GUIDELINES ON STORAGE OF HAZARDOUS CHEMICALS:

A Guide for Safe Warehousing of Packaged Hazardous Chemicals

DEPARTMENT OF OCCUPATIONAL SAFETY AND HEALTH
MINISTRY OF HUMAN RESOURCES
MALAYSIA
2005

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The Guidelines has also been endorsed by the Department's Jawatankuasa Dasar chaired by the Director General of DOSH.

FOREWORD

These guidelines may be cited as the *Guidelines on Storage of Hazardous Chemicals:*

A Guide for Safe Warehousing of Packaged Hazardous Chemicals

The guidelines provide practical guidance and advice on how to comply with

a) *Section 15 (1) & (2) of Occupational Safety and Health Act 1994 with respect to the duty of employers and self employed persons to their employees;*

b) *Regulation 15 of The Occupational Safety & Health (Use and Standard of Exposure of Chemical Hazardous to Health) Regulation 2000* (USECHH Regulation) with respect to the duty of employers to control chemicals hazardous to health at workplaces during storage.

c) *Regulation 7 of the Occupational Safety and Health (Control of Industrial Major Accident Hazards) Regulations 1996 with respect to the duty of employers to identify and notify of an industrial activity.*

These guidelines set out practical measures on the design, construction, operation and maintenance of storage areas and buildings used for storing packaged hazardous chemicals when they are contained in packages such as drums, gas cylinders, bottles, boxes, intermediate bulk containers (IBCs) and sacks. These measures are designed to protect people at work and others who may be affected by the storage of packaged hazardous chemicals.

Employers are advised to read these guidelines in conjunction with the *Guidelines on Control of Chemicals Hazardous to Health* at work places which have been prepared to assist employers to perform their duties stipulated under mentioned Regulation.

These guidelines will be reviewed from time to time. Written comments from any interested persons or parties are welcomed. These should be sent to the Department

of Occupational Safety and Health so that they may be considered and, if appropriate, taken up to keep improving the guidelines.

Director General
Department of Occupational Safety and Health
Malaysia

DISEMBER 2005

GLOSSARY OF TERMS

"Adverse Health Effects" refer to effects that cause changes in the morphology, growth, development or life span of an organism and which results in the impairment of functional capacity or impairment of the ability of the organism to maintain homeostasis or do not enhance susceptibility to the deleterious effects of other environmental factors. In short, adverse health effects range from irritation at the low end to death at the high end.

"Chemicals" means chemical elements, compounds or mixtures thereof, whether natural or synthetic, but not include micro-organisms;

"Chemicals hazardous to health" means any chemical or preparation which:

- Is listed in schedule I or II of the Occupational Safety and Health (Use and Standard of Exposure of Chemicals Hazardous to Health) Regulations 2000 (USECHH);
- Possesses any of the properties categorised in part B of Schedule I of the *Occupational Safety and Health (Classification, Packaging and Labeling of Hazardous Chemicals) Regulations 1997* [P.U.(A) 143/97];
- Comes within the definition of "pesticide" under the Pesticide Act 1974 [Act 149].
- Is listed in the First Schedule of the *Environment Quality (Schedule Wastes) Regulations, 2005* [P.U.(A) 139/89].

"Controls" are those measures that eliminate or reduce the potential for events such as chemical storage accidents, the occupational exposure of producers, employees, other persons and effects on environment.

"Degree of hazard", in relation to classification or labelling of hazardous chemicals refers to the specific nature of the risk involved in the following order:

a) For the hazardous chemicals in Part A of Schedule I -

(i) explosive, which is more hazardous than oxidising;
(ii) oxidising, which is more hazardous than extremely flammable;
(iii) extremely flammable, which is more hazardous than highly flammable; and

(iv) highly flammable, which is more hazardous than flammable; and

b) For the hazardous chemicals in Part B of Schedule I-

(i) very toxic, which is more hazardous than toxic;
(ii) toxic, which is more hazardous than corrosive;
(iii) corrosive, which is more hazardous than harmful; and
(iv) harmful, which is more hazardous than irritant;

"Emergency Response Plan" is a plan, which outlines how something should be done or what actions are to be taken, or a particular strategy to be followed in an unexpected event requiring prompt action, which is beyond to normal day to day activity, in order to ensure the safety of the people, public, environment and equipment.

"Flammables" are those chemicals, which have low flash points i.e. they are easy to catch fire.

"Hazardous chemical" means any chemical which possess any of the properties categorised in Schedule I of *the Occupational Safety and Health (Classification, Packaging and Labelling of Hazardous chemicals) Regulations 1997,* and any chemicals which is specified in schedule 1 or schedule 2 (Part 1) of *the Occupational Safety and Health (Control of Industrial Major Accident Hazards) Regulations 1996,* or for which relevant information exists to indicate that the chemical is hazardous.

"Isolation" or segregation is the separation of a hazardous chemical, or equipment, or process, by distance or by the use of physical barriers from those who might be exposed or at risk.

"Major hazard Installation" means an industrial activity which produces, processes, handles, uses, disposes of or stores, whether permanently or temporarily, one or more hazardous chemicals or a categories of hazardous chemicals in a quantity or quantities which is or are **equal to or exceed the threshold quantity,** or an industrial activity which is so determined by the Director general in accordance with sub-regulation 7 (2) of *the Occupational Safety and Health (Control of Industrial Major Accident Hazards) Regulations 1996;*

"Non-Major hazard Installation" means an industrial activity which produces, processes, handles, uses, disposes of or stores, whether permanently or temporarily,

one or more hazardous chemicals or a categories of hazardous chemicals in a quantity or quantities which is or are **above to 10% of the threshold quantity but less than the threshold quantity,** or an industrial activity which is so determined by the Director general in accordance with sub-regulation 7(2) of *the Occupational Safety and Health (Control of Industrial Major Accident Hazards) Regulations 1996;*

"Oxidising chemicals" or oxidisers are those chemicals, which can react violently with flammable and combustible materials.

"Safe Work Practices" means administrative practices which require workers to work safer way. Examples of safe work practices include job rotation, restricted access to a hazardous process, good housekeeping and good personal hygiene. Immediate clean up any spills of hazardous chemicals is also important safe work practices.

"Storage" means the keeping of a chemical at any workplace; the term includes the keeping of any chemicals in use or in a ready to use conditions.

"Supplier" means a person who supplies chemicals and includes a formulator, a manufacturer, an importer or a distributor.

"Toxic" is those chemicals and preparations, which if inhaled or ingested or penetrated into the skin may involve serious acute or chronic health risks or even death.

"Use of chemicals hazardous to health" means the production, handling, storage, transport, disposal and treatment of any chemicals, which have the potential to cause adverse health effects.

"Warehouse" means a building where large quantities of chemicals are stored before being sent abroad, to shop, etc".

"Warehousing" means the practice of storing things in a warehouse.

Chapter 1

INTRODUCTION

Hazardous chemicals that are being improperly stored in the warehouse are capable of causing fire or explosion, or of producing injury by inhalation, skin or eye contact, or by ingestion. These potential safety and health hazards can be avoided by implementing control measures in the early design stage and during operation. However, built in protection, inherent in the design of warehouse, is preferable to a method that depends on continual human implementation or intervention. **A** complete understanding of hazard and risk associated with chemicals storage is required in choosing methods that will provide adequate control. These require the employer of a warehouse to implement a risk management system to enable him to systematically assess all factors such as hazard associated with chemicals and hazard related to an activity involving chemicals, to make a judgement about the associated risks and to implement appropriate controls.

These guidelines propose a safer way to establish safe storage and warehousing of chemicals whether already existing or in a planning stage. **A** proper storage of chemicals can contribute to the safety and health of employees and also the environment. The contents are as follows:

- Key responsibilities: those of the supplier or owner of the chemicals, employer and employees;
- Legal framework: including main points to be regulated and state of the existing legislations;
- Hazard Identification and Communication: the importance of chemical safety data sheet, classification and labelling and a chemical register;
- Hazard: highlighting common causes of incidents and hazard classification of chemicals;

- Siting and Design of Storage Area: the design of warehouse, location of warehouse or sites, the integrity of the structure and control of possible hazards;

- Warehouse Management: preparation of the quality of management, day to day management of warehousing and safe procedures for normal work as well as for abnormal conditions need to be prepared.

