Model Course 1.10

Dangerous, Hazardous and Harmful Cargoes

(2002 Edition)

IMO

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Foreword

Since its inception the International Maritime Organization has recognized the importance of human resources to the development of the maritime industry and has given the highest priority to assisting developing countries in enhancing their maritime training capabilities through the provision or improvement of training facilities at national and regional levels. IMO has also responded to the needs of developing countries for postgraduate training for senior personnel in administration, ports, shipping companies and maritime training institutes by establishing the World Maritime University in Malmö, Sweden, in 1983.

Following the earlier adoption of the International Convention on Standards of Training Certification and Watchkeeping for Seafarers, 1978, a number of IMO Member Governments had suggested that the IMO should develop model training courses to assist in the implementation of the Convention and in achieving a more rapid transfer of information and skills regarding new developments in maritime technology. IMO training advisers and consultants also subsequently determined from their visits to training establishments in developing countries that the provision of model courses could help instructors improve the quality of their existing courses and enhance their effectiveness in meeting the requirements of the Convention and implementing the associated Conference and IMO Assembly resolutions.

In addition, it was appreciated that a comprehensive set of short courses in various fields of maritime training would supplement the instruction provided by maritime academies and allow administrators and technical specialists already employed in maritime administrations, ports and shipping companies to improve their knowledge and skills in certain specialized fields. IMO has therefore developed the current series of model courses in response to these generally identified needs and with the generous assistance of Norway.

These model courses may be used by any training institution and the Organization is prepared to assist developing countries in implementing any course when the requisite financing is available.

W. A. O'NEIL
Secretary General

Introduction

■ Purpose of IMO model courses

The purpose of the IMO model courses is to assist maritime training institutes and their teaching staff in organizing and introducing new training courses, or in enhancing, updating or supplementing existing training material where the quality and effectiveness of the training courses may thereby be improved.

It is not the intention of the model course programme to present instructors with a rigid "teaching package" which they are expected to "follow blindly". Nor is it the intention to substitute audiovisual or "programmed" material for the instructor's presence. As in all training endeavours, the knowledge, skills and dedication of the instructor are the key components in the transfer of knowledge and skills to those being trained through IMO model course material.

Because educational systems and the cultural backgrounds of trainees in maritime subjects vary considerably from country to country, the model course material has been designed to identify the basic entry requirements and trainee target group for each course in universally applicable terms, and to specify clearly the technical content and levels of knowledge and skill necessary to meet the technical intent of IMO conventions and related recommendations.

■ Use of the model course

To use the model course the instructor should review the course plan and detailed syllabus, taking into account the information provided under the entry standards specified in the course framework. The actual level of knowledge and skills and the prior technical education of the trainees should be kept in mind during this review, and any areas within the detailed syllabus which may cause difficulties because of differences between the actual trainee entry level and that assumed by the course designer should be identified. To compensate for such differences, the instructor is expected to delete from the course, or reduce the emphasis on, items dealing with knowledge or skills already attained by the trainees. He should also identify any academic knowledge, skills or technical training which they may not have acquired.

By analysing the detailed syllabus and the academic knowledge required to allow training in the technical area to proceed, the instructor can design an appropriate pre-entry course or, alternatively, insert the elements of academic knowledge required to support the technical training elements concerned at appropriate points within the technical course.

Adjustment of the course objectives, scope and content may also be necessary if in your maritime industry the trainees completing the course are to undertake duties which differ from the course objectives specified in the model course.

Within the course plan the course designers have indicated their assessment of the time which should be allotted to each learning area. However, it must be appreciated that these allocations are arbitrary and assume that the trainees have fully met all entry requirements of the course. The instructor should therefore review these assessments and may need to re-allocate the time required to achieve each specific learning objective.

Lesson plans

Having adjusted the course content to suit the trainee intake and any revision of the course objectives, the instructor should draw up lesson plans based on the detailed syllabus. The detailed syllabus contains specific references to the textbooks or teaching material proposed to be used in the course. Where no adjustment has been found necessary in the learning objectives of the detailed syllabus, the lesson plans may simply consist of the detailed syllabus with keywords or other reminders added to assist the instructor in making his presentation of the material.

Presentation

The presentation of concepts and methodologies must be repeated in various ways until the instructor is satisfied that the trainee has attained each specific learning objective. The syllabus is laid out in learning-objective format and each objective specifies what the trainee must be able to do as the learning outcome.

Implementation

For the course to run smoothly and to be effective, considerable attention must be paid to the availability and use of:

- properly qualified instructors
- support staff
- rooms and other spaces
- equipment
- textbooks, technical papers
- other reference material

Thorough preparation is the key to successful implementation of the course. IMO has produced a booklet entitled Guidance on the Implementation of IMO Model Courses, which deals with this aspect in greater detail. The text of this booklet is included at the end of this course.

Part A: Course Framework

Scope

This course is intended for:

- seafaring personnel responsible for the cargo handling of packaged dangerous, hazardous and harmful cargoes (hereafter referred to as "dangerous goods") aboard ships

and

- shore-based personnel (including Competent Authority and similar personnel) responsible for the transport of dangerous goods by sea and involved in any of the aspects set out below.

The course will include, but is not limited to, classification, packaging, consignment procedures, loading, segregation, etc.

Most of the course material is common to both target groups, although the time needed for individual topics will vary. For example, seafaring staff need more detailed consideration of stowage than those on shore, whilst the reverse is true of package manufacturing and testing. The two course timetables, although intended for general guidance only, reflect these varying needs. However it may be possible for experienced instructors, by amending the timetables and presentations, to accommodate seafaring and shore-based staff on the same course.

The course has been prepared in accordance with sections A-II/2 and B-V/5 of the STCW Code (R1).

The course also provides the basis for training set out in chapter 1.3 of the IMDG Code for shore-based personnel.

The training provided by this course should be supplemented by practical experience at sea, or in shore-based operations as appropriate.

Objectives

Trainees successfully completing this course will thereby be enabled to contribute to the preparation and execution of the safe carriage of dangerous goods and marine pollutants by sea, will understand the legal implications of and correctly apply or verify compliance with the:

1 detailed instructions (including safe packing, handling, stowage and segregation of dangerous, hazardous and harmful cargoes, also the precautions necessary in relation to other cargoes) as set out in the International Maritime Dangerous Goods (IMDG) Code and its Supplement (T1 and T2);

2 IMO/ILO/UNECE Guidelines for the Packing of Cargo Transport Units (CTUs) (B3);

3 Recommendations on the Safe Transport of Dangerous Cargoes and Related Activities in Port Areas (B2);

and, as far as they affect the transport of dangerous goods, the:

1 Code of Safe Practice for Cargo Stowage and Securing (T4);

2 Recommendations on the Safe Use of Pesticides in Ships (B4);

3 International Convention for Safe Containers, 1972 (CSC) (R4).

In addition trainees will have an appreciation of the importance and impact of:

1 Part A of chapter VII of the International Convention for the Safety of Life at Sea, 1974 (SOLAS), as amended (R2);

2 Regulation II-2/54 of SOLAS 1974, as amended, in respect of ships intended to carry dangerous goods (R2);

3 Annex III of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78) as amended (R3);

4 Protocol I to MARPOL 73/78, as amended, and the associated reporting procedures set forth in resolution A.648(16), General Principles for Ship Reporting Systems and Ship Reporting Requirements, Including Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants, adopted by the IMO Assembly on 27 October 1989 (R3);

Entry standards

Introduction. The course is designed as a free-standing one and is not dependent on a set level of knowledge of other aspects of ship operation or detailed chemical manufacturing knowledge required. However, for seafarers, additional training as specified by the STCW Convention may be necessary to achieve appropriate qualifications. If used as a module for the certification of seafarers in accordance with the STCW Convention the required educational background for such certification applies.

The course can also be used for the training of experienced key ratings who have or are intended to have responsibilities for dangerous goods.

Shore-based personnel wishing to enter this course should ideally have a general knowledge of dangerous goods regulations and a minimum of 12 months recent experience in dealing with the transport of dangerous goods by a mode of transport (national or international) whose requirements are based on the United Nations Recommendations (B6).

Course certificate, diploma or document

Provided that this course has been approved by the Administration, a trainee who successfully completes it may be issued with a certificate attesting that he or she has completed a course which meets or exceeds the level of knowledge specified in the 1978 STCW Convention, regulations A-II/2 and B-V/5, and if he is the holder of or is to be issued with a certificate under the provisions of that convention, such certificates may be suitably endorsed by the issuing administration.

A similar certificate should be available for shore-based staff but with reference to the STCW Convention replaced by a suitable reference to competence in following the IMDG Code and related international documents.

Course intake limitations

The number of trainees should not exceed twenty. Any practical training should be undertaken in small groups of not more than five and be subject to adequate supervision.

Staff requirements

All training and instructions should be given by properly qualified personnel. The senior instructor, in addition to being familiar with the legislative regime governing the transport of dangerous goods should have considerable practical experience in safe handling, stowage and transport of such goods by ship. All assistant instructors should have practical knowledge in these areas and should be familiar with marine operations involving dangerous goods. During practical training, one instructor must be in charge of each group. Experts may be recruited from the Administration, local organizations, other competent authorities or bodies to whom certain responsibilities have been delegated, shippers, forwarders and the shipping industry.

Any practical exercises/demonstrations on basic chemistry and physics should be given or conducted by experts familiar with the intrinsic hazards and risks, and the UN classification system, of such cargoes.

Teaching facilities and equipment

Ordinary classroom facilities (a room equipped with a blackboard and flipchart) and an overhead projector are needed for the theoretical part of the course. When audiovisual material such as films, videos, slides, etc. and taped recordings are intended to be used, the appropriate equipment must be available. In addition, notice boards for the display of posters, labels, placards and other similar teaching aids and a demonstration table measuring 3m x 1m would be an advantage.

For some of the practical part of the course and for the demonstrations, it would be advantageous if the training facilities of a nearby port could be used. In addition, smaller rooms suitably equipped, should be available for group activities.

Visits to a ship, port or other installations where course related activities take place should if possible be arranged. As the recommended timetable does not make provision for such visits it should be adjusted accordingly. It is particularly valuable if seafaring staff see shore-based operations (and problems) and vice versa.

Teaching aids (A)

A1 Instructor Manual (Part D of the course).
A2 Any national rules and regulations for the handling, storage and transport of dangerous goods, including any notices to mariners (or others) published in order to disseminate changes in the legislation or other important information.
A3 Any national rules and regulations for ports, terminals and warehouses.
A4 Any national rules and regulations for hazardous installations, i.e. those handling or storing chemicals or other dangerous materials.

A5 Any available in-house shipping company instruction folders or codes of safe practice, including informational brochures to shippers and others concerned on the company's procedures and safe practices.

A6 Any available informational material from manufacturers and shippers of dangerous goods.

A7 Set of all documents required or used at the national level in connection with the handling and transport of dangerous goods.

Optional audiovisual aids

In Part C, the detailed teaching syllabus, references have been included to some of the available videos, films or slide programmes. However, in the course timetable only one specific reference to an audiovisual aid has been included. The senior instructor should decide whether other audiovisual aids should be used to supplement the theoretical training.

For example for a course for shore-based personnel if a film is regarded as necessary they should probably be limited to A8 and A12.

		IMO No.	Format	Time
	Dangerous goods at sea	125	V	
A8	• Part I			19 min
A9	• Part II			18 min
A10	Handling and storage of packaged dangerous goods in port areas	126	V	
	• Part I – Preparation			25 min
	• Part II – Implementation			25 min
A11	Portable tanks and tank containers	127	V	25 min
A12	Safe packing and securing of cargo in freight containers and vehicles	124	V	25 min
A13	The MV *Poona* fire 1971	10	F	25 min
A14	Container matters (UK P&I Club)		V	30 min
A15	Any fool can stuff a container (UK P&I Club)		V	30 min

The above video cassettes and films may be obtained from:

Videotel Marine International – (UK)
Ramillies House
1-2 Ramillies Street
London W1V 1DF
Telephone +44 (0)20 7299 1800

Audiovisual aid A13 may be obtained from:

U.S Coast Guard
2100 Second Street S.W.
Washington, D.C. 20593
USA

Audiovisual aids A14 and 15 may be obtained from:

Thomas Miller P&I Ltd.,
International House
26 Creechurch Lane
London EC3A 5BA
Telephone +44 (0)20 7204 2307
Fax: +44 (0)20 7283 6517

There are a number of other films that illustrate various aspects of the transport of dangerous goods by sea. However films and videos can become out of date very quickly and instructors would be advised to firstly review any films that are used.

IMO references (R)

Note: these are intended as background documents and are not intended for students on this course. IMO references which need to be studied by the student are included under textbooks and bibliography.

R1 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended in 1995 (STCW Convention) (IMO Sales No. 938E).

R2 International Convention for the Safety of Life at Sea, 1974, as amended (SOLAS 1974) (IMO Sales No. 110E), and any pending amendments thereto.

R3 International Convention for the Prevention of Pollution from Ships, 1973, and the 1978 Protocol relating thereto, as amended (MARPOL 73/78) (IMO Sales No. 520E).

R4 International Convention for Safe Containers, 1972 (CSC), as amended (IMO Sales No. 282E).

R5 MSC.2/Circ.31/Rev.1, or any revisions thereof, on the implementation of the International Maritime Dangerous Goods Code (IMDG Code), its annexes and supplements.

R6 General principles for ship reporting systems and ship reporting requirements, including guidelines for reporting incidents involving dangerous goods, harmful substances and/or marine pollutants. Adopted 27 October 1989 (included in IMO Sales No. 516E and the Supplement to the IMDG Code, IMO Sales No. 210E).

R7 Focus on IMO provides background information on the IMO – these free leaflets include the following titles:

IMO and dangerous goods at sea (May 1996)
A summary of IMO conventions
IMO conventions: status
Basic facts about IMO
SOLAS: the International Convention for the Safety of Life at Sea, 1974
Preventing marine pollution
MARPOL 73/78

Textbooks (T)

It is recommended that every student has a copy of T1, T2 and T3.

T1 2002 Consolidated edition of the *International Maritime Dangerous Goods Code (IMDG Code)* (Sales No. 200E).
T2 Supplement to the IMDG Code and any amendments thereto (IMO Sales No. 210E).
T3 *Course Compendium.*
T4 *Code of Safe Practice for Stowage and Securing* (IMO Sales No. 292E).

Bibliography (B)

It is recommended that B1 – B13 are available in the classroom for students to view.

B1 Wall chart of IMO Dangerous Goods Labels, Marks and Signs (IMO Sales No. 223E).
B2 *Recommendations on the Safe Transport of Dangerous Cargoes and Related Activities in Port Areas* (IMO Sales No. 290E).
B3 *IMO/ILO/UN ECE Guidelines for Packing Cargo in Cargo Transport Units (CTUs)* (IMO Sales No. 284E).
B4 *Recommendations on the Safe Use of Pesticides in Ships* (IMO Sales No. 267E).
B5 *National law affecting the carriage of dangerous goods in ships and their handling in port areas.*
B6a *United Nations Recommendations on the Transport of Dangerous Goods* ("Orange Book"), Twelfth revised edition 2000.
B6b *Manual of Tests and Criteria, Parts I to IV* (ISBN 92 1 1390494). United Nations, Sales Section, New York or Geneva.
B7 *Technical Instructions for the Safe Transport of Dangerous Goods by Air* and Supplement, 2001-2002 Edition
International Civil Aviation Organization (ICAO)
999 University Street
Montreal, Quebec
Canada H3C 5H7.
B8 *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.*
B9 *European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)* 2001 Edition (ISBN). UN Publications New York or Geneva.
B10 *Convention concerning International Carriage by Rail (COTIF)*
Appendix B. Uniform Rules concerning the Contract for International Carriage of Goods by Rail (CIM).
B11 Annex 1 to CIM
Regulations Concerning the International Carriage of Dangerous Goods by Rail (RID)
2001 Edition
SO Publications Centre
P.O. Box 276,
London SW8 5DT
United Kingdom
French and German texts are available from OTIF Berne.
B12 International Air Transport Association (IATA)
Dangerous Goods Regulations
42nd Edition, effective 1 January 2001 (ISBN 92 9035 984 6)
2000 Peel Street, Montreal Quebec, Canada H3A 2R4.
B13 The previous edition of the IMDG Code that includes Amendment 30.

B14 *Shippers Guide to Loading and Securement of Packaged Hazardous Materials/ Dangerous Goods in Intermodal Equipment*
Institute of Packaging Professionals
481 Carlisle Drive
Herndon, VA 20170
USA
www.iopp.org

B15 *Chemistry References*

B15a Sax, N. Irving and Richard J Lewis, Sr.
Dangerous Properties of Industrial Materials
Van Nostrand Reinhold
115 Fifth Avenue, New York, N.Y. 10003
USA
Vol. I – ISBN 0-442-31810-3
Vol. II – ISBN 0-442-31811-4
Vol. III – ISBN 0-442-31813-8.

B15b *Hawley's Condensed Chemical Dictionary*
Van Nostrand Reinhold
115 Fifth Avenue, New York, N.Y. 10003
USA
(ISBN 0-442-28097-1).

B15c E. Mayer,
Chemistry of Hazardous Materials
Prentice-Hall, 66 Wood Lane End
Hemel Hempstead, Herts, HP2 4RG
United Kingdom
(ISBN 1-31-292390).

B15d F C Hess,
Chemistry Made Simple
Heinemann Ltd.
10 Upper Grosvenor Street
London W1X 9PA
United Kingdom
(ISBN 0-43-498471-X).

B14 *Regulations for the Safe Transport of Radioactive Material – Requirements TS-R 1*
International Atomic Energy Agency (IAEA)
Wagramstrasse 5
PO Box 100
A-1400 Vienna
Austria

Part B: Course Outline and Timetable

Section	Subject		Hours (seafarers)		Hours (shore personnel)	
			Class	Lab	Class	Lab
1	Introduction and course administration		0.75		0.75	
2	Background and general introduction	*Titanic*, early SOLAS, *Ariadne* IBC and IGC Codes excluded also BC Code (except MHB), Role of IMO	0.5		0.5	
3	Conventions	SOLAS 74, chapters VI and VII MARPOL 73/78, Annex III	0.5		0.5	
4	IMO and dangerous goods	UN Committee of Experts UN Recommendations	0.5		0.5	
5	The IMDG Code	Formation of IMCO relationship with SOLAS and MARPOL UN Committee and recommendations IMDG application, status, national aspects Layout: contents including the Dangerous Goods List and its relationship with the other parts of the Code	1.25		1.25	
6	Classification – physics and chemistry	Basic physics/chemistry Physical characteristics Physical hazards Chemical properties Chemical hazards, including chemical stability and controlled temperature requirements Marine pollutants	1.5		2	

Section	Subject		Hours (seafarers)		Hours (shore personnel)	
			Class	Lab	Class	Lab
7	Classification – the UN system as used by IMO	The 9 classes Proper shipping names UN Numbers Packaging Groups Unnumbered/Unlisted substances/articles Solutions and mixtures (SOLAS and MARPOL) Multiple hazards (precedence) Special Provisions	1		1	
8	Classification – the IMDG classes	Part 2 Classes 1-9 criteria PG as applicable Special items eg marine pollutants, elevated temperature Video DG at Sea Part 1 Solid bulk Wastes	1.5 0.5 0.25 0.25		2 0.5 0.25 0.25	
Exercise				1.5		1.5
9	Packing and tank requirements	Packing IBCs, large packagings Gas cylinders Portable tanks	1		1.5	
10	Construction and testing of packagings, IBCS and portable tanks	Packagings, IBCs Large packagings Gas receptacles Class 6.2 packaging Class 7 packaging Portable tanks (UN and IMO types)	0.5		1.5	
11	Consignment procedures	General Marking and labelling of packages Placarding/Marking of cargo transport units Documentation Special Provisions	1.5		2	
12	Limited Quantities	Provisions	0.5		0.5	

Section	Subject		Hours (seafarers)		Hours (shore personnel)	
			Class	Lab	Class	Lab
Exercises (two during sessions)				2.5		2.5
13	Transport operations	Stowage Segregation Fire precautions Container traffic Ro–ro ships Shipborne barges Marine pollutants Competent Authority approval	6		4	
Exercises				1.5		1.5
14	IMDG Code Supplement	Container packing Video A14 for seafarers, A15 for shore-based staff. Emergency procedures Medical first aid guide Reporting procedures Use of pesticides in ships INF Code Appendix	1.5		1.5	
15	Safe transport of dangerous cargoes etc. in port areas		1.5		1.5	
Exercise				1		1
16	Future updating	Amendments Harmonization with other modes International/National legislation Trade assns, magazines etc.	0.5		0.5	
Course review			0.5		0.5	
Examination				3		3
		Totals	21	10.25	22.5	10.25

Part C: Detailed Teaching Syllabus

The syllabus has been written in the form of specific learning objectives. These objectives describe what the trainee should be able to do to demonstrate that the objective has been achieved.

All objectives are understood to be prefixed by the words "The expected learning outcome is that the trainee can....."

Each time the course is conducted, the teaching methods and/or material will have to be reviewed to ensure that it is up to date (Note: the IMDG Code is normally updated every two years) and where necessary adjusted in order to ensure that each group of trainees can achieve the objectives.

References are given against the learning objectives to indicate the relevant parts of the Compendium, other supporting material and exercises which, together with the instructor's inputs, make up the substantive part of the course.

In order to assist the instructor, references are shown against the learning objective to indicate IMO references and publications, textbooks, additional technical material and teaching aids, which the instructor may use when preparing course material. The material listed in the course framework has been used to structure the detailed teaching syllabus; in particular:

- IMO references and publications (indicated by R)
- Textbooks (indicated by T)
- Bibliography (indicated by B)
- Teaching aids (indicated by A)

The abbreviations used are:

The Code is structured in 7 parts: each reference begins with the part number, the chapter within the part and then the appropriate subsection, e.g.

Part	4	Packing and Tank Provisions
Chapter	4.1	Use of packagings, including intermediate bulk containers (IBCs) and large packagings
Section	4.1.2	Additional general provisions for the use of IBCs
Sub section	4.1.2.4	This deals with the filling of certain types of IBCs

Note: Some sections go to 5 and 6 digit parts e.g. 5.2.1.5.1.

Ports	Recommendations on the Safe Transport of Dangerous Cargoes and Related Activities in Port Areas
Supp	Supplement to the IMDG Code
UN	UN Number

Example of the use of references:

B6a
United Nations Recommendations on the Transport of Dangerous Goods

Learning objectives		Compendium parts	IMDG Code and other references
1	**Purpose of the course**		R1
1.1	list the main issues taken into account in devising the course	1.1	
1.2	determine personal objectives for the course	1.2	
2	**Background and general introduction**		Preamble and part 1
2.1	explain the necessity for international agreements covering the transport of dangerous goods by sea	2.1	
2.2	explain the reasons for the establishment of the International Maritime Organization	2.2	
2.3	state and understand that there are separate IMO Instruments covering: – bulk liquids (International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code) and Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (BCH Code)) – bulk gases (International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code)	2.3	R7
2.4	explain the difference between the terms "Code" and "International Code" used in 2.3	2.3	
3	**Conventions**		R2, R3 and R7
3.1	describe SOLAS 1974 as the International Convention for the Safety of Life at Sea and explain that chapter VII refers to dangerous goods in packaged form	3.1	1.1.2
3.2	describe MARPOL 73/78 as the International Convention for the Prevention of Pollution from Ships	3.2	1.1.2.2
3.3	describe the background to MARPOL 73/78	3.2	
3.4	explain the objective of MARPOL 73/78	3.2	
3.5	explain how harmful substances in packaged form are addressed	3.3	
3.6	describe dangerous goods (SOLAS) vis-à-vis harmful substances (MARPOL)	3.3	
3.7	explain how the two conventions relate to the International Maritime Dangerous Goods (IMDG) Code	3.3	

Learning objectives		Compendium parts	IMDG Code and other references
4	**IMO and dangerous goods**		B6-B12 and R7
4.1	describe how IMO through its committee structure deals with packaged dangerous goods	4.1/4.2	
4.2	explain the reasons for the establishment of the UN Committee of Experts on the Transport of Dangerous Goods	4.3	
4.3	explain how the UN Recommendations relate to other modes of transport, especially marine	4.4	
5	**The IMDG Code**		R5 and R7
5.1	describe the IMDG Code	5.1	
5.2	determine how the IMDG Code is applied in various countries and explain the extent to which national variations exist, and their application	5.2	1.1.1, 7.9
5.3	outline the contents of the IMDG Code and explain the layout and part numbering system of the IMDG Code	5.3	
5.4	describe the Dangerous Goods List and explain that it is the core to identifying substances and the requirements they must follow	5.3	3.1 and 3.2
5.5	explain the role of Special Provisions (SP) applicable to various entries and that they are properly taken into account in the classification process	5.4	3.1 column 6 and 3.3
6	**Classification – physics and chemistry**		Part 2
6.1	explain the basic chemistry of elements, compounds, solutions mixtures etc.		
6.2	define the physical parameters (e.g. flashpoint; LD_{50}, melting point) used in the Code to describe the properties of substances		
6.3	present the basis of danger in terms of the hazardous properties and reactions of chemicals and the terminology used in the Code to describe them		
6.4	explain the physical, chemical and biological criteria used to divide substances and articles amongst the classes		
6.5	describe the criteria for determining marine pollutants (definitions, GESAMP)		

Learning objectives		Compendium parts	IMDG Code and other references
7	**Classification – the UN system as used by IMO**		Part 2 and B6
7.1	describe the 9 classes into which the UN Recommendations and the IMDG Code divide dangerous goods	7.1	2.0 and B6
7.2	determine where appropriate the packing group (PG) for various dangerous goods	7.2	2.0.1.3
7.3	explain the Proper Shipping Name (PSN) and United Nations (UN) Number for varying dangerous goods, including articles/substances and mixtures/solutions not listed in the IMDG Code	7.3	2.0.2
7.4	describe the correct procedure for classifying articles/substances and mixtures/solutions not listed in the IMDG Code taking account of both SOLAS and MARPOL aspects	7.3	2.0.3 and 3.1.3
7.5	describe the correct procedure for classifying items with multiple hazards (i.e. more than one class involved) using the hazard precedence table and related information	7.1	2.0.3
7.6	describe the rules of classification of explosives	7.4	2.1 and B6b
7.7	describe the rules of classification of radioactive materials	7.5	2.7 and B14
7.8	describe the classification of class 6.2	7.6	2.6.3
7.9	describe the procedure for moving unclassified samples that are probably dangerous for classification	7.7	2.0.4
8	**Classification – the IMDG Code classes**		
8.1	explain that with the exception of marine pollutants the classification requirements of the Code align with the UN system	8.1	
8.2	detail the procedure for classifying unusual items such as articles, marine pollutants, elevated temperature items, etc.	8.2	
8.3	describe the special requirements applicable to the transport of wastes, including particularly the extra documentation required	8.3	

Learning objectives		Compendium parts	IMDG Code and other references
9	**Packing and tank requirements**		
9.1	explain that packaging is intended to provide safe containment and get the goods to the destination	9.1	4.1.1
9.2	list the terminology used in packagings (packagings, IBCs, large packagings and tanks)	9.2	1.2.1
9.3	list the key items to be taken into account by the consignor when selecting packagings (e.g. vibration, temperature, compatibility, reactions)	9.3	4.1.1
9.4	identify the significance of packing groups in this context	9.4	6.1, 6.5 and 6.6
9.5	explain how a consignor should select a suitable packaging, IBC and large packaging for a particular substance or article, using the various types of packing instructions	9.5	4.1.3 and 4.1.4
9.6	identify that classes 1, 2, 4.1 (self-reactive substances), 5.2, 6.2, and 7 have special packing requirements that are additional to the other classes and understand the reasons	9.6	4.1.5, 4.1.6, 4.1.7 and 4.1.8
9.7	explain that mixing two chemicals in a package must only be carried out when permitted and there is no risk of a dangerous reaction	9.7	4.1.1.7.2
9.8	explain that Intermediate Bulk Containers (IBCs) are basically packagings for quantities that are delivered in bulk	9.8	4.1.1, 4.1.3 and 4.1.4
9.9	explain that large packagings are big combination packagings designed for mechanical handling, relevance of large packagings and their use	9.9	4.1.1, 4.1.3 and 4.1.4
9.10	identify the general technical requirements for portable tanks and road tank vehicles together with the various tank types. Explain that two regimes for portable tanks will exist for many years while the new UN tanks replace the IMO tanks	9.10	4.2 Introduction
9.11	explain how to identify a suitable tank for a substance using IMO tanks	9.11	4.2 and B13
9.12	explain how to identify a suitable tank for a substance using UN tanks using the Dangerous Goods List	9.12	4.2
9.13	explain the use of the tank table and the equivalence table	9.13	4.2.4.5 and 4.2.5.6
9.14	describe how solid dangerous goods may be carried in tanks	9.14	4.2.6
9.15	explain that certain solids may be carried in bulk inside containers	9.15	4.3

Learning objectives		Compendium parts	IMDG Code and other references
10	**Construction and testing of packagings, IBCs and portable tanks**		
10.1	explain that most of the packaging types in part 9 (above) require testing and approval	10.1	
10.2	outline the different types of packagings	10.2	6.1
10.3	explain the various performance tests, their preparation, frequency and application to the differing packagings (and packing groups)	10.3/10.4	6.1.5
10.4	state what details have to be included in the test report for packagings	10.5	6.1.5
10.5	identify the elements that make up the UN package mark and understand how to interpret a mark	10.6	6.1.3
10.6	describe the general constructional requirements and general constructional requirements for IBCs	10.7	6.5.3
10.7	describe the test requirements for the various type of IBC (and for varying packing groups)	10.8	6.5.4
10.8	state what has to appear in the test report issued following tests on IBCs	10.9	6.5.4
10.9	identify the elements that make up the UN IBC mark and understand how to interpret a mark	10.10	6.5.2
10.10	identify the national procedure for undertaking and supervising tests for packagings and IBCs, and know what systems are in place to ensure compatibility with other national authorities	10.12	
10.11	explain that some IBCs are subject to periodic inspections whilst they remain in use	10.11	6.5.2
10.12	describe the general constructional requirements for large packagings and compare the tests with the requirements for IBCs	10.12 – 10.14	6.6
10.13	discuss why gas receptacles are not treated like other packagings, explain the role of Competent Authority approvals for gas receptacles and the future requirements for UN approved cylinders	10.17	6.2
10.14	list the national marking, testing and inspection requirements for gas receptacles	10.18	6.2
10.15	summarize the requirements for the construction and testing of receptacles for class 6.2 substances	10.19	
10.16	identify the requirements for the construction and testing of packagings for class 7	10.20	6.4

Learning objectives		Compendium parts	IMDG Code and other references
10.17	describe the general requirements and general design and constructional requirements for portable tanks	10.21	GI 13.1, 13.102 and 13.202 of Amendment 29 (1999 Code)
10.18	identify the national procedure for testing the various types of portable tank, both for classes 3-9 and also for refrigerated and non-refrigerated liquefied gases	10.22	
10.19	explain that tanks are subject to periodic inspections whilst they remain in use	10.23	
11	**Consignment procedures**		
11.1	identify the importance of dangerous goods being properly and durably marked, labelled and placarded; also correctly described and certified on documentation	11.1	5.1
11.2	explain the various marking requirements applicable to dangerous goods, salvage packagings and marine pollutants, including empty uncleaned packagings, the provisions for unit loads and overpacks, and describe the specifications	11.2	5.2
11.3	explain the labelling requirements for dangerous goods, including subsidiary risk labels, variations and exemptions, unit loads and overpacks, and describe the specification and durability requirements	11.3	5.2
11.4	write the definition of a cargo transport unit, outline the requirements for marking and placarding, durability and responsibility for the application of information	11.4	5.3
11.5	determine the marking and signing requirements for different cargo transport units	11.5	5.3
11.6	determine the placarding requirements for different cargo transport units	11.6	5.3
11.7	write the basic information required on the dangerous goods transport document, distinguishing between those items which are always required and those which are sometimes required, and be aware of the required sequence of information and how it should be set out; explain what special requirements apply to documentation, e.g. for class 1, class 6.2, class 7, Limited Quantities, fumigants	11.7	5.4.1
11.8	write the dangerous goods declaration (certificate) and state who should sign it	11.8	5.4.1
11.9	write the container/vehicle packing certificate/declaration and state when it is required and who should sign it	11.9	5.4.2
11.10	explain that special certificates are required under certain circumstances e.g. weathering certificate	11.10	5.4.4
11.11	identify what documentation is required on board ship	11.11	5.4.5

