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Implementation of a training course on safe transport, handling and storage of packaged dangerous goods in port...

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IMPLEMENTATION OF A TRAINING COURSE ON SAFE TRANSPORT, HANDLING AND STORAGE OF PACKAGED DANGEROUS GOODS IN PORT AREAS FOR THE PANAMANIAN NATIONAL PORT AUTHORITY

by
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The contents of this paper reflect my personal views and are not necessarily endorsed by the UNIVERSITY.

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Course on safe transport, handling and storage of packaged dangerous goods in port areas

INTRODUCTION

Background

Technically the port, is an strategic point for the success of maritime transportation, mainly because:

a. it is an interface between land transport, (railways, roads and inland waterways transportation) and sea transport.

b. it is the handling place for transshipment of cargoes.

c. it is the main storage place for intermediate storage of cargoes.

During the last two decades, ports in developing countries (like in the case of Panama), have faced two major influencing factors which have had a decisive impact on the safe transport, handling and storage of dangerous goods in ports.

Firstly: there have been radical changes and developments in maritime transport technologies, e.g. containerization and the specialization in shipping with many different types of ships, requiring special port handling facilities.

Secondly: there has been an enormous increase in the amount as well as in the different types of chemicals and other dangerous goods carried by sea.

Therefore in order to keep the ports in competitive operational conditions the port management had concentrated the port investments on those developments, or in other words there adaptation to this changes in technologies have absorved the bulk of port consideration leaving safety matters in transport to secondary interest.

Another kind of problems is the qualitatively lower general education and the lack in special training of port personnel at all levels.

Finally, in general terms the efforts at international levels for setting standards and minimum recommendations relating to educational and training in marine transportation had been concentrated mainly on the seafarers side and little or none had been done on port personnel.

Taking into account all the above problems and facts, port management must do something to keep the safe matters at adequate levels and pay more attention to the training of port personnel.

Thesis Objective

The objective of this thesis is to provide to all persons involved in the handling, storage and transport of packaged dangerous goods in ports, the necessary knowledge and the appreciation of measures which should be taken with respect to such cargoes in order to perform safe operations and to protect the personnel and the environment.

Abstract

Aspects covered include the hazards and characteristics of such cargoes, their recognition, necessary documentation, packing, marking, labelling and placarding, segregation and stowage; and the precautions to be taken for safe operations. Also included are emergency procedure in the event of accidents and first aid to injured personnel.

Those who successfully complete the course will be able to make proper decisions and use of the International

Maritime Dangerous Goods Code; The Emergency Procedures for Ships Carrying Dangerous Goods (Emergency Schedules (EmS); The Medical First Aid Guide for use in Accidents involving Dangerous Goods (IMO/WHO/ILO MFAG).

Abstract

In addition to follow the provisions contained in the Recommendations on the Safe Transport, Handling and Storage of Dangerous Goods in Port Areas; and the aspects of Pollution Prevention from Harmful Substances.

Abstract

Another objective of the course contained in this thesis is to create consiousness and awareness when dealing with such cargoes, and to improve communication between the port personnel and port users like shipping companies, agents and forwarders.

CHAPTER ONE

Justification for the Training Course

1.1 International recommendations on training for port personnel.

At the present there is no standard recommendations by any international organization regarding training aspects on the transport, handling and storage of dangerous goods in port areas, but some which have been already prepared for shipboard personnel are to some extent applicable to ports. In this connection the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, STCW,1978, and the annex 2 to this Convention given by Resolution A.537 (13), Recommendations on Training of Officers and Ratings Responsibles for Cargo Handling on Ships Carrying Dangerous and Hazardous Substances in Packaged Form, gives an excellent basic structure by which a training course for port personnel can be developed.

The direct provisions for such a training for port personnel is contained in the IMO Recommendations on Safe Transport, Handling and Storage of Dangerous Substances in Port Areas, in the section 3.4.4. training. They state as follows:"The Master of a ship and the Berth Operator within their respective areas of responsibility should ensure that personnel involved in the handling or storing of dangerous substances are properly trained commesurate with their respective duties". Unfortunately this provision only gives advise for the training required but does not give detail of the standard structure of subjects to be covered. It is therefore necessary to sett up such structure at an international level in order to minimize to some extent the occurrence of accidents and to reduce the damage which could be caused if an accident takes place when dealing with dangerous substances in ports.

1.2 Actual status of port operations with dangerous good.

Since the beginning of operations of the major ports in Panama, Balboa and Cristobal, the former Panama Canal Company, took care of all aspects regarding administration and operation, but since 1977 when the last treaty on the Panama Canal was signed between the Government of Panama and the Government of the United States of America, the Panamanian government took control of the operations and the National Port Authority was created. After ten years of operations still exists a lack of training structure for port personnel involved with handling of dangerous goods in packaged forms, eventhough there have been international expert missions mainly from IMO, which had given some recommendations regarding training aspects and safety of operations in ports with dangerous goods.

To recall some of the recommendations given by the expert mission, they are as follows:

- IMO Mision Report on Consultance for the Issueing a National Plan for the Technical Cooperation during the period 1981-85, main topics : Maritime Safety and Marine Pollution Prevention.(April 1980) by Jose Luis Guerola , IMO regional Adviser for Latin America on Maritime Safety. In this report one of the recommendations was given on training for port safety, specially on storage of dangerous goods in ports.

- IMO Inter Regional Consultance for Port Management and

Operation and Maritime Training (dangerous substances). The training aspect of dangerous goods was carried out by Capt. Karsten Brunings (September 1980). Among other recommendations on handling of dangerous substances in port, it was recommended that all management body and port personnel should attend a special training on port safety with the dangerous goods as one of the most important subjects. At long term, plans should be made in order to set out as mandatory the attendance of all port personnel and operators to a special training course only on dangerous goods. It was recommended that the course must be given in Spanish and in Panama by at least two experts, the duration of the course for at least two weeks and mandatory for new candidates to be selected.

- IMO Regional Consultant for Marine Pollution Prevention and Port Safety and Security, by Edmond R. Morris, June 1985. Among other recommendations, the segregation requirements for hazardous cargoes in pier 18 at Balboa terminal. The application of provisions of the IMDG Code in panamanian ports. To provide enough copies of the IMDG Code in different port offices and procure training of supervisory personnel in its use. The dangerous cargo manifest of each vessel utilizing Panamanian port facilities should be compared with the code for compliance.

- IMO Inter Regional Sectorial Support Consultant in Maritime Training. by consultant Eric Moat , January 1986. Among other recommendations, the training of port personnel who deals with planning and handling of dangerous goods in ports.

CHAPTER TWO

DEFINITION OF PERSONNEL TO BE TRAINED AND PEDAGOGICAL ASPECTS

2.1 General situation on education level of port personnel.

The present situation of transport safety in port requires considerable improvements. The safety in the transport of dangerous goods is only a part of the overall safety questions of a port, but a very important one and more emphasis on safety for dangerous goods would mean a considerable enhancement of the general safety situation.

The most effective way of improving certain conditions is provided by raising the general knowledge level of the subject, however, this would not better the prevailing condition of a port in the short term, in particular not as regards safety in such a specialized field as the transport of dangerous goods. Therefore special training of various kinds is needed, so that a quick improvement of the situation is guaranteed.

Since the lack of knowledge in this subject is spread over all port personnel and at all levels, adequate training would require different courses for the different levels of employees and also a different contents as to the different types and forms of dangerous goods, and that would involve considerable financial and organizational problems.

The depth of involvement of employees at different levels and from different port industries and the educational prerequisites of port personnel ask for the design of different types of training events, satisfying the appropriate aims and objectives.

Grouping the trainees into two different types or levels will make the training organization more practical. Top and senior management, middle management, and junior or safety personnel, who are directly and indirectly involved in the handling of dangerous goods, will comprise the advanced level. The other level is composed by the steevedores and personnel of the marine services, custom and others, this group comprises the basic level.

2.2 Entities involved

The port industry includes governmental, semi-governmental and private entities. The governmental and semi-governmental personnel includes: port personnel, security and safety personnel, fire brigate, medical centres personnel, custom, police and or coast guard. Private entities include: shipping companies, port users (carriers, forwarders, agents). It would not be wise to organize different courses for the different authorities or companies of one port, since joint training events for all port-related personnel promote the good co-operation, thus increasing the safety through better communication within the port.

2.3 Target group for this training (advanced level)

The training will be provided for personnel of port authority, shipping companies,and related entities at the following levels:

- Top and senior management who are responsible for a wide area, even they cannot be expected to know all technical details, they require sufficient consciousness of the involved dangers so that the introduction of appropriate and adequate safety measures are initiated. Their participation in the training should be repeated approximately every five years.
- Middle management, who make the day to day decisions of a practical nature which have a considerable bearing on safety. These employees may work in operational, administrative or other areas and are marginally involved in the handling of dangerous cargoes, thus dangerous goods are only part

their daily responsibilities, nevertheless an important part, and they not need to become technical experts but a kind of intensive awareness is essential. A regular repetition of the training of every three to four years is important in order to keep the middle management up to date.
- Junior and safety personnel, whose sole responsibility are dangerous cargoes have to receive the most extensive training because they have to supervise the enforcement of safety. The training need to be repeated every three years.

2.4 Pedagogical aspects

a. The education of adults:
The level of education and background of port personnel and port users at top and senior management, middle management, and junior and safety personnel are very different and their required level of knowledge for safety aspects with dangerous goods is also different. Also the fact that these people have to some extent been away from proper education process. Therefore the methods of lecturing for this training requires special attention and it is recommended that lectures should be given in a form of seminars with discussions and allowing for active participation of the trainnees some kind of typical exercises, examples and case studies must be used.

b. Entrance requirements
As mentioned before the level of education and background of this target group is very different, it is also difficult to ask for entrance requirements at least in this moment, but in the near future they must be established. As common basis for this target group,it could be possible to require that participants should have already participated or received a general course on fire-fighting, as well as a first aid

course.

c. Applied teaching methods

The transport, handling and storage of dangerous substances in port areas may be considered as a specialized and practical subject, and the majority of participants is already involved in the operations with such cargoes. Therefore the course may be conducted by lectures on general and basic principles, while the use of examples, discussions and on site-visits will make it more interesting to participants, thus the goals and objectives could be more easily achieved.

d. Teaching facilities and equipment.

It is highly recommended that the use of adequate classroom, with good ventilation; chairs and tables; blackboards; audio visual aids like overhead projectors and video recorders; sufficient sets of handouts for each participant; reference materials sufficient for work in groups, like chemical dictionaries and handbooks, as well as sets of the main codes and conventions related to dangerous goods.

e. Teaching staff requirements

The lecturers for the training should be at least two, with good academic background and experienced in the subject. One of them must posses a good background on chemistry while the other needs experience in practical operation and safety in port(s). If the selected staff do not feel confident to carry out the lecturing of the training course then they should attend a seminar in a foreign country where this kind of training is already well implemented.

f. Assessment or evaluation

It is the objective of the course to provide the participants with sufficient background to understand the recommendations given mainly in the IMDG Code, and to promote the awareness and conscientiousness needed for safety operation with dangerous goods. Therefore any assessment through the participants will evaluate the success of the course and not the participant's progress, Two types of assessment may be used, either : a. subjective (precise type) questions, for example

q. Explain the relationship between Solas Convention and the IMDG Code.

q. List and identify the classes of dangerous goods stablished in the IMDG Code. or b. objective (multiple choice type) questions.

It is advisable that the assessment should not be to long and considers only the most relevant parts of the subject.

g. Availability of reference books, documents and materials

The latest version of the following reference books must be available in sufficient numbers,

- The International Convention for the Safety of Life at Sea (Solas)1974, and amendments
- The International Convention for the Prevention of Pollution from Ships (Marpol) 1973, and amendments
- The International Maritime Dangerous Goods (IMDG) Code and amendments
- Brochure of approved labels
- The Medical First Aid Guide (MFAG) for Use in Accidents Involving Dangerous Goods, and any supplement
- The Emergency Procedures for Ships (Ems) Carrying Dangerous Goods - Group Emergency Schedules and any supplement
- The IMO/ILO Guidelines for Packing of cargo in Freight Containers or Vehicles and any supplement
- The Recommendations on the Safe Transport, Handling and

Storage of Dangerous Substances in Port Areas and any supplement

- The ILO Code of Practice on Safety and Health in Dock Work
- The International Convention on Standards on Training, Certification and Watchkeeping for Seafarers (STCW) 1978
- IMO Assembly Resolution A. 573 (13) on Training of Officers and Ratings Responsibles for Cargo Handling on Ships Carrying Dangerous and Hazardous Substances in Solid Form in Bulk or in Packaged Form.
- Recommendations for Port Designers and Port Operators on Dangerous Goods in Ports. By The Permanent International Association of Navigation Congresses
- Various handbook and dictionaries of chemistry
- The United Nations Reports of the Committee of Experts on the Transport of Dangerous Goods (the Orange Book)

h. General remarks

The suggested course should be given in a maximum of 10 days, and should not be more than 60 hours of 45 minutes in total, six hours per day are recommended. During a lecture day, two breaks are recommended and within the possibilities coffee and snacks should be provided to participants free of charge.

The number of participants should be limitated to a maximum of 20 per course. The attendance is a very important element and only those who have an 80% of attendance must be awarded with the certificate which should be issued on behalf of the National Port Authority.

CHAPTER 3

COURSE ON SAFE TRANSPORT, HANDLING AND STORAGE OF PACKAGED DANGEROUS GOODS IN PORT AREAS

3.1 INTRODUCTION:

Cargoes which are commonly transported by sea include a wide variety of types and some possess a danger to human being, living creatures and to the environment, due to their individual nature and properties. The hazards coming from cargoes are very diverse and may include: explosion, flammability, toxicity, corrosion, radiation, suffocation, support for combustion, and others. All these hazards may derive from the property of a substance itself, may be the result of a contact between two or more different substances, or may come under special circumstances only, and in general the hazards are of a chemical, physical or biological nature.

For the purpose of the proceeding course, we will discuse the safe transport, handling and storage in port areas of such substances having a dangerous nature, which are packaged and transported in general cargo, container, Ro-Ro and on barge ships; so the called packaged dangerous goods.

For a fairly precise and formal definition of what are hazardous substances, we may say:
"materials defined to be hazardous substances are those which have been categorized into a number of classes as laid down by the United Nations Committee of Experts on the Transport of Dangerous Goods".