- Emergencies: covering points such as emergency response plan and it components and general principles of emergency procedures. Other sub topics such as fire fighting procedures and clean-up operation will not be discussed. Please refer to the Fire and Rescue Department for information on these aspects.

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Chapter 2

KEY RESPONSIBILITIES

2.1 The Supplier or Owner of the Chemicals

On considering a warehouse for storage of his chemicals, the owner or supplier of the hazardous chemicals should as far as practicable:

Satisfy himself of the suitability of the warehouse;
Satisfy himself as to the competence of the warehouse keeper to undertake the storage required;
Give advance notice to the warehouse keeper of the requirement;
Ensure that the warehouse keeper understand what is requirement of him, and clearly specify in the contract the various responsibilities;
Prepare and submit information on his chemicals which will permit safe storage to be achieved;
Ensure that the warehouse keeper formally acknowledges receipt of information on hazards of the materials, recommendations for safe handling and instructions to be followed should spillage occur;
Seek confirmation that the implications of the information including those relating to first aid and emergency situations are understood.
Seek confirmation that emergency arrangements are adequate and carry out the necessary inspections;
Be prepared to supply an emergency telephone number through which specialist advice may be obtained.

2.2 The Warehouse Employer/Owner

In considering a warehouse for storage of chemicals, the employer must ensure as far as practicable, the safety and health of employees at the place of work. Section 15 of *The Occupational Safety and Health Act 1994* stipulates the general duties of employer of place of work:

- To provide and maintain plant and systems and that are safe and without risks to health;

- To make arrangements for the safe use, operation, handling, storage and transportation of plant and chemicals so that they are safe and without risks to health.

- To provide information, instruction, training and supervision to ensure the safety and health of his employees at work;

- To provide and maintain place of work and means of access to and egress from any place of work so that they are safe and without health risks;

- To provide and maintain working environment for his employees that it is safe, without health risks and with adequate welfare facilities.

2.3 The Warehouse Keeper/Employees

The warehouse keeper/employees who are working in the warehouse are obliged to maintain safe work practices. This is in order to protect them from being affected by chemicals hazardous to health. Any responsibilities of employees should comply with the requirement under *Section 24,* The *Occupational Safety and Health Act 1994. Section 24* under The *Occupational Safety and Health Act 1994* stipulates the duties of every *employee* while at work:-

- To take reasonable care for the safety and health of himself and of other persons who may be affected by his acts or omissions at work;

- To co-operate with his employer or any other person in the discharge of any duty or requirement imposed on the employer by this Act or any regulation made there under;

- To wear or use any protective equipment or clothing provided by the employer for the purpose of preventing risks to his safety and health; and

- To comply with any instructions given by his employer under this Act or any regulation made there under.

Chapter 3

LEGAL FRAMEWORK: THE CURRENT LEGISLATION RELATED TO STORAGE

Government agencies deal with some of the legal and technical aspects of warehousing of hazardous chemicals. The Department of Occupational Safety and Health is enforcing three chemical regulations under the Occupational Safety and Health Act 1994.

One of existing legislation in Malaysia is The *Occupational Safety and Health (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations 1997* stipulates the duties of supplier to classify chemicals according to their hazardous properties, pack them into appropriate containers, label the container with prescribed information and accompany the chemicals with an information sheet known as the Chemical Safety Data Sheet (CSDS)/Material Safety Data Sheet (MSDS).

In order to ensure the safety and health of the employer and employees, *The Occupational Safety and Health (Use and Standard of exposure of Chemicals Hazardous to Health) Regulations 2000* elaborate on this requirement i.e. employer is obliged to identify chemicals hazardous to health, comply with the permissible exposure limits; conduct chemical health risk assessment; take action to control hazardous exposure; label and relabel chemicals hazardous to health; provide information, instruction and training; monitor employee exposure at the place of work; conduct health surveillance; post of warning signs; and keep records.

Other legislation is the *Occupational Safety and Health (Control of Industrial Major Accident Hazards) Regulations 1996.* These Regulations apply to certain premises where specified quantities of particular chemicals are stored or used. These quantities, when further compared against the threshold quantity of each of the chemicals, will determine the category of the premises, whether they are under Major Hazard Installation (MHI) or Non Major Hazard Installation (NMHI). The

main aim of these Regulations is to prevent major accidents occurred; a secondary objective is to limit the effects of any which do happen. A major accident is a major emission, fire or explosion resulting from uncontrolled developments which leads to serious danger to people or the environment.

These guidelines will not elaborate in depth any aspect for which the requirements are compliance with the other government agencies and local authorities of concern. References shall be made to the relevant government department such as the Department of Environment, the Royal Customs and Excise Department, the Fire and Rescue Department, the Department of Occupational Safety and Health, the Department of Electricity Supply and the respective local Authorities.

Chapter 4

HAZARD IDENTIFICATION AND COMMUNICATION

The owner or the supplier of the hazardous chemicals is responsible to classify chemicals, provide a chemical safety data sheet, provide a label for chemicals for each product in order that hazard of the products stored in the warehouse are clearly understood by all personnel.

4.1 Chemical Safety Data Sheet (CSDS)

The hazardous chemicals supplier must provide a Chemical Safety Data Sheet (CSDS) or a product data sheet for each hazardous product in order that physical, chemical and biological properties of the chemicals stored in the warehouse are clearly understood by all personnel. The purpose of a CSDS is to provide information needed to allow for the safe handling of hazardous chemicals. An acceptable CSDS for a chemical should describe the chemical's identity, relevant health hazard information, and precautions for use, safe handling information and other relevant information related to chemicals.

The CSDS should contain appropriate information in accordance with one of the regulations i.e. the *Occupational Safety and Health (Classification, Packaging and Labeling of Hazardous Chemicals) Regulations 1997* or *The Pesticides Act 1974* or *The Environmental Quality (Scheduled Wastes) Regulations 2005.*

4.2 Classification, Labelling and Relabelling of Chemicals

The employer shall ensure that chemicals to be stored should be classified, labeled and/or relabeled as per The *Occupational Safety and Health (Classification, Packaging and Labeling of hazardous Chemicals)*

Regulation 1997, or The Pesticides Act 1974 or *The Environmental Quality (Scheduled Wastes) Regulations 2005.*

The details on which containers are to be labeled and relabeled please refer to *The Occupational Safety & Health (Use and Standard of Exposure of Chemical Hazardous to Health) Regulations 2000.*

4.3 Chemical Register

The employer of workplaces which have chemicals hazardous to health should maintain a chemical register. The chemical register consists of the chemical inventory and the chemical safety data sheets for all the listed chemicals. For further information, refer to the *Guidelines for the Registration of assessors, Hygiene Technician and Occupational Health Doctor* that is published by the Department of Occupational Safety and Health.

Chapter 5

CHEMICAL HAZARDS

5.1 Hazards Arising from Chemicals

The storage of packaged hazardous chemicals may create serious risks, not only to people working at the storage site, but also to the emergency services, the general public offsite and the environment.

The incidents causing the greatest concern have generally resulted from the outbreak of fire. Such fire exposes employees, members of the emergency services and the general public to the threat of radiated heat, missiles, harmful smoke and fumes.

In addition, a major fire may cause widespread distribution of chemicals hazardous to the environment, either in the smoke plume or in the water used to fight the fire.

Common causes of such incidents include:

a) Lack of awareness of the properties of the hazardous chemicals;
b) Operator error, due to lack of training;
c) Inappropriate storage conditions with respect to the hazards of the chemicals;
d) Inadequate design, installation or maintenance of buildings and equipment;
e) Exposure to heat from a nearby fire;
f) Poor control over sources of ignition, including smoking and smoking materials;
g) Vandalism and arson.

