



TECHNICAL REPORT
SERIES N° 3

Storage of Hazardous Materials:

A Technical Guide
for Safe Warehousing
of Hazardous Materials

**STORAGE OF HAZARDOUS MATERIALS:
A TECHNICAL GUIDE FOR SAFE WAREHOUSING
OF HAZARDOUS MATERIALS**

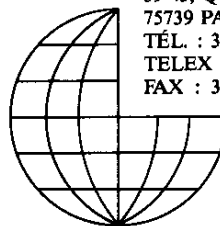


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**INDUSTRY AND ENVIRONMENT
Programme Activity Centre (IE/PAC)**

39-43, QUAI ANDRÉ-CITROËN
75739 PARIS CEDEX 15 - FRANCE
TÉL. : 33 (1) 44 37 14 50
TELEX : 204 997 F
FAX : 33 (1) 44 37 14 74



This is the third publication in a new Technical Series that regroups the Guidelines, Overviews, Technical Reviews and Workshop Proceedings previously published by UNEP/IEO. The regrouping into a single series will ensure a greater cohesion among future publications, and allows a single document to include the various elements of IEO work that had earlier been presented separately.

As before, the Technical Series aims to meet the needs of a wide range of government officials, industry managers and environment protection associations, by providing information on the issues and methods of environmental management relevant to various industrial sectors.

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Mr. C.M. HARMER GIFAP, International Group of National Associations of Manufacturers of Agrochemical Products, Brussels

Dr. F. KAFKA CEFIC, European Chemical Industry Federation, Brussels

Mr. Ph. ROCARD Ingénieur des Mines, Ministry of the Environment, France

Mr. J. SALAMITOU RHÔNE-POULENC S.A., France

Mrs. M.E. SILVA Direcção General da Indústria, Lisboa, Portugal

Mr. G.S. SCHADE CMA, Chemical Manufacturers Association, USA

Dr. R.O.M. van LOO Ministry of Housing, Physical Planning and Environment, The Netherlands

UNEP/IEO:

Mrs. J. ALOISI de LARDEREL Director

Mr. F. BALKAU Senior Programme Officer

Ms. F. GALLIOT Legal Consultant

Mr. G.P. LOISEAU Senior Industry Consultant who was in charge of the project and drafted the manuscript

UNEP/IEO further acknowledges the most valuable comments and suggestions on the text which have been provided by the following experts:

Mr. S. ASSE AKAKFO	Ministère de l'Environnement, Cotonou
Mrs. B. BENDER	International Register of Potentially Toxic Chemicals (IRPTC), UNEP, Geneva
Mr. D.W. BISSET	Industrial Programs Branch, Environment Canada, Conservation and Protection, Ottawa
Mr. C.H. BOWDEN	Environmental Protection International Division, Department of the Environment, London
Mr. E.W. BRETTAVER	Office of Research and Development, United States Environmental Protection Agency, Washington, D.C.
Mr. Y. BRIAND	Direction de l'Environnement, de la Normalisation et de la Technologie, Ministère de l'Industrie et du Plan, Abidjan
Mr. R. CRAIG MATTHIESSEN	Chemical Accident Prevention Staff, United States Environmental Protection Agency, Washington, D.C.
Mr. G. DEL BINO	Directorate General for the Environmental Nuclear Safety and Civil Protection, Commission of the European Communities, Brussels
Mr. H. DOUGLAS	Department of Mines, Western Australia, Perth
Mr. T.D. ELLISON	Organizacion Panamericana de la Salud, Mexico
Mr. EL MOHAMADY EID	Environment Affairs Agency, Cairo
Mr. R. GAADE	Canadian Association of Fire Chiefs, Toronto

Dr. M. GILBERT	International Programme on Chemical Safety (IPCS), World Health Organization (WHO), Geneva
Mr. F.G. HURTUBISE	External Relations Directorate, Environment Canada, Hull, Quebec
Mr. P. KELLEHER	Department of Trade and Industry, London
Mr. L.R. KOHLER	Energy, Environment and Human Settlements, International Labour Office (ILO), Geneva.
Mr. D. LARRE	Organisation et Environnement, Paris
Dr. E. MELLER	Bundesverband der Deutschen Industrie e.V., Cologne
Mr. P.C. MERRIMAN	Chemical Industry Association (CIA), London
Mr. R. PAPP	Atochem, Groupe Elf Aquitaine, Paris
Mr. K. SANDER	Bundesverband der Deutschen Industrie e.V., Cologne
Mr. J.E. SMITH Jr.	Office of Research and Development, United States Environmental Protection Agency, Cincinnati
Mr. D.C. TABAR	Foam-Water Research Coalition, Washington, D.C.

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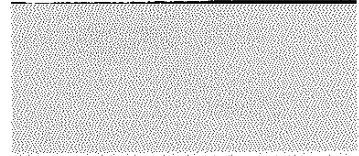


SUMMARY

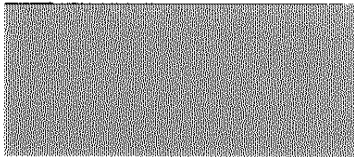
The recent outbreak of dramatic accidents involving storage of materials such as fertilizers, pesticides and chemicals have emphasized the need to make known the conditions for the safer warehousing of hazardous chemicals. As for the other Technical Reports regularly issued by the UNEP Industry and Environment Office, the aim of this Technical Guide is to introduce practical guidelines for the safe storage and warehousing of hazardous materials, thus protecting human health and environment. Designed to be used worldwide and to meet requirements of developing as well as developed countries, this Guide is an aid to safe storage and warehousing of hazardous chemicals, whether within industrial sites or outside, whether managed by the manufacturers or users themselves or contracted out to independent warehousekeepers. It is divided into chapters dealing with the main aspects and requirements for safe warehousing of hazardous materials which are the following:

- key responsibilities: those of authorities and those of the warehousekeeper whether he is the owner of the goods or a contractor;
- examples of legal frameworks for regulations including the main points to be regulated and the state of the existing legislation;
- appreciation of product hazards using the MATERIAL SAFETY DATA SHEET provided by the supplier of the goods and the UNITED NATIONS CLASSIFICATION AND DEFINITIONS OF CLASSES OF DANGEROUS GOODS;
- location and buildings: covering points such as the preferred location and layout of the warehousing site as well as of the buildings, the integrity of the structure and control of possible sources of ignition and environmental pollution;
- warehouse management: underlining that the quality of management and the day-to-day management of warehousing is of utmost importance and that safe procedures for normal work as well as for abnormal conditions have to be prepared;
- fire and environment protection: addresses the problems of fire and environmental pollution as examples of major accidents originating from warehousing which can have serious effects not only within the warehousing site, but also outside. On-site and Off-site Emergency Plans are designed to prevent the consequences of such accidents.

A TECHNICAL GUIDE FOR SAFE WAREHOUSING OF HAZARDOUS MATERIALS



A Checklist is proposed in order that the safety and security conditions of the premises may be regularly reviewed. The Guide ends with Appendices bringing together technical information such as the United Nations Classification of Dangerous Goods and the relevant Hazard Warning Labels, a glossary of terms, examples of Material Safety Data Sheets, and a list of useful addresses and references for further information.



INTRODUCTION

It is a task of the UNEP Industry and Environment Office to facilitate the exchange of information and experience on pollution control between and within countries and industries. One of the means used to achieve this goal is the issuing of Technical Guides which examine the various technologies used in each professional area and their effects on the environment. They address governments, industry management and members of non-governmental organizations, inducing them to take environmental management decisions.

Recent and dramatic accidents involving storage of hazardous chemicals, such as the fire and discharge of contaminated fire fighting waters into the Rhine river from a warehouse in Basel in 1986, and the fire and the explosion risk of a fertilizer warehouse in Nantes in 1987, emphasize the need to reconsider the conditions for safer warehousing of hazardous chemicals. The most damaging consequences of such disasters have been the result, not of the gravity of the emergency itself, but rather of the failure to be prepared for it or to respond to it as planned, thus negating many of the defence mechanisms carefully engineered into the building, site or systems at the design and construction stage. This Technical Guide which should be considered as a guideline and not as an instruction, is designed as an immediate and practical contribution towards helping to solve problems in the warehousing of substances with hazardous characteristics.

These guidelines must be regarded as additional to the regulatory requirements applicable to each particular country and location. They are also aimed at prompting the warehouse management to prepare, in conjunction with authorities responsible for safety and protection of the environment, an emergency plan for the surroundings of the warehouse and to provide any necessary information to the population. To be efficient, the guidelines are in the form of a practical and workable manual rather than of an exhaustive document and are applicable to most types of warehouses, whether already existing or in the planning stage. The advice is based on experience gained in the chemical industry with warehouses which are controlled by chemical manufacturers as well as by contractors.

KEY RESPONSIBILITIES

1

Before authorizing the setting up of a new warehouse, authorities should consider:

- avoiding further development to encroach on existing warehouses;
- avoiding location in inappropriate neighbourhoods or surroundings;
- the means to avoid pollution of nearby water sources (surface or underground) in the event of a fire;
- providing access for traffic to and from the warehouse, adequate roads and infrastructure including emergency services, inspections, implementation of inspections.

Once the siting, building or use of a warehouse storing hazardous materials has been authorized and registered, government and local authorities should not allow any further siting of any incompatible building or facilities too close to the warehouse, e.g. grant of a building licence to a school, a supermarket, an explosives factory, or a liquefied petroleum gas (LPG) storage across the street.

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

- satisfy himself of the suitability of the warehouse;
- satisfy himself as to the competence of the warehousekeeper to undertake the storage required;
- give advance notice to the warehousekeeper of the requirement;
- ensure that the warehousekeeper understands what is required of him, and clearly specify in the contract the various responsibilities;
- prepare and submit information on his goods which will permit safe storage to be achieved;
- ensure that the warehousekeeper 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.

1.1

**AUTHORITIES:
NATIONAL, REGIONAL
AND LOCAL
AUTHORITIES**

1.2

**THE SUPPLIER OR
OWNER OF THE
GOODS**

1.3 THE WAREHOUSEKEEPER

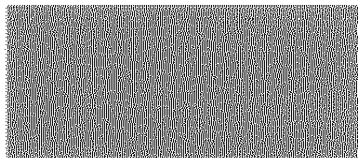
In addition to his other responsibilities, the warehousekeeper is also responsible for occupational health, hygiene and safety of the people and goods in the warehouse as well as environmental protection, whether or not an authorization system exists. In the case of warehouses owned by large companies, he should make sure that there is a clear company policy on SAFETY and ENVIRONMENT issued by top management and made known to employees. Persons directly responsible for operating the warehouse, for safety, for environment protection and for security, as well as a contact person with authorities and media, should be nominated.

It should be the responsibility of the person(s) nominated to be responsible for the SAFETY, SECURITY and PROTECTION of the ENVIRONMENT to familiarize himself with the subjects, ensure the security of the premises, analyze incidents and establish ways of preventing their recurrence. He should review the effectiveness of work practices and procedures from a safety and hygiene standpoint, promote and maintain safety, hygiene and environmental awareness among personnel, and establish effective training programmes and courses. He should also contribute to emergency plans for implementation in the event of fire, explosion, flooding, and keep plant management fully informed on relevant matters. Where appropriate and necessary, the setting up of a Safety and Health Committee composed of employers' and workers' representatives (ILO Recommendation n° 164) could facilitate personnel awareness and co-operation. Within the scope of his responsibilities, the warehousekeeper must:

- ascertain and comply with the relevant laws and regulations concerning handling and storage of materials likely to be stored: notification, permits, planning conditions, etc.;
- arrange occupational medical service for accidents at work and industrial hygiene;
- arrange liaison with local competent and emergency authorities, e.g. the local fire brigade, doctors, hospitals, the police and other bodies to ensure good co-ordination between internal and external emergency plans, and to establish mutual consultation and advice on safety and environmental protection;

- collect all relevant information on chemicals to be stored: classification, labelling, MATERIAL SAFETY DATA SHEETS, TRANSPORT EMERGENCY CARDS, etc., arrange safe segregation/storage in accordance with these data;
- prepare clear and comprehensive instructions for safe procedures under normal as well as emergency situations and make safety arrangements covering periods of minimum manning or complete absence of personnel; prepare an “on-site” emergency plan and assist the local authority in preparing an “off-site” emergency plan;
- provide and maintain appropriate equipment, organize safe systems of work (work permits, audits, reporting...), encourage holding of safety circles amongst the employees and ensure that all motor vehicle drivers, contractors and visitors are aware of and obey safety rules;
- provide adequate insurance coverage including general liability;
- ensure proper communication with the owner of the goods, authorities and information to the public and media in case of accidental events.

On being approached concerning the storage of any material, he must establish the nature of the goods using the MATERIAL SAFETY DATA SHEET and decide, with expert advice if necessary, whether and how he can store the goods safely. Having decided where the material is to be located, he must ensure that staff have received and understood the information and have received appropriate training in accordance with the labelling. He is responsible for proper documentation, loading and transport of goods shipped by him.



2 LEGAL FRAMEWORK

2.1

MAIN POINTS TO BE REGULATED

It should be the responsibility of governments and local authorities to formulate and implement appropriate regulations ruling the main relevant aspects of warehousing of goods which may be hazardous to human health and the environment. Such a legal framework could include, for example, laws and regulations covering the following:

- land use planning, infrastructure and environment protection;
- building regulations;
- safety and fire precautions;
- transport, classification, packaging and labelling of dangerous substances;
- emergency planning, notification and response.

2.2

THE STAGE OF THE EXISTING LEGISLATION

The warehousekeeper must ascertain and comply with laws and regulations applying in his country and locality regarding the premises and buildings, labour, industrial medicine as well as the handling and storage of materials likely to be stored.

Most countries have planning regulations for land use that set aside protected areas, provide specific conditions for the building of plants and warehouses or prevent incompatible development around the warehouse possibly involving: notifications, permits or licences, environment impact studies, etc. Worker Protection Acts and other regulations to control health and safety at work, fire precautions, etc. may also be laid down.

There may also be specific legislation to be complied with relating to storage and warehousing of chemicals and dangerous goods.

Many United Nations Organs and Agencies such as the International Labour Organisation (ILO), the World Health Organization (WHO), the United Nations Environment Programme (UNEP) and its International Register of Potentially Toxic Chemicals (IRPTC), the International Maritime Organization (IMO), and international institutions such as the European Economic Community (EEC) (Seveso Directive 87/501, 2nd amendment), the Organisation for Economic Co-operation and Development (OECD), as well as national authorities of certain countries deal with some of the legal and technical aspects of warehousing of hazardous materials. Their addresses are listed in Appendix V (see p. 78).

APPRECIATION OF PRODUCT HAZARDS

3

3.1

THE MATERIAL SAFETY DATA SHEET

The owner or the supplier of the goods must provide a "MATERIAL SAFETY DATA SHEET" (MSDS) or a "PRODUCT DATA SHEET" for each product in order that physical, chemical and biological properties of the products stored in the warehouse are clearly understood by all personnel.

DATA SHEET	
<i>Physical and chemical data</i>	
<i>Safety data and instructions</i>	
<i>Product handling instructions</i>	
<i>Storage conditions</i>	
<i>Protective clothing</i>	
<i>Cleaning, decontamination and disposal instructions</i>	
<i>First-aid measures</i>	
<i>Information to doctors</i>	
<i>Fire-fighting instructions</i>	
<i>Sources of advice</i>	

The Material Safety Data Sheet of which examples are given in Appendix IV, pages 74-77, should contain, where appropriate:

- physical and chemical data (physical state and appearance, odour, flammability, instability, reactivity);
- safety data and instructions (toxicity, ecotoxicity, corrosivity);
- classification, if appropriate, as per the UNITED NATIONS Classification and Definitions of Classes of Dangerous Goods;
- safe handling instructions;
- storage conditions;
- any necessary personal protection clothing;
- cleaning, decontamination, spillage procedures;
- disposal instructions;
- first-aid measures ;
- information to doctors;
- fire prevention and fire-fighting instructions;
- name, address, telephone number of the manufacturers, sources of advice and assistance in case of emergency.

3.2 CLASSIFICATION AND LABELLING OF PRODUCTS

In accordance with their properties stated by the Material Safety Data Sheet, the products to be stored will be classified and labelled as per the United Nations Classification and Definitions of Classes of Dangerous Goods (see Appendix I, p. 63), the EEC classification system (Directive 67/548, 6th Amendment) or another system in force locally.

Products may be flammable, explosive, toxic, corrosive, combustible, reactive with air or water, subject to spontaneous combustion, oxidizing, chemically unstable (e.g. undergoing decomposition, polymerization), smelling. However, the hazards that will be most commonly met are those arising from flammability, combustibility, corrosivity, toxicity and oxidizing properties. The possible effects of fire on products must be taken into account, since, on burning, many substances normally thought of as harmless can produce harmful products of combustion. The main gaseous components of toxic fumes generally include carbon monoxide and dioxide, steam, to which may be occasionally added: sulphur and nitrogen oxides (SO₂, NO_x), hydrochloric acid (HCl), hydrocyanic acid (HCN), depending on the composition of the materials involved, e.g. wood, wool, etc.

Smoking and naked flames must be prohibited in and around buildings when flammables or combustibles are stored, though the flammability of packaging must also be borne in mind even if the products themselves are not flammable. "No smoking" notices should be prominently displayed.

FLAMMABLE GASES AND LIQUIDS

United Nations labels:

Class 2



Inflammable gases
Symbol (flame): black or white
Background: red

Class 3



Inflammable liquids
Symbol (flame): black or white
Background: red

Flammable gases and liquids can readily produce flammable vapour/air mixtures at ordinary and ambient temperatures. Vapours of such mixtures can be ignited by sparks from electrical equipment or static electricity produced during drum-filling operations as well as by the more obvious naked flame. For a liquid, indication of the degree of flammability is provided by the flash-point of the product; this is the lowest temperature at which a product will form a flammable vapour/air mixture.

Examples of gases are: LPG, camping gas, welding acetylene

Examples of liquids are: hydrocarbon solvents, alcohols, ketones, petrol, paraffin, paints

Care must be exercised in the use of fork lift trucks in areas where these substances are stored. Electrically powered fork lift trucks and diesel engine equipment should be specially protected to eliminate any potential ignition sources.

COMBUSTIBLE SUBSTANCES:

United Nations labels: **Class 4**



Division 4.1
Inflammable solids
Symbol (flame): black
Background: white with
vertical red stripes



Division 4.2
Substances liable
to spontaneous combustion
Symbol (flame): black
Background: upper half white
lower half red



Division 4.3
Substances which, in contact with
water,
emit inflammable gases
Symbol (flame): black or white
Background: blue

These are materials which are liable to continue to burn if ignited and some substances (e.g. nitrocellulose, matches, wood, paper, grain and certain fertilizers) are more readily combustible than others. In some cases, solids in powder form can be ignited fairly easily and can also, if dispersed as a dust cloud, burn with explosive violence; examples are organic powders including coal dust and flour.

CORROSIVE SUBSTANCES:

United Nations labels: **Class 8**



Corrosives

Symbol (liquids, spilling from two glass vessels and attacking a hand and a metal): black; Background: upper half white, lower half black with white border

These are products that will attack or eat away skin, metals, etc. Corrosivity varies between substances; such products are sometimes also flammable and/or toxic. It is important when dealing with spillages of these substances, that adequate protective clothing including eye and skin protection, as advised by the supplier, is worn so as to avoid any contact with the body.

Examples are:

acids; e.g. sulphuric acid, hydrogen chloride;
alkalis; e.g. caustic soda, ammonia liquor.

TOXIC SUBSTANCES:

United Nations labels: **Class 6**



Division 6.1
Poisonous (toxic) substances
Packing Groups: I and II
Symbol (skull and crossbones):
black; Background: white



Division 6.1
Poisonous (toxic) substances
Packing Groups: III
The bottom half of the label
should bear the inscriptions:
HARMFUL
Stow away from foodstuffs
Symbol (St. Andrew's Cross over an
ear of
wheat): black; Background: white

They may cause harmful effects by:

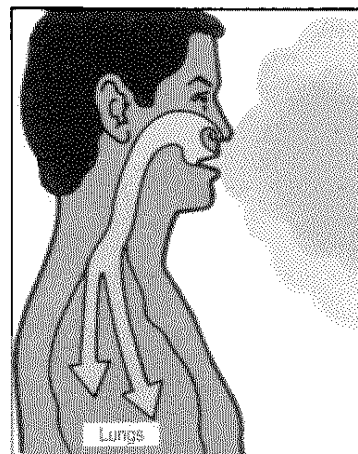
- Ingestion: entry into mouth and swallowing



No eating, drinking and smoking in working areas

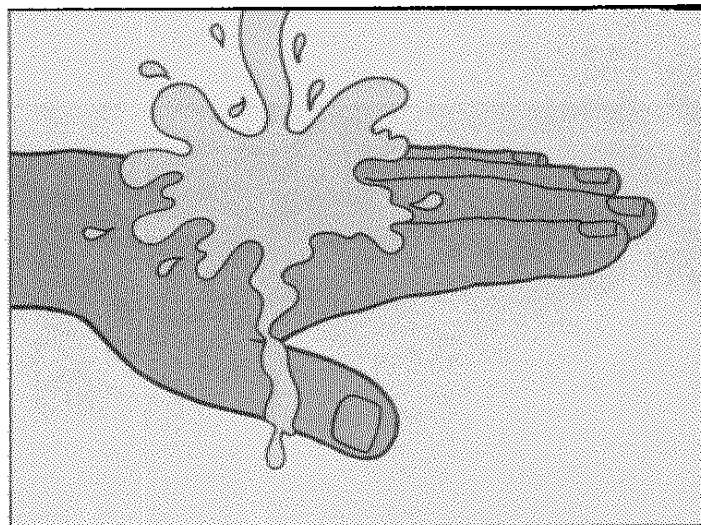
Ingestion is the least common cause of accidental poisoning. When it does happen, it is usually because people have taken food and drink into a working area or have been smoking when their hands are contaminated.

- Inhalation is one of the fastest ways of being poisoned. This is because the fumes, vapours and dust pass quickly into the bloodstream via the lungs. Vapours of flammable products are usually toxic, as are also the products of combustion of materials normally thought of as non-hazardous e.g. plastic, rubber.



Fumes, vapours and dust pass quickly in to the bloodstream via the lungs

– Absorption into the body through the skin, notably via the hands.



Skin is no barrier to toxic substances

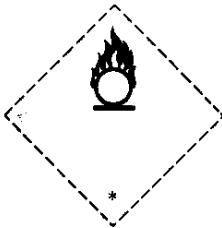
Skin contact is the most common cause of poisoning. It is more common than it need be, partly because people are often not aware that they have been in contact with toxic substances (perhaps through damaged or internally soiled clothing) and so do not take remedial action, and partly because, even when people are aware of contact, they think they are only at risk if their skin is broken. In fact, many toxic substances, in either liquid or powder form, will pass readily through healthy, unbroken skin into the bloodstream (the eyes, the nose and the area around the genitals are particularly vulnerable).

It is important that adequate personal protective equipment is available any time toxic substances are handled and for use when clearing up spillages of toxic products. This will include suitable gloves, boots, eye shields and when appropriate, face shields or even breathing apparatus. Ideally ventilation of the building should be such to minimize accumulation of toxic vapours should an unforeseen incident (such as a drum leaking) occur.

Spillages should be dealt with in such a way as to avoid contamination of surface water drains.

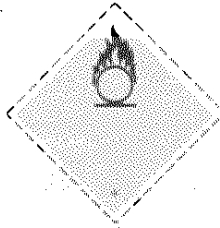
OXIDIZING SUBSTANCES:

United Nations labels: **Class 5**



Division 5.1
Oxidizing substances

Symbol (flame over circle): black; Background: yellow



Division 5.2
Organic peroxides

These are substances which supply their own oxygen and do therefore readily assist and maintain combustion; examples are sodium chlorate, potassium nitrate (salpetre) and ammonium nitrate. Also some oxidizing agents, for example concentrated nitric acid, may create fire if they come into contact with organic combustible substances such as timber or packing materials. Storage rules must therefore be strictly observed and, in particular, sodium chlorate should never be stored on wooden pallets. Oxidizing substances should not be stored in close proximity to combustible substances. If these materials are to be stored in the same building, they should be isolated by a fire wall.

RADIOACTIVE SUBSTANCES AND BIOLOGICAL COMPOUNDS:

In these special cases, there are specific requirements.

RADIOACTIVE SUBSTANCES

United Nations labels:

Class 7



Category I - WHITE; Symbol (trefoil); label "RADIOACTIVE": "Contents" ...
RADIOACTIVE

INFECTIOUS SUBSTANCES

Class 6

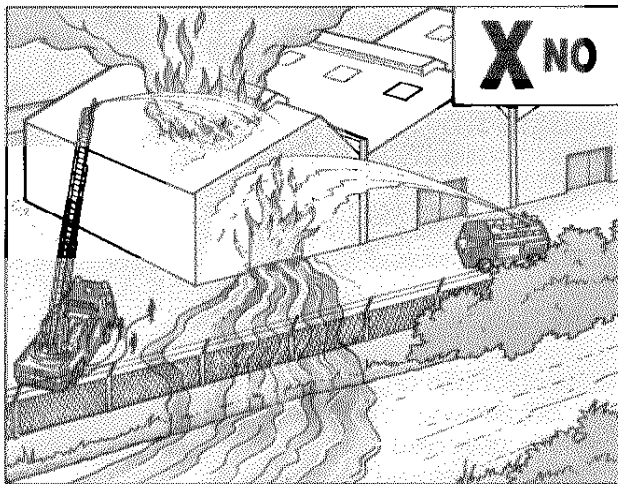


Division 6.2
Infectious substances

4.1

LOCATION

Ideally a warehouse storing hazardous materials should be located away from densely populated areas, from drinking water sources, from areas liable to flooding and from external sources of hazards.

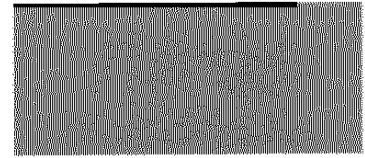


Escape of fire-fighting water can cause environmental contamination

Location should have easy access for transport and emergency services on 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.

LOCATION AND BUILDINGS

4

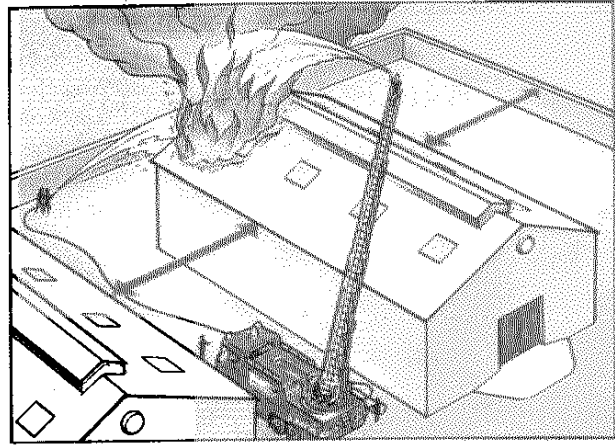
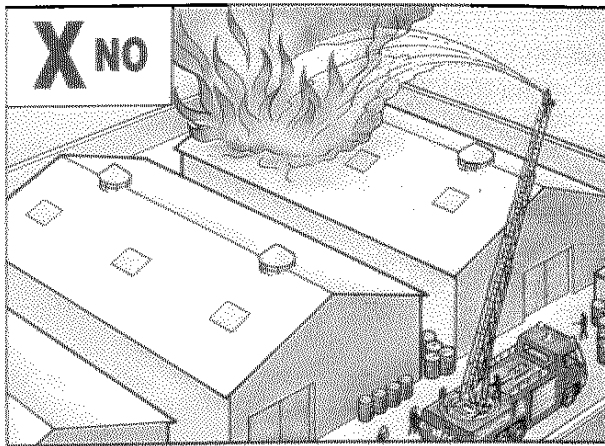


4.2

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.

Provide access for fire-fighting and prevent fire spreading



4.3

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.

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 use of additional security aids should be considered e.g. perimeter lighting, etc.

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.

4.4 DESIGN OF WAREHOUSE BUILDINGS

Building Access:

Within the site each separate warehouse building should be capable of being securely locked when not in use and windows should be fitted with security devices. Lower parts of walls should be made from robust materials and bars could be sealed on windows. Keys should be located on a keyboard at a convenient point, e.g. office or gatehouse. Each key and its corresponding lock should be clearly labelled. The keyboard should not be publicly displayed but should be readily accessible by means of a master key. The number of master key holders should be limited but should include those personnel who would be called out in an emergency.

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 goods.

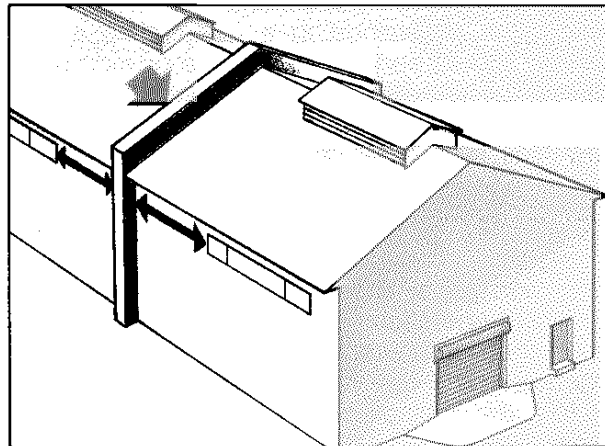
Warehouses should be substantially closed in and capable of being locked.

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.

Walls:

External walls may be covered with steel or 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 fibre. Internal division walls, designed to act as fire breaks, must provide at least 60 minutes resistance and should extend to a height of one metre above the roof or have other means of preventing a fire from spreading.

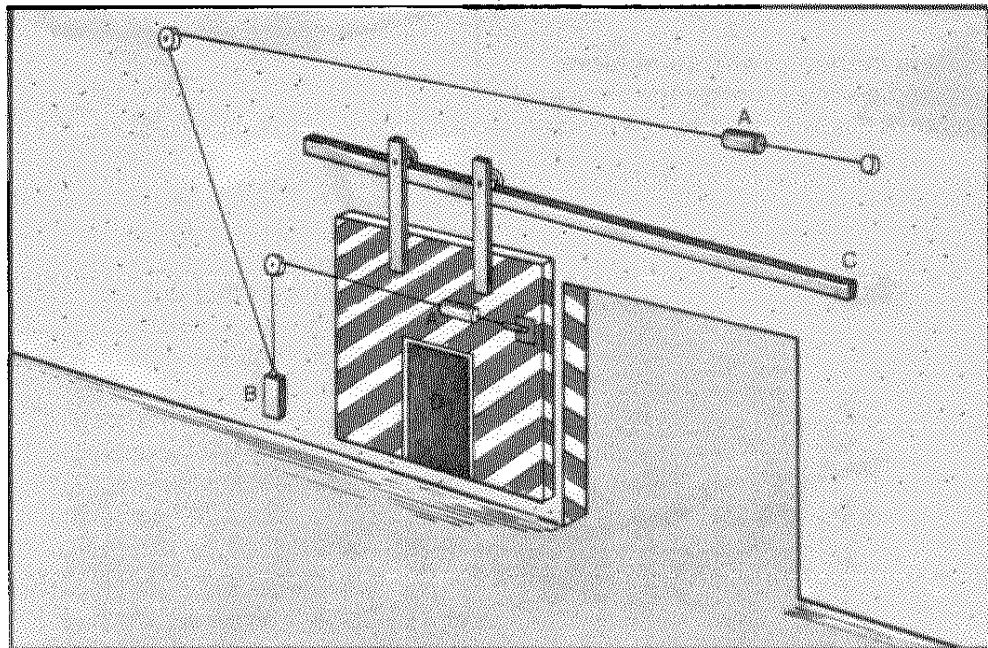
Fire separation wall extending through roof



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 (6 inches) thick 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 fire wall 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-resistant walls, they should be placed in fire retardant sand cups

Fire Doors

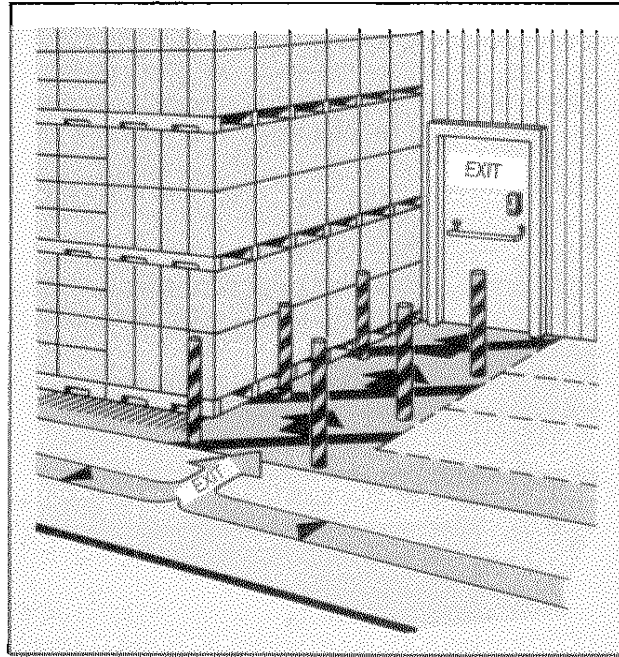
- A Fusible links: note one is positioned over door frame. Heat or flame encroaching from storage area on far side of wall will activate this link
- B Counterweight. Cable passes through running eye on top of weight. It is not fixed to the counterweight
- C Inclined track
- D Emergency exit with same fire resistance as fire door



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.