This Committee of Experts established in 1956 a complete report with minimum technical requirements for the transport of dangerous goods by all modes, this report usually known as the United Nations Recommendations (orange Book) offered a scientific classification and a general framework from which regulations could be adapted or developed. The classification of dangerous goods into the classee 1 to 9 was based on the type of risk involved and not by the order of the degree or magnitude of the hazard.

As far as Maritime Transport was concerned, the International Maritime Organization (IMO, a specialized agency of the United Nations and internationally aimed for the safety at sea, incorporated the recommendations as applicable into its main instrument "The International Convention for the Safety of life at sea (SOLAS)."

But for practical safety application on board ships and for handling such cargoes in ports, a more detailed definition of the classes is needed as well as to provide general guidance as to which goods are dangerous and as to the class in which, according to their characteristic they should be included.

The international Maritime Organization (IMO) through its Maritime Safety Committee, established a Working Group on the Carriage of Dangerous Goods. In May 1961 the group met for the first time in order to set and prepare a draft for "unified international maritime code" as envisaged by the 1960 SOLAS Conference. After many sessions, good progress was made in preparing the draft code and the resulting document became known as the International Maritime Dangerous Goods Code (IMDG), after approval by Maritime Safety Committee it was adopted by the IMO Assembly in 1965 under its Resolution A.81(IV).

Although designed primary for mariners, the provisions of the IMDG Code affects the industries, handling and transport services from manufacturers to consumers.

Manufacturers, packers, shipers and forwarders are guided by its provisions on terminology, packing, identification and labelling. Feeder services, such as road, rail and harbour craft are guided by its provisions in respect of classification, identification and labelling. Port Authorities consults the Code to segregate dangerous substances in loading, discharge and storage areas.

Over the last two decades, the movement of dangerous substances by sea has increased considerably, and today estimation accounts for more than 50 % of the total tonnage transported and handled.

Even if excluding those cargoes transported in bulk, such as solid or liquid chemicals and other materials, gases and products for and of the oil industry a significant volume of hazardous cargoes is being moved, It has been estimated for example, that dangerous goods in containers, in conventional dry cargo (break bulk), and in Ro-Ro vessels account for up to 10% of the total tonnage moved by those methods.

As the world becomes increasingly industrialized and as industry itself becomes ever more complex, so the transport of dangerous substances will continue to rise and the list of cargoes transported will grow. Therefore it is essential if shipping is to maintain and improve its safety record, that such cargoes are handled with greatest possible care.

No matter how closely regulations are followed, there is always the danger that an incident may lead to an emergency, and in response to a request from the Maritime Safety Committee that an advise on emergency procedures should be made available to those concerned with the carriage of dangerous goods, the IMO's Sub-Committee on the Carriage of Dangerous Goods prepared group emergency schedules for all substances and articles covered by the IMDG Code, and these are contained in the IMO publication Emergency Procedures for Ships Carrying Dangerous Goods, which is a supplement to the IMDG Code.

The IMDG Code, the IMO Emergency Procedures for Ships Carrying Dangerous Goods (Emergency Schedules -EMS) will be discussed in details in the proceeding lectures as well as other relevant and applicable International Regulations and Recommendations to packaged dangerous goods, prepared by the IMO and some in conjunction with other International Organizations like the World Health Organization (WHO), and the International Labour Organization (ILO), e.g. the IMO/WHO/ILO Medical First Aid Guide for use in accidents involving Dangerous Goods (MFAG); IMO Recommensndations on Safe Transport, Handling and Storage of Dangerous Substances in Port Areas; the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) specially Annex III. The recommendations and regulations contained in these International documents will lead our discussion, in order to perform the cargo operation in a safe manner, therefore two main objectives may be achieved: to reduce the unnecessary exposure so, to avoid injuries to the personnel and damage to the environment; and secondly if operations with dangerous goods are safe and in accordance with the International regulations, the port will be considered to be at these recommended standards; at the end both will be beneficiated, the personnel and the National Port Authority.

As mentioned before, there is always a probability that an incident with dangerous goods cargo may occur, but these probabilities may be reduced to some extend if the personnel related with, are well aware of the danger when dealing with such cargoes. An incident may be caused by fortuitous circumstances affecting the physical states of a packaged substance but while it is the port, dangerous goods are moved, stored and handled; therefore generally it is in the port that an human error may cause an incident well by lack of knowledge, inadequate handling procedure or by lack of safety precautions.

Providing an adequate training program to port personnel, the possibilities of an incident by human error may be largely reduced. So the objective of this training is to create and strength on you the necessary conscientiousness which is required for safe handling of dangerous goods in ports, also will be discussed the procedures and safety aspects that must be considered when dealing in the transport of such cargoes.

For port personnel the training requirement for packaged dangerous goods is indirectly contained in the revised version of the IMO Recommendation on the Safe Transport, Handling and Storage of Dangerous Substances in Port Areas (1980) and in its new ammended version of 1983.

The following three examples of incidents with dangerous goods cargo refer to truck drivers who in general are poorly trained (specially with dangerous goods) and probably would not be difficult to find similar incident examples in port areas while handling such cargoes. In order to preclude such incidents in the future, simple training courses to those operators would take care of the ignorance which had a hand in the development and severity of each of these scenarios.

Example 1

This incident involved a driver who must often carried general cargo and who was ocassionally called on to take what to him were mysterious packaged with diamond-shaped labels in his load; he had received no training in relation to hazardous substances and thus he did not recognise the significance of the labels, nor did he recognise that the container of a particular insecticide he was to deliver one sunny day was defective. The leaking liquid gave off a pungent vapour which he tolerated while he carried out his other deliveries and until he in fact collapsed at the wheel of the truck. This man later recovered and his highly significant explanation was that for him, time was money and he could not stop to investigate what he termed a bad smell in the back of the truck nor could he really take time to inspect labels or read documentation which accompanied his loads. Even rudimentary training in the recognition of warning labels for hazardous substances would however have alerted him to the fact that his load that day was somewhat out of the ordinary and required extra care.

Example 2

A general carrier, city based with much rural business, was called on one day to transport a mixed load consisting mostly of his normal stock feed/hardware/farm implement type goods but including on this ocassion a quantity of liquid and solid chemicals for the use by the science department of a secondary school. He was told the broad nature of this particular package, which incidentally had all the various chemicals packed together, and he was somewhat alarmed at having what he rather graphically described as "witches brew", as part of his load. The well-labelled materials and the nature of the packing and contents which included several large glass ampoules of concentrated nitric acid were however accepted without question by the driver who, probably had no training in any aspect of hazardous substances transportation.

The driver thought that "out of sight/out of mind" would be a good precept to follow with regard to this particular package so he placed it upon a bed of empty sacks in one corner of the truck tray and placed other sacks over it. At later stage of his deliveries a container was inadvertently dropped on the sacks and several of the chemical containers were broken including, not surprisingly, the nitric acid ampoules. A later fortuitous refuelling stop at which time the load was checked revealed a smoking mess of rapidly charming sacks and "fumming chemical soup" which the driver was able to control with his on-board extinguisher until emergency services arrived.

An adequately trained man would rarely not have accepted a package in such a condition and, in any case, knowing the nature of its contents, he would have stowed it with much more consideration for the possible hazards and to ensure the safe carriage of this load.

Example 3

Some inadequately secured drums of a solvent material which was both flammable and had highly irritant properties had fallen from a truck. The driver was aware of the incident and he stopped and attempted to retrieve the drums, most of which had been damaged and were leaking. His intention , he said later, was to clean up the mess without alerting anyone to the spillage since bad publicity about the incidentt could lead, he beleived, to his dismissal. The irritant substance burned his hands and he required hospital treatment although he suffered no lasting ill-effects. This man had not received training in matters relating to hazardous substances, eventhough he was quite often called on to transport such materials in his load. He knew, at least vaguely, that the particular substance in this case was flammable but he had no idea of its toxicity, eventhough thorough documentation was included with the load.

During recent years there have been comparatively few major accidents on ships involving dangerous goods, with the exception of accidents involving oil tankers. Nevertheless, dangerous goods have been involved in some of the worst disasters in shipping history and small accidents still occur frequently. In virtually every case the disaster could have been avoided or its effects mitigated if the procedures now incorporated in the IMDG Code and on the IMO Publications had been observed. The examples on the annex will reflect the impact of the hazards of dangerous goods on the most catastrophic incidents of the century, involving mishandlind or misuse of dangerous goods, ignorance of their potential hazards or inadequate training of the crew manning the ships involved or the shore personnel in the ports where the accidents occured.

ANNEX TO THE INTRODUCTION

Halifax, 1917

Explosives are normally treated with great care on board ships, but by the end of 1917 with the world war at its height, the 3,000 tons freighter "Mont Blanc" was heavily overloaded with more than 2,600 tons of explosives when she entered Halifax Harbour on her way to Europe. Following a series of navigational errors, she collided with another ship and caught fire.

Shortly afterwards the ship exploded in the biggests man-made explosion until the advent of the atomic bomb. The blast devasted the centre of the port; as many as 3,000 people were killed; 9,000 were injured and 6,000 houses were compeletely destroyed.

Bombay, 1944

The freighter "Jala Padmu" was carrying 1,400 tons of explosives when she entered Bombay Harbour, but her cargo also included a large quantity of cotton which had been taken on board in Karachi. Cotton sounds innocuous enough, but as the IMDG Code points out "it is liable to spontaneous combustion, especially where contaminated with oil", and several drums of oil had also been loaded on to the ship and were separated from the cotton only by a badly-fitting sheet of tarpaulin.

Fire broke out, perhaps through a carelessly dropped cigarette, or just as likely, through spontaneous combustion. The danger was not immediately realized there having been several similar fires in the past and the previous months and the fire-fighting response was slow to materialize and poorly executed. There were two explosions, as a result of which 1,200 people were killed and 15 ships destroyed or damaged.

The court of inquiry at that time decided that steam should have been used to fight the fire, but the use of steam as fire-fighting as agent nowadays is frowned upon. The actual Emergency Procedures state that when substances, such as contaminated cotton, catch fire the correct action is "batten down" and use ship's fixed fire-fighting installations. Otherwise adapt action as for "on deck" (which is to use water jets).

Texas City, 1947 ✓

Ammonium nitrate a raw material for the production of various explosives is also widely used as an agricultural fertilizer. The freighter "Grandcamp" in April 1947, was being loaded with ammonium nitrate in the port of Texas City. The longshoremen noticed that a fire had started in one of the holds and asked for water to put it out. The only supply available consisted of two jugs of drinking water and two gallon fire extinguisher. Naturally this failed to quell the blaze but the ship's master refused to allow a hose to be used on the grounds that the water might damage the cargo. As a result the fire spread and by the time the fire department had been called it was too late; less that an hour later the ship exploded with such a force that two light planes flying overhead were destroyed by the blast. The explosion also blew the hatch covers off another ship which was moored 200 meters away and was also carrying ammonium nitrate and caught fire and subsequently blew up.

A total of 468 people were killed, mostly as a result of the first explosion.

The subsequent inquiry exposed numerous deficiencies. The cargo on board the "Grandcamp" was labelled 'fertilizer compound' which had a lower freight rate than ammonium nitrate and no danger labels were attached. As a result the longshoremen were unaware of the danger and failed to take the normal precautions such as banning smoking.

The fire fighting methods used were also wrong, attemps were made to extinguish the fire with steam which probably made things worse. The IMO Emerging Procedures now advise that a fire involving ammonium nitrate should be fought with large ammounts of water and that no steam or inert gases should be used.

<u>Brest, 1947</u>

Ammonium nitrate was involved in another disaster three months after the Texas City explosion. This time the ship involved was the "Ocean Liberty" which caught fire in the harbour of Brest (France).

The authorities had learned enough from the American incident to get the ship out of the port as soon as possible but fire-fighting methods failed just as dramatically, again steam was used and the firemen were not equipped with breathing apparatus. Their attemps to remove the hatch covers and pump water into the ship were made to late and the ship exploded, killing 21 people.

Bahrain, 1957

Toe puff is a mixture of cotton or wool impregnated with cellulose and is used to make caps for shoes. But although the finished product may be safe, toe puffs can be very dangerous in the raw state. The IMDG Code advises that the substance "ignites readily". When involved in a fire, toxic fumes are evolved. In enclosed compartments, these fumes may form an explosive mixture with air".

That is exactly what happened on board the freighter "Seistan" as it approached Bahrain. Fire broke out and to make matters worse the toe puffs were stowed beneath the ship's magazine. Attemps were made to smother the fire with steam, to no avail. The ship blew up, killing 57 people.

The correct procedure, according to IMDG Code is to deluge the fire with water. The code also advises that self-contained breathing apparatus and protective clothing should be worn.

Los Alfarques, 1978 ✓

Liquefied gases have become a very important source of energy during the last two decades and the accident record of the ships which carry them has been extremely good. There has been no major incident at sea, but there have been enough on land to show just how dangerous such substances are if not correctly handled.

In July 1978, a road tanker transporting liquefied propylene sprang a leak as it passed a camp site at Los Alfraques in Spain. It was the peak of the summer tourist season and the camp site was crowded.

The leak resulted in some of the liquefied gas escaping and pouring rapidly across the camp site in a huge cloud, which immediately ignited possibly as a result of coming into contact with flames from one of the many camp stoves in use at that time.

The explosion resulted in a fireball some 200 metres in diameter which was so intense that more than 1500 people in the camp site were burnt to death. The detonation spread for 400 metres in all directions.

Yet the lorry carried only 43 cubic metres of liquefied gas. Some ships carry 125,000 cubic metres or even more.

Port Kelang, 1980

Three people were killed and more than 12 million U.S. dollars worth of damage was caused by a fire and series of explosions in this Malaysan Port.

The fire began in a warehouse and although fire engines arrived within ten minutes after the alarm was given, the flames had taken such a firm grip on the building that the firemen were unable to control the blaze. Their efforts were hampered by the fact that cargo in the warehouse was piled right up to the roof: They could not, as a result, get to the root of the fire.

A series of explosions occured about 1 1/2 hours later, the third of which was so great that burning debris led to fires starting elsewhere in the port, and at the same time knocked out most of the fire engines. It is believed that the explosion may have been caused by empty gas cylinders which were heated in the fire to such an extent that they blew up. The fire raged for two days, destroyed four warehouses completely and severely damaged virtually every other building in the port.

3.2 APPLIED SCIENCE

In order to gain as much benefit as possible and for better understanding from the following lectures it is necessary a few explanations or states definitions of some technical and scientific terminology used in the IMDG Code and in the other recommendations.