5.2 Hazard Classification

In any situation, the precaution needed to achieve a reasonable standard of control will vary but must take into account the properties of the chemicals to be stored. Different chemicals create very different risks because of their hazards. It is therefore important that the standards adopted at a particular site are based on understanding of the physical and chemical properties of the chemicals concerned. Interactions between different chemicals, especially those which are incompatible, may create additional hazards.

Other important factors are the overall quantities of the chemicals to be stored and the maximum size of the individual packages. Obviously the risk from packaged hazardous chemicals is dependent on the amount of hazardous chemicals present within any given package. The type of packaging used can also influence the fire hazard.

Many hazardous chemicals are harmful to health if they are inhaled, ingested or come into contact with skin and eyes. You can obtain information on the health hazards of a particular chemical, and on any specific precaution required, from the material safety data sheet or from the supplier. *The Occupational Safety & Health (Use and Standard of Exposure of Chemical Hazardous to Health) Regulations 2000* require employers to assess the risk from exposure to chemical hazardous to health and put in place any precautions needed.

The hazards of any particular chemical should have been classified according to a recognized classification system. Many chemicals arriving on site will be marked with carriage labelling. Those chemicals should be re-classified into hazard categories in accordance with *The Occupational Safety & Health (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations 1997.*

There are 10 hazard categories which comprise five hazard categories based on physicochemical properties (i.e.: explosive, oxidising, extremely flammable, highly flammable and flammable and 5 hazard categories based on health effect (i.e.: very toxic, toxic, corrosive, harmful and irritant).

The various classifications are given in the following paragraphs:

i. Explosive

The Occupational Safety & Health (Classification, Packaging and Labelling of Hazardous Chemical) Regulations 1997 define explosive as the Chemicals or preparation which may explode under the effect of flame or which are more sensitive to shocks or friction than dinitrobenzene.

The storage places should be situated far away from other buildings and structures so as to minimise damage in case of explosion. Manufacturers of explosives issue construction as to the most suitable type of storage.

The storerooms should be of solid construction and kept securely locked when not in use. No store should be near a building containing oil, grease, waste combustible material or flammable material, open fire or flame. The magazines should be situated at least 60m away from any power plant, tunnel, mine shaft, dam, highway or building. Advantage should be taken of any protection offered by natural features such as hills, hollows, dense woods or forests. Artificial barriers of earth or stone walls are sometimes placed around such storage places.

The storage place should be well ventilated and free from dampness. Natural lighting or portable electric lamps should be used, or lighting provided from outside the warehouse. Floors should be constructed of wood or other non-sparking material. The area surrounding the warehouse should be kept free of dry grass, rubbish or any other material likely to burn. Black powder and explosives should be stored in separate warehouses, and no detonators, tools or other material should be kept in an explosive store. Non-ferrous tools should be used for opening cases of explosives.

ii. Oxidising

Oxidising chemicals and preparations are chemicals and preparation which give rise to highly exothermic reaction when in contact with other chemicals, particularly flammable chemicals.

These are chemicals that supply their own oxygen and do readily assist and maintain combustion; examples are sodium chlorate, potassium nitrate and ammonium nitrate. For examples concentrated nitric acid, may create fire if they come into contact with organic combustible materials. Storage rules must therefore be strictly observed and particular, sodium chlorate should never be stored on wooden pallets. Oxidising chemicals should not be stored in close proximity to combustible chemicals.

If these chemicals are stored in the same building, they should be isolated by a firewall. Generally, oxidising chemicals should be isolated from organic materials, flammable solvents, corrosives, toxicants, heat and strong sunlight.

iii. Flammable Groups

Under The *Occupational Safety & Health (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations 1997,* flammable chemicals are classified into three sub-categories i.e. Extremely Flammable, Highly Flammable and Flammable. The details of criteria with regards to hazard classification of the sub-categories should be referred to the above mentioned regulations. The precautions to be taken are different between liquids, solids and gases as follows:

a. Liquids

Under the *Occupational Safety & Health (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations 1997,* there are three criteria in order to classify a liquid either as extremely flammable, highly flammable or flammable, viz:

- **Extremely Flammable**

  Liquid chemicals and preparation having a flash point lower than 0° Celsius and a boiling point lower than or equal to 35° Celsius.

- **Highly Flammable Liquids**

  Liquid chemicals and preparations having a flash point below 21° Celsius but which are not extremely flammable.

- **Flammable Liquids and Preparation**

  Liquid substances and preparations having a flash point equal to or greater than 21° Celsius and less than or equal to 55° Celsius.

Flammable liquid fires can grow rapidly once the integrity of the flammable liquids container is breached, the fire spreading quickly as the escaping liquid flows from the stored material, regardless of their categories. If the fire comes into contact with other flammable or oxidising chemicals, it will increase significantly in size, and there will be more difficult to control. Sealed containers may explode if exposed to intense heat. Depending on ground conditions at that time, liquids may travel some distance while a leak remains undetected.

Precautions to be taken for all categories include storing flammable liquids in a cool dry place, away from sources of ignition and heat, and securely closed containers specifically designed for the purpose. It is preferable for the store to be in the open air, but in all cases adequate ventilation at high and low level will be needed to disperse any vapours from leaking containers.

b. Solids

Under the *Occupational Safety & Health (Classification, Packaging and Labelling of Hazardous Chemicals)*

Regulations 1997, there are two criteria of solids in order to classify it as highly flammable.

- Solids that can be ignited by brief contact with a source of ignition or be sensitive to friction, and that will continue to burn after removal of the source of ignition. Examples are matches, fire lighters, nitrocellulose and sulphur. Precautions to be taken include storing flammable solids in a cool dry place, away from sources of ignition and heat, and securely closed containers specifically designed for the purpose.

- Chemicals and preparations which, when in contact with water or damp air, evolve highly flammable gases in hazardous quantities e.g. fumigants such as aluminium phosphide, calcium carbide, zinc or magnesium metal powder. The humidity of the air may be enough to cause a reaction. Many of these are stored under kerosene to prevent contact with air. It is important therefore to ensure such substances are well away from fire fighting water or sprinkler systems. Precautions to be taken include storing flammable solids away from sources of sunlight, other classes of chemicals and chemical that is combustible.

c. Gases

The United Nations Recommendations on the Transport of Dangerous Goods classified gases into compressed gases, liquefied gases or dissolved under pressure. Under the *Occupational Safety & Health (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations 1997,* gases that are flammable in air at normal pressure are classified as highly flammable. Safety precautions are required when handling, using and storing flammable gases. Minor leaks from cylinders of compressed gases may disperse more readily if the cylinders are stored in the open air. Cylinders of liquefied gases should be stored in upright position so that any leaks from valves etc. will be of vapour or gas rather than liquid.

Most types of cylinders will explode if exposed to intense heat, causing a risk of impact to people in the vicinity even if the cylinder contents are non-hazardous. Acetylene cylinders in particular are liable to explode without warning, during or for some time after exposure to heat, because of the self-decomposition of the product.

Where flammable gas cylinders are stored in buildings, good ventilation is needed to ensure that minor leaks will disperse safely. When considering storage locations and determining ventilation design criteria, your assessment will need to consider the densities of the gases involved, for example whether they are heavier or lighter than air.

iv. Toxic Chemicals

Toxic chemicals can be harmful by contact, inhalation and ingestion. These chemicals should be avoided from contact with heat, acids, moisture and oxidising chemicals. Very toxic chemicals and carcinogen should be stored in ventilated storage areas in unbreakable secondary containers. Chemicals with a high chronic toxicity such as mutagen, teratogens and carcinogens, should be identified with a label. It is important that employees do not handle these materials without being made aware of their hazards and be given proper training. Typically known and probable carcinogens are arsenic powder and arsenicals, sodium arsenate and etc.

It is important that adequate personal protective equipment is available at any time toxic chemicals are handled and for use when clearing up spillages and toxic chemicals. This will include suitable gloves, boots, eye shields, and when appropriate, face shield or even breathing apparatus.

v. Corrosive Chemicals

Corrosive chemicals include strong acids, alkalis and other chemicals which will cause burns or irritation of the skin, mucous membranes or eyes or will damage most materials. Typical examples of these

chemicals include hydrofluoric acid, hydrochloric acid, sulphuric acid, nitric acid and perchloric acid. Such material may cause damage to their containers and leak into the atmosphere of the storage area; some are volatile and others react violently with moisture, organic matter or other chemicals. Acid mists or fumes may corrode structural materials and equipment and have a toxic action on personnel.