Learning objectives		Compendium parts	IMDG Code and other references
12	**Limited Quantities**		
12.1	explain the term "Limited Quantity" and the opportunity it provides to shippers of small consignments	12.1	3.4
12.2	describe the restrictions that apply and identify goods which are permitted as Limited Quantities from the Dangerous Goods List	12.2	3.4 and Dangerous Goods List
12.3	outline the packaging requirements and describe how they differ from normal shipments explained in 9 (above)	12.3	
12.4	explain the mixed packing and segregation provisions	12.4	
12.5	describe the variations to the documentation and consignment procedures	12.5	
13	**Transport operations**		
13.1	explain that this part of the Code is generally unique to sea transport whereas the previous sections are largely multimodal	13.1	7
13.2	outline the stowage groupings and list the 5 stowage categories	13.2	7.1.1
13.3	relate the various general stowage requirements	13.3	7.1.1
13.4	explain the requirements regarding stowage in relation to: – living quarters – undeveloped film – foodstuffs – marine pollutants – solutions and mixtures	13.4	 7.1.2 7.1.3 7.1.5 7.1.4 7.1.6
13.5	discuss the special requirements applicable to the stowage of class 1 explosive materials	13.5	7.1.7
13.6	explain that the Code provides detailed additional advice for other classes in the Code	13.6	7.1.8 – 7.1.16
13.7	relate the 4 segregation terms and discuss the reasons for segregation and explain the general requirements relating thereto	13.7	7.2.1
13.8	explain the segregation table and, given examples, use it effectively including the use of segregation groups	13.8	7.2.1.7.2 – 7.2.1.16

Learning objectives		Compendium parts	IMDG Code and other references
13.9	present the different requirements, including where applicable the use of the relevant tables, for segregation: – of packages, especially those within cargo transport units – of freight containers on board container ships – of cargo transport units on board ro-ro ships – in shipborne barges – between bulk materials possessing chemical hazards and dangerous goods in packaged form	13.9	 7.2.2 7.2.3 7.2.4 7.2.5 7.2.6
13.10	outline the precautions to be taken to prevent fire in a cargo of dangerous goods and explain that more detailed fire-fighting information is contained in the Emergency Response Procedures (EmS Guide) in the Supplement to the Code	13.10	7.3
13.11	determine the applicability, definitions and permitted shipments of cargo transport units (CTUs) used for packaged dangerous goods or as bulk packagings for solid dangerous goods	13.10	7.4./7.5
13.12	explain how packages containing dangerous goods and other goods should be packed, secured, etc. in CTUs	13.11	7.5.2
13.13	list the contents of the container packing certificate and discuss how it relates to other dangerous goods declarations	13.12	7.5.2
13.14	discuss the Code's requirements relating to containers: – ventilation and condensation – empty containers – temperature controlled dangerous goods – containers under fumigation	13.11	 7.4.2.5 7.5.3 7.7 7.4.3
13.15	describe the requirements for general handling, stowage, segregation and securing of units on ro-ro ships	13.11	7.4.5
13.16	identify the factors to be taken into account when packing/loading dangerous goods into a unit	13.11	7.5
13.17	determine the applicability, definitions and permitted shipments relevant to the carriage of dangerous goods in ship-borne barges on barge carrying ships	13.13	7.6
13.18	identify the requirements for barge loading, stowage, segregation, ventilation and condensation, fire protection and securing of barges	13.14	7.6.6
13.19	describe the requirements concerning temperature control of certain substances	13.15	7.7
13.20	explain that there are special additional requirements concerning the transport of wastes that are not the responsibility of IMO	13.16	7.8

Learning objectives		Compendium parts	IMDG Code and other references
13.21	state the concept of Competent Authority approval, and know how to ascertain which countries have delegated certain approval functions (e.g. package testing and certification) to other bodies	13.17	7.9
13.22	outline the national procedure for Competent Authority approvals	13.18	7.9
14	**IMDG Supplement**		
14.1	list the contents of the Supplement	14.1	
EMERGENCY PROCEDURES			
14.2	describe the purpose of the Emergency Procedures for Ships Carrying Dangerous Goods and how to locate in the Code any particular Emergency Schedule (EmS) from the General Index to the Code	14.2	
14.3	list the sections of the EmS and summarize their general recommendations and the introductory notes to the EmS for the different classes	14.3	
FIRST AID			
14.4	explain the role of the MFAG in providing emergency treatment to crew	14.4	
14.5	explain that the MFAG procedures are left to the crew on the ship and there is no direct relationship to the IMDG Code itself	14.5	
REPORTING INCIDENTS			
14.6	identify the general principles for ship reporting systems and requirements	14.9	
14.7	describe the guidelines for reporting incidents involving dangerous goods, harmful substances and/or marine pollutants	14.6	
14.8	given relevant examples describe the procedures, reporting format and guidelines for detailed requirements for the various reports	14.7	
14.9	outline the contents of the MARPOL Protocols and IMO Resolution A.648(16), and know where to find the various national operational contact points	14.7	
14.10	relate the national system applicable to such reports	14.7	

Learning objectives	Compendium parts	IMDG Code and other references
PACKING CARGO AND FREIGHT		
14.11 describe the scope of the IMO/ILO Guidelines for Packing Cargo in Freight Containers or Vehicles	14.8	
14.12 state what visual inspections should be made before packing	14.9	
14.13 outline the stowage planning, packing and securing of cargo applicable, together with the additional advice relevant to dangerous goods	14.10	
14.14 explain that on receipt of containers or vehicles for loading personnel should be aware of potential hazards inside, e.g. badly stowed cargo or fumigants	14.11	
PESTICIDES		
14.15 discuss the contents of the Recommendations on the Safe Use of Pesticides in Ships, and explain the additional information in the Annexes	14.12	
IRRADIATED NUCLEAR FUEL		
14.16 explain that most of the requirements of the INF Code apply to specialist ships but certain types of INF can be carried by any ship	14.13	
APPENDIX		
14.17 outline the contents of the various resolutions and circulars contained in the Appendix to the Supplement	14.15	
15 Recommendations on the safe transport of dangerous cargoes and related activities in port areas		
15.1 summarize the introduction, application and definitions of the Recommendations. Explain that it is essential that ports are aware of the arrival of dangerous goods and that ship's masters also must have access to information.	15.1	Parts 1, 2
15.2 outline the recommendations regarding warehouses, terminal areas and infrastructure	15.2	Parts 3
15.3 state the recommendations regarding training and responsibility	15.3	Parts 4, 5
15.4 explain the general recommendations for regulatory authorities, port authorities, ships, berth operators and cargo interests. Identify how each of the persons is informed that dangerous goods are entering their area of responsibility.	15.4	Parts 6

Learning objectives		Compendium parts	IMDG Code and other references
15.5	describe the recommendations applicable to: – dangerous cargoes in packaged form – liquid bulk dangerous cargoes (including liquefied gas) – solid bulk cargoes	15.5	Parts 7,9
15.6	select as necessary additional information from that contained in the annexes and appendices to the recommendations	15.5	Parts
15.7	discuss the differences between the IMO Recommendations and applicable national requirements.	15.6	Parts
16	**Updating the IMDG Code**		
16.1	explain why it is necessary: – to be aware of the pending future Amendments to the IMDG Code and other relevant international documents (e.g. the UN Recommendations) – to give prior consideration to their effect on national and international maritime movements – to obtain copies of such amendments as soon as they are published and take any necessary action, including bringing them into effect on the relevant dates	16.1/16.2	
16.2	state why errata sheets to such amendments are sometimes necessary, and know the importance of obtaining them and taking the necessary action	16.3	
16.3	explain the need for harmonization with other modes of transport and particularly with the UN Recommendations, in the interests of multi-modal transport	16.2	
16.4	describe the importance of all involved in this subject keeping up to date by the various means, including membership of Trade Associations, attending courses/conferences, reading relevant journals, etc.	16.4/16.2	

Part D: Instructor Manual

Introduction

The course is intended to give the participants a knowledge of the IMDG Code and its associated documents.

The course material is in two parts: the course manual and course Compendium. The course manual contains guidance for the instructors who conduct the course including detailed learning objectives. The course Compendium contains the syllabus, learning objectives and substantive material. It, together with the IMDG Code, constitutes the "textbook" in accordance with which the participants are to be trained and supporting material for tasks which the instructor may use.

The course Compendium is suitable for distribution to the trainees. The trainees should add any handouts, as well as their own notes, to the Compendium as the course develops.

While the course manual and Compendium – as well as the teaching aids – facilitate the planning of the course, the instructors will have to prepare their own inputs on an ad hoc basis. This requirement follows from the fact that circumstances, particularly the composition of a group of trainees, will be different every time a course is conducted. The input, therefore, must be adapted according to the particular conditions prevailing for each course in order to achieve the objectives of each session.

The purpose of the learning objectives is to define clearly what the trainee should be able to do in a specified area of knowledge on completion of the course. The objectives should be made known at the beginning of each session.

In recent years amendments to the International Maritime Dangerous Goods Code (hereafter referred to as "the IMDG Code") have been published every two years, and other documents dealing with dangerous goods also tend to be updated relatively frequently. It is therefore *essential* that well before *every* course the instructors check that the material to be used correctly reflects the up to date position, and that all necessary amendments have been made.

Guidance notes

1 Introduction and course administration

It is recommended that the maximum number on a course should be 20 persons. As the course will involve exercises and tests to ensure practical understanding, the course leader should ask the course participants to introduce themselves, explaining their current job, their knowledge of the IMDG Code or other dangerous goods rules and their reason for attending the course.

As with all courses there is likely to be a significant cross section of delegates who may be apprehensive, reluctant or hostile. It is essential to gain their confidence by explaining the course is intended to assist a better understanding of the transport of dangerous goods by sea and in this respect it is perhaps worth having short videos/press reports/statistics of incidents/accidents.

2 Purpose of the course

The course is one of several published by IMO. The training role comes from IMO's founding convention. During the 20th century the development of marine transport has been rapid and revolutionary. Following the end of the Second World War in 1945 it was recognized that there would be a need for greater co-operation and IMO was founded in 1959.

Article 1(a) of the founding convention states:

"To provide machinery for co-operation among governments in the field of Governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade; to encourage and facilitate the general adoption of the highest practical standards in matters concerning Maritime safety, efficiency of navigation and prevention and control of marine pollution from ships; and to deal with administrative and legal matters related to the purposes set out in this article."

Explain to the course that many of the IMO courses are integrally linked to one another and form the basis of marine qualifications. Whilst the IMDG Code course forms part of those qualifications it is a stand alone course suitable in addition for Competent Authorities, consignors, shippers, agents, etc.

Emphasize the course is participative, interactive and practical and that students will be expected to make full use of the Code.

3 Course contents

The learning objectives and the Compendium have 16 parts. The current Compendium is based from a technical legal position on the current IMDG Code, including Amendment 31, published in 2002 to come into force 1 January 2003 as an optional document. The Code becomes a mandatory document from 1 January 2004.

4 Guidance to individual sections and exercises

The following notes are intended to aid tutors in preparing their material for presentation. Included are exercises which the student can do using the Code.

> **Note:** The course is designed in such a way that each student should have access to a current up to date copy of the IMDG Code. Ideally they should also have the Supplement, however where the course consists of shippers (consignors) this is less essential. There should also be a copy of the old Code, Amendment 29 (the last 4 volume edition), available, especially if students need a complete understanding of tank requirements.

Parts 1 and 2: Background and general introduction

Explain that the IMDG Code came about because of accidents in ships which led to SOLAS Conventions and in turn the Code. Later there was increasing concern about marine pollution: hence the MARPOL Convention and inclusion of this aspect of the Code.

Also explain that IMO has developed codes on the transport of bulk chemicals (IBC, IGC and BC Codes) and with minor exceptions they will not be addressed during this course as the IMDG Code concentrates on packaged dangerous goods, but also covers tanks, containers and certain bulk solids.

The dangerous goods rules have been developed as the result of accidents or potential incidents. In part 1 there is a list of some serious incidents that have occurred mainly at sea. However a land- or air-based accident can lead to changes to the sea rules and vice versa. An example is the ValuJet airline accident in Miami (1996). All the modes of transport agreed that new restrictions on the carriage of oxygen generators was required and the Code reflected these decisions.

It is useful to monitor the trade press (e.g. Lloyds List, Journal of Commerce etc.) for reports of incidents. There are specialist magazines devoted to the transport of dangerous goods. These include:

- Gerfärliche Ladung (German)
- Gefahr Gut (German)
- Hazardous Cargo Bulletin (UK)
- Hazmat Packager and Shipper (USA)

The above magazines report dangerous goods accidents/incidents in detail and also report the work of the UN and its various committees including IMO.

Explain that IMCO and IMO are the same. The former term was replaced in 1982. However, some commercial references to the IMDG Code still quote IMCO – it should be emphasized that this is wrong.

Focus on IMO (R7) a series of information sheets available from IMO can provide useful background to many of the issues discussed throughout the course.

Parts 3 and 4: Conventions, IMO and dangerous goods

Tutors should ensure that copies of the main Conventions are available during the course. For *seagoing* staff and *shippers* (consignors) reference to them is most unlikely. Where a trainer is teaching government officials then it may be appropriate to give rather more time to these sessions. Government officials likely to attend IMO meetings should understand the working arrangements and other officials may need to know the legal bases in the event of challenges to enforcement action.

Emphasize that most parts of the Code will be updated following decisions of the UN Committee of Experts on the Transport of Dangerous Goods; only decisions unique to sea transport are made independently.

> **Note:** For parts 5-13 of the Learning Objectives the student must have an IMDG Code to use and refer to at all times.

Part 5: The IMDG Code

This session should be an overview of the IMDG Code, the layout, the indexes and the numbering system.

Much of this session will be repeated as the course goes into more detail but students, to obtain full benefit from the course, must be made to find their way around the book.

Having outlined the provisions of the Code and how it works, it would be useful to make the students do one or two class exercises from the blackboard/flip chart:

1 select some substances by name, get them to find the UN No., class and packing group
2 select some UN Numbers and get the students to find the name and the other information required in 1
3 using the Dangerous Goods List, ask students to explain some of the terminology used (e.g. what is the difference between 4-05 and 4-05 in column 15?)
4 get the students to look at packing and tank instructions

Explain that the 2000 edition of the Code introduced a new structure that aligns with other modal regulations and is intended to make it simpler to compare requirements. However this exercise was not intended to change most of the principles of the Code. Students may come across the old Code and it should be pointed out that this should not be used except when using IMO tanks (see parts 9 and 10 of the Compendium).

Also use these exercises to explain the schedules: what they contain, how they refer back to other parts of the Code.

EXERCISE 1 can follow part 5. See the appendix to this part of the model course.

Part 6: Classification – physics and chemistry
It is not the intention of this section to turn students into chemists, rather to explain in simple terms and where possible show by practical examples what some of the chemical and physical terms used in the Code mean.

The video *Dangerous Goods at Sea,* Part I (A8), illustrates flashpoint and a number of dangerous chemical reactions. If this film is going to be used, the start of section 6 is a good point to show it as it covers a number of the following sessions and provides a good introduction to the course and the IMDG Code.

Qualified chemists may well say this section is too simplistic but it should be remembered that the model course is intended for personnel involved in the day to day movement of dangerous goods and these personnel, particularly seafarers, need an understanding of the terms so that they know the consequences of any actions they might take. For example, *explosive limits*: the seafarer needs to understand that at certain levels of concentration there can be explosions; he does not need to understand how to determine those levels.

The section includes a description of the basic UN rules on classification. Students should not need much more detail than is reflected here, however it should be noted that whilst the detail for classifying substances into classes 3, 6.1 and 8 is included in the IMDG Code the detail for the other classes is not always shown and the reader is referred to the *UN Manual of Tests and Criteria* (B6b) for the other classes except for class 7 (Radioactive materials), where the reference is to *Regulations for the Safe Transport of Radioactive Material T-S-R1* (B14).

In most countries, classification is the responsibility of the consignor. There is not normally a requirement to obtain government approval. The exceptions are class 1 (Explosives) and class 7 (Radioactive materials). Tutors should check whether their own national Competent Authorities have other arrangements.

Seafarers may need to have an awareness rather than a detailed knowledge of this part.

Parts 7 and 8: Classification – UN and IMDG Code
This section naturally follows from the chemistry.

Part 7 deals with the UN classification system. IMO has followed most of these principles since the Code was first published. It is perhaps worth explaining to students that in the old Code there were three divisions. In class 3 these did not equate to UN provisions and have been removed. Thus, with this exception, the classification rules set down in various parts of the Code are the same as the UN's, however it would be useful to have the *UN Recommendations* (B6a) available.

The rules for marine pollutants are unique to IMO. There is work going on with a view to getting a standard classification system for chemicals and pollutants but this is not going to be in place for some years (2007/10).

There is a learning objective 7.6 to learn the role of Special Provisions (SP). When the UN allocates a number to a substance or article they sometimes add conditions on the use of the number – e.g. they might state that if the substance is in a low concentration it is not dangerous or it may include a special labelling requirement. The Code incorporates the UN SP and a number of its own. It cannot be emphasized enough that the Special Provisions are very important to the use of the Code and its provisions.

EXERCISE 2 can follow part 5. See the appendix to this part of the model course.

Parts 9 and 10: Packaging
Packaging includes all methods of containment approved in the IMDG Code i.e. packages (boxes, bags and drums), intermediate bulk containers, large packagings and tanks – portable (ISO) tanks and road tankers. In a few instances IMO permits articles to move unpackaged because of their size and in some other places packaging is not specified. These are shown in individual schedules.

The video *Any fool can stuff a container* shows the effect of the sea on packaging and it is worth showing to students who have a special responsibility for package design.

This section is intended to show how to identify a packaging type and the responsibilities that fall on the consignor.

The general packing requirements are not all reflected in the UN tests but they require an assessment by the shipper.

Instructors should select a few other examples of their own.

Packaging is divided into two parts. The first (part 9) deals with the procedure for selecting a suitable packaging from the Code's packing instructions and tank tables. Students should be made to use several of the packing instructions in order to get familiar with the structure and special exceptions that exist in some of them. It should be noted that P200 for gas cylinders is new to Amendment 31 and has a different structure from the rest.

The tank arrangements should be explained and this cannot be done without reference to the old four-volume Code. IMO tanks and their specifications will only be found in the old Code. IMO tanks will gradually disappear but in some cases this could take 20 years.

It should be made clear that UN tanks are a more stringent standard for most substances and that by 2010 industry will have to change to the appropriate UN tank type. Column 12 should disappear in its current form around 2010.

Some existing IMO tanks will be converted to UN tanks but many type 1 IMO tanks will not be capable of conversion.

The second part (part 10) considers packaging approval. Most dangerous substances and articles are required to be moved in packagings listed in the Code and approved (usually tested) under schemes adopted by the Competent Authorities. A new chapter in Amendment 31 is added to address UN-approved gas cylinders.

Shippers need to have a detailed knowledge of part 9, but they would normally only need to get approvals once.

Seafarers need to understand that only packagings listed and approved in the IMDG Code are allowed unless there are Competent Authority approvals (see below). Seafarers should be aware that packagings need an approval and they should have an awareness of the different types of marking that will appear. In general they do not need to be able to interpret all parts of the mark, although they should be aware of where to find the relevant text in the Code. Shippers should be able to interpret a mark and they should understand the basic tests/inspections that need to be undertaken.

Part 10 deals with most of these issues and in either case (the seafarer's or the shipper's) there is not a need on the course to go into the detailed constructional requirements of any packaging type and especially tanks. Tests are usually a one-off exercise and often carried out by the packaging manufacturer or designer.

Where it is necessary to obtain a Competent Authority approval the procedure will be covered in part 13.

If there should be a request for particular emphasis on tank construction or testing there is the Video *Portable tanks and tank containers* (A11). For the average course this is probably too much detail.

EXERCISE 3 can follow part 5. See the appendix to this part of the model course.

Part 11: Consignment procedures

This is probably the most important section of the course for the *seafarer*. When the ship accepts a consignment of dangerous goods the ship's crew must be provided with paperwork and the packagings must be labelled and the paperwork must agree with what is actually being stowed. Thus if for example the dangerous goods note describes goods in class 3 then the labels must be class 3.

It is essential that the shipper gets the marking, labelling and documentation correct. Incorrect documentation can lead to serious accidents – e.g. 1987 *Cason* (see part 1).

Important changes to the section on documentation appear in Amendment 31.

Part 12: Limited Quantities
This is a form of limited exemption from some parts of the rules. It is based on the assumption that the quantities to be shipped are small and that they are in combination packagings. They are a very important concession for industries which sell dangerous goods for consumers e.g. paints, perfumes, adhesives etc. Because the risk is small the goods are allocated to stowage category A.

EXERCISE 4 can follow part 5. See the appendix to this part of the model course.

Part 13: Transport operations
This part of the course is unique to sea transport. The previous sections are really multimodal but most of part 7 deals with dangerous goods on ships. In the main the UN does not get involved in modal operations unless it is providing specific advice for all modes. Although most of this part is addressed to seafarers there are some provisions that affect shippers and they cannot afford to ignore this section.

This part of the course will have more emphasis for the seafarers. Shippers have little control over where their goods are located in the ship's stowage plans although they must take into account the rules on segregation.

The final section of this part deals with Competent Authority approvals and this is relevant to all users of the Code. It is recognized that the Code cannot always keep pace with technical developments and Competent Authorities do have wide powers to issue variations.

Part 14: Code Supplement
The Supplement is an optional document. Many shippers will not have a copy but there are a number of important sections. For seafarers it is essential.

The guidance on packing freight containers can be supplemented by a video, *Safe Packing and Securing of Cargo in Freight Containers and Vehicles* (A12).

Container matters (A14) illustrates many of the hazards presented by containers at sea. Along with *Any fool can stuff a container* (A15) these two videos made by the insurance industry show many of the problems with poor packaging and inadequate securement of containers on ships.

The EmS and MFAG can be linked to a video, *Dangerous Goods at Sea Part II* (A10). This film is very much intended for incidents and accidents likely to occur on board ship and is unlikely to be relevant for shippers.

EXERCISE 5 can follow part 5. See the appendix to this part of the model course.

Part 15: Port areas
Seafarers – Ship's masters need to be aware that the majority of ports around the world will have regulations. This IMO document is an attempt to provide standard guidance. Not all the rules will apply in every port and not all the ports will adopt these recommendations.

Shippers need to understand that entering port areas can require compliance with additional rules over and above those that might apply domestically.

Part 16: Updating the IMDG Code

It is essential that students understand that using an out of date IMDG Code is not only technically incorrect but could also be dangerous.

There are mixed views on whether a two-year cycle for amending the IMDG Code and the other regulations is a good or bad thing. Both industry and governments have different views. Some nations see a two-year cycle as essential whilst others want a four-year cycle.

Appendix 1: Exercises

The following exercises are intended to familiarize the students with the IMDG Code and the principles behind it.

The exercises will take approximately 30-45 minutes to complete with 15 minutes for answers and discussion. It is recommended that the students are invited to give the answers orally rather than the tutor reading them out. This will enable an assessment to be made as to whether the students understand the subject and they can immediately discuss any problems.

It is strongly recommended that tutors develop an examination based on the course and the exercises set out below. Such an examination should last about three hours and the student should be able to refer to the IMDG Code throughout.

Parts 3-5: Conventions, IMO and dangerous goods, IMDG Code

Exercise 1

1 Which international convention provides the basis for the IMDG Code?

2 The provisions of the IMDG Code are based on the recommendations contained in which international publication?

3 IMO's Maritime Safety Committee delegates detailed work on the Code to which sub-committee?

4 What is the title of the Competent Authority for Latvia and in which section of the Code will this information be found?

5 Chapter 4.2 deals with what subject?

6 What part and chapter deals with the classification of toxic gases?

7 What is the UN Number for FLARES, WATER-ACTIVATED?

8 Which sections of the Code cover:
   (a) Limited Quantities?
   (b) Fire precautions?

9 Indicate, as applicable, the name, class/division, UN Number, packaging group and subsidiary risk(s) for the following substances/articles:
   (a) UN 1298
   (b) Acetoin
   (c) Fluorine, compressed
   (d) Sulphuric acid (40% acid)
   (e) UN 2794

Exercise 1: Answers

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

2 UN Recommendations on the Transport of Dangerous Goods (UN Orange Book)

3 Sub-Committee on Dangerous Goods, Solid Cargoes and Containers (DSC)

4 Maritime Administration of Latvia: chapter 7.9 in volume I

5 Use of portable tanks

6 Part 2, chapter 2.2, 2.2.2.3 deals with toxic gases

7 See CONTRIVANCES, WATER-ACTIVATED – UN 0248 or UN 0249 (alphabetical index, volume 2)

8 (a) Chapter 3.4 volume 2
(b) Chapter 7.3

9 (a) TRIMETHYLCHLOROSILANE, 3, UN 1298, II, 8
(b) Acetoin (PSN: ACETYL METHYL CARBINOL), 3, UN 2621, III
(c) FLUORINE, COMPRESSED, 2.3, UN 1045, –, 5.1, 8
(d) SULPHURIC ACID (40% acid), 8, UN 2796, II
(e) BATTERIES, WET, FILLED WITH ACID, 8, UN 2794, III

Parts 6-8: Classification, identification

Exercise 2

Determine, as appropriate, the proper shipping name, class/division, UN Number, packaging group and subsidiary risk(s) for the following substances/articles:

(a) A consignment of UN 3272 containing ethyl propionate with the following properties: flashpoint 30°C, initial boiling point 45°C

(b) A liquid which has a flashpoint of 25°C and an initial boiling point of 40°C. The only dangerous component in this product is acetone, which is a ketone

(c) A shipment of UN 1783. The liquid causes full thickness destruction of intact skin tissue in 10 days after an exposure time of 2 hours

(d) Bromomethane

(e) 1,2-Dichloroethane

(f) *para*-Dichlorobenzene

Exercise 2: Answers

(a)

PSN:	ESTERS, N.O.S (CONTAINING ETHYL PROPIONATE)
Class/Division:	3
UN No:	UN 3272
PG:	III
Sub-risk(s):	–

(b)

PSN:	KETONES, LIQUID, N.O.S. (CONTAINING ACETONE)
Class/Division:	3
UN No:	UN 1224
PG:	III
Sub-risk(s):	–

(c)

PSN:	HEXAMETHYLENEDIAMINE; SOLUTION
Class/Division:	8
UN No:	UN 1783
PG:	III
Sub-risk(s):	–

(d)

PSN:	METHYL BROMIDE
Class/Division:	2.3
UN No:	UN 1062
PG:	–
Sub-risk(s):	Flammable gas (2.1)

(e)

PSN:	ETHYLENE DICHLORIDE
Class/Division:	3
UN No:	UN 1184
PG:	II
Sub-risk(s):	Toxic (6.1)

(f)

PSN:	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (*para*-DICHLOROBENZENE)
Class/Division:	9
UN No:	UN 3082
PG:	III
Sub-risk(s)	–

Parts 9-10: Packagings (including IBCs), UN testing and approval procedures, tank containment systems, packages, IBC and tank selection

Exercise 3

1 Select a suitable packing arrangement for the following consignments, indicating the type of packaging, the number of packages and the quantity of product per package:

Examples: 4 steel drums x 200l; 1 fibreboard box x 50 kg

Assume that 1 litre = 1 kg

(a) 150 litres of UN 1245. The consignee requires supply of the substance in 5 litre glass bottles, if possible.

(b) 20 x 5 kg plastics bottles of barium cyanide

2 Why is the following consignment, as packed, not acceptable for transport by sea?

4 x 55 kg (gross) fibreboard boxes each containing 2 x 20 kg paper bags of UN 2471

3 Create a suitable UN specification package mark for the following consignment:

A fibreboard box containing 4 x 5 litre plastics bottles of UN 1300 (flashpoint 20°C, initial boiling point 40°C). The package design was tested and approved in France.

4 Select an appropriate IBC for a consignment of 2000 litres of UN 1301. Specify the type of IBC using the UN Code and any particular design features which apply.

5 Describe the conditions for a cylinder of compressed nitric oxide

6 Select a suitable portable tank for each of the following consignments. Indicate the tank type, minimum test pressure, the requirements for pressure relief devices and bottom openings, minimum shell thickness and any applicable special requirements. Where an IMO and a UN tank are permitted list both including details for each. When only one type is permitted explain why.

(a) 3000 litres of UN 1288 (flashpoint –5°C)

(b) 5000 litres of UN 1739

(c) 5000 litres of iron pentacarbonyl

Exercise 3: Answers

1 (a) UN 1245 = METHYL ISOBUTYL KETONE

Class 3, PG II. P001 appears in column 8 and there are no packing provisions in column 9. 150 litres in total to consign.

Various options available using 5 litre glass bottles: wooden box, fibreboard box, moulded expanded or solid plastics box, subject to compliance with relevant gross weight limit: several outers therefore required irrespective of option selected.

Example: 5 wooden boxes each containing 30 litres of UN 1245 (6 x 5 litre glass bottles per box)

(b) BARIUM CYANIDE = UN 1565

Class 6.1, PG I. P002 appears in column 8 and PP31 appears in the packing provisions in column 9.

100 kg in total to consign. Choices listed P002. The product is packed in 5 litre plastics bottles so one of the outers at the beginning of the instruction is appropriate.

PP31 requires that the bottles must be hermetically sealed.

2 UN 2471 = OSMIUM TETRACHLORIDE

Class 6.1 PG I. P002 is allocated in column 8 and PP30 and PP31 appear in column 9.

The product is packed in 2 x 20 kg paper bags.

Paper bags are not permitted PP30. The package must be hermetically sealed PP31.

3 UN 1300 = TURPENTINE SUBSTITUTE

Flashpoint (20°C) and initial boiling point (40°C) PG II.

Various answers available but packagings must be tested and approved to at least PG II standards.

Maximum design weight must exceed 20 kg (probably at least 25 kg).

Example: UN/4G/x or Y 30/S/97

F/01234

4 UN 1301 = VINYL ACETATE, INHIBITED

Class 3, PG II. IBC 02 is allocated in column 10 without any special provisions. Any IBC listed can be selected.

5 Nitric oxide can be packaged in cylinders or bundles of cylinders (P200). Cylinders should be tested every 5 years, they should be tested to 200 bar with a working pressure of 50 bar. Special packing provisions k and o apply:

k valve outlets shall be fitted with gas tight plugs or caps

o working pressure or filling ratio must not be exceeded.

6 (a) UN 1288 = SHALE OIL

Class 3, PG II (as product has a flashpoint of –5°C). Column 12 permits type T1 and column 13 T4. TP1 and TP8 apply to either tank.

	IMO Column 12	UN Column 13
Tank type:	T1	T4
Minimum test pressure:	1.5 bar (4.2.4.2.6)	2.65
Pressure relief devices:	N = normal as per 6.7.2.8 (old Code for IMO tanks 13.1.9.1 and 13.1.9.4)	N = normal as per 6.7.2.8
Bottom openings:	Bottom openings allowed (two shut-off devices) (6.7.2.6.2)	Bottom openings allowed (three shut-off devices) (6.7.2.6.3)
Minimum shell thickness:	As per 6.7.2.4.2	As per 6.7.2.4.2
Special requirements (4.2.4.3)	TP1 Fill as per 4.2.1.9.2 TP8 Pressure may be reduced where flashpoint is greater than 0°C.	TP1 Fill as per 4.2.1.9.2 TP8 Pressure may be reduced where flashpoint is greater than 0°C.

(b) UN 1739 = BENZYL CHLOROFORMATE
Class 8, PG 1

Column 13 shows T10. There is no tank type listed in column 12 because an IMO tank has to be to the same standard as T10.

	IMO Column 12	UN Column 13
Tank type:		T10
Minimum test pressure:		4.0 bar
Pressure relief devices:		Normal preceded by a frangible disc in series as per 6.7.2.8.3
Bottom openings:		No bottom openings allowed
Minimum shell thickness:		
Special requirements (4.2.4.3)		TP2 Fill in accordance with 4.2.1.9.3 TP12 Highly corrosive to steel TP13 self-contained breathing apparatus to be provided on board

(c) Iron pentacarbonyl = UN 1994
Class 6.1, PG I

Columns 12 and 13 indicate that carriage in tanks is prohibited.

Parts 11-12: Marking and labelling of packages, marking and placarding of CTUs, consignor documentation, Limited Quantities

Exercise 4

1 Describe the marks and labels which should be displayed on the following consignments for shipment by sea in accordance with the provisions of the IMDG Code:

(a) A wooden slatted crate containing 20 x 10 kg batteries (UN 2794)

(b) A steel drum containing 100 litres of UN 2023

(c) A fibreboard box containing 4 x 5 litre plastics bottles of diallylamine (flashpoint 7°C)

2 What marks and placards should be displayed on the outside of an ISO tank container loaded with 20,000 litres of UN 1099? Describe all the information that needs to be displayed and its location on the outside of the tank container.

3 A box van vehicle is about to be loaded onto a ro-ro ferry. The vehicle is carrying the following dangerous goods: 5 x 200 litre drums of UN 2622 and 5 x 100 kg drums of magnesium arsenate. What marks and placards are required on the outside of the vehicle and where should they be located?

4 Complete a dangerous goods note for all the consignments identified in question 1 above. The goods are to be shipped together in one ISO freight container. You are responsible for loading the container. Where necessary, invent suitable entries, e.g. consignor/consignee details. Assume 1 litre = 1 kg.

5 Indicate whether the following consignments, as packed, may be consigned as Limited Quantities under the provisions of the IMDG Code. Briefly explain your answers.

(a) 12 x 0.5 litre glass bottles of UN 1300 (PG II), shrink-wrapped on a 10 kg (gross) fibreboard tray. The substance does not contain any marine pollutants.

(b) A 20 kg (gross) fibreboard box containing 10 x 1 litre glass bottles of UN 2518

Parts 13-14: Transport operations, stowage and segregation, Supplement

Exercise 5

1 Determine the minimum number of freight containers required to ship the following three consignments by sea:
   (a) 6 x 100 litre drums of UN 1865
   (b) 8 fibreboard boxes each containing 4 x 2 litre glass bottles of UN 1744
   (c) 10 x 50 kg plastics drums each containing UN 1333

2 The next available sailing is a cargo ship; it has no on-deck stowage facilities. Using your answer to question 1, indicate which (if any) of the containers may be shipped on this vessel. Briefly explain.

