcal/mole of heat, respectively. This feature is the reason that hydrocarbons are such excellent heating fuels.

Organic compounds that have a relatively high carbon content tend to burn with a very sooty flame, even in a plentiful supply of air. Aromatic hydrocarbons burn with more accompanying soot than the aliphatic hydrocarbons that contain five or less carbon atoms per molecule. The flames of burning by carbons are yellow. The organic compounds that contain oxygen-the alcohols, ethers, ketones, aldehydes and esters – burn with a clear blue flame. The incomplete combustion of organic compounds is always accompanied by the formation of carbon monoxide.

Most organic compounds are much less stable to heat than inorganic compounds. The fully halogenated derivatives of hydrocarbons, such as carbon tetrachloride, are noncombustible. Most organic compounds are insoluble in water. Thus, the use of water as a fire extinguisher is frequently ineffective in extinguishing the flames of burning organic materials. Fires involving organic compounds are classified as wither Class A or Class B fires. Class A fires involve the burning of cellulosic materials, which are organic compounds. These fires are extinguished with water. Class B fires involve the burning of most other organic compounds. Their fires are extinguished with carbon dioxide, foam or one of the Halon agents.

Organic compounds also tend to react easily with oxidizing agents. Only the saturated alkanes and organic acids are not easily oxidized by such oxidants as hydrogen peroxide or potassium dichromate. A mixture of an oxidizing agent and organic matter is usually susceptible to spontaneous ignition.

The ease with which organic compounds volatilize is partially responsible for the health hazards associated with them. Upon inhalation, many organic compounds act as anesthetics. For example, Cyclopropane, ethylene, ethyl chloride and diethyl ether. Other organic compounds are irritants, such as formic acetic acid. Still others are poisonous.

SAFETY PRECAUTIONS

The promotion of safety and efficiency in the laboratory depends to a large extent upon design, layout, furnishings and equipment – allied, of course, to effective managerial discipline and a careful and intelligent staff.

Hazards

The two main hazards involved in laboratory work are (a) accidents and (b) long-term effects such as cumulative small doses of radiation. Only the hazards falling within the general term 'accidents' are a direct concern of the architect, though he will be concerned in facilitating the health protection measures to be undertaken by the employer. Long-term effects more usually are associated with specialized bypes of work; the measures of protection required are to be considered in accordance with the dictates of individual cases.

It is important to fully appreciate the number of potential dangers involved in any laboratory work. Apparatus and containers usually are fragile and often consist largely, if not wholly of glass. The handling of poisonous, inflammable explosive materials is a commonplace risk and even more dangerous, there may be the possibility of the release of poisonous, inflammable or explosive fumes. On an increasing scale the handling of radioactive materials adds a further and yet greater danger. Electrical apparatus (sometimes necessarily of makeshift nature) almost invariable is utilized operation being common at extremes of temperature and pressure requiring varying precautions to offset dangers. The degrees of risk involved also affect the inclusion of safety precautions in the design. While this degree may in some (perhaps in most) cases be difficult to estimate, the architect always must err on the side of safety [3].

Layout and services

Gangways must be wide enough to permit (a) safe movement in normal working; (b) quick escape in an emergency; (c) movement despite the expected accumulation of miscellanea such as movable stools, mobile apparatus, cupboard doors (left open) and so on. It is repeatedly mentioned elsewhere that the type of bench used will affect the width required; for example, the peninsular bench requires a greater width of gangway than the island bench, since in the former only one escape route is available.

It is essential to provide adequate and easily accessible facilities for chemical storage for individual use. Storage, at the back of benches, of breakable materials and particularly, of noxious or inflammable liquids, should be discouraged. No heavy items should be stored above bench level, preferably on the floor. When it is necessary to store small bottles above the bench a rack should be provided to give them direct support, and this rack should be fitted with a lip, or trays, to prevent spillage on to the bench. Bottles should not be stored more than one layer deep in cupboards; pull-out trolleys are a possible and very desirable alternative. Substances which are poisonous or actively dangerous in any other ways should be stored in a separate, lockable, room or cabinet.

Observation panels should be provided in all doors and in certain cases, it is desirable to provide for automatic opening of doors (for example, by using a photo-electric cell).

Service Outlets

Service outlets should be placed above bench-top level at a height which can easily be reached without undue stretching but which, at the same time, is safely above the equipment normally in use on the bench. All controls should be color-coded in addition to their normal identification marks or labels. Electrical outlets should not be placed above or adjacent to a sink or basin, and continuous open channels are dangerous if electrical outlets are provided in the area. Electrical outlets should be provided in quantity sufficient to obviate the necessity for makeshift wiring with its obvious attendant dangers [4].