Example: where containers of corrosive chemicals are stored, shelves should be lined with sheets of polypropylene or made of particle board laminated with chemically resistant material. Such materials should be kept cool but well above their freezing point, since a substance such as acetic acid may freeze at a relatively high temperature, rupture its container and then escape when the temperature rises again above its freezing point.

Some corrosive chemicals also have other hazardous properties; for example perchloric acid, in addition to being highly corrosive, is also a powerful oxidising agent, which can cause fire and explosion. Storage areas for corrosive chemicals should be isolated from the rest of the plant or warehouse by impervious walls and floor, with provision for the safe disposal of spillage. The floors should be made of cinder blocks, concrete that has been treated to reduce its solubility, or other resistant material.

No store should be used for the simultaneous storage of nitric acid mixtures and sulphuric acid mixtures. Sometimes it is necessary to store corrosive and poisonous liquids in special types of containers; for example, hydrofluoric acid should be kept in leaden ceresin bottles. Since hydrofluoric acid interacts with glass, it should not be stored near glass or earthenware carboys containing other acids. Carboys containing corrosive acids should be packed with infusorial earth or other effective inorganic insulating material. Any necessary first-aid equipment such as emergency showers and eyewash bottles should be provided in or immediately close to the storage place. For segregation or separation of corrosive chemicals from other chemicals, please refer to Appendix.

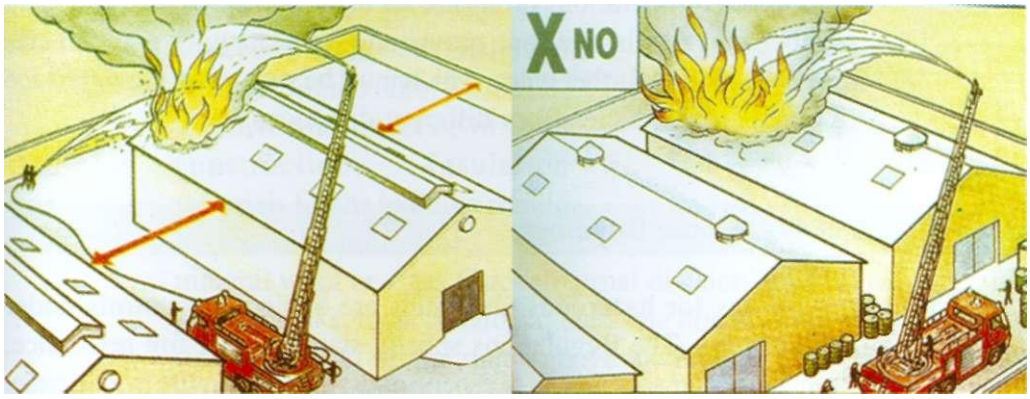
Chapter 6

SITING AND DESIGN OF STORAGE AREA

6.1 Siting

Chemicals storage areas should be located away from densely populated areas, from drinking water sources, from areas liable to flooding and from flooding and external sources of hazards. The siting and zoning of new industry building is controlled by the planning legislation. Location should provide easy access for transport and emergency services on the ground stable enough to support robust and safe buildings and roadways. Adequate services should be provided including: electricity with emergency supply if needed, potable water and fire-fighting water, drainage preventing ground run-off to either public/storm sewer or a waste treatment plant as a part of a site containment plan.

6.2 Site Layout



The site layout designed to allow possible separation of incompatible materials by use of separate buildings, fire walls or other acceptable

precautions should permit safe movement and transport of materials; it should have sufficient space to give reasonable working conditions and allow clear access from two sides.

6.3 Security

Site and buildings should be adequately protected from trespassers by secure fencing, gates and other security measures since many warehouse fires are the result of arson. Measures taken will vary widely, particularly between isolated warehouses and those forming part of a complex on a site dedicated to warehousing.

6.3.1 Boundaries

The site should be surrounded by a secure boundary wall or fence, which should be maintained in a good state of repair. The fence line should be located so as to provide room for spill isolation and the activation of spill mitigation procedures. During the silent hours a night watchman and/or additional security aids should be considered e.g. perimeter lighting, etc.

6.3.2 Site Access

The number of access gates should be kept to a minimum consistent with efficient operation. From the security point of view, the ideal number of gates is one, but provisions for managing emergencies may well require further gates, which must be such as to allow passage of emergency vehicles from different directions.

6.4 Design of Warehouse Buildings

Storage buildings for hazardous chemicals are subject to controls under building legislation. The Regulations specify standards for fire resistance, compartment size and also means of escape and assistance to the fire brigade. Requirement for the above matters can be referred to the *Uniform Building by Laws 1984.* The related agencies should be consulted such as the Fire and Rescue Department and local authorities of concern. However, the

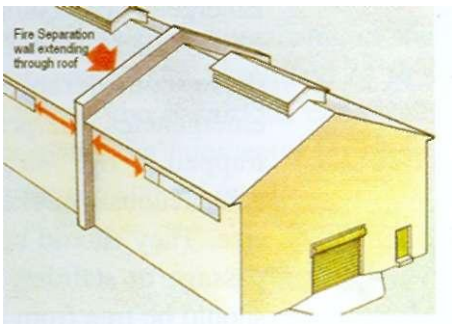
information laid down as follows will supplement the requirement of the above mentioned Regulations.

The layout of warehouses should be designed in accordance with the nature of materials to be stored with adequate provision for emergency exits. If necessary, the floor area and the volume of storage should be limited by compartmentalizing the building in order to allow the necessary segregation of incompatible hazardous chemicals.

Warehouses should be substantially closed in and capable of being locked. The construction materials should be non-flammable and the frame of the building should be in reinforced concrete or steel. A steel frame should preferably be protected from heat by insulation.

The standards of fire resistance required under health and safety legislation are attended to allow sufficient time, in the event of a fire, for the alarm to be raised, for people to escape, and for fire fighting to be put safely in hand. The standards of structural fire resistance are determined by the local authority building control department via the building regulations, or standard.

6.4.1 Walls



External walls may be covered with steel or with similar sheeting, when these are not intended to provide fire protection against external risks. Where such risks do exist, external walls must be of solid construction; Insulation materials for the building should be non-combustible, e.g. mineral wool or glass fibres. Internal division walls, designed to act as fire breaks, must provide at least *one hours resistance* and should rise to a height of one metre above the roof or have other means of preventing a fire from spreading.

The materials best suited to combine fire resistance with physical strength and stability are concrete, solid brick or concrete blocks. To

achieve the desired fire resistance, reinforced concrete walls should be at least 15 cm thick (6 inches) and brick walls should be at least 23 cm (9 inches) thick. Hollow brick is not suitable. Concrete blocks without reinforcing require a minimum thickness of 30 cm (12 inches) in order to achieve the requisite strength and stability.

To achieve greater structural stability, reinforcing columns (pilasters) in the firewall are recommended. The fire wall should be independent of the adjoining structure to avoid a collapse in the event of fire. Where piping, ducting and electric cables penetrate fire-resistance walls, they should be placed in fire retardant sand cups.

6.4.2 Fire Doors

Doors in internal walls should have a fire resistance similar to that of the wall itself and be self-closing, i.e. fitted with a fusible link or a link activated by the automatic fire detection system, to ensure automatic closure in the event of a fire. The space required for closure should be kept free from obstruction.

6.4.3 Emergency Exits

Emergency exits other than those afforded by the main doors should be provided with not less than two exits from every floor. In planning these, considerable thought should be given to all conceivable emergencies, the prime requirement being that nobody should be trapped in the warehouse. Emergency exits shall be clearly and conspicuously marked by a notice printed in red letters of an adequate size. They should be fitted so as to open outwards from the room, passage or staircase and shall not be kept locked or fastened and should be free from obstruction. They should be easy to open in the dark.