3 A drum containing UN 2821 has leaked on board a ship and a crew member has been contaminated – some of the substance has got onto his clothing and his hands. Where in the Code will guidance on immediate first aid actions be found?

4 A drum containing methanol has leaked onto the deck of the ship and a fire has started.
   (a) Where in the Code will guidance on fire-fighting measures for this substance be found?
   (b) What is the relevant schedule reference?
   (c) What type of fire extinguishers should be used? Which extinguishers would be inappropriate?

5 What is the address of the Competent Authority for France?

Exercise 4: Answers

1 (a) Marks: Batteries, wet, filled with acid
UN 2794
Label: Class 8 with "8"

(b) Marks: Epichlorohydrin
UN 2023
Marine pollutant mark
Labels: Class 6.1 with "6"
Class 3 with "3"

(c) Marks: Diallylamine
UN 2359
Labels: Class 3 with "3"
Class 6.1 with "6"
Class 8 with "8"

2 Marks: PSN Allyl bromide x at least both sides
UN 1099 on/adjacent to class placard x all four sides
Marine pollutant mark x all four sides
Placards: Class 3 placard with "3" x all four sides
Class 6.1 placard with "6" x all four sides

3 Marks: Marine pollutant mark x both sides and rear
Placards: Class 3 placard with "3" x both sides and rear
Class 6.1 placard with "6" x both sides and rear

4 BATTERIES, WET, FILLED WITH ACID, class 8, UN 2794, PG III
1 x wooden slatted crate
Gross weight: 220 kg (approx.)
EPICHLOROHYDRIN, class 6.1, (3), UN 2023, PG II, (or UN 2023, EPICHLOROHYDRIN, class 6.1, (3), PG II) F.P. 32°C, MARINE POLLUTANT 1 steel drum x 100 litres Gross weight: 125 kg (approx.)
DIALLYLAMINE, class 3, (6.1, 8), UN 2359, PG II, (or UN 2359, DIALLYLAMINE, class 3, (6.1, 8), PG II,) F.P. 70C 1 fibreboard box Gross weight: 25 kg (approx.)
plus
Declaration to be completed/signed, container packing certificate to be completed/signed, and other entries re: consignor/consignee etc.

5 (a) Yes. UN 1300 (PG II) = TURPENTINE SUBSTITUTE, class 3.2:
Each 0.5 litre glass bottle is acceptable (maximum = 500 ml for class 3, PG II) and the total gross weight of the consignment is 10 kg (maximum = 20 kg for a shrink-wrapped tray)

(b) No. UN 2518 = 1,5,9-CYCLODODECATRIENE, class 6.1, PG III, severe marine pollutant: Although the gross weight of the package is under the 30 kg maximum limit, each of the glass bottles (1 litre) exceeds the 500 ml limit which applies in column 7 (Chp. 3.4.8)

Exercise 5: Answers

1 (a) UN 1865 is normal-PROPYL NITRATE, class 3: no specific segregation instructions on schedule – stowage category D.

(b) UN 1744 is BROMINE, class 8: schedule requires segregation "as for class 5.1" but "separated from classes 4.1, 5.1 and 7" – stowage category D.

(c) UN 1333 is CERIUM, class 4.1: schedule requires "separated from classes 3 and 5.1" – stowage category A.

Stowage requirements do not prevent use of single container: "on deck" on "cargo ship" is acceptable for all substances. Using schedule instructions and segregation table in section 15:

item (a) (class 3) cannot be loaded together with item (b) (class 5.1 for segregation) as "separated from" is specified in table;

item (a) (class 3) cannot be loaded together with item (c) (class 4.1) as "separated from class 3" is specified in schedule for item (c);

item (b) (class 5.1 for segregation) cannot be loaded together with item (c) (class 4.1) as "separated from class 5.1" is specified in schedule for item (c). Therefore a minimum of three freight containers is required to ship these consignments.

2 UN 1865 and UN 1744 are both stowage category D = "on deck only" on a "cargo ship"; the containers loaded with these consignments cannot therefore be shipped on the next sailing.

UN 1333 is stowage category A = "on deck or under deck" on a "cargo" or "passenger" vessel; this container can therefore be carried on the next ship.

3 Medical First Aid Guide – Supplement

4 (a) Emergency Schedules (EmS) – Supplement

(b) EmS F-E and S-D

(c) Water spray should be used; water jet or foam should not be used.

5 Ministre de l'équipement, des transports et du logement
Direction des affaires maritimes et des gens de la mer
Sous-direction de la sécurité maritime
Bureau du contrôle des navires et des effectifs
3 Place de Fontenoy
75700 Paris

Appendix 2: Case studies for MFAG and EmS

These are case studies relating to the use of the Medical First Aid Guide (MFAG) and the Emergency Schedules (EmS). Unlike other exercises, these are smaller and should be used by a small group of students over a shorter period of time, i.e. 34-45 minutes. Thereafter, the group can report back to the whole class for a general discussion.

These case studies are primarily addressed to ships' personnel and are not generally intended for use on a course consisting of consignors, packers and agents. However, if time permits, it may be useful for the course tutor to use one of these exercises to illustrate the need for safe packaging and accurate documentation. It will enable these students to appreciate the need for compliance with the IMDG Code.

It should be noted that the MFAG guidance is based on the use of the new MFAG and should be regarded as an illustration of the steps that need to be taken.

Case study number 1
A container vessel was passing off the coast of Portugal on its way to the Suez Canal. Two crew members, John and Albert, were walking along the weatherdeck of the vessel. Suddenly John slipped and fell, and a liquid on the deck impregnated his hands, arms, T-shirt and jeans. A leakage of a yellow liquid was noticed from an adjacent container. With Albert's assistance John was soon back on his feet, and they went to the chief officer and reported the incident. Shortly after John had changed his clothes and washed he complained about headache, stomach pains and weakness, which Albert reported to the chief officer.

The captain was informed of the accident, the leaking container was found, and when the stowage position and container number was known it could be determined that it contained two different liquids, classified as dangerous goods:

- five steel drums ethyl chloroformate
- three plastic drums UN 3018

What action should be taken with regard to:

(a) Medical treatment of John?

(b) Cleaning of spillage?

Proposed actions:
Send John and Albert to ship's hospital for thorough washing of skin, observation and treatment.

Ascertain that no possible dangerous vapours penetrate ventilation systems.

A check of the two suspected liquids in the IMDG Code reveals that ethyl chloroformate is colourless, whilst no detail is provided concerning the colour of UN 3018 which is shown in the DGL to be an organophosphorus pesticide, liquid, toxic (fenabutatin oxide). Consequently, it was concluded that the substance causing the incident was unlikely to be the ethyl chloroformate and that the procedures for UN 3018 should be followed. It was also noted that UN 3018 is possibly a marine pollutant.

The advice regarding emergency procedures for a spillage of UN 3018 is found in EmS no. S-A; information for first aid is in the MFAG.

Medical treatment:
The MFAG Emergency Action chart was consulted and followed. It was concluded that the chemical fumes may have been inhaled and table 9 of the MFAG was consulted and prepared to be acted upon. Before this action got under way the Diagnosis chart of the MFAG was checked and the specific treatment box was seen to make reference to organophosphorus insecticides and table No. 17 was shown to be a more appropriate source of advice than table 9.

It was seen that treatment for eye and skin contact together with inhalation and ingestion treatment was necessary in all cases, regardless of exposure. Routines were put in place for eyewash treatment and a more thorough assisted shower wash with the assistants wearing protective kit. A mouthwash was administered and a single glass of water was drunk.

Medical advice was received by radio, and in view of the vessel's position off the coast of Portugal it was decided to make an emergency call at the nearest port and send John to hospital.

In the meantime he was kept warm in bed and he was given 1 mg atropine intramuscularly. John was then closely observed to check that his skin and mouth became dry. If they did not dry, repeat injections would have to be administered at 30 minute intervals.

It was also decided that Albert should also be kept under observation and have a medical check in port due to his contacts with John when the accident happened. All clothing worn by John and Albert during the incident was bagged and labelled prior to being thoroughly washed.

Cleaning of spillage:
An emergency team was formed, equipped with protective clothing and self-contained breathing apparatus. The vessel's supply of absorbent material was brought forward, measures were taken to prevent as much as possible of the spillage from entering into the sea (marine pollutant)(see special cases in S-A), and the absorbed spillage was collected in a salvage packaging carried onboard for emergency situations. The doors of the container were opened, and since the leaking drum, which leaked from the bottom, was stowed at the door end it was possible to turn it over and stop the leak that way. The areas which had been penetrated by the leaking liquid were thoroughly washed with copious quantities of water. The container was discharged during the emergency call for total cleaning, and the salvage packaging was also discharged for final disposal of contents. All emergency equipment used was thoroughly washed and cleaned.

The Portuguese authorities were informed of the leakage of a marine pollutant into the sea.

Case study number 2
On the main deck of a ro-ro vessel a pallet with dry calcium hypochlorite had been damaged during bad weather conditions. Some fibreboard boxes with plastic bags had been torn and a white powder was spilt on the deck. Suggest suitable emergency actions.

Proposed actions:

Calcium hypochlorite, dry, UN 1748, is classified in class 5.1 (Oxidizing Substances) and referred to EmS no. S-Q.

Note: In the indexes the EmS number is underlined, which means that there is an additional remark for this product at the bottom of the Emergency Schedule. It reads: "In spillage situation, do NOT repack".

An emergency team is formed, wearing protective gloves, boots and goggles and equipped with brushes and trays. The spillage, which is not a marine pollutant, is thoroughly collected and disposed of overboard together with the damaged packagings.

Remaining intact packages are secured to the pallet, and the clothing and other equipment used by the emergency team are thoroughly washed with copious quantities of water.

Case study number 3
On the weather deck of a conventional cargo ship a fire was detected, affecting wooden and plastics materials. It was determined that no dangerous goods were directly involved; however, not far from the fire a 20-foot flat was stowed, containing plastic drums with methanol.

What action should be taken?

Proposed actions:

It was decided to fight the fire with water jets and that normal fire-fighting equipment and clothing should be used. The removal of the methanol drums to a safe area was not considered possible, and therefore two fire hoses only were used for cooling down the drums with copious quantities of water.

Case study number 4
During a voyage some cargo in the 'tween-deck of hatch no. 2 had moved and the securing had to be improved. One shrink-wrapped pallet, loaded with plastics jerricans containing battery acid, had to be partly restowed, and a crew member wearing rubber gloves started the work. He did not notice that the top of one of the jerricans had been damaged; when he attempted to lift the jerrican it broke and acid spilled over his arms, chest and legs. There was no evidence that the liquid had penetrated his eyes but after immediate removal of clothing and a thorough washing he still complained about skin irritation and redness of skin could be observed.

What action should be taken?

Medical treatment:
The Emergency Action table of MFAG was consulted. In accordance with the Emergency Action table, table 8 was consulted to determine the correct response to skin contamination.

The victim was quickly taken to the nearest shower and then washed thoroughly but gently with soap and water for 10 minutes by attendants wearing protective equipment. Since redness of skin could still be observed he was washed gently for another 10 minutes with attention paid to skin folds and nails. He was then taken to the sick bay for observation.

No evidence was found that the acid had been absorbed through the intact skin, and no burns had developed; however, for the sake of order a medical centre ashore was contacted for advice. The victim was kept under observation for 48 hours to ensure that no delayed symptoms presented themselves.

Cleaning of spillage:
Even if the concentration of the acid was on the low side it was feared that it might damage the bilge-pumping system. The vessel's supply of inert absorbent was brought forward and a team equipped with protective clothing and self-contained breathing apparatus tried to absorb as much of the spilt acid as possible, which was collected in an empty plastic drum for later disposal. The remainder of the spill was washed off and diluted with copious quantities of water.

Part E: Evaluation

Introduction

The effectiveness of any evaluation depends on the accuracy of the description of what is to be measured. The learning objectives that are used in the detailed teaching syllabus will provide a sound base for the construction of suitable tests for evaluating trainee progress.

Method of evaluation

The methods chosen to carry out an evaluation will depend upon what the trainee is expected to achieve in terms of knowing, comprehending and applying the course content.

The methods used can range from a simple question-and-answer discussion with the trainees (either individually or as a group) to prepared tests requiring the selection of correct or best responses from given alternatives, the correct matching of given items, the supply of short answers or the supply of more extensive written responses to prepared questions.

Where the course content is aimed at the acquisition of practical skills, the test would involve a practical demonstration by the trainee making use of appropriate equipment, tools, etc.

The responses demanded may therefore consist of:

- the recall of facts or information, by viva voce or objective tests
- the practical demonstration of an attained skill
- the oral or written description of procedures or activities
- the identification and use of data from sketches, drawings, maps, charts, etc.
- carrying out calculations to solve numerical problems
- the writing of an essay or report

Validity

The evaluation must be based on clearly-defined objectives, and it must truly represent what is to be measured. There must be a reasonable balance between the subject topics involved and also in the testing of trainees' knowledge, comprehension and application of concepts. The time allocated for the trainees to provide a response is very important. Each question or task must be properly tested and validated before it is used to ensure that the test will provide a fair and valid evaluation.

Reliability

To be reliable, an evaluation procedure should produce reasonably consistent results no matter which set of papers or version of the test is used.

Subjective testing

Traditional methods of evaluation require the trainee to demonstrate what has been learned by stating or writing formal answers to questions. Such evaluation is subjective in that it invariably depends upon the judgement of the evaluator. Different evaluators can produce quite different scores when marking the same paper or evaluating oral answers.

Objective testing

A variety of objective tests have been developed over the years. Their common feature is that the evaluation does not require a judgement by the evaluator. The response is either right or wrong.

One type of objective test involves supplying an answer, generally a single word, to complete the missing portion of a sentence. Another involves supplying a short answer of two or three words to a question. Such tests are known as "completion tests" and "short answer tests".

Another form of objective testing consists of "selective response tests" in which the correct, or best, response must be selected from given alternatives. Such tests may consist of "matching tests", in which items contained in two separate lists must be matched, or they may be of the true/false type or of the multiple-choice type.

The most flexible form of objective test is the multiple-choice test, which presents the trainee with a problem and a list of alternative solutions from which he must select the most appropriate.

Distracters

The incorrect alternatives in multiple-choice questions are called "distracters", because their purpose is to distract the uninformed trainee from the correct response. The distracter must be realistic and should be based on misconceptions commonly held, or on mistakes commonly made.

The options "none of the above" or "all of the above" are used in some tests. These can be helpful, but should be used sparingly.

Distracters should distract the uninformed, but they should not take the form of "trick" questions that could mislead the knowledgeable trainee (for example, do not insert "not" into a correct response to make it a distracter).

Guess factor

The "guess factor" with four alternative responses in a multiple-choice test would be 25%. The pass mark chosen for all selective-response questions should take this into account.

Scoring

In simple scoring of objective tests one mark may be allotted to each correct response and zero for a wrong or nil response.

A more sophisticated scoring technique entails awarding one mark for a correct response, zero for a nil response and minus one for an incorrect response. Where a multiple-choice test involves four alternatives, this means that a totally uninformed guess involves a 25% chance of gaining one mark and a 75% chance of losing one mark.

Scores can be weighted to reflect the relative importance of questions, or of sections of an evaluation.

Information Requested of Instructors Who Implement IMO Model Courses

Introduction

1 IMO model courses are periodically revised to take into account the changes which have taken place in relevant conventions, resolutions and other matters affecting each course. To help IMO to improve the content of courses when they are revised, the assistance of all instructors who implement or participate in implementing courses is requested, whether the implementation is part of an IMO technical co-operation project or part of a maritime training academy's regular programme.

Information requested and its format

2 To simplify their consolidation by IMO, the technical comments and suggestions for the improvement of model courses should follow the format that is outlined below. If no comments or suggestions are to be provided under a topic, please insert "no comment" against the item.

3 Please identify:

.1 the course number and title;

.2 the date and location of its implementation;

.3 the approximate number of IMO model courses you have implemented to date; and

.4 the approximate number of times you have implemented this particular model course.

4 In commenting on Part A: Course Framework, please comment on the items ("Scope", "Objectives", etc.) in the order in which they appear in the course; in all cases, please indicate:

.1 the number of participants who met the entry standards and the number who did not;

.2 the course intake and, if the recommendations in "Course intake limitations" were exceeded, the reasons for this and your observations on the effect of this on the quality of the course;

.3 if the conditions under "Staff requirements" were met; if not, please indicate the nature of the deficiency and give your observations of the effect of this on the quality of presentation of the course; and

.4 any lack of equipment or facilities as compared with the recommendations under "Teaching facilities and equipment" and your observations of the effect of this lack on the quality of presentation of the course.

5 In commenting on Part B: Course Outline, please bear in mind that minor variations in time allocations are inevitable. Major difficulties with allocations of time and any omissions or redundancies of subject areas should be briefly explained.

6 In commenting on Part C: Detailed Teaching Syllabus, please identify the specific learning objectives concerned by their paragraph numbers.

7 In commenting on Part D: Instructor's Manual, please clearly identify the section concerned. If the bibliography or the practical exercises are found to be unsatisfactory, please identify suitable alternative texts, as far as is possible, or outline alternative exercises, as appropriate.

8 In commenting on the Compendium, please clearly identify the paragraphs being commented upon.

9 Any further comments or suggestions you may have which fall outside the scope of the items listed above may be added at the end. In particular, your views on the usefulness of the course material to you in implementing the course would be appreciated, as would the contribution to IMO of any additional teaching material you found useful in implementing it.

10 Please address your comments to:

Maritime Safety Division
International Maritime Organization
4 Albert Embankment
London SE1 7SR
United Kingdom

Fax (+) 44 (0)20 7587 3210

Guidance on the Implementation of Model Courses

CONTENTS

Part 1 – Preparation

1 Introduction

1.1 The success of any enterprise depends heavily on sound and effective preparations.

1.2 Although the IMO model course "package" has been made as comprehensive as possible, it is nonetheless vital that sufficient time and resources are devoted to preparation. Preparation not only involves matters concerning administration or organization, but also includes the preparation of any course notes, drawings, sketches, overhead transparencies, etc., which may be necessary.

2 General considerations

2.1 The course "package" should be studied carefully; in particular, the course syllabus and associated material must be attentively and thoroughly studied. This is vital if a clear understanding is to be obtained of what is required, in terms of resources necessary to successfully implement the course.

2.2 A "checklist", such as that set out in annex A1, should be used throughout all stages of preparation to ensure that all necessary actions and activities are being carried out in good time and in an effective manner. The checklist allows the status of the preparation procedures to be monitored, and helps in identifying the remedial actions necessary to meet deadlines. It will be necessary to hold meetings of all those concerned in presenting the course from time to time in order to assess the status of the preparation and "trouble-shoot" any difficulties.

2.3 The course syllabus should be discussed with the teaching staff who are to present the course, and their views received on the particular parts they are to present. A study of the syllabus will determine whether the incoming trainees need preparatory work to meet the entry standard. The detailed teaching syllabus is constructed in "training outcome" format. Each specific outcome states precisely what the trainee must do to show that the outcome has been achieved. An example of a model course syllabus is given in annex A2. Part 3 deals with curriculum development and explains how a syllabus is constructed and used.

2.4 The teaching staff who are to present the course should construct notes or lesson plans to achieve these outcomes. A sample lesson plan for one of the areas of the sample syllabus is provided in annex A3.

2.5 It is important that the staff who present the course convey, to the person in charge of the course, their assessment of the course as it progresses.

3 Specific considerations

3.1 Scope of course

In reviewing the scope of the course, the instructor should determine whether it needs any adjustment in order to meet additional local or national requirements (see Part 3).

3.2 Course objective

3.2.1 The course objective, as stated in the course material, should be very carefully considered so that its meaning is fully understood. Does the course objective require

expansion to encompass any additional task that national or local requirements will impose upon those who successfully complete the course? Conversely, are there elements included which are not validated by national industry requirements?

3.2.2 It is important that any subsequent assessment made of the course should include a review of the course objectives.

3.3 Entry standards

3.3.1 If the entry standard will not be met by your intended trainee intake, those entering the course should first be required to complete an upgrading course to raise them to the stated entry level. Alternatively, those parts of the course affected could be augmented by inserting course material which will cover the knowledge required.

3.3.2 If the entry standard will be exceeded by your planned trainee intake, you may wish to abridge or omit those parts of the course the teaching of which would be unnecessary, or which could be dealt with as revision.

3.3.3 Study the course material with the above questions in mind and with a view to assessing whether or not it will be necessary for the trainees to carry out preparatory work prior to joining the course. Preparatory material for the trainees can range from refresher notes, selected topics from textbooks and reading of selected technical papers, through to formal courses of instruction. It may be necessary to use a combination of preparatory work and the model course material in modified form. It must be emphasized that where the model course material involves an international requirement, such as a regulation of the International Convention on Standards of Training, Certification and Watchkeeping (STCW) 1978, as amended, the standard must not be relaxed; in many instances, the intention of the Convention is to require review, revision or increased depth of knowledge by candidates undergoing training for higher certificates.

3.4 Course certificate, diploma or document

Where a certificate, diploma or document is to be issued to trainees who successfully complete the course, ensure that this is available and properly worded and that the industry and all authorities concerned are fully aware of its purpose and intent.

3.5 Course intake limitations

3.5.1 The course designers have recommended limitations regarding the numbers of trainees who may participate in the course. As far as possible, these limitations should not be exceeded; otherwise, the quality of the course will be diluted.

3.5.2 It may be necessary to make arrangements for accommodating the trainees and providing facilities for food and transportation. These aspects must be considered at an early stage of the preparations.

3.6 Staff requirements

3.6.1 It is important that an experienced person, preferably someone with experience in course and curriculum development, is given the responsibility of implementing the course.

3.6.2 Such a person is often termed a "course co-ordinator" or "course director". Other staff, such as lecturers, instructors, laboratory technicians, workshop instructors, etc., will be needed to implement the course effectively. Staff involved in presenting the course will need to be properly briefed about the course work they will

be dealing with, and a system must be set up for checking the material they may be required to prepare. To do this, it will be essential to make a thorough study of the syllabus and apportion the parts of the course work according to the abilities of the staff called upon to present the work.

3.6.3 The person responsible for implementing the course should consider monitoring the quality of teaching in such areas as variety and form of approach, relationship with trainees, and communicative and interactive skills; where necessary, this person should also provide appropriate counselling and support.

3.7 Teaching facilities and equipment

Rooms and other services

3.7.1 It is important to make reservations as soon as is practicable for the use of lecture rooms, laboratories, workshops and other spaces.

Equipment

3.7.2 Arrangements must be made at an early stage for the use of equipment needed in the spaces mentioned in 3.7.1 to support and carry through the work of the course. For example:

.1 blackboards and writing materials
.2 apparatus in laboratories for any associated demonstrations and experiments
.3 machinery and related equipment in workshops
.4 equipment and materials in other spaces (e.g. for demonstrating fire fighting, personal survival, etc.).

3.8 Teaching aids

Any training aids specified as being essential to the course should be constructed, or checked for availability and working order.

3.9 Audio-visual aids

Audio-visual aids (AVA) may be recommended in order to reinforce the learning process in some parts of the course. Such recommendations will be identified in Part A of the model course. The following points should be borne in mind:

.1 Overhead projectors

Check through any illustrations provided in the course for producing overhead projector (OHP) transparencies, and arrange them in order of presentation. To produce transparencies, a supply of transparency sheets is required; the illustrations can be transferred to these via photocopying. Alternatively, transparencies can be produced by writing or drawing on the sheet. Coloured pens are useful for emphasizing salient points. Ensure that spare projector lamps (bulbs) are available.

.2 Slide projectors

If you order slides indicated in the course framework, check through them and arrange them in order of presentation. Slides are usually produced from photographic negatives. If further slides are considered necessary and cannot be produced locally, OHP transparencies should be resorted to.

.3 Cine projector

If films are to be used, check their compatibility with the projector (i.e. 16 mm, 35 mm, sound, etc.). The films must be test-run to ensure there are no breakages.

.4 Video equipment

It is essential to check the type of video tape to be used. The two types commonly used are VHS and Betamax. Although special machines exist which can play either format, the majority of machines play only one or the other type. Note that VHS and Betamax are not compatible; the correct machine type is required to match the tape. Check also that the TV raster format used in the tapes (i.e. number of lines, frames/second, scanning order, etc.) is appropriate to the TV equipment available. (Specialist advice may have to be sought on this aspect.) All video tapes should be test-run prior to their use on the course.

.5 Computer equipment

If computer-based aids are used, check their compatibility with the projector and the available software.

.6 General note

The electricity supply must be checked for voltage and whether it is AC or DC, and every precaution must be taken to ensure that the equipment operates properly and safely. It is important to use a proper screen which is correctly positioned; it may be necessary to exclude daylight in some cases. A check must be made to ensure that appropriate screens or blinds are available. All material to be presented should be test-run to eliminate any possible troubles, arranged in the correct sequence in which it is to be shown, and properly identified and cross-referenced in the course timetable and lesson plans.

3.10 IMO references

The content of the course, and therefore its standard, reflects the requirements of all the relevant IMO international conventions and the provisions of other instruments as indicated in the model course. The relevant publications can be obtained from the Publication Service of IMO, and should be available, at least to those involved in presenting the course, if the indicated extracts are not included in a compendium supplied with the course.

3.11 Textbooks

The detailed syllabus may refer to a particular textbook or textbooks. It is essential that these books are available to each student taking the course. If supplies of textbooks are limited, a copy should be loaned to each student, who will return it at the end of the course. Again, some courses are provided with a compendium which includes all or part of the training material required to support the course.

3.12 Bibliography

Any useful supplementary source material is identified by the course designers and listed in the model course. This list should be supplied to the participants so that they are aware where additional information can be obtained, and at least two copies of each book or publication should be available for reference in the training institute library.

3.13 Timetable

If a timetable is provided in a model course, it is for guidance only. It may only take one or two presentations of the course to achieve an optimal timetable. However, even then it must be borne in mind that any timetable is subject to variation, depending on the general needs of the trainees in any one class and the availability of instructors and equipment.

Part 2 – Notes on Teaching Technique

1 Preparation

1.1 Identify the section of the syllabus which is to be dealt with.

1.2 Read and study thoroughly all the syllabus elements.

1.3 Obtain the necessary textbooks or reference papers which cover the training area to be presented.

1.4 Identify the equipment which will be needed, together with support staff necessary for its operation.

1.5 It is essential to use a "lesson plan", which can provide a simplified format for co-ordinating lecture notes and supporting activities. The lesson plan breaks the material down into identifiable steps, making use of brief statements, possibly with keywords added, and indicating suitable allocations of time for each step. The use of audio-visual material should be indexed at the correct point in the lecture with an appropriate allowance of time. The audio-visual material should be test-run prior to its being used in the lecture. An example of a lesson plan is shown in annex A3.

1.6 The syllabus is structured in training outcome format and it is thereby relatively straightforward to assess each trainee's grasp of the subject matter presented during the lecture. Such assessment may take the form of further discussion, oral questions, written tests or selection-type tests, such as multiple-choice questions, based on the objectives used in the syllabus. Selection-type tests and short-answer tests can provide an objective assessment independent of any bias on the part of the assessor. For certification purposes, assessors should be appropriately qualified for the particular type of training or assessment.

REMEMBER – POOR PREPARATION IS A SURE WAY TO LOSE THE INTEREST OF A GROUP

1.7 Check the rooms to be used before the lecture is delivered. Make sure that all the equipment and apparatus are ready for use and that any support staff are also prepared and ready. In particular, check that all blackboards are clean and that a supply of writing and cleaning materials is readily available.

2 Delivery

2.1 Always face the people you are talking to; never talk with your back to the group.

2.2 Talk clearly and sufficiently loudly to reach everyone.

2.3 Maintain eye contact with the whole group as a way of securing their interest and maintaining it (i.e. do not look continuously at one particular person, nor at a point in space).

2.4 People are all different, and they behave and react in different ways. An important function of a lecturer is to maintain interest and interaction between members of a group.

2.5 Some points or statements are more important than others and should therefore be emphasized. To ensure that such points or statements are remembered, they must be restated a number of times, preferably in different words.

2.6 If a blackboard is to be used, any writing on it must be clear and large enough for everyone to see. Use colour to emphasize important points, particularly in sketches.

2.7 It is only possible to maintain a high level of interest for a relatively short period of time; therefore, break the lecture up into different periods of activity to keep interest at its highest level. Speaking, writing, sketching, use of audio-visual material, questions, and discussions can all be used to accomplish this. When a group is writing or sketching, walk amongst the group, looking at their work, and provide comment or advice to individual members of the group when necessary.

2.8 When holding a discussion, do not allow individual members of the group to monopolize the activity, but ensure that all members have a chance to express opinions or ideas.

2.9 If addressing questions to a group, do not ask them collectively; otherwise, the same person may reply each time. Instead, address the questions to individuals in turn, so that everyone is invited to participate.

2.10 It is important to be guided by the syllabus content and not to be tempted to introduce material which may be too advanced, or may contribute little to the course objective. There is often competition between instructors to achieve a level which is too advanced. Also, instructors often strongly resist attempts to reduce the level to that required by a syllabus.

2.11 Finally, effective preparation makes a major contribution to the success of a lecture. Things often go wrong; preparedness and good planning will contribute to putting things right. Poor teaching cannot be improved by good accommodation or advanced equipment, but good teaching can overcome any disadvantages that poor accommodation and lack of equipment can present.

Part 3 – Curriculum Development

1 Curriculum

The dictionary defines curriculum as a "regular course of study", while syllabus is defined as "a concise statement of the subjects forming a course of study". Thus, in general terms, a curriculum is simply a course, while a syllabus can be thought of as a list (traditionally, a "list of things to be taught").

2 Course content

The subjects which are needed to form a training course, and the precise skills and depth of knowledge required in the various subjects, can only be determined through an in-depth assessment of the job functions which the course participants are to be trained to perform (job analysis). This analysis determines the training needs, thence the purpose of the course (course objective). After ascertaining this, it is possible to define the scope of the course.

(NOTE: Determination of whether or not the course objective has been achieved may quite possibly entail assessment, over a period of time, of the "on-the-job performance" of those completing the course. However, the detailed learning objectives are quite specific and immediately assessable.)

3 Job analysis

A job analysis can only be properly carried out by a group whose members are representative of the organizations and bodies involved in the area of work to be covered by the course. The validation of results, via review with persons currently employed in the job concerned, is essential if undertraining and overtraining are to be avoided.

4 Course plan

Following definition of the course objective and scope, a course plan or outline can be drawn up. The potential students for the course (the trainee target group) must then be identified, the entry standard to the course decided and the prerequisites defined.

5 Syllabus

The final step in the process is the preparation of the detailed syllabus with associated time scales; the identification of those parts of textbooks and technical papers which cover the training areas to a sufficient degree to meet, but not exceed, each learning objective; and the drawing up of a bibliography of additional material for supplementary reading.

6 Syllabus content

The material contained in a syllabus is not static; technology is continuously undergoing change and there must therefore be a means for reviewing course material in order to eliminate what is redundant and introduce new material reflecting current practice. As defined above, a syllabus can be though of as a list and, traditionally, there

have always been an "examination syllabus" and a "teaching syllabus"; these indicate, respectively, the subject matter contained in an examination paper, and the subject matter a teacher is to use in preparing lessons or lectures.

7 Training outcomes

7.1 The prime communication difficulty presented by any syllabus is how to convey the "depth" of knowledge required. A syllabus is usually constructed as a series of "training outcomes" to help resolve this difficulty.

7.2 Thus, curriculum development makes use of training outcomes to ensure that a common minimum level and breadth of attainment is achieved by all the trainees following the same course, irrespective of the training institution (i.e. teaching/lecturing staff).

7.3 Training outcomes are trainee-oriented, in that they describe an end result which is to be achieved by the trainee as a result of a learning process.

7.4 In many cases, the learning process is linked to a skill or work activity and, to demonstrate properly the attainment of the objective, the trainee response may have to be based on practical application or use, or on work experience.

7.5 The training outcome, although aimed principally at the trainee to ensure achievement of a specific learning step, also provides a framework for the teacher or lecturer upon which lessons or lectures can be constructed.

7.6 A training outcome is specific and describes precisely what a trainee must do to demonstrate his knowledge, understanding or skill as an end product of a learning process.

7.7 The learning process is the "knowledge acquisition" or "skill development" that takes place during a course. The outcome of the process is an acquired "knowledge", "understanding", "skill"; but these terms alone are not sufficiently precise for describing a training outcome.

7.8 Verbs, such as "calculates", "defines", "explains", "lists", "solves" and "states", must be used when constructing a specific training outcome, so as to define precisely what the trainee will be enabled to do.

7.9 In the IMO model course project, the aim is to provide a series of model courses to assist instructors in developing countries to enhance or update the maritime training they provide, and to allow a common minimum standard to be achieved throughout the world. The use of training outcomes is a tangible way of achieving this desired aim.

7.10 As an example, a syllabus in training-outcome format for the subject of ship construction appears in annex A2. This is a standard way of structuring this kind of syllabus. Although, in this case, an outcome for each area has been identified – and could be used in an assessment procedure – this stage is often dropped to obtain a more compact syllabus structure.