Waste products

The waste products of laboratory work may retain the danger potential of the original chemicals, and the architect must provide safe means of disposal for them. Liquid wastes should be diluted as near to the sink as possible. Traps and gulleys from sinks must be designed so that material is not deposited in them; easy access for clearing is essential. If solid wastes are deposited in containers, separate containers must be available for each type of waste and these should be color-coded and clearly labelled; it also is desirable that their normal position on the floor be marked with the same color-code. Metal containers with lids should be provided for inflammable liquids, and lids should be provided for special containers for toxic materials. The containers should be constructed of, or lined with a material not affected by the chemicals used. Leakage in waste lines can be dangerous unless an impervious layer is provided to protect the floor below. If it is possible to ensure that waste lines are run above ground level, then a leak will be noticed more quickly and repairs can be undertaken before excessive damage is caused.

Electrical wiring

The main electrical supply switch should be easily accessible and boldly indicated, as should the main controls for other services.

When it is obvious that certain laboratory rooms will have special dangers, these rooms should be separately wired and controlled so that they can be taken out of service without disturbing the working of the remainder of the laboratory. Emergency lighting with automatic changeover may be necessary, so may similar arrangements in case of power failure to, for example, fume extractors.

Floor finishes should have a high insulation value, and bench-tops must be non-conducting. It is desirable that switches, fans, compressors, and so on be spark-proof: this is essential when there is the possibility of the presence of inflammable vapors [5].

Other requirements

If gas cylinders are to be used, supports and clamps should be provided. If inflammable liquids are to be used in any quantity it may be necessary to install a carbon-dioxide extinguishing system; a fume-disposal installation will be necessary if noxious vapors are likely to be released. If both systems are to be available, it may be necessary to arrange for automatic shutdown of the fume-disposal system upon release of the carbon dioxide. Fume extractor fans may be automatically switched on by opening fume cupboard sashes. The sashes themselves should be sized so that it is impossible for the operator to insert head and shoulders.

Special problems require special measures; the use of high-pressure equipment, for example, requires separate consideration by the architect. Ideally, such equipment should be housed in a separate building at a safe distance from other buildings and traffic routes. The building should have light panelled walls and a roof specially designed to relieve blast pressure, together with protective barricades of concrete or steel which should be provided inside. The walls should be covered with a 4-inch layer of light weight concrete to absorb splinters from an explosion. Remote-control equipment and periscopic viewing may be required for high-risk operations. Similarly, special rooms with air locks at entrances should be provided if noxious fumes on a large scale are to be encountered for long periods.

First aid apparatus is essential and a first aid room is desirable in all but the smallest laboratories.

Other apparatus requirements depend upon the particular risks involved; for instance, it is necessary to provide resuscitation equipment when the risk of electric shock is high. The position of all such equipment must be very clearly marked so that it can easily be found in an emergency, even by personnel unfamiliar with the building layout. Consideration should be given to the provision of direction-indicator signs at circulation junctions, at least in regard to fire fighting, first aid and resuscitation equipment, and to service cut-off switches.

Electrical heaters, if used, should be of the totally-enclosed immersion or low-temperature types and that all wiring should be completely conduited in steel.

General Storage

Minimize carrying distances and to reduce the quantity of materials stored in the working areas, general storage should be sited as centrally as possible. Poisonous chemicals must be kept in a separate locked room or in a locked cabinet, and separate stores must be provided for chemicals having high accident hazards, such as petroleum, explosives and compressed gases, and access for trolleys is essential, as are good lighting and ventilation.

In some instances special measures may be required such as, for example, the exclusion of direct sunlight, temperature and/or humidity control. Provision may have to be made for decanting, refilling and re-packing and the store must be sited for safe and easy reception of materials, preferably direct from transport.

If the laboratory is connected with a factory the Factories Act, 1937, 1948, 1959 may apply. The Petroleum (Consolidation) Act, 1928 and the Explosives Act, 1875, will be relevant if quantities of inflammable liquid or explosives material have to be stored. The Public Health Act, 1936, will apply to laboratories as to other work places.

Safety, industrial safety in particular, conjures up only the thoughts of accidents, injuries, compensation, investigation. Vision of causes of unsafe acts generally does not go beyond the realm of carelessness, ignorance, sabotage, negligence and at times passes-off even as an act of `nature’.

Concern for safety, attention to safety, ensuring safety of operations, building safety into products manufactured and processes employed have to get their due increased attention in industrial activity. Government laws and regulations also have to have their impetus and impact on industrial organizations to discharge well their obligations towards safety of their employees and customers [6].