6.4.4 Floors

Foundations and floors shall be of sufficient strength to sustain the loads for which they are designed. Floors should be of safe construction so as to prevent a risk of persons falling and structurally

sound so as to prevent a risk of collapse and shall be properly maintained and kept from any loose material. They also should be impermeable to liquids. They should be smooth, but not slippery, and free from cracks to allow for easy cleaning and be designed to contain leakage and contaminated fire-fighting water, for instance by means of a surrounding sill or curb.

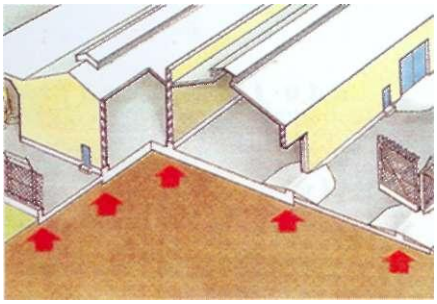
6.4.5 Drainage System

Drainage system should be provided to take rainwater away from roof and outside areas. The drainage arrangements should aim to prevent uncontrolled release of contaminated fire-fighting water and spilled or released chemicals. An impervious sill or low bund should be installed to contain spillages in outdoor storage areas. This should enclose a volume which is at least 110% of the capacity of the largest container. Ramps can be provided over the sill to allow for the access of fork-lift trucks, pallet trucks etc. into the storage area.

The surface of the storage area needs to be impervious and slightly sloped so that any liquid spilt from the containers can flow away to a safe contained place. An alternative method to using a bund is to direct spillages of liquid to another area. This could be an evaporation area, or via drainage to a remote sump, interceptor or separator.

Good drainage of surface rain water away from containers, or the storage of container or pallets, can reduce the likelihood of this corrosion. Depending on the hazards of the hazardous chemicals stored, it may be necessary to incorporate an interceptor pit in the site drains, so that small spillages can be retained on site.

6.4.6 Bunding



Where the hazardous chemicals stored, there should be bunds to contain the liquid and sills to prevent its spread through doorways. The bunds should be impervious and resistant to the liquid. In areas where the risk

of spillage is high, there should be a separate drainage system with sloped floor, a bund and a collection sump.

6.4.7 Roof

Roofing must be able to keep out rain water and the design should allow for fumes and heat to be vented in the event of fire. Construction materials need have no special fire resistance but external surface materials such as wood, which might increase fire spread should be avoided.

The supporting structure of the roof should be made of non-combustible material. Hard wood or treated wood frames are acceptable provided the roof covering itself is non-flammable. The roof covering may be of light-weight, friable contsruction, that will readily fail in the event of fire and thus provide relief of smoke and heat. Where the roof is of a solid construction, smoke and heat relief must be provided with either low melting transparent panels or ventilation panels with an adequate opening. Ventilation panels must be permanently open, able to be opened by hand or they must open automatically in case of a fire. Early relief of smoke and heat will improve visibility of the source of the fire and retard lateral spread.

6.4.8 Ventilation

The warehouse should be well ventilated, taking into account the products stored and the need to provide generally agreeable working conditions. Good ventilation is necessary to keep down the levels of gases or vapours from reaching the lower flammability limit or concentration hazardous to health. Ventilation may be afforded by natural or mechanical means.

6.4.9 Lighting and Electrical Equipment

Where warehousing operations are only carried out during daytime and natural lighting is adequate, there may not be any need to install artificial lighting. In such circumstances where natural lighting is

inadequate, it may be possible to improve it by e.g. inserting transparent panels in the roof.

Where lighting and other facilities are required, all electric equipment, including wiring, must be installed and maintained by a qualified electrician. Electrical installations for temporary purposes should be avoided but, where necessary, they should be installed to an appropriate standard, by a qualified person.

All electrical equipment must be positioned so as to avoid accidental damage by vehicle or pallet movements, or a contact with water. Equipment must be adequately earth and provided with suitable overload protection.

It is generally accepted that flameproof electrical equipment not normally required in storage areas. However, in some circumstances, e.g. storage of low flash point solvents, or fine dust liable to explosion, it may be necessary to use flame-proofed equipment, including fork lift trucks. This will depend on the nature of the products, their flash point, the normal ambient temperature and the quality of the ventilation. Such a judgement should normally be taken on advice from the supplier of the materials concerned.

Battery-charging equipment must be well ventilated to permit safe dispersal of hydrogen generated during charging, preferably outside of or separate from the storage itself, and it must kept clear of stored products or other combustible materials. Other ancillary operations such as shrink-wrapping packaging, welding, etc., which present a potential ignition source, should not be allowed to take place in the storage area. If in avoidable in the warehouse, special precaution must be taken.

6.4.10 Heating

It is generally preferable that warehouses are unheated. Where heating is necessary to maintain acceptable working conditions or the condition of the material stored which might freeze, indirect heating by some safe means, such steam, hot water or warm air, is recommended, the heat source being located outside the storage area.

Hot water radiation steam pipes should be located so that direct heating of stored product cannot occur. Radiant electrical heating equipment portable gas or oil fired hot air units should not be used. If building insulation is used, the materials should be non-combustible, e.g. mineral wool or glass fibre.

6.4.11 Lightning Protection

In a warehouse containing flammable chemicals, protection against the effects of lightning strikes should be considered.

6.4.12 Other Accomodation

Ideally, there should be no offices, mess rooms or changing rooms built as an integral part of the warehouse. Where such facilities do exist within a warehouse, the separation structure should provide a minimum fire resistance of 60 minutes.

6.5 Outdoor Storage

Where hazardous chemicals are stored outdoors, bunding arrangements should be identical to those for indoor storage and a roof or a cover to protect from sun and rain should be provided. This poses a number of problems:

- Outdoor storage of chemicals exposes the chemicals to high temperatures that may lead to thermal degradation. Careful selection of chemicals with the help of their Chemical Safety data Sheet would be therefore important.

- To avoid contamination of the soil and the water table, the storage area should be surfaced with impervious, heat and water-resistant material, avoiding asphalt because it softens in hot climates and under the influence of certain solvents;

- The bunded area must be equipped with a drain controlled by a valve.

- Products stored in this manner must be scrupulously checked for leakage so as to avoid contamination of the drainage system.

Weatherproof packs such as 200 litre drums may be stored in the open provided their contents are not sensitive to extremes of temperature and security can be guaranteed. Drum storage upright on pallets is recommended. Drums stored on the roll must be wedged. All drums must be stored in such a way that there is always sufficient space for fire- fighting access. With certain materials such as highly flammable liquids, gas cylinders or liquid chlorine, outdoor storage is recommended.

Chapter 7

WAREHOUSE MANAGEMENT

7.1 Controlling Chemical Hazards In Warehouse

Each chemical hazardous to health stored in a warehouse should be listed in a chemical register and be evaluated. Before decision can be made on appropriate control measures, induction and training of employees, monitoring and health surveillance activities employer should conduct chemical health risk assessment. Based on assessment report, then such activities can be decided. Storage requires combining several control measures, including isolation, engineering controls and safe work practices. It is essential that each chemical to be stored is assessed and grouped according to chemicals classification (excluding for certain chemicals that are incompatible with their members in the same group.

The procedures on how to conduct a chemical health risk assessment could be referred to Chemical Health Risk Assessment Manual (2nd Edition) - A Manual of Recommended Practice published by the Department of Occupational Safety and Health.

7.1.1 Isolation

Isolation, or segregation, is the separation of a hazardous chemicals or processes from those who might be exposed by distance or by the use of physical barriers. Hazardous chemicals can be isolated from work operations, thus eliminating exposures to the majority of the workers. Following are some practical examples of isolation as a control measure for storage: containers and lids; enclosed transfer; flash arrestors; fire-rated walls and doors; fire-rated storage cabinets; segregated storage; spill trays and bunding; and splash barriers.

Figure 1 : 9 separated room specially design for segregation of incompatible chemical Example Flammable, Toxic, Oxidising & Corrosive.
(picture with courtesy from BASF(Merck Electronic Chemical Sdn. Bhd) -Mr. Francis Jaw)

7.1.2 Engineering Controls

Engineering controls are plant or processes that minimise generation of hazardous chemicals, suppress or contain hazardous chemicals, or that limit the area of contamination in the event of spills and leaks. They include total or partial enclosures, different types of ventilation control, automation of process, explosion vents, and controls for static electricity and so on.