8 Assessment

Training outcomes describe an outcome which is to be achieved by the trainee. Of equal importance is the fact that such an achievement can be measured OBJECTIVELY through an evaluation which will not be influenced by the personal opinions and judgements of the examiner. Objective testing or evaluation provides a sound base on which to make reliable judgements concerning the levels of understanding and knowledge achieved, thus allowing an effective evaluation to be made of the progress of trainees in a course.

Annex A1 – Preparation checklist

Ref	Component	Identified	Reserved	Electricity supply	Purchases	Tested	Accepted	Started	Finished	Status OK
1	Course plan									
2	Timetable									
3	Syllabus									
4	Scope									
5	Objective									
6	Entry standard									
7	Preparatory course									
8	Course certificate									
9	Participant numbers									
10	Staffing									
	Co-ordinator									
	Lecturers									
	Instructors									
	Technicians									
	Other									

Annex A1 – Preparation checklist (continued)

Ref	Component	Identified	Reserved	Electricity supply	Purchases	Tested	Accepted	Started	Finished	Status OK
11	Facilities									
	(a) Rooms									
	Lab									
	Workshop									
	Other									
	Class									
	(b) Equipment									
	Lab									
	Workshop									
	Other									
12	AVA Equipment and materials									
	OHP									
	Slide									
	Cine									
	Video									
13	IMO reference									
14	Textbooks									
15	Bibliography									

Annex A2 – Example of a Model Course syllabus in a subject area

Subject area:	Ship construction
Prerequisite:	Have a broad understanding of shipyard practice
General aims:	Have knowledge of materials used in shipbuilding, specification of shipbuilding steel and process of approval
Textbooks:	No specific textbook has been used to construct the syllabus, but the instructor would be assisted in preparation of lecture notes by referring to suitable books on ship construction, such as *Ship Construction* by Eyres (T12) and *Merchant Ship Construction* by Taylor (T58)

COURSE OUTLINE

Knowledge, understanding and proficiency		Total hours for each topic	Total hours for each subject area of Required performance
Competence:			
3.1 CONTROL TRIM, STABILITY and STRESS			
3.1.1 FUNDAMENTAL PRINCIPLES OF SHIP CONSTRUCTION, TRIM AND STABILITY			
.1	Shipbuilding materials	3	
.2	Welding	3	
.3	Bulkheads	4	
.4	Watertight and weathertight doors	3	
.5	Corrosion and its prevention	4	
.6	Surveys and dry-docking	2	
.7	Stability	83	102

Part C3: Detailed Teaching Syllabus

Introduction
The detailed teaching syllabus is presented as a series of learning objectives. The objective, therefore, describes what the trainee must do to demonstrate that the specified knowledge or skill has been transferred.

Thus each training outcome is supported by a number of related performance elements in which the trainee is required to be proficient. The teaching syllabus shows the Required performance expected of the trainee in the tables that follow.

In order to assist the instructor, references are shown to indicate IMO references and publications, textbooks and teaching aids that instructors may wish to use in preparing and presenting their lessons.

The material listed in the course framework has been used to structure the detailed training syllabus; in particular:

Teaching aids (indicated by A)
IMO references (indicated by R) and
Textbooks (indicated by T)

will provide valuable information to instructors.

Explanation of information contained in the syllabus tables

The information on each table is systemtically organized in the following way. The line at the head of the table describes the FUNCTION with which the training is concerned. A function means a group of tasks, duties and responsibilities as specified in the STCW Code. It describes related activities which make up a professional discipline or traditional departmental responsibility on board.

The header of the first column denotes the COMPETENCE concerned. Each function comprises a number of COMPETENCES. Each competence is uniquely and consistently numbered on this model course.

In this function the competence is **Control trim, stability and stress**. It is numbered 3.1, that is the first competence in Function 3. The term "competence" should be understood as the application of knowledge, understanding, proficiency, skills, experience for an individual to perform a task, duty or responsibility on board in a safe, efficient and timely manner.

Shown next is the required TRAINING OUTCOME. The training outcomes are the areas of knowledge, understanding and proficiency in which the trainee must be able to demonstrate knowledge and understanding. Each COMPETENCE comprises a number of training outcomes. For example, the above competence comprises three training outcomes. The first is concerned with FUNDAMENTAL PRINCIPLES OF SHIP CONSTRUCTION, TRIM AND STABILITY. Each training outcome is uniquely and consistently numbered in this model course. That concerned with fundamental principles of ship construction, trim and stability is uniquely numbered 3.1.1. For clarity, training outcomes are printed in black type on grey, for example TRAINING OUTCOME.

Finally, each training outcome embodies a variable number of Required performances – as evidence of competence. The instruction, training and learning should lead to the trainee meeting the specified Required performance. For the training outcome concerned with the fundamental principles of ship construction, trim and stability there are three areas of performance. These are:

3.1.1.1 Shipbuilding materials
3.1.1.2 Welding
3.1.1.3 Bulkheads

Following each numbered area of Required performance there is a list of activities that the trainee should complete and which collectively specify the standard of competence that the trainee must meet. These are for the guidance of teachers and instructors in designing lessons, lectures, tests and exercises for use in the teaching process. For example, under the topic 3.1.1.1, to meet the Required performance, the trainee should be able to:

- state that steels are alloys of iron, with properties dependent upon the type and amount of alloying materials used
- state that the specification of shipbuilding steels are laid down by classification societies
- state that shipbuilding steel is tested and graded by classification society surveyors who stamp it with approved marks

and so on.

IMO references (R*x*) are listed in the column to the right-hand side. Teaching aids (A*x*), videos (V*x*) and textbooks (T*x*) relevant to the training outcome and Required performances are placed immediately following the TRAINING OUTCOME title.

It is not intended that lessons are organized to follow the sequence of Required performances listed in the Tables. The Syllabus Tables are organized to match with the competence in the STCW Code Table A-II/2. Lessons and teaching should follow college practices. It is not necessary, for example, for ship building materials to be studied before stability. What is necessary is that *all* of the material is covered and tha teaching is effective to allow trainees to meet the standard of the Required performance.

COMPETENCE 3.1	Control trim, stability and stress	IMO reference

3.1.1 FUNDAMENTAL PRINCIPLES OF SHIP CONSTRUCTION, TRIM AND STABILITY

Textbooks: T11, T12, T35, T58, T69

Teaching aids: A1, A4, V5, V6, V7

Required performance:

1.1 Shipbuilding materials (3 hours) R1

- states that steels are alloys of iron, with properties dependent upon the type and amounts of alloying materials used
- states that the specifications of shipbuilding steels are laid down by classification societies
- states that shipbuilding steel is tested and graded by classification surveyors, who stamp it with approved marks
- explains that mild steel, graded A – E, is used for most parts of the ship
- states why higher tensile steel may be used in areas of high stress, such as the sheer strake
- explains that the use of higher tensile steel in place of mild steel results in saving of weight for the same strength
- explains what is meant by:
  - tensile strength
  - ductility
  - hardness
  - toughness
- defines strain as extension divided by original length
- sketches a stress-strain curve for mild steel
- explains
  - yield point
  - ultimate tensile stress
- ● modulus of elasticity
  explains that toughness is related to the tendency to brittle fracture
- explains that stress fracturemay be initiated by a small crack or notch in a plate
- states that cold conditions increase the chances of brittle fracture
- states why mild steel is unsuitable for the very low temperatures involved in the containment of liquefied gases
- lists examples where castings or forgings are used in ship construction
- explains the advantages of the use of aluminium alloys in the construction of superstructures
- states that aluminium alloys are tested and graded by classification society surveyors
- explains how strength is preserved in aluminium superstructures in the event of fire
- describes the special precautions against corrosion that are needed where aluminium alloy is connected to steelwork

Annex A3 – Example of a lesson plan for annex A2

Subject area: 3.1 Control trim, stability and stress **Lesson number: 1** **Duration: 3 hours**

Training Area: 3.1.1 Fundamental principles of ship construction, trim and stability

Main element Specific training outcome in teaching sequence, with memory keys	Teaching method	Textbook	IMO reference	A/V aid	Instructor guidelines	Lecture notes	Time (minutes)
1.1 Shipbuilding materials (3 hours)							
States that steels are alloys of iron, with properties dependent upon the type and amounts of alloying materials used	Lecture	T12, T58	STCW II/2, A-II/2	V5 to V7	A1	Compiled by the lecturer	10
States that the specifications of shipbuilding steels are are laid down by classification societies	Lecture	T12, T58	STCW II/2, A-II/2	V5 to V7	A1	Compiled by the lecturer	20
Explains that mild steel, graded A to E, is used for most parts of the ship	Lecture	T12, T58	STCW II/2, A-II/2	V5 to V7	A1	Compiled by the lecturer	15
States why higher tensile steel may be used in areas of high stress, such as the sheer strake	Lecture	T12, T58	STCW II/2, A-II/2	V5 to V7	A1	Compiled by the lecturer	10
Explains that use of higher tensile steel in place of mild steel results in a saving of weight for the same strength	Lecture	T12, T58	STCW II/2, A-II/2	V5 to V7	A1	Compiled by the lecturer	15

Compendium for Model Course 1.10

Dangerous, Hazardous and Harmful Cargoes

Part 1: Purpose of the Course

1.1 Main issues

The transport of dangerous goods by sea causes potential problems primarily with respect to safety but also political.

Why have dangerous goods transport rules? Over the years there have been some serious accidents, and it is not acceptable for innocent people to be hurt or for damage to be caused to the environment.

Road accidents account for far more deaths and injury than accidents involving dangerous goods in transport. Nevertheless, even quite small quantities of dangerous goods can cause significant damage, and when accidents do happen they can be very serious. Listed below are some examples of the consequences of accidents involving dangerous goods. Many relate to sea journeys:

- in 1974, unknown to the crew, a number of arsine cylinders were loaded inside a container being shipped across the Atlantic. One of the cylinders leaked because it was incorrectly stowed. Some twenty years later, crew members who went to investigate were still unable to work because of the effects;

- in 1978 over 200 people were killed when a road tanker exploded in Spain;

- in 1984 the *Mont St Louis*, a cargo vessel, sank in the North Sea after colliding with a ro-ro ferry. Part of the cargo contained uranium hexafluoride. Although there was no leakage, the fact that nuclear material sank in one of the busiest shipping lanes in the world caused an outcry;

- in 1985 the East African port of Mogadishu (Somalia) was put on alert for possible evacuation when the *Ariadne* ran aground and began to break up. The ship's manifest showed that there were dangerous goods from six of the nine classes on board. As the ship broke up and the containers washed overboard the population had to be warned not to eat fish and dead fish began to be washed up on the shore;

- in 1987 the *Cason* ran aground in bad weather off the Spanish coast. On board here were dangerous goods from six of the nine classes, amounting to over 1,000 tonnes. Large quantities of dangerous goods were spilt into the sea. The incident raised questions regarding the adequacy of packaging, stowage and on board documentation;

- in 1989 in Peterborough, UK, a vehicle carrying explosives killed one person and almost destroyed an industrial estate;

- in 1990 in Bangkok, Thailand, a tanker of petrol exploded killing a large number of people;

- in 1992 the *POL East*, a container ship trading between the Far East and European ports was travelling through the Red Sea when the crew became aware of an unusual smell. Eventually it was discovered that two 200 litre drums of fungicide were leaking in one of the containers. A salvage party joined the ship in Gibraltar as the contamination increased. The problem was exacerbated because the particular chemical had two UN Numbers, one for the pure solid substance and another for the substance in solution.

It was not clear whether the substance being carried was in solid form and therefore liable to melt during the voyage or in solution which presents an additional flammable risk. On arrival in Rotterdam the experts were expecting to remove two contaminated containers but the vapours had contaminated most of the ship. It took six days to clean and decontaminate the vessel;

- in 1993 the *Santa Clara I* lost two containers overboard on arrival in Baltimore, USA. Another container was dangling precariously over the side and the deck was awash with arsenic trioxide, a highly toxic substance. It was also discovered that the ship was carrying magnesium phosphide which had also spilt. The worry here was the casual approach to the cargo by the crew, the ship's owners and the longshoremen. The US government took action against the owners to recover the $5 million costs of the clean-up operation;

- in 1996 a Boeing 727 crashed into the Florida everglades. A severe fire in one of the cargo holds which contained old oxygen generators (units which provide emergency oxygen in the event of cabin depressurization) appears to have been the main cause. This discovery led to urgent action by the International Civil Aviation Organization (ICAO) and the UN Committee of Experts;

- in 2000 an explosion at a fireworks store in the Netherlands led to massive damage to the town of Enschede. During the investigation it emerged that some of the fireworks had been misclassified and had been stored in the wrong place. The classification system used for storage is the same as for transport.

Many chemicals are dangerous but we take them for granted in our everyday lives. There is no published comprehensive list of the dangerous goods which are sold or transported; estimates range from 60,000 to 200,000.

Dangerous goods can be substances or articles: e.g. gunpowder is a substance but if it is put into a firework it is an article; lithium is a substance but a battery containing lithium is an article.

Dangerous goods are sometimes called hazardous materials (mainly in the USA). Examples of dangerous goods in the home include: paint, camping gas, petrol, perfumes, aftershave, bleach, aerosols, nail varnish, fireworks, fibreglass kits, safety-type matches, firelighters. Examples of dangerous goods in the workplace include: acetylene, propane, sulphuric acid, solvents, sodium, gas cylinders.

The objective of this Compendium is to give a brief guide to the rules covering the carriage of dangerous goods at sea – as contained in the International Maritime Dangerous Goods (IMDG) Code.

The Compendium is directed to those personnel responsible for the handling and transport of dangerous goods and to government officials who have to enforce the rules. The regulations themselves run to several thousand pages and this Compendium should not be seen as a replacement for the Code but rather as a short guide to how it works.

1.2 Personal objectives

At the end of this course, the student should be familiar with:

- the reasons for the IMDG Code's existence;
- the layout of the Code;
- the procedures for classifying and identifying dangerous substances and articles;
- safe packaging methods and the procedures for ensuring the safety of tank containment systems;
- the requirements for marking, labelling and documentation;
- the requirements for stowage and segregation;
- the procedures to be adopted in an emergency on board a ship.

Part 2: Background and General Introduction

2.1 Need for international agreements

Although international maritime trade had been carried on for thousands of years, the need for international agreements to regulate it was not generally recognized until stimulated by the loss of the *Titanic* ocean liner in April 1912, when more than 1,500 passengers and crew died. Two years later an International Conference adopted the first International Convention for the Safety of Life at Sea (SOLAS), which included chapters on navigation, construction, radiotelegraphy, life-saving appliances etc.

Mainly because of the First World War, SOLAS 1914 never came into force and the maritime community had to wait until 1933, when SOLAS 1929 came into operation. By the time of SOLAS 1948, many aspects were dealt with in much more detail. However, a basic problem was that there was no international organization which could coordinate the practical working out of detail necessitated by these Conventions. Further, the differing national regulations imposed by individual governments created increasing problems for the rapidly-growing international trade by sea. For example, the labels identifying different dangerous goods varied from country to country, as did the permitted packagings.

2.2 Establishment of IMO

The formation of the United Nations organization and its specialized agencies provided the opportunity for creating a suitable marine agency and the Inter-Governmental Maritime Consultative Organization (IMCO) – as IMO was originally known – came into being in January 1959. One of its first tasks was to arrange a Conference to revise SOLAS 1948, and SOLAS 1960 duly came into force in 1965, in which year the first edition of the IMDG Code was adopted.

In 1982, IMCO's name was changed to International Maritime Organization (IMO).

2.3 IMO's dangerous goods codes

As well as the IMDG Code (see part 4), IMO is also responsible for keeping up to date a number of other Codes dealing with dangerous goods, including:

1 Code of Safe Practice for Solid Bulk Cargoes (BC Code).

2 International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code).
This applies to chemical tankers constructed after 1st July 1986.

3 Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (BCH Code).
This applies to older chemical tankers, constructed before 1st July 1986.

4 International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code).
This applies to gas carriers constructed after 1st July 1986.

5 Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.
This is applicable to such ships constructed between December 1976 and July 1986.

6 Code for Existing Ships Carrying Liquefied Gases in Bulk.
This is applicable to such ships constructed before 31st December 1976.

These instruments are not dealt with in this course. They are concerned with operational provisions relating to bulk carriers etc., which are not relevant to the transport of packaged dangerous goods.

Part 3: Conventions

3.1 International Convention for the Safety of Life at Sea, 1974 (SOLAS 74)

This is the current SOLAS Convention and came into force in 1980. Because of improved amendment procedures it is unlikely that it will need to be replaced; instead is amended when necessary.

Chapter VII of SOLAS 74 deals with dangerous goods and refers to the IMDG Code. In May 2002 the Maritime Safety Committee confirmed its earlier decision to make the Code mandatory with the issue of Amendment 31. Amendment 31 was published in 2002, became available for use from 1 January 2003 and mandatory from 1 January 2004. Chapter VII is reproduced in full in chapter 1.1 of the IMDG Code.

3.2 International Convention for the Prevention of Pollution from Ships, 1973/78 (MARPOL 73/78)

Although concern for safety of life at sea was addressed early in the 20th century, it was not until much later that the task of protecting the marine environment was tackled, following tanker accidents (notably the *Torrey Canyon* in 1967) which caused extensive oil pollution. An international convention was drawn up in 1973, but the complications were such that additional work was required, and a modifying Protocol had to be produced in 1978 – hence the usual abbreviation of "MARPOL 73/78".

There are 6 Annexes to MARPOL 73/78, containing regulations for the prevention of various forms of pollution, as follows:

		Entry into force
Annex I	Pollution by oil	2 October 1983
Annex II	Pollution by noxious liquid substances carried in bulk	6 April 1987
Annex III	Pollution by harmful substances carried in packages, portable tanks, freight containers, or road or rail tank wagons, etc.	1 July 1992
Annex IV	Pollution by sewage from ships	Not yet in force
Annex V	Pollution by garbage from ships	31 December 1988
Annex VI	Air pollution from ships	Not yet in force

Annex III, like chapter VII of SOLAS 74, comprises short regulations cross-referenced to the IMDG Code which, as mentioned above, contains detailed information. Annex III is reproduced in full in chapter 1.1 of the IMDG Code.

3.3 Dangerous goods and harmful substances

The use of the terms "dangerous goods" (SOLAS) and "harmful substances" (MARPOL) tends to cause confusion, especially as they originate in two completely separate conventions.

However, MARPOL Annex III defines "harmful substances" as "those substances which are identified as marine pollutants in the IMDG Code", so that references in the IMDG Code to marine pollutants relate to the MARPOL Convention.

Many dangerous goods are of course also harmful to the marine environment and in such cases the requirements of both conventions must be met, although SOLAS takes precedence in the event of conflict (e.g. MARPOL prefers marine pollutants to be stowed under deck, but SOLAS requires certain particularly dangerous items to be stowed on deck only).

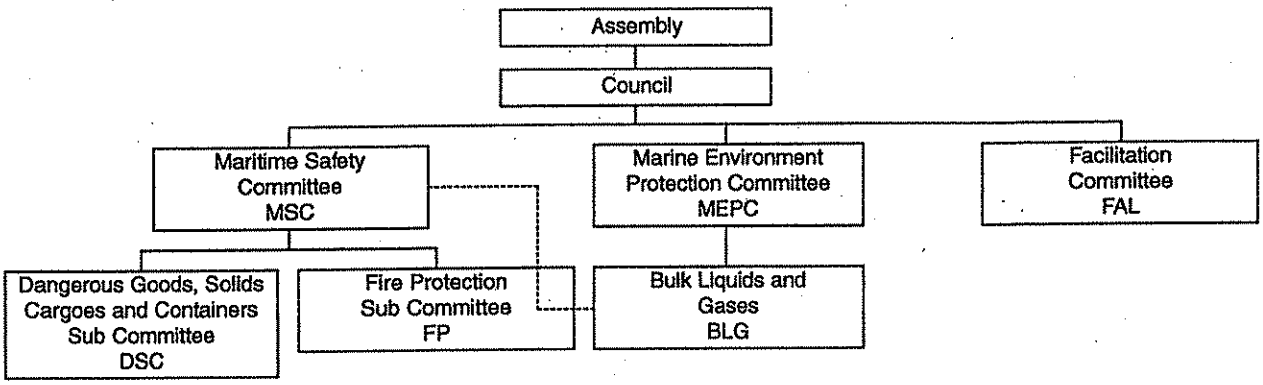
However, some marine pollutants do not meet the criteria of any class of dangerous goods, and special entries in the IMDG Code ensure these are controlled in a similar way to dangerous goods i.e. by proper classification, packing, labelling, marking, documentation and stowage etc., as described in later parts.

Part 4: IMO and Dangerous Goods

4.1 Introduction

The SOLAS and MARPOL Conventions (see part 3) include chapters on the carriage of dangerous goods in ships. These chapters set down guidelines and IMO is requested to make detailed provisions. This is carried out within IMO's Committee structure and has led to the publication of the IMDG Code.

4.2 The Committee structure



The chart above does not show all of IMO's Committee structure, only those committees which impact on the IMDG Code.

The day to day work of developing the IMDG Code rests with DSC which is made up of members of IMO that have adopted the IMDG Code along with non-governmental organizations accredited to IMO with consultative status. Any of the delegations can submit proposals to the Committee for consideration. If it is necessary to vote then only government delegations may do so. Having discussed and adopted proposals the DSC has an Editorial and Technical Group of about 8 Member States which, following each DSC meeting, reviews the adopted proposals and ensures they are embodied in the correct parts of the Code with appropriate cross references. On completion of a particular amendment the report is submitted to the MSC which has the opportunity to reject, amend or accept its contents. If the MSC agrees to the changes then the amendment is published and comes into force on a date specified by the MSC.

The FAL Committee provides input on certain documentation issues.

The MEPC also has an input into the IMDG Code. When MARPOL Annex III was adopted (see part 3) it was decided that, as most pollutants were also dangerous goods, rather than publish a separate set of regulations they would incorporate the provisions of Annex III into the IMDG Code. This means that some of the work of the MEPC is included in the IMDG Code.

4.3 UN Committee of Experts on the Transport of Dangerous Goods

In 1953 the United Nations Economic and Social Council (ECOSOC) adopted a resolution that created the UN Committee of Experts on the Transport of Dangerous Goods and it held its first meeting in Geneva in 1954. The first meeting did not start its work without the knowledge that there were already in existence and at various stages of development rules on the transport of dangerous goods, including: SOLAS, RID (railways) and IATA (air).

That first meeting established the class numbers and recognized that labels should be applied to packagings. The Committee circulated some recommendations which were considered two years later in 1956. The work of the UN progressed and when IMO began to develop a Code the UN Recommendations provided a helpful guide which from the outset had taken account of the requirements of SOLAS.

The UN Committee now consists of 26 voting countries based broadly on representation from all parts of the world; in addition, non-governmental organizations and other UN agencies (e.g. IMO) attend. Members of the IMO DSC (comprising about 50 countries) do not have an automatic right of membership of this Committee, although all UN members can attend as observers.

The UN Committee broadly considers common multi-modal issues:

- classification
- Dangerous Goods List (identification) and Limited Quantities
- packaging
- marking
- labelling
- documentation
- transport operations

The results are published as the United Nations Recommendations on the Transport of Dangerous Goods every 2 years; provisions in the current (12th) edition, published in 2001, are included in Amendment 31 to the IMDG Code in 2003. The 13th edition will be agreed in December 2002 by the UN and appear in Amendment 32 of the Code in 2005.

4.4 The UN Recommendations and IMO

Today the bodies responsible for the different modal transport controls, including IMO, generally adopt the UN Recommendations and add to them where they believe they are deficient or where the mode has particular problems.

Although in the early years of the IMDG Code there were significant deviations from the UN Recommendations, in the last decade IMO has taken the majority of the UN Recommendations and incorporated them into the Code. This makes multi-modal transport much easier.

The UN Recommendations are not written in isolation: representatives of the IMO Secretariat and some DSC delegations attend the UN meetings. IMO also provides a useful feedback to the UN Committee – they often find inconsistencies in the text from the UN and they can propose appropriate changes.

Part 5: The IMDG Code

5.1 Introduction

The International Maritime Dangerous Goods (IMDG) Code is an international agreement for the transport of dangerous goods by sea. It is published by IMO.

The IMDG Code was developed as a consequence of the implementation by IMO of Recommendation 56 of the 1960 International Conference on Safety of Life at Sea, which stated that governments should adopt unified procedures for the carriage of dangerous goods by sea.

Requirements relating to the carriage by sea of marine pollutants – arising from Annex III of MARPOL 73/78 – are also encompassed within the provisions of the Code (see also part 3).

The first edition of the Code was published in 1965 and it has since been regularly updated and revised – generally every two years.

The latest edition of the Code incorporates the 31st Amendment, adopted in 2001 (Amendment 31-2001) and comes into effect on 1 January 2003. Amendment 32 should be published in late 2004 for implementation on 1 January 2005.

The guidance contained in the Code is intended for use by all personnel involved in the shipment of dangerous goods by sea: mariners, manufacturers, consignors, agents and any associated feeder or support industries and services, competent authorities.

The various parts of the Code contain advice on dangerous goods classification, identification, containment, labelling, stowage, segregation, handling and emergency response procedures (see 5.3).

5.2 Application of the Code

The IMDG Code has until Amendment 31 no binding force; it has simply been recommended to governments for adoption. Of the 130 members of the International Maritime Organization, 51 countries have currently adopted the IMDG Code. These countries account for 80% of world shipping tonnage.

When a country decides to apply the provisions of the IMDG Code, it must incorporate them into national legislation. This facilitates the establishment of a system of penalties for non-compliance and the designation and appointment of a body or organization as the Competent Authority. National legislation will also define the scope of the application of the IMDG Code within the country concerned.

From 1 January 2004 the IMDG Code becomes mandatory and member of IMO are required to put in place legislation to enforce the provisions. However it should be noted that some parts of the Code cannot be mandatory and chapter 1.1 (1.1.5) lists those parts of the Code that remain recommendations, notably training, determination of flashpoint, Emergency Schedule and the MFAG.

Some national governments also apply variations to, and exemptions from, the standard provisions of the Code.

5.3 Content and layout of the Code

The IMDG Code comprises two volumes and a Supplement, the contents and layout of which are described below.

The structure of the IMDG Code Amendment 30 is based on the UN structure (see 4.3).

Part	Title	Volume
1	General provisions, definitions and training	1
2	Classification	1
3	Dangerous Goods List and Limited Quantity exceptions	2
4	Packing and tank provisions	1
5	Consignment procedures	1
6	Construction and testing of packagings, intermediate bulk containers (IBCs), large packagings, portable tanks and road tank vehicles	1
7	Provisions concerning transport operations	1
Appendix A	List of Generic and N.O.S proper shipping names	2
Appendix B	Glossary of terms	2
Index	Alphabetical index	2
Supplement	Emergency Procedures (EmS), Medical First Aid Guide (MFAG), reporting Procedures, Packing Cargo Transport Units, Safe Use of Pesticides, International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High Level Radioactive Wastes on Board ships (INF Code), Appendix	3

Part 1 of the Code, which consists of general provisions e.g. definitions, conversion tables etc is not dealt with in this Compendium, but the remaining parts are covered.

For most day-to-day shipment procedures, shore personnel and seafarers will normally use part 3 of the Code as the key to identifying information and duties. The contents of this part, in particular the Dangerous Goods List, are explained in 5.4.

Each part of the Code is divided into chapters which are in turn subdivided into sections and sub-sections. A sequential numbering system applies to the paragraphs within each sub-section.

For example, a reference to 6.5.1.4.1 means that the information concerned will be found in part 6, chapter 5, section 1, sub-section 4, paragraph 1.

5.4 The Dangerous Goods List

Most of volume two of the Code consists of a Dangerous Goods List (DGL). This comprises a list of UN Numbers allocated to dangerous goods of different classes. The list has 18 columns (as shown below) spread across two pages. The list is in UN Number order. There is an alphabetical list of chemical names in the index at the back of volume 2.

UN No.	Proper Shipping Name (PSN)	Class or division	Subsidiary risk(s)	Packing Group	Special provisions	Limited quantities	Packing		IBC	
							Instruc-tions	Provisions	Instruc-tions	Provisions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1088	ACETAL	3	–	II	–	1/	P001	–	IBC02	–

Tank instructions			EmS	Stowage and segregation No.	Properties and observations	UN
IMO	UN	Provisions				
(12)	(13)	(14)	(15)	(16)	(17)	(18)
T3	T4	TP1	F – E S – D	Category E	Colourless, volatile liquid with an agreeable odour. Flashpoint: below –18°C c.c. Explosive limits: 1.6% to 10.4%. Miscible with water.	1088

The Introduction to the DGL in chapter 3.2 provides guidance to the purpose of each column. The notes below are to supplement those notes.

Column	Title	Description	IMDG Part/Chapter	Compendium Ref.
1	UN Number	To identify the consignment requirements for a particular substance or article, it is necessary to know the UN Number. This is allocated by the UN Committee of Experts on the Transport of Dangerous Goods. It is common to all modes of transport. It is unique to the name in column 2.	2.0	7.3
2	Proper Shipping Name	The name in CAPITALS (upper case) is the one allocated by the UN to the number shown in column 1. Lower case text is optional information and is not required on packages or documentation Although the name is shown in capitals there is no requirement to use this style on packages or documents.	3.1	7.3

Column	Title	Description	IMDG Part/Chapter	Compendium Ref.
3	Class or Division	All substances are allocated to one of nine classes.	2	6 and 7
4	Subsidiary Risk(s)	Many substances have more than one hazard. Any secondary hazards are known as subsidiary risks. The UN generally allocates these but IMO includes information concerning marine pollutants in this column.	2	7
5	Packing Group	Packing groups indicate a level of danger within a class. The level can determine the type of packaging or tank to be used. Where more than one packing group is listed for a particular entry, the rules of classification for the primary hazard must be used to determine which group is applicable. Packing groups are not allocated in classes 1, 2, 6.2 or 7 although the concept is used when determining some types of packaging.	2	7.2
6	Special Provisions	These are very important. They can give criteria for: exempting the substance from the Code, clarifying classification detail, changing labelling requirements etc. There are two types of SP: 1 UN special provisions (numbered 15 – 310). These are common across the modes. 2 IMDG special provisions (numbered from 900 upwards). These are unique to maritime shipments.	3.3	
7	Limited Quantities	These are dangerous goods consignments that can be carried without full compliance with the Code subject to certain conditions being met with respect to package quantity limitations and markings.	3.4	12
8	Packing Instructions	Columns 8 and 9 are linked. Column 8 identifies the applicable packing instruction, prefixed with the code "P" for a packaging or "LP" for a large packaging from the options available under the instructions for the substance concerned. These are explained in 4.1.3.	4.1 for package selection and 6.1, 6.2, 6.3 and 6.6 for design and construction	9 for package selection and 10 for design and construction

Column	Title	Description	IMDG Part/Chapter	Compendium Ref.
9	Packing Provisions	If a number prefixed with the code "PP" for packagings or "L" for large packagings appears in this column, it is an additional condition concerning the use of that packaging. It will usually add restrictions to use but occasionally relaxations are provided.		
10	IBC Instructions	Columns 10 and 11 are linked. Column 10 identifies the applicable IBC instruction, prefixed with the code "IBC" for a packaging from the options available under the instructions for the substance concerned. These are explained in 4.1.3.	4.1 for IBC selection and 6.5 for design and construction	9 for IBC selection and 10 for design and construction
11	IBC Special Provisions	If a number prefixed with the code "B" for IBCs appears in this column it is an additional condition concerning the use of that IBC. It will usually add restrictions to use but occasionally relaxations are provided.		
12	IMO Tank Instructions	Columns 12 to 14 are linked for tank selection. There are two types of tank available: IMO tanks based on Amendment 29 of the IMDG Code and UN tanks, a new category that takes over from IMO tanks in due course. Where both are permitted, either type can be used.	4.2 for tank selection and 29th amendment to the Code Road tanks 6.8	9 for tank selection and 10 for design and construction
13	UN Tank Instructions	See explanation for column 12 above.	4.2 for tank selection and 6.6	
14	Tank Instructions: Provisions	These Provisions are additional conditions applicable to the tank used for the substance.		
15	EmS	This column indicates the relevant Emergency Schedule number in the emergency procedures. These are explained in the Supplement to the Code. There are two Schedules shown: "F–" for fire and "S–" for spillage.	Supplement 1	14
16	Stowage and Segregation	This column indicates a stowage category for the substance and identifies any special segregation instructions.	7	13
17	Properties and Observations	This column provides background information about the properties and nature of the substance.		
18	UN Number	As per column 1.		

Part 6: Classification – Physics and Chemistry
(Part 2 of the Code)

6.1 Introduction

The purpose of this training module is to give sea-going and shore personnel involved in handling dangerous goods a basic knowledge of chemistry so that they are able to understand the terms used in the IMDG Code and to appreciate the hazards associated with the dangerous goods they are dealing with.

It is not the intention of the module to turn non-chemists into chemists and it must be stressed at the outset that expert advice must always be sought if there is any doubt.

One area for confusion that potentially can have disastrous results is in the pronunciation and writing of chemical names some of which may be difficult to pronounce correctly e.g. "isocyanatobenzotrifluorides" or may be easily confused during an emergency telephone call e.g. thionyl chloride and vinyl chloride.