BASIC CONCEPTS

Some of the basic concepts are as follows:

Safe Production

Achieving safety means achieving safe production without injury or loss. Emphasis is on `built-in safely’, `integrated safety’.

Prevention at-source

Unsafe acts, unsafe situations and accidents (unsafe things for short) have their sources in functional areas for removed from their scene of happening.

Unique and Specialized Activities related to Safety

For prevention at-source to operate effectively, recognize that every functional group in the organization, as already enumerated earlier, has its own unique and specialized contribution to make, in order to build and achieve safety in products manufactured as well as, resources employed to manufacture.

Possibility of hazard prediction

It is possible “to protect that certain sets of circumstances will produce severe injuries and these circumstances can be identified and controlled.” Typical examples are unusual and non-routine jobs; non-repetition activities like Maintenance, R & D, Construction, Erection; sources of high energy like electricity, flammable liquids.

Die-hard unsafe habits

When unsafe habits do not change inspite of earnest efforts (educational, motivational and punitive) change the very environment to render unsafe habits as of non-consequence. Typical examples are guard for presses that can be operated only when both hands together are securely on the knobs well outside the hazard zone.

Treatment of causes as against symptoms

“An unsafe act, an unsafe condition, and an accident are all symptoms of something wrong” in the operational systems; from symptoms trace the causes; treat the causes and not the symptoms to ensure prevention-at-source [7].

Objective

The objectives of the review procedure for the introduction of a new chemical is to identify in advance the likely problems to be encountered with the introduction; to ensure that appropriate measures have been taken to avoid these problems. This procedure is applicable to all cases involving the use of a new chemical in a process.

Points of Control and Responsibility

a. The points of control and responsibility for implementation are as follows

Preparing a brief on the introduction of the new chemical and its circulation to concerned departments. Responsibility is that of R & D.

b. Conveying review sessions with all the concerned departments viz:

Production, QC, Safety, Materials; recording the decisions/follow-up of actions decided in the review session and their communication to all concerned till the final decision is taken. Responsibility is that of R & D [8].

Control Procedure, Forms and Reports

a. R & D in preparing its brief on the introduction of the new chemical can make use of the format

b. In review sessions the following guidelines can be made use of:

1. Generalized list of characteristics
2. Safety related points

R & D BRIEF ON THE INTRODUCTION OF NEW CHEMICAL

R & D Brief must cover the following points:

1. Name of the Chemical
2. The chemical (s) to be substituted by (1)
3. Nature of substitution : permanent/standby
4. Products affected by substitution
5. Process changes to be made as a result of substitution
6. Implications of (5), if any on,

a. safety of operations;

b. any additional reinforcement related to process-safety, on-line instrumentations, safety-devices; and

c. changes to be made in safety instructions of the process, handling, storage etc.

7. Reasons for substitution (quantitative assessment to be given)
   - total cost benefit,
   - quality and safety improvement,
   - productivity/throughput gain,
   - import-substitution,
   - easy availability,
   - any other (specify).
8. Who else is using this chemical within and outside the country?
9. Any information available about their experience?
10. If no one is using the material, possible reasons for the same, could it be that the idea has never struck anyone?

11. Grade recommended for use:
    - pure,
    - technical,
    - analytical,
    - any other (specify).
12. Source of supply:
    - indigenous,
    - imported,
    - own manufacture.
13. Ultimate chemical form in which used.
14. Role of the chemical in final product system.

a. Is the chemical a hazardous one?

b. Have all the properties been know and studied?

c. Are facilities available to handle and store it?

d. What are the additional facilities, if any, needed to handle, store and use the chemical?

15. a. What are the safety-related characteristics of the product which have been examined?

b.What are the results?

c.How do they compare with the current ones?

GENERALIZED LIST OF CHARACTERISTICS OF A CHEMICAL

1. Visual/Appearance Characteristics

Odor, structure, foreign matter etc.

2. Physical Characteristics

Melting point (^{0}C), Particle size/shape, Bulk density (g/cc), Apparent density (g/cc), Flow property, Distillation range (Boiling Point etc.), Specific Gravity Softening point / set point, Ignition temperature (^{0}C), Caloric value (Bomb calorimeter), Flash Point (^{0}C), Viscosity in cps, Refractive Index, Optical density, Miscibility (Specify solvent).