Self-closing fire door

Emergency Exits



Safety markings and stanchions should define emergency exits and protect them from being blocked

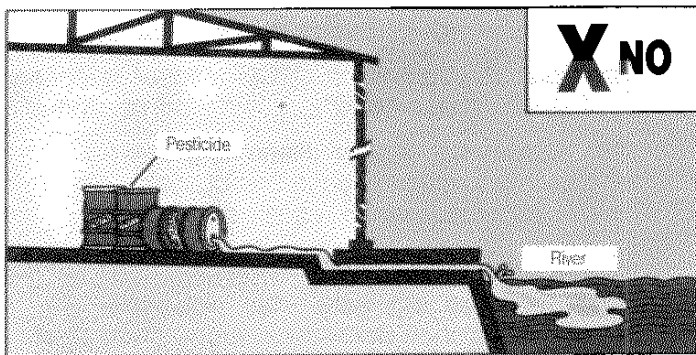
Emergency exits other than those afforded by the main doors should be provided. In planning these, considerable thought should be given to all conceivable emergencies, the prime requirement being that nobody should be trapped in the warehouse. Emergency exits should be clearly marked and of such a design that, consistent with security, they provide easy exit in case of emergency. They should be easy to open in the dark or in dense smoke and preferably be equipped with panic bars. Escape should be possible from any enclosed area in at least two directions.

Floors

Floors 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.

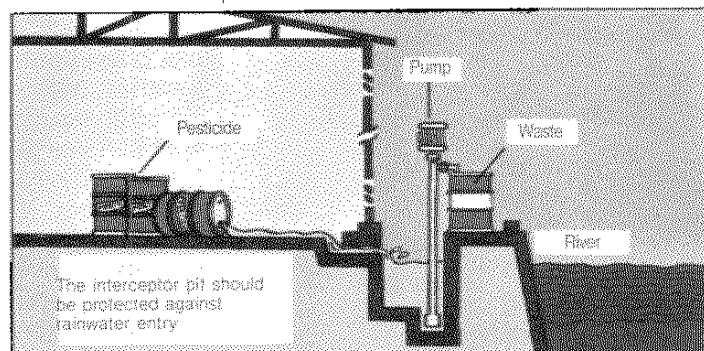
Drainage

Open drains should be avoided in stores housing toxic chemicals in order to prevent the uncontrolled release of contaminated fire-fighting water and spilled product. However, drains should be provided to take rainwater away from the roof and outside areas. Roof downpipes should be external if possible, but if internal, be non combustible. Both should be sealed at ground level and protected from damage by vehicle and pallet movements. This can possibly be achieved by means of a concrete or brick kerb surrounding the pipe at floor level and to a height of at least 20 cm (8 inches) or the height of the kerb around the building, if greater. This will also prevent the ingress of water during a fire which destroys the downpipe.



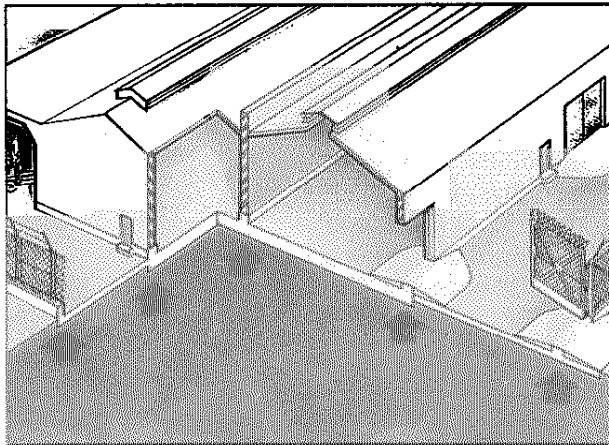
Drains connected directly to waterways or public sewers can easily cause environmental contamination

Any drain should connect to an interceptor pit for later disposal



Bunding:

In the event of a large fire involving toxic chemicals, it is essential that fire fighting water is retained rather than allowed to run off in an uncontrolled way, thereby contaminating water courses and surrounding land. This is achieved by bunding, or dyking, which may be defined as the physical retention of fire fighting water or spillage.



Bunds around the warehouse and at the site perimeter

All warehouses holding toxic products should be banded, the retention volumes depending upon the hazardous characteristics of the stored materials. The following standards, already accepted by several chemical companies for large warehouses equipped with sprinklers, are given for guidance.

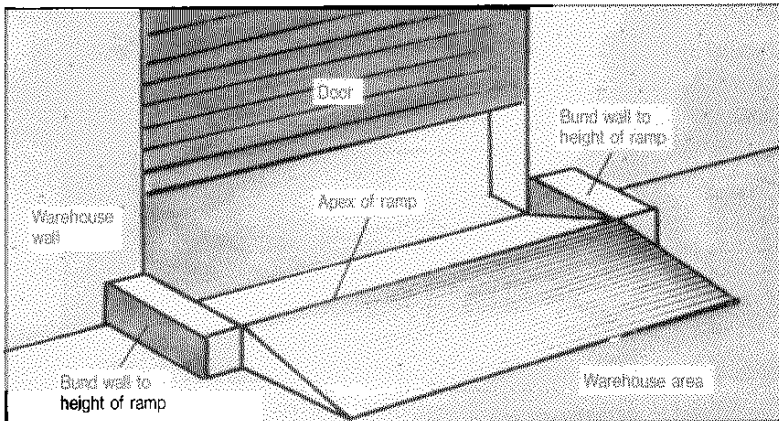
Hazardous characteristics of stored materials	Fire water retention volume m ³ per ton of material
Explosive substances, easily inflammable	3
Substance liable to spontaneous combustion	5
Inflammable substances with a flash-point < 55 °C	5
Inflammable solids	5
Ecotoxic substances, e.g. pesticides, wood preservers, organochlorine derivatives, etc.	5

For smaller warehouses, non-equipped with sprinklers, these figures should be approximately increased by a factor 10 which has often been put forward.

Another way of estimating fire retention volumes for large warehouses with sprinklers is to consider the design of the sprinkler, as proposed by the Fire Protection Handbook (14th Edition pp. 14-43). For example, a 60 % density for 3,000 square foot (278.7 m²) of coverage requires 1,800 gallons (6.8 m³) per minute (0.6 × 3,000). This flow rate is often required for 10-15 mn and others demand 1 hour. Thus, water demand can range from 18,000 gallons (68 m³) to 108,000 gallons (408.8 m³) i.e. from 0.244 to 1.47 m³/m².

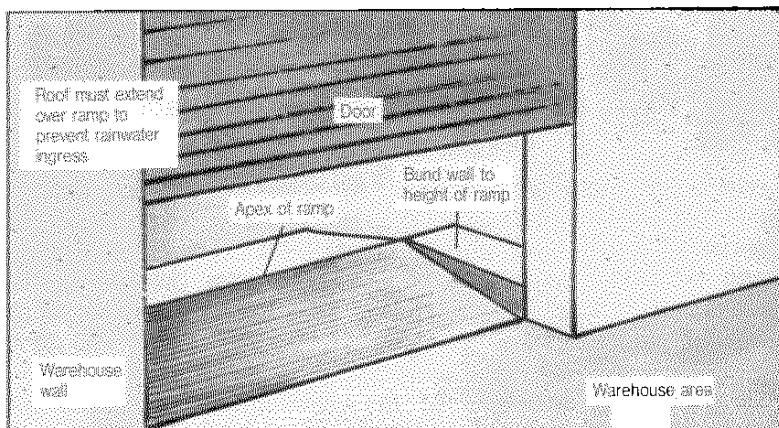
For existing warehouses of brick or block construction, it will normally be necessary to construct ramps across external doorways and for existing warehouses of clad construction, it will be necessary to construct a bund wall around the entire internal perimeter of the warehouse.

It is recognized that the space available for constructing ramps at the doorways may present problems in this respect (ramp gradients should not exceed 1 in 50). However, where space on the outside of the warehouse is restricted, the ramp may be constructed with its apex inside the warehouse, containment capacity being retained by constructing additional bund walls on either side of the ramp.



Ramp inside warehouse

Where space on the inside of the warehouse is restricted, the ramp may be constructed with its apex outside the warehouse, containment being retained by constructing additional bund walls on either side of the ramp. In this case, the roof should extend over the ramp to prevent ingress of rainwater.



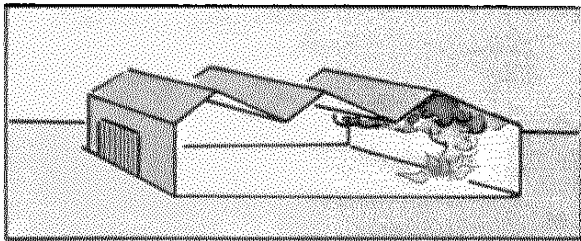
Ramp outside warehouse

For warehouses constructed above ground level however, it is necessary to make special provision for bunding or other arrangements such as retention basin for collecting fire water, spillage, etc. When space is limited, the retention basin may be arranged as car-park for the warehouse employees.

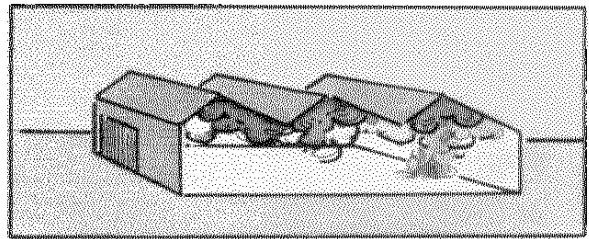
Whatever is the selected bunding solution, the owner of the warehouse must check that the overall fire water retention volumes are in accordance with the hazardous properties and volumes of the stored materials.

Roof

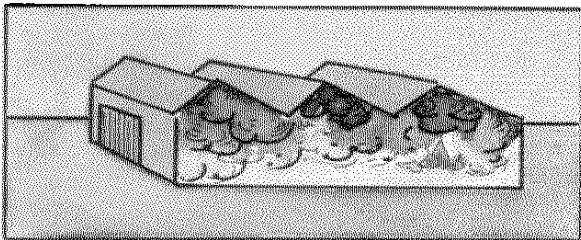
Roofing must be able to keep out rain water and the design should allow for fumes and heat to be vented in the event of a fire.



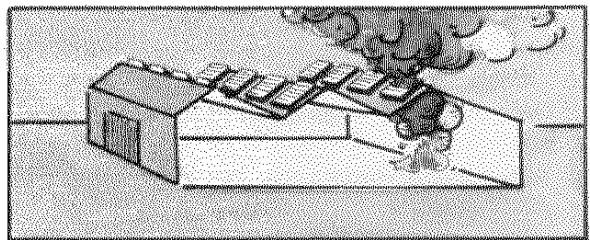
Unventilated building - Fire after 1 minute



Unventilated building - Fire after 2 minutes



Unventilated building - Fire after 3 minutes



Similar building with fire ventilation

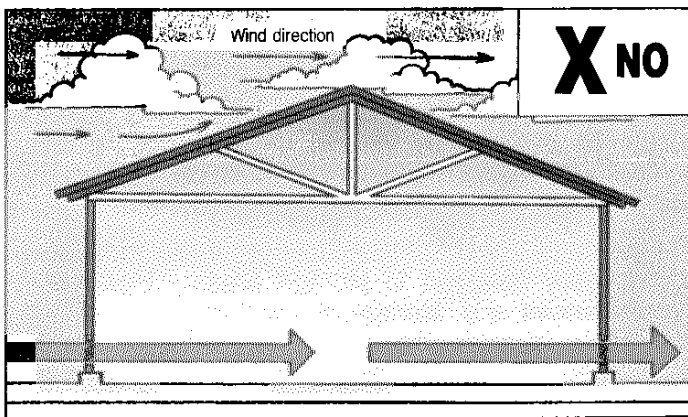
(Coll International)

Construction materials need have no special fire resistance but external surface materials such as wood, which might increase the risk of fire spread, should be avoided. However, certain types of wood support beams actually can provide better long-term structural integrity during a fire than the net effect of a hot fire on metal beams.

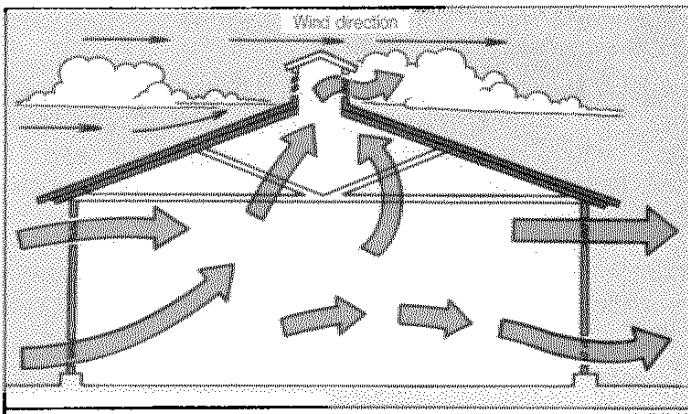
The supporting structure of the roof should be made of non-combustible materials. Hard wood or treated wood frames are acceptable provided the roof covering itself is non-flammable. The roof covering may be of light-weight, friable construction, that will readily fail in the event of a fire and thus 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 available opening of at least 2% of the floor area. Ventilation panels must be permanently open, be 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.

Ventilation

The warehouse should be well ventilated, taking into account the products stored and the need to provide generally agreeable working conditions.



Vents in the lower walls only give poor ventilation



Roof and wall vents together give good general ventilation

Adequate ventilation will be achieved if vents are placed in the roof or in the wall just below roof level, as well as near the floor.

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. Many warehouses worldwide are operated on this basis and such an operation obviously minimizes initial costs, maintenance and the need to install special electrical equipment. 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 any contact with water. Equipment must be adequately earthed and provided with suitable overload protection.

It is generally accepted that flameproof electrical equipment is 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 be kept clear of stored products or other combustible materials. Other ancillary operations such as shrink-wrapping of packaging, welding, etc., which present a potential ignition source, should not be allowed to take place in the storage area. If unavoidable in the warehouse, special precautions must be taken.

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 as steam, hot water or warm air, is recommended, the heat source being located outside the storage area. Hot water radiators or steam pipes should be located so that direct heating of stored product cannot occur. Radiant electrical heating equipment or 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.

Lightning protection

In all buildings containing flammable materials, protection against the effects of lightning strikes should be considered.

Other accommodation

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.

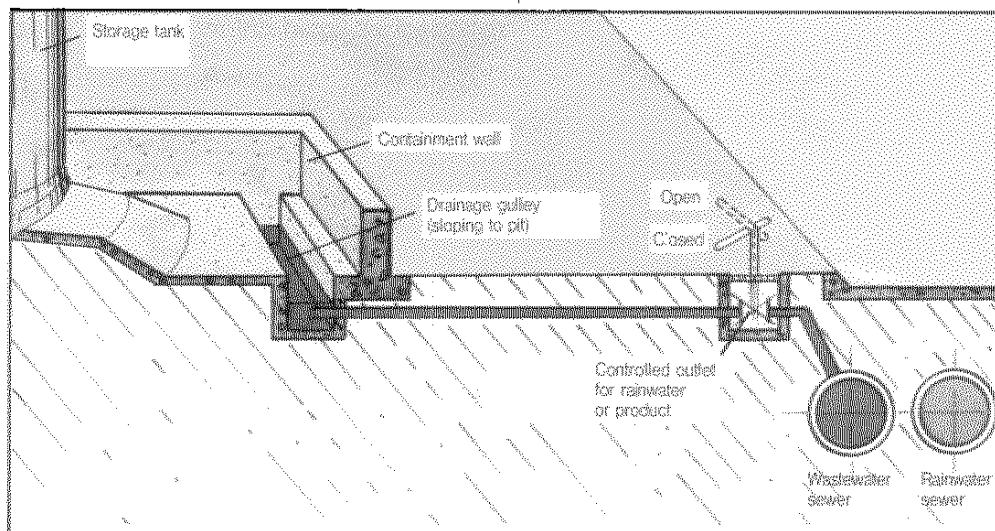
4.5

OUTDOOR STORAGE

Where hazardous materials are stored outdoors, bunding arrangements 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:

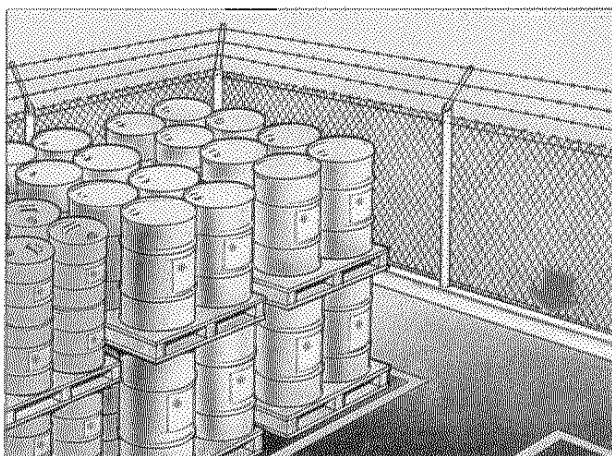
- outdoor storage of chemicals in tropical areas expose the products to high temperatures which may lead to thermal degradation. Careful selection of products with the help of their Material Safety Data Sheet would be therefore important;
- to avoid contamination of the soil and the water table, the 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;

During normal operations this must be kept closed and it will be opened by an authorized person only to release rainwater



– 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.



Outdoor storage on a firm base surrounded by a sill

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.

WAREHOUSE MANAGEMENT

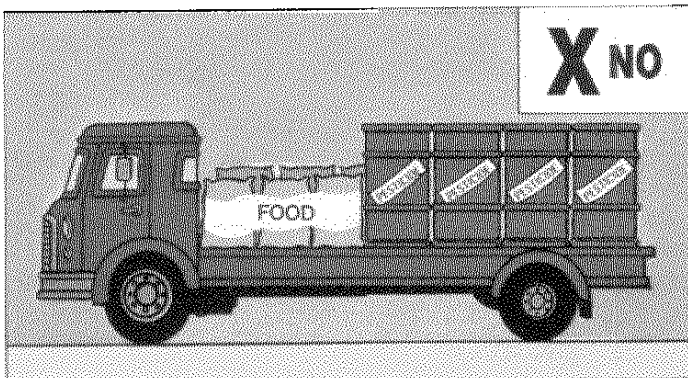
5

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 minimize risk of deterioration of goods or packages and labels, and other markings. The following written instructions must be readily available to all warehouse personnel:

- instructions for the safe and correct operations of any equipment and storage of materials;
- Material Safety Data Sheet for all stored and transported products;
- hygiene and safety instructions and procedures;
- emergency instructions and procedures.

On arrival, goods are identified by the bill of lading, the labelling, and the Material Safety Data Sheets provided by the supplier. Their characteristics are checked as per information for quantity and condition. If the goods or packaging are not in a good condition, or if for any reason they seem to present a particular hazard, appropriate action must be taken.



Hazardous chemicals must not be loaded on the same vehicle as foodstuffs

5.1

WAREHOUSE OPERATION

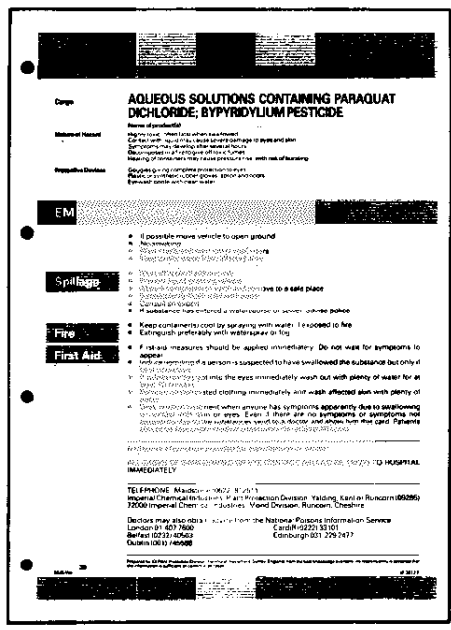
5.2

RECEIPT, DESPATCH OF GOODS AND TRANSPORT PROCEDURES

This is a typical Transport Emergency (TREM) card as used in Europe

Any vehicle must be checked before loading materials for shipment from the warehouse, as well as proper packaging and labelling of the goods. The driver must be provided with the appropriate accompanying documentation, e.g. a TRANSPORT EMERGENCY CARD (TREM) that will identify in the relevant language or languages:

- the shipping company including its address and telephone number;
 - the product being carried;
 - the basic hazards and the precautions to be taken;
 - actions to be taken in case of an accident or of a spill.
- A suitable fire extinguisher and protective and clean-up equipment should be available on board for use by the driver.



5.3 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.

Products 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 fork lift 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 meters unless the use of racking prevents overloading the lower tiers and ensures stability. Where racking is not provided, materials should not be stacked to a height which is likely to cause damage to the lower tiers.

Packages capable of being stacked higher should be specially marked to indicate maximum permissible stacking height.

Special attention should be paid to "this way up" signs on cartoned packs and, where these are not displayed, to ensure that packs are stored with the closure of the inner receptacle uppermost.

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 materials or groups of materials with their hazard characteristics;
- location of available emergency and fire-fighting equipment, access and escape routes.

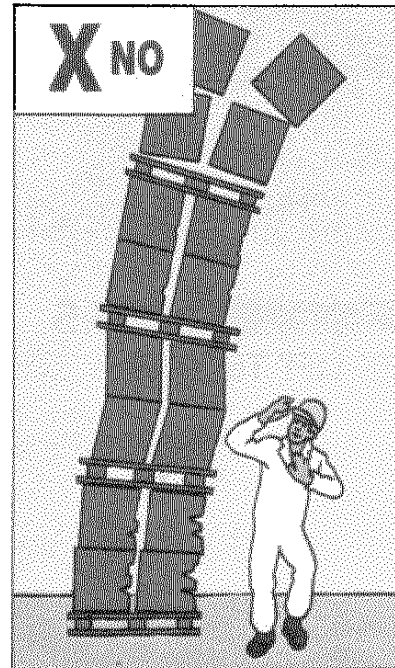
This should be kept in the main office and a copy given to the local fire brigade. It should be regularly up-dated.

A complete inventory of materials stored with their location in the warehouse should be kept updated as well.

In this section, 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 product groups, e.g. in separate warehouses or by a fire wall within a single warehouse.

The primary objective of product separation and segregation is to minimize the risks of fire or cross contamination often presented by mixed storage arrangements of incompatible materials. Correct separation will also minimize the extent of hazardous zones and the requirement to bund or to install protected electrical equipment.



Never exceed the recommended stacking heights

5.4

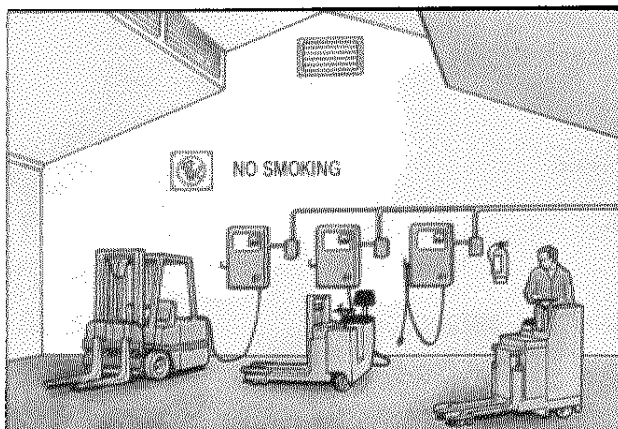
PRODUCT SEPARATION AND SEGREGATION

The basic rule is not to mix packages of different hazard classes as defined by the symbols of the United Nations Classification of Dangerous Goods (Appendix I, see p. 63). In addition:

- outside storage should be considered for highly flammable liquids and gas cylinders;
- materials that are liable to explode in a fire (e.g. gas cylinders or aerosols) should be kept separate from other inflammable materials.

5.5 FORK-LIFT TRUCKS

Fork-lift trucks can be diesel or battery powered or be equipped with engines fuelled by liquified petroleum gas (LPG) or gasoline, though trucks falling into the last mentioned category are relatively uncommon. Where there is a requirement to use protected, i.e. flameproofed fork-lift trucks, the complete unit must be certified as meeting this qualification. In the case of diesel-powered trucks, for example, flameproofing will involve the protection of the engine intake and exhaust systems, as well as the electrical equipment on the vehicle. It is also important to recognize that, in order to uphold the flameproof standard, any maintenance work required on the vehicle must be carried out to an appropriate standard by trained and qualified personnel.



Keep battery charging facilities away from stored goods

General operating procedures for fork-lift trucks:

Fork-lift trucks should be driven only by trained drivers adequately maintained. They should travel with the forks lowered, should not carry passengers and should not be left unattended with their engines running.

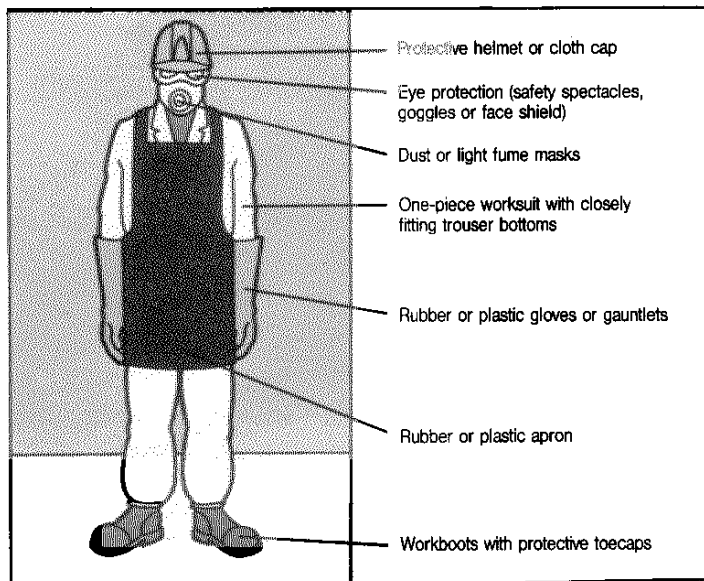
Battery charging facilities for electrically operated fork-lift trucks must be located in a well-ventilated area, clear of stored product. The area must be kept clean and clear of any combustible materials. Ideally, battery charging and the overnight parking of fork-lift trucks should take place in a segregated area of the warehouse.

Ventilation in battery charging areas should be located in the roof or the upper part of the walls to provide adequate dispersion of the hydrogen generated during charging. This is also true of parking areas for LPG fuelled fork-lift trucks.

Work clothes as well as changing and washing facilities should be provided and a separate clean area should be made available where workers can eat, drink and smoke. Provision must be made for the frequent and regular washing of 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.

For routine work, the following items of protective equipment should be made available for use as appropriate:



The design of the equipment and the type of operations being carried out will determine which items in this illustration should be worn. Special emergency equipment should be located outside the building but in close proximity to the entrance.

5.6 AMENITIES AND PERSONAL HYGIENE

5.7 PERSONAL PROTECTIVE CLOTHING AND EQUIPMENT

5.8

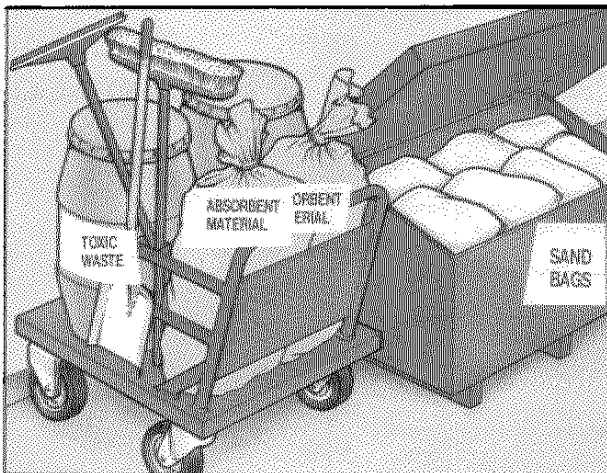
SPILLAGES AND LEAKING CONTAINERS

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 minimize hazards, all spillages and leakages should be dealt with immediately, having consulted the MATERIAL SAFETY DATA SHEET.

For dealing with spillages, the following equipment is recommended:

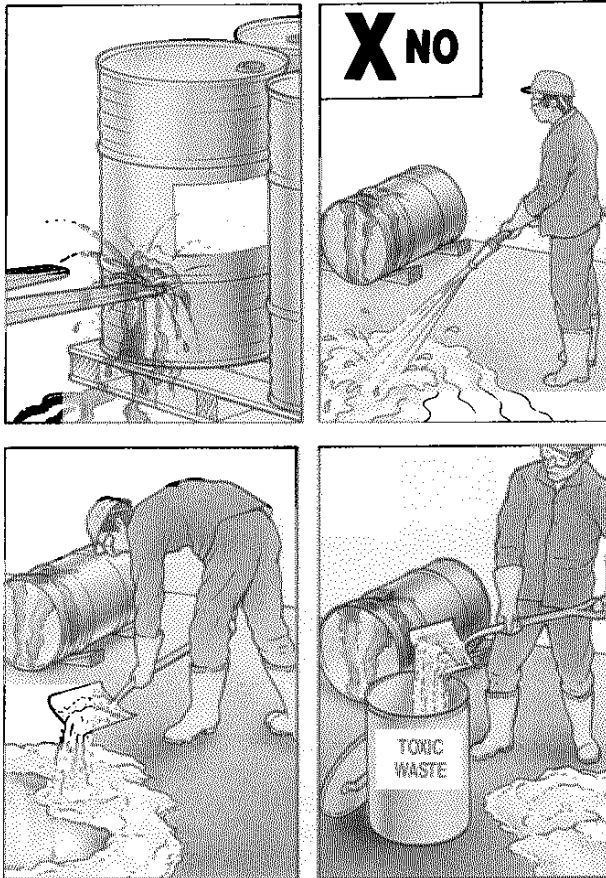
- personal protective equipment;
- empty drums, oversized if possible;
- self-adhesive paper labels for marking drums;
- absorbent material: sand, granulated clay, sawdust;
- detergent solution;
- brooms;
- shovels;
- drum spanners;
- metal funnels.



Keep clean-up equipment for spills handy

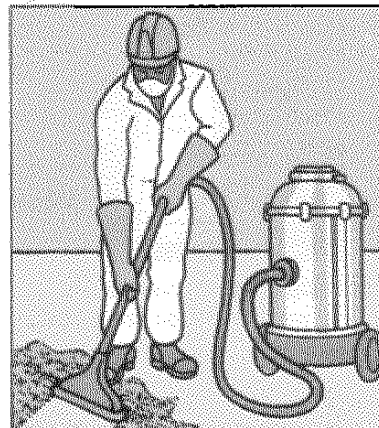
All emergency and safety-related equipment must be frequently and regularly checked and maintained to ensure that its condition is satisfactory. Personal protective equipment must be decontaminated and cleaned after use and properly maintained. Records should be kept of all checks and maintenance carried out on this equipment.

Liquid spillage should be absorbed into a suitable dustless solid absorbent such as granular absorptive clay, sand or sawdust which, however, should not be used with flammable or strongly oxidizing liquids. The area should then be decontaminated according to the instructions given in the MATERIAL SAFETY DATA SHEET, and the waste disposed of safely according to manufacturers instructions.



All spillage must be dealt with immediately

Water must not be used to wash away liquid spills. Use absorbent materials



Spilt solids can best be cleaned up with an industrial vacuum cleaner (see chapter concerning electrical equipment, p. 32). Brushes and shovels can be used minimizing generation of dust by use of dampened sand, etc.

5.9

WASTE DISPOSAL

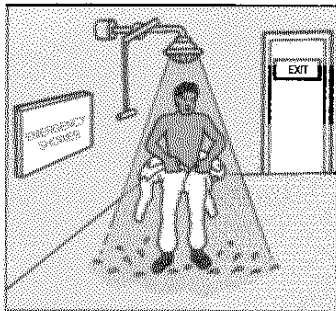
All wastes including packaging materials, broken pallets, etc., must be disposed of in a safe and environmentally responsible manner. On no account must even a small amount of spillage of potentially hazardous materials be flushed into the surface water drainage system, or any water courses, or sewers, unless they lead to a hold up basin or a proper treatment plant. Potentially hazardous wastes include obsolete stocks, off-specification products, contaminated packaging materials, aqueous wastes and absorbent material that has been used to clean up spills. Environmentally safe disposal of such wastes is often difficult and the responsible authorities should be consulted to determine local requirements. The manufacturer's MATERIAL SAFETY DATA SHEET may indicate the most suitable technical disposal method for chemical substances concerned. All contaminated containers not intended for re-use must be decontaminated where necessary and made unusable by puncturing before disposal.

5.10

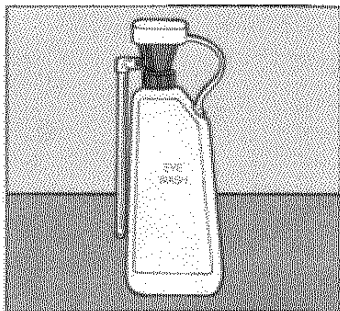
FIRST AID

All warehouses should have basic first aid materials facilities and selected employees should be trained in first aid procedures.

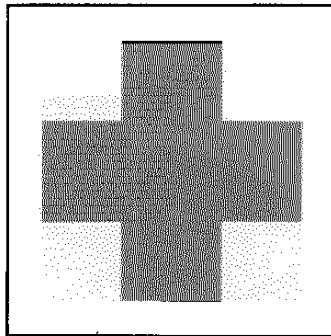
The warehouse must have basic first aid facilities, and trained first aiders.



Emergency shower - accessible and easy to use



Squeeze-operated eye-wash bottle - change water frequently

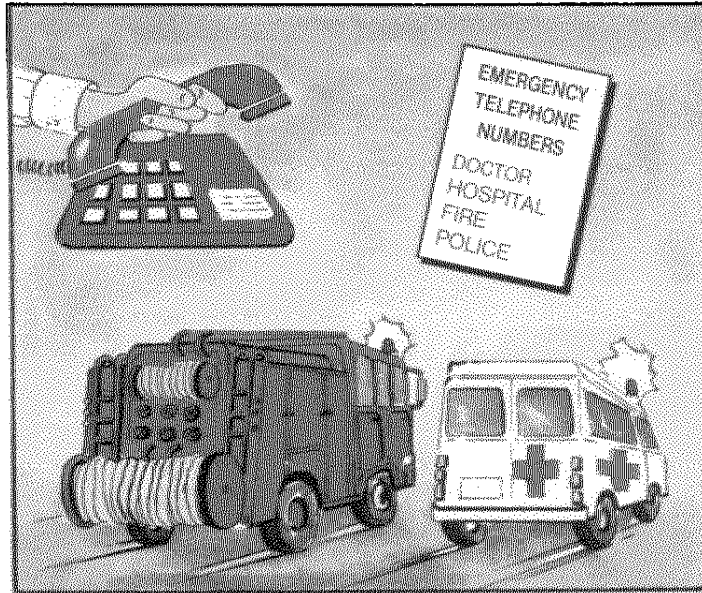


The necessary first aid equipment will include:

- emergency showers and eye-wash facilities;
- first aid boxes;
- stretchers;
- fire blankets;
- emergency lighting and luminous tape.

This 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, such as an acute intoxication. The hospital or doctor must be informed of the nature of the chemicals handled and

they should keep the necessary antidotes. In case of emergency, the label of the Material Safety Data Sheet of the chemical involved must be sent to the doctor with the patient.



For detailed advice on first aid relating to individual products, the MATERIAL SAFETY DATA SHEET must be consulted. However, the following is given as a general guide:

Exposure to fumes or vapour: Remove the affected person at once to fresh air. Obtain medical assistance.

Eye contact: Irrigate with water for a minimum of 15 minutes. Obtain medical advice.

Skin contact: Wash off promptly and thoroughly with water, after first removing all contaminated clothing. This should be placed in a plastic bag for subsequent decontamination or disposal. Obtain medical advice.

Ingestion: Do not induce vomiting unless counterindicated by medical advice or Material Safety Data Sheet. Obtain medical advice.

Burns and scalds: The affected area should be cooled as rapidly as possible with cold water until pain subsides. If naked skin is affected, cover with a sterile dressing. Do not pull off adhering garments. Obtain medical advice.

In all cases, obtain professional medical attention, after the initial treatment.

Pre-arrangement with emergency services allows a quick response

5.11 TRAINING

As with other operations, safety and job training for all employees engaged in warehousing operations is necessary if good safety 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 fire-fighting team should be trained on the use of all types of fire-fighting equipment present on the site in addition to being rehearsed in their allocated duties under the emergency plan (see chapter 6: Fire and Environment Protection, page 46).

5.12 HOUSEKEEPING

Good housekeeping will minimize 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 of dust, rags, rubbish and any 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;
- all parts of the installation shall be kept in good repair.

5.13 WORK PERMITS

A "work permit" is a written document authorizing persons to carry out non routine work concerned with, e.g. maintenance, modifications, etc., warning them of possible dangers and detailing the prevention measures to be taken to ensure that the job is done safely and certifying that the job has been properly done on completion. All precautions to ensure safe normal working procedures and equipment safety may be frustrated if unauthorized maintenance or modifications are allowed to take place in the warehouse. This particularly, but not exclusively,

applies where work involving entering a vessel, a tank, or a pit, and/or which can present a fire hazard such as paint burning, cutting, welding or other similar operations, are carried out in the vicinity of flammable products, as well as all electrical work. Such a control should apply equally to own staff and contractors.

Safety inspections of the whole warehousing operation i.e. covering equipment and procedures help to:

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

It is recommended that safety inspections be regularly organized by the warehousekeeper or the safety and security adviser and that any noted deficiencies be corrected promptly.

5.14 SAFETY INSPECTIONS

5.15 SIGNS

The use of signs and symbols indicating smoking restrictions, location of emergency equipment, telephones and escape routes is recommended. Safety instructions should be in local languages. The use of easily understood symbols (pictograms) is also recommended.



Examples of easily understood symbols



**FIRE AND
EMERGENCY
PROCEDURES**

6.1

An emergency in a warehouse can pose a potential threat to the employees, the environment and the neighbouring population, in addition to the loss of the goods. For instance, a fire involving products that can evolve toxic or noxious fumes or that decompose when heated could cause a risk, or at least considerable nuisance, to people in the adjoining locality. Also, the use of excessive fire-fighting water on a fire involving toxic products may cause overflow into, and contamination of, water courses, soil, etc. Occasionally, the correct decision may be to allow the fire to burn instead of risking pollution from use of an excess of fire-fighting water.

Successful fire protection includes rapid:

- detection of the fire;
- alarming of the workforce and emergency services;
- combatting the fire itself, but only by trained personnel.

Similarly, successful protection against environmental pollution, whether as a result of a fire, spillage or other causes, includes rapid:

- detection of emission/discharge (or threat thereof);
- containment of the discharge;
- alerting of the authorities;
- absorption, neutralization, disposal of pollutant.

An arrangement must be made with the local fire brigade to provide immediate assistance in the case of fire. As far as the fire is limited within the fences of the warehouse, the fire brigade should take action under the responsibility and the guidance of the warehousekeeper or of its representative. By the means of regularly updated inventories, the fire brigade must be informed of the nature of the chemicals present on the site and, when appropriate, advised on any specific high risk areas. The warehouse personnel should be trained in fire-fighting, and on site fire-fighting exercises should be regularly organized in order to check the condition of the fire-fighting equipment and to familiarize people with its use.

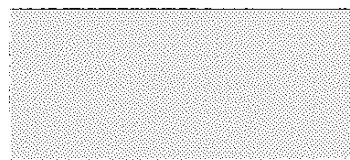
EMERGENCY PLAN

6.2

In conjunction with local authorities and the fire-brigade, an emergency plan including the raising of the alarm and an evacuation procedure must be established. An emergency plan involves two parts: an on-site or internal emergency plan and an off-site or external emergency plan:

FIRE AND ENVIRONMENT PROTECTION

6



– On-Site (internal) Emergency Plan

A set of procedures designed to protect personnel present on the site of the warehouse, and to combat and contain the emergency endangering the personnel and the structure or contents of the warehouse. This set of procedures is to be prepared by the warehousekeeper.

– Off-Site (external) Emergency Plan

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 appropriate local authority in co-operation with the warehousekeeper who has to supply any necessary information normally in his possession, e.g. hazards of the materials stored and the like. With this respect, a useful guidance could be provided by the UNEP Handbook on Awareness and Preparedness for Emergencies at Local Level (APELL) designed to assist decision-makers and technical personnel in improving community awareness of hazardous installations and in preparing response plans, should unexpected events at these installations endanger life, property, or the environment.

If considered appropriate, fire detectors can provide early warning that a fire has started and are particularly useful in warehouses which are unmanned at weekends and outside work hours. However much of the advantage is lost if the fire brigade takes longer than 15 minutes to arrive on the scene.

Flame detectors: include infrared, ultraviolet detectors or a combination of both.

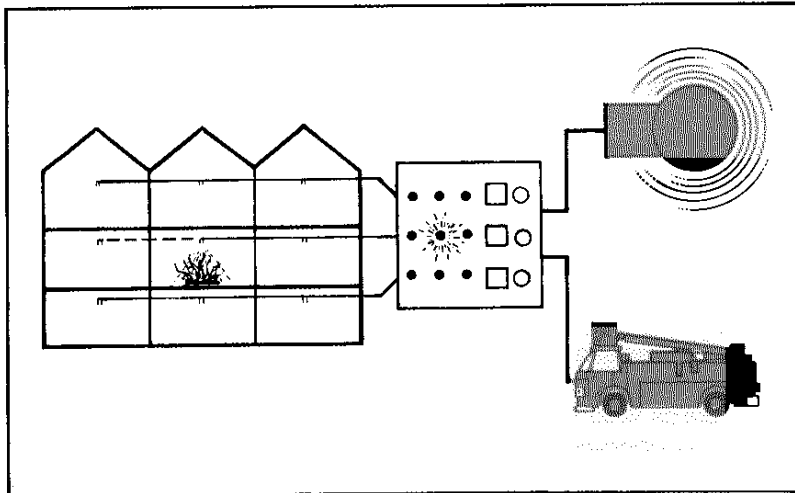
Smoke detectors: There are two types of smoke detectors "ionization" and "optical". Each has its applications and an appropriate choice should be made in consultation with specialists.

Heat detectors: Heat detectors are generally less prone to the initiation of false alarms than smoke detectors. However, by definition, they only respond when a fire has developed sufficient heat and hence may be viewed as "delayed action detectors".

6.3 FIRE DETECTION AND PROTECTION EQUIPMENT

Sprinkler systems

A sprinkler system consists of a network of pipes and heat sensitive valves called sprinkler heads.



Smoke detector/sprinkler network with local and Fire Brigade alarm connections

With automatic sprinkler systems, each head is equipped with a fusible link or quartzoid glass bulb which, at a predetermined temperature, will permit the release of water or foam-water to the immediate area. By this means, a fire can be automatically detected, the alarm given, and the fire kept under control pending the arrival of the fire brigade. The advantage of the system, when compared to heat and smoke detection systems, is that it provides continuous protection against fire, and simultaneously, can be used to initiate an alarm to the fire brigade. That is to say, an automatic sprinkler system will both detect and fight a fire. The disadvantage is one of costs. The high cost of installation means that sprinkler systems are only likely to be justified in large warehouses, or where the risk is of a special category, or where fire brigade response time is likely to be very prolonged. Attention should be paid to the fact that water may not necessarily be the most appropriate extinguisher (see p. 50).

Particular care will be required in cold climates where wet sprinkler systems may suffer frost damage in unheated buildings. This can be avoided by maintaining the network of pipes in a dry state, pressurized only with air or employing a dry riser system hand operated outside the warehouse. The further risk that water damage may occur as a result of accidental impact with a sprinkler pipe or detector head can be overcome by careful siting of the installation in relation to the stacking patterns. All risks related to damage caused by an accidental release of water from the sprinkler system should, however, be included in the cover provided by the operator's insurance policy. All sprinkler systems must be covered by a routine programme of testing and maintenance, details of which will normally be prescribed by the supplier.

Detection response: Smoke or heat detectors are of no value and sprinkler systems of limited value if they do not trigger an effective response. Thus, it is essential that the alarm which is triggered by the system, is relayed to a control point or, better still, to the fire brigade. This is particularly important in warehouses which are unmanned during the silent hours and at weekends. It is vitally important that all automatic systems including smoke and heat detectors and sprinkler systems be routinely maintained and tested according to the supplier's instructions.

Emergency roof vents could be installed to combat lateral spread of smoke and fire in accordance with specialist advice (see p. 30-31).

Where fire hydrants for fire brigade use are available or can be installed, they should be well marked so that all areas of storage can be reached by means of at least two hoses, preferably from two hydrants, especially the escape routes. An alternative source of water can be provided from a static water reservoir.



Position fire extinguishers close to the exit and keep clear

If appropriate for the kind of warehouse, adequate and easily accessible hose reels, water and foam nozzles, and fittings can be provided within the warehouse as well as supplies of foam and other equipment such as fixed monitors, fire blankets, powders, etc.

It is recommended that the system is agreed and reviewed periodically with the local fire authority.

**FIRE-FIGHTING
MEDIA**

6.4

Portable fire extinguishers of types suitable for fighting fires, associated with specific stored materials, should be selected and strategically located within and outside the warehouse.

All the fire detection and protection equipment must be regularly inspected by a competent person at least once a year and maintained to ensure that its condition is satisfactory.

Equipment Plan

A fire equipment plan showing the position of all fire-fighting equipment on site should be drawn up and displayed in at least two places, one of which should be in the warehousekeeper's office (see also page 37).

The fire-fighting media will be selected according to their mode of action and their use in combatting or preventing the spread of fire, depending of the materials stored in the warehouse.

Water

Water acts as a coolant, i.e. it reduces the temperature of the burning product to a point below its fire point and hence extinguishes the fire. Water should preferentially be used as a fine spray or fog rather than a jet. This both enhances its cooling potential and prevents fire spread.

In addition to its use to extinguish fire, water provides a valuable means of minimizing the spread of fire by cooling adjacent goods, tanks, pipes or other premises.

However, care should be taken when using very large quantities of water for warehouse fires involving toxicants because of the problems arising from contaminated fire water run-off or chemicals which react with water in a hazardous manner. Water should never be used on water-reactive chemicals such as calcium carbide, isocyanates, calcium oxide (quicklime), certain halogen-containing compounds e.g. acetyl chloride, aluminium chloride and metals such as sodium and calcium. When storing such materials, the special risk should be discussed with the fire authorities.

Dry Chemical Powders

They are generally effective on flammable solvents, aerosols, products which react adversely with water and electrical fires.

However, dry chemical powders are normally used in portable or mobile extinguishers for dealing with small fires and so, although of considerable value, they are basically "first aid" extinguishants.

Carbon Dioxide and Halons

Carbon dioxide and halons extinguishers are generally effective on flammable solvents, products which react with water and electrical fires. However, as with dry chemical powders, carbon dioxide can only be used as a "first aid" extinguishant. Due to their depleting effect on the stratospheric ozone layer, the use of halons will be progressively reduced.

Foam

A number of different types of foam are commercially available which are recommended for certain classes of chemical products and considerable skill is required for effective application and, in most circumstances, it is preferable to use dry-powder.

Use on water-immiscible products

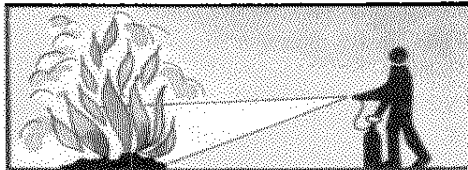
Fire involving products such as petrol, kerosine, fuel oil and hydrocarbons generally (e.g. white spirit, hydrocarbon solvents, benzene, styrene, etc.) are best tackled with fluoroprotein foam or aqueous film forming foam.

Use on water-miscible products

Alcohol-resistant foams are the most effective for fires involving products such as alcohols, ketones, glycol ether, etc.

Alcohol-resistant foams are recommended for pesticide fires. However, because they contain water, foams should not be used on water-reactive products or electrical fires.

Different types of fires need the correct extinguishing techniques



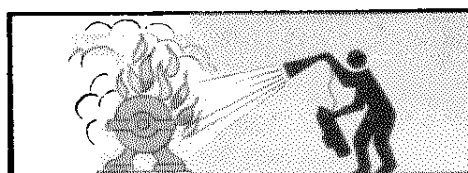
WATER BASED

Direct stream at base of fire.



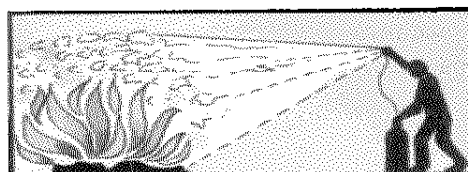
DRY POWDER

Start at base of flame and move up where burning.



CO₂ AND HALON

Discharge as close to fire as possible from edge of flame forwards and upwards.



FOAM

Do not play stream onto the burning liquid. Allow foam to fall lightly on fire.

SUMMARY OF EXTINGUISHANTS

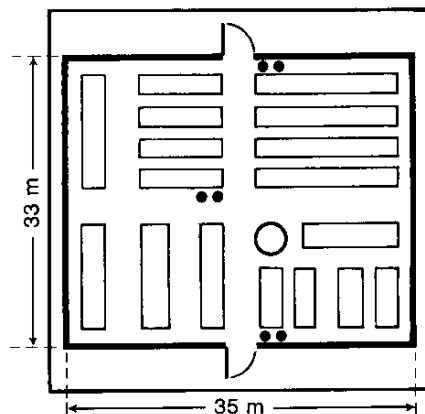
Decide the Class of Fire you are Fighting

Match up Proper Extinguisher with Class of Fire Shown at Left

TYPE OF EXTINGUISHER

	Foam	Carbon Dioxide	Water Based	Pump Tank	Gas Cartridge	Multi Purpose Dry Chemical	Ordinary Dry Chemical
CLASS Ordinary Combustibles Wood, Paper, Cloth	YES	NO	YES	YES	YES	YES	NO
CLASS Flammable Liquids, Gasoline, Paints, Oils, etc.	YES	YES	NO	NO	NO	YES	YES
CLASS Electrical Equipment, Motors, Switches, etc.	NO	YES	NO	NO	YES	YES	YES

Extinguishers for general protection should be located as near as possible to exits from the building. Where specific risks exist, however, the appropriate extinguisher should be placed close to such risks, e.g. carbon dioxide extinguishers in association with a battery charging unit.



An example of distribution of fire extinguishers

6.5 SITING OF EXTINGUISHERS AND HOSE REELS

Where large undivided floor areas necessitate positioning extinguishers at intermediate points away from exits or outer walls, they should be installed on escape routes. The location plan for fire extinguishers within and outside a warehouse should ensure that units are placed within 30 m of one another, excluding any extinguishers installed for special risks.

Extinguishers should be in a conspicuous position and be kept clear and accessible for immediate use. They should be mounted on brackets, such that the top of the extinguisher is not more than 1 m from floor level. A notice should be mounted on the wall or structure above the extinguisher to indicate clearly its location.

Fire extinguishers for general protection (water and/or dry powder) should be distributed within the warehouse on the basis of one unit per 200 m² of floor area, with no less than two units on any space.

Water-filled extinguishers should have a capacity of no less than nine litres (total weight 12-15 kg) while dry powder extinguishers should not be less than 10 kg capacity (total weight 15-20 kg). These units will have discharge times of 60 and 20 seconds, respectively.

Where hose reels are installed, these should be arranged so that it is possible to reach any part of the store with the discharge from at least one hose reel.

6.6

FIRE FIGHTING

In the event of fire, the following actions should be taken immediately and, as far as possible, simultaneously in accordance with the scale of the emergency. Correct allocation of duties is therefore essential:

- sound the alarm and clear the area of the personnel except those actually dealing with the fire;
- call the fire service;
- try to extinguish it, if possible, but at least to limit it and prevent it spreading to adjacent facilities until the arrival of the fire brigade; do not however endanger yourself;
- ensure that the warehouse-keeper or site manager and other designated personnel are aware of the fire and the impending arrival of the fire brigade;
- consider the need to evacuate adjacent premises and act accordingly;

- make arrangements for a doctor to be advised and asked to attend;
- hold a roll call to ensure that all personnel are accounted for.

When fighting the fire:

- work from the upwind side. Do not work downwind. Work as far away as is practicable from the source of the fire in case there is an explosion;
- cool adjacent facilities with water.

In large fires, if fire containment cannot be guaranteed and a serious threat to outside water courses becomes imminent, then, provided there is no immediate threat to people or other adjacent property, a decision to stop fire-fighting may cause the least damage overall. If this course is adopted:

- there is no risk of environmental pollution due to run-off of contaminated fire-fighting water;
- as no extinguishant is applied, there is no cooling effect and thus combustion of the toxicant will be more complete.

When a fire breaks out in a warehouse storing hazardous materials, the main environment risks are due to emanation of combustion gases, flood of contaminated fire-fighting water and soil contamination by polluted water or combustion wastes. When there is a risk of environmental contamination by heavy fumes, evil smelling and toxic gases, the fire authorities may decide to request the population either to stay at home with doors and windows closed or, depending on circumstances or when there is a risk of explosion, to evacuate. Such contingencies should have been discussed before with the local and fire Authorities and dealt with in the off-site Warehouse Emergency Plan.

Flooding of contaminated fire-fighting waters into drains and waterways with damaging consequences to the surface water is another likely risk to the environment. It is then essential that fire-fighting water is retained by bunding the warehouse (see p. 28), or that only very limited amounts of water are used.

In order to avoid further contamination of the soil and ground water after a fire, all the warehouse area and the surroundings must be carefully cleaned up.

6.7

PROTECTION OF THE ENVIRONMENT AND NEIGHBOURING POPULATION



CLEAN-UP OPERATIONS

6.8

After a fire, a site cleaning-up operation should be carried out taking care of adequate personal protection and preventing further environmental pollution.

Initial action

The affected area should be isolated and roped off to prevent unauthorized entry. Warning signs should be posted and access allowed only to personnel involved with clean-up. Arrangements should be made to ensure that toxicants cannot be carried out of the area, and that all personnel physically involved in the clean-up operation are aware of any toxicity hazards and are provided with suitable protective clothing. If there is a possibility of contamination by rainwater run-off, the area should be covered with tarpaulins or bunded with sand or earth.

Clean-up procedures

The initial objective should be to separate the debris into the following categories:

- retained fire water;
- solid or liquid product residues;
- contaminated debris;
- damaged packs;
- undamaged packs.

The second objective is the safe disposal of the debris, which needs specialist advice, and the re-location of undamaged stock.

Retained fire water should be analysed for contamination. If clean, it may be disposed of into the drainage system, but this should only be done with the approval of the local authorities. If contaminated, it should first be decontaminated. Advice on the methods to be employed, which will be specific to the contaminants, should be sought from MATERIAL SAFETY DATA SHEETS or the Service Companies.

In a hot climate, contaminated fire water may be pumped out to an area where there is no risk of contaminating ground water, for solar evaporation provided the contaminant is not volatile. Then the sludge should be collected and treated as waste. Solid product residues should be collected and placed in tight containers, whereas liquid product residues should be

absorbed, collected and placed in tight containers and both treated as hazardous wastes. Products in damaged packages should be decanted into sound containers, labelled and treated as obsolete stock and totally undamaged packages should simply be re-located.

Wherever possible, mechanical handling equipment should be used to minimize human contact with contaminated debris.

Notification of local authorities

The Local Authorities should be notified of the plan for clean-up. In many cases, their assistance or cooperation may be helpful or their involvement mandatory.

Assessment of environmental contamination

Fields and ditches contaminated with run-off water or downwind air-borne pollutants should be sampled and analysed to determine the seriousness of the contamination. This will determine whether wells must be closed, cattle moved, etc.

Decontamination of buildings and equipment

Tools, vehicles, concrete slabs should be decontaminated with 5% caustic soda solution or preferably a 10% saturated sodium carbonate solution and rinsed until clean. The wheels of all vehicles leaving the site should be cleaned as well.

Personal protection

For the protection of the individual, the following precautions should be taken:

- provide clean protective clothing and equipment each day;
- when leaving the site, wash or shower using plenty of soap and water to remove any traces of toxic chemicals and put on clean clothes;
- wash all personal clothing;
- be on the outlook for any symptoms of poisoning. They may not show up immediately.

7.1
LOCATION AND BUILDINGS

This check-list has been written in such a way as to make it easy for you to fill it in. On the basis of your answers, it is also easy to check afterwards whether any action is needed.

Appropriate parts of the check-list can be used for determining whether a particular warehouse (owned or contracted) is suitable for storage of specific materials; for assisting in building a new warehouse; or for determining any necessary improvements (if any) to an existing warehouse and its management.

Please, be as accurate as you can in your answers, it could help prevent accidents. Any action needed will be influenced by the nature of the materials stored (or due to be stored); a list of these materials must, therefore, also be available together with their properties (MSDS).

No.	Question	Yes	No	Page
	Location and buildings			22
1	Does the warehouse satisfy the requirements relating to the location? If NO, in what respects does it fail?	<input type="checkbox"/>	<input type="checkbox"/>	
2	Does the warehouse satisfy the stipulations for site access?	<input type="checkbox"/>	<input type="checkbox"/>	23
3	What is the nominal storage capacity of the warehouse? tons			11
4	Does the warehouse fulfill requirements regarding construction materials: construction materials? floor surface? internal fire break walls? roof covering and ventilation? heat and smoke release? drainage? local fire regulations? If NO, in what respects does it fail?	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	22
5	Is the warehouse bunding at least 20 cm in height?	<input type="checkbox"/>	<input type="checkbox"/>	28

CHECK-LIST 7

No.	Question	Yes	No	Page
6	What additional system for containment of fire-fighting water exists? none? underground retention pit? external containment wall? other? Describe	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	29
7	What is the overall capacity of containment? m ³ Is this sufficient to contain the expected volume of fire-fighting water?	<input type="checkbox"/>	<input type="checkbox"/>	28
8	Is the warehouse well ventilated?	<input type="checkbox"/>	<input type="checkbox"/>	31
9	Are all vents above bunding height?	<input type="checkbox"/>	<input type="checkbox"/>	31
10	If the warehouse is heated, is the heating source located away from the storage area and is direct heating of products avoided?	<input type="checkbox"/>	<input type="checkbox"/>	32
11	Is there sufficient light? Is it properly positioned?	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	32
12	Is the warehouse fitted with a lightning conductor?	<input type="checkbox"/>	<input type="checkbox"/>	33
13	Are sufficient emergency exits provided? Do these conform to local safety requirements?	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	26
14	If any office or amenity accommodation exists in the warehouse structure: Is it adequately segregated from the store? Has it an exit other than through the warehouse?	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	39

**WAREHOUSE
MANAGEMENT**

7.2

No.	Question	Yes	No	Page
Warehouse management				
15	Is there a defined management structure with clear areas of responsibility?	<input type="checkbox"/>	<input type="checkbox"/>	35
16	Do these responsibilities include:			35
	receipt and dispatch of goods?	<input type="checkbox"/>	<input type="checkbox"/>	
	occupational health and safety?	<input type="checkbox"/>	<input type="checkbox"/>	
	industrial hygiene and safety?	<input type="checkbox"/>	<input type="checkbox"/>	
	maintaining suitable storage conditions?	<input type="checkbox"/>	<input type="checkbox"/>	
	security?	<input type="checkbox"/>	<input type="checkbox"/>	
	protection of the environment?	<input type="checkbox"/>	<input type="checkbox"/>	
	emergency procedure plans?	<input type="checkbox"/>	<input type="checkbox"/>	
17	Does the warehouse have adequate precautions against arson and burglary?	<input type="checkbox"/>	<input type="checkbox"/>	23
18	Do these precautions include:			23
	alarm systems?	<input type="checkbox"/>	<input type="checkbox"/>	
	burglar-proof gates and windows?	<input type="checkbox"/>	<input type="checkbox"/>	
	fenced-in premises?	<input type="checkbox"/>	<input type="checkbox"/>	
	24 hour guard service?	<input type="checkbox"/>	<input type="checkbox"/>	
	perimeter lighting?	<input type="checkbox"/>	<input type="checkbox"/>	
19	Are all staff adequately trained concerning:			44
	knowledge of product hazards?	<input type="checkbox"/>	<input type="checkbox"/>	
	safe operating procedures?	<input type="checkbox"/>	<input type="checkbox"/>	
	emergency procedures?	<input type="checkbox"/>	<input type="checkbox"/>	
20	Is a supervisor present during receipt and dispatch of all goods to check documents, package integrity, etc.?	<input type="checkbox"/>	<input type="checkbox"/>	35
21	Are Material Safety Data Sheets for all products available?	<input type="checkbox"/>	<input type="checkbox"/>	15
22	Is an outline of the storage plan of the materials in each warehouse kept up to date?	<input type="checkbox"/>	<input type="checkbox"/>	36
23	If any product is stored outside the warehouse are conditions satisfactory regarding:			33
	security?	<input type="checkbox"/>	<input type="checkbox"/>	
	weather protection?	<input type="checkbox"/>	<input type="checkbox"/>	
	access for fire-fighting?	<input type="checkbox"/>	<input type="checkbox"/>	
24	Is the warehouse divided into distinct and separate storage bays?	<input type="checkbox"/>	<input type="checkbox"/>	24
25	Are passage ways clearly marked and accessible?	<input type="checkbox"/>	<input type="checkbox"/>	36

No.	Question	Yes	No	Page
26	Does the arrangement for block storage comply with recommendations? Are inspection aisles kept free?	<input type="checkbox"/>	<input type="checkbox"/>	36
27	Are the racks used in the warehouse non-combustible?	<input type="checkbox"/>	<input type="checkbox"/>	37
28	Are stock records kept up to date?	<input type="checkbox"/>	<input type="checkbox"/>	37
29	Does this guarantee knowledge of the quantity and location of the goods at any time?	<input type="checkbox"/>	<input type="checkbox"/>	37
30	Does product segregation or separation within the premises satisfy requirements?	<input type="checkbox"/>	<input type="checkbox"/>	37
31	If ancillary operations like shrink wrapping using open flames or refilling or repacking are carried out, are these done in a segregated room?	<input type="checkbox"/>	<input type="checkbox"/>	32
32	Are all non-routine maintenance or construction activities authorized in writing?	<input type="checkbox"/>	<input type="checkbox"/>	45
33	Are the requirements on use and charging of fork-lift trucks satisfied?	<input type="checkbox"/>	<input type="checkbox"/>	38
	Hygiene and personal safety			39
34	Are standards of hygiene and housekeeping adequate?	<input type="checkbox"/>	<input type="checkbox"/>	44
35	Are personnel issued with work clothes and protective gloves?	<input type="checkbox"/>	<input type="checkbox"/>	39
36	Are these routinely worn when handling products?	<input type="checkbox"/>	<input type="checkbox"/>	39
37	Does protective equipment exist on the premises for handling spills?	<input type="checkbox"/>	<input type="checkbox"/>	40
38	Are adequate first aid materials and facilities provided and are staff familiar with their use?	<input type="checkbox"/>	<input type="checkbox"/>	42
	Spillages			40
39	Is there an agreed procedure for dealing with spillages?	<input type="checkbox"/>	<input type="checkbox"/>	40
40	Are spilled dry products removed by vacuum cleaner?	<input type="checkbox"/>	<input type="checkbox"/>	41
41	Is absorbent material available?	<input type="checkbox"/>	<input type="checkbox"/>	40

7.3 **HYGIENE AND PERSONAL SAFETY**

7.4 **SPILLAGES**

7.5
WASTE
DISPOSAL

7.6
FIRE AND
ENVIRON-
MENTAL
PROTECTION

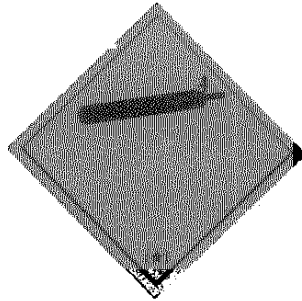
No.	Question	Yes	No	Page
	Waste disposal			42
42	Are wastes disposed of in a safe manner?	<input type="checkbox"/>	<input type="checkbox"/>	42
43	Have the methods of disposal been approved by the authorities?	<input type="checkbox"/>	<input type="checkbox"/>	42
44	Is the re-use of emptied containers satisfactorily prevented?	<input type="checkbox"/>	<input type="checkbox"/>	42
	Fire and environmental protection			46
45	Is the prohibition of smoking rigidly enforced in the warehouse?	<input type="checkbox"/>	<input type="checkbox"/>	39-45
46	Are fork lift trucks operating in warehouses with flammable goods properly protected from generating sparks?	<input type="checkbox"/>	<input type="checkbox"/>	38
47	Is product stored at a safe distance from light fittings, electrical equipment and ancillary operations such as shrink wrapping?	<input type="checkbox"/>	<input type="checkbox"/>	32
48	Does the number and type of fire extinguishers, hydrants and hose-lines satisfy requirements?	<input type="checkbox"/>	<input type="checkbox"/>	49
49	Does the warehouse have automatic protection such as sprinklers or smoke detectors?	<input type="checkbox"/>	<input type="checkbox"/>	47
50	Are fire alarms automatically linked with the fire-brigade? What is their response time?	<input type="checkbox"/>	<input type="checkbox"/>	46-47 mins
51	Is there a plan to deal with emergencies?	<input type="checkbox"/>	<input type="checkbox"/>	46
52	Has this been agreed with the local fire-brigade?	<input type="checkbox"/>	<input type="checkbox"/>	46
53	Is there a fire plan showing positions of all fire fighting equipment?	<input type="checkbox"/>	<input type="checkbox"/>	37-50
54	Are personnel trained in fire-fighting?	<input type="checkbox"/>	<input type="checkbox"/>	44-46
55	Is a fire drill regularly practised in cooperation with the local fire-brigade?	<input type="checkbox"/>	<input type="checkbox"/>	46

APPENDIX I

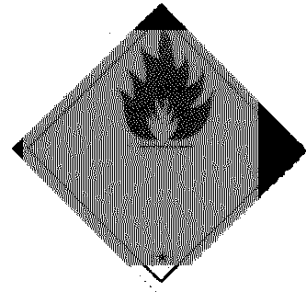
THE UNITED NATIONS HAZARD WARNING LABELS



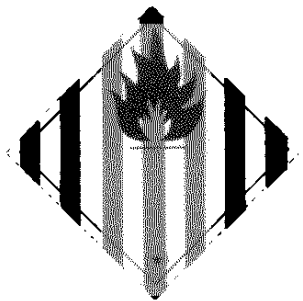
Class 1
Explosives



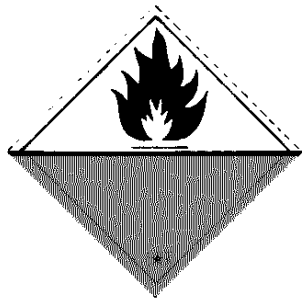
Class 2
Compressed non-
inflammable gas included



Class 3
Inflammable liquids



Class 4 - Division 4.1
Inflammable solids



Class 4 - Division 4.2
Substances liable to
spontaneous combustion



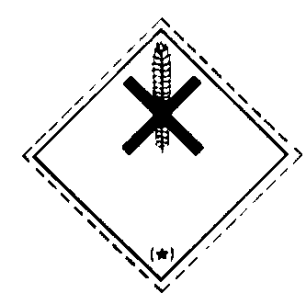
Class 4 - Division 4.3
Substances which, on
contact with water, emit
inflammable gases



Class 5
Oxidizing substances:
organic peroxides



Class 6 - Division 6.1
Poisonous (toxic)
substances
Danger groups: I and II



Class 6 - Division 6.1
Danger group: III
The bottom part of the label
should bear the inscription
Harmful - Stow away from
foodstuffs

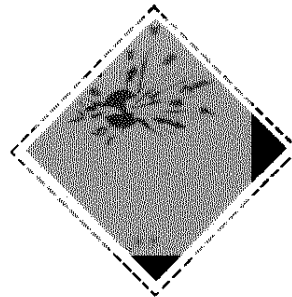


Class 8
Corrosives

(*) Place for class number

Class 1

Class number	Division	Definition
Class 1 EXPLOSIVES	1.1	Substances and articles which have a mass explosion hazard
	1.2	Substances and articles which have a projection hazard but not a mass explosion hazard
	1.3	Substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard
	1.4	Substances and articles which present no significant hazard
	1.5	Very insensitive substances which have a mass explosion hazard

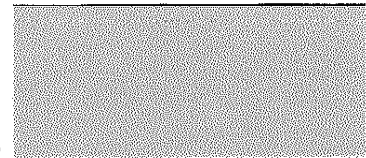


Explosives
Divisions 1.1, 1.2 and 1.3
Symbol (exploding bomb): black; Background: orange



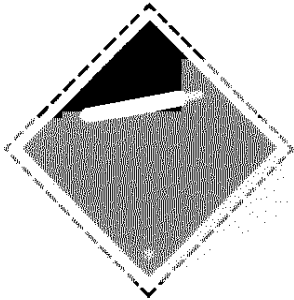
Division 1.4 (except compatibility group S*) and
Division 1.5
Background: orange; Figures: black; Numerals
should be about 30 mm in height and be about 5 mm
wide (for a label measuring 100 mm × 100 mm)

**UNITED NATIONS CLASSIFICATION
AND DEFINITIONS OF CLASSES
OF DANGEROUS GOODS**

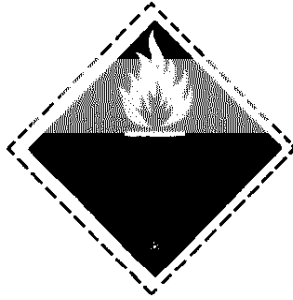


Class 2

Class number	Division	Definition
Class 2 GASES		Permanent gases Liquefied gases Dissolved gases Deeply refrigerated permanent gases



Non-inflammable gases
Symbol (gas cylinder) black or white.
Background: green



Inflammable gases
Symbol (flame) black or white
Background: red



Poison (toxic) gases
Symbol (skull and crossbones) black
Background: white



Class 3

Class number	Division	Definition
Class 3 INFLAMMABLE LIQUIDS		Inflammable liquids



Inflammable liquids
Symbol (flame) black or white.
Background: red

Class 4

Class number	Division	Definition
Class 4 INFLAMMABLE SOLIDS	4.1	Inflammable solids
	4.2	Substances liable to spontaneous combustion
	4.3	Substances which, on contact with water, emit inflammable gases



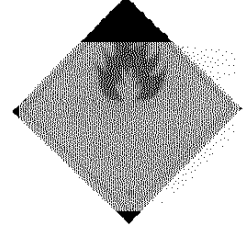
Division 4.1
Inflammable solids

Symbol (flame): black
Background: white with vertical red stripes



Division 4.2
Substances liable to spontaneous combustion

Symbol (flame): black
Background: upper half white, lower half red

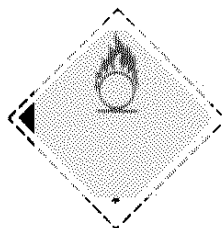


Division 4.3
Substances which, on contact with water, emit inflammable gases

Symbol (flame): black or white;
Background: blue

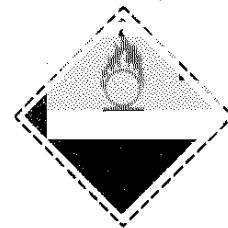
Class 5

Class number	Division	Definition
Class 5 OXIDIZING SUBSTANCES ORGANIC PEROXIDES	5.1	Oxidizing substances
	5.2	Organic peroxides



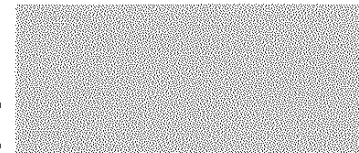
Division 5.1
Oxidizing substances

Symbol (flame over circle): black; Background: yellow



Division 5.2
Organic peroxides

**UNITED NATIONS CLASSIFICATION
AND DEFINITIONS OF CLASSES
OF DANGEROUS GOODS**



Class 6

Class number	Division	Definition
Class 6 POISONOUS (toxic) AND INFECTIOUS SUBSTANCES	6.1	Poisonous (toxic) substances
	6.2	Infectious substances



Division 6.1
Poisonous (toxic) substances
Packing Groups: I and II
Symbol (skull and crossbones)
black. Background: white



Division 6.1
Poisonous (toxic) substances
Packing Group: III
The bottom half of the label
should bear the inscriptions
HARMFUL
Stow away from foodstuffs
Symbol (St. Andrew's Cross over an ear of
wheat): black. Background: white



Division 6.2
Infectious substances
The bottom half of the label should bear Infectious
Substance (Optional) and the Inscription "In case of
damage or leakage immediately notify Public Health
authority" (optional). Symbol (three crescents
superimposed on a circle) and Inscription: black.
Background: white

UNITED NATIONS CLASSIFICATION AND DEFINITIONS OF CLASSES OF DANGEROUS GOODS

Class 7



Radioactive substances
 (a) Category I - White; Symbol (trefoil): black; Background: white; Text (mandatory) black in bottom half of label: "Radioactive"; "Contents..."; "Activity...". One red vertical stripe must follow the word "Radioactive".



Radioactive substances
 (b) Category II - Yellow; Symbol (trefoil): black; Background: top half yellow, bottom half white; Text (mandatory) black in bottom half of label: "Radioactive"; "Contents..."; "Activity..."; in a black outlined box - "Transport Index". Two red vertical stripes must follow the word "Radioactive".



Radioactive substances
 (c) Category III - Yellow; Symbol (trefoil): black; Background: top half yellow, bottom half white; Text (mandatory) black in bottom half of label: "Radioactive"; "Contents..."; "Activity..."; in a black outlined box - "Transport Index". Three red vertical stripes must follow the word "Radioactive".

Class number	Division	Definition
Class 7 RADIOACTIVE SUBSTANCES		Radioactives substances

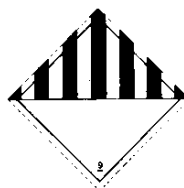
Class 8



Corrosives
 Symbol (liquids, spilling from two glass vessels and attacking a hand and a metal): black; Background: upper half white, lower half black with white border

Class number	Division	Definition
Class 8 CORROSIVES		Corrosives

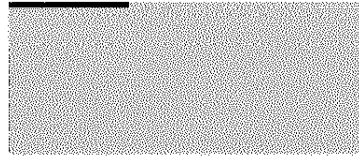
Class 9



Class number	Division	Definition
Class 9 MISCELLANEOUS DANGEROUS SUBSTANCES		Miscellaneous dangerous substances

APPENDIX II

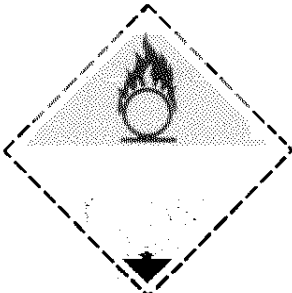



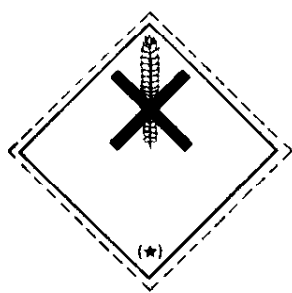
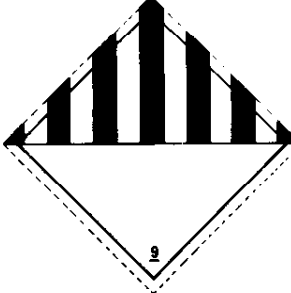
TRANSPORT "HAZARD DIAMONDS" AND "USER" HAZARD WARNINGS



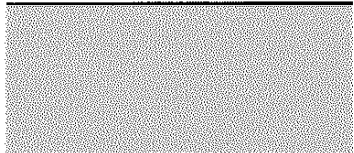
Hazard Diamonds

Classification	Hazard warning sign	Classification	Hazard warning sign
Explosive substance Class 1	 (orange)	Flammable gas Class 2.1	 (red)
Non-flammable compressed gas Class 2.2	 (green)	Toxic gas Class 2.3	 (white)
Flammable liquid Class 3	 (red)	Flammable solid Class 4.1	 (red/white)
Spontaneously combustible substance Class 4.2	 (red/white)	A substance which on contact with water emits flammable gas Class 4.3	 (blue)


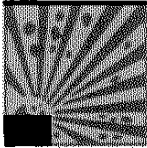

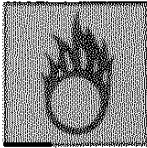
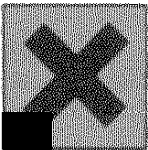

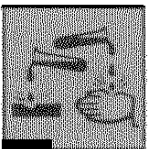
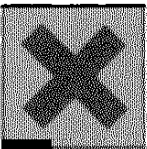
Hazard Diamonds

Classification	Hazard warning sign	Classification	Hazard warning sign
Oxidizing substance Class 5.1	 <p>(yellow)</p>	Organic peroxide Class 5.2	 <p>(yellow)</p>
Toxic substance Class 6.1	 <p>(white)</p>	Corrosive substance Class 8	 <p>(black/white)</p>
Harmful substance Class 6.1	 <p>(white)</p>	Other dangerous substance Class 9	 <p>(white)</p>

TRANSPORT "HAZARD DIAMONDS" AND "USER" HAZARD WARNINGS



User Hazard Warnings

Classification and indication of general nature of risk	Symbol Black symbol on orange background	Classification and indication of general nature of risk	Symbol Black symbol on orange background
Very toxic		Explosive	
Toxic		Oxidizing	
Harmful		Extremely flammable and Highly flammable	
Corrosive		Irritant	

ABSORBENT	Soaks up (like blotting paper)
ABSORPTION	Soaking in
AMBIENT	Surrounding
AQUEOUS	Watery, contains water, substance dissolved in water
"BLANKET EFFECT"	Use of inert vapour or foam to protect something from air or ignition
BUNDING	Physical retention of fire-fighting water or spillage (see: dyking)
COMBUSTIBLE	Liable to burn if ignited
CORROSIVE	Attacks and/or eats away skin, metal, etc.
DECOMPOSES	Breaks down chemically
DYKING	Physical retention of fire fighting water or spillage (see: bunding)
ENVIRONMENT	Soil, water, air, flora and fauna
EVAPORATE	Change from liquid to vapour; "dry up"
FIRST AID	Basic means of providing initial treatment for wounds and injuries, e.g. wound dressing, etc.
FIRST AID FIRE-FIGHTING	Generally includes hand-held fire extinguishers, installed hose reels, fire blankets; this provides the initial attack on a developing fire
FLAMMABLE OR INFLAMMABLE	Burns easily
FLAME PROOF	Designed to prevent the accidental ignition of flammable vapour-air mixture
FLASH POINT	Minimum temperature at which vapour over the product can be ignited
FOAM COMPOUND	Synthetic material for the generating of fire-fighting
HEAT DETECTOR	Device which responds when a fire has developed sufficient heat and hence may be viewed as delayed action detector
HOSE REEL	Hose pipe and jet permanently installed and connected to a water supply, designed to provide an initial attack on a fire. Not suitable for use on electrical fire or immiscible solvents
HYGIENE	System of rules and facilities for preserving or promoting health
IGNITION	Initiation of a fire, catching alight
IMMISCIBLE WITH	Does not mix with

APPENDIX III

GLOSSARY OF TERMS

INERT	Non-reactive
INHALATION	Action of breathing in
"IN HOUSE"	In-company arrangements (e.g. for testing pressure systems, expertise, etc.)
INTRINSICALLY SAFE	Equipment in which any spark or thermal effect is incapable, under prescribed conditions, of causing ignition of a given gas or vapour
MATERIAL SAFETY DATA SHEET (MSDS)	Document outlining the physical, chemical, and other related properties of a material as well as advice to be followed in case of an emergency
MISCIBLE WITH	Mixes with
NON-COMBUSTIBLE	Will not burn or catch fire
NON-TOXIC	Not poisonous (but not necessarily harmless in every way)
ORGANIC SOLVENTS	Liquids, not containing water, which dissolve certain materials (e.g. meths, spirit thinners, etc.)
OXIDIZING AGENT	Chemical which supplies oxygen; usually helps things to burn more easily
PERCEPTIBLE ODOUR	Noticeable smell
PERIMETER LIGHTING	Lighting to illuminate a boundary fence
PESTICIDES	Crop-protection products (insecticides, herbicides, rodenticides, etc.)
SEGREGATION	Physical separation of different product groups, e.g. in separate warehouses or by a fire wall within a single warehouse
SELF-IGNITION (TEMPERATURE) OR AUTO-IGNITION	Temperature at which product vapour in air catches fire by itself
SEPARATION	Positioning of different product groups in separate areas within a warehouse
SMOKE DETECTOR	Optical detectors initiated by diminution or scattering of light caused by smoke particles
SPRINKLERS	A network of pipes and heat sensitive valves, called sprinkler heads, designed to release water to the immediate area on fire
THERMAL INSULATION	Lagging, barrier to heat transfer (e.g. roof insulation)
TOXIC	Poisonous
VOLATILE	Easily and quickly changed from liquid to vapour; evaporates quickly

METHYL ISOCYANATE

ICSC: 0000

UN: 2 4 80

CH₃NCO

CAS No. 624-83-9
 RTECS No. NQ9450000
 Other names: MIC;
 Isocyanatomethane



toxic



extremely flammable

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Highly flammable. Many reactions may cause fire or explosion.	No open flames, no sparks, no smoking. No contact with alcohols, acids, amines or warm water.	Powder, halons, carbon dioxide NO hydrous agents.
EXPLOSION	Vapour/air mixtures are explosive. Risk of fire and explosion when heated, on contact with water, and catalysts.	Closed system, ventilation, explosion protected electrical equipment and lighting.	In case of fire: keep drums etc. cool by spraying with water. Combat fire out of sheltered position.

EXPOSURE		Avoid all contact	In all cases consult a doctor
<input type="checkbox"/> INHALATION	Sore throat, cough, laboured breathing, dizziness, nausea, unconsciousness, diarrhoea, extreme fatigue.	Ventilation, local exhaust or breathing protection.	Fresh air, rest, half upright position, artificial respiration if indicated, and refer for medical attention.
<input type="checkbox"/> SKIN	<i>May be absorbed!</i> Redness, pain and skin burns.	Protective gloves, protective clothing	Remove contaminated clothes. Rinse with plenty of water or shower, and refer for medical attention.
<input type="checkbox"/> EYES	Corrosive: redness, pain, blurred vision, loss of vision.	Safety goggles or eye-protection in combination with breathing protection.	First rinse with plenty of water, then take to a doctor.
<input type="checkbox"/> INGESTION	Sore throat, diarrhoea, abdominal cramps.	Do not eat drink or smoke during work	Rinse mouth, give a slurry of activated coal in water to drink, then take to doctor.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Evacuate danger area, consult an expert. Collect leaking and spilled liquid in sealable containers as far as possible, absorb remaining liquid in dry sand or inert absorbent material and remove to safe place (see NOTES). (extra personal protection: self-contained breathing apparatus and complete protective clothing).	Fireproof. Separated from alcohol, amines, oxidants and acids. Cool. Dry. Ventilation along the floor.	Special material, unbreakable packaging; put breakable packaging into closed unbreakable container. T-symbol, F-symbol R: 12-23/24/25 - 36/37/38 S: 9-30-43-44

ADDITIONAL INFORMATION

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0000 - 1; 12-1988

Prepared in the context of cooperation between the IPCS and the Commission of the European Communities © CEC, IPCS, 1988.

APPENDIX IV



EXAMPLES OF MATERIAL SAFETY DATA SHEETS

I M P O R T A N T D A T A	<p>VERY VOLATILE COLOURLESS LIQUID, WITH PUNGENT ODOUR</p> <p>The vapour is heavier than air and may travel along the ground, distant ignition possible. The substance decomposes on heating above boiling point or on burning producing very toxic gases. Reacts vigorously with amines, alcohols, acids and strong bases causing fire and explosion hazard. Reacts slowly with cold water and humid air, and violently with hot water generating heat and CARBONDIOXIDE. Attacks steel and copper alloys and some forms of plastics and rubber.</p> <p>OCCUPATIONAL EXPOSURE LIMITS: TLV, ppm 0.02; mg/m³ 0.05 (skin) (ACGIH 87/88) MAK: 0.01 ppm</p> <p>ROUTES OF EXPOSURE: The substance can be absorbed into the body by inhalation, ingestion and through the skin.</p>		<p>ACUTE INHALATION RISK: A harmful contamination of the air can very quickly be reached on evaporation of this substance at 20°C.</p> <p>EFFECTS OF SHORT-TERM EXPOSURE: The substance irritates the skin and the respiratory tract. The substance is corrosive to the eyes. Inhalation of this substance can cause shortness of breath (lung oedema, see NOTES). The substance may cause effects on the central nervous system. High exposures may result in death. The effects may be delayed. Medical observation is indicated.</p> <p>EFFECTS OF LONG-TERM EXPOSURE: Repeated or prolonged contact may cause skin sensitization or prolonged inhalation exposure may cause asthmatic reactions (see NOTES).</p>
	PHYSICAL PROPERTIES	<p>Boiling point: 38°C Melting point: -45°C Relative density (water = 1): 0.96 Solubility in water: reaction Vapour pressure, mbar at 20°C: 464 Relative vapour density (air = 1): 2.0</p>	<p>Relative density of the vapour/air mixture at 20°C (air = 1): 1.45 Flash point: -7°C Auto ignition temperature, 534°C Explosive limits, vol % in air: 5.3 – 26 Relative molecular mass: 57.1</p>
ENVIRONMENTAL DATA			
NOTES			
<p>Reacts violently with fire extinguishing agents such as foam and water. Spilled liquid rendered harmless by treating with a mixture of 50% water, 45% ethanol and 5% ammonia.</p> <p>The symptoms of asthma often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation is therefore essential.</p>			
<p>Anyone who has shown symptoms of asthma should never again come into contact with this substance.</p> <p>The odour warns insufficiently upon exceeding the exposure limit value.</p>			
<p>The symptoms of lung oedema often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation is therefore essential.</p> <p>Transport Emergency Card: TEC (R)-61G03</p>			
ADDITIONAL INFORMATION			
<p>ICSC: 0000 — 2 12-1988 © CEC, IPCS, 1988</p>		METHYL ISOCYANATE	

ACETONITRILE

Methyl cyanide; Cyano methane; Ethane nitrile



CH₃CN

PHYSICAL PROPERTIES		OTHER CHARACTERISTICS
Boiling point °C Melting point °C Flash point °C Autoignition temperature °C Relative density (water=1) Relative vapour density (air = 1) Vapour pressure in mbar at 20 °C Solubility in water Explosive limits, vol.% in air Relative molecular mass	80 -46 2 525 0.8 1.4 93 ∞ 3.0 - 16 41.1	COLOURLESS LIQUID, WITH CHARACTERISTIC ODOUR. The vapour is heavier than air and may travel along the ground; distant ignition possible. Do not use compressed air for filling, discharging or handling. The substance decomposes upon heating, forming flammable and toxic fumes. Reacts with steam and acids, forming flammable and toxic vapours. Reacts violently with oxidants. The substance may be absorbed into the body by inhalation, ingestion and through the skin. The substance irritates the eyes, the skin and the respiratory tract. The substance inhibits cellular respiration.
MAC in ppm ₃ MAC in mg.m ⁻³	40 70	
HAZARDS/SYMPTOMS	PREVENTION	FIRE EXTINGUISHING AGENTS/FIRST AID
<p>Fire: high flammable,</p> <p>Explosion: vapour-air mixtures are explosive</p> <p>Inhalation: headache, dizziness, faintness, laboured breathing, spasms</p> <p>Skin: may be absorbed, see also 'Inhalation'</p> <p>Eyes: redness,</p> <p>Ingestion: headache, dizziness, faintness, laboured breathing, spasms</p>	<p>no open flames, no sparks and no smoking,</p> <p>closed system, ventilation, explosion protected electrical equipment and lighting,</p> <p>STRICT HYGIENE</p> <p>ventilation, local exhaust or breathing protection</p> <p>protective gloves, protective clothing</p> <p>face shield</p>	<p>powder, alcohol-resistant foam, large amounts of water, halons, carbon dioxide,</p> <p>in case of fire: keep drums cool by spraying with water</p> <p>IN ALL CASES CALL A DOCTOR</p> <p>fresh air, rest, inhale amyl nitrite, and transport to hospital</p> <p>remove contaminated clothes, rinse skin with plenty of water or shower</p> <p>first rinse with plenty of water, then transport to a doctor, if necessary</p> <p>rinse mouth, give plenty of water to drink, induce vomiting, inhale amyl nitrite, and call a doctor or transport to hospital</p>
SPILLAGE	STORAGE	PACKAGING & LABELLING
evacuate danger area, consult an expert, collect leaking liquid in sealable containers, absorb spilled liquid in sand or inert absorbent and remove to safe place, neutralise remainder with chlorine bleaching liquor (extra personal protection: self-contained breathing apparatus)	fireproof, separated from oxidants,	UN: 1648   R: 11-23/24/25 S: 16-27-44
<p>NOTES</p> <p>The odour threshold is above the MAC-value. Upon poisoning by acetonitrile specific first aid and treatment are essential. The requisite means with instructions for use must be available. The symptoms often do not appear until some time has passed, observation in hospital is therefore essential. PUBLIKATIEBLAD P 107 of the Dutch Labour Inspectorate gives comprehensive instructions for safe handling of acetonitrile.</p>		
<p>Transportgevaarskaart nummer 148. Transport Emergency Card TEC(R)-148</p>		

TOLUENE

Methylbenzene*; Toluol

C₆H₅CH₃

PHYSICAL PROPERTIES		OTHER CHARACTERISTICS
Boiling point °C Melting point °C Flash point °C Autoignition temperature °C Relative density (water=1) Relative vapour density (air=1) Vapour pressure in mbar at 20 °C Solubility in water Explosive limits, vol.% in air Relative molecular mass	111 -95 4 510 0.9 3.2 29 none 1.2 - 7 92.1	COLOURLESS LIQUID, WITH CHARACTERISTIC ODOUR. The vapour is heavier than air and may travel along the ground; distant ignition possible. Due to low electric conductivity the substance can generate electrostatic charges as a result of flow, agitation, etc. Do not use compressed air for filling, discharging or handling. Reacts with <i>sulfuric acid</i> liberating heat. The substance may be absorbed into the body by inhalation, ingestion and through the skin. The substance irritates the eyes, the skin and the respiratory tract. The substance affects the nervous system. Serious cases may result in unconsciousness. The liquid degreases the skin. Swallowing the liquid may cause droplets to enter the lungs (aspiration) with the risk of pneumonia.
MAC in ppm ₃ MAC in mg/m ³	100 375	
HAZARDS/SYMPTOMS	PREVENTION	FIRE EXTINGUISHING AGENTS/FIRST AID
Fire: highly flammable, Explosion: vapour-air mixtures are explosive Inhalation: headache, dizziness, nausea, dullness, Skin: <i>may be absorbed</i> , redness, Eyes: redness, pain, Ingestion: abdominal spasm, headache, dizziness, dullness,	no open flames, no sparks and no smoking, closed system, ventilation, explosion protected electrical equipment and lighting, connect to earth, ventilation, local exhaust or breathing protection protective gloves, safety goggles	powder, AFFF, foam, halons, carbon dioxide, fresh air, rest, and call a doctor remove contaminated clothes, rinse skin with plenty of water or shower first rinse with plenty of water, then transport to a doctor, if necessary rinse mouth, give plenty of water to drink, DO NOT induce vomiting, and transport to hospital immediately
SPILLAGE	STORAGE	PACKAGING & LABELLING
collect leaking liquid in sealable containers, absorb spilled liquid in sand or inert absorbent and remove to safe place, (extra personal protection: self-contained breathing apparatus)	fireproof, separated from sulfuric acid,	UN: 1294   R: 11-20 S: 16-29-33
NOTES The use of alcoholic beverages enhances the toxic effect. Technical grades often contain <i>benzene</i> .		
Transportgevaarskaart nummer 31. Transport Emergency Card TEC(R)-31		

APPENDIX V

A KEY TO UNITED NATIONS AGENCIES AND INTERNATIONAL ORGANIZATIONS

UNITED NATIONS:

- Food and Agriculture Organization of the United Nations (FAO)
Via Delle Terme di Caracalla, 00100 Rome, Italy
Telephone (6) 57971
- International Labour Organisation (ILO)
4, rue des Morillons, CH-1211 Geneva 22, Switzerland
Telephone (22) 799 61 11
- United Nations Conference on Trade and Development (UNCTAD)
Palais des Nations, CH-1211 Geneva 10, Switzerland
Telephone (22) 734 60 11
- International Maritime Organization (IMO)
4 Albert Embankment, London SE1 7SR, United Kingdom
Telephone (1) 735 76 11
- United Nations Environment Programme International Register of Potentially Toxic Chemicals (UNEP/IRPTC)
Palais des Nations, CH-1211 Geneva 10, Switzerland
Telephone (22) 798 58 50
- United Nations Environment Programme Industry and Environment Office (UNEP/IEO)
39-43, quai André-Citroën, F-75739 Paris Cedex 15, France
Telephone (1) 45 58 88 50
- United Nations Industrial Development Organization (UNIDO)
P.O. BOX 300, Vienna International Centre, A-1400 Vienna, Austria
Telephone (222) 2631
- World Health Organization (WHO)
20, avenue Appia, CH-1211 Geneva 27, Switzerland
WHO/UNEP/ILO/International Programme on Chemical Safety (IPCS)
20, avenue Appia, CH-1211 Geneva 27, Switzerland
Telephone (22) 791 35 70
- United Nations Economic Commission for Europe (UN/ECE)
Committee of Experts on the Transport of Dangerous Goods
Palais des Nations, CH-1211 Geneva 10, Switzerland
Telephone (22) 734 60 11

INTERNATIONAL INSTITUTIONS:

- CEC
Commission of the European Communities
Directorate General for the Environment, Nuclear Safety and Civil Protection
Service for Chemicals Control, Industrial Risks and Biotechnology
Rue de la Loi, 200, B-1049 Brussels, Belgium
Telephone (2) 235 11 11
- CEFIC
European Chemical Industry Federation
Avenue Louise 250, Bte 71, B-1050 Brussels, Belgium
Telephone (2) 640 20 95
- CMA
Chemical Manufacturers Association
2501 M Street, N.W., Washington D.C. 20037, USA
Telephone (202) 887 1100
- GIFAP
International Group of National Associations of Manufacturers of Agrochemical Products
Avenue Albert Lancaster 79a, B-1180 Brussels, Belgium
Telephone (2) 375 68 60
- OECD
Organisation for Economic Co-operation and Development, Environment Directorate
2, rue André-Pascal, 75775 Paris Cedex 16, France
Telephone (1) 45 02 77 00

APPENDIX VI

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Evaluation Questionnaire

STORAGE OF HAZARDOUS MATERIALS: A Technical Guide for Safe Warehousing of Hazardous Materials

As part of its continuing review of the impact of the publications it supports, the United Nations Environment Programme Industry and Environment Office (UNEP/IEO) would appreciate your co-operation in completing the following questionnaire.

Please note: complete the questionnaire in the numerical order in which it is presented and do not correct and do not erase your initial answers.

1. Quality

Please rate the following quality aspects of the publication by ticking the appropriate box.

	Very good	Adequate	Poor
a. Objectivity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Rigour of analysis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Subject coverage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Up-to-date	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Readability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Organization	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. Presentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. Usefulness

In general, how much of the content of the publication is:

	Most	About half	Little
a. Of technical/substantive value to you?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Relevant to you?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. New to you?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Will be used by you?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. Effectiveness in achieving the objective

The publication was designed to improve environmental management in the storage of hazardous materials. In your opinion to what extent will the publication contribute to the achievement of this objective?

Please tick one box fully adequately inadequately

Please state reasons for your rating.

4. Uses

- a. Please state how the publication will affect or contribute to your work illustrating your answers with examples.

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For your own information _____

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Translation in your own language _____

Specific regional information _____

Additional technical information _____

7. The following data would be useful for statistical analysis

Your name _____

Professional background _____

Position/function/occupation _____

Government agency/ organization/
institution _____

Date _____

UNEP/IEO would like to thank you for completing the questionnaire. Please airmail to:

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United Nations Environment Programme
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