Also, names for the same chemical will often be different in different languages. To avoid misunderstandings, the United Nations Number given in column 1 of the DGL must always additionally be quoted, preceded by the letters "UN". UN Numbers are only assigned to substances and articles which meet the classification criteria (see part 7).

Basic terms

6.2 What are physics and chemistry?

Physics
Physics is the study of the basic laws that govern our universe, including the forces that exist between objects and the interrelationship between energy and matter.

Chemistry
Chemistry is defined as the science of elements and compounds and their laws of combination and behaviour under various conditions. For study purposes, chemistry is divided into a number of major branches including physical, inorganic, organic and polymer chemistry.

Physical chemistry
This branch of chemistry is concerned with the effect of a chemical's structure on its physical properties such as shape, colour, odour, solubility, melting point etc.

Organic chemistry
This is the chemistry of carbon compounds apart from some of the most simple ones such as carbon monoxide, carbon dioxide and carbonates. There are over a million organic substances, some natural, some man made (synthetic), some both, with new ones being found every day. Many substances are familiar: sugar and crude oil, which are produced naturally, plastics such as polyethylene, which are produced synthetically, and alcohol, which can be made through both natural fermentation or by synthesis, are examples of organic substances. Our organs and tissues are composed of organic compounds including carbohydrates, proteins and fats. All living things are organic but not all organic substances are not found in living organisms.

Inorganic chemistry
This branch of chemistry is devoted to those substances which are not considered to be organic. Many of these are derived from minerals: iron ore and common salt are inorganic naturally occurring substances, as is water. They all have a characteristic chemical composition.

Polymer chemistry
This is really a sub-branch of organic chemistry but is so important that it is treated as a specialized subject. It is the study of large or macro molecules which consist of repeating units of small molecules (monomers). These may be naturally occurring, such as proteins, or manufactured synthetically, such as polyethylene.

Terms
A number of terms commonly used in chemistry, some of which have been used in the above definitions, are found in the Code and these are explained as follows:

Elements
These are the basic building block blocks from which all chemical structures are made. They cannot be broken down into simpler substances and are composed of identical atoms which are the smallest particles of an element that can chemically exist. An atom consists of a dense nucleus containing positively charged protons and uncharged neutrons. In orbits surrounding this nucleus are small negatively charged electrons, the number of which equals the number of protons so that the overall atomic charge is neutral. There are over 100 elements, most of which are easily divided into two main classes, metals which conduct electric current and heat and non metals which do not. Some examples are:

Physical state	Examples of metals	Examples of non metals
Solids	Calcium, copper, gold, iron, silver, sodium	Carbon, iodine, phosphorus, sulphur
Liquids	Mercury	Bromine
Gases	none	Chlorine, hydrogen, nitrogen, oxygen

Some elements such as silicon exhibit some of the properties of metals such as partial conduction of electricity (semi conductors) and some gases when in a liquefied state also conduct electricity.

Some elements such as oxygen and nitrogen, which make up about 21% and 78% respectively of dry air, and hydrogen, from which 90% of the universe is composed, occur naturally but most occur combined with other elements to form compounds.

For convenience every element is assigned an internationally agreed symbol which represents either their English or Latin name. Symbols for the elements are listed below:

METALS		NON METALS	
Name	**Symbol**	**Name**	**Symbol**
Calcium	Ca	Bromine	Br
Copper	Cu	Carbon	C
Gold	Au	Chlorine	Cl
Iron	Fe	Hydrogen	H
Mercury	Hg	Iodine	I
Silver	Ag	Nitrogen	N
Sodium	Na	Oxygen	O
		Phosphorus	P
		Silicon	Si
		Sulphur	S

Mixtures

If the elements iron and sulphur are blended together in powder form, then a mixture is formed. The two components retain their individual chemical and physical characteristics and can be separated from each other again, in this instance by applying a magnetic field which will separate the metallic iron from the sulphur. Mixtures may be either solid, such as gunpowder (carbon, sulphur and saltpetre), liquid (whisky and water), solid/liquid (sugar in tea) or gaseous such as air (oxygen and nitrogen). Each component within the mixture is called a constituent.

Compounds

If the mixture of iron and sulphur powders is heated together their atoms combine to form molecules (fundamental units) of a new substance called a chemical compound, in this instance iron or ferrous sulphide. The reaction is:

iron + sulphur + heat = iron sulphide

Chemists would write the reaction using symbols as follows:

$$Fe + S \xrightarrow{\text{heat}} FeS$$

This chemical representation of the reaction is known as an equation and the way of representing the chemical compound formed is called the formula i.e. FeS.

Compounds have a definite chemical composition and have properties which may be significantly different to the substances from which they have been formed. Unlike mixtures, compounds cannot be separated by physical means but may be decomposed into simpler compounds or elements. For example, if limestone (a compound containing the elements calcium, carbon and oxygen and known chemically as calcium carbonate) is heated it decomposes to give molecules of a new simpler compound (quick lime/calcium oxide) and the gas carbon dioxide. The model equation is:

$$CaCO_3 \xrightarrow{\text{heat}} CaO + \uparrow CO_2$$

Materials
A material is defined as having some general properties but these may vary depending upon the composition. For example, wood has some general properties that we all recognize but different kinds of wood have different colours and textures.

Substances
The IMDG Code refers to the term "substance". This is a generic term covering chemicals the chemical composition of which do not vary significantly from one sample to another. Many substances are compounds, some are elements. Examples of substances are common salt (sodium chloride), iron and cane sugar.

Articles
The IMDG Code also refers to the term "article". An article is a device that contains a dangerous substance or mixture of substances. Examples of articles are fireworks, aerosols, lighters, bombs etc.

6.3 Physical chemistry

Note: Many of the terms in this section are used in column 17 of the DGL.

Physical states of matter
Matter exists in three states, solid, liquid or gas. The physical state of many substances will vary depending upon the temperature and pressure applied to them.

Solids
Many solids such as common salt have a regular shape and are crystalline (the atoms or molecules composing the substance are arranged in a regular pattern). Solids, which have no particular structure, are said to be amorphous. Glass, rubber and many plastics are amorphous. Some solids take water from the air and become damp. These are called hygroscopic. Common salt is an example of a hygroscopic solid. Some crystals actually dissolve in the water from the atmosphere to become concentrated solutions. Such solids are called deliquescent. It is difficult to compress solids.

Liquids
Liquids have a definite mass and volume but no shape; they take up the shape of the container into which they are poured. Some liquids, like water, flow easily and are said to be mobile whilst others like treacle are said to be viscous. The Code recognizes that increasing viscosity can reduce hazard (chapter 2.3) and affect packing (chapter 4.1 – 4.1.1.4). Liquids are difficult to compress.

Gases
Gases, like air, have a definite mass but no defined volume and will expand to fill the volume of the containment vessel. Gases are much less dense than solids or liquids and whilst some gases like chlorine are heavier than air, others like hydrogen are lighter than air. Gases are easily compressed and are available in pressure resistant gas cylinders.

Physical properties
Chemicals are identified and characterized by their properties. Physical properties are used to assist in the classification of substances and articles within the Code and some important physical properties are also specified in the Code on the individual schedules.

Boiling point
This is the temperature at which a liquid boils and begins to turn into a vapour. The boiling point will vary depending upon the pressure applied. The atmospheric pressure (the pressure exerted by the mass of air in the atmosphere at any one point on the Earth's surface) will determine the boiling point. At sea level the atmospheric pressure is 1 atmosphere = 101.13 kiloPascals (kPa) = 14.7 pounds per square inch gauge (psig) = 760 mm mercury (mmHg) and the boiling point of water is 100°C. If the pressure is decreased (e.g. at the top of a high mountain), the boiling point will be less and will be increased if the pressure is raised. Boiling point criteria are used together with flashpoint to allocate flammable liquids into packing groups (see chapter 2.3 of the Code). The IMDG Code uses kPa to define pressure and degrees Celsius (°C) to specify temperature. Tables to convert degrees Fahrenheit (°F) into °C are included in chapter 1.2.

Vapour pressure
All solids and liquids give off vapour consisting of atoms or molecules of the substance that have evaporated from the surface. The pressure which the vapour exerts under specified conditions is known as the vapour pressure. Vapour pressure increases with temperature and a liquid boils when its vapour pressure is equal to the atmospheric pressure.

In general, the higher the substance's vapour pressure, the lower the boiling point and the more volatile (likely to vaporize) it is likely to be. Vapour pressure is an important consideration in defining whether a particular substance should be classified as a gas (see chapter 2.2 of the Code) and also in determining the toxicity of a substance if inhaled.

In the IMDG Code, the unit used to describe pressure is the kiloPascal (kPa). For conversion, Standard Atmospheric Pressure = 1 atmosphere = 14.7 psig (0 psig) = 101.13 kPa = 760 mmHg.

Flashpoint
This is the lowest temperature at which a volatile liquid gives off sufficient vapour to form a combustible liquid in air and in the presence of a naked flame gives a momentary flash but not a sustained fire under controlled conditions. It is an indication of the flammability of a substance. Standardized open cup (o.c.) or closed cup (c.c.) test methods are used to determine the flashpoint. In view of the importance of flashpoint in the classification of flammable substances (see below), further details on the test methodology may be found in chapter 2.3 of the Code.

A liquid cannot be ignited at a temperature below its flashpoint. Some liquids have flashpoints at very low temperatures. Petrol, for instance, has a flashpoint of below –18°C which enables cars to start even in arctic conditions. A flashpoint criterion of 61°C c.c. is used to determine if a substance should be classified within class 3 – Flammable Liquids. Along with the boiling point, the flashpoint is used to assign flammable liquids within packing groups.

Autoignition point
This is the temperature to which a liquid must be raised to cause a sustained fire or explosion when touched by a flame or hot object or by the heat generated during the reaction or by friction. There is no relationship between flashpoint and ignition temperature.

Explosive limits
This is the percentage by volume vapour/air concentration of a substance which is ignitable. Below the lower explosive limit (LEL), the mixture is too "lean" to ignite and above the upper explosive limit (UEL) the mixture is too rich. Schedules for flammable gases and liquids give the explosive limits for each substance.

Melting point
The melting point is the lowest temperature at which a solid will change into a liquid when heated e.g. ice turning to water.

Chemists measure melting points for two reasons. Each substance has its own specific melting point which can assist in its identification and also to determine its purity, as impure substances may have a lower melting point than their pure form or may melt over a temperature range. Some solids not normally classified as hazardous will become so if they are transported molten and the melting point is at or above 240°C (see chapter 2.9 of the Code). Care must be exercised in the selection of packaging materials for solids which have a relatively low melting point since changes in climatic temperatures during export shipments from a temperate to a tropical climate can change a solid into a liquid.

Density
The density of a sample of a substance is determined by dividing its mass by the volume it occupies. The resulting number is expressed as kilograms per cubic metre (kg/m^3): the higher the number the more dense and heavy is the substance. For example, mild steel has a density of 7.9 kg/m^3 whereas balsa wood has a density of 0.2 kg/m^3. To compare densities of different substances, relative density (r.d.) is used. For liquids and solids, it is the ratio of the density (usually at 20°C) of the substance to that of water at its maximum density of 1.000 at 4°C. For gases, the Code compares the density of the gas to that of dry air and is known as the relative vapour density. Relative densities have no units assigned to them.

Relative density is used to determine the net mass of different substances packed into e.g. drums of the same volumetric capacity. For instance the net mass of 200 litres of ethanol (r.d. 0.61) = 122 kg whereas the same drum filled with 200 litres of carbon tetrachloride (r.d. 1.586) = 317 kg. The United Nations Package Performance Tests recognize that product r.d. can affect container performance, particularly impact strength, and therefore the drop height for packagings destined to carry substances with a relative density exceeding 1.2 must be increased over the standard heights for packing groups I, II, and III (see chapter 6.1 of the Code).

Relative vapour density is important in stowage planning. For example, the toxic gas arsine, which has a relative vapour density of 2.8 compared to air would not be stowed below deck where it could not easily disperse. For gases, the Code defines the terms "much lighter than", "lighter than", "heavier than" and "much heavier than" air based on the vapour density of the gas compared to air (see chapter 3.2 – Structure of the Dangerous Goods List – explanation of column 17).

Solubility/Miscibility
When a solid or a gas (a "solute") dissolves in a liquid (a "solvent") a homogeneous mixture or solution is formed. Eventually as more and more solute is added, the solution cannot dissolve any more and is said to be saturated. For example, common salt will dissolve in water forming a clear solution. By adding more and more salt the solution will become cloudy regardless of how much it is stirred. The only way of increasing the solubility of the salt is by heating the solution. Generally, for a solid in a liquid, solubility will increase with temperature rise; for a gas in a liquid the reverse is true.

If a liquid mixes completely with another liquid then it is said to be miscible (e.g. alcohol is completely miscible with water). Some liquids will only partially mix with other liquids and these are said to be partially miscible, whilst others such as petrol and water will not mix and are immiscible. In this instance the liquid with the lower relative density (petrol) will float on

the water as a separate layer. Miscibility and relative density are important criteria used in determining what medium should be used in fighting fires involving chemicals. For example water would not be suitable for fighting fires involving petrol which would merely float on the water and spread the fire.

Water is the main solvent used in chemistry and solutions in water are called aqueous solutions after the Latin name for water (*aqua*). Water is a good solvent for gases and aquatic life depends upon the solubility of oxygen dissolved in water for its very existence. If water is not used as the solvent then the name of the solvent must be specified.

The IMDG Code classifies a solution of a hazardous chemical as though it were the pure substance unless the dilution is such that the chemical no longer meets the hazard criteria for the pure substance or has been changed by the nature of the diluent.

Odour

Many substances have a characteristic smell which may be the first indication of product escape. Any unusual odour should be treated as a warning and appropriate emergency action taken. The Code uses a number of words (see column 17 of the DGL) to assist in identification of the odour, such as:

Anaesthetic	–	Causes drowsiness
Acrid	–	Burning
Ammoniacal	–	Ammonia
Ethereal	–	Ether-like, an anaesthetic
Fragrant	–	Pleasant
Irritating	–	Smell which is unpleasant to the senses
Lachrymatory	–	Brings tears to the eyes
Narcotic	–	Causes drowsiness
Phenolic	–	Smells like creosote
Pungent	–	Has a strong effect on the senses

It must be emphasized that many chemicals are odourless and some of these (e.g. carbon monoxide) are highly toxic and therefore odour must not be relied upon to detect if chemicals are present.

6.4 Hazardous chemicals and chemical reactions

Introduction

All chemicals are to a greater or lesser extent hazardous to human health or to the environment. An iron bar dropped onto somebody's head can maim or kill and even water can, under certain circumstances, be highly dangerous: probably more people have died by drowning than from exposure to any other chemical. However the United Nations Committee of Experts on the Transport of Dangerous Goods have recognized that certain families or classes of substances and articles present particular and significant hazards from which the general public and those involved in their transport need to be protected.

The hazard posed arises from either the substances or article itself, often caused by a change in its storage or transport conditions (e.g. cylinders of compressed air can explode if involved in a fire due to the increased pressure formed within the cylinder as the temperature is raised) or by reaction of the substance or article with other substances either in the surrounding environment such as oxygen or water or those chemicals which make up living tissues.

A chemical reaction is a process in which a new substance is formed and which either requires energy to initiate it usually in the form of heat (endothermic) (e.g. the formation of acetylene gas from carbon and hydrogen) or generates heat energy during the reaction (exothermic) (e.g. the reaction of calcium carbide with water, which not only generates heat but the gas acetylene).

There are many examples of hazardous reactions:

- flammable substances react with oxygen in the air and in the presence of an ignition source to generate heat, light and new substances. Some oxygen-containing substances decompose when heated in a fire, liberating their oxygen and therefore making a fire more intense;
- many toxic (poisonous) substances act by reacting with substances in the body, thus interfering with the normal life processes;
- some substances react exothermically with water, generating gases which may be flammable or toxic;
- some substances, such as metal alkyls, react so violently with air that spontaneous ignition occurs. Such reactions are said to be pyrophoric;
- some substances, e.g. radioactives, can alter genetic material, causing cancer and birth abnormalities.

The rate at which a chemical reaction occurs normally increases as the temperature rises, which is why thermally unstable substances such as many organic peroxides are stored and transported at low temperatures; however, some substances, often in very small amounts, can also promote chemical reactions without themselves undergoing any chemical change. These are called catalysts and an example is the use of finely divided platinum in car exhaust systems, which assists the conversion of some hazardous by-products of combustion into carbon and sulphur dioxides before they leave the exhaust system. Some impurities can act as catalysts promoting the exothermic decomposition of unstable chemicals such as organic peroxides.

More recently, IMO has also recognized that some substances, if accidentally released into the sea, will pollute the marine environment.

For convenience, the UN has divided these families of hazardous substances and articles amongst nine classes based on the type of hazard that they represent and criteria have been developed to enable science-based decisions to be made on the assignment of substances or articles to these classes. A basic knowledge of the chemistry of these families will assist in understanding the hazards they present.

Chemical hazard classes

Explosives (class 1)

Chemical explosions are usually caused by very rapid burning of a substance or mixture of substances in the presence of oxygen in the air ("deflagration"). The rapidly expanding gaseous products of this reaction cause damage by the propulsion of fragments of its container and other nearby material at high velocity and also by disturbance of the surrounding air ("blast").

The first practical explosive was gunpowder, invented by the Chinese some 1,300 years ago. It consisted of a fine mixture of carbon, sulphur and potassium nitrate (saltpetre) with the carbon and sulphur acting as a fuel and the potassium nitrate (KNO_3) as a supply of oxygen to promote rapid combustion. Until the 1800s, gunpowder was the only known explosive. Then Alfred Nobel produced nitro-glycerine. Unlike gunpowder, nitro-glycerine is a chemical compound containing both the fuel and the oxidizer chemically bonded in one molecule.

Nitro-glycerine is an example of an explosive that burns much faster than gunpowder, so fast in fact that it takes place at the speed of sound. When this occurs the process is called detonation and the result is far more damaging than burning of gunpowder. Unfortunately, nitro-glycerine can spontaneously explode and cannot be reliably initiated by a flame. Nobel solved these problems by absorbing the nitro-glycerine into kieselguhr (a diatomaceous earth) and using a mercury fulminate detonator (a compound formed by reacting mercury with cyanic acid) to produce dynamite.

At about the same time, nitro-cellulose was also found to have explosive properties, but was also unstable. From this discovery, other nitro compounds were developed, of which the most important was trinitrotoluene (TNT).

Explosives may be classified in a number of different ways:

- *Primary and secondary explosives*
  A primary explosive is easily initiated; a secondary explosive requires a primary explosive for initiation but, when initiated, tends to be more powerful. An example of a primary explosive is mercury fulminate. TNT is a secondary explosive whilst nitro-glycerine has the initiation properties of a primary explosive and the power of a secondary explosive, hence the problems in handling this substance.

- *High and low explosives*
  A high explosive such as nitro-glycerine will burn at such a rate that detonation occurs. A low explosive such as gunpowder will not detonate. In detonation a shock wave is generated which provides the energy not only to initiate the oxidation reaction but also cause much more damage to the surroundings.

- *The UN system*
  Explosives are classified within class 1 into six sub-divisions depending upon the type of explosive hazard (mass, projection, fire) and how sensitive the explosive is to initiation. For stowage purposes explosives are also assigned to one of 13 compatibility groups. The combination of class, hazard division and compatibility group is known as the hazard classification code which provides the key to identify the provisions for safe storage and transport of explosive substances and articles assigned to class 1.

Gases (class 2)
The IMDG Code defines a gas as a substance that has a vapour pressure greater than 300 kPa at 50°C or is completely gaseous at 20°C at atmospheric pressure.

Gases are stored and transported in one of four states:

- compressed
- liquefied
- refrigerated liquefied
- in solution

The state in which a particular gas is transported depends primarily upon the minimum temperature required in order to liquefy the gas by pressure. This is known as the critical temperature, above which a gas cannot be liquefied by pressure alone. Some gases such as hydrogen, nitrogen and oxygen – known collectively as permanent gases – need to be cooled to a very low temperature before pressure can liquefy them (e.g. oxygen has a critical temperature of –119°C). Such gases are either transported in high-pressure cylinders or in refrigerated gas tanks. Other gases such as butane have much higher critical temperatures and are therefore relatively easy to liquefy. These gases are transported in lower pressure

cylinders or non refrigerated gas tanks. Some gases such as butane are used as propellants and are transported in aerosols. A few gases (e.g. acetylene) do not liquefy and are transported dissolved in a solvent under pressure.

Gases can present a variety of hazards:

- all gases in pressure cylinders/tanks could explode if involved in a fire;
- "inert" gases such as nitrogen, neon, xenon, etc. are asphyxiant and can cause suffocation by reducing the oxygen content in the air if released in confined spaces;
- some gases such as oxygen are strong oxidizers that could enhance the effects of a fire;
- some gases such as methane are highly flammable;
- some gases are highly toxic (arsine) or corrosive (sulphur dioxide).

Flammable liquids (class 3)
This class comprises liquids that have a flashpoint of 61°C c.c. or below. Also included are any substance that is transported as a liquid at an elevated temperature at or above its flashpoint even if the flashpoint is above 61°C.

This class is composed almost entirely of liquids which are organic and the major hazard is the potential for their vapours to catch fire. Fire is the result of a chemical oxidation reaction involving three components:

1 A fuel
2 Oxygen (normally air)
3 A source of ignition

The fuel reacts with the oxygen to produce reaction products, heat and light energy. The internal combustion engine uses petrol, a hydrocarbon liquid, which is mixed in the carburettor with air and subsequently ignited in the cylinder head by the spark plug to produce gases that force the piston down the cylinder to turn the crankshaft. The chemical reaction may be shown as follows:

$$CH_3 - CH_2 - CH_2 - CH_2 + O_2 \xrightarrow{\text{SPARK}} CO_2 + H_2O + \text{Heat and Light energy}$$

This reaction shows the complete oxidation of the fuel. In practice combustion is rarely complete and intermediate products such as carbon and carbon monoxide are formed. Impurities present in the petrol, such as sulphur-containing compounds, will also be completely or partially oxidized.

If one of the components is removed then combustion will not occur or will stop. Petrol will not spontaneously ignite when exposed to air at ambient temperatures. Car engines stop when the ignition is turned off and fires can be put out by removing the oxygen with CO_2 or foam extinguishers.

Not all organic liquids are flammable. In fact, some chlorinated organic liquids are used to extinguish fires, although for environmental reasons such products are now being phased out. All flammable liquids have a narcotic effect if inhaled.

Flammable solids (class 4)
This class comprises both inorganic and organic substances and is divided into three classes:

Class 4.1 – Flammable solids
This class includes:

- readily combustible solids which if ignited can rapidly spread the resulting fire (e.g. celluloid);
- solids which may catch fire through friction which can produce sufficient heat energy to ignite the substance (e.g. matches);
- self-reactive solids and liquids and substances related to them. These are thermally unstable molecules which if heated will undergo a strongly exothermic decomposition reaction and some will burn vigorously. Typical self-reactive substances contain nitrogen. Some self-reactive substances need to be temperature controlled during storage and transport;
- desensitized explosives. These are explosives which are wetted with water or alcohol or diluted with other substances to suppress their explosive properties (e.g. mixtures containing between 2% and 10% nitro-glycerine).

Class 4.2 – Substances liable to spontaneous combustion
The IMDG Code defines two types of spontaneously combustible substances:

1 Pyrophoric substances. These are substances (including mixtures and solutions) which even in small quantities will spontaneously ignite due to the rate of heat produced during the reaction with oxygen in the air exceeding the rate at which heat can be removed. The overall effect is that the substance is raised to its auto-ignition temperature and thus catches fire. Ignition occurs within five minutes of exposure. Typical examples of spontaneously combustible substances are some finely divided metal powders and metal catalysts.
2 Self-heating substances. These are substances which will only auto-ignite when stored for long periods of time (hours or days) in large (kg) amounts. Carbon powder and some vegetable fibres are liable to self-heating and are therefore classified as class 4.2.

Class 4.3 – Substances which, in contact with water, emit flammable gases (water-reactive)
Many of the substances involved are inorganic, including the metals caesium, lithium, potassium and sodium, which form part of the alkali metal family, and some of their compounds. Some compounds of the alkaline earth metals (calcium, lithium, magnesium and strontium) are also water-reactive.

The major gas produced in the reaction with water is hydrogen. For example, the reaction between sodium and water is:

$$Na + H_2O \longrightarrow NaOH + \uparrow H_2 + \text{heat energy}$$

The other reaction product apart from heat (as the reaction is strongly exothermic) is the alkali sodium hydroxide.

However, depending upon the substance involved, other flammable gases such as methane, acetylene and ammonia and/or toxic gases such as phosphine and arsine are produced.

Oxidizing substances and organic peroxides (class 5)
Class 5 is divided into two:

Class 5.1 – Oxidizing substances
This class contains mainly inorganic compounds which have in common their ability during thermal decomposition to liberate oxygen contained within the molecule, which is then available to react with other substances to form oxides. This process is called oxidation.

Rusting of iron is a typical example of an oxidation reaction: oxygen dissolved in water reacts with iron to form iron (ferric) oxide (rust). The equation is:

$$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$$

As previously discussed, burning is also a form of oxidation in which, for example, organic substances such as petrol, paraffin, alcohol, paper, sugar, coal, etc., react with oxygen in a fire to form oxides of carbon. It is for this reason that oxidizing substances are considered so dangerous: they increase the risk and intensity of fire in combustible materials and make fires involving them difficult to extinguish.

Many inorganic compounds end with the suffix "-ate" (e.g. nitrate, bromate, borate) indicating the presence of oxygen. These are oxidizers. The prefix "per-" also indicates the presence of additional oxygen (as in permanganate, perchlorate and peroxide). Chlorine is also a strong oxidizer and is found in compounds such as chlorates and hypochlorites (bleach).

Class 5.2 – Organic peroxides
These compounds are related to the oxidizer hydrogen peroxide (H_2O_2), but one or both hydrogen atoms have been replaced by organic molecules. The resulting compounds are not only very strong oxidizers but many are thermally unstable some even at normal transport temperatures. Decomposition is initiated not only by temperature rise but sometimes by the presence of impurities. The reaction is exothermic, sometimes explosively so, and may result in the evolution of harmful or flammable gases. In this respect this sub-class is similar to the self-reactive substances in class 4.1. Organic peroxides burn vigorously and attack eyes and skin. Depending upon their reactivity, organic peroxides are assigned to one of seven generic types within class 5.2.

Toxic and infectious substances (class 6)
Class 6 is divided into two:

Class 6.1 – Toxic substances
Toxicology is the science of poisons and their effects on the body. Substances (both inorganic and organic) and articles assigned to class 6.1 are either known from experience to cause death or serious injury to humans by poisoning or, based on the results of testing the chemical on animals under strictly controlled conditions, are strongly suspected of causing harm to human health.

The IMDG Code is concerned with the effects of a single dose of short duration (known as an acute exposure) that a transport worker or member of the public may be exposed to in the event of a spillage or fire. Unlike safety in the workplace regulations, the Code is not concerned with the effects on health of long-duration (days, months or years) repeated exposure (known as subchronic and chronic exposures).

Usually exposure can occur through one or more of three routes:

- oral route = gastrointestinal absorption via the mouth
- dermal route = absorption through the skin
- inhalational route = absorption via the lungs through breathing in contaminated air

Of these, the dermal and inhalation routes are the most important in accidental poisonings, and chemicals absorbed by these routes tend to be more serious as they pass directly into the blood stream and only a small proportion is detoxified by the liver (unlike ingested materials, which pass totally through that organ before dispersion). Mercury and lead alkyls in particular are much more toxic if inhaled or absorbed through the skin than if they are swallowed.

Dosage is the most important factor in determining if a particular chemical will produce an acute toxic effect and this is measured by the median lethal dose (LD_{50}) for oral and dermal exposure or median lethal concentration (LC_{50}) for inhalation exposure for dusts, mists and vapours. This is a statistical estimate of the amount of chemical required to kill 50% of a given population of test animals. To be meaningful the test must specify the species of animal used, their sex and age and the time of the measurement. For oral and dermal routes, the results are expressed in terms of milligrams of chemical required per kilogram of body mass (mg/kg). For the inhalational route results are expressed either in milligrams/litre (mg/l) for dusts and mists or millilitres/cubic metre (ml/m^3) = parts per million (ppm) for vapours. The details for LD_{50} and LC_{50} determinations are given in the chapter 2.6 of the Code.

Class 6.2 – Infectious substances
This class controls the transport of cultures of biological micro-organisms that are known or reasonably expected to cause infectious disease in humans or in animals. The class includes clinical waste.

Radioactive materials (class 7)
As mentioned in 6.2, atoms are composed of protons, neutrons and electrons. Not all atoms in the same element have the same atomic mass because a few have a different number of neutrons. These are called isotopes or nuclides. For example, hydrogen has three isotopes with masses 1 (hydrogen 1), 2 (hydrogen 2 – called deuterium) and 3 (hydrogen 3 – called tritium). They all contain the same number of protons and electrons and have the same chemical properties but differ in the number of neutrons. Naturally occurring hydrogen contains 99.9% of hydrogen 1; the remaining 0.1% is composed of the other two isotopes. Isotopes are identified by their chemical symbol followed by a number denoting their atomic mass: e.g. cobalt (Co)–60, uranium (U)–235.

If the number of neutrons greatly exceeds the number of protons, as is common in heavy elements like uranium, radium and thorium, the isotopes become unstable and eject particles from their nuclei to make them more stable. These are called radioactive isotopes, radioisotopes or radionuclides because the particles ejected can be detected using a Geiger counter. Two types of particles are emitted, alpha particles, which only travel a few centimetres in air, and beta particles, which may travel several metres. They are often accompanied by energy in the form of gamma radiation. As a radioactive element decays a new element is formed which may also decay, and the process is repeated until a stable isotope is reached.

When large atoms split vast amounts of energy are released. This is called nuclear fission and elements which are capable of undergoing this process are called fissile. These are uranium–233, uranium–235, plutonium–238, plutonium–239, plutonium–241 and any

combination of these radioisotopes. When the nucleus of a fissile isotope is irradiated by neutrons it can absorb a neutron, becoming unstable in the process and splitting into approximately two halves releasing energy and neutrons. These cause more atoms to split releasing more energy and neutrons. A chain reaction ensues releasing a vast amount of energy in a fraction of a second.

The major hazard of radioactive materials is the damage which may be caused to external or internal body tissues by the effect of invisible radiation. Also heat emission and liability to criticality are potential hazards.

The international unit used to express the activity of a radioisotope is the becquerel (Bq) named after the discoverer of radioactivity A.H. Becquerel (1852-1908). The becquerel is the rate at which a radioactive isotope decays and relates to the contents of the package. This is replacing the former unit, the curie (Ci).

In the past the IMDG Code required that any material with a specific activity of greater than 70 kBq/kg had to be declared as a radioactive material. The 2001 edition of the Code introduces a new definition of radioactivity: "Radioactive material means any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in 2.7.7.2.1 – 2.7.7.2.6".

The effect is that if a substance is listed in the table (see part 7 of this book) and exceeds two values it is dangerous. If the radionuclide is not listed then a Competent Authority would have to approve the classification.

The sievert (Sv), formerly known as the "rem" is the dose equivalent and measures the relative effects of different types of emitted radiation: 1 Sv = 100 rem. Sieverts are used in the calculation of the Transport Index which is given on each package containing a radionuclide. The figure assigned (normally between 1 and 10) depends on the maximum radiation detectable at a distance of 1 m from any point on the package.

Corrosives (class 8)
This class comprises both organic and inorganic substances and articles which contain them. All have the common property of causing damage to living tissue such as burns to skin, eyes and mucous membranes and/or corrosion to the metal structures of ships.

Many of the substances in this class are either acidic (e.g. sulphuric acid), will form acids on contact with moisture or are basic (alkaline).

Acids
Acids are substances which contain hydrogen and when dissolved in water dissociate to form hydrogen ions: atoms or groups of atoms that have lost one or more electrons making the atom positively charged. The easiest way to recognize an acid in water is to test the solution with litmus paper which turns red. The degree to which ionization takes place is measured by its pH (potential of hydrogen) meter which has a range of 0 to 14. A pH of 7 is neutral; below 7 is acidic and above 7 is alkaline.

Inorganic acids such as sulphuric, nitric and hydrochloric acids (known collectively as the mineral acids) are almost completely dissociated in water, have a pH approaching 0 and are known as strong acids, whereas organic acids, the most important of which are the carboxylic acids having the structure COOH (e.g. acetic acid – the main ingredient of vinegar), are generally much weaker, having pH values in the range 2 to 5. In general, the stronger the acid the more corrosive to skin, eyes and metal it is likely to be. Many but not all metals react with inorganic acids to form hydrogen and a salt (e.g. hydrochloric acid reacts with iron to form the salt iron chloride and hydrogen):

$$2HCl + Fe \longrightarrow FeCl_2 + \uparrow H_2$$

Acid anhydrides (e.g. acetic anhydride) and acid halides (e.g. benzoyl chloride), also found in class 8, react with water to form acids.