The best time to introduce engineering controls is when a plant is at blueprint stage. At that time, control measures can be integrated more readily into design than after the plant has been built or the process gone on stream.

7.1.3 Safe Work System and Practices

Safe work system practices are administrative practices, which require workers to work in a safer way. These contain administrative controls, good housekeeping and personal hygiene.

The main approaches related to storage are:

- Reducing the number of employees exposed;
- Excluding any access which is not essential;
- Providing means for safe storage of hazardous chemicals;
- Providing adequate hygiene facilities, such as sinks, showers, soaps and towels;
- Providing adequate emergency facilities, eye wash, eye shower;
- Providing first-aid facilities;

- Prohibiting eating, drinking, smoking in contaminated areas;
- Keeping lids on containers when not in use; and
- Regular decontamination of walls and surfaces.

7.2 Warehouse Operation

Within the warehouse, operations must be closely supervised by a trained and experienced supervisor. In all cases, the area and line of responsibility must be clearly defined and understood.

Working procedures should take the first in-first out principle as a basis in order to minimise risk of deterioration of chemicals or packages and labels, and other markings. The following written instructions must be readily available to all warehouse personnel:

- Instruction for the safe and correct operations of any equipment and storage of material;
- Chemical Safety data Sheet for all stored and transported chemicals;
- Hygiene and safety instructions and procedures;
- Emergency instructions and procedures.

7.3 Procedures for Receipt of Hazardous Chemicals

On arrival, chemicals are identified by the bill of loading, the labelling and the chemical safety data sheet provided by the supplier. Their charateristics are checked as per information for quantity and condition, if the chemicals or packaging are not in good condition, or if for any reason they seem to present a particular hazard, appopriate action must be taken. In certain companies, a chemicals inventory system is used to develop safety and health information system on chemicals used. Nowadays the chemicals inventory database is available for applying the chemicals inventory system.

7.4 Storage Plan

A clear space should be left between all outside walls and the nearest packs and within block stacks, to allow access for inspection, free movement of air and fire-fighting. Chemical containers must be arranged so that forklift trucks and other handling or emergency equipment is not obstructed. Narrow

aisles or tight corners will increase the risk of damage to packs. All aisles as well as gangways and forklift truck routes should be clearly defined by markings on the floor and kept free from obstructions and from pedestrians to avoid injury.

Stacking heights should not exceed three metres unless the use of racking prevents overloading the lower tiers and ensures stability. Where racking is not provided, chemical containers must not be stacked to a height which is likely to cause damage to the lower tiers.

A plan should be drawn up showing the nature of hazard in each part of the warehouse;

- Sub-section number for each separated area;
- Location and quantities of the stored chemicals or groups of chemicals with their hazard characteristics.
- Location of available emergency and fire-fighting equipment, access and escape routes.

This should be kept in the main office and a copy given to the local fire brigade. It should be updated. A complete inventory of chemicals or workplace list of chemicals stored in their location in the warehouse should be kept updated as well.

7.5 Chemicals Separation and Segregation

The word separation denotes the positioning of different product groups in separate areas within a warehouse. The word segregation denotes the physical separation of different hazard classes, e.g. in separate warehouses or by a fire wall within a single warehouse.The primary objective of product separation and segregation is to minimise the risks of fire or cross contamination often presented by mixed storage arrangements of incompatible materials.

Correct separation will also minimise the extent of hazardous zones and the requirement to bund or to install protected electrical equipment. Some chemicals with multiple hazards fit into different storage classes. Phenol, for example, is flammable, toxic and corrosive. The storage class it is put in depends upon the most likely hazard found in the warehouse. If sources of ignition are present, perhaps it should be stored as a flammable. On the

other hand, if contact is possible, it should be stored as a contact hazard, but separate from oxidisers like nitric acid. If the possibility of human contact is minimal, its storage as a toxic chemical becomes less important.

Appendix gives recommendation for the segregation of hazardous chemicals according to their hazard classification in accordance with the Carriage of Dangerous Chemicals (Classification, Packaging and Labelling) and Use of Transportable Pressure Receptacles Regulations 1996.

The guidance in Appendix will not necessarily achieve safe storage conditions. You need to consult the material safety data sheets for reactivity data to determine whether the chemicals are compatible. Many corrosive chemicals in Class 8 are compatible. These may react together to produce heat or toxic gases. Examples are:

a) Acias/hypochlorites - generate chlorine gas;
b) Acids/cyanides - generate hydrogen cyanide gas;
c) Acids/alkalis - generate heat;
d) Acids/sulphides - generate hydrogen sulphide.

Generally segregation of acids from other chemicals will go some way to ensuring incompatible chemicals is not stored together. The extent of such incompatibility problems is reduced because damage to two packages must occur before any reaction can take place. Also, mixing and reaction is likely to be slow if both incompatible components are solids.

The miscellaneous hazardous chemicals and other hazardous chemicals in the carriage Regulation have quite varied properties, and no general advice can be given regarding segregation. The advice should be obtained from the supplier. Following the assessment of the hazard chemicals, you are able to decide where the material should be physically stored.

7.6 Amenities and Personal Hygiene

Work clothes as well as changing and washing facilities should be provided and a separate clean room should be made available where workers can eat, drink and smoke. Provision must be made for the frequent and regular washing for dirty clothing, either by the plant's own facilities or by those of an approved contract service. Eating, drinking and smoking must not be allowed in the work areas.

7.7 Personal Exposure and Protection

The employer should ensure the workers exposure to hazardous chemicals hazardous to health are kept to a minumum and the permissible exposure limits are not exceeded. Permissible exposure limits represent an air concentration below which health hazards are unlikely to occur among most exposed workers. The permissible exposure limit can be of three forms: a time weighted average (TWA), a ceiling limit, or maximum exposure limit.

They are defined as follows:

a) *Time-weighted average (TWA)* - the average airborne concentraton of a particular substance when calculated over a normal eight-hour work day, for a five-day working week;
b) *Ceiling limit* - means the aiborne concentration that should not be exceeded during any part of the working day;
c) *Maximum exposure limit* - means a fifteen-minute time weighted average airnorne concentration which which is three times the eight hour time weighted average airborne concentration of the chemicals specified in Schedule I of *The Occupational Safety & Health (Use and Standard of Exposure of Chemical Hazardous to Health) Regulations 2000.*

When the use of personal protective equipment is considered to control the workers from being exposed to chemical hazardous to health in a warehouse the following items of protective equipment should be made available for use as appropriate (for routine work):

- Protective helmet or cloth cap;
- Eye protection (safety spectacles, goggles or face shield)
- appropriate respiratory protection;
- One piece work-suit with closely fitting trouser bottoms;
- Rubber or plastic gloves or gauntlets;
- Rubber or plastic apron;
- Work-boots with protective toe-caps.

The personal protective equipment should be approved by Director General of Department of Occupational Safety and Health.

7.8 First-Aid Facilities

All warehouses should have basic first-aid materials facilities and selected employees should be trained in first-aid procedures. The warehouse must have basic first-aid facilities, and trained first-aiders.

The recommended first-aid facilities will include but not limited to:

- First Aid Box;
  (Eg : First aid manual, Elastic bandage, Sterile eye pads, etc.)
- First Aid Equipment;
  (Eg : Emergency showers and eye-wash facilities)
- First Aid Room.
  (Eg : First aid box, antiseptic hand wash soap, etc.)

The first-aid equipment must be frequently and regularly checked and maintained to ensure that its condition is satisfactory. Records should be kept of all checks and maintenance.

Arrangements must be made with a local hospital or doctor for immediate assistance to be provided in an emergency. The doctor and hospital must be informed of the nature of the chemicals handled and they should have necessary antidotes. In case of emergency, the label of the Chemical Safety Data Sheet of the chemical involved must be sent to the doctor with the patient. For further information on the recommended first aid facilities please refer to *The Guidelines on First-Aid in Workplace* published by the Department of Occupational Safety and Health. For detailed advice on first-aid relating to chemicals, the chemical safety data sheet must be consulted.