It will not be a formal course on physics and chemistry but of a refreshing character. The contents and extends will be confined and related to the classes, according to the physical and chemical properties; potential hazards and on the effects on health.

3.2.1 Physical and Chemical Properties

Before going into more complicated terminologies it is needed to recall some very basic knowledge related to the study of physic and chemistry, only as a quick reference. As the world is made up of matter, it is essential to define What is matter?.

- Matter is anything that occupies space and possesses mass. In setting down the previous definition a careful distinction should be made between the terms mass and weight, eventhough we generally use them as if they were interchangeable.

- Mass is the quantity of matter in a particular body, also the mass of a body is a measure of its resistance to a change in velocity. A ping-pong ball moving at 20 km/h for example is easily deflected by a soft breeze, while a cement brick is not. Quite clearly the mass of the cement brick is considerably greater than that of the ping-pong ball.

- The term weight of a body refers to the gravitational force by which it is attracted to the earth.

- The word substance is used to mean the material of which an object is composed. For example, an ice cube is composed of the substance water, complicated objects of course, can be composed of many substances.

- The simplest forms of matter that can exist are Elements, they serve as the building blocks for all of the more complex substances, from the table salt to extremely complex proteins . All substances are composed of a limited set of elements.

- Elements combine to form a Compound, which is characterized by having its constituent elements always present in the same proportions. For example water is composed of two elements, hydrogen and oxygen. All samples of pure water contain these two elements in the proportion of one part by weight hydrogen to eight parts by weight oxygen.

- Mixtures differ from elements and compounds in that they may be of variable composition. A solution of sodium chloride (table salt) in water is a mixture of two substances, and we know that by dissolving varying quantities of salt in water we can obtain solutions with a wide range of composition.

Mixtures can be described as being either homogeneous or heterogeneous

- A homogeneous mixture is called a solution and has uniform properties throughout. If we sample any portion of a sodium chloride solution we would find that it has the same properties (e.g. composition) as any other portion of the solution.

- A heterogeneous mixture such as oil and water, is not uniform, if we sample one portion of the mixture, it would have the properties of water, while some other part of the mixture would have the properties of the oil.

In describing the properties of substances, its may be classified into physical and chemical properties.

-. Physical Properties: it specifies the property without reference to any other substance, e.g. melting point, boiling point, density. It also refers to that properties that can be observed without changing the composition of the substance.

- Chemical properties: states some interaction between substances. Also are those properties that can be observed only when substances undergoes a change in composition. These properties include the fact that iron rusts, that coal and gasoline burns in air, that chlorine reacts violently with sodium (the previous properties are exampled of chemical reactions).

In stablishing the properties of substances we shall observe certain changes or conversions from one form to another in these subatances. These changes are divided into physical and chemical changes.

- Physical changes: are those changes that can be observed without a change in the composition of the substance taking place, e.g. the changes in state of water from ice (solid), to liquid, to vapour (gas). The difference between a property and a change is that property distinguishes one substance from another. Whereas a change is a conversion from one form of substance to another.

- Chemical changes: are those changes that can be observed only when a change in the composition of the substance is occuring, say a new substance is formed. For example chlorine reacts violently with sodium. The chage that occurs and that determines chemical properties is a chemical change. Chlorine (Cl) + sodium (Na)   sodium choride (Na Cl) (table salt).

- Chemical reactions: as stated previously is a chemical change or transformation by the interaction of molecules, ions, or radicals among two substances to form one or more new substance. Simplest chemical reactions may be by:

direct combination: in which a new substance is formed when two different substances combine to form a third.

descomposition: one substance is changed into simple parts; descomposition of a compound into elements; descomposition of a compound into simplest compounds.

replacement: in which one element takes the place of another that is in the compound.

In some chemical reactions, heat is necessary to maintain them, it is called endothermic; and when the reaction evolve heat it is called exothermic.

Common types of reactions are: oxidation, reduction, ionization, combustion, hydrolisis (reaction with water), polymerization, condensation, corrosion.

- <u>Density</u>: another property of matter is that a given volume of different substances may have different masses, this property is measured by the density, which is defined as the mass of a substance occupying a unit volume or, "denstity = mass/vol.". For instance certain substances are heavier than other eventhough the volumes are the same. For example some amount of sea water is heavier than fresh water. The units must be always given.

- Relative density: of a substance is the density of the substance divided by the density of some substance taken as standard. For expressing the relative density of a substance, water at 4 degrees centigrades is the standard unit with a density of 1 X 10 kg/m or 1.00 g/ml.

$$\text{Relative density} = \frac{\text{density of substance}}{\text{density of water at } 4^{o}\text{ C.}}$$

In calculating the relative density of a substance, both densities must be expressed in the same units, therefore relative density has no units.

If the relative density of a liquid is greater than 1, water will float on top of it and may be used for fire extinguishing purposes (cooling and smothering effect), if applied carefully and with spray nozzle. On the contrary, if relative density is smaller than 1.0, as in the case for most hydrocarbons, then the application of water will have a worsening effect, since it may contribute to the spreading of the burning liquid.

- Evaporation: is the actual escape of molecules from the surface of the substance to form a vapour in the surroundings space above the surface of the substance.

The easy escape of a molecule from the surface of a liquid is related to the strength of the attractive forces between the molecules in the liquid. For example, gasoline and alcohol evaporate faster than water. As the temperature increases, molecules escape more readily, because more will have sufficient energy to leave the surface and overcome the attractive forces in the substance. In addition, as surface area increases, the rate of escape increases, since more surface is exposed for evaporation to occur.

- Condensation: is the reverse of evaporation. The vapour. molecules coalesce to form the liquid, and the attractive forces between molecules increase in the formation of the liquid heat energy is evolved in this process.

- Vapour density: of a substance is the vapour density of the substance divided by the air density as a standard unit. If the vapour density of substance is smaller than 1.0, the vapour will rise, and depending on weather conditions, disperse in the air more or less quickly. If, however, the vapour density is greater than 1.0, the vapour will gather near the ground or deck and in structural pocket of a building or ship and may even travel down stairs and alleways. It will not disperse quickly and may retain its fire, toxic and or suffocating danger for a long time, e.g. vapours given off by hydrocarbons are heavier than air.

- Water solubility: if a substance dissolves partly or fully in water, the carefull application of water in cases of a fire will result in a substance/water mixture, with water not only having cooling effects, but also with a resulting mixture whose flashpoint (and fire point) will raised with the increasing percentage by volume of water. In such a case the careful application of water may eventually lead to a flashpoint temperature, where not enough vapour is produced to keep the fire burning. On the other side if the substance is not soluble in water, the application of water may have a worsening effect.

- <u>Flashpoint</u>: for flammable liquids, say liquids or mixture of liquids, or liquids containing solids in solutions of suspensions (e.g. paints, varnishes, lacquers, etc.), the flashpoint has been the main criterion for determining the degree of hazards, it is defined as: "the lowest temperature of the liquid at which its vapour form an ignitable mixture with air". It should not be confused with the term ignition temperature.

· The flashpoit gives a measure of the risk of formation of explosive or ignitable mixtures when the liquid escaped from its packing. A flammable liquid does not burn by itself, it is the vapour which is given off by a liquid that acts as a fuel in combustion. Enough vapour for combustion is given off when the liquid temperature reaches the flashpoint. As a rule of thumb, we can say that:

FP > ambient temperature	no sufficient vapour,
FP < ambient temperature	sufficient vapour.

However these rules do not include the possibilities of a liquid being heated up beyond its flashpoint by other sources such as being exposed to the sun's rays, being stowed near hot bulkheads, getting involved in a fire, etc. The flashpoint is not an exact physical constant for a given liquid. It depends to some extent on the construction of the test apparatus used and on the testing procedures. Several apparatus are in use, and all operate on the same principle: a specific quantity of the liquid is introduced into a receptacle at a temperature well below the flashpoint to be expected, then slowly heated; periodically a small flame is brought near to the surface of the liquid and the flashpoint is the lowest temperature at wich a flash is observed.

The test methods can be divided into two major groups, depending on the use in a apparatus of an open receptacle (open cup method, o.c.) or a close one which is only opened to admit the flame (close cup method, c.c.). Since the open cup technique allows some vapour to diffuse into the air, the flashpoint as determined by the o.c. method is usually few degrees higher than in a c.c. flashpoint. Therefore when flashpoint of flammable liquids are given, they should be followed by a specification with regard to the technique used.

Substances which have a flashpoint above 61 º C (141º F) c.c. are not considered to be dangerous by virtue of their fire hazard.

The subdivision of class 3 in the IMDG Code takes into account the flashpoint as follows:

class 3.1: low flashpoint group of liquids having a flashpoint below -18 º C c.c. (with very great danger)

class 3.2: intermediate flashpoint group of liquids having a flashpoint of -18 º C (0 º F) up to, but not including 23 º C (73 º F) c.c. (with great danger)

class 3.3: High flashpoint group of liquids having a flashpoint of 23 º C (73 º F) up to, and including 61 º C (141 º F) c.c.

Some flashpoints

Gasoline	- 27 o C to 50 o C c.c.
Benzene	- 11 o C c.c.
Naphta	0 o C to 40 o C c.c.
Kerosene	40 o C to 55 o C c.c.
Lubricating oils	around 200 o C c.c. (thus not flammable)

- Ignition temperature

Is the temperature to which an explosive vapour air mixture must be heated to cause actual flame.

- Fammable range

Flames or combustion can only occur in mixtures (flammable vapour/air) within a certain composition range bounded by limits of flammability, in other words it means that sufficient oxygen must be present to support the combustion and that the mixture composition lies within a range of gas in air concentration known as flammable range or flammability limits. The limits of flammable range are expressed as percentage by volume of vapour in air.

Normal air is composed of:
78 % nitrogen, 21 % oxygen and 1 % rare gases. The more presence of axygen in a combustion the more vigorously a fire will burn, and as the contents of oxygen decreases in a mixture then the combustion will be less rigorous. At a level of about 14 to 12 % by volume oxygen in the mixture the fire will suffocate. About 11 % by volume oxygen in a composition is generally taken to be the point at which no mixture can burn.

If there is not enough vapour present to support the combustion then the vapour/air mixture is too "lean", and if there is too much vapour present in the mixture then it is too "rich". The limits of flammable range of a mixture are called "lower flammable limit (LFL)" or "lower explosion limit (LEL)" and "upper flammable limit (UFL)" or "upper explosion limit (UEL)".

Each flammable liquid and gases has its specific flammable range, and there are enormous variation between different fuels, thus, for acetylene (C_2H_2) the range of flammability in air is LFL = 2.5 % to UFL = 80 % , while for propane (C_3H_8) the range is LFL = 2.2% to UFL = 9.5 % .

It is quite obvious that a substance with a wide flammable range like the acetylene presents a greater hazard than one with a very narrow range.

Examples for flammable ranges of flammable gases and flammable vapours, (at normal pressure and room temperature)

Reactants	LFL (LEL) VOL %	UFL (UEL) VOL %
Hydrogen H_2	4.0	76
Carbon monoxide CO	12.5	74
Methane CH_4	4.6	14.2
Acetylene C_2H_2	2.5	80
Ethylene C_2H_4	2.7	34
Ethane C_2H_6	3.5	15.1
Propane C_3H_8	2.4	8.5
Butane C_4H_{10}	1.9	8.5
Benzene C_6H_6	1.5	7.5

Explosion limits are determined in a closed vessel of sufficient size -in general >1 litre, with an ignition source located in the centre. But it must be kept in mind that various external influences can affect the fammable limits, and also that the ignition energy used has an important influence on the width of the flammable range, for example the flammable limits of methane in air are LFL 4.6% to UFL 14.2 % with a flammable range of 9.6 % but when the ignition energy is largely increased the limits move from 3.6 to 17.5 % with a flammable range of 13.9 %. Also the relative humidity of common gas/air mixture has a perceptible influence on the width of the flammable range with widest range observed in extremely dry mixtures.

The flammable limits and flammable range of flammable gases make clear that this data are by no means physical constant.

They depend to a high degree on the experimental method used for their determination. However, it is customary to deterrmine flammable limits at room temperature and normal pressure, using as ignition source a spark gap to produce the ignition energy. Therefore, relying on the non-flammability of a rich mixture (that is one above the UFL) would mean to play with fire. To be on the safe side, one will always have to stay well below the LFL.

3.2.2 Potential Hazards

As mentioned before the classification of substances into the classes 1 to 9 as laid down by the United Nations Committee of Experts on the Transport of Dangerous Goods, and the detailed classification for maritime transportation contained in the IMDG Code, was based on the type of risk involved and not by the order of the degree or magnitude of the hazard. A glance to the 9 classes reflect that the potential risk mainly are: explosion, flammability, spontaneous combustion, oxidation, reaction with water, toxicity, radiation, and corrosion.

- Combustion

It is the phenomenon wich arise from the interaction of chemical and physical processes. It commences with the chemical occurence of a self supporting exothermic reaction initiated by a source of ignition, in general it produces more energy per unit of time that it consumes.

The physical processes involved in combustion are principally those which involve transport of matter and transport of energy like: the conduction of heat, the difussion of chemical species, and the bulk flow of gas; all these follow from the release of chemical energy in an exothermic reaction.

In combustion, the chemical reaction normally involves two components, one of which is termed the fuel and the other the oxidant. But combustion takes place only according to certain parameters depending of the substance, like the ratio of mixture say flammable vapour/air, ignition temperature and pressure.

The combustion phenomenon may derive in general two different effects, flames and or explosion, depending mainly on the physical properties of both the reactants and the container and on the rate of energy released by the chemical reaction.

The phenomena described are not necessarily restricted to gaseous media. Indeed most of them can occur equally well in both liquids and solids and also in dispersions of one substance in another (mist and dust clouds), however, it is only the gases (vapours) that burn, not the solid or liquid substance, itself.

- Flames: or slow combustion , occur where the pre mixed components in gaseous form, and within the limits of flammability for the particular substance, are heated slowly, provided the temperature does not rise above a certain value, the heat produced by the reaction will be dissipated at the vessel walls, or into the surroundings. A steady state is thus established and reaction proceeds smoothly to completion.

Combustion not only occurs uniformily throughout the volume of the containing vessel, but ignition may occurs in a localized region, and a zone of combustion reation can propagate through the reactant mixture. As in the case of flammable gases contained in a tube and if the reaction is initiated at one end, for example, by a spark then a combustion wave will travel along the tube, such a wave is described as a flame in which the reaction is luminous.

If the reactant gas is forced to travel at the appropriate velocity towards the flame front, the flame should come to a stand still, like in the case of burners. In a propagating combustion wave, reaction is induced in the layer of gas approaching the flame front and two possible mechanisms can be visualized: thermal combustion, in which heat conduction from the hot, and burnt gas cause reactions to commence; while for branched-chain mechanism, diffusion of active intermediated from the reaction zone intiates combustion.

Substances that by its chemical and physical characteristics possesses a flammability hazard are classified in the IMDG Code, mainly according to its physical state as: gases, liquids and solids. In general substances with a flammability hazard are classified in:

class 2.1: flammable gases, which is a sub-division of class 2 (gases: compressed, liquified or disolved under pressure)

class 3 (flammble liquids)
Also including mixtures of liquids, or liquids containing solids in solution or suspension like: paints, varnishes, lacquers, etc., which in general are able to give off a flammmable vapour at of below 61 o C.

class 4.1 (flammable solids) which are substances or solids possessing the properties of being easily ignited by external sources, such as sparks and flames, and of being readily combustible or of being liable to cause or contruibute to fire through friction.

While class 4.1 is specific to flammable solids whithin the class 4, the other two sub-divisions 4.2 and 4.3 are also liable to combustion but their risk are considered separately according to their specific characteristics.

Substances in class 5.2 -organic peroxides- because being oxidizing agents, or give off oxygen when involved in a fire, so most of them are also combustible.

-Explosion:

Beyond a certain critical limit, which depends on the physical properties of both the reactants and the container, the rate of energy released by chemical reaction may exceed the rate at which it can be lost from the vessel by the various processes of heat transfer. If it occurs, the temperature rises, and, in consequence, the rate of reaction and hence the rate of energy release both increase even further. The reaction rate thus accelerates indefinetely (so long as the supply of reactants is adequate) leading to an explosion. Strictly speaking the term explosion refers to the violent increase in pressure which must accompany the rapid self-acceleration of the reaction. The state at which self-acceleration occurs is termed ignition and the corresponding temperature, self-ignition temperature. Self-acceleration occurs because rates of reaction vary exponentially with temperature, whilst heat transfer by conduction depends linearly on temperature.

The velocities of combustion wave are limited by transport processes, for example, heat conduction and difussion, cannot exceed the speed of sound in the reactant gas mixture. However, it is often found that a propagating combustion wave undergoes a transition to a quite defferent type of wave travelling at a much higher velocity, well above the sound speed. In this case "detonation wave" reaction is initiated by a supersonic compression or "shock wave" travelling through the reactants. The energy released by chemical reaction behind the shock front provides the driving force for the shock wave.

The destructive power of explosives are classified in two orders: "high order explosives", where the maximum amount of energy is released in the minimum period of time, the physical processes involved is characteristic of a detonation rather than a slower combustion wave. "Low order explosives" which find a particular application as propellants are those in which deflagration occurs and energy is released much more slowly.

Explosives substances are classified in the IMDG Code as class 1, providing the prohibition of transporting explosives substances which are unduly sensitive or so reactive as to be subject to spontaneous reaction. The Code define an explosive substance as: "a solid or liquid substance (or a mixture of substances) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings". Included are pyrotechnic substances even when they do not evolve gases. A pyrotechnic substance is "a substance or a mixture of substances designed to produce an effect by heat, light, sound, gas or smoke or a combination of these as the result of non-detonative self-sustaining exothermic chemical reactions". And finally an explosive article is "an article containing one or more explosives substances".

It is important to notice that class 1 -is unique in that the type of packaging frequently has a decisive effect on the hazard and therefore on the assignment to a particular division. Where multiple hazard classifications have been assigned, they are listed on the individual schedule. This class is divided into five divisions which present different hazards, as follows:
Division 1.1 substances and articles which have a mass explosion hazard (a mass explosion is one which affects virtually the entire load practically instantaneously).

Division 1.2 Substances and articles which have a projection hazard but not a mass explosion hazard.

Division 1.3 Substances and articles which have a fire hazard and either a minor blast hazard or minor projection hazard or both, but not a mass explosion hazard.

Division 1.4 Substances and articles which present no significant hazard.

Division 1.5 Very insensitive substances which have a mass explosion hazard.

Explosives are among the most dangerous of all goods carried by sea and the precautions outlined in this class of the code are particular stringent. Goods in this class are also assigned to various "Stowage categories" from category I (ordinary), up to category IV (for special items). This will be considered later. Although the safety of goods in class 1 can best assured by stowing them separately, this can rarely be done in practice. Therefore to ensure that they are stowed as safely as possible, the goods in the class are arranged in twelve "compatibility groups". These are lettered from A to L and S, ommiting letter I. This also will be discussed later.

Substances in class 5.1 -oxidizing substances- and 5.2 -organic peroxides- may also be sensitive to impact, function or a rise in temperature and some may react vigorously with moisture, so increasing the risk of fire. Mixtures of these substances with organic and combustible materials are easily ignited and may burn with explosive force.

- Toxicity

The transport, handling and storage of some substances may have various kinds of toxic (or poisonous) effects on the human organism and on the environmental flora and fauna. Naturally goods with toxic properties as those classified in class 6: (toxic or poisonous) and infecions substances-, may have more effects in this respect because they react chemically with certain parts of the body of living creatures and with plants. Class 6 is sub-divided further in:

class 6.1 Toxic substances- "which are substances liable either to cause death or serious injury or to harm human health if swallowed or inhaled. or by skin contact".

class 6.2 -infectious substances- "these are substances containing viable micro-organisms or their toxins which are known, or supected to cause disease in animals or humans". Details of kinds of toxic effects of dangerous goods on human being will be given in other topic.

class 2.3 Poisonous gases- "it comprises gases in compressed, liquefied or dissolved under pressure" forms.
Substances in other classes which its main criteria for classification are different to toxicity, are also under certain circumstances be liable to produce toxic effects, for example: class 1. -substances containig both explosives and chemical agents- which can evolve tear-producing or toxic gases; class 4.2 substances liable to spontaneous combustion- may also give off toxic gases when involved in a fire; class 4.3 -substances which in contact with water emit flammable gases- sometimes are also subject to spontaneous ignition and are also toxic. Class 5.1 - oxidizig substances- most goods in this class by a violent reaction with strong liquid acids may evolve highly toxic gases. Class 5.2 -organic peroxides- a violent

decomposition of substances in this class may be caused by traces of impurities such as acids, metallic oxides or amines and as a result from this decomposition highly toxic gases may be evolved. Also some organic peroxides can be particularly dangerous to the eyes, even after only momentary contact. Class 8 -corrosives- some of them give off irritating, poisonous or harmfull vapours, and others are poisonous.

- Corrosion

Corrosive substances can react chemically with living tissue damaging it and also may damage materials and the environment, in some cases very severely. Substances in class 8 -corrosives- may be corrosive to metals such as aluminium, zinc and tin but not to iron or steel, while others are corrosive to all metals, and some substances may even corrode glass.

It is very immportant to bear in mind that water can also affect some substances by making them more corrosive, by liberating gases, and in some cases by generating heat.

- Reactions with oxygen

The term "oxydation" originally meant a reaction in which oxygen was introduced into another substance , but it usage has long been broadened to include any reaction in which electrons are transferred. Oxidation and reduction always occur simultaneously, and the substance which gains electrons is termed oxidizing agent. For example cupric iron is the oxidizing agent in the reaction:

$$Fe\ (metal) + Cu \qquad Fe \quad + Cu\ (metal).$$

A relative simple oxidation process is identified when the electrons are completely transferred from one molecule to another, without simultaneous transfer of atoms. However, electrons may be displaced within the molecule without being completely transferred away from it. Such partial loss of electrons likewise constitutes oxidation in its broader sense and leads to the application of the term to a large number of processes which at first sight might not be considered to be oxidation.

Chemically, oxygen is a very reactive element, and normal air surrounding contains 21 % oxygen which reacts with almost all metals (exeptions: gold, platinum) very rapidly with metals such as sodium, potassium or calcium.

Non metals do not react with oxygen at normal temperatures but may do so at higher ones (fires).

Oxidation always takes place with the release of heat and often toxic gases. The more rapidly the oxidation process proceeds, the more heat is released in a fixed period of time.

Since oxidation binds the oxygen of the air care has to be taken when enclosed spaces, cargo areas or tanks are entered which contains or have contained cargoes which are liable to oxidation such as: seed cake, vegetable oils (also ballast tanks).

Substances in class 5.1 -oxidizing substances (agents) give off oxygen when involved in a fire, then creating obviously fire-fighting difficulties. This substances which, although in themselves are not necessarily combustible, may increase the risk and intensity of fire in other materials with which they come into contact.

Substances in class 5.2 -organic peroxides- most of them are combustible, are thermally unstable wich may undergo exothermic self-accelerating decomposition and in addition to being oxidizing agents, most substances in this class are also liable to explosive decomposition. Most will burn rapidly and are sensitive to heat, some are also sensitive to impact or friction, some may react dangerously with other substances, and some can be particularly dangerous to the eyes.

- Reactions with water

In general, water is an efficient fire extinguishing agent for many fires, however, water also is reactive and may react with certain substances as thus in class 4.3 - substances emitting flammable gases when wet- this substances when react with water give off gases which are sometimes subject to spontaneous ignition.

A chemical reaction between metal and water forms a hydroxide and liberate hydrogen which is highly flammable, a typical example of this, is the reaction between sodium (Na) and water (H2O) to produce sodium hydroxide or caustic soda:

$$2\ Na + 2\ H_2O \qquad 2\ Na\ O\ H + H_2$$

Non metals which react with water form acids, for example a reaction between chlorine (Cl) and water to produce hydro-chloric acid:

$$2\ Cl_2 + 2\ H_2O \qquad 4\ H\ Cl + O_2$$

although not flammable , all inorganic acids are toxics besides their corrosivity.

- Other reactions or hazards

. Radioactivity: this hazard or effects are produced by substances in class 7 -Radiactive Materials- "comprising substances which spontaneously emit a significant radiation and of which the specific activity is greater than 0.002 microcurie per gramme.

The provisions of this class are based upon the principles of the International Atomic Energy Agency's (IAEA) Regulations for the Safe Transport of Radioactive Material, 1973 (as amended).

Packing, labelling and plackarding, stowage and other requirements vary according to the radioactivity of the material. Radiactive substances are divided into three catergories, depending upon radiation levels, category I (white) being the less dangerous. The labels for categories II and III (yellow) are printed in yellow and white for additional emphasis.

. Spontaneous Combustion: Class 4.2 -substances liable to spontaneous combustion- "which are either liquids or solids possesing the common property of being liable spontaneously to heat and to ignite".

Some are more likely to do so when wetted by water or in contact with moist air. Because of these properties, packing and stowage requirements are important which detailed information is given in the individual schedules.

Common products in this class are charcoal, copra, iron oxide, some plastics, fishmeal and seed cakes.

. Reacting among other substances

Many cargoes in different classes or even of the same class may react dangerously with each other , but also with cargoes of a non-dangerous type. For dangerous goods which may react dangerously with each other, the IMDG provides segregation requirements for their stowage which are based on Regulation 6 "Stowage Requirements" of Chapter VII of SOLAS.

3.2.3 Effects on health:
Included as dangerous goods are substances and articles, which may be the cause of explosions, fires or damage to vessels, structures, warehouses or buildings, as well as loss of life, injury, poisoning, burns, radiation or diseases of men and animals. In a wider toxicological sense the effect of noxiuos substances is not only their ability to cause acute and chronic poisoning but also: their capacity for acting selectively on some organs and physiological systems, macromolecules and metabolic links; and their capacity for affecting the ability of the organism to react. However, in marine cargo handling operations, a still wider use has been found for the primary definition as it includes in practice the whole variety of adverse effects connected with the carriage of dangerous goods by sea.

- Definitions and criteria of hazard
The dominat hazardous properties of many cargoes are flammability, liability to explode and toxicity, and goods can easily be catergorized according to this properties. While other goods disclose this hazardous properties only under specific conditions (for instance, goods which emit toxic gases and vapours when they come into contact with water or fire). In all cases, the goods are to be regarded as dangerous, bearing in mind that their hazardous properties could appear in emergency situations.

Considering the fact that the exhibition of hazardous properties by various goods depends both on the goods themselves and on the specific conditions of transportation, which usually differ from those in industry, and every day life, it is necessary to define such basic concepts as "transport hazard" and "transport toxicity".

Transport hazard: from the viewpoint of toxicology and hygiene, is the totality of properties of the cargo which define its ability to have adverse effects on the human body, the vessel and the environment under specific conditions of transport. The amount of cargo, the type of packing, the stowage location, the nature of adjacent cargoes, as well as many other factors of marine transport, have a considerable bearing on the transport hazard.

Transport toxicity: is a more individual and specific concept involving the ability of the goods during their transport, storage and handling to have various kinds of toxic efect on the human organism and on the environmental flora and fauna.

While the variety of hazardous properties of shipped substances are reflected in the classification of dangerous goods by the International Maritime Organization (IMO) in compliance with regulation 2 of chapter VII of the SOLAS, and known as the International Maritime Dangerous Goods Code; the medical information on dangerous goods, including their toxic properties, methods of first aids, treatment and prevention of poisoning are given in the Medical First Aid Giuide for Use in Accidents involving Dangerous Goods, issued jointly by the IMO, the World Health Organization (WHO), and the International Labour Organization (ILO).

The hazardous properties of goods as explosive risks, fire hazard and radioactivity are assessed according to specially elaborated criteria, but with regard to the assessment of the toxic properties of substances, the UN Committee of Experts, proposed criteria for the classification of Dangerous Goods depending on their physical state and the route of exposure as contained in the following table.

TABLE FOR CLASSIFICATION OF DANGEROUS GOOD DEPENDING ON DEGREE OF TOXICITY, PHYSICAL STATE AND ROUTE OF EXPOSURE

Route of exposure	Criterion (measure)	Danger Group I	II	III
through mouth (a) (perorally)	mg/kg	< 5	5-50	50-500 50-2000(b)
through skin (percutaneously)	mg/kg	<40	40-200	200-1000
by inhalling vapour and gases	mg/m3	<50	50-200	200-1000
dust	mg/m3	<0.5	0.5-2.0	2.0-10.0

(a) for solids
(b) for liquids

Consideration of the criteria indicated in the table is of vital importance for the prevention of accidents among seamen and dockside workers, specially in emergency incidents involving real danger of acute poisoning. At the same time it must be taken into account that the medium lethal dosis (LD50) and concentrations (LC50) have been established in toxicological experiments on laboratory animals and may differ substantially from those with respect to human beings, depending on their specific shipping conditions. The latter are of paramount importance because the toxicological principle of classification of vapuors and gases can be evaluated only relatively because their toxicity varies with the rise of temperature, reduction of oxygen content and presence of carbon dioxide, and carbon monoxide and other gases in the surrounding air, i.e. environmental conditions typically existing in ship's spaces and cargo holds.