Bases (alkalis)
Metal oxides and hydroxides are bases and most are insoluble in water. Alkalis are bases which will dissolve in water, turning litmus indicator paper blue, and have a pH above 7. Common alkalis are sodium hydroxide, potassium hydroxide, ammonia and sodium carbonate. Bases will neutralize acids to form a salt and water (e.g. sodium hydroxide reacts with hydrochloric acid to form common table salt and water):

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

Such reactions can be strongly exothermic, which is why some acids and bases must be stowed at least away from each other, an example of stowage incompatibility within the same class.

Sodium and potassium hydroxides, even in dilute solutions, will attack skin and eyes and are said to be caustic. If you rub dilute sodium hydroxide between two fingertips they will soon feel soapy as the alkali emulsifies the natural oils in the skin.

Ammonia when dissolved in water acts as an alkali because it forms hydroxide ions in water:

$$NH_3 + H_2O \longrightarrow NH_4^+ + OH^-$$

Many organic amines (e.g diethylamine) which are derivatives of ammonia are also basic.

The determination of whether a particular material should be included within class 8 depends upon human experience or on the time taken for the product to cause full-thickness destruction of skin. Also account is taken of its potential to corrode metals. Mercury metal is included in class 8 because of its corrosivity to aluminium.

Miscellaneous dangerous substances and articles (class 9)
Substances and articles in this class do not meet the criteria for the other eight classes but nevertheless are considered sufficiently dangerous to warrant inclusion in the Code. This class includes substances likely to cause cancer (carcinogens) after even a single exposure (asbestos, PCBs), irritants and allergens (benzaldehyde, castor beans), fire risk (substances carried at elevated temperatures), asphyxiants (dry ice, containers under fumigation) and environmentally hazardous substances (marine pollutants).

The inclusion of such substances has added significantly to the number of substances in class 9 that have been identified as marine pollutants by GESAMP (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). For packaged goods, marine pollutants are defined using criteria such as the potential for bioaccumulation (concentration of the substance in the food chain), tainting of seafood or high toxicity to aquatic life (defined as having an LC_{50}/96 hour of less than 1 mg/l (ppm)). The Code differentiates between marine pollutants, which meet the GESAMP criteria, and severe marine pollutants, which are bioaccumulated or extremely toxic to aquatic life, having an LC_{50} /96 hour of 0.001 mg/l or less.

Substances meeting these criteria are classified as marine pollutants and if they have no other hazard are classified under the liquid or solid entry for Environmentally Hazardous Substance in class 9.

The criteria used by IMO to define the environmental hazard of marine pollutants differs from that used to classify substances "dangerous to the environment" by user classifications and also by international road and rail transport regulations (RID/ADR). Consequently, a substance can be a marine pollutant as defined by IMO but not dangerous to the environment as defined by other authorities and vice versa.

Part 7: Classification – The UN System as Used by IMO

(Part 2 and chapter 3.1 of the Code)

7.1 United Nations classes

The purpose of the United Nations dangerous goods classification system is twofold: firstly, to draw out boundary lines to determine which goods are dangerous and which goods are not dangerous in the transport environment; secondly, to show in broad terms what kind(s) of danger are to be found in a particular substance or article. There are a series of standard tests for deciding if a substance or article presents risks that make it dangerous to transport.

Dangerous goods are split into nine broad groups or classes dependent upon the major kind of danger that the substance presents; other risks may be present in a product and these are known as sub-risks or secondary risks whilst the main risk is referred to as the class risk. Some classes are further split into divisions which categorize risk more finely. Each class or division has a diamond-shaped label assigned to it; these have broadly universal acceptance by all transport controls. The nine UN classes and divisions of dangerous goods are:

1 Explosives
2 Gases
  - 2.1 – Flammable gases
  - 2.2 – Non-flammable, non-toxic gases
  - 2.3 – Toxic gases
3 Flammable liquids
4 Other flammable substances
  - 4.1 – Flammable solids
  - 4.2 – Spontaneously combustible substances
  - 4.3 – Water-reactive substances
5 Oxidizers and organic peroxides
  - 5.1 – Oxidizers
  - 5.2 – Organic peroxides
6 Toxic and infectious substances
  - 6.1 – Toxic substances
  - 6.2 – Infectious substances
7 Radioactive materials
8 Corrosives
9 Miscellaneous items

The chemical and physical nature of these various items was considered in part 6. Articles and substances that are not specifically identified in the alphabetical index to the IMDG Code must be placed in the class that corresponds with the kind of risk known to be in the product. If necessary, chemical analysis should be undertaken to determine this.

If the substance has more than one risk there is a set procedure for determining the classification: a product that is a flammable liquid which gives off toxic fumes could be a flammable liquid with a toxic sub-risk, *i.e. class 3, sub-risk 6.1*; it could also be a toxic liquid with a flammable sub-risk, *i.e. class 6.1, sub-risk 3.* Only one classification can be correct. The class will be the one indicated by use of the precedence of hazard table in chapter 2.0 of the Code. By checking one risk factor from the horizontal rows and the other risk factor from the vertical columns, the precedence of risk is given at the point of intersection. **The classes and divisions not included in the table always take precedence over the featured classes and divisions.**

Extract from 2.0.3.6 – Precedence of hazards

Class and packing group	4.2	4.3	6.1, I Dermal	6.1, I Oral	6.1 II	6.1 III	8, I Liquid	8, I Solid
3 I*		4.3	3	3	3	3	3	–
3 II*		4.3	3	3	3	3	8	–
3 III*		4.3	6.1	6.1	6.1	3+	8	–
4.1 II*	4.2	4.3	6.1	6.1	4.1	4.1	–	8
4.1 III*	4.2	4.3	6.1	6.1	6.1	4.1	–	8
4.2 II		4.3	6.1	6.1	4.2	4.2	8	8
4.2 III		4.3	6.1	6.1	6.1	4.2	8	8
4.3 I			6.1	4.3	4.3	4.3	4.3	4.3
4.3 II			6.1	4.3	4.3	4.3	8	8
4.3 III			6.1	6.1	6.1	4.3	8	8

- substances of class 4.1 other than self-reactive substances and solid desensitized explosives and substances of class 3 other than liquid desensitized explosives
- 6.1 for pesticides
- – denotes an impossible combination

The table above shows a section of the precedence of hazard table. A substance presenting risks associated with a flammable liquid of PG II and a toxic liquid of PG III may be classified as a *flammable liquid with a toxic sub-risk* because there is a figure 3 for class 3 (flammable liquid) at the point of intersection of the reference row and column.

7.2 Packing groups

Dangerous goods present wide ranging levels of danger as well as wide ranging kinds of danger. As shown above, the kinds of danger are revealed by the classification of the substance; the level of danger is usually shown by a simple measure known as the packing group (PG) of the substance.

There are three levels of danger, always indicated by the use of roman numerals, thus:

PG I – High danger
PG II – Medium danger
PG III – Low danger

The packing group of a substance determines the quality of packaging required for safe and acceptable transport. PG I items require the highest standard of UN specification packaging; PG II materials may be safely transported in slightly less substantial containment systems whilst PG III represents a range of items where a further reduction in packaging standards can safely be permitted. Parts 9 and 10 of this Compendium explain further the link between packing groups and packaging selection.

Packing groups are allocated to substances on the basis of the test criteria used for each class (e.g. a substance with a flashpoint not exceeding 61°C which boils below 35°C is allocated to PG I in class 3 (flammable liquids) whilst a substance which causes full-thickness destruction of intact skin tissue within 10 minutes after 2 minutes exposure is allocated to PG I in class 8 (corrosives)).

There are some classes (1, 2, 5.2, 6.2 and 7) where the packing group concept is not used: there are no specific criteria and special packaging requirements apply.

In the case of substances/articles in classes 1 and 5.2, the UN Recommendations indicate that any packagings used must be to PG II standards so as to avoid over-confinement in the event of a fire or explosion.

Infectious substances are not allocated to packing groups but clinical or medical waste for the purposes of packaging is allocated to PG II.

In the Code, the Damaged Goods List (see part 5.4 of this Compendium) to the IMDG Code lists the packing groups of all substances entered, with the exception of the classes/divisions referred to above.

7.3 Proper shipping names and United Nations Numbers

Identification of dangerous goods for shipment by sea means using a name recognized by the IMDG Code together with the linked UN Number for the substance. These methods of identification are then used on the documentation prepared to accompany the goods and they are also marked on packages or tanks that contain the goods. The procedures for documentation and for package or tank marking will be considered later in this Compendium (part 11).

Chapter 2.0 and chapter 3.1 of the Code detail the procedures for identifying dangerous goods for transport by sea.

Identification is straightforward for products that can be found in the DGL of the IMDG Code. A name printed in capital letters in column 2 of the DGL that has no qualification placed upon it is known as a proper shipping name (PSN); this is the proper name to use. A qualification would normally appear in either:

- a qualification to the name in column 2 (e.g. "with not less than 20% water by mass");
- a Special Provision in column 6; or
- Notes in column 17 of the DGL.

To find the name of a substance when the UN Number is not known there is an alphabetical index at the back of volume 2 (an extract is shown below). If the name is printed in lower case and qualified by the word "*see*" it is a synonym that is not acceptable as a PSN. The correct PSN is found by cross referencing the DGL entry for the UN Number shown in the right hand column against such entries.

Index **Substance, material or article**	**MP**	**Class**	**UN No.**
2-ETHYLBUTANOL	–	3	2275
2-ETHYLBUTYL ACETATE	–	3	1177
2-ethylbutyl alcohol, *see*	–	3	2275
2-ETHYLBUTYRALDEHYDE	–	3	1178
ETHYLDICHLOROARSINE	**P**	6.1	1892
ETHYLDICHLOROSILANE	–	4.3	1183

In the table above, 2-ethylbutyl alcohol is not a PSN. The reader is referred to UN 2275 and in column 2 of the DGL entries for this UN Number, 2-ETHYLBUTANOL is listed as the PSN.

For certain Explosives after the word "see" there is an alternative name offered e.g. "Explosive Articles N.O.S., *see* ARTICLES, EXPLOSIVE, N.O.S."

Unnumbered/Unlisted substances and articles
If the UN Number is not known and a substance PSN cannot be found in the alphabetical index then a little more work is required.

In addition to specific substance names (e.g. acetone), the alphabetical index also contains generic entries for groups of substances/articles (e.g. Adhesives), general entries which relate to a particular family of substances (e.g. BARIUM COMPOUNDS N.O.S), and entries which describe a particular type of risk or risks (e.g. FLAMMABLE LIQUID, TOXIC N.O.S). The letters N.O.S. stand for "not otherwise specified", meaning the substance has not been directly named elsewhere in the alphabetical index. If both a family and a descriptive N.O.S. entry effectively describe the substance, the generic entry should be used.

The nature of the risk(s) "family" associated with the substance must be determined by the classification procedures as described in part 7.1 and 7.2; the most appropriate "family" or descriptive PSN must then be chosen. For a flammable liquid with no other risks the most appropriate PSN may well be UN 1993 FLAMMABLE LIQUID N.O.S. However it should be noted that use of this number is a last resort. Where a person is classifying a ketone for which there is no UN Number the procedure should be that UN 1224 KETONES, LIQUID N.O.S takes precedence over UN 1993 (see 2.0.2.7).

If the substance has more than one risk then at least two PSNs will present themselves: a product that is a flammable liquid which gives off toxic fumes could be described as a FLAMMABLE LIQUID, TOXIC N.O.S. but an entry will also be found in the index for TOXIC LIQUID, FLAMMABLE N.O.S. Only one entry is correct. The PSN must reflect the hazard precedence procedure referred to in 7.1. For example, a substance presenting risks associated with a flammable liquid of PG II and a toxic liquid of PG III should be identified as a FLAMMABLE LIQUID, TOXIC N.O.S. because at the point of intersection of the reference row and column there is a figure 3 for class 3, flammable liquid. This PSN has a UN Number of UN 1992.

To complete the identification process for a PSN that ends with the letters N.O.S. (and some others e.g. many generic pesticide entries) it is generally necessary to undertake one further task.

Following the N.O.S. letters a bracket is opened and the chemical name of the risk substance is entered, the brackets are then closed. If there are several constituents contributing to the risk only the two major substances are listed. Similarly, if there are two risks present then the major generator of each risk is listed and nothing further. Thus, FLAMMABLE LIQUID, TOXIC N.O.S. (contains acetone and phenol) would be a complete PSN. The bracketed information is reproduced in the same sequence as the risks are described in the first part of the name, i.e. the flammable risk is from the acetone and the toxic risk is from the phenol. If appropriate, the word "contains" should precede the chemical name. Names requiring this extra detail have SP274 listed column 6 of the DGL. A complete list of N.O.S. shipping names can be found in Appendix A towards the back of volume 2 of the IMDG Code.

Solutions, mixtures, preparations etc.
Many of the substances that will be identified by the foregoing procedures will be solutions, mixtures or preparations. That is to say, they will not be pure chemicals but pure chemicals mixed with other substances, dangerous or otherwise. The identification of such a product is subject to three different possibilities. Using diethyl ether as an example, the possibilities will be addressed.

Pure diethyl ether is a rare commodity, as are all truly pure chemicals. Commercial grades of a substance will be in the order of 97% pure; these are the substances that will be shipped. According to the details shown in the DGL, diethyl ether is a flammable liquid (class 3.1, PG I, with no sub-risk), and has the UN Number UN 1155.

Combining pure diethyl ether with other substances to produce a new product may create a solution, mixture or preparation. The item is no longer pure diethyl ether and it is no longer correct to identify it as such. The correct form of identification depends upon the hazard criteria exhibited by the newly made substance.

If analysis shows the new substance to be of class 3, PG I, *with no sub-risk*, the new product will share the same hazard characteristics as its parent material. In this situation, when there is no variation of hazard rating by class, physical state or packing group between the chemical and the preparation, identification proceeds as for the original substance but with the addition of "solution" or "mixture" immediately after the PSN.

Thus, a preparation consisting largely of diethyl ether and presenting exactly the same hazard characteristics as diethyl ether would be identified as diethyl ether 75% solution, UN 1155. The percentage concentration is required (chapter 3.1 of the Code refers).

If the preparation contains a rather smaller proportion of diethyl ether and a greater proportion of the other substances it may well be that the hazard characteristics of the new preparation are not exactly the same as those of the commercially pure chemical.

If upon analysis the new substance is determined to be of class 3, PG III, then it is not diethyl ether, nor is it diethyl ether solution. It must now be shipped under the most appropriate "family" or descriptive PSN which in this case, because diethyl ether is an ether, would be ETHERS N.O.S. (contains diethyl ether), UN 3271.

Yet further dilution of the preparation with other materials could eventually produce a substance that no longer possesses the hazard characteristics of a flammable liquid; it is no longer to be considered to be dangerous for transport.

Marine pollutants
Substances of all classes may be classified as marine pollutants; as such they are dangerous goods which also pollute the marine environment. A distinction is made between substances which are marine pollutants and those which are severe marine pollutants. Substances which possess this pollution risk are identified as marine pollutants or severe marine pollutants in the DGL by a "**P**" or a "**PP**" respectively in column 4.

Solutions, mixtures or preparations which contain 10% or more of a marine pollutant or 1% or more of a severe marine pollutant are also classified as marine pollutants and must be identified as such when being consigned by sea. Products which may possibly be classified in this way are marked in the DGL by a black spot (●).

The IMDG Code also encompasses substances, articles and materials which do not fall within the criteria of any of the hazard classes but which are pollutants in the marine environment. These are shipped under class 9 (miscellaneous dangerous substances and articles) using the following PSN and UN Number as appropriate: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S., UN 3077, or ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S., UN 3082.

The same identification procedures applies to a solution or mixture which does not meet the criteria of any of the hazard classes but which contains 10% or more of a marine pollutant or 1% or more of a severe marine pollutant.

7.4 Explosives

Explosive substances/articles require the provision of one extra piece of information before classification and identification of the goods is complete. In the nature of these materials it is possible for one explosive item to provide the appropriate circumstances to bring about activation of another explosive material (e.g. detonator and explosive charge).

To prevent such circumstances from arising during transport all explosives are allocated to compatibility groups designed to distinguish between those that may explode and those that may bring about such an explosion. These compatibility groups are indicated by the use of a capital letter code ranging through the letters A to H, J to L, N and S (see chapter 2.1 of the Code).

Classification is not complete until the correct compatibility group letter has been determined for any explosive item. This information is recorded immediately after the class/division designation (e.g. class 1.4S).

Note: In most countries it is a requirement that the classification of an explosive is approved by the Competent Authority or another government agency.

7.5 Radioactive materials

There are seven groups of radioactive material (RAM) in the transport rules: special form; other form; low specific activity (LSA); surface contaminated object (SCO); low dispersible; fissile material; fissile excepted. Materials may meet the criteria of more than one of these groups. Chapter 2.7 of the IMDG Code contains definitions in sections 2.7.2, 2.7.3, 2.7.4, 2.7.5 and 2.7.10 – from which the following explanations are drawn.

Special form
RAM that is prepared in such a way that contamination is a most unlikely transport occurrence is called "special form" material. At least one surface of such material must have a dimension of 5 mm or more. It may be in sealed capsules or in a solid mass such that dust etc. will not be generated. Sealed capsules must be such that they can only be opened by destroying them. Generally, larger quantities of special form material may be carried compared to non-special form material. Unilateral approval is needed for special form material. There are a range of performance tests that must be complied with before a Competent Authority can classify material as special form.

Other form
RAM that is not special form is referred to as "other form" material.

Low specific activity material (LSA)
These are materials that present a low level of radiation activity compared to the bulk quantity of the material involved. They tend to be ores and waste materials in a low hazard state or they are materials that effectively bind the source into a matrix, such as bitumen. Varying degrees of activity and material are covered by this description; these variations are catered for by splitting the classification into three sub-groups, LSA-I, LSA-II, LSA-III.

Surface contaminated objects (SCO)
SCO are non-radioactive items that have their surfaces contaminated by radioactive materials. Such a classification may be applied to a pipework system that has been used to conduct radioactive materials. The pipes themselves are not radioactive but they do contain quantities of harmful RAM. This classification falls into two groupings, SCO-I and SCO-II dependent upon the nature and level of the contamination.

Low dispersible material
These are materials that possess similar qualities to special form material in that they are of a sufficient mass or are engineered in capsules to ensure that they will not spread over a wide area in a transport incident. They cannot be in powder form. The grouping may be advantageous in arranging air transport of RAM but may also be encountered by those involved in maritime movements.

Fissile material
Fissile material is a range of RAM that have the capability, when gathered into a large enough mass, to create high levels of heat and radiation. The result of this high activity can be the creation of even higher levels of heat and activity; this is known as a chain reaction where each action causes yet greater activity.

It is a little like running fast downhill: at first you are in control but there comes a point at which your legs are beyond your control and the descent proceeds at a faster and faster speed. The descent has to end in disaster in the form of some crash to the ground as all control is finally lost. The consequence of a chain reaction in fissile material is loss of control and eventual major explosion or melt down. The mass of a particular material that will cause a chain reaction is known as the critical mass; ensuring that such a situation cannot arise during the transportation of fissile material is a function called criticality control.

Fissile excepted
Consignments of fissile material that are made in defined ways relative to quantities and presentation may be moved as fissile excepted items. Such fissile material is deemed not to warrant the full level of criticality control normally afforded to fissile material because as presented for transport it does not possess sufficient mass to reach criticality. Fissile excepted items are regulated in the same manner as non-fissile RAM.

RAM identification
Radioactive material is identified following the normal routines of the IMDG Code. The choice of an appropriate name is determined by the nature of the material being moved and the manner of its packaging, in line with the groupings indicated above. Excepted packages contain materials as described above but they present such minor transport hazards that significant concessions are given to them within the Code. Further detail on this aspect is contained in part 9 of this Compendium.

Within chapter 3.5 of the IMDG Code the various radioactive material UN Number/PSN combinations are each allocated to one of 14 schedules. These schedules reflect a system developed by the International Atomic Energy Agency (IAEA). They are offered as an aid to the user of the IMDG Code to the extent that they summarize consignment and transport duties in a single location; they are not, however, part of the IMDG Code procedural system and the preface to chapter 3.5 makes it clear that if there is any conflict between schedule statements and duties listed elsewhere in the Code then the latter must prevail.

As explained in part 6, the new system of classification is based on a knowledge of the radionuclide values. The table below is extracted from the table in chapter 2.7 of the Code.

Table 2.7.7.2.1 – Basic radionuclide values

Radionuclide (atomic number)	A_1 **(TBq)**	A_2 **(TBq)**	**Activity concentration for exempt material (Bq/g)**	**Activity limit for an exempt consignment (Bq)**
Actinium (89)				
Ac-225 (a)	8×10^{-1}	6×10^{-3}	1×10^{-1}	1×10^{-4}
Ac-227 (a)	9×10^{-1}	9×10^{-5}	1×10^{-1}	1×10^{-3}

If the activity is below this value the goods are not dangerous

If the activity of the consignment is below this level then the consignment is exempt

Notes to table

A1 The activity value of special form. Special form is either an indispersible solid or a sealed capsule that can only be opened by destruction.

A2 The activity of material which is not special form.

(a) A_1 and/or A_2 values include contributions from daughter nuclides with half lives less than 10 days.

(b) Once it is determined that a consignment is not exempt then there will be a need to calculate the Transport Index (TI), which is a measure of the radiation at a distance of 1 metre from the package. There is a numbering system relating to the level of activity similar to that for packing groups, i.e. I, II, and III that will be seen on labels: however, for class 7, "I" indicates low activity and "III" high activity (i.e. the *reverse* of PGs).

If the substance is fissile (certain types of uranium and plutonium), a criticality safety index has to be calculated.

If a radionuclide is not listed a consignor has two choices. There is a default value in chapter 2.7 of the Code that can be used but it is very restrictive. The alternative is to approach a Competent Authority to provide a classification and make a special arrangement with the receiving country's Competent Authority to permit transport.

7.6 Infectious substances

The classification of infectious substances is based on rules set down by the World Heath Organization (WHO).

Infectious substances can fall into one of four risk groups which are described in chapter 2.6 of the Code.

In addition, the class includes genetically modified micro-organisms, biological products, diagnostic specimens and clinical waste.

A new provision appearing for the first time in Amendment 31 concerns diagnostic specimens. These are samples, usually taken from patients who are not suspected as having an infectious disease, and a specimen is being sent for analysis. Special packaging has been established to deal with these samples.

7.7 Classification of samples

This is a new procedure for the UN and the IMDG Code and will be found in chapter 2.0. Substance identification and allocation to a UN class for a newly developed product is dependant in principle on product testing. Industry has had a problem with this concept given that facilities for testing are often not available at the product development site.

Under the provisions for samples is a belief that a substance is dangerous but it has to be sent to another laboratory for testing. A consignor can provide a classification and UN Number based on the knowledge available. The most severe packing group has to be applied. Where this provision is used the PSN will be supplemented by the word "sample". Where the consignor uses an N.O.S entry for a sample the name need not be supplemented by a technical name (which is generally required under special provision 274 for N.O.S entries – see unnumbered/unlisted substances and articles in 7.3).

The sample must be transported in a combination packaging with a net mass not exceeding 2.5 kg and must not be packed with other goods.

Part 8: Classification – The IMDG Code Classes

8.1 Presentation and use of information

Part 2 of the Code addresses classification and follows the UN system as described in part 7. Part 2 of the Code consists of an introductory chapter (2.0) that describes the UN principles:

- The nine classes
- Marine pollutants and wastes
- UN Numbers and Proper Shipping Names
- Classification of:
  - substances
  - mixtures and solutions
  - multiple hazards

This chapter is followed by nine chapters (one for each class – 2.1 to 2.9). The procedures are aligned to the UN provisions. There is an additional chapter (2.1.0) for marine pollutants, a subject unique to sea transport.

8.2 Classification of unusual items

Certain items are of a very particular nature and do not readily conform to the standard pattern for any given class. Such items are given individual classification procedures within their appropriate schedules. The following is an example:

The alphabetical index to the IMDG Code (volume 2) contains six separate entries related to batteries; each entry represents a variation upon the formation or nature of the item in question. The first task must be to identify the correct entry for the item being shipped. If the batteries to be shipped are known to contain acid then it can be determined that two entries may be appropriate: *BATTERIES, WET, FILLED WITH ACID, electric storage* or *BATTERIES, WET, NON-SPILLABLE, electric storage*. It is necessary to check the detail of the respective entries in the DGL to determine which of these options is correct.

The key difference between the two entries is revealed in the content of Special Provision 238 which applies to BATTERIES, WET, NON-Spillable, electric storage. Special Provisions are explained in chapter 3.3 of the Code. This one applies to performance standards (by testing) for the batteries. Quite simply, if the items to be shipped meet the demands of the listed vibration and pressure tests, they may be shipped under this PSN; if they do not, then the entry *BATTERIES, WET, FILLED WITH ACID, electric storage* is the correct PSN to use.

Note: the above example deals with acid/alkaline batteries. Sodium or lithium batteries have separate entries.

8.3 Waste materials

All waste materials shipped across international boundaries are subject to stringent controls derived from the decisions of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989. Any waste carried by sea that presents any of the hazards controlled by the IMDG Code, i.e. the nine UN classes of danger, is subject to the IMDG Code in addition to any controls placed upon it by virtue of it being waste material. As such, the waste is classified and identified in the manner outlined in parts 6 and 7 of this Compendium. Chapter 7.8 of the Code describes the provisions as they apply to sea shipments.

Single-substance wastes that present the same hazards as the pure material should be shipped as that material, *e.g. waste methanol, class 3.2, UN 1230, PG II.*

Materials containing more than one constituent dangerous substance should be classified and identified according to the procedures outlined in part 7 of this Compendium. If this is impracticable, they should be classified according to the "predominant hazard" based on the class of the constituents or, where they fall under more than one class, the outcome of the multiple hazard precedence procedures.

Part 9: Packing and Tank Requirements
(Part 4 of the Code)

9.1 Introduction

All cargo carried on ships, whether dangerous or not, is being sent by one party to another for some reward – usually money – and it is therefore not in the interests of the consignor to dispatch goods that will not arrive in a safe condition. However, goods have different market values and the type of packaging may reflect this.

Once a substance or article has been classified as dangerous, there is an additional regulatory reason for ensuring it is contained safely – whether in a box, drum, intermediate bulk container (IBC), large packaging or tank – whilst in transit to the customer.

All containment systems face potential dangers during distribution and it is a requirement of the IMDG Code that the consignor considers these and selects a containment method that will survive the entire journey. In addition, there is often a need to have the package/IBC tested, approved and marked in accordance with UN provisions.

This part of the course deals with the general principles which apply to *all* packagings (including IBCs and large packagings) and tanks. Part 10 considers the detailed testing and approval requirements.

9.2 Terminology

A number of terms appear in this section. These include:

- *Cylinders*: these are transportable pressure receptacles of a water capacity not exceeding 150 litres;

- *Packages*: these are the complete product of the packing operation, including the packaging (e.g. the box or drum) and its contents (the chemical). They are generally limited to 400 kg or 450 litres. Packages can be divided into two broad types:
  - *single packagings* – these provide a safe containment system without any special overpacking (e.g. steel drums)
  - *combination packagings* – these usually consist of an outer packaging with the chemical contained in an inner packaging (e.g. plastics bottle in a fibreboard box).

- *Intermediate bulk container (IBC)*: a packaging designed for bulk product (e.g. a liquid or solid). IBCs do not carry inner packagings (e.g. bottles). There is no lower size/capacity limit but an IBC must be designed for mechanical handling and must not exceed 3 m^3 (3000 litres) capacity.

- *Large packagings*: these are intended for the carriage of inner packagings or articles. They are designed for mechanical handling. They exceed the normal packaging threshold of 400 kg net or 450 litres but must not exceed 3 m^3.

- *Bulk packagings*: these are cargo transport units loaded with solid dangerous goods without any intermediate form of containment (see 9.15).

- *Tank*: the definition of a tank covers a portable tank or a road tank vehicle – it must have a capacity exceeding 450 litres or more and the shell must be fitted with items of service equipment.

9.3 Distribution hazards for packages

The distribution hazards begin at the point of filling and in the case of sea transport this will rarely be at the port but somewhere inland.

Chapter 4.1 of the Code list a number of requirements with which the shipper must comply. These requirements apply to all packagings and some are relevant to tanks although the general provisions for tanks are set out in chapter 4.2.

Packages must be of good quality. They do not have to be new (in fact the UN system recognizes reconditioning, reuse, repair and maintenance of different packaging types – definitions can be found in chapter 1.2), and when closed for the transport journey they must not leak as a result of:

- *Vibration:* there is vibration during all forms of transport and it can be particularly serious during sea voyages. Leakage can occur if the product is not effectively contained. One of the most common effects of vibration is to loosen closures. In more extreme circumstances the vibration can lead to leakage through package seams and welds.

- *Handling*: no packaging gets from a filling point to a ship without involving some other means of transport (e.g truck, train and sometimes an air journey). Packages will be handled on several occasions and the consignor is required to take this into account in selecting a packaging.

- *Changes in temperature, humidity or pressure:* a container loaded in January in Rotterdam for shipment to Australia will encounter significant variations in temperature. Temperature changes could cause expansion of liquids sufficient to deform and ultimately damage packages, leading to leakages.

  The same voyage will pass through areas of high humidity near the equator. As a result, packages such as fibreboard boxes could be weakened and made ineffective, whilst steel drums could rust.

  Changes in pressure are somewhat less important in sea transport than in the air but they could lead to leakage especially if a package has been overfilled.

- *Compatibility:* most chemicals can affect other materials. It is therefore necessary to know whether the chemical will attack the material from which the intended packaging or tank is constructed.

- *Ullage:* It is also important to ensure that sufficient *ullage* is provided in packagings intended for liquids: this is an amount of space left in the top of packagings to allow for the liquid to expand.

These principles have to be taken into account for all packagings (including tanks and IBCs).

An additional provision requires that packages are closed in accordance with the manufacturer's instructions. This involves having the correct information on closure torques for drums etc. and the method of taping for boxes and bags. The provision applies equally to inner packagings of combination packagings.

It is worth noting here that packages are usually placed in cargo transport units (CTUs) for their journey. These units can affect package design and package designers should be aware of the stresses that will be applied during a journey (CTUs are considered in more detail in parts 13 and 14 of this Compendium). Advice on packing CTUs can be found in the Supplement to the Code.

It is the responsibility of the consignor to select a packaging that meets the above parameters and, except in the case of tanks, the UN testing requirements for packagings (as outlined in part 10 of this Compendium).

Tanks and most IBCs are recognized as being reusable and they are subject to 2.5 and 5 year inspection programmes. These are explained in part 10 of the Compendium. The person responsible for filling a tank or IBC must ensure, prior to commencing the filling operation, that the vessel is within the inspection period.

Further details of the requirements applicable to the selection and use of IBCs and tanks are given in 9.8-9.12 of this Compendium.

9.4 The relevance of packing groups (PG)

The PG concept was introduced to grade the danger of a substance which in turn would affect:

- the packaging to be used
- the performance level to be achieved in testing and
- the quantity permitted per package.

Selection of suitable packagings

9.5 Packagings for all classes (except class 7)

With the exception of class 7, all packaging (including IBCs and large packagings) are listed in a series of packing instructions. They appear in columns 8 and 10 of the DGL. The type of instruction can be identified as follows:

PXXX	Packagings
IBCXXX	Intermediate bulk containers
LPXXX	Large packagings

The instructions can also be further identified as follows:

For packagings:

P0XX are general packing instructions (e.g P001) applicable to substances in any class except 1, 2 and 7. These general instructions cover over 1800 UN Numbers. P099, P101, IBC99 and LP99 require the packaging to be approved by the Competent Authority.

P1XX are for class 1

P2XX are for class 2

P3XX are for class 3 etc.

These are class specific. It should be noted that there are a few substances, notably in classes 4, 6.1 and 8, where the class number and the packing instruction are different (e.g. Bromine UN 1744 is in class 8 but is allocated to P601). This was done because the packing arrangements are similar to those for substances in class 6.1. It affects about 20 very dangerous substances (all PG I and toxic by inhalation). It was agreed that repeating the same instruction in each class was unnecessary.

For IBCs:

The system is slightly different. The main IBC instructions are numbered IBC01-IBC08. IBC01 is the most restrictive packing instruction while IBC08 is the most liberal. There are instructions for class 1 (IBC100), class 5.2 (IBC520) and class 6.2 (IBC620). IBC099 requires the IBC to be approved by the Competent Authority.

For large packagings:

At present large packagings are limited to substances in PG III without any subsidiary risk, except for certain class 1 articles and clinical waste (UN 3291). There are two general instructions, LP01 for liquids and LP02 for solids. There are three other packing instructions, for class 1 (LP101 and 102) and class 6.2 (for clinical waste) (LP621). LP99 requires the packaging to be approved by the Competent Authority.

The packing instructions generally follow a standard format:

Title – P= packaging, IBC = intermediate bulk container, LP = large packaging	**PXXX PACKING INSTRUCTION PXXX**
General provisions (for certain classes there are other references e.g. 4.1.5 for class 1). Also some packing instructions are specific to UN Numbers and these are shown here.	The following packagings are authorized, provided the general packing provisions of 4.1.1 and 4.1.3 are met
Packaging options.	This is a list of packagings authorized for use under the instruction
Specific additional general provisions (not all instructions).	**Additional provisions** Example: "Matches should be packed tightly"
Specific requirements for certain substances (optional). UN Numbers generally appear in the provision (not all instructions).	**Special packing provision** Example: "**PP31** For UN 1381, packagings shall be hermetically sealed" B3 Only flexible IBCs fitted with a coating or liner are authorized

Set out below is an extract from P001. This covers the majority of liquid substances listed by the UN. It offers the most packaging options. P002 offers packagings for solids in a similar way.