3. Chemical Characteristics

Moisture (temperature and time), Hygroscopicity (%RH, time of exposure and temperature), Chemical purity, Water solubles, Water insolubles

Acid Solubles (Specify Acid), Acid insolubles (Specify Acid),

Solvent solubles (Specify solvent), Solvent insolubles (Specify solvent)

Acidity (expressed as ……………..), Alkalinity (expressed as ……………..), Ash content, Volatile matter, Residue on evaporation, Grit (a) Inorganic (b) Organic

4. Usage Characteristics

Flow property, Bulk density, Grain size, Particle shape, Heat test, Chemical stability, Storage sensitivity, Minimum value,

Impact sensitivity

NOTE :

1. This is not an exhaustive list
2. This needs to be updated from time to time
3. In any given case, relevant characteristics must be considered.

ISO 14000

The ISO 14000 series is a family of environmental management standards developed by the International Organization for Standardization (ISO) The scope of TC 20% is standardization in the field of environmental management tool and systems.

The ISO 14000 standards are designed to provide an internationally recognized framework for environmental management, measurement, evaluation and auditing. They do not prescribe environmental performance targets, but instead provide organizations with the tools to assess and control the environmental impact of their activities, products or services. The standards are designed to be flexible enough to be used by any organization of any size and in any field. They address the following subjects:

- Environmental management systems (EMS 14001, 14004)
- Environmental auditing (14010, 14011, 14012)
- Environmental labels and declarations (14020, 14021, 14024)
- Environmental performance evaluation and (14003)
- Life cycle assessment (14040)

ISO 14000 is applied to all types and sizes of organization in all geographical, cultural and solid conditions [9].

The Development of ISO 14000

The International Organization for Standardization (ISO) is responsible for the development of the ISO 14000 series of international environmental management standards. ISO was founded in 1946 and its headquarters is located in Geneva, Switzerland. ISO has developed international voluntary consensus standards for manufacturing, communication, trade and management systems. Its mission is to promote international trade by harmonizing international standards. Over 100 countries have national standards bodies that are members of ISO. The American National Standards Institute (ANSI) is the U.S. representative to ISO.

In June 1991, ISO created the Strategic Advisory Group on the Environment (SAGE). SAGE assessed the need for international environmental management standards and recommended that ISO move forward with their development. In January 1993, ISO created Technical Committee 207 (TC 207) which is charged with the development of the ISO 14000 series of standards. TC 207 is comprised of various subcommittees and working groups. Representatives from the ISO member countries contribute their input to TC 207 through national delegations.

In the United States, the U.S. Technical Advisory Group (U.S.TAG) develops the U.S. position on the various ISO 14000 standards. The U.S. TAG is comprised of approximately 500 members representing industry, government, not-for-profit organizations, standard organizations, environmental groups, and other interested stakeholders. The U.S.TAG has the largest number of members of ISO member delegations. These are several organizations involved in the administration of the U.S.TAG's input to TC 207, including: ANSI; the American Society for Quality (ASQ); the American Society of Testing and Materials (ASTM); and NSF International (NSF).

TC 207 developed the ISO 14001 Standard which specifies requirements for an environmental management system. Other documents in the areas of environmental labeling, life-cycle assessment, and environmental performance evaluation are under development. Published ISO standards must be reviewed and revised every five years.

Environmental Management System (EMS)

An environmental management system is a management structure that allows an organization to assess and control the environmental impact of its activities, products or services. ISO 14001, Environmental management systems – Specification with guidance for use, outlines the requirements for an EMS.

According to ISO 14001, there are six key elements of an EMS:

- An environmental policy, in which the organization states its intentions and commitment to environmental performance
- Planning, in which the organization analyses the environmental impact of its operations
- Implementation and operation: the development and putting into practice of processes that will bring about environmental goals and objectives
- Checking and corrective action: monitoring and measurement of environmental indicators to ensure that goals and objectives are being met
- Management review: review of the EMS by the organization's top management to ensure its continuing suitability, adequacy and effectiveness and
- Continual improvement [10].

ISO 14000 Registration

Registration is the formal recognition of an organization's EMS. Some organizations, mainly those outside North America, refer to this as "certification".

An independent third party, known as a "registrar", assesses and audits the organization's EMS to ensure that it complies with the requirements of the standard.

A further level of confidence is provided by the accreditation of registrars. The Standards Council of Canada is the Canadian ISO 14000 accreditation.

Benefits of ISO 14000

An ISO 14000 EMS gives the tools to monitor and improve organization's impact on the environment. It may help to:

- Assure customers of commitment to demonstrable environmental management

- Maintain good public relations
- Satisfy investor criteria and improve access to capital
- Obtain insurance at reasonable cost
- Enhance image and market share
- Meet client's registration requirements
- Improve cost control
- Reduce incidents that result in liability
- Demonstrate reasonable care
- Reduce consumption of materials and energy
- Develop and share environmental solutions; and
- Improve industry-government relations.

Role of the Standards Council of Canada in ISO 14000

The Standards Council of Canada plays several important roles in the development and implementation of ISO 14000.

Technical Committee and environmental management (TC 207), develops and maintains the standards.

Canadian Standards Association (CSA), manages both positions of behalf of the Standards Council.

The Standards can be obtained from:

IHS Canada
240 Catherine Street, Suite 305
OTTAWA, ON K2P 2G8

GENERAL GUIDELINES FOR SAFETY

It is the responsibility of each person in the plant to ensure safety in his area. The Production Superintendent, will ensure the following:

a. That all safety measures are followed before the start up, during the work and while closing down.
b. Whenever any maintenance job is carried out in the plant, a safety permit will be made and issued.
c. That all the safety equipment in the department and first aid devices are in good working condition
d. That all personnel follow safety methods and make use of proper equipment's
e. That all MSDS's are made available for the plant personnel, to help them be aware of the hazardous nature of the chemicals
f. Ensuring periodical check up of fire fighting equipment's and arranging for fire drills
g. During shut down he ensures all electrical connections are isolated and also all utility lines in the working area are properly closed [11].

Do's and Don'ts to Maintain Safety:

a. Always use protective equipment before handling any chemical
b. Do not smell any chemical
c. Never use or handle any container with chemical, which is unlabeled/unidentified
d. Seek Supervisor's advice if situation arises
e. After handling any chemical ensure that you wash your hands before touching any food stuff
f. While handling any solvents take care of static electricity
g. If any chemical spillage occurs affecting any person, ensure that the affected part of the body is properly washed with water. Contact Supervisor if first aid procedure is unknown to you
h. Sufficient numbers of all safety equipment required by each section have to be procured by each section
i. All safety equipment is to be located in a place defined for them. All the employees should know the location of the safety equipment, so that it can be found quickly even in blackout conditions
j. It is essential that the right type of equipment should be used for each job
k. When safety appliance is issued to an employee, it is the duty of the Supervisor to see whether they are in good condition.

Safety in Handling Compressed Gas Cylinders:

a. Never drop cylinders
b. Avoid dragging cylinders
c. Assign a definite are for storage of cylinders
d. Cylinders containing liquids bring about expansion that may cause dangerous hydrostatic pressure. Prevent spark or flame from contacting cylinders. Do not permit cylinders to contact electrical apparatus or circuits
e. Protect cylinders stored in the open area from weather extremes
f. Keep apart cylinders containing flammable gases from those, containing oxygen
g. Use regulators with cylinders when connecting to systems of a lower pressure rating
h. Store full and empty cylinders separately
i. Do not try to identify the cylinders by the size, shape or color or by the smell of the gas in it. Always refer to the label.

Hazards of Flammable Liquids:

When fluids such as petroleum products are flowing though pipes or from an orifice into a tank, static electricity is generated and an electric charge may accumulate on the body of the container and piping. Static spark ignition sources are prevented by bonding or grounding or by both.

When flammable liquids are poured from one container to the other, the edge of one container should rest on the other container which is grounded. The storage tank should be filled through bottom and not through top.

Precautions:

Dyke or bund wall to be constructed around the storage tanks of flammable liquids.

The earthing of storage tanks is to be checked at regular interval. No person other than the trained operating personnel should be allowed to enter the area. Electrical equipment and lights should be of explosion proof type.

The tank should be kept under cold condition to minimize vaporization. End of the dip rod/or scale used must be non-metallic and must be lowered slowly into the liquid.

Firefighting equipment kept in such areas should be accessible and unobstructed and maintained in good working condition at all times. Pipelines carrying flammable liquids should have jumpers across flanges to ensure continuity.

Fire protection and prevention

a**. Fire or combustion**

Combustion may be defined as a chemical reaction accompanied by the evaluation of light and heat.

Three factors are essential for combustion namely:-

1. Combustible materials (Fuel)
2. Oxygen
3. Temperature

b. Fire extinction

The principle of fire extinction consists in the elimination of one or more of the above three factors and the method may be classified as follows:-

a. Starvation of limitation of fuel
b. Smothering or limitation of oxygen
c. Cooling or limitation of temperature

c. **Classification of fires**

Depending upon the extinguishing methods the fire has been divided into five:

1. Class- A Fire: Fires that occur in ordinary material such as
wood, paper rags, rubber and rubbish.
2. Class- B Fire: Fires that occur with flammable materials like
oil, paint, gasoline etc.
3. Class- c Fire : Fires that occur with gases and vapors
4. Class- D Fire: Fires that occur with combustible metals such
as Magnesium, Titanium, Lithium, Sodium etc.
5. Class- E Fire: Fires involving electricity in any form.

Extinguishing media required for each type of fires

i. Class 'A' fires can be extinguished with water and foam type extinguisher.
ii. Class 'B' fires can be fought with foam, Carbon-di-oxide
iii. Class 'C' fires can be extinguished with carbon-di-oxide and dry chemical powder extinguisher.
iv. Class 'D' fires can be extinguished only by dry powder extinguisher.
v. Class 'E' fires can be extinguished with dry chemical powder and Carbon-di-oxide.
vi. Dry sand can be used as an extinguishing medium for all the fires.
vii. Steam purging can be adopted to displace oxygen to extinguish fire inside equipment like furnaces.

d. Flash point and ignition temperature

Flash point of a flammable liquid is the lowest temperature at which it gives enough vapors to form a flammable mixture with air near the surface of the liquid or within the container.

Ignition temperature of a substance denotes the temperature at which the substance will ignite with or without the application of fire.

The flash point gives us an idea about the relative hazard of the flammable liquid. Liquids like petrol, benzene etc., which have flash points lower than the atmospheric temperature are more dangerous.

e. **Fire point**

It is the lowest temperature at which a liquid in an open container will give off enough vapors to continue to burn when ignited.

Detonation is defined as high speed explosion [12].

Preventive steps to avoid fire accident

- Smoking is strictly prohibited inside the factory
- Do not heat a flammable liquid above its flash point
- Do not allow the formation of an inflammable mixture anywhere in the plant (tank, vessel, pipe line and drains) with air or oxygen.
- Any gas leak in the equipment or pipeline should be brought to the notice
- Before opening a line or equipment containing inflammable gas or liquid consult Production Superintendent
- Avoid the use of open flame in the area where combustible materials are handled.
- Persons working in the plant should know the location and use of the firefighting equipment.
- Don't drain any organic liquid under pressure at a rate faster than 3 ft./second to avoid static electricity.
- Toxic gases or liquids should not be depressurized into the atmosphere.

Fire protection facility

- All electrical fittings and appliances in the hazardous areas are of Explosion/Flame proof nature.
- Factory has fire extinguishers located in many places and is easily accessible.
- Sign boards, hoardings with safety slogans are displayed in areas where it can be easily noticed.
- Trailer pump/portable pump is provided in the premises, which can be used in case of emergency.
- Water points are provided all over the plant premises and swing hose reels are fixed for immediate usage in an emergency situation.
- The employees are trained in fire fighting and handling of firefighting equipment.

Fire fighting appliances

Firefighting appliances are kept in various locations of the plant as recommended by the Tariff Advisory Committee

These appliances include:-

a. CO_2 gas filled extinguishers
b. Chemical foam extinguishers
c. Dry chemical powder extinguishers
d. Soda-acid extinguishers
e. Halon fire extinguishers
f. Sand buckets [13]

Fire fighting methods

Reactor Fire

a. Switch off the electric supply.
b. Before attempting to extinguish a fire on a reactor extinguish the fire in the surroundings.
c. Cool the adjacent reactors with water.
d. A BOIL OVER is a violent eruption of burning liquid.
e. Evacuate all the personnel from the area if there is a possibility of boil over.
f. Reduce the temperature of the reactor surface by cooling the reactor shell with water.
g. Do not direct a water jet into a burning reactor.
h. Use dry chemical powder to extinguish the flame.

Process Unit Fire

a. Switch off the mains
b. The fire is to be extinguished principally by starvation.
c. Put out small fires by foam or dry powder extinguisher.
d. Do not use foam if it cannot be spread over a surface.

Electrical Machinery Fire

a. Stop the equipment and isolate power immediately.
b. Do not use water or foam to quench the fire.
c. Apply Carbon-di-Oxide or dry powder to extinguish the fire.

Fire in a Trench or Pit

a. Operators should immediately locate and stop the leakage of organic into the pit.
b. Apply steam, Carbon-di-Oxide or dry powder to the fire area.
c. Avoid overflowing of trenches or pits with water as this may cause spreading of fire.

Spill fires above ground level

a. Operators should immediately determine the source of leakage or spill and stop it if possible.
b. Blanket small fire areas with dry powder or asbestos cloth but avoid scattering of burning material.

Fire in Hot Oil Unit

Fire in hot oil unit is caused main by rupture of hot oil line outside or inside the furnace.

Shut down the hot oil circulation pump, fuel oil feed to burner and stop the blower.

If the fire is outside the furnace, extinguish the same with foam extinguisher kept in hot oil unit area.

If the fire is in hot oil line insulation in plant, extinguish with foam extinguisher kept nearby and cool the adjacent lines by water spray from the nearest wash point by a hose line.

Fire in Raw Material Store

Fire in raw material stores is causes by inflammable materials – use dry chemical powder or CO_2 for small/localized fire.

Fire in Fuel Oil Storage

Fire in fuel oil storage is caused by spillages catching fire; can be extinguished by FOAM EXTINGUISHER dept in the area.

Do not enter a smoke filled area without respiratory protection.

If any case of big or small fire, avoid over crowding and over reaction.

If outside help is necessary, get it in an organized manner [14].

Type of Extinguishers

a. Soda-Acid
b. Water-Gas / Light Water
c. Foam
d. Halon or Halogenated Hydro Carbon
e. CO_2 Extinguisher
f. Dry powder

Operation of fire extinguisher

a. Soda Acid Extinguisher

This extinguisher consists of a cylindrical container made up of steel lined with lead. The charge of the extinguisher consists of Sulphuric Acid and a solution of Sodium bi carbonate.

The sulphuric acid may be in a tube or bottle sealed of fitted with a loose lead stopper. The extinguisher is a turnover type if it is not fixed with a discharge tube. When the extinguisher is brought into action due to mix-up of the acid with alkali, carbon-di-oxide gas is formed together with sodium sulphate.

$$H_2So_4 \; + \; 2NaHCo_3 \; \text{--------} \; N_a2So_4 \; + \; 2H_20$$

The carbon-di-oxide gas produced gives the pressure to throw about 6 meters jet of the solution. The sodium sulphate takes not part in putting out the fire.

Two types of Soda acid extinguisher are available – invertible and non invertible. It is suitable for 'A' class fire only.

b. Water Gas/Light Water Extinguisher:

This is an effective alternative for Soda acid fire extinguisher and employs more advanced technology for safer fire fighting. Ideal for 'A' class fire.

It consists of one gas cartridge filled with CO_2 and outer container (main body) is filled with fresh water. During operation CO_2 gas is released which provides the necessary pressure to throw water in the form of a powerful jet. Available in invertible as well as non-invertible types.

Operation:

Take the extinguisher to the fire. Remove the discharge from the housing. Strike the knob. Direct the water to the fire.

c. Foam Extinguishers

These are available as only invertible type. There are three types of foam:

1. Chemical Foam Extinguishers

The inner container of a foam type extinguisher contains generally Aluminium Sulphate (acidic) dissolved in clean water while the outer container houses a solution that contains Sodium Bi-Carbonate (Alkali) with foam stabilizer.

Aluminium Sulphate and Sodium bi-Carbonate produce foam and Carbon-di-Oxide.

Foam withstands heat and prevent re-ignition of surfaces already covered. Foam also spreads freely over the surface of the blazing liquid. So foam is more effective than an inert gas.

2. Mechanical Foam

Usually contains a 3 to 6% solution of stabilized protein base substance in water that is aerated to produce foam. This is cheaper and easily available. Stabilizer normally used is Ferrous Sulphate. Protein based substances used are animal hoof and horn meal and hydrolysed blood and sodium hydroxide solution.

3. Detergent Foam

This is again aerated detergent solution in water. At present usage is limited due to:

(a) Poor heat response
(b) Poor stability

Operation of Foam Extinguishers

Take the extinguisher to the scene of fire. Pull the nozzle up, turn it right and let it rest on the Cap. Invert (only portable model) the extinguisher and direct the jet to the fire.

d. HALONE - 1211 (BCF) Extinguishers

It is the safest and most effective vaporizing extinguisher for use on A, B, C and E class fires. It is non-toxic, non-conductive, odourless, colorless and transparent liquid and has no adverse effect on the materials on which it is applied. It is discharged as a semi-liquid jet a high nozzle velocity and vaporises rapidly and penetrates fires in the form of mist. The high nozzle velocity has the advantage of a long throw, enabling its use from a safe distance.

When Halon 1211 is discharged on a fire, the heat of the fire decomposes Halon-1211 and the product of this decomposition, particularly, bromine, interferes with the process of combustion and puts off the fire quickly.

e. Carbon di Oxide (CO_2) Extinguishers

Carbon di oxide is a colorless gas which is one and half times heavier than air. It is filled in the extinguisher as liquid by the application of pressure (50 kg/cm^2 and at a temperature of 15.5 C)

Carbon di oxide extinguishes the fire by replacing some of the oxygen in the air, so that it does not support combustion, (Blanketing effect). The high velocity with which the gas is released and the sudden cooling effect play an important part in extinguishing the fire. It is a non-conductor of electricity. So it can be effectively used for electrical fire.

A small cylinder of liquid CO_2 during vaporization expands 450 times. The expansion ratio of carbon-di-oxide is 8.5 cubic feet per pound.

Operation of CO_2 Extinguisher

Take the extinguisher close to the fire. Remove safety pin. Remove the discharge horn from the clip. Open the valve. Direct the gas at the base of the fire.

f. Dry Powder Chemical

Extinguisher contains 90% sodium-bicarbonate in fine powder form and the rest is made of other chemical which will improve fluidity, non-caking and water repellant properties.

The dry powder extinguishes the fire by blanketing it. It has no cooling effect. The dry powder is very effective for fires that react with water and carbon di oxide.

The charge constitutes dry powder with a sodium carbonate base filled in outlet container. A carbon di oxide catridge is placed inside the inner container screwed on to the inner side of the cup assembly with the sealing disc.

The main container assembly is fitted with a syphon tube. The interior shape of the extinguisher is so designed that CO_2 expels practically 98% of the contents [15].

Composition of the Material

Sodium bicarbonate	:	97%
Magnesium Sulphate	:	1-1/2%
Magnesium Carbonate:	1%	
Tricalcium phosphate	:	½ %

Operation of the Extinguisher:

Take the extinguisher to the fire. Remove the discharge tube from the housing. Strike the knob. Direct the powder to the fire.

DOT CLASSIFICATION OF HAZARDOUS MATERIALS

United Nations Hazard Class Number	Description
1	Class A, B and C explosives
2	Nonflammable and flammable compressed gases
3	Flammable liquids
4	Flammable solids, spontaneously combustible substances and water-Reactive substances
5	Oxidizing materials, including organic peroxides
6	Class A and B poisons, irritants and etiologic (diseasing) materials
7	Radioactive materials
8	Corrosive materials (acids, alkaline liquids and certain corrosive liquids and solids)
9	Miscellaneous hazardous materials (materials not covered by any of the other classes.

TREATMENT OF SYMPTOMS Vs TREATMENT OF CAUSES SOME CASE EXAMPLES OF COMMON EXPERIENCE

Sl.No	Treatment of Symptoms	Treatment of Causes
1.	`Discover' that a hazardous chemical is stored with other materials in Stores and then remove it for its proper storage.	Following system operates to prevent mix-up: All connected departments have a manual on hazardous chemicals giving their hazard data, handling and storage methods. Material receipt note to Stores indicates that the material to be received is a hazardous one and thus alerts in advance the need for special handling and storage. Special identification labels are fixed on the containers and then sent to appropriate place of storage. Periodic safety audit is done to ensure adherence to set practice.
2	Fingers are caught in moving machinery and get jammed. Investigation reveals that there was no guard for the machinery and the person injured was new. Guard is put. Injured person is advised to be careful on his job.	Following ground rules are set even before any injury takes place: Maintenance Department shall not release to Production the equipment's / machineries without guards. Inadvertently if any equipment/machinery were to be released without all its guards, it is put into use only after fixing the guards. Specify minimum training period for operating each type of machinery/equipment and a certification scheme to permit the workman to operate independently.
3.	Chemical splashes over the body of a worker due to hose getting dis-engaged from the pipe-line. Hose is fixed back with new fasteners.	Action plan would be as follows: Any point of `joining' is recognized as potential hazard point; type of hose, type and method of fastening which do with-stand the worst unfavorable process condition are specified and followed. A schedule of periodic examination and replacement is laid down and followed.
4.	Acid burns are sustained while repairing acid lines. Investigations indicate the following: Maintenance Department had indicated that they would take up the repair of acid lines. Production Department was not aware of the particular lines that would be taken up for repair. But they had kept some lines cleaned. Maintenance took un-cleaned ones for repair resulting in injury. In short, a case of `all-are-right'. Instruction is given `once again': Take only well cleaned lines for repairs.	Following ground rules are followed to prevent injury" Production notifies to Maintenance the lines requiring repair: certifies that the lines are thoroughly cleaned and free from acid; physically marks/flags the stretches of, lines thus prepared for maintenance work and hands over to Maintenance; records the details in log-book for reference by Maintenance; and retains a plant staff for giving any clarification sought for by Maintenance. Maintenance takes up the work only when the above measures are conformed to.

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