-Shipping conditions and toxic effects of Dangerous Goods
Shipping as industrial and communal entity, in which its distinctive features have a pronounced influence on the toxic effects of dangerous goods and other chemical factors well on seamen and dockside workers. There are some conditions which influence the potential toxic danger on board ships, depending on the purpose and type of the ship, and the duration of the voyage and the sailing area and of the specific features appeartaining to the typical working activities within the ship, so it is important to bear in mind the toxicological hazards during loading of goods, passage by sea with the cargo on board, discharging of goods, washing or gas-freeing of holds and tanks.

The passage by sea with cargo on board is the chief part of the overall transport process, and is during this period that noxious sibstances are emitted into the surrounding atmosphere exclusively from the ship's sources, and the estimated concentration of vapours and gases depends on the period of time the goods are stowed as well on the climatic and geographical conditions (specially on the meteorological factors).

Any forthcoming change of cargo or repairs to the ship demand special preparation of the cargo spaces , which is known on dry cargo vessel and bulkers as cleaning of holds, these operations are characterized by a sharp increase in the concentrations of noxious fumes, and dust in the air, not only in the cargo spaces but often in the crew accommodation areas as well, whereby the toxic substances are not only inhalled but also find their way into the organism through the skin.

The handling of dangerous goods in ports involves the accumulation of large amounts of toxic substances within limited areas or spaces (piers, holds) and their transfer by lifting cranes, vehicles and dockside workers, which creates a risk of damage to the containers and packing and thus a risk of poisoning a great number of seamen and dock workers in a short time. During these handling operations, the principal sources of gas emission and dust formations are the goods stowed on shore. When discharging the goods, a short intensive release of vapours and gases may take place upon opening the holds, owing to the accumulation of fumes during the voyage following contact of chemical substances with water, intensive oxidizing process during the voyage, or damage to containers and packing. All these factors must be taken into considertion when elaborating measures to ensure safety in handling dangerous goods.

- Kinds of toxic effect of Dangerous Goods.

The variety of kinds and conditions of contact of seamen and dockside workers with dangerous goods brings about the multiple character of display of toxic effects, along with physical, chemical and biological properties specific to each substance. Both direct and indirect consequences of chemical injury can considerably hinder diagnosis and treatment of developed pathological states and disease conditions.

Depending upon the active dosis and concentrations, the individual features of the organism and the conditions of contact, dangerous goods and their components can cause the following kinds of toxic effects:

1.- accidents involving acute poisoning diseases
2.- chronic poisoning and occupational diseases
3.- certain symptoms, syndromes, prepathological states, reduction of adaptive reserves and changes in reactivity.

The first group of the above mentioned effects is most important in carriage of dangerous goods in all cargo vessels.

According to their type of toxic action, all dangerous goods can be conventionally subdivided into substances having a predominantly local or systematic (resorption) effect In the first case, a reaction of skin and mucous membranes at the place of contact is evident, whereby burning, irritation or an inflammatory effect is noted. Evidence of the local effect will not exclude resorption sympthoms which can develop as the poison is absorbed and circulated in the organism.

Sometimes, under the action of irritants or toxic agents, the nervous system may be damaged; this can cause serious lesions and even have a fatal outcome.

As a rule, under conditions of acute poisoning with toxic components of dangerous foods, a selective action of the toxic agent on the functional systems of the organism is noticed. However, detection of a specific action is hindered because most of the toxic agent have mediatory, indirect effects. Besides in intoxication with some chemical substances, the characteristic features are the development of the pathological process in phases and the occurrence of a latent period, the manifestation and duration of which depend on the amount (dose, concentration) and properties of the toxic agent and on the rate of its biotransformation and elimination from the organism, as well as on the toxicity of the formed metabolities.

Most important in the development of the toxic effect and in the clinical picture of poisoning is the route of exposure. Under shipboard conditions when carrying dangerous goods, poisoning occurs most often by inhalation and also through the skin, however some cases may occur by ingestion and radiation.

In spite of the fact that practically all chemical substances have specific toxic effects, the collective intoxication symptoms following acute poisoning are usually confined to a number of basic clinical syndromes, among which the most significant diagnostically, under shipboard conditions, are the following: neurological syndrome, disturbance of respiration, circulatory disturbance, hepatic and renal insufficiency, and gastric disturbance.

3.3 International Conventions, Codes and Recommendations

3.3.1 The Role of the United Nations

In 1956 the Committee of Experts on the Transport of Dangerous Goods established by the United Nations Economic and Social Council (ECOSOC), completed a report which established minimum requirements for the transport of dangerous goods by all modes. This report, usually known as the United Nations Recommendations (Orange Book) offered a general framework within which existing regulations could be adapted and developed, the ultimate aim being world-wide uniformity.

The Recommendations gave also a scientifically achieved classification of the commonly known and transported dangerous goods. That classification into the classes 1 to 9 was not done in order of degree or magnitude of hazard of the dangerous goods, but by the type of risk involved, in order to meet technical conditions of transport.

3.3.2 International Convention for the Safety of Life at Sea (SOLAS)

The International Maritime Organization (IMO) a specialized agency of the United Nations and internationally responsible for the safety at sea, after official establishment, held in 1959 the first IMO Assembly and one of its first actions was to arrange for a new conference to be held and the main purpose of which was to revise the 1948 SOLAS Convention. This conference took place in 1960, which entered into force on 26 May 1965, its Chapter VII deals exclusively with the carriage of dangerous goods including the fundamental classification.

Another conference held in 1974 further revised the convention which version SOLAS 1974 entered into force on 25 May 1980 (amendments to SOLAS 74 were adopted on November 1981, which entered into force on September 84; and the most recent amendments were adopted on June 1983, which entered into force in July 1986). Today Chapter VII of SOLAS 74 deals with carriage of dangerous goods. Part A -Carriage of Dangerous Goods in Packaged Form or in Solid Form in Bulk-

Regulation 1 prohibits the carriage of dangerous goods by sea except when they are carried in accordance with the provisions of the SOLAS Convention and requires each Contracting Government to issue, or cause to be issued, detailed instructions on safe packing and stowage of dangerous goods which shall include the precautions necessary in relation to other cargo.

Regulation 2 divides dangerous goods into the following classes:

class 1 . Explosives

class 2 . Gases: compressed, liquefied or dissolved under pressure

class 3 . Flammable liquids

class 4.1 Flammable solids

class 4.2 Substances liable to spontaneous combustion

class 4.3 Substances which in contact with water, emit flammable gases

class 5.1 Oxidizing substances

class 5.2 Organic Peroxides

class 6.1 Poisonous (toxic) substances

class 6.2 Infectious substances

class 7 . Radiactive materials

class 8 . Corrosives

class 9 . Miscellaneous dangerous substances, that is any other substance which experience has shown, or may shown, to be such a dangerous character that the provisions of this part shall apply to it.

The other regulations on part A, 3 to 7, of Chapter VII deal with the packing, identification, marking, labelling and plackarding of dangerous goods, the documents which are to be provided, stowage requirements, and the carriage of explosives in passenger ships.

Therefore Chapter VII of the most updated version of SOLAS 74 provides the necessary legal basis for the International regulation of the carriage of dangerous goods by sea.

3.3.3 The International Maritime Dangerous Goods (IMDG) Code

The International Maritime Organization through its Maritime Safety Committee, established in 1960 a Working Group on the Carriage of Dangerous Goods, and Governments which have considerable experience in the carriage of such substances were invited to nominate experts, the objective of the Working Group was to set and prepare a draft for "Unified International Maritime Code" as envisaged by the 1960 SOLAS

Conference, the work included such matters as packing, container traffic and stowage, with particular reference to the segregation of incompatible substances and in cooperation with the U.N.Committee of Experts on the Transport of Dangerous Goods, to pursue its studies on such an international code, especially in respect of classification, description, labelling and shipping documents.

The Working Group met several times and good progress was made in preparing the draft code and the resulting document became known as the International Maritime Dangerous Goods (IMDG) Code, which was approved by the IMO Maritime Safety Committee, and adopted by the IMO Assembly in 1965 under IMO Assembly Resolution A.81 (IV).

Since its introduction in 1965, the IMDG Code has undergone many changes, both in appearance and content to keep pace with the ever changing needs of industry, amendments which do not affect the principles upon which the code is based may be adopted by the Maritime Safety Committee alone, so the code may respond to transportation developments in reasonable time. The latest version of the code is published in five loose-leaf volumes for easy insertion of amendments in order to keep it updated. The original version of the code is published in English and since 1984, it is also published the French and Spanish edition.

Although designed primarily for mariners, the provisions of the IMDG Code affect industries, handling and transport services from manufacturers to consumers. Manufacturers, packers, shippers and forwarders are guided by its provisions on terminology, packing, identification and labelling. Feeder services such as road, rail and harbour craft are guided by its provisions in respect of classification, identification and labelling. Port authorities consult the code to segregate dangerous goods in loading, discharging and storage areas.

The first part of the Code consist of a General Introduction, in which it are reproduced Chapter VII of the 1974 SOLAS Convention and Resolution 56 of the 1960 SOLAS Conference, followed by the classification of dangerous goods and a description of standardized methods for establishing the flashpoint of substances. The General Introduction goes on to describe the required marking, identification and consignment procedures, labelling and plackarding, documentation and packing of dangerous goods.

The General Introduction includes sections containing special requirements for freight containers, portable tanks and road tank vehicles, stowage and segregation, fire prevention and fire-fighting. The final sections deal with the carriage of dangerous goods on roll-on roll-off ships, in limited quantities, in shipborne barges on barge-carrying ships, the chemical stability of substances and requirements for transport under controlled temperatures.

Annex I to the General Introduction gives packing recommendations and a glossary of packagings with illustrations.
Following the General Introduction, the IMDG Code then details the nine classes of dangerous goods, the code is diveded in 5 volumes for easy handling, on which
Vol 1 refers to the General Introduction and details to class 1
Vol 2 refers to details classes 2 and 3
Vol 3 refers to details classes 4 and 5
Vol 4 details classes 6 and 7 and
Vol 5 details classes 8 and 9 and also contain General Index (alphabetical) of dangerous goods, Numerical Index (table of U.N. numbers with corresponding IMDG code page numbers, EmS numbers and MFAG table numbers).

3.3.4 Emergency Procedures for Ships Carrying Dangerous Goods (Emergency Schedules EmS)

The sub- Committee on the carriage of Dangerous Goods prepared group emergency schedules for all substances and articles covered by the IMDG Code, in response to a request from the Maritime Safety Committee that advise on emergency procedures should be made available to those concerned with the carriage of dangerous goods.

The group emergency schedules, were adopted by the Maritime Safety Committee in 1981, and designated as IMO Emergency Procedures for Ships Carrying Dangerous Goods, this publication is a supplement to the IMDG Code. It contains information designed to protect the ship as well as those onboard.

The Emergency schedules divide the various substances and articles contained in each class into groups and advise on any special emergency equipment which should be carried; also include the emergency action to be taken in case of spillage of fire. The recommended action may vary depending on whether the goods are stowed on deck or under deck and suplementary advice where necessary. General advice when dealing with emergencies are given on the Introduction, while particular advice is given in the individual emergency schedules.

3.3.5 Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG)

The International Maritime Organization was responsible for the preparation and publication of the Medical First Aid Guide for use in Accidents Involving Dangerous Goods (MFAG), which was developed in close cooperation with the World

Health Organization (WHO) and the International Labour Organization (ILO), the Guide gives information on how injuries, which may arise from such accidents, should be dealt with. It is also intended to supplement the information contained in the International Medical Guide for Ships (IMDG) published by the World Health Organizatio (WHO) on which information may be found on the treatment of illness of a general nature and not predominantly concerned with chemical poisoning.

The Sub-Committee on the Carriage of Dangerous Goods completed its extensive revision in 1981, of which the revised version was adopted by the Maritime Safety Committee in April 1982. The advice given in the MFAG refers to the chemicals, substances and other dangerous goods covered by the IMDG Code, therefore, it should be used in conjunction with the information provided in the IMDG Code, , the Solid Bulk Cargoes Code (BC Code) and the IMO Emergency Procedure for Ships Carrying Dangerous Goods (EmS).

The MFAG is intended to provide advice necessary if chemical poisoning is to be diagnosed an treated within the limits of the facilities available on board ships. It covers such matters as diagnosis of poisoning, first aid, the complication of poisoning, general toxic hazards emergency treatment , chemical tables including indexes and a list of medicines.

With the MFAG, chemicals are grouped into tables according to their chemical properties, and there may be a variable degree of toxicity within a group. In the rare circumstances where a chemical could not be classified in an appropriate table according to its chemical properties, it has been assigned to a table which is consistent with the toxic medical effects to be expected from poisoning by that chemical.

The tables themselves give general information about the particular group of chemicals and indicate the toxic effects likely to be encountered. The treatment recommended in the MFAG is specified in either the appropriate section or the appropriate table.

The MFAG emphasize about the danger of smoking, drinking, taking food or being under the influence of alcohol or drugs whilst handling chemicals. It is also of importance to notice that crew members of ships regularly carrying chemical or anyone who handle such cargoes ought to have been trained in the general hazards involved as well as the necessary precautions to be observed as specified or in accordance with the provisions contained in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, and on the relevant resolutions to it, as well as on relevant resolutions of the IMO Assembly. In general the personnel should have been instructed about the safety rules and the first aid procedures to be used in case of an accident.

3.3.6 Recommendations on the Safe Transport, Handling and Storage of Dangerous Substances in Port Areas

In order to mitigate the hazards involved in handling dangerous goods in port areas, the IMO Assembly, in 1973, by resolution A.289 (VIII) adopted a "Recommendation on Safe Practice on Dangerous Goods in Ports and Harbours".

The recommendation provided a standard framework within which port authorities or other relevant organizations can formulate regulations to ensure the safe storage and handling of dangerous goods. The recommendation defined the responsibilities of port authorities, lays down certain principles which should be observed and gave advise on the movement of ships and the handling of dangerous goods themselves. It also outlined the emergency prodedures which should be followed in the event of an incident or accident involving dangerous goods.

But it was necessary to revise the original recommendation, because subsequent development of new techniques in shore and ship operations, as well as the desirability of having more comprehensive recommendations to include dangerous goods in packaged form, liquid substances and solid dangerous materials, and gases carried in bulk. Therefore the Assembly in 1979, by resolution A.435 (XI), authorized the Maritime Safety Committee (MSC) to adopt revised recommendations on this subject. The MSC in 1980, adopted and issued under the title "Recommendations on the Safe Transport, Handling and Storage of Dangerous Substances in Port Areas".

The revised recommendations are more extensive than the previous one, but even so, are not intended as a complete guide to all aspect of the handling and storage of dangerous substances in ports. The preamble to the recommendations list various publications and guides, produced by IMO and other organizations. The recommendations are concerned only with the operational matters and not with the construction of ships nor equipment or terminals.

The recommendations outlined under the heading General Recommendations, the powers and responsibilities of shore authorities. The instrument also deals with the duties of the Master and berth operator regarding such matters as fire precautions, ship handling and the reporting of incidents.

There are four appendixes to the recommendations which deal with advance notification, transport and handling of explosives, segregation of radioactive materials on shore and at the end a ship/shore safety check list.

Under the heading "Dangerous Goods" the recommendations give guidance in various aspects concerned with goods in packaged form including those which may be carried in portable tanks or transport units. The subsequent section outlines precautions to be followed in handling liquid bulk (including liquefied gases) and solid bulk dangerous substances.

3.3.7 International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). Specially Annex III.

The 1973 International Convention for the Prevention of Pollution from Ships (MARPOL 73) was modified by a Protocol adopted in 1978 and the combined instrument is now usually known as MARPOL 73/78 which entered into force on October 1983.

Annex III to the MARPOL Convention contains general requirements relating to the prevention of pollution by harmful substances carried by sea in packaged form including those in freight containers, portable tanks, road and rail vehicles or shipborne barges. This Annex is one of the three optional annexes and it will, in accordance with article 15 (2) of MARPOL 73/78, enter into force 12 months after the date on which it has been accepted by not less than 15 states representing at least 50% of the gross tonnage of the world's merchant shipping.

To supplement the basic requirements of Annex III, Governments parties to the convention are required for the purpose of preventing or minimizing pollution, to issue or cause to be issued detailed requirements on packing, marking, labelling and plackarding, documentation, stowage, quantity limitations, exceptions and notifications by the master or owner of the ship or his representative of the intent to load or unload harmful substances.

The 1973 MARPOL Conference also adopted resolution 19 recommending that IMO develop more detailed requirements on this subject, therefore in 1975 as a first step, the ninth IMO Assembly adopted a "Recommendation on Marking and Labelling of Dangerous Goods" by resolution A.453 (IX). This recommendation states that the method of marking the label and the correct technical name on packages and receptacles containing goods should be such that this information will be still identifiable on packages surviving at least three months inmersion in the sea.

IMO developed in 1977, basic principles for good practice for packaged substances, which are considered to present a serious hazard to the marine environment,in order to provide a uniform basis for national regulations required by annex III to the convention. The basic principles were circulated for use by Governments as guidelines in taking interim measures to protect the marine environment from pollution.

3.4 Analysis of the IMDG Code

3.4.1 Assesment of Hazards from substances

The variety of cargoes transported today is so tremendous and diverse that it has been difficult to evaluate each type scientifically. Work is in constant progress on national and International levels and will continue, until almost all cargoes which may poses a danger to human being and to the environment have been systematically assessed.

In general, the work for the assessment of substances involve the finding of clear definitions and delimitations to pinpoint the hazards inherent to the substances, as well as, the ways and means to achieve in order to minimize such hazards to the lowest possible levels. Taking out the danger of a cargo involved in an incident while been handled, the assessment of the hazards for a substance may be obtained in different ways :

- Knowledge, based on historic experience (e.g. the case of certain explosives).
- Practical use and experience over a large period (e.g. asbestos).
- Accidents (the bad way experience)
- Systematic approach in connection with laboratories and large scale tests (scientific approach)

Another possibility is the trial and error method, which is not accepted or recommended, because it involves a conscious risk that may be lethal when applied to dangerous goods. Today the systematic or scientific approach is the only acceptable way, because, it uses laboratory work and controlled tests to ascertain the unknown properties and hazards for a particular substance.

3.4.2 Main content of the IMDG Code

While regulation 2 of chapter VII of SOLAS 74 (as amendmed) only outlines the various classes of dangerous goods, the IMDG Code considering practical application on board ships and in port areas, gives more detailed definitions for each of these classes, with the aim to provide general guidance as to which goods are dangerous and as to the class in which, according to their characteristic, they should be included.

The IMDG Code classification and definition for each class are contained in the General Introduction on section 5.

Each class is preceded by an introduction which describes the properties and definitions of the goods and gives details of stowage and segregation, that is the degree to which goods should be kept separated from other dangerous substances, or other goods. The class introduction also gives information concerning procedures which should be followed during loading and unloading.

Each individual schedule in the code shows the level or labels which should be affixed to a package, or as plackards which should be affixed to a portable tanks, freight containers or other transport units under conditions set out in the Code.

The individual schedules of the Code follow a similar pattern throughout, in which at the top left of the page, appear the substance's or article's proper shipping name (or current technical name) and any known and commonly used alternative names (synonyms). To the right of this, other vital information is given, such as the serial number assigned to the substance or articles by its United Nations number (UN number), its chemical formula, explosive limits, flash point and so on.

The other headings used in the individual schedule include properties, special observations, packing, stowage, and segregation. The schedule also shows the label or labels appropriate to the substance.

In the General Index of the Code, all substances and articles which appear in the IMDG Code are listed, in which it gives the product's UN Number; its Emergency Schedule Number (EmS No.); Medical First Aid Guide table Number (MFAG table No.); and the IMDG Code- page Number of the individual schedule. By looking up the substances or article in this Index it is a simple way to ascertain the appropriate Emergency Schedules or Medical First Aid Guide Table.

3.4.3 The Classes and their properties

Class 1- Explosives

These are among the most dangerous of all goods carried by sea. This class is unique in that the type of packing used frequently has a decisive effect on the hazard and therefore on the assignment of a explosive substance to a particular division. The class is divided into five divisions which present different hazards.

Goods in this class are also assigned to various stowage categories, of which stowage category I (ordinary) covers goods which present relatively little hazard. Category II involves the provision of a magazine for stowage of such goods, and is itself divided into three groups. Category III is for pyrotechnics and Category IV for special items which are mainly goods which contain both explosive and chemical agents which can evolve tear-producing or toxic gases.

Although the safety of goods in class 1 can best be assured by stowing them separately, this can rarely be done in practice. To ensure that they are stowed as safely as possible, the goods in the class are arranged in twelve compatibility groups. These are lettered from A to L and S, ommiting letter I.

The Individual Schedules for substances in class 1, give the proper shipping name (correct technical name), the UN number, in addition also give the substance's or article's division and compatibility group, information which must be shown on the label or plackard that goes on the package. The information given in the schedule concerning the substance's stowing category must be included in the shipping documentation.

Class 2 - Gases

Gases carried on board come in different forms and have varied properties. They may be permanent gases liquefied at ambient temperature under high pressure, dissolved under pressure, or liquefied by refrigeration. Some gases are lighter than air and some are heavier. They may be in general non-flammable, flammable, poisonous, corrosive, support to combustion or be a combination of all or some of these.

For the purpose of stowage and segregation class 2 is further subdivided according to the hazards presented by gases during stowage and transport:

class 2.1 - Flammable gases

class 2.2 - Non-flammable gases

class 2.3 - Poisinous gases

The above subdivision of class 2, give additional description in order to accurately convey the hazards presented by gases, and supplement the classification contained in regulation 2 of chapter VII of SOLAS 74.

The schedules for substances in this class include the UN number, the chemical formula of each gas, and where flammable, the range of its explosive limits (that is the percentage of gas required in a gas air atmosphere to make the mixture explosive). The schedule describe's the gas properties and includes appropriate additional information and details on packing requirements, stowage and segregation.

Class 3 - Flammable liquids

This class deals with liquids which give off a flammable (ignitable) vapour at or below 61ºC (141ºF), close cup test (c.c.) some flammable liquids are included in other classes (mainly 6.1 and 8) because of their other more predominant poisonous and corrosive properties.

Class 3 is divided into three sub-classes according to the flashpoint of the liquid, also is a supplement to the classification contained in regulation 2 of chapter VII of SOLAS 74.

Class 3.1 covers liquids with a low flashpoint below -18ºC (0 º F); class 3.2 covers liquids with an intermediate flashpoint of -18 º C (0 º F) up to, but not including 23 º C (73 º F); and class 3.3 covers liquids with a high flashpoint of 23 º C (73 º F) and above up to 61 º C (141 º F). It should be noted that the flashpoint must also indicate the method used, in this description it is used the closed cup (c.c.). Also should be noted that transport of liquids within Europe with flashpoints above 61 º C up to 100 º C

(212 o F) is regulated.

The General Introduction in the IMDG Code set outs the various methods that can be used to establish the flashpoint of flammable liquids, which is an important factor as far as safety is concerned. Packing and stowage requirements for liquids with low flashpoints are stricter than those with high flashpoints.

The Introduction to class 3 includes information on packing,stowage and segregation. The individual schedules give information of substance's name, UN number, chemical fomula, explosive limits and flashpoint as well as information provided under the standard headings of properties, observations, packing, stowage and segregation.

In general, water is unsuitable for fighting a flammable liquids, in particular those liquids with relative density lower than 1. Packaging group is also assigned to this class, which is determined by the degree of danger they present. Packaging group I includes liquids presenting great danger, group II medium danger and group III minor danger.

Class 4 - Flammable solids or substances

This class deals with substances other than those classed as explosives, which under conditions of transportation are readily combustible or may contribute or cause fires. The class is divided into three sub-classes which have very different properties. The class include some commonly known products, many of which seem harmless but which can be very dangerous unless properly packaged, handled and transported.

Class 4.1 - Flammable solids

Substances in this class are easily combustible and can be readily ignited by external sources, such as sparks or flames. The individual schedules give the product's name, UN number and chemical formula; and the schedules are often detailed because properties vary considerably.

Products included in this class are vegetable fibres such as cotton, jute and hemp, hay and straw, matches, rubber scrap and sulphur.

Class 4.2 - Substances liable to spontaneus combustion.

Substances in this class are liable to heat and to ignite spontaneously. Some are more likely to do so when wetted by water or in contact with moist air. Some may also give off toxic gases when involved in a fire. Because of those properties, packing and stowage requirements are important. Although some general comments are made in the introduction of the class and more detailed information is given in the individual schedules. Common products in this class are charcoal, celluloid scrap, copra, wet or oily cotton, iron oxide, some plastics, fishmeal and seed cakes.

Class 4.3 - Substances emmiting flammable gases when wet.

Because the products in this class give off gases which are sometimes subject to spontaneous ignition and are also toxic, fire fighting is a particular problem.

The use of water, steam or water-foam extinguishers may make matters worse and even the use of carbon dioxide can do more harm than good in some situations.

Common products in this class include calcium carbide, powder derivatives of aluminum and calcium, ferrosilicon, lithium, magnesium-based products, potassium-based products, rubidium, sodium and zinc.

Class 5 - Oxidizing substances (Agents) and Organic peroxides.

This class is further sub-divided into two, namely :

Class 5.1 Oxidizing substances (Agents), which although not necessarily combustible themselves, may increase the risk and intensity of a fire by giving off oxygen, therefore when these substances are involved in a fire creates obvious fire fighting difficulties.

Some substances may also be sensitive to impact, friction or a rise in temperature, and some may react vigorously with moisture. Mixtures of these substances with organic and combustible materials are easily ignited and may burn with explosive force. There also will be a violent reaction between most oxidizing substances and strong liquid acids evolving highly toxic gases.
The use of steam, carbon, dioxide or other inert gas extinguisher may be ineffective because substances in this class give off oxygen when involved in a fire. This class includes ammonium nitrate fertilizers, chlorates, chlorite, and calcium and potassium permanganate.

Class 5.2 Organic Peroxides
Most substances in this class are liable to explosive decomposition. Most will burn rapidly and are sensitive to heat. Some are sensitive to impact or friction. Therefore to

reduce this sensitivity to a safe level they are carried in a solution, as a paste, wetted with water or with an inert solid.

It is very important the segregation aspects for this class because some may react dangerously with other substances. Violent decomposition may be caused by traces of impurities such as acids, metallic oxides or amines. The fact that some substances may begin to decompose when a certain temperature is exceeded and in some cases this may lead to an explosion, some organic peroxides have to be transported at a controlled temperatures, and the information regarding this aspect is contained in the General Introduction to the IMDG Code, and in the Introduction to this class as well as in the individual schedules.

Fire involving substances in this class is another problem and may result in an explosion, therefore packages containing organic peroxides should be moved away from the seat of any fire or jettisoned. If this is not possible, packages should be sprayed (cooled) with large quantities of water as far away as possible and even when the fire has been controlled packages should be treated with great care, since this substances which have been exposed to high temperature may start a violent decomposition at any time.

In some cases, packages may be required to carry a second or subsidiary risk label in addition to the class 5.2 label, e.g. class 1 (explosive) or a class 3 (flammable liquid) label.

Class 6 - Poisonous (toxic) and infections substances

This class is subdivided into two sub-classes; as follow:
class 6.1 - Poisonous substances: in general substances in this class may cause serious injury or even death if swallowed, inhaled or absorbed by contact through the skin.

For packing purposes they are arranged in three groups, in descending order of risk, the information regarding the criteria for this grouping is contained in the Introduction to the class in the code.

Fire fighting measures are basically the same as those given for class 3 (flammable liquids) but because of the high risk of poisoning through fumes, the IMDG Code provides that ships carrying poisonous substances should always carry protective clothing and self contained breathing apparatus.

If leakage or spillage occurs involving toxic substances, such as liquid pesticides, decontamination should be carried out by trained staff wearing suitable portective clothing and equipment.

Class 6.2 - Infectious substances, includes substances containing viable micr-organisms or their toxions which are known, or suspected, to cause disease in animals or humans. The danger labels required for the various substances in this class vary according to the substance's properties. Most are required to carry the poison label, but some carry a label indicating that the substance is harmful and should, therefore, be stowed away from foodstuffs. In addition, further subsidiary labesls may be required, depending upon the substance's properties.

Class 7- Radioactive materials

This class comprises substances which spontaneously emit a significant radiation and of which the specific activity is greater than 0.002 microcurier per gramme. The provisions of the class are based upon the principles of the International Atomic Energy Agency's (IAEA) Regulations for the Safe Transport of Radiactive Materials, 1973. (as amended). They offer guidance to those involved in handling and transport of radiactive materials in ports and on ships.

Packing, labelling and plackarding, stowage, segregation, and other requirements vary according to the radioactivity of the material. Radioactive substances are divided into three categories, depending upon radiation levels, of which category I (white) being the least dangerous. The labels for category II and III (yellow) are printed in yellow and white for additional emphasis.

Class 8- Corrosives

Substances in this class comprises solids or liquids possessing, in their original state, the common property of being able more or less severely to damage living tissue. The scape of such substance from its package may also cause damage to other cargo or to the ship. Some of them give off irritating, poisonous of harmful vapours, while others are also poisonous. Some substances are also flammable or give off flammable gases under certain conditions.

Some substances in this class may be corrosive to metals such as aluminium, zinc and tin, while others are corrosive to all metals including steel and iron, and some may even corrode glass.

The contact of water with some of this substance may affect making them more corrosive, liberating gases, and in a few cases generating heat.

Taking these different properties into account, packing, segregation and stowage are extremely important. The substances are divided into three packaging groups, being the packaging group I the most dangerous. The information or details for the types of packaging to be used are given on the General Introduction to the class.

Most fires involving corrosives can be dealt with by any extinguishant, including water, although those which are also flammable should be dealt with in the same way as substances in class 3, and care must also be taken in view of the risk of poisoning through fumes and the generation of heat.

Class 9- Miscelaneous dangerous substances

This class includes those substances which present a danger not covered by other classes. Because their characteristic and properties are so varied, the individual schedules usually include detailed information on stowage and segregation, packing and further observations.

Packages containing substances in this class do not need to be labelled so no label is provided for class 9. Examples of products of this class are: aerosols, some ammonioum nitrate fertilizers, asbestos, safety matches and pollutants.

3.4.4 Identification marking and labelling

Regulation 4 of chapter VII of the International Convention on the Safety of Life at Sea (SOLAS) 1974, states the requirements concerning marking, labelling and plackarding for packages containing dangerous goods, as follows:

Point 1 of regulation 4 establishes that packages containing dangerous goods shall be durably marked with the correct terchnical name in addition prohibit the use of trade name alone.
Point 2 states that packages containing dangerous goods shall be provided with distinctive labels or stencils of the labels, or plackards, as appropriate, in order to make clear the dangerous properties of the goods contained therein.

Point 3 deals with the pollution aspects, establishing that the method of marking the correct technical name and of affixing packages containing such substances, shall be such that this information will still be identifiable on packages surviving at least three months immersion in the sea. And in considering the suitable methods of marking, labelling and plackarding, account shall be taken of the durability of the materials used as well as of the surface of the package.
Point 4 deals with the exceptions to do so in limited quantities and exceptions of packages that are stowed in units already identified by labels or plackards.

For practical application to this matter, the IMDG Code gives detailed information in the General Introduction, in addition it states the distinctive label or plackard for each class in order to identify the plackage. Where appropriate, each individual schedule in the code shows the label or labels (100 mm X 100 mm) which should be affixed to a package, or as plackards (enlarged labels) (250 mm X 250 mm) which should be affixed to portable tanks, freight container or other transport units under conditions set out in the Code.

3.4.5 Packaging and packing

The provisions of packing of dangerous goods for carriage by sea is contained in Regulation 3 of Chapter VII of SOLAS 74, as amended; and it states as follows:

1.- The packaging of dangerous goods shall be:

-1 well made and in good condition;

-2 of such a character that any interior surface with which the contents may come in contact is not dangerously affected by the substance being conveyed; and

-3 capable of withstanding the ordinary risk of handling and carriage by sea.

2.- Where the use of absorbent or cushioning material is customary in the packaging of liquids in receptacles, that material shall be:

-1 capable of minimizing the dangers to which the liquid may give rise;

-2 so disposed as to prevent movement and ensure that the receptacle remains surrounded; and

-3 where reasonably possible, of sufficient quantity to absorb the liquid in the event of breakage of the receptacle.

3.- Receptacles containing dangerous liquids shall have an ullage at the filling temperature sufficient to allow for the highest temperature during the course of normal carriage.

4.- Cylinders on receptacles for gases under pressure shall be adequately constructed, tested, maintained and correctly filled.

5.- Empty uncleaned receptacles which have been used previously for the carriage of dangerous goods shall be subject to the provisions of this part for filled receptacles unless adequate measures have been taken to nullify any hazard.

For practical considerations, detailed provisions on packing of dangerous goods are contained in section 10 of the General Introduction to the IMDG Code.

Detailed specifications and a number of performance test applicable to a wide range of packagings recommended in the IMDG Code are to be found in Annex I to the Code.

The types of receptacles, inner packagings, outer packagings, packages and combination packagings recommended in the code are those based on extensive past experience, to ensure a high degree of safety.

Dangerous goods of all classes other than classes 1,2,6.2 and 7 have for packing purposes be apportioned among three categories (the called packaging groups) according to the degree of danger they present: Packaging Group I for those presenting great danger; Packaging Group II for medium danger; and Packaging Group III for minor danger. The packaging group to which a substance is assigned is given in the individual schedule.

Performance tests should be made on packaging to be used in commercial practices and a suitable evidence must be established and kept to enable the fact that the tests have been passed succesfully to be verified. Each packaging manufactured and intended for use according to the Code should bear the markings specified in section 6 of Annex I.

The equivalence provisions contained in paragraph 10.3 of section 10 of the General Introduction and in Annex I are retained to allow Administrations to approve those packagings not specifically listed but which meet the safety standards of the IMDG Code, and by January 1990 all packagings used should have been tested and marked.

3.4.6 Stowage and Segregation

Even under normal conditions of transport, and taking into account that appropriate protection and containment of a dangerous substance is provided by suitable packagings which are strong enough and compatible with the contents, leakage, damage or spillage cannot be ruled out.
Regulation 6 of the chapter VII of Solas 74, deals with the stowage requirements. For practical application the General Introduction of the IMDG Code, gives details about stowage and segregation and the compliance with these requirements will prevent serious incidents to happen because the substances which may react dangerously with other substances are kept "away from" or "separated from" each other.

For the implementation of these requirements, two substances or articles are considered mutually incompatible when their stowage together may result in undue hazards in case of leakage or spillage, or any other accident. Some reasons for segregation are:

1.- Explosives shall be well segregated from other dangerous goods, because explosive may decompose by the ingress of acid or alkali and because other dangerous goods may be released by explosive effects (i.e. blast, projection, fire).

2.- Flammable liquids should be effectively segregated from gas cylinders which may explode in case of fire and may release their toxic or flammable contents.

3.- Flammable substances should be effectively segregated from ignition sources in other cargoes to minimize the rapid spread of fire.

4.- Substances which react dangerously with water, emitting flammable gas, should be effectively segregated from substances which may be a source of ignition or are oxidating agents.

5.- Infectious substances should be segregated from other dangerous goods in order to avoid contamination of packages or cargo spaces.

6.- Radioactive materials should be segregated from other dangerous goods to avoid the effects of radiation and decay-heat.

7.- Corrosive liquids should not be stowed in the same cargo space with oxidizing agents or arganic peroxides, because they can damage the packagings of these goods causing dangerous reactions such as accelerating decomposition producing heat, flammable gases or vapours, or oxygen. These reactions can lead to self- ignition or even explosion.

The terms used for segregation are: "away from"; "separated from"; "separated by a complete compartment or hold from"; "separated longitudinally by an intervening complete compartment or hold from". These terms are defined in section 15.2 of the General Introduction, the definition includes distances as well as sketch for easy understanding, and in other sub-section are given their use in regards to the different modes of sea transport.

In addition to segregation which may be general as between whole classes of dangerous goods, there may be a need to segregate a particular substance or article from materials which would contribute to its hazard. Such segregation requirements are indicated in the individual schedule of the substance.

3.4.7 Dangerous substances documentation

Exporters of dangerous substances are required to accept legal responsibility for the packing, identification / marking, labelling and plackarding and documentation of their consignments. These responsibilities are laid down, according to the mode of transport, in national and international regulations and recommendations.

For the transport by sea, Regulation 5 of chapter VII of the SOLAS 74, Convention, as amended, prescribes that:

1.- In all documents relating to the carriage of dangerous goods by sea where the goods are named, the correct technical name of the goods shall be used (trade names alone shall not be used) and the correct description given in accordance with the classification set out in Regulation 2 of this Chapter.

2.- The shipping documents prepared by the shipper shall include, or be accompanied by, a signed certificate or declaration that the shipment offered for carriage is properly packaged and marked, labelled or plackarded, as appropriate, and in proper condition for carriage.

3.- Each ship carrying dangerous goods shall have a special list or manifest setting forth, in accordance with the classification set out in regulation 2 of this Chapter, the dangerous goods on board and the location thereof. A detailed stowage plan which identifies by class and sets out the location of all dangerous goods on board may be used in place of such special list or manifest.

The United Nations Economic and Social Council's Committee of Experts on the Transport of Dangerous Goods has long provided a valuable central point of reference bringing about the uniformity in the overall requirements of all modes of transport. For marine transport, the International Maritime Organization (IMO) has followed the Committee of Experts' Recommendations in this respect. An examination in the Standardization of information (data elements) required under different regulations and conventions shows the following overall requirements, which generally follow a similar pattern. These details are required whether or not the dangerous goods declaration is in the form of a separate document, and can be divided into:

1.- Data elements required solely because of the dangerous nature of the goods:

- hazard class / division
- United Nations (UN No) number relating to the substance
- flashpoint (when required)
- dated and signed declaration or undertaking
- additional information as to the hazard (e.g. radioactive materials)
- net quantity of substance (not always required, but for explosives sometimes)

2.- Other data required

- shipper (name and address)
- reference number
- name of ship or means of transport
- ports/places of departure and destination
- marks and number
- number and kind of packages, etc.
- gross weight (usually per item/package and total of consignment)
- description of goods -correct technical name (proper shipping name)

The above list enumerates generally accepted requirements, however, in practice supplementary data must be required to satisfy certain national or commercial requirements.

Where appropriate, reference could be made to the need to provide additional information in certain circumstances (for example, radioactive materials, weathering certificate, freight container or vehicle transport unit, packing certificate, etc.)

The declaration of dangerous goods is of a legal and practical importance, whether it appears on a separate document or is combined with a transport or cargo-handling document. The declaration normally stated that:

1.- The goods are packaged, and labelled according to applicable regulations, and the packages marked, labelled or stencilled to indicate the identity of the goods and the nature of the danger.

2.- The packaging is of an approved and listed type and suitable to withstand the ordinary risks of handling and transport.

3.- The provisions of the appropriate regulations or convention, especially in relation to the description of the goods, have otherwise been observed.

4.- The information provided is correct, admitting the possibility of liability for damage resulting from mis-statement or omission.

5.- It is to be signed by the declarant.

For the IMDG Code and transport by sea, the following suggested form for such a declaration has been included in section 9 -Documentation of Dangerous Goods Shipment- of the General Introduction to the Code: "I hereby declare that the contents of this consignment are fully and accurately described above by the correct technical name(s) (proper shipping name(s)), and are classified, packaged, marked and labelled, and are in all respects in proper condition for transport by (insert mode(s) of transport involved) according to the applicable international and national governmental regulations".

3.4.8 Unit loads definitions

In the sub-section 10.18 of the Code, a unit load is taken to mean a number of packages which are either:

a) placed or stacked on and secured by strapping, shrink-wrapping or other suitable means to a load board such as a pallet; or

b) placed in a protective outer packaging such as a pallet box; or

c) permanently secured together in a sling.

A single large package such as a portable tank, intermediate bulk container or freight container is specifically excluded from the provisions of this subsection.

Packages containing dangerous goods as permitted by the Code may be shipped in unit loads provided that the following provisions are met:

1.- circumstances may arise in which the unit load will be broken down; packages comprising the unit load should therefore be suitable for safe handling individually. 2.- Unit loads must be compact and, where practicable, regularly shaped with essentially vertical sides and level at the top; they should be suitable for stacking, and constructed and secured in a manner unlikely to damage the individual packages comprising the unit load,

3.- Unit loads must be sufficiently strong to withstand repeated handling and to support over-stowage of unit loads of a similar density to a height likely to be met during transport; and

4.- The materials used to bond the unit together should be compatible with the substances unitized, and retain their efficiency when exposed to moisture, extremes of ambient temperature and sunlight.

The unit load should be suitable for lifting directly by fork lift truck or other suitable apparatus. Where they are not apparent the safe lifting points should be marked on the unit load.

3.4.9 Dangerous goods in freight Containers.

The recommendatios of section 12 of the General Introduction of the Code applies for freight containers in which dangerous goods are packed.

For the purpose of the Code, freight container, means an article of transport equipment that is of a permanent character and accordingly strong enough to be suitable for repeated use; specially designed to facilitate the transport of goods, by one or more modes of transport, without intermediate reloading; designed to be secured and/or readily handled, having fittings for that purposes. The term freight container includes neither vehicles nor packaging; however, containers when carried on chassis are included.

Containers used for the carriage of dangerous goods should be of adequate strength to resist the possible stress imposed by the conditions of the services in which they are employed and they should be adequately maintained. They should be approved in accordance with the International Convention for Safe Containers (CSC), 1972 as ammended, when applicable, or with a certification or approval system of a competent authority or a certification authority acting on its behalf. For Container Packing Certificate, the provisions are contained in sub-section 12.3

Closed container means a container which totally encloses the contents by permanent structures. While open container means a container which is not a close one.

After a container carrying dangerous goods has been unpacked, precautions should be taken to ensure that there is no contamination likely to make the container dangerous; and old labels or plackards should be removed or masked over.

3.4.10 Dangerous goods in portable tanks and roads tanks vehicles.

The requirements of section 13 of the General Introduction apply to portable tanks and roads tanks vehicles intended for the transport of dangerous substances by sea. In addition to these requirements, or unless otherwise specified, the applicable requirements of the International Convention for Safe Containers (CSC) 1972, as amended, should be fulfilled by any tank which meets the definition of a container within the terms of that convention. The appendices to the sub-sections or section 13 comprise the lists of dangerous substances showing the particular requirements which modify or supplement the general requirements for each particular substance suitable for transport in portable tanks.

The requirements do not apply to rail tank-wagons, non-metalic tanks, tanks intended for the transport of liquid having a capacity of 450 litres or less, and for the transport of gases having a capacity of 1,000 litres or less.

For the purposes of the requirements "portable tank" means a tank having a capacity of more than 450 litres (liquid) or 1,000 litres (gases) whose shell is fitted with items of service equipment and structural equipment necessary for the transport of liquid or gases. It is a tank that has stabilizing members external to the shell and is not permanently secured on board the ship. Its contents should not be loaded or discharged while the tank remains on board. It should be capable of being loaded and discharged without the need of removal of its structural equipment and be capable of being lifted on and off the ship when loaded.

For the purposes of the requirements a "road tank vehicle", is a vehicle fitted with a tank complying with relevant requirements for the type 1 or 2 portable tanks or is a type 4 tank, intended for the transport or dangerous liquids by both road and sea modes of transport, the tank which is rigidly and permanently attached to the vehicle during all normal operations of loading, discharging and transport and is neither filled nor discharged on board and is driven on board on its own wheels. And tanks means a portable tank or a road tank vehicle.

Portable tanks have been divided into 8 different types so far as IMO tank type consideration, the provisions and characteristics of each type are contained from sub-section 13.1 to 13.200.

3.4.11 Dangerous goods in limited quantities.

Section 18 of the General Introduction to the Code establish the requirements concerning the transport of dangerous goods of certain classes in limited quantities. The quantity limitation are specified in sub-section 18.3, but are subject to the exception listed in sub-section 18.2 The full requirements of the Code apply equally to limited quantities except as provided elsewhere in the Section(18).

The requirements contained in the section do not apply to:

1. Explosives of class 1

2. Gases of class 2 which have a subsidiary risk such as flammable, corrosive, oxidizing or toxic.

3. Self reactive substances of class 4.1

4. Substances which are liable to spontaneous combustion of class 4.2

5. Organic peroxides of class 5.2, with the exception of test kits, repair kits or similar mixed packages that may contain small quantities of these substances.

6. Infections substances of class 6.2

7. Radioactive materials of class 7

8. Aerosols included in class 9

9. Dangerous goods to which packaging group I has been assigned.

The following table summarize the provisions of quantity limitations.

CLASS	PACKAGING GROUP	STATE	MAXIMUM QUANTITY PER INNER PACKAGING
2	--	GAS	120 ml
3	II	LIQUID	1 l (metal) 500 ml(glass or plastics)
3	III	LIQUID	5 l
4.1	II	SOLID	500 g
4.1	III	SOLID	3 kg.
4.3	II	LIQUID	25 ml
		SOLID	100 gr.
4.3	III	LIQUID OR SOLID	1 kg.
5.1	II	LIQUID OR SOLID	500 g
5.1	III	LIQUID OR SOLID	1 kg
5.2	II	SOLID	100 g
5.2	II	LIQUID	25 ml
6.1	II	SOLID	500 g
6.1	II	LIQUID	100 ml
6.1	III	SOLID	3 kg
6.1	III	LIQUID	1 l
8	II	SOLID	1 kg
8	II	LIQUID	500 ml/a
8	III	SOLID	2 kg
8	III	LIQUID	1 l

/a glass, porcelain or stoneware inner packagings should be enclosed in a compatible and rigid intermediate packaging.

Dangerous goods transported according to the special requirements should be packaged only in inner packagings placed in suitable outer packagings that would be capable of meeting the requirements for packaging group III. The total gross weight of a package should not exceed 30 kg. and should in no case, exceed that permitted in the individual schedules for the substances concerned.

Different dangerous goods in limited quantities may be packaged in the same outer packaging, provided the segregation requirements of the individual schedules are taken into account and the goods will not interact dangerously in the event of leakage. The segregation requirements of section 15 of the General Introduction of the Code are not applicable for packagings containing dangerous goodsin limited quantities.

Packages of dangerous goods transported in accordance with these special requirements need not to be labelled but should, unless otherwise provided, be marked either with the proper shipping name or names or"dangerous goods in limited quantities of class/ classes ..."

In addition to the requirements for documentation specified in section 9 of the General Introduction to the Code, the words "limited quantity" should be included on the dangerous goods declaration together with the description of the shipment.

3.5 Emergency Procedures and Response Organizations

The transport of dangerous substances by sea, incorporates by nature a higher risk than the shipment of non-hazardous substances. Awareness and consciousness, applied precautions, good management, good equipment and regular training of personnel can minimize the risk, but will never totally eliminate it.

It is of vital importance that all thinking and planning must be done and all precautions must be taken before the accident happens, so that in case of an emergency inmediate action can be taken without delay. First minutes measures, contact persons, available equipments, etc. must be laid down in writing in an emergency response plan.

Many of the precautions and emergency response procedures prepared and applied to ships are also applicable to ports, therefore reference literature like IMDG Code, the Emergency Procedures for Ships Carrying Dangerous Goods and the Medical First Aid Guide, contain invaluable information for the ports. However, the fact that the port is serviced by the fire brigate, either by the port fire brigate directly or by the town fire brigate indirectly, it is not necessarily for port personnel to be able to fight fires or spillages on their own, but instead they should be able to known how to tackle an accident in the vital first minutes until the emergency services arrive on the scene and take over.

There is no International Convention which imposes constructional features on a port or which requires certain special equipment for dangerous good handling. Article 32 of the Convention Concerning Occupational Safety and Health in Dock Work by the International Labour Organization only demands certain and adequate measures which have to be taken when handling dangerous goods. The ILO Code of Practice on Safety and Health in Dock Work contain further recommendations regarding equipment and operational procedures and the IMO Recommendations on the Safe Transport, Handling and Storage of Dangerous Substances in Port Areas, also contain useful information.

Accident prevention and in the case of an occurrence, emergency procedures would be greatly facilitated if the port is equipped with a special area for the storage of dangerous goods, which should be at a remote place within the port area and specially designed. This special area needs to be provided with fire-fighting equipment, and in areas where dangerous goods are being handled or stored, the fire-fighting system should be able to supply foam (of the aqueous film forming type-AFF foam) and for warehouse a fixed detection system (heat and /or smoke). Other additional equipment would include:

- Portable fire extinguishers of foam and dry powder or halon type.
- Portable detection devices (for explosives and poisonous gases and for oxygen)
- A sufficient amount of spillage collection material (diatomacious earth) plus tools for application and collection.
- Several full sets of personnel protection outfits and self contained breathing apparatus (if not available at the fire brigate)
- Special attachments to fork lifts like barrel graps, and big open- top drums which can be used to put damaged receptacles inside, in order to avoid further spillage.

The port should have international shore connections available, in order to link a vessel's fighting gear to the port fire-fighting system. This international connection have been required by IMO Assembly Resolution A. 470 (XII) (adopted november 1981) and should conform with the standards given in Regulation 19 of Chapter II-2 of the Amendments to the SOLAS 74 Convention.

Since it would be too late to start thinking once an incident has occurred, it is essential that an emergency response plan is available which not only guides the decision maker in charge of port operations, but in which main decisions are laid down in writing, so that adequate action can be taken inmediately and carried out effectively.

The Port Authority should establish an emergency co-ordination centre, which assembles all information, keeps records of all dangerous substances in port (whether ashore or on board) , keeps reference publications and literature (like the IMO Emergency Procedures for Ships Carrying Dangerous Goods, chemical dictionaries, special instructiones, etc.) and which acts as centre point in an emergency.

The core of all activities in case of an incident will be the emergency response plan. It is the port's Authority responsability to initiate the setting up of such a plan. Cooperation must be sought with all bodies and persons concerned, in particular with emergency services like, police, armed forces or coast guard, local hospital, and with chemical department of the University, local industries, representation of workers associations and with the local municipality or community.

The committee thus establish should agreed on detailed plans which have to be put down in writing and should be a standing one, in order to review the plans and to exchange ideas and views. The emergency response plan should clearly spell out the responsible person who will coordinate all actions in an emergency and who will be advised by others in his decision making.

The plan which should be put into effect from the port co-ordination centre at the time of an incident , should at least include:

- order of actions to be initiated and to be taken;
- arrangements to be taken to evacuate a certain area (personnel , ships, population);

- alarm signals and means by which the alarm is raised; - contact telephone numbers and addresses;
- means of communication;
- resposible person(s);
- list of available equipment ;
- sources of replenishment of equipment (air for breathing apparatus, fire-fighting gear, spillage collection material,etc.)

The actions to be taken in case of an accident are dependent on its location, type, size, on weather conditions and on other circumstances which may have an effect on it, all this must considered and included in the pre-planned response procedures.

Finally, to be prepared for an accident can be vital both for the ship and the port. If considerations on actions to be taken starts after an accident has happened, it will be too late to avoid extensive damage. Therefore, additional investments of a modest size for training, equipment and planning, may in the long term, incur savings which could make the port profitable and more reputable.

3.6 General Remarks

All the above subjects in this chapter have been described in general way mainly because it can be applied in a broaded sense and cover standard regulations and recommendations that each contracting party should follow. But there are other subjects that need to be considered according to the status and the location of the port, therefore, these subjects have to be worked out taking into consideration the realities, policies and the actual practical procedures.

The following list of subjects and its items will serve as a guide for the lecturers to prepare and issue details, it is also advisable to use local documents andsample papers in order to prepare typical exercises and examples, also to arrange for on site visits to look after equipments and procedures, and the use of case studies.

a) Shipment of dangerous goods
- general procedure for shipment
- areas of responsabilities: shipper, carrier, master of the ship, and port authority.
- acceptance procedure: packing, marking, labelling and placarding, documentation.
- planning for stowage and segregation in port and on board.
- local documentation requirements.

In this subject attention should be paid to local actual procedure as well as the recommendations contained in section 9 of the General Introduction of the IMO Code, also the recommendations and provisions contained in the IMO facilitation Convention.

b) Safety equipment and safe practice with dangerous goods:
- protective clothing
- use of adequate cargo handling equipment
- personnel safety equipment: breathing apparatus, oxygen masks, flammable and toxic vapours measuring devices.
- emergency devices: smoke and heat detectors, fire and emergency alarms.
- supervision of personnel during operation
- precautions to be observed when repairing or maintenance work in adjacent areas to dangerous goods.
- the use of adequate sign board/ information for

alerting and for prevention of accidents.

- fire-fighting equipment and techniques in relation to the different classes.
- the pollution aspects.
- first aid according to Medical First Aid Guide for use in accident involving dangerous goods.

This subject should take care of the provisions contained in the IMO Recommendations on Safe Transport, Handling and Storage of Dangerous Goods in Port Areas. The ILO Code of Practice on Safety and Health in Dock Work; and the Medical First Aid Guide for use in accident involving dangerous goods.

c) The inclusion of any subject that the lecturer may consider necessary in addition to all subjects covered and suggested in this chapter, as well as the use of last session for discussion and conclusion in order to get an evaluation of the course as a feedback.

CHAPTER FOUR

RECOMMENDATIONS

1- The above suggested course on safe transport, handling and storage of dangerous goods in port areas, must be implemented by the National Port Authority, which should take care of the provisions for organizational and economical support. The National Port Authority should also look after the inclusion of this training course within its structure of training and to issue regulations for establishing it as a mandatory requirement for port personnel.

2- The transport of dangerous goods by sea is very dynamic, therefore the structure of the course must be revised from time to time to keep it in pace with changes in technologies and operations in maritime transport.

3- The award of certificates may be considered as an incentive to the participants who succesfully attend the course. The succesfull attendance may also be considered for promotions, and it should be mandatory for all port personnel.

4- To facilitate a success of the course enough reference documents and materials must be available to participants as well as facilities to prepare handouts.

5- the National Port Authority also should issue provisions for refreshing courses after a certain period considering the different levels and needs.

6- The National Port Authority should develop and enforce a similar training course to a basic level for dock workers, stevedores, and marine services, custom, and other related personnel not considered in the advanced level course.

7- As a general basis requirement all personnel should have attended a basic courses in fire-fighting and first aid.

List of abbreviations

SOLAS - International Convention for the Safety of Life at sea

IMDG Code - International Maritime Dangerous Good Code

Marpol - International Convention for the Prevention of Pollution from Ships

STCW - International Convention on Standard of Training, Certification and Watchkeeping for Seafarers

ECOSOC - United Nations Economic and Social Council

WHO - World Health Organization

IMO - International Maritime Organization

ILO - International Labour Organization

MFAG - Medical First Aid Guide for use in accidents Involving Dangerous Goods

CSC - International Convention for Safe Containers

EmS - Emergency Schedules, Emergency Procedures for Ships Carrying Dangerous Goods

MSC - IMO Maritime Safety Committee

c.c. - close cup test method for determine the flashpoint of a substance

o.c.	-	open cup test method for determine the flashpoint of a substance
F.P.	-	flash point
L.F.L.	-	lower flammable limit
U.F.L.	-	upper flammable limit
L.E.L.	-	lower explosive limit
U.E.L.	-	upper explosive limit
LD50	-	medium lethal dosis
LC50	-	medium lethal concentration

List of References

- International Convention for the Safety of Life at Sea, SOLAS 1974 as amended.

- International Convention for the Prevention of Pollution from Ships, MARPOL 1973/78, mainly ANNEX 111 to the Convention.

- International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) 1978.

- IMO Assembly Ressolution A. 573 (13) on Training of Officers and Ratings Responsibles for Cargo Handling on Ships Carrying Dangerous and Hazardous Substances in Solid Form in Bulk or in Packaged Form.

- International Maritime Dangerous Goods (IMDG) Code.

- Recommendations of the Committee of Experts on the Transport of Dangerous Goods (Orange Book), United Nations 1984

- IMO Recommendations on the Safe Transport, Handling and Storage of Dangerous Substances in Port Areas.

- Medical First Aid Guide (MFAG) for Use in Accidents Involving Dangerous Goods.IMO/WHO/ILO.

- Emergency Procedures for Ships (EmS) Carrying Dangerous Goods. Group Emergency Schedules.

- IMO/ILO Guidelines for Packing of Cargo in Freight Containers or Vehicles.

- Code of Practice on Safety and Health in Dock Work, ILO 1984.

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