4.1.4 List of packing instructions

4.1.4.1 Packing instructions concerning the use of packagings (except IBCs and large packagings)

P001	PACKING INSTRUCTION (LIQUIDS)			P001
The following packagings are authorized provided the general provisions of 4.1.1 and 4.1.3 are met.				
Combination packagings		**Maximum capacity/net mass (see 4.1.3.3)**		
Inner packagings	**Outer packagings**	**Packing group I**	**Packing group II**	**Packing group III**
Glass 10*l* Plastics 30*l* Metal 40*l*	**Drums** steel (1A2) aluminium (1B2) fibre (1G)	 75 kg 75 kg 75 kg	 400 kg 400 kg 400 kg	 400 kg 400 kg 400 kg
	Boxes steel (4A) fibreboard (4G)	 75 kg 75 kg	 400 kg 400 kg	 400 kg 400 kg
	Jerricans steel (3A2) plastics (3H2)	 60 kg 30 kg	 120 kg 120 kg	 120 kg 120 kg
Single packagings				
Drums steel, non-removable head (1A1) steel, removable head (1A2)		 250*l** prohibited	 450*l* 250*l*	 450*l* 250*l*
Jerricans steel, non-removable head (3A1) plastics, removable head (3H2)		 60*l* prohibited	 60*l* 60/	 60*l* 60/
Composite packagings Plastics receptacle in fibre, plastics or plywood drum (6HG1, 6HH1, 6HD1) Glass receptacle in steel, aluminium, fibre, plywood, solid plastics or expanded plastics drum (6PA1, 6PB1, 6PG1, 6PD1, 6PH1 or 6PH2) or in a steel aluminium, wood, fibreboard or plywood box (6PA2, 6PB2, 6PC, 6PG2 or 6PD2)		 120*l** 60*l*	 250*l* 60*l*	 250*l* 60*l*
Special packing provisions				
PP1	For UN 1133, UN 1210, UN 1263 and UN 1866, packagings for substances of packing groups II and III in quantities of 5*l* or less per metal or plastics packaging are not required to meet the performance tests in chapter 6.1 when transported: (a) in palletized loads, a pallet box or a unit load device, such as individual packagings placed or stacked and secured by strapping, shrink- or stretch-wrapping or other suitable means to a pallet. For sea transport, the palletized loads, pallet boxes or unit load devices should be firmly packed and secured in closed cargo transport units; (b) as an inner packaging of a combination packaging with a maximum net mass of 40 kg.			
PP2	For UN 3065 and UN 1170, wooden barrels (2C1 and 2C2) may be used.			
PP81	For UN 1790 with more than 85% hydrofluoric acid and UN 2031 with more than 55% nitric acid, the permitted use of plastics drums and jerricans as single packagings shall be two years from the date of manufacture.			

* Not permitted for class 3, packing group I.

Using the extract above and taking the following substances, it is possible to see how to use the packing instruction:

Paint UN 1263: there are three entries for this substance in the DGL – PG I, PG II and PG III. In column 8 of the entries for each packing group P001 is given as the packing instruction. In column 9 (Packing Provisions) there is nothing for the PG I entry but for PG II and PG III **"PP1"** is shown. Whichever packing group applies, P001 requires compliance with 4.1.1 and 4.1.3.

If a consignor wishes to send two 1 litre glass bottles of a PG I paint then the first part of the Packing Instruction dealing with combination packagings is applicable. Glass inner packagings are permitted up to a capacity of 10 litres. An outer packaging is then required from the options listed in the second column. For PG I the limit is 75 kg maximum net mass.

If the consignor wishes to send PG II or PG III paint in 5 litre metal receptacles then PP1 is relevant. The main benefit of PP1 is that it provides exemption from the need to use UN tested packagings if the conditions described in PP1 can be met.

PP81 is not optional. If a consignor is sending UN 1790 (hydrofluoric acid) above 55% concentration in plastics packagings (drums or jerricans) he must ensure that the packaging is not more than two years old.

The principles set out above apply to every packing instruction. Within the constraints of any additional or special packing provisions, the consignor can select any packagings that suits his operation.

For gases of class 2 a new P200 appears in Amendment 31 addressing the use of different types of pressure receptacles including cylinders, tubes and MEGCs (multi-element gas containers). This packing instruction deals with compressed, liquefied and dissolved gases. Packing instruction P203 is reserved for cryogenic gases, which remain subject to Competent Authority approval.

Class 5.2 and 4.1(self-reactive) substances are dealt with slightly differently. P520 applies to these substances and the DGL refers readers to P520, but it is necessary to know which packing method OP1-8 applies to a particular substance. OP1-8 are allocated to named organic peroxides in the table in chapter 2.5 (2.5.3.2.4). Thus there is an additional step in determining the packaging to be used.

Diagnostic specimens of class 6.2 are covered by P650. This is rather unusual in that it not only contains packaging requirements but also consignment procedures. Providing a medical practitioner complies fully with the requirements of P650 then no other parts of the Code apply. This was designed by the UN recognizing that the medical professions would not want to purchase large volumes of regulations for tiny consignments where the risk is minimal.

The packing instructions described above generally require the use of UN tested packagings (including IBCs and Large Packagings). There are two exceptions:

1 P003, P650, P905, and P907 are specific packing instructions that do not require UN tested packagings.
2 Special packing provisions e.g. PP1, B6.

NOTE; *Readers using other international regulations on the transport of dangerous goods e.g. RID or ADR should note that they use the same packing instruction numbers for the same substances (with a few exceptions) BUT the types of packaging and maximum quantities may vary.*

9.6 Packagings for classes 1, 2, 4.1 (self-reactive substances), 5.2, 6.2, and 7

For certain classes the Code adds particular general requirements. With the exception of class 7 these additional requirements are referred to at the beginning of the packing instruction.

For example, in class 1, the following statement appears in the packing instructions: "The following packagings are authorized, provided the general packing provisions of 4.1.1, 4.1.3 and special packing provisions of 4.1.5 are met".

4.1.1 and 4.1.3 are common to all packing instructions except P200 but 4.1.5 are additional requirements for explosives.

The following paragraphs provide similar additional requirements for the classes shown:

4.1.6 Class 2
4.1.7 Class 4.1 and 5.2
4.1.8 Class 6.2
4.1.9 Class 7

Class 7 (radioactive material)
The design, testing, selection and use of packaging systems for radioactive material (RAM) follows a radically different procedure to that for packagings for other hazardous materials.

Because RAM cannot be entirely contained, the overriding principle applied to other substances cannot be applied to RAM. Protection of the material, protection of persons within the vicinity of the material and the limitation of emissions to acceptably safe levels are the functions of RAM packaging.

The range of packagings in use for class 7 substances is unique to the class and is intertwined with the classification and identification of the material for transport purposes – e.g., UN 2909 RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, ARTICLES MANUFACTURED FROM NATURAL THORIUM. The standard IMDG packaging controls are not employed for the selection of RAM shipments. The general requirements and the product-specific requirements are all contained within section 4.1.9 of the Code; the DGL makes this distinct reference in the packing and IBC instructions columns.

In very general terms it may be said that the most efficient packaging selection decisions will be made if the following list of RAM packaging types is considered to be a league table of options, with the first type (excepted) representing the cheapest and easiest option whilst the final type (Type C) represents the most expensive and complex packaging available.

Given this presumption, it makes sense for the consignor to use the least demanding option, consistent with such factors as acceptability, suitability, company policy, availability, etc.

The statements which follow are only intended as a very general guide to packaging types. For detailed descriptions reference should be made to section 4.1.9 and chapter 6.4 of the Code.

Excepted packages
RAM within these packages have low activity levels. Surface radiation levels cannot be in excess of 5 mSv/h. They must be of good quality with smooth external surfaces.

Industrial packages
There are three types which are appropriate for varying levels of RAM, referred to as IP-1, IP-2, IP-3. They are intended for the transport of LSA/SCO material. Part 7 of this Compendium identifies the nature of such items. Maximum activity limits are laid down. One face on every package must have minimum dimensions of at least 100 mm x 100 mm. In addition, IP-2 must be UN packs rated as PG I/II (X/Y) or they must meet equivalent RAM-based performance criteria. IP-3 packages must be type A test competent. Type A package tests establish competence in normal transport conditions.

9.7 Mixed packing

The assumption to this point has been that there will be one package for one chemical. This is not always practical or necessary. Sometimes a number of small quantities of different chemicals have to be sent to the same destination. The Code does not prevent different chemicals being contained within one outer packaging but certain rules must be followed:

- the chemicals must not be required to be "away from" each other or require more strict segregation in the segregation table of chapter 7.2;

- there must not be any adverse chemical reaction if the chemicals become mixed following a leakage. Such reactions would include the evolution of excessive heat, toxic gases etc. as described in 4.1.1.6 of the Code.

9.8 Selecting a suitable IBC

Selecting an IBC follows precisely the same procedure described for packagings except that the IBC packing instruction is found in column 10 of the DGL and any IBC special provision (an alphanumeric code prefixed with the letter "B" e.g. B3) in column 11.

9.9 Large packagings

An IBC is for the carriage of bulk solids or liquids while a large packaging is intended to carry large articles (e.g. bombs and missiles) or a large number of inner packagings. The selection procedures for large packagings are broadly the same as for other packagings except that the large packaging packing instruction found in column 8 of the DGL is prefixed "LP". Any large packaging special provision (an alphanumeric code prefixed with the letter "L", e.g. L1) is found in column 8. The inner packaging quantities are the same as those in P001 and P002.

The large packaging was developed originally for large explosive articles that exceeded the parameters for ordinary packaging and during development it was recognized that the concept could also be applied to wastes and other goods that could be distributed in larger quantities.

9.10 Unpackaged articles

The provisions of the Code provide for the carriage of unpackaged articles with the approval of the Competent Authority. The conditions are set out in 4.1.3.8 for classes 2-6, 8 and 9 and for class 1 in 4.1.5.15.

Generally the Competent Authority will have to be satisfied that the item cannot be packaged in accordance with the provisions, either because of the size or shape, and that in an unpackaged state it is strong enough to withstand the normal rigours of transport without constituting a danger.

There is no exemption from other consignment procedures.

Tank systems

9.11 General requirements

The 2000 edition of the Code introduced a new concept for tank transport and it led to some complications that will exist for a very long time, possibly up to 25 years. The previous edition of the IMDG Code listed permitted tanks as IMO tanks (see below). Now the UN has developed the concept of multimodal "UN tanks" and these will gradually replace IMO tanks. Tanks, unlike most packagings, have very long lives (decades) and to build new tanks takes a long time. It would be impossible to make a change from IMO to UN overnight and the IMO therefore agreed to permit a long transition. This can be summarized as follows:

> IMO tanks can be manufactured until 31 December 2002; thereafter only UN tanks can be manufactured.

At the same time the UN decided to apply a more rational approach to tank selection for different substances and this affects the use of IMO tanks as follows:

> IMO tanks can be used for substances even when the IMO specification is inferior to the new UN specification until 31 December 2009.
>
> IMO tanks can continue in use indefinitely after 31 December 2009 so long as they remain safe and their specification is the equivalent of a UN tank.

There are probably tens of thousands of IMO tanks in existence and they will remain so well into the 21st century. Therefore DO NOT DISPOSE OF THE LAST EDITION OF THE LOOSE-LEAF CODE until you have made a complete change to UN tanks.

9.12 IMO tanks (pre-2000)

Tank information is found in section 13 of the General Introduction in volume I of the loose-leaf edition of the Code (Amendment 29). Tanks tend to be operated by tank container companies on behalf of chemical companies. The selection of the tank is ultimately the responsibility of the consignor but he will place a great deal of reliance on the operator's expertise for identifying the type to be used.

Section 13 is in three parts:

13.1 liquid dangerous goods (tank types 1, 2 and 4)
13.100 non-refrigerated liquefied gases (tank types 5 and 6)
13.200 refrigerated liquefied gases (tank types 7 and 8)

Within the Code, tanks are allocated to one of the following tank "types":

Type 1 portable tank with pressure relief devices having a maximum allowable working pressure of 1.75 bar or above
Type 2 portable tank with pressure relief devices having a maximum allowable working pressure equal to or above 1.0 bar but below 1.75 bar
Type 4 a road tank permanently attached to a chassis or with at least four ISO twistlocks, having a capacity of more than 450 litres. It need not comply fully with all the requirements for a Type 1 or 2 tank. It should only be used on short international voyages.
Type 5 a portable tank for non-refrigerated liquefied gases designed for a particular gas
Type 6 a road tanker for non-refrigerated liquefied gases which should only be used on short international voyages
Type 7 a thermally insulated portable tank for refrigerated liquefied gases
Type 8 a road tanker for refrigerated liquefied gases which should only be used on short international voyages

A *short international voyage* is defined as follows – one where the ship is no more than 200 miles from a port or place of safety. Neither the distance between the last port of call in the country in which the voyage begins and the final port of destination nor the return voyage shall exceed 600 miles.

Constructional requirements for tanks are considered in part 10.

9.13 UN tanks (2000 onwards)

Chapter 4.2 of Amendment 30 of the Code relates to the use of UN portable tanks (most of the provisions apply to IMO tanks, but the requirements are of Amendment 29). The chapter contains general provisions for the use of tanks for substances in classes 3 to 9 (4.2.1); non-refrigerated liquefied gases of class 2 (4.2.2); refrigerated liquefied gases of class 2 (4.2.3); and a list of tank instructions (4.2.4).

Instead of 7 tank types the UN system consists of 25 types as follows:

Types 1-22 for substances of classes 3-9
Type 23 For self-reactive substances of class 4.1 and for organic peroxides of class 5.2
Type 50 For gases of class 2
Type 75 For non-refrigerated gases of class 2

The applicable UN tank type code (tank instructions) is listed in column 13 of the DGL.

The tank instructions are simpler than the packing instructions because there are limited alternatives. An extract from the table for classes 3 – 9 is shown below.

T1 – T22	PORTABLE TANK INSTRUCTIONS			T1 – T22
These portable tank instructions apply to liquid and solid substances of classes 3 to 9. The general provisions of 6.7.2 should be met.				
Portable tank instruction	**Minimum test pressure (bar)**	**Minimum shell thickness (in mm – reference steel) (see 6.7.2.4)**	**Pressure-relief provisions (see 6.7.2.8)**	**Bottom opening provisions (see 6.7.2.6)**
T1	1.5	See 6.7.2.4.2	Normal	See 6.7.2.6.2
T2	1.5	See 6.7.2.4.2	Normal	See 6.7.2.6.3
T3	2.65	See 6.7.2.4.2	Normal	See 6.7.2.6.2
T4	2.65	See 6.7.2.4.2	Normal	See 6.7.2.6.3

If a substance is allocated to type T1 then any tank from 1 – 22 may be used but if the substance is allocated to T4 then types 1 – 3 are not permitted. The instruction for T2 is the single line of information i.e. a 1.5 bar tank with a minimum shell thickness in accordance with 6.7.2.4, normal pressure relief devices in accordance with 6.7.2.8 and the option of bottom openings in accordance with 6.7.2.6.

For the special instructions for class 4.1(self-reactive substances) and classes 5.2 and 2 the instructions have different requirements depending on UN Numbers.

Constructional requirements for tanks are considered in part 10.

9.14 Selecting a suitable tank

As explained in 9.11 and 9.12 above, there are potentially two choices of tank: a tank meeting the pre-2000 IMO standards (referenced in column 12 of the DGL) or a tank meeting the new UN provisions (column 13 of the DGL).

The procedure for selecting a tank can be explained using two example substances. The applicable instructions (the "T" codes shown in columns 12/13 and any "TP" tank special provisions in column 14) are decoded in 4.2.4 of the IMDG Code.

Examples

(a) UN 1664 nitrotoluenes, liquid: for UN 1664 there is no tank number in column 12 – IMO, but T7 appears in column 13 – UN. This means that the same standard of tank is required whether it is an IMO or UN tank. A T7 tank has to have a minimum test pressure of 4 bar. In addition, in column 14 there is TP2. This is explained in 4.2.4.3 and states that the filling limits in 4.2.1.9.3 shall be met; this section provides a formula for a degree of filling.

(b) UN 1595 dimethyl sulphate: column 12 indicates IMO T10 and column 13 UN T14. T100 requires a minimum of 4 bar pressure while T14 requires 6 bar.

TP2 and TP13 apply in either case. TP2 is explained above while TP13 states that self-contained breathing apparatus must be carried.

Until 31.12.2009 the lower pressure tank corresponding to the T10 requirements may be used but from 1.1.2010 a tank meeting the specifications for T14 must be used.

Note: *Although the T10 will no longer be permitted for this substance it may still be used for other substances provided it is still safe.*

9.15 Solids in tanks

The concept of tanks carrying solid dangerous goods is relatively new. The requirements are found in 4.2.6 and chapter 6.9 of the Code. The provisions are very short – there is a set of constructional and testing general requirements and in some instances Competent Authority approval is needed.

9.16 Solids in bulk packagings

Certain solid substances may be carried in bulk packagings. This is permitted in the Code. "BP" appears in column 8 of the DGL e.g. UN 1495 sodium chlorate. The provisions relating to the use and transport of bulk packagings are laid down in chapter 4.3 of the Code.

Part 10: Construction and Testing of Packagings, IBCs and Portable Tanks

(Part 6 of the Code)

10.1 Introduction

Part 9 sets out the procedure for selecting a suitable packaging or tank for a particular dangerous goods consignment. For many dangerous goods, initial selection is only one step towards compliance with the regulations. Generally the dangerous goods have to be placed in a package or tank that has been tested to show that it should remain safe during normal transport journeys (the exception is radioactive materials where the package must be safe in all conditions).

This part of the Compendium is divided into sub-sections covering the construction and testing requirements for:

- packagings
- IBCs
- large packagings
- gas cylinders
- infectious substances packagings
- radioactive materials packagings
- tanks and portable tanks (tank containers)

10.2 Packaging definitions

Packagings are described in part 9 of this Compendium and the requirements for packaging selection are set out in part 4 of the Code. The provisions concerning testing and certification are set down in detail in part 6 of the Code: it is these provisions which are considered here. Chapter 6.1 reproduces text from the UN Recommendations and the requirements are therefore common to all modes of transport. It is often referred to as the UN packaging system. In the majority of cases, a package tested in accordance with chapter 6.1 of the IMDG Code is acceptable for all modes of transport.

The UN system requires that every package (including IBCs and large packagings) design type is tested, that the tests are carried out on the package as prepared for transport, that the package is manufactured in accordance with a quality control system approved by the Competent Authority and that a mark is issued in accordance with a scheme approved by the Competent Authority.

Definitions

- *combination packagings* (see part 9);
- the term *Package* means the complete product of the packing operation, consisting of the packaging(s) and the contents as prepared for transport;
- *packagings* are receptacles and any other components or materials necessary for the receptacle to perform its containment function.

Chapter 4.1 permits the use of reconditioning, reuse and remanufacture of packagings. Chapter 6.1 provides guidance on the marking of reconditioned packagings.

In part 9 it was stated that the IMDG Code does not require new packagings to be used for chemicals and these definitions underline that provision. Packages must be safe.

6.1.4 gives detailed specifications for particular packaging types, including:

- steel or aluminium drums
- steel or aluminium jerricans
- wooden boxes
- fibreboard boxes
- textile bags
- plastics film bags etc.

Performance tests for packagings

10.3 Preparation for testing

Having selected a suitable packaging (see part 9) the consignor must ensure that it has been tested in accordance with the Code – unless it is exempt for some reason (e.g. it is being consigned under special "Limited Quantity" provisions) (see part 12).

Every design type must be tested. A design type is defined by the material, thickness and manner of construction. The UN text leaves some discretion to the Competent Authority to interpret this provision. If a steel drum which has a metal thickness of 1.00 mm throughout is subsequently made from 0.9 mm steel this would be regarded as a design change. The use of glue instead of metal stitches to secure the side seams of a fibreboard box would be regarded as a design change.

The tests must be carried out on the package as prepared for transport. This means that if a liquid is to be put into a steel drum then a liquid should be used for the test. If a glass bottle is to be carried inside a fibreboard box then a glass bottle should be used in the test. The test contents need not be the actual substance but must reflect it: in the case of liquids water is normally used. The density may be adjusted by the addition of lead weights. Where a solid is to be transported the substance used in the testing procedure must reflect the physical characteristics of the actual substance to be carried.

10.4 Packaging performance tests

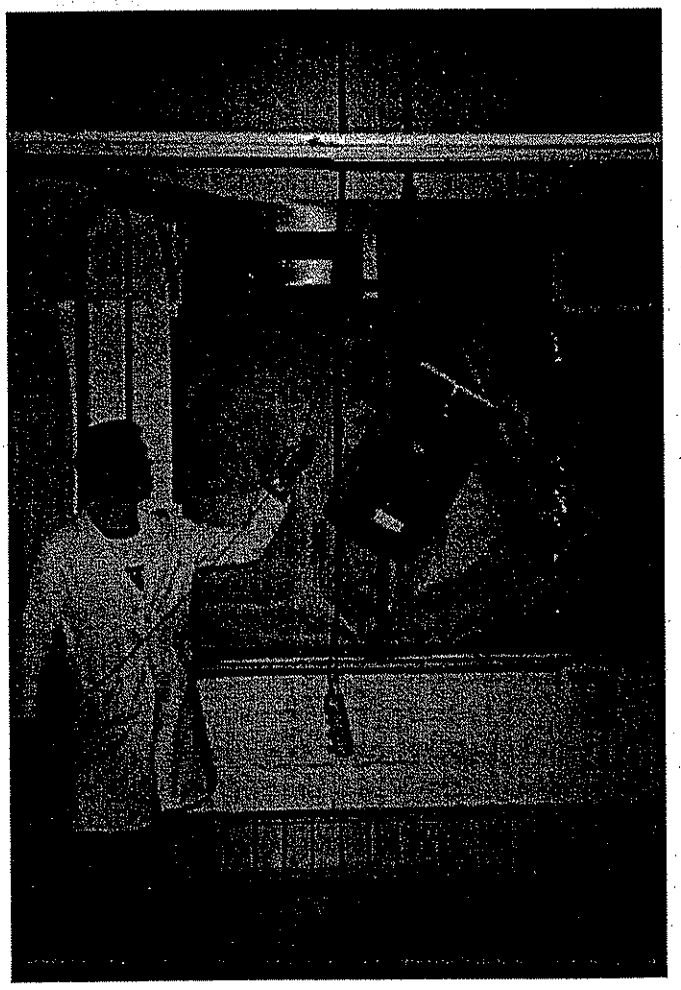
There are five tests:

Drop	– all packagings
Stack	– not bags
Leakage	– only single packagings for liquids
Hydraulic pressure	– only single packagings for liquids
Cooperage	– only wooden barrels

Drop test
The normal height for a drop test is 1.2 m and this is applied to substances in PG II, explosives, certain self-reactive substances, organic peroxides and clinical wastes of class 6.2 (see 10.19).

Packagings for substances and articles of PG I normally undergo a drop test from 1.8 m, whilst those for PG III undergo a drop from 0.8 m.

These are the normal drop heights for liquid substances with a relative density (specific gravity) not exceeding 1.2. Where the density exceeds 1.2 and the test substance is water, 6.1.5.3.4 provides a formula to increase the height.



The drop test is normally carried out at ambient temperatures but the one exception is that plastics materials are dropped when the temperature of the test sample and contents have been conditioned to –18°C or lower to test the effects of embrittlement on the plastics material.

Following the drop the package must not leak.

Stack test
The stack test involves applying a force to the top surface of the test sample equivalent to the total weight of identical packages which might be stacked on it during transport. The minimum height for the stack test (including the test sample) is 3 metres. The test is normally carried out with dead weights and the load is applied for 24 hours at ambient temperatures. The exception to this is that plastics packagings intended for liquids must be stack tested for 28 days at 40°C in order to check the strength of the plastics material.

Hydraulic pressure test
Single packagings for liquids must be capable of withstanding a build-up of pressure which may come about because of heat. The tester must know the vapour pressure of the substance at 50°C or 55°C, using the formula in 6.1.5.5, to determine the pressure the package must be able to withstand. This equates in general terms to a 50% safety factor.

A table in 4.1.1.10 illustrates the effect of this formula with certain chemicals.

Leakproof test
This test only applies to single packagings intended to contain liquids (e.g. drums and jerricans). The package is connected to an air supply and placed under water. The pressure applied is 20 kPa for PG II and PG III and 30 kPa for PG I.

Every single packaging intended to contain liquids is subjected to a leakproof test before it is filled with a chemical. This is production testing and it is not necessary to carry out the test under water as long as an equivalent test is used.

There is a requirement in the Code for some packagings to be hermetically sealed (i.e. vapour tight), but there is no recognized test for this: testing authorities often recommend a leakproof test even for packagings intended for solids.

Cooperage test
This is an additional test for wooden barrels.

10.5 Packaging test reports

Following testing, a report must be prepared and made available to the packaging manufacturer, the user of the packaging and the Competent Authority. The test report does not have to be produced to the ship's master or his agent.

The report must contain information which will enable:

- the manufacturer to produce packagings in accordance with the specification of the design type which was tested
- the user to identify the design type and understand how the packaging should be used (e.g the closure torque on drums or the method of taping boxes)
- the Competent Authority to enforce the regulations.

The report must state who carried out the tests and it must contain a statement that the package was tested in accordance with the provisions of the Code.

10.6 UN packaging mark

Following successful testing and the issue of a satisfactory test report, a UN mark can be allocated to the packaging. The procedure varies from country to country (see 10.15).

The UN mark consists of a number of elements of information. These elements can vary slightly according to the packaging type.

Example 1

1A1/Y1.8/200/98
USA/++AA34700

	UN symbol
1	Drum
A	Material of manufacture: steel
1	Drum type: non-removable head
Y	Suitable for packing groups II or III
1.8	Suitable for a product with a relative density of 1.8 (single packagings only)
200	Pressure tested to 200 kPa
98	Year of manufacture – if the drum was plastics the month of manufacture would also need to marked on the drum. This is because plastics drums have a maximum five-year life.
USA	Country authorizing the mark
++AA34700	Identification of the packaging, as specified by the Competent Authority

Example 2

4G/X16/S/98
NL/23897

	UN symbol
4	Box
G	Fibreboard
X	Suitable for packing groups I, II or III
16	Maximum gross mass in kilograms
S	Solids or inner packagings. The box may be designed for solids, inner packagings or articles: there is no way to identify this information from the mark.
98	Year of manufacture
NL	Country authorizing the mark
23897	Identification of the packaging specified by the Competent Authority

It can be seen that the mark does not give complete explanations of the uses to which the package may be put – notes in 6.1.3 of the Code warn of this fact.

6.1.3 also shows a number of examples of packaging marks, including those for reconditioned packagings.

10.7 Intermediate bulk container (IBC) definitions

Intermediate bulk containers (IBCs) are packagings as described in part 9 of this Compendium. They are intended for bulk substances such as powders and liquids.

There are six types of IBC which may be used and chapter 6.5 of the Code contains specific provisions relating to the design, construction and testing of each type:

- metal IBCs
- flexible IBCs
- rigid plastics IBCs
- composite IBCs with plastics inner receptacles
- fibreboard IBCs
- wooden IBCs
  – (see 6.5.3)

IBCs are restricted by the UN to:

- solids of packing group I, II or III
- liquids of packing group II or III

A designatory code system has been developed which is similar to that used for conventional packagings. A two-digit code indicates the type and purpose of the IBC; this is followed by a letter or letters indicating the material(s) of construction and, where necessary, a further numeral indicating the category of IBC. These are explained in 6.5.1.4 of the Code.

10.8 Performance tests for IBCs

The tests for different IBC types are as follows:

- bottom lift
- top lift
- tear
- stacking
- leakproofness
- hydraulic pressure
- drop
- topple
- righting

The tests are sequential and are carried out in the above sequence. The actual tests carried out on any particular IBC vary according to the design type and its intended use. For example, an IBC not capable of being top lifted does not have to undergo the top lift test. The tear, topple and righting tests are unique to flexible IBCs.

Full details are given in 6.5.4 of the Code.

10.9 IBC test reports

The IBC test report has the same requirements as the packaging test report described in 10.5 above (6.5.4.13 of the Code refers).

10.10 UN mark for IBCs

Having undergone testing, the IBC has to be UN marked in a similar way to conventional packagings. A typical mark for a composite IBC might be:

31HA1/Y/04 97
NL/VL9099
10800/1200

	UN symbol
31	Liquid
H	Plastics material
A	Steel frame
1	Rigid inner receptacle
Y	Packing group II or III
04 97	Month and year of manufacture
NL	Country authorizing the mark
VL9099	Identification as given by the Competent Authority
10800	Stacking load in kilograms
1200	Maximum permissible gross mass in kilograms

A number of other examples can be found in 6.5.2 of the Code.

In addition to the UN mark, most IBCs require extra markings; these are set out below:

	Metal	Rigid Plastics	Composite	Flexible	Fibreboard/ Wooden
Capacity in litres of water	X	X	X		
Tare mass (kg)	X	X	X		X
Date of last leak test	X	X	X		
Date of last inspection	X	X	X		
Max. loading/discharge pressure	X	X	X		
Body material and thickness	X				
Manufacturers serial no.	X				
Test (gauge) pressure		X	X		
Pictograms indicating lifting position				X	

10.11 Periodic inspections of IBCs

Every metal, rigid plastics and composite IBC must be inspected:

a) before being put into service
b) every 2.5 years regarding external condition and service equipment, and
c) every 5 years for conformity to a design type, internal and external condition and the proper functioning of equipment (6.5.1.6).

Those intended for liquids or for solids filled or discharged under pressure must also be leakproof tested, before use and then very 2.5 years (6.5.4).

IBCs must be marked with the date of the last inspection and last leak test.

A report must be kept and be available to the Competent Authority.

Like testing and certification arrangements, these inspections are left to Competent Authorities and vary from country to country.

10.12 Large packagings

Large packagings are described in part 9 of this Compendium. They are intended for the carriage of a large number of inner packagings or large articles. There are five types of large packagings:

- metal
- flexible material
- plastics
- fibreboard
- wooden large packagings

Large packagings are restricted to:

- certain articles of class 1
- clinical waste (UN 3291) and
- substances of PG III, with no subsidiary risk

A designatory code system has been developed which is similar to that for other packagings and IBCs.

A two-digit Code (50 for rigid and 51 for flexible materials), followed by a letter indicating the material of manufacture, is used. The full text describing the codes and testing procedures is in chapter 6.6 of the Code.

10.13 Performance tests for large packagings

The tests for large packagings are:

- bottom lift test*
- top lift test*
- stacking test*
- drop test

* Only required when the large packaging is designed for that purpose (see 6.6.5).

10.14 Test reports for large packagings

The large packaging test report has the same requirements as the packaging test report in 10.5 above

10.15 UN marks for large packagings

The mark allocated is similar to that for IBCs and can be found in 6.6.3:

50H/Z/07 01/AUS/ABCpty 2000/800

50	Rigid large packaging
H	Plastics material
Z	PG III
07 01	Date of manufacture (month and year)
AUS	State authorizing the allocation of the mark
2000	Stacking load capacity in kilograms
800	Maximum gross mass in kilograms

10.16 National procedures for packaging: IBC and large packagings tests

There is no standard method for the allocation of marks. The system is multimodal and it is left to competent authorities to establish a procedure which enables them to identify packagings in response to enquiries from any interested party, including other Competent Authorities.

The majority of countries have a single organization which allocates the marks and usually carries out the UN tests for all modes of transport. Others allow testing at many testing facilities but issue the final mark centrally. Some allow companies to do their own testing and allocate their own UN marks. All of these systems are mutually recognized as long as they are enforceable by the national authorities.

Gas cylinders

10.17 Receptacles for gases

Receptacles for gases are generally designed to hold a gas under some pressure and in some cases in a liquid state. To achieve these two objectives the package will tend to be a gas cylinder of some description.

The IMDG Code states that cylinders should be either:

- UN cylinders in accordance with chapter 6.2 of the Code or
- approved by the Competent Authority in countries of transport and use.

Gas cylinders tend to have very long service lives – up to 50 years is not unknown – and therefore cylinders currently in use will continue to be so for a considerable period of time. UN cylinders are a new concept appearing for the first time in Amendment 31 to the Code and it is unlikely that such cylinders will be generally on the market, particularly for international transport, for several years.

Amendment 31 to the Code now permits either type of cylinder. However, non-UN cylinders are subject to Competent Authority approval.

10.18 Testing and marking of gas cylinders

The construction and testing requirements are specified in chapter 6.2 of the Code.

Gas cylinders are subject to an initial inspection. Sample batches of cylinders must be checked for metal thickness and quality whilst every cylinder must be hydraulically tested.

The general provisions apply to both UN and existing cylinders.

UN cylinders must generally be constructed to an ISO standard and approved by an inspection body approved by the Competent Authority. Such a body must comply with written procedures and be able to show independence from the manufacturer.

Similarly a manufacturer must have a documented quality inspection scheme.

Physical testing, unlike packaging, is rather less although a hydraulic pressure test is required. To get an approval for a design type of cylinder the manufacturer's quality system must be approved.

Once approved the manufacturer is permitted, under a scheme approved by the Competent Authority, to apply a UN mark.

(m)	(n)	(o)	(p)
25E	D MF	765432	H

(i)	(f)	(g)	(j)	(h)
PW200	PH300BAR	62.1KG	50L	5.8MM

(a)	(b)	(c)	(d)	(e)
(un)	ISO 9809-1	F	IB	2000/12

(a) the UN packaging symbol
(b) the technical standard used for design, manufacture and testing
(c) the character(s) identifying the country of approval
(d) the identity mark or stamp of the inspection body
(e) the date of the initial inspection, the year (four digits) followed by the month (two digits) separated by a slash (i.e. "/")
(f) the test pressure in bar, preceded by the letters "PH" and followed by the letters "BAR"
(g) the empty mass of the pressure receptacle including all permanently attached integral parts (e.g. neck ring, foot ring, etc.) in kilograms
(h) the minimum guaranteed wall thickness of the pressure receptacle in millimetres
(i) in the case of pressure receptacles intended for the transport of compressed gases, UN 1001 acetylene, dissolved, and UN 3374 acetylene, solvent free, the working pressure in bar, preceded by the letters "PW"
(j) in the case of liquefied gases, the water capacity in litres
(k) in the case of UN 1001 acetylene, dissolved, the total of the mass of the empty receptacle
(l) in the case of UN 3374 acetylene, solvent free, the total of the mass of the empty receptacle
(m) identification of the cylinder thread
(n) the manufacturer's mark registered by the Competent Authority
(o) the serial number assigned by the manufacturer
(p) in the case of steel pressure receptacles and composite pressure receptacles with steel liner intended for the transport of gases with a risk of hydrogen embrittlement, the letter "H" showing compatibility of the steel

10.19 Packagings for infectious substances (class 6.2)

This part deals with two broad categories of infectious substance packagings: packagings for clinical waste and those for infectious substances.

Clinical waste
Clinical waste includes dressings, needles and blades which have a low probability of containing infectious substances. These items may be packaged in rigid UN-certified packagings that meet the PG II performance level (see 10.3-4).

Infectious substances
These will usually be laboratory samples in vials, slides, test tubes etc. These substances must be packaged in accordance with the provisions set down in chapter 6.3.

The vial/test tube is considered the primary packaging and this must be placed inside a secondary packaging. Both must be watertight. There must be absorbent material between the primary and secondary packagings. The outer package must be of adequate strength.

Packagings for infectious substances are subject to the following requirements:

- a 9 m drop test (fibreboard outers must be subjected to a water spray test before dropping and plastics packagings must be conditioned at –18°C prior to being drop tested;
- if any packaging is to carry dry ice then it must be used in the test;
- a puncture test with a steel rod of defined mass is required for packagings of 7 kg or less;
- an impact test onto a steel rod from a height of 1 m is required for packagings which exceed 7 kg.

As with standard UN packagings, the testing system leads to the allocation of a UN mark similar to that shown below:

4G/Class 6.2/98
S/SP – 9989 – ERIKSSON

The mark is similar to those applied to conventional packagings but instead of showing mass and packing group it states "Class 6.2".

10.20 Packagings for radioactive materials (class 7)

A range of general requirements are applied to all RAM packaging selections but they are not entirely the same demands as those laid upon packages for the other classes. The basic requirements take into account ease and safety of transport handling and securing plus the provision of smooth external surfaces to ease decontamination.

These general requirements together with package type specific demands can be found in chapter 6.4 of the Code. They are based on the construction, testing, certification and authorization systems contained in the IAEA publication *Regulations for the Safe Transport of Radioactive Material* No ST-1 but this section of the Code is free-standing. It does not relate back to ST-1 and provides full operational details in the Code text.

The structure of chapter 6.4 is:

- 6.4.2-6.4.11 provide the performance standards for the different pack types;
- 6.4.12-6.4.21 lay down the tests that have to be undertaken to prove that a package meets the performance standards;
- 6.4.23 provides the systems of package certification and marking to provide proof that a package has met the required standards and can be used on any particular journey.

Excepted packages
The quality requirements for excepted packages are less demanding than those for other package types. The basic criteria for the acceptability of a shipment within an excepted package is that the radiation level must not exceed 5 mSv/h at any point on the external surface.

The packagings must be able to retain their contents under the conditions likely to be encountered in transport. Typically, a stout outer packaging might contain cushioning material shielding a plastic bag that holds the low activity material; other RAM package types may be classed as excepted packages when they are being returned as empties with a low level of residual activity.

Industrial packagings
LSA and SCO would normally be carried in industrial packages of varying types designated IP-1, IP-2, IP-3. The construction and test standards for IP-1, IP-2 and IP-3 packs are of increasing severity through the various types. IP-2 packs are broadly equivalent to UN-specification packages of PG I/II and may indeed be such packs.

Tanks, tank containers and ISO freight containers may be IP-3 packs if they are constructed in conformity with UN or other specified standards.

Type A packages
These packages must meet the general requirements together with those identified in 6.4.7. Liquids and gas carrying type A packages are subjected to enhanced drop and penetration tests; liquids packs have also to satisfy substantial demands for liquid retention performance.

Type A packages must have suitable physical capabilities for the RAM to be shipped and the activity of the material to be packaged must be within the A1 limit for special form RAM, or the A2 limit for other form RAM. The activity limits for the various radionuclides are listed in table 2.7.7.2.1.

In many ways Type A packs may be compared to UN-specification packs for other hazardous materials: they are of proven competence in normal transport circumstances.

As well as boxes, drums, etc., freight containers may be type A packages for radioactive material.

Type B packages
These packagings have to meet test criteria that emulate accident conditions in addition to those of the normal conditions of transport applicable to type A packs. They take two forms: type B(U) packs have unilateral approval for use granted by their country of origin; type B(M) packs are authorized for use within one country or between specified countries and under specified conditions. All fissile shipments must be in type B(M) packages.

Type B packs are authorized for use in the carriage of designated radioactive material at activity levels above the A1 and A2 levels appropriate for type A packs. These items must comply with the demands of 6.4.8, which supplement provisions for type A packages. The supplementary requirements centre on an ability to withstand accident conditions and to limit heat transfer from the RAM to the packaging outer surfaces. Accident conditions are simulated by three means: an enhanced drop test sequence, a fire test and a water immersion test. Each test is carried out on each sample submitted for testing; the cumulative demands thus made on the packagings are extreme.

Further criteria for type B(U) packages
Type B(U) packages are required to achieve their test competence without depending upon filters, mechanical cooling or venting.

Criteria for type B(M) packages
The requirements listed above for type B(U) packages have to be met as far as is practicable by type B(M) packs. However, venting/mechanical cooling of these packages may be permitted by the Competent Authorities concerned.

All type B packages are Competent Authority-registered and carry serial numbers.

Type C packages
These packagings are required to prove themselves competent in extreme impact conditions representative of a descent from operating height when being transported by air as well as an ability to survive effectively if buried in the earth. They are Competent Authority-registered and carry serial numbers.

Fissile material packaging
The requirements for industrial packages and for either type A, type B or type C packages as appropriate must be fulfilled by packages for fissile material. In addition, the need to ensure the maintenance of sub-criticality under transport and accident conditions has to be taken into account.

Uranium hexafluoride packagings
This material must be packaged to the ISO standard 7195:1993(E) which takes account of the high pressures that can be generated in transport by such materials. Section 6.4.6 provides details.

All Type B packages are Competent Authority-registered and carry serial numbers.

10.21 Tank construction and testing

There are three broad categories of tank listed in the IMDG Code for construction purposes:

- tanks for all classes other than class 2;
- non-refrigerated gas tanks for class 2;
- refrigerated gas tanks for class 2.

As explained in part 9 of the Compendium there are now two types of portable tank (tank container) in existence: the IMO tank and the UN tank. Many of the principles of construction are common but the details are different. Those wishing to construct IMO tanks up to 31 December 2002 are referred to Amendment 29 of the Code and the following sections:

- section 13.1.3 – 13.1.18 tanks for all classes other than class 2;
- section 13.103 – 13.115 non-refrigerated gas tanks for class 2;
- section 13.203 – 13.212 refrigerated gas tanks for class 2.

In future, tanks will have to be constructed to new UN standards in accordance with chapter 6.7 of the 2000 edition of the Code (Amendment 30). Road tanks carried on ships are subject to the provisions of chapter 6.8 of the Code.

The Code lays down strict design guidelines, many of which are similar to the rules for packagings: e.g. the tank and its components must be compatible with the substances which will be carried in them and they must be capable of withstanding a build-up of pressure.

Tanks must be designed so that they can be safely secured on board ship.

In addition to these general points, the tank must be capable of absorbing certain dynamic forces:

- in the direction of travel: twice the mass;
- horizontally at right angles to the direction of travel: the total mass;
- vertically upwards: the total mass; and
- vertically downwards: twice the total mass.

These factors, along with a number of others, lead to the strict definition of the types of metal (usually steel) that must be used and criteria for ancillary equipment such as valves, pressure relief devices, frameworks and lifting and tie-down devices.

All tanks must be fitted with pressure relief devices and the type of devices required are shown against the entries in the relevant tank instuctions (see part 9). The pressure relief devices must discharge at five sixths of the test pressure. The capacity of relief devices is defined.

10.22 Approval of tanks

Like packagings, tanks must be approved. However, the approval system is different. The Competent Authority must make arrangements to approve tanks or it must appoint an authorized body(ies) to undertake this work. In many countries this has been the responsibility of the ship classification societies or insurance companies (e.g. Lloyds Register, Bureau Veritas, DNV).

A test report and certificate must be issued and every tank must be fitted with a corrosion-resistant metal plate. The information on the plate is extensive and includes:

- the tank type
- approval country
- test pressures
- capacity
- date of last inspection.

10.23 Periodic inspections

Every tank must undergo a 2.5 and 5 year inspection. The 5 year inspection must be carried out by the Competent Authority or his agent.

The 2.5 year (midway) inspection consists of:

- leak testing the service equipment;
- an internal and external inspection of the tanks.

The 5 year inspection requires the same checks as the mid-term inspection, plus a more detailed engineering inspection.

In both cases, the date of the last test should be marked on the plate on the tank.

Part 11: Consignment Procedures

(Part 5 of the Code)

11.1 Introduction

In order to ensure that safe transport and handling is maintained throughout the journey and, in particular, that appropriate actions are taken in the event of an emergency, it is essential that everyone involved in the movement of dangerous goods is aware of the danger(s) they present.

When dangerous goods are offered for transport by sea they must therefore be properly marked, labelled and placarded, and be accurately described and certified on a transport document. Part 5 of the Code addresses these procedures.

Chapter 5.1 is concerned with general provisions. Chapters 5.2 and 5.3 of the Code contain specific provisions relating to both the marking and labelling of packages (including IBCs and large packagings) and the placarding of any cargo transport unit containing dangerous goods.

If the package (including IBCs and large packagings) or cargo transport unit is capable of surviving three months immersion in the sea, the method of applying all the marks, labels, placards and other signs identified in this part must be such that they also survive for this period.

In addition, with respect to documentation, particular requirements are laid down in chapter 5.4 concerning the detail and manner of presentation of information about the goods being consigned and the completion of declarations confirming compliance with the requirements of the Code.

Chapter 5.5 considers special provisions for infectious substances and cargo transport units under fumigation.

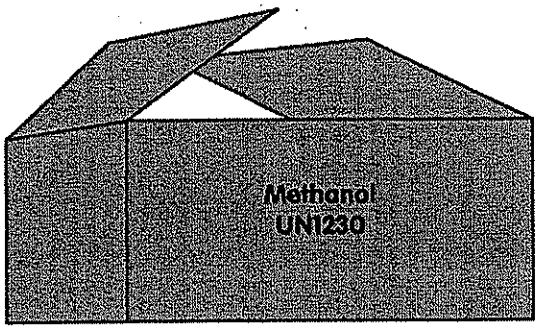
Marking and labelling of packages (including IBCs and large packagings)

11.2 Marking of packages

Except where otherwise specified in the Code, every package, IBC and large packaging must be durably marked with the following two items of information – both as determined by the identification procedures detailed in part 7 of this Compendium:

Proper shipping name (PSN) of the contents and UN Number (preceded by the letters "UN").

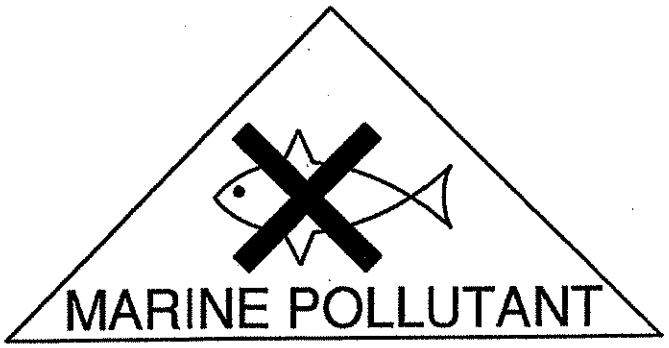
There are no particular specifications with respect to the dimensions of these marks.



Marine pollutants
The marine pollutant mark must be durably marked on the following packages:

- single packagings containing marine pollutants or severe marine pollutants;
- packages containing marine pollutants in inner packagings with contents of more than 5 litres or 5 kg;
- packages containing severe marine pollutants in inner packagings with contents of more than 0.5 litre or 500 g.

This mark must be in a contrasting colour to the outside of the package or, when applied by means of a sticker, coloured black and white. It must have sides of at least 100 mm except in the case of a package which, because of its size, can only bear smaller marks. It should be located adjacent to any label(s) required to be displayed on the package (see 11.3).



IBCs
Each IBC with a capacity greater than 450 litres must bear all the required markings on two opposite sides.

Salvage packagings
In addition to the above markings, salvage packagings must be marked "SALVAGE".

Explosives
For explosives in division 1.4S, the division and compatibility group letter must also be shown unless the 1.4S label is displayed.

Overpacks and unit loads
Where dangerous goods are consigned in an overpack or unit load, any package markings which are not visible must be displayed on the outside of the overpack or unit load.

Empty uncleaned packagings
Other than for radioactive materials (class 7) the marking requirements identified above apply equally to any packaging which previously contained dangerous goods unless it has been sufficiently cleaned of residue or vapour so as to nullify any danger or filled with a non-dangerous substance.

Mixed dangerous goods
Where two or more dangerous goods are contained in the same outer package, the markings required for each substance must be displayed.

Limited quantity consignments
Different marking requirements apply to packages consigned in accordance with the "Limited Quantity" provisions of chapter 3.4 of the Code (see part 12 of this Compendium).

UN packaging approval marking
Most packagings also need to bear a UN packaging approval mark confirming that the packaging has been tested and approved to the relevant United Nations performance standards (see parts 9 and 10).

11.3 Labelling of packages

Except where otherwise specified in the Code, every package and IBC must bear a diamond label or stencil of the label indicating the danger class of the substance it contains. Where the substance has a subsidiary risk or risks, the appropriate subsidiary risk label(s) must also be displayed.

The appropriate danger class and subsidiary risk labels can be identified by reference to the substance entries (column 3 and 4) in the DGL (chapter 3.2) of the Code.

Examples of the labels and signs are shown in chapter 5.2.

The class number must be shown in the bottom corner of all labels. In the case of labels for class 5 substances, the appropriate division must be indicated (i.e. 5.1 or 5.2).

Part 3 - *Dangerous Goods List and limited quantities exceptions*

UN No.	Proper Shipping Name (PSN)	Class or division	Subsidiary risk(s)	Packing group	Special provisions	Limited quantities	Packing		IBC	
							Instructions	Provisions	Instructions	Provisions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1091	ACETONE OILS	3	-	II	-	1 ℓ	P001	-	IBC02	-
1092	ACROLEIN, STABILIZED	6.1	3	I	-	None	P601	-	-	-
1093	ACRYLONITRILE, STABILIZED	3	6.1	I	-	None	P001	-	-	-

The use of text on labels (e.g. "Toxic" or "Flashpoint") is optional, except for class 7 (radioactive) labels when specified text must be shown.

Labels must be not be less than 100 mm x 100 mm except in the case of a package which, because of its size, can only bear smaller labels.

IBCs
Each IBC with a capacity greater than 450 litres must show the required label(s) on two opposite sides.

Exemptions
If a substance is exempt from the package labelling requirements this is indicated by a special provision (column 6 of the DGL).

Explosives
For explosives of division 1.4S a label is not generally required. However each package should be marked "1.4S".

Gas cylinders
Gas cylinders for class 2 substances may bear reduced-size shoulder labels (i.e. labels affixed to the non-cylindrical part of the cylinder), provided that they are clearly visible from a distance.

Other supplementary labelling instructions
A number of supplementary instructions and/or variations apply to the labelling of certain consignments. Full details are provided in chapter 5.2 of the Code.

Overpacks and unit loads
Where dangerous goods are consigned in an overpack or unit load, any package labels which are not visible must be displayed on the outside of the overpack or unit load.

Empty uncleaned packagings
Other than for radioactive materials, the labelling requirements identified above apply equally to any packaging which previously contained dangerous goods unless it has been sufficiently cleaned of residue or vapour so as to nullify any danger or filled with a non-dangerous substance.

Mixed dangerous goods
Where two or more dangerous goods are contained in the same outer package, the labels required for each substance must be displayed but subsidiary risk labels need not be applied where a hazard is already represented by a danger class label.

Limited quantity consignments
Different labelling requirements apply to packages consigned in accordance with the "Limited Quantity" provisions of chapter 3.4 of the Code (see part 12).

Marking and placarding of cargo transport units

11.4 General provisions

Cargo transport units carrying dangerous goods must display appropriate marks, placards and, in certain circumstances, other signs, indicating the dangers of the load. The term "cargo transport unit" (CTU) encompasses road freight vehicles, freight containers, road tanker vehicles and portable tanks (tank containers) and rail freight or tank wagons.

The person responsible for the final loading of the CTU must ensure that all the necessary marks, placards and signs have been applied. The person responsible for offloading a CTU must ensure that all marks, placards and signs have been removed or masked once the CTU is empty and that it has, where necessary, been adequately cleaned.

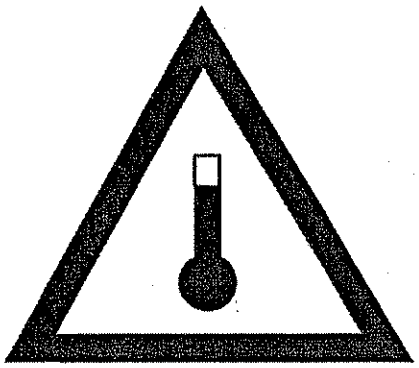
The requirements identified in this section do not apply to CTUs loaded with solely packaged dangerous goods carried under the "Limited Quantity" provisions of chapter 3.4 of the Code. There are different requirements for such consignments (see part 12).

11.5 Marks and signs

Proper shipping name
The full proper shipping name (PSN), as determined by the identification procedures detailed in part 7 of this Compendium, must be durably marked on **at least both sides** of: all tank transport units; all loads of bulk packagings; and any semi-trailer, vehicle, freight container or rail wagon carrying a full load of packages of a single substance for which no label (and hence placard) or marine pollutant mark (see below) is required.

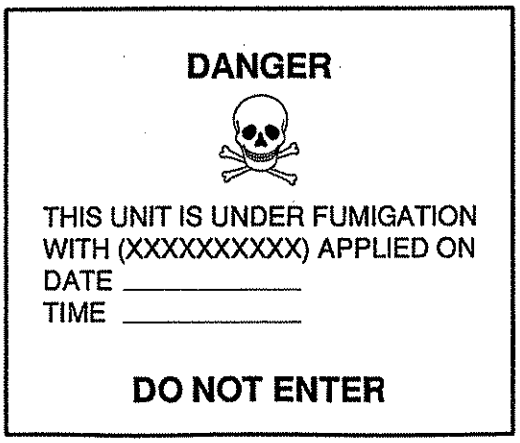
Marine pollutant mark
Where the substance being carried is identified as a marine pollutant, a marine pollutant mark with sides of at least 250 mm must be applied to the CTU as follows: on **at least both sides** of a rail wagon; on **each compartment side** of a multi-compartment tank carrying more than one substance;on **both sides and the rear** of a road vehicle; **all four sides** of a semi-trailer, freight container or portable tank.

Elevated temperature mark
A red "elevated temperature" mark, with sides of at least 250 mm, must be displayed on **all four sides** of any CTU carrying such a substance(s).



Fumigant warning sign
Where a closed CTU is loaded with cargoes under fumigation, a fumigation warning sign must be displayed on the access doors in a location where it will be easily seen by anyone attempting to enter the unit.

The sign, which is rectangular, must be at least 300 mm wide and 250 mm high, with black lettering (of not less than 25 mm height) on a white background. The sign must show the date and time of fumigation and the type of fumigant used.



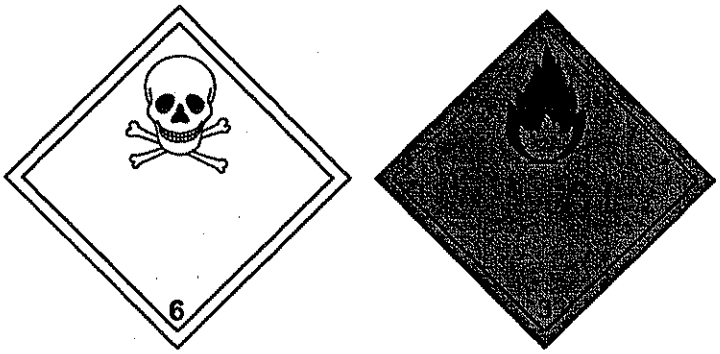
Limited Quantities
Cargo transport units must be marked "LIMITED QUANTITIES" or "LTD QTY" in at least 65 mm high letters. They must be placed in the same position as placards (see 11.6).

11.6 Placards

The basic principle is that any danger class diamond labels (including subsidiary risk labels) relevant to the substance(s) being carried must be reproduced in large format on the outside of the cargo transport unit (CTU) in which the goods are loaded unless, in the case of packaged goods, the marks and labels affixed to the packages are clearly visible from outside the CTU.

These enlarged labels, which must be at least 250 mm x 250 mm in size, are known as placards.

Where a CTU contains goods of different classes, subsidiary risk placards are not required if the risk concerned is already indicated by a primary class placard.



Number and location
The number and location requirements for placards vary according to the type of CTU in which the dangerous goods are being carried.

Rail wagons must be placarded on **at least both sides**. Multiple compartment tanks carrying more than one substance need appropriate placards on **each compartment side**. Road vehicles carrying packaged dangerous goods must display appropriate placards on **both sides and the rear**. Semi-trailers, freight containers and portable tanks must be placarded on **all four sides**.

UN Numbers
In certain circumstances the UN Number of the substance being carried must be indicated (in black digits not less than 65 mm high) either in a white panel in the lower half of the class placard or, alternatively, in an orange rectangular panel (not less than 120 mm high and 300 mm wide and with a 10 mm black border) placed immediately adjacent to the class placard or marine pollutant mark.

This requirement applies to the following CTUs:

- all tank traffics;
- packaged goods loads comprising goods of a single UN Number in quantities exceeding 4000 kg;
- unpackaged LSA-1 or SCO-1 class 7 radioactive loads;
- packaged radioactive material consignments comprising a single UN Number being moved under "exclusive use";
- the movement of bulk packagings.

Where no placard is required – because no danger labels are specified for the substance – and the substance is not a marine pollutant, the UN Number must be displayed immediately adjacent to the proper shipping name (PSN) (see 11.5).

Exemptions
Placards are not required on CTUs carrying 1.4S explosives, dangerous goods in "Limited Quantities" (as defined in chapter 3.4 of the Code) or excepted packages of class 7 radioactive material.

Where danger labels are not required on a package, placards are not required on CTUs.

Explosives
Placards indicating the highest explosive risk only need be affixed to CTUs carrying explosives of more than one division in class 1.

Documentation

11.7 Dangerous goods note

When dangerous goods are offered for shipment by sea the consignor must complete a dangerous goods document (often referred to as a dangerous goods note – DGN) and declaration of compliance with the provisions of the Code. This documentation must be provided to the operator of the ship which is to carry the goods.

No particular format is specified for this documentation but the Code contains very detailed instructions with respect to the content of the information which must be provided and manner of its presentation.

Chapter 5.4 of the Code details the information which must be included on the DGN. This falls into two categories: information which is necessary for all dangerous goods consignments and information which is only required for particular shipments.

Standard information requirements
The basic items of information required for all dangerous goods consignments are:

a) the UN Number (preceded by the letters "UN"); the proper shipping name (PSN); the UN class (division) and, when assigned, the subsidiary risk; the packing group (if applicable).

These items of information may appear in either order as follows and nothing should be interspersed in the sequence (e.g. flashpoint – see below).

UN 1230, Methanol, 3, (6.1), PG II
or
Methanol, 3, (6.1), UN 1230, PG II

The word "class" may be inserted (e.g. UN 1230, Methanol, class 3, (6.1), PG II)

Note: there is no requirement that the name should be in capital letters or upper and lower case.

b) a description of the manner in which the consignment has been packed: i.e. the number and kind of packages/IBCs/large packagings/tanks, and the total quantity of dangerous goods covered by the description (by volume or mass).

This information may precede or follow the information required under (a) above.

There is no restriction on the number of individual consignment descriptions which may appear on a single transport document (DGN).

Additional information
Where applicable, the following additional items of information must also be provided:

- the technical name where required when SP 274 appears in column 7;
- the minimum flashpoint if 61°C (c.c) or below;
- the words "EMPTY UNCLEANED" or "RESIDUE LAST CONTAINED" before or after the PSN where the packages, IBCs or tanks concerned contain the residue of the dangerous goods;
- the word "WASTE" before the PSN where waste dangerous goods are being transported for disposal, or for processing for disposal;
- the identification of the goods as "MARINE POLLUTANT", if applicable;
- for class 1 explosives, the net explosives mass of the contents should be included in the description of the consignment;
- in the case of a class 4.1 self-reactive substance or a class 5.2 organic peroxide, the control and emergency temperatures, if applicable;
- for dangerous goods consigned in salvage packagings, the words "SALVAGE PACKAGING" should be included.

A number of examples are shown in the Code to illustrate these additional requirements.

Limited quantity consignments
For these consignments, the phrase "Dangerous goods in Limited Quantities of class/classes..." may be used instead of the proper shipping name (PSN) in accordance with the provisions of chapter 3.4 of the Code (see part 12) but all other documentation entries are required. The words "Limited Quantity" or "Ltd Qty" must be added to standard entries.

Special requirements
Special additional information is required on the documentation for certain consignments (e.g. class 1 explosives, self-reactive substances in class 4.1, organic peroxides in class 5.2, class 6.2 infectious substances, class 7 radioactive materials and elevated temperature loads). Full details are provided in chapter 5.4 of the Code.

Where a vehicle/container is being transported under fumigation the documentation must show the date of fumigation and the type and amount of the fumigant used. Instructions for the disposal of a residual fumigant, including fumigation devices (if used) must also be provided.

11.8 Compliance declaration

The DGN must incorporate, or be accompanied by, a certificate or declaration by the consignor confirming that the shipment is properly classified, packaged, marked and labelled, and in proper condition for carriage in accordance with the applicable regulations. This declaration must be signed on behalf of the consignor.

DANGEROUS GOODS DECLARATION
I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name(s), and are classified, packaged, marked and labelled/ placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

11.9 Container/vehicle packing certification

Where packaged dangerous goods are being consigned in a freight container or vehicle, a certificate must be completed by the party responsible for the packing/loading operation, confirming that it has been properly carried out. The identification number of the freight container/vehicle must be indicated.

A container packing certificate is not required for tanks.

The certificate provides confirmation that a number of actions or checks have been carried out, including:

- the freight container or vehicle was clean, dry and apparently fit to receive the goods;
- any goods which need to be segregated have not been loaded together in the freight container or vehicle unless Competent Authority approval has been obtained (see part 13);
- all packages have been externally inspected for damage and only sound packages loaded;
- all packages have been properly packed and secured;
- drums have been stowed in an upright position unless otherwise authorized by the Competent Authority (see part 13);
- the freight container or vehicle and any packages therein are properly marked, labelled and placarded.

Chapter 5.4 provides a fully itemized checklist for this certificate. The importance of the certificate is highlighted in a circular (MSC/Circ.506/Rev.1) issued in 1990 by the IMO Maritime Safety Committee (see part 14).

This particular aspect of documentation can cause some significant problems about its completion. The duty for completion lies with the person who fills the container or vehicle. This will quite often be someone who is not the consignor. The container packing certificate is intended to make the person who is filling the transport unit check that it appears to be fit for the journey and that incompatible goods are not carried in the same unit. This is not intended as an engineering inspection. Consignors with groupage consignments will very often not see the transport unit that will travel the oceans.

11.10 Special certificates

Where indicated for the substance concerned in the DGL, the following certificates must also be provided: a weathering certificate; a certificate exempting a substance, material or article from the provisions of the Code.

For new self-reactive substances and organic peroxides or new formulations of currently assigned self-reactive substances and organic peroxides, a statement by the Competent Authority (see part 13) of the country of origin confirming the approved classification and conditions of carriage for the goods must be provided with the documentation.

11.11 Documentation required on board the ship

Each ship carrying dangerous goods or marine pollutants should have a special list or manifest providing full details of the goods being carried and their location on the ship.

This list or manifest should be based on the contents of the dangerous goods transport documents and certificates required by the Code and should include details of stowage locations.

Appropriate emergency response information must be available at all times for use in the event of an accident or incident involving dangerous goods. This information must be held in a location away from packages containing dangerous goods and immediately accessible in the event of an incident.

Example DGN
The diagram overleaf provides an example of a completed DGN for a sample consignment.

MULTIMODAL DANGEROUS GOODS FORM

1. Shipper / Consignor /Sender Sydney Chemical PTY Circular Quay Sydney Australia	2. Transport document number 3. Page 1 of 1 Pages 4. Shipper's reference 5. Freight Forwarder's reference
6. Consignee The Indian Chemical Company Clive Road Calcutta India	7. Carrier (to be completed by the carrier)
	SHIPPER'S DECLARATION I hereby declare that the contents of this consignment are fully and accurately described below by the proper shipping name, and are classified, packaged, marked and labeled/placarded and are in all respects in proper condition for transport according to the applicable international and national governmental regulations.
8. This shipment is within the limitations prescribed for: (Delete non-applicable) ~~PASSENGER AND CARGO AIRCRAFT~~ ~~CARGO AIRCRAFT ONLY~~	9. Additional handling information
10. Vessel / flight no. and date SS Marpol 3 March 2003	11. Port / place of loading Sydney
12. Port / place of discharge Calcutta	13. Destination Calcutta

14. Shipping marks	* Number and kind of packages; description of goods	Gross mass (kg)	Net mass	Cube (m^3)
	1 UN 1320 Dinitrophenol wetted, 4.1 (6.1), PGI Marine Pollutant 2 x removable head plastics drums 25kg each 2 EXTRACTS, FLAVOURING LIQUID, 3, UN1197 PG II, Flashpoint 28°C 1 x 200 litre stainless steel drum 3 UN3072 Life saving appliances, not self-inflating, 9 1 Liferaft in a wooden crate 200kg			

15. Container identification No./ vehicle registration No.	16. Seal number (s)	17. Container/vehicle size & type	18. Tare (kg)	19. Total gross mass (including tare) (kg)

CONTAINER/VEHICLE PACKING CERTIFICATE

I hereby declare that the goods described above have been packed/loaded into the container/vehicle identified above in accordance with the applicable provisions **

MUST BE COMPLETED AND SIGNED

CONTAINER/VEHICLE LOADS BY PERSON RESPONSIBLE FOR PACKING/LOADING

20. Name of company Bondi Packing Company	Hauller's name
Name / Status of declarant B A Bong Supervisor	Vehicle reg. no.
Place and date Bondi Sydney 3 March 2003	Signature and date
Signature of declarant BABong	DRIVER'S SIGNATURE

21.RECEIVING ORGANISATION RECEIPT

Received the above number of packages/containers/trailers in apparent good order and condition unless stated hereon: RECEIVING ORGANISATION REMARKS:

22. Name of company (OF SHIPPER PREPARING THIS NOTE) Sydney Chemical PTY	
Name / Status of declarant J. Swagman Shipping	
Place and date Sydney 2 March 2003	
Signature of declarant JSwagman	

** See 5.4.2.

* FOR DANGEROUS GOODS: you must specify: proper shipping name, hazard class, UN no., packing group (where assigned) and any other element of information required under applicable national and international regulations

Part 12: Limited Quantities

(Chapter 3.4 of the Code)

12.1 Limited Quantities

Chapter 3.4 of the Code provides concessions from a number of the duties normally placed on the consignor when dangerous goods are being shipped in small packages which qualify for "Limited Quantities" status.

The "Limited Quantities" section comprises:

- the general packing requirements for Limited Quantity consignments;
- directions relating to the mixed packing, stowage and segregation of different dangerous goods shipped as *Limited Quantities;*
- details of the concessions which apply to Limited Quantities consignments.

12.2 Permitted consignments

For dangