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SAFE HANDLING OF INDUSTRIAL HAZARDOUS MATERIALS

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INTRODUCTION

The industrial world is now witnessing a great development in the field of raw materials and chemicals used .

Some of these materials present a certain degree of fire risk and sometimes have to be even dealt with under explosion risks such as all volatile inflammable liquids.

Spontaneous ignition may occur when the substance in question is exposed to air as with white phosphorus, or is exposed to water as with active metals such as sodium.

Self ignition may occur during storage at a temperature rise even within the environmental probable range such as many organic peroxides.

Furthermore, there are certain fire hazardous materials which may react to certain extinguishing agents, causing unfavorable consequences eg. CO2 increases the intensity of magnesium fire, and carbon tetrachloride and may bring it to explosion.

Certain substances such as sulphur, aluminum or flour are not highly inflammable themselves, but still they represent a definite explosion risk when their dust is dispersed in a confined place as sulphur, flour or introducing, on-and-off, a case of dust explosion .

Other substances are hazardous due to their toxicity to man and living creatures such as hydrocyamic acid gas and tertraethyl lead, etc.... The pollution hazard may take place if leakage occurs as in the case of DDT, parathione or radioactive substances.

The following represent an appropriate guideline to the safe handling , transportation and storage for most of the hazardous materials in question with the following main objectives :-

1 - To provide a reasonable level of safety for human life and protection of the environment.
2 - To minimize the disasters which can be created during the transportation and storage of these substances.
3 - To take all actions and suitable procedures to face all risks during handling of these substances.

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SECTION 1

SAFETY REQUIREMENTS FOR THE TRANSPORTATION OF DANGEROUS SUBSTANCES BY ROAD.

1. DEFINITIONS.

1.1) Dangerous Substances.

a) A substance specified as dangerous substance in accordance with the classification of dangerous substances mentioned in these requirements (Appendix 1).

b) Any other substance which by reason of its characteristic properties creates a risk to the health and safety of any person in the course of conveyance by road .

1.2) Vehicle.

The unit used for the transportation of dangerous substance by road, it can be a motor vehicle, articulated vehicle (a tractor with a loading unit), trailers and semi-trailers.

1.3) Tank Vehicle (Road Tankers).

A vehicle carrying one or more tanks used to contain the dangerous substance in a form of liquid, gases, powdery or granular during the conveyance of the substance. The tanks may be fixed or demountable.

1.4) Consignor .

The person who supplies the dangerous substance, whether as principal or as agent for another.

1.5) Vehicle Operator .

The operator in relation to a vehicle carrying a dangerous substance is either the holder of an operator's licence or, where no such licence is required, the keeper of the vehicle. In this respect the keeper is the person having the actual operational control of the vehicle during the carriage. Such a person may not necessarily be the owner if, for example, the vehicle is on hire.

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2. LICENSING REQUIRMENTS.

2.1) It is not permitted to use any vehicle for the transportation of dangerous substance by road until the safety requirements mentioned in these regulations are complied and a certificate of license obtained from the appropriate authority. The license shall be renewed on fixed dates mentioned in the license, after passing the required technical test of the vehicle and containers used for carrying the dangerous substance, complying to the methods of tests mentioned in these regulation.

2.2) The certificate must be returned to the issuing authority when:

a) The vehicle is taken out of service .
b) If the vehicle is transferred to another owner.
c) If there is a material change in one or more essential characteristics of the vehicle.
d) On expiry of the validity of the certificate.

3.) THE REQUIRMENTS OF VEHICLES AND TANK CONTAINERS.

3.1) Any vehicle or tank container used for the conveyance by road of a danger ous substance shall be :

a) Properly designed, of adequate strength and good contruction from sound and suitable material.

b) Suitable for the purpose for which it is being used with regard to the nature and circumstances of journey being undertaken, the characteristic properties and quantity of the dangerous substance and all other substances being conveyed.

c) The carrying tank of the road tanker or the tank container and any fittings attached shall be designed, constructed and maintained to prevent any of the contents escaping, except that this requirement shall not prevent the fitting of a suitable safety device. In case they are likely to come in contact with the substance, they shall be made of materials which are neither liable to be adversely effected by the substance nor in conjunction with it to form any other substance which would significantly increase the risk of health or safety of any person.

d) The carrying tank shall either be a component part of the frame of the vehicle or be securely attached, except that in the case of composite vehicle carring a removable tank, it shall be securely fasterned to a cradle.

3.2) Testing and examination of the tank containers.

3.2.1) A dangerous substance may only be conveyed by road in the carrying tank of a road tanker if :

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a) There is in existence a suitable written scheme for initial examination, testing, periodic examination and where appropriate, testing of the tank and its fitting to insure that they are properly maintained.

b) The appropriate examinations and tests of the tank and its fitting have been carried out by a competent person in accordance with that scheme before being into use for the first time for the conveyance of a dangerous substance. The tank has been certified by that person as suitable for the purpose for which it is intended to be used and those purposes have been specified in the certificate.

c) There is in existence a current report signed by the competent person stating:
   - The date on which the examination and tests required under this paragraph where carried out and the result thereof.
   - The interval before which further examinations and where appropriate, tests must be carried out which shall be that specified in the scheme.
   - That the tank is suitable for the purposes specified in the certificate.
   - In the case of a pressure vessel, the maximum working pressure to which the vessel may be subjected.

d) The tank and its fittings have not been damaged, modified or repaired in such a way as might affect their safety.

3.2.2) Where the carrying tank has been damaged, modified or repaired in such a way as might affect its safety, it shall not be taken into use for the conveyance of a dangerous substance until it has been examined, tested and certified.

3.2.3) In addition to the above requirement for testing and examination of the carrying tanks, the vehicle itself used for the conveyance of dangerous substances shall pass periodic checks by a competent person to ensure that all the mechanical and electrical systems are in good condition at all times.

3.2.4) It sall be the duty of the operator of the vehicle or as the case may by, the operator of the tank container to comply with this regulation.

4.) CONSTRUCTION OF ROAD TANKERS CARRYING FLAMMABLE SUBSTANCE.

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4.1) The body of road tanker, its fitting and the carrying tank shall be constructed strongly and of fire resisting materials.

4.2) A quick action cut-off valve shall be fitted to the fuel feed pipe in an accessible and clearly marked position. Unless no gravity fuel tank is incorporated in the fuel feed system, and the fuel feed system pump is driven directly from the engine of the vehicle or electrically with a cut-off switch, if the ignition switch or the case may be, the cut-off switch is in an easily accessible and clearly marked position.

4.3) The engine and electric batteries shall be efficiently screened from the body of the vehicle by a fire resisting shield carried down to at least the top of the chassis frame and upwards to the top of the tank, or if the roof of the cab is of fire resisting construction and is without an opening, to the top of the cab.

4.4) In any case where the fuel used to propel the vehicle has a flash point of less than 65° C, the fuel tank shall not be behind the aforesaid sheild unless the following requirements are complied with, this is to say:

a) The fuel tank is protected from blows by stout steel guards or by the frame of the vehicle.
b) The cover of the filling hole of the fuel tank is provided with a lock.
c) A fuel feed apparatus placed in front of the fire resisting shield is used to lift the contents of the fuel tank.

4.5) In any case where windows are provided in the aforesaid shield, they shall be fitted in fire resisting framing with wired glass or other approved heat resisting material and shall not be capable of being opened.

4.6) The exhaust system of the vehicle shall be wholly in the front of the aforesaid shield.

4.7) The following requirements shall be complied with the lighting of any vehicle:

- The voltage shall not exceed 24 volts.
- The circuit shall be heavily insulated and be independent of the chassis.
- The wiring shall be so fixed and protected as to reduce as far as practicable any risk of damage.
- The battery shall be in an easily accessible postion.
- Means of cutting off the current close to the battery by a double pole switch, or other suitable method shall be provided in an accessible position.

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- In any case where the vehicle is required to be provided with a fire resisting shield, the generator, battery switches and fuses shall be carried in front of that shield.

4.8) A trailer shall have not less than two axles, and in a case where a trailer is attached to a motor tractor, the trailer shall be effectively screened from the tractor by a fire resisting shield carried down to at least the top of the chassis frame and upwards to the level of the top carrying tank. If the tractor is wider than the trailer the said shield shall, unless the sides of the trailer themselves provide an efficient fire resisting shield, extend back to a distance of not less than 600 millimetres on both sides.

4.9) The capacity of the road tanker shall not, in any case, exceed 30 cubic metres, nor shall the capacity exceed 6.9 cubic metres unless:

a) In case of articulated vehicle, the load unit and the tractor unit are constructed with a design approved as suitable, when the two said units are used together, for conveyance of quantities of flammable liquid exceeding 6.9 cubic metres.

b) In case the vehicle is constructed in accordance with a design approved as suitable for the conveyance of said quantities of flammable substance.

4.10) The capacity of the carrying tank of a trailer shall not exceed 4.6 cubic metres.

4.11)There shall be a space of not less than 150 millimetres between the carrying tank and the fire resisting shield required to be provided which shall be clear except for any part of the framework or vallances used to screen the sides. Where any such vallances are used as aforesaid their ends shall be insulated from the said shield by a layer of heat resisting material.

4.12) The carrying tank of more than 5 cubic metres shall be divided into self-contained compartments, each compartment shall be no more than 5 cubic metres in capacity.

5.) <u>IDENTIFICATION AND MARKING.</u>

5.1) Dangerous substance should be identified by its correct technical name, where appropriate, by it U.N. number given in the approved list of the U.N. recommendations on the transport of dangerous goods, and the nature of danger of the substance (e.g. " Inflammable Liquid", "Corrosive").

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5.2) A name under which a substance is commonly known may be considered to be a correct name, provided it is sufficient to enable interested parties to find out the chemical name.

5.3) Mixtures of substances should be declared under the most hazardous constituent.

5.4) The technical name of an inflammable liquid should be supplemented by its flashpoint which is 61° C or below.

5.5) Each package containing a dangerous substance should be clearly marked according to the design approved by the appropriate authorities.

5.6) The operator of any vehicle,which is being used for the conveyance by road of one or more dangerous substance, shall ensure that it is provided with three displays of hazard warning panels, one at the rear and one on each side of the vehicle.

5.7) The hazard warning panel shall be in the form and colour as shown in the drawings attached to the regulations, (Appendix 3).

5.8) The hazard warning sign to be used on a hazard warning panel or label shall conform in form and colour to those approved as shown in (Appendix 4.)

5.9) The following information shall be shown on each warning panel:
a) The hazard warning sign for the classification of the substance.
b) The chemical substance name.
c) The United Nations number U.N.
d) The emergency action code "HAZCHEM".
e) Manufacturer's name or local agent.
f) The telephone number, indicating where a specialist advice can be obtained at all times when the substance is being conveyed by road.

5.10) Each warning panel shall be :
a) Weather resistant and comply with the form, specification, colour and information required.
b) Either rigid or fixed .

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c) The centre of the panel shall be as close as is reasonably practicable to a position midway between the front and rear of the tank or container.

6.) PACKING.

6.1) The receptacles containing the dangerous substances should be made of suitable materials which are not liable to be adversely affected by the substance, and must be packed in accordance with the recommendations related to methods of packing and sizes of packages contained in the rules of the Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR).

6.2) Packages shall be so closed and leak-proof as to prevent any loss of the contents.

6.3) Packages must be sufficiently rigid and strong in all their parts to prevent any loos during carriage.

6.4) Cushioning materials shall be suited to the nature of the contents.

6.5) Each package or receptacle must be distinctly marked to indicate:
a) The identity of the goods with their correct technical name.
b) The nature of the danger to which the substances give rise.
c) The U.N. number for each substance.

6.6) Marking and labelling should be as prescribed in these requirements (Appendix 3 and 4).

7.) FIRE FIGHTING APPLIANCES.

7.1) Every transport unit carrying dangerous substances shall be equipped with:
a) At least one portable fire extinguisher of adequate total capacity, suitable for fighting a fire in the engine or in any other part of the transport unit, and such that, if it is used to fight a fire in the load, it does not aggrevate the risk.
b) In addition to the equiment prescribed under (a) above, at least one portable fire extinguisher of adequate total capacity, suitable for fighting a fire in the load.

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7.2) Where a transport unit comprises a trailer and the laden trailer is uncoupled from the drawing vehicle, the trailer shall be equipped with at least one fire extinguisher conforming to the provisions of subparagraph (b) above.

8.) INFORMATION TO BE OBTAINED BY THE OPERATOR.

8.1) It shall be the duty of the consignor of the dagnerous substance or some other person acting on his behalf, to provide the operator with accurate and sufficient information related to that substance, to enable the operator to comply with the requirements of these regulations and to be aware of the hazards created by the substance to health or safety of any person.

8.2) An operator shall not carry a dangerous substance unless he has obtained the relevant information form the consignor.

9.) WRITTEN INFORMATION FOR THE DRIVER.

9.1) The operator should ensure the driver receives information in writing which:

a) Identifies the dangerous substance.

b) Describes the dangers that can arise and the safety measures that need to be taken to avert it.

c) Specifies the action which the driver should take in the event of an emergency.

9.2) This information shall be prepared for each dangerous substance, in Arabic and English languages. The driver's duty is to keep the information regarding the carried substance only on the vehicle.

10.) INSTRUCTION AND TRAINING OF DRIVERS.

10.1) The operator of a vehicle used for the conveyance of a dangerous substance by road shall ensure that the driver of that vehicle has received adequate instruction and training to enable him to understand:

a) The nature of the dangers to which the substance being conveyed may give rise to and the emergency action he should take.

b) His duties under these Regulation.

The operator shall keep a record of such instruction and training received by a driver whilst in his employment, and a copy of that record shall be made available to the driver.

11.) CHECK LIST OF DUTIES UNDER THE REGULATIONS.

11.1) Duties of the Consignor (whether as principal or as agent for another):

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a) Ensure that the receptacles containing the dangerous substances and the methods of packing has been carried according to the requirements of these regulations.
b) Ensure that sufficient and accurate information is given to the operator of a vehicle concerning the substances and the size of the receptacles to be carried to enable the operator to fulfill his obligations.
c) Ensure that the carriage of dangerous substances, including loading, storage and unloading, is carried out safety and all reasonable precautions necessary to prevent fire or explosion has been taken.

11.2) Duties of the vehicle operator:
a) Check whether the Regulations apply to the carriage of the substance in the receptacle sizes or manner in which it is to be carried.
b) Obtain from the consignor the necessary information about the substance in order to comply with all the requirements of the Regulations and to be aware of the hazards created by the substance.
c) Ensure that the vehicle and/or any freight container is suitable for the journey proposed and the substances to be carried.
d) Ensure that the driver is provided with adequate information in writing about the substances so that he knows the nature of the dangers involved and the emergency action he should take.
e) Ensure that the driver has received adequate instruction and training and keep necessary records.
f) Ensure that loading, storage and unloading is carried out safely.
g) Ensure that all precautions to prevent fire or explosion are taken.
h) Ensure that any special conditions necessary for the carriage of individual dangerous substances are observed.
i) Ensure that the vehicle is provided with hazard warning panels and labels and to be kept clean and free from obstructions.
j) Ensure that local authorities are informed of any fire which involves the consignment or any uncontrolled release or escape of the substance being carried.

11.3) Duties of the driver:
a) Ensure that information in writing about the substance given to him by the operator is always available during carriage and that information about previous loads or other substances not being carried is destroyed or removed .

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b) Ensure that loading, storage and unloading is carried out safely.
c) Ensure that all precautions to prevent fire or explosion are taken throughout carriage.
d) Ensure that the special conditions related to the temperature of organic peroxides and other self-reactive flammable solids are observed.
e) Ensure that hazard warning panels and labels are displayed at all time as required by the Regulations and that they are clean and free from obstruction.
f) Ensure that the vehicle, when not being driven, is either parked in a safe place or is supervised by himself or some other competent person over the age of 18 years.
g) If requested, provide appropriate informtion to a police officer or traffic examiner who wishes to carry out an inspection of the vehicle and load.
h) Ensure that the operator is informed of any fire which involves the consignment or any uncontrolled release or escape of the substance being carried.

11.4) General instructions for drivers:
a) Smoking, lighting matches or suing naked flames are strictly prohibited.
b) Fuelling the vehicle while loading or unloading is strictly prohibited.
c) Operating the engine while loading or unloading is strictly prohibited.
d) The vehicle should be provided with appropriate manual fire extinguishers recommended by Civil Defence & Fire authority.
e) The vehicle should be provided with first aid kit.
f) The vehicle should be thoroughly checked for safety before commencement of the journey.
g) Posters indicating cargo nature should be stuck on packages.
h) Telephone numbers of Police Stations and Civil Defence authorities should be always kept with the driver.
i) The vehicle should not be at any moment left unguarded.
j) The vehicle should never be loaded with any material other than those permitted.

11.5) Intructions for drivers in case of breakdown or accident (without leakage or fire):
a) Park the vehicle in a suitable place away from the inhabited and crowded areas. Stop the engine. Switch on hazard and warning lights, and make sure that they are clear and easily seen by the coming traffic.
b) Notify the nearest Police Station.

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c) Never leave the vehicle. Keep a constant eye on it.
d) Never let anybody approach the vehicle.

11.6) Instructions for drivers in case of leakage or fire:

a) Park the vehicle in a suitable place away from the inhabited and crowded areas.
b) Urgently notify the Police and Civil Defence authorities.

c) Try to fight the fire using the available fire fighting equipment if the fire is not in the cargo and there is no leakage.
d) Keep away from the vehicle if the fire reaches the cargo.
e) If there is a leakage or a fire in the cargo, block the area and warn the coming traffic.
f) Provide Civil Defence men, upon their arrival, with as much information as you can on the nature, kind and quantity of the cargo.
g) Provide the required first aid and try to speedily move the injured and evacuate the area.

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SECTION 2

SAFETY REQUIREMENTS FOR STORAGE AND HANDLING OF DANGEROUS SUBSTANCES

1.) INTRODUCTION.

1.1) Many potential hazards are associated with the storage and handling of dangerous substances. These potential hazards will always exist, but accidents can be avoided by:

a) Acquiring a thorough knowledge of the properties of the materials to be stored and handled.

b) Planning a safe procedure by which they can be stored and handled.

c) Informing all personnel who will come in contact with these materials of the hazards involved and safety precautions which must be taken.

1.2) These Regulations cover the necessary safety precautions which should be carried in case of storage and handling of dangerous substances.

2.) LICENSING.

2.1) It is not permitted to estabiiah a store for substances considered as dangerous substances according to the classification mentioned in these requirements (Appendix 1), until the site is approved by the concerned authorities.

2.2) Before any construction work commences the concerned authority shall be consulted and an application shall be made for a license to start construction. The application shall include plans of the site showing the type of building to be erected, together with the location of any buildings and access roads in proximity to the site.

2.3) The application shall also include all detailed information about the properties and quantities of the substances needed to be stored or handled, and the safe procedure by which they can be stored and handled, together with other details about the action which must be taken in case of emergencies.

2.4) After granting of the licence to commence work and on completion, an application shall be made requesting final approval. The store shall not be operated

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until re-inspected by the authorities.

3.) GENERAL REQUIREMENTS FOR STORAGE OF DANGEROUS SUBSTANCES.

3.1) Location:

3.1.1) The best locations for storage buildings are those which provide minimum exposure to risks.

3.1.2) Adequate water supplies for fire fighting purposes should be provided.

3.1.3) Ready access for emergency appliances and should be free from flooding.

3.2) Building Construction:

3.2.1 The storage building should be a separate building and constructed of non-combustible materials providing a minimum period of fire resistance of 2 hours.

3.3) Access:

3.3.1) Good access should be provided both outside and inside storage buildings to facilitate easy manoeuvring of all portable and transportable fire appliances required to give full cover to the risk involved, and to enable removal of stored materials quickly and safely in the event of emergencies.

3.3.2) It is important that gangways are not obstructed by temporary marshalling of materials in transit and that ready access is maintained to all important switch-gear and main service controls.

3.4) Ventilation:

3.4.1) Good ventilation should be provided in all storage areas.

3.4.2) Many oxidizing agents, and substances which react with water to liberate heat and flammable gases, require special climatic conditions demanding ventilation, cooling and in some cases dehumidification. The appropriate literature and legislative requirements should be consulted and appropriate measures taken before storage of such substances is permitted.

3.5) Drainage:

3.5.1) Suitable steps should be taken by the use of traps, separators, neutralizing pits or effluent treatment plant, to prevent flammable or toxic materials

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entering drainage systems of any public authority.

3.5.2) Where flammable materials are stored in large quantities, due consideration should be given to the need of emergency drainage systems. This should be designed to drain off fire fighting water which may contain flammable, combustible or toxic materials to a safe location.

3.5.3) Each application will need individual consideration, and requirements will be governed by the total risk involved; the advice of appropriate authorities should be sought.

3.6) Lighting:

3.6.1) Adequate lighting intensities should be maintained at all times during working hours.

3.6.2) Suitable artificial lighting should be provided for hours of darkness and in areas not sufficiently illuminated naturally.

3.7) The control of ignition sources:

3.7.1) Ignition of products in storage can arise from open flames, smoking, cutting and welding hot surfaces, sparks (mechanical, electrical and static), frictional heat, spontaneous ignition, chemical reaction and radiant heat.

3.7.2) All practical steps should be taken to avoid possibility of ignition occurring by designating areas as "NO SMOKING AREA" where appropriate, providing adequate ventilation and adopting safe procedures for storage, material movement and maintenance operations.

3.8) Safety and Fire protection Equipments:

3.8.1) The storage area should be provided by safety and fire protection equipment as determined by the authorities.

4.) <u>STORAGE LAYOUT AND STACKING</u>

4.1) All dangerous substances containers should be stored , handled and piled with due consideration of their hazard characteristics.

4.2) The containers of dangerous substances which are needed to be stored should be made of suitable materials which are not liable to be adversely effected by the substances. Each container should be identified by the correct technical name of the substance, and marked according to the design approved by the authorities (Appendix x 4).

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4.3) Good access should be maintained at all times by the provision of adequate gangways, which should be clearly defined.

4.4) Special consideration, appropriate to the individual circumstances, should be given to fire protection in mechanised storage systems.

4.5) Stacking should be arranged with the object of minimizing the spread of fire and be conductive to any salvage operations.

4.6) High fire hazard materials should be separated from the main bulk of storage by appropriate fire walls and commodities that may be hazardous if combined with others, should be stored and separated so that they cannot come into contact with each other.

4.7) Stacking should be arranged so as to provide stability even under fire conditions.

4.8) Storage piles should be kept as narrow as practicable, consistent with acceptable operating conditions, in order to facilitate fire fighting operations.

4.9) Combustible materials should not be stored or piled near main building columns which are not protected or inherently fire resistant.

4.10) Consideration should be paid to the effect of stored materials on the operation of built-in-fire-fighting systems.

4.11) Materials that are susceptible to water damage should be arranged at least 100mm from the floor on suitable pallets, skids or other means.

4.12) Some materials expand considerably when wetted and in such cases, to avoid the possibility of structure damage, materials should be stored closer than 1mm to outside walls.

4.13) Adequate clearance should be maintained around fire doors to ensure proper and effective operation. A clearance of 0.6m should be maintained around the path of travel of fire doors.

4.14) Combustible materials should not be stored within 1m of any fire door

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opening.

5.) SPECIAL REQUIREMENTS FOR THE HAZARDOUS NATURE OF EACH SUBSTANCES.

In addition to the previous general requirements which shall be carried in all storage cases of dangerous substances; these are special requirements needed to be considered, which suite the hazardous nature of each substance.

5.1) Flammable liquids.

5.1.1) The following requirements shall apply to the indoor storage of flammable liquids in portable containers, and not apply to the storage of bulk tanks, the service stations and refineries which comply with other requirements.

5.1.2) Containers should be constructed so that they are not easily broken. They should be labelled with the name of the material (chemical name if possible), with a brief statement of flammability, toxicity and any special fire fighting precautions.

5.1.3) Construction design of exterior walls should provide accessibility for fire fighting operations through provision of access openings, windows or lightweight non-combustible wall panels.

5.1.4) The exterior wall or roof construction shall be designed to include explosion venting features such as lightweight wall assemblies, lightweight roof assemblies, roof hatches or windows of explosion venting type. Consideration must be given to the direction in which an explosion is to be vented in order to prevent injury to personnel and damage to exposures.

5.1.5) If the storage building is located more than 3 metres but less than 15 metres from an important building or line of adjoining property that can be built upon, the exposing wall shall have a fire resistance rating of at least 2 hours with each opening protected with at least 1.5 hour fire door.

5.1.6) If the storage building is located 3 metres or less from an important building or line of adjoining property that can be built upon, the exposing wall shall have a fire resisting rating of 4 hours with each opening protected with a listed 3 hours fire door.

5.1.7) Any doorways or openings should be arranged with kerbs or ramps not less than 15mm in order to contain any spillage likely to occur.

5.1.8) Electrical fittings and their associated wiring should conform to the appropriate standard.

5.1.9) Ventilation shall be provided with either :

a) Exhaust air shall be taken from a point near a wall on one side of the

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store and within 300mm of the floor with one or more located on the opposite side of the store within 300mm from the floor. The location of both the exhaust and inlet openings shall be arranged to provide as far as practical, air movements across all portions of the floor to prevent accumulation of flammable vapours.

(or)

b) Mechanical ventilation systems shall provide at least 1m3 per minute per 3m2 from the floor area, but not less than 4m3 per minute.

5.1.10) Satisfactory arrangements should be made for the temporary storage of empty containers, and for their prompt removal to the main storage compound.

5.1.11) The storage area should be identified by approved hazard warning panels. "No Smoking" signs in Arabic and English.

5.1) Flammable Gases:

5.2.1) Storage of flammable gas containers are not permitted in residential areas.

5.2.2) Safety distances should be considered according to the quantities of containers needed to be stored, in reference with the neighbouring.

5.2.3) Any sources of heat shall not be permitted to be used inside the place.

5.2.4) The location of the place shall be readily accessible and shall facilitate quick removal of cylinders.

5.2.5) The location and design of the place shall be such that in case of explosion, it shall be possible for the explosion pressure to be released in the direction which presents minimum danger.

5.2.6) The place shall be single-storeyed and have openings for doors and windows for ventilation and day lighting, well dispersed at high and floor levels in the walls. The areas of the opening shall not be less than 10% of the combined area of the walls and roof of the place. The area of permanent ventilation openings shall not be less than 25% of the combined area of the walls and roof.

5.2.7) The height of the base of upper ventilation windows shall not be less than 2.5 metres above ground level and the base of the lower ventilation windows shall be at the ground level. The distance between two adjacent openings shall not exceed 2 metres.

5.2.8) The store shall have at least 2 means of exit, not adjacent to one another and shall at all times provide easy means of escape within.

5.2.9) The place shall have a roof to protect cylinders from rain,sun etc..

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5.2.10) The floor shall be concrete and smooth finish and not contain any drains or openings.

5.2.11) Electrical installations and equipment in the place shall not be less than 2 metres above the floor and shall be explosion-proof design, electrical lamps shall be of the type which emit no excessive heat and shall be provided with protective covers. They shall be fixed on the roof or near the upper end of walls.

5.2.12) The place, and all its component parts, shall be manufactured from non-combustible materials.

5.2.13) Cylinders shall be stacked in rows separated by passages permitting easily handling of each cylinder. The cylinders shall be arranged to stand vertically with their valves uppermost.

5.2.14) A place shall be assigned for filled cylinders and another for empty cylinders. A notice indicating this shall be displayed.

5.2.15) Oxygen cylinders should not be stored within the storage area of flammable gas cylinders to avoid any extra hazardous conditions.

5.2.16) The storage area should be provided with safety and fire protection equipments, as recommended by the authorities.

5.2.17) The storage place shall be marked with warning signs at its entrances to indicate the risks and action to be taken in case of emergencies.

5.3) Toxic Chemicals:

5.3.1) Toxic substances can enter the body by inhalation, ingestion, absorption through the skin, or by any combination of these routes. Information concerning toxicity and potential toxic hazards may be obtained from the supplier of the chemical. It is also important that information be obtained concerning personnel protective equipment, to guard against exposure and medical treatment, to be used if exposure should occur.

5.3.2) Some chemicals will decompose to form toxic materials when in contact with heat, moisture or acids. These chemicals, even though they are toxic in their normal form, must be carefully considered in light of their potential hazard.

5.3.3) The quantity of toxic chemicals stored should always be kept to a realistic minimum.

5.3.4) Drums of toxic liquids of high vapour pressure should be protected from the direct rays of the sun.

5.3.5) Toxic materials should not be stored near flammables.

5.3.6) The storage area should be well ventilated and cool.

5.3.7) All personnel in an area where toxic chemicals are stored must be in-

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structed concerning the potential hazard of these chemicals.

5.3.8) The eating of food and the drinking of coffee and other liquids should not be permitted in areas where toxic materials are stored, dispensed or used.

5.3.9) Access to toxic materials by unauthorized personnel must be prevented by adequate security measures.

5.3.10) Protective equipment, including respirators, gloves and boots made of rubber or some suitable plastic material must be available, and personnel must be periodically instructed in the use of these equipment. The symptoms of exposure and necessary first aid and medical treatment must be known.

5.3.11) Warning signs should be posted cautioning fire fighters to use self-contained breathing equipment.

5.3.12) In the event of leakage from one of the receptacles the following precautions should be taken :

Avoid:

a) contact with the skin.

b) Inhalation of vapours

c) introduction of the liquid into the mouth.

5.4) Oxidizing Agents:

5.4.1) Oxidizing Agents are chemicals which can supply oxygen to a reaction. Some examples of Oxidizing Agents are oxides, chlorates, dichromates, percolates, and permanganates. Since oxidizing agents can initiate the combustion reaction, these materials present a definite fire hazard when stored with combustible. Some oxidizable materials will react with oxidizing agents at room temperature to produce a fire or an explosion.

5.4.2) Oxidizing Agents should not be stored in the same area with any fuel, such as flammables, organic chemicals, dehydrating agents, or reducing agents.

5.4.3) The storage area of oxidizing agents should be fire resistant (shelving included), cool, well ventilated, and preferably remote from other operations.

5.4.4) The floor of the storage room should be fire resistant, water tight, and without cracks in which these materials can lodge.

5.4.5) Good housekeeping practices are essential. Any spills in the storage area should be cleaned up immediately

5.4.6) The storage area should be provided with fire protection equipment as required by the authorities. Sprinklers may be recommended for the storage area.

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5.5) Corrosive Chemicals:

5.5.1) Many acids and alkalies are corrosive to their containers, other materials in the storage area and body tissue. Acids react with many metals to form hydrogen gas. Alkalies may form hydrogen gas on contact with aluminum. Since hydrogen forms an explosive mixture with air, accumulation of hydrogen in storage areas must be prevented.

5.5.2) Corrosive liquids should be stored in fire resistant non-combustible store. The store area should be cool, dry and well ventilated.

5.5.3) The storage area should provide for good corrosion-resistant drainage and hoses for clean-up of spills.

5.5.4) With some corrosive liquids, such as sulfuric acid, periodic venting of drums may be necessary to relieve the accumulated internal pressure of hydrogen formed by the reaction of the corrosive with the metal drum.

5.5.5) Safety showers, eye wash fountains and other required protective equipment should always be operable and available for personnel handling corrosive chemicals or working in the storage area.

5.6) Water and Air-reactive Chemicals :

5.6.1) Some chemicals like alkalies, anhydrides, carbide, hybridises and oxides,etc.. react with water to evolve heat and flammable or explosive gases. Potassium and sodium metals and metal hydrides react on contact with water. Hydrogen is produced with sufficient heat to ignite with explosive violence.

5.6.2) These chemicals should be stored in water and air tight containers that are kept off the floor by skids.

5.6.3) Water sensitive chemicals should be stored in an isolated area which must be designed to prevent their accidental contact with water. This is best accomplished by keeping all sources of water out of the storage area.

5.6.4) Storage construction should be fire resistant and other combustible materials should not be stored in the same area. The area of storage should be cool, well-lighted and well-ventilated.

5.6.5) Air-reactive chemicals are usually stored under water or other liquid or inert gas according to the nature of each substance, (for example while or yellow phosphorus is kept under water, metallic sodium is kept under oil).

5.7) Incompatible Chemicals :

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5.7.1) Seperate storage areas should be provided for "incompatible chemicals" , chemicals which may react together and create a hazardous condition because of this reaction. Some examples of common incompatible chemicals are listed in Appendix 2.

6.) GENERAL INSTRUCTIONS WHILE STORING AND HANDLING

a) Smoking, foods and drinks are strictly prohibited in areas where dangerous substances are stored and handled.
b) Pollution on work area should be avoided. The storage area should be carefully managed and arranged with a view of minimizing dispersion of poisonous vapours and dusts in the atmosphere, thus bringing fir possibilities to a minimum.
c) Employees are not allowed to enter storing areas unless they wear the protective clothes according to the nature of the potential hazards. Appropriate respiratory equipment should be used when necessary.
d) Artificial ventilation systems together with natural ventilation should be provided to ensure minimizing the concentrates of dangerous dusts, gases or vapours in the area.
e) Reasonable quantities of antiseptics and antipollution substances have to be made availabe.
f) An emergency clean water source has to be provided in the area where dangerous and poisonous chemicals are stored.

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APPENDIX NO.1
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CLASSIFICATION OF DANGEROUS SUBSTANCES.

Dangerous substances are classified in accordance with the international recommendation into the following classes:

Class 1- Explosive substances:
Not included in these requirements.

Class 2- Gases: compressed, liquefied or dissolved under pressure.
This Class comprises:
a) Permanent Gases
Gases which cannot be liquefied at ambient temperatures;
b) Liquefied Gases
Gases which can become liquefied under pressure at ambient temperatures;
c) Dissolved Gases
Gases dissolved under pressure in a solvent, which may be absorbed in a porous material .

Class 3 - Inflammable liquids:
These are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (e.g. paints, varnishes, lacquers, etc., but not including substances which on account of their other dangerous characteristics have been included in other classes) which give off an inflammable vapour at or below 61°C (141°F) closed cup test (corresponding to 65.5°C (150°F) open cup test).
This Class is sub-divided further into three categories, namely:

Class 3.1. Low flashpoint group of liquids having a flashpoint below - 18°C (0°F), closed cup test, or possessing a low flashpoint in combination with some dangerous property other than inflammability.

Class 3.2. Intermediate flashpoint group of liquids having a flashpoint of - 18°C (0°F) up to, but not including 23°C (73°F), closed cup test.

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Class 3.3. High flashpoint group of liquids having a flashpoint of 23°C (73°F) up to, and including, 61°C (141°F), closed cup test.
- Substances which have a flashpoint above 61°C (141°F), closed cup test, are not considered to be dangerous by virtue of their fire hazard.

Class 4 - Inflammable solids or substances:
This Class is subdivided further into three categries, namely:

Class 4.1. Inflammable solids. The substances in this group are solids possessing the common property of being easily ignited by external sources, such as sparks or flame, and of being readily combustible.

Class 4.2. Spontaneously combustible substances. The substances in this group are either solids or liquids possessing the common property of being liable spontaneously to heat and to ignite.

Class 4.3. Substances emitting inflammable gases when wet. The substances in this group are either solids or liquids possessing the common property, when in contact with water, of evolving inflammable gases. In some cases these gases are liable to spontaneous ignition.

Class 5 - Oxidizing substances:
The substances which may readily liberate oxygen and as a result may stimulate combustion and increase the violence of a fire in other material.
This Class is sub-divided further into two categories; namely:

Class 5.1. Oxidizing substances. These are substances which, while in themselves not necessarily combustible, may generally by yielding oxygen, cause, or contribute to, the combustion of other material.

Class 5.2 Organic peroxides. Most substances in this group are combustible. They may act as oxidizing substances, and are liable to explosive decomposition. In either liquid or solid form they

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may react dangerously with other substances. Most will burn rapidly and are sensitive to impact or friction.

Class 6 - Poisonous (toxic) and infectious substances:

Class 6.1 Poisonous (toxic) substances. The substances in this group are liable to cause death or serious injury to human health if swallowed, inhaled, or by skin contact.

Class 6.2 Infectious substances. These are substances containing disease-producing micro-organisms.

Class 7 - Radioactive substances:

The substances which spontaneously emit a significant radiation and of which the specific activity is greater than 0.002 microcurie per gram.

Class 8 - Corrosives:

The substances which are solids or liquids possessing, in their original state, the common property of being able more or less severely to damage living tissue.

The escape of such a substance from its packing may also cause damage to other goods or to the vehicle.

Class 9 - Miscellaneous dangerous substances:

Any other substances which experience has shown, or may show, to be of a dangerous character, and which cannot be properly covered by the provisions of the other Classes.

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APPENDIX NO.2

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EXAMPLES OF COMMON INCOMPATIBLE CHEMICALS

Chemical	Keep out of contact with :
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds ethylene glycol, perchloric acid, peroxides, permanganates.
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury.
Alkaline metals, such as powdered aluminium or magnesium, sodium, potassium.	Water, carbon tetrachloride or other chlorinated hydrocarbon, carbon dioxide, the halogens.
Ammonia, anhydrous	Mercury (in manometers, for instance), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous).
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustibe materials.
Aniline	Nitric acid, hydrogen peroxide.
Bromine	Same as for chlorine.
Carbon, activated	Calcium hypochlorite, all oxidizing agents.
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials.
Chromic acid	Acetic acid, naphthaline, comphor, glycerin, turpentine, alcohol, flammable liquids in general.
Chlorine	Ammonia acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals.
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide.
Copper	Acetylene, hydrogen peroxide.
Cumene hydroperoxide	Acids, organic or inorganic.
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, the halogens.
Fluorine	Isolate from everything.
Hydrocarbons (butane,	

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Chemical	Keep out of contact with :
propane, benzene, gasoline, turpentine, etc.	Fluorine, chlorine, bromine, chromic acid, sodium peroxide.
Hydrocyanic acid	Nitric acid, alkali
Hydrocyanic acid, anhydrous	Ammonia, aqueous or anhydrous
Hydrogen peroxide	Copper, chromiun, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids, combustible materials .
Hydrogen sulfide Iodine	Fuming nitric acid, oxidizing gases .
Mercury	Acetylene, ammonia (queous or anhydrous), hydrogen.
Nitric acid (concentrated)	Acetylene, fulminic acid, ammonia. Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfidem flammable liquids, flammable gases.
Oxalic acid	Silver, mercury .
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood .
Potassium	Carbon tetrachloride, carbon dioxide, water.
Potassium Chlorate	Sulfuric and other acids.
Potassium perchlorate (see also Chlorates)	Sulfuric and other acids.
Potassium permanganate	Glycerin, ethylene glycol, benzazaldehyde, sulfuric acid.
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds.
Sodium	Carbon tetrachloride, carbon dioxide, water.
Sodium peroxide	Ethyl or methly alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycil, ethyl acetate, methyl acetate, furfural.
Sulfuric acid	Potassium permanganate (or compounds with similar light metals, such as sodium, lithium).

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