7.9 Training

As with other operations, safety and health and job training for all employees engaged in warehousing operations is necessary if good safety and health management is to be achieved. Regular periodic safety meetings, training sessions and practices of emergency procedures should be arranged and provide the opportunity to check that updated instructions, emergency plans and relevant information are made known and available to employees. All members of the emergency response team should be trained in the use of all types of fire-fighting and chemical spill handling equipment present on the site.

7.10 Housekeeping

Good housekeeping will minimise damage, leakage and fire risks as well as leading to safe and efficient operation. The following practices should be observed:

- Stocks should be frequently inspected for leakage or mechanical damage and used on a first in first out basis;
- Floors should be kept clean and dust free with particular attention to ensuring the prevention of a greasy surface;
- The whole area should be free from dust, rubbish and redundant machinery and equipped with proper receptacles such as metal drums for waste collection which should be disposed of regularly;
- Empty, combustible packaging materials should ideally be kept out of a warehouse holding flammable products. At the very least they should be kept to an operational minimum;
- All access to exits , emergency equipment, etc. must be kept clear;
- After any work, including maintenance, all remaining materials and equipment must be properly cleaned away.

7.11 Spillage and Leakage Containments

With good housekeeping and careful handling, containers of adequate quality may be expected to remain intact for long periods. However, they may be damaged by bad handling and then begin to leak. In order to minimise hazards, all spillages and leakages should be dealt with immediately, having consulted the Chemical Safety Data Sheet.

For dealing with spillages, the following equipments could be used:

- Personal protective equipment;
- Empty drums, oversized if possible;
- Self-adhesive paper labels for marking drums;
- Absorbent material: sand, granulated clay, sawdust;
- Detergent solution;
- Brooms;
- Shovels;
- Drum spanners;
- Metal funnels.

All emergency and safety related equipment must be checked at least once a month to ensure that they are maintained in good condition. Personal protective equipment must be decontaminated and cleaned after use. Personal protective equipment should also be inspected and maintained on a regular basis. Records should be kept of all checks and maintenance carried out on these equipments.

Liquid spillage should be absorbed into a suitable dustless solid absorbent such as granular absorptive clay, sand or saw dust which, however, should not be used with flammable or strongly oxidising liquids. Proprietary salvage containers are available to hold leaking drums. The used spare bags or salvage containers should be label accordingly.

The area should then be decontaminated according to the instructions in the Chemical Safety Data Sheet, and the waste disposed off safely according to manufacturer instructions. Spilt material can best be cleaned up with an industrial vacuum cleaner. Brushes and shovels can be used minimising generation of dust by use of dampened sand, etc.

7.12 Waste Disposal

All wastes including packaging materials, broken pallets, etc. must be disposed off in a safe and environmentally responsible manner. Potentially hazardous waste should be disposed in accordance with *The Environmental Quality (The Scheduled Wastes) Regulation 2005* published by the Department of Environment.

7.13 Safety and Health Inspection & Investigation

Safety and health inspection and investigation of the whole warehousing covering equipment and procedures help to:

- Ensure that objectives are understood by all concerned;
- Ensure that deficiencies are brought to light and corrected; and
- Stimulate safety awareness.

The procedures for inspection and investigation should comply with Regulation 12 and 13 of the *Occupational Safety and Health (Safety and Health Committee) Regulations 1996.* Regulation 12 of the mentioned

Regulations stipulate the duty of safety committee to conduct safety and health inspection at least once in 3 month time, to discuss the observation during the inspection and make recommendations to the employer.

For safety and health investigation, as required under regulation 13 of the same regulations the safety committee should investigate any accident, near miss accident, hazardous occurrences, occupational poisoning or occupational diseases and should discuss the cause of such accident/incident/ poisoning/disease and make recommendations to employer of measures to be taken to prevent the reoccurrence of such accident/incident/poisoning/ disease.

7.14 Signages

The use of signage indicating location of hazardous chemicals to health (e.g. very toxic chemicals), smoking restrictions, and location of emergency equipment, telephones and escape routes are recommended.

The signage indicating location of chemical hazardous to health is called warning sign under the *Occupational Safety & Health (Use and Standard of Exposure of Chemical Hazardous to Health) Regulations 2000.* Regulation 29 (1), (2) & (3) of the mentioned Regulation stipulate the requirement for warning sign as:

- Warning sign should be posted at easily seen place at every entrance;
- Other relevant information are given to person who likely to be at risk;
- Warning sign should meet the following criteria:
  - i) Warning of hazard;
  - ii) Be written in national language and English;
  - iii) Be printed in dark red against white background.

Other signages may be displayed at the storage area provided that:

- The instructions are in local languages understood by the workers.
- The symbols used such as pictogram are readily recognized and understood by workers.

Chapter 8

EMERGENCIES

8.1 General

An emergency in a warehouse can pose a potential threat to the employees, the environment and neighbouring population, in addition to the loss of chemicals. Some of the most common situations that may lead to an emergency in a warehouse are spillage, chemical release and fire etc. For instance, fire involving products that can produce toxic gas could create risks to people nearby. Careful measures to prevent such situation are essential through good design, operation, maintenance and inspection, but it will not eliminate it altogether. It is necessary, therefore, to plan for such emergencies. Emergency planning is an integral and essential part of the loss prevention strategy. When emergencies occur, the minimisation of loss and the protection of people, property, and the environment can be achieved through the proper implementation of an appropriate emergency response plan.

This section is prepared to provide an employer/owner of a warehouse method for mitigating the effects of an accident of a workplace that stores hazardous chemicals by an appropriate on-site emergency response plan (ERP). This section also provides a framework for each workplace that needs to have its own ERP, suited to the local situation and based on potential hazards particular to its own activities.

8.2 Emergency Response Plan

The employer of the warehouse should establish an emergency response plan which describes the immediate, specific response to an emergency. The plan should be established in conjunction with local authorities and Fire and Rescue Department. The plans address the personnel, equipment, counter measures, and shutdown procedures to effectively combat the emergency situation. Some response plan will not adequately address the

unique hazards such as chemical release and spillage but this is readily overcome by additional planning.

An emergency response plan involves two parts: on-site or internal comprehensive emergency response plan and off-site or external emergency response plan.

- On-site emergency response plan is a set of procedures designed to protect personnel present on-site of the warehouse, to combat and to contain a danger from being affected to personnel and contents of the warehouse. This set of procedures is to be prepared by the employer/owner.

- Off-site emergency response plan is a set of procedures designed to protect the population, property and environment surrounding the warehouse site against possible consequences of an emergency originating in or from the warehouse site.

- This set of procedures is to be prepared by the local authority in co-operation with the employer/owner who has to supply any necessary information such a hazards of chemicals stored and the like.

The following paragraph describes the general on-site emergency response plan in which the emergency procedures being included.

8.2.1 Components of Emergency Response Plan

The type, content and format of the emergency plan are dependent upon the facility's needs and objectives. The emergency planning shall consist of the following components:

- List of emergencies arising from the warehouse operation such as fire, spillage and chemical release;
- Location/center where the place or room to be used during emergency for the purpose of strategic planning to handle such emergency and list of equipment or facility at the center;
- Organisation and emergency team and their responsibility or activity;
- Procedures used to handle emergencies as stated in item 1;

- Procedures associated with the general emergency principle as follows:
  - Alarm sequence
  - Emergency action
  - Evacuation/search and rescue/first aid
  - Communication with external emergency services
  - Termination of emergency
- Records
  - List of emergency equipment and facilities and, its maintenance
  - Emergency drill
  - Review and updating of emergency plan

8.2.1.1 General Principles of Emergency Procedures

There are some general principles, which must be addressed in an ERP in order to develop complete emergency procedures. These principles include:

i. Alarm

It is the practice at many works that any employee can raise an emergency alarm, thus allowing the earliest possible action to be taken to control the situation. Alarm system is varying and will depend on the size of the works.

There should be an adequate number of points from which the alarm can be raised either directly, via a signal or message to a permanently manned location. The alarm should alert the Emergency Commander, who should assess the situation and activate appropriate emergency procedures. In the areas where there is a high level of noise, it may be necessary to install more than one audible alarm transmitter of flashing lights. Automatic alarms may be appropriate on some sites.

ii. Emergency Action

Emergency action includes actions that need to be taken during the emergency. Emergency actions are usually

represented in the form of flowcharts or checklists, which guide the responder through the actions and decision making process in the event of an emergency. These should include actions and decisions such as: whatever it is better to contain, remove or eliminate the cause of the accident.

iii. Evacuation/Rescue/First Aid

These standard sub-procedures that is essential in writing emergency action procedures. The evacuation, rescue, and first aid procedures should address at the minimum, the following:

- Evacuation should be to a predetermined assembly point in a safe part of the works.
- The procedure should designate someone to record all personnel arriving at assembly point.
- Account for all personnel, including visitors.
- Initiate a search for missing persons. Ensure that the searchers will not be endangered.
- Activate rescue teams (ensure teams are fully equipped and are using appropriate safety equipment).
- Apply first aid on injured persons only if qualified after removing persons from the accident area.
- The doctor should be prepared for any foreseeable type of injury.

iv. Communications

The communication is a crucial factor in handling an emergency. The communication procedure involves the Coordination and the flow of information within the company and outside of the company. Procedure must be established to declare the emergency. There can be only one person in charge.

When writing emergency procedures for emergencies, they should address communication among the following persons:

- Emergency Commander of the company.
- Internal Communications Controller(s) such as the Communications Operator in the FLRC and the Site Contact in the ORCC.
- External Communications Controller such as the External Agencies Contact person in the ORCC.

A detailed organisational chart showing the flow of command during an emergency and the flow of communication should be established.

v. Notification

The aims of notification are:

- To summon for assistance from local emergency services such as Fire & Rescue Department, police, ambulance, hospital, neighbouring plants, etc.
- To provide for statutory notifications to organisations such as the DOSH, etc.
- To provide warning to neighbours close to the facility and public or community in the surrounding area to initiate contingency plans without delay. This allows the industry contingency plan or the state contingency plan to be placed on alert status.
- To inform families of injured/deceased employees. The families of casualties need to be informed and helped promptly. It may not be possible to have a standard method for informing next of kin that some general rules was apply:

    - It is essential that the next of kin of deceased or seriously injured personnel are notified at the earliest opportunity
    - Prompt action is required by the doctor in providing an initial report
    - Notification is on basis of this report
    - Any information provided to next of kin should be given in person, preferably by a

doctor. A senior supervisor or manager known by the family and a social worker should help where necessary.

The procedures should include a notification list, listing the various local emergency services and immediate neighbours to be contacted during an emergency.

It may be necessary to notify other key personnel such as plant manager or physician during off-duty hours.

vi. Emergency Termination

Procedures for termination of an emergency should be listed in the emergency procedures. When the Fire & Rescue Department officer's role is completed, he is to hand back control to the company Emergency Commander who will then carefully consider the overall situation.

The company Emergency Commander may have additional actions to attend to before declaring the emergency is over. His next task would be facilitating the reorganisation and reconstruction activities so that normal operation can be resumed. The conditions for the termination of emergency should be clearly addressed. When these conditions are met, the emergency commander declares that the emergency is over. Generally, a specific signal or alarm would be given to announce the emergency is over.

Before people and workers are allowed to return to the emergency area, or its surroundings, an assessment of health risk is necessary.

This section must also include provision for clean up, safe storage and disposal of all contaminated material, refilling of fire extinguishers and resetting of automatic alarms, etc. before resumption of operations.

vii. Special procedures

Special procedure must be established to handle chemical release of flammable/toxic gases. The chemical release procedure describes the specific actions and responsibilities taken by emergency response team when containing and controlling a hazardous material release. The procedure should state the steps the emergency commander to recognize and identify hazards of a chemical release. The important feature is early detection and rapid safe initial response with the objective of isolating the source of the release. The procedure should include assigning personnel, personal protective equipment to be used, establishing team communication, ensuring use of buddy system, setting proper decontamination procedures, conducting reconnaissance operations, establishing action plan to gather information about the incident and other relevant information, termination and medical follow up.

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APPENDIX

Table 1: General Recommendation for the Segregation of Dangerous Substances According to Their Hazard Classification

Table 1

CLASS		2			3	4			5		6	8
COMPRESSED GASES			KEEP APART	Segregate From OR KEEP APART	Segregate From	Segregate From	Segregate From	Segregate From	Segregate From	ISOLATE	KEEP APART	KEEP APART
2.1 Flammable	2	KEEP APART		KEEP APART	KEEP APART	Separation may not be necessary	Segregate From	Separation may not be necessary	Separation may not be necessary	Segregate From	Separation may not be necessary	KEEP APART
2.2 Non-Flammable/non-toxic		Segregate From OR KEEP APART	KEEP APART		Segregate From	KEEP APART	Segregate From	KEEP APART	Separation may not be necessary	Segregate From	Separation may not be necessary	KEEP APART
2.3 Toxic												
FLAMMABLE LIQUIDS	3	Segregate From	KEEP APART	Segregate From		KEEP APART	Segregate From	Segregate From	Segregate From	ISOLATE	KEEP APART	KEEP APART
FLAMMABLE SOLIDS												
4.1 Readily combustible		Segregate From	Separation may not be necessary	KEEP APART	KEEP APART		KEEP APART	Segregate From	Segregate From	Segregate From	KEEP APART	Separation may not be necessary
4 2 Spontaneously combustible	4	Segregate From	Segregate From	Segregate From	Segregate From	KEEP APART		KEEP APART	Segregate From	ISOLATE	KEEP APART	KEEP APART
4.3 Dangerous when wet		Segregate From	Separation may not be necessary	KEEP APART	Segregate From	Segregate From	KEEP APART		KEEP APART	Segregate From	Separation may not be necessary	Separation may not be necessary
OXIDISING SUBSTANCES												
5.1 Oxidising substances		Segregate From	Separation may not be necessary	Separation may not be necessary	Segregate From	Segregate From	Segregate From	KEEP APART		Segregate From	KEEP APART	KEEP APART
5.2 Organic peroxides	5	ISOLATE	Segregate From	Segregate From	ISOLATE	Segregate From	ISOLATE	Segregate From	Segregate From		KEEP APART	KEEP APART
TOXIC SUBSTANCES	6	KEEP APART	Separation may not be necessary	Separation may not be necessary	KEEP APART	KEEP APART	KEEP APART	Separation may not be necessary	KEEP APART	KEEP APART		Separation may not be necessary
CORROSIVE SUBSTANCES	8	KEEP APART	KEEP APART	KEEP APART	KEEP APART	Separation may not be necessary	KEEP APART	Separation may not be necessary	KEEP APART	KEEP APART	Separation may not be necessary	

Key To Table 1

Separation may not be necessary

Separation may not be necessary, but should be consulted about requiren individual substances. In particular, it noted that some types of chemicals within class, particularly Class 8 corrosives violently, generate a lot of heat if mixed toxic fumes.

KEEP APART

Separate packages by at least 3 metre gangway width, whichever is the greater in the storeroom or storage area o Materials in non-combustible packaging not dangerous substances and which pres fire hazard may be stored in the separat This standard of separation should be as a minimum between substances know together readily, if that reaction would the danger of an escalating incident.

Segregate From

These combinations should not be kept in building compartment or outdoor compound. Compartment walls sh imperforate, of at least 30 minutes fire r and sufficiently durable to withstand nor and tear. Brick or concrete constru recommended. An alternative is to separate outdoor storage compounds adequate space between them.

ISOLATE

This is used for organic peroxides, f dedicated buildings are recom Alternatively, some peroxides may b outside in fire-resisting secure cabinets. case, adequate separation from other buil boundaries is required.

Segregate From OR KEEP APART

* The lower standard refers to th storage of gas cylinders. Where non- flammable gases are concerned the separation distance may be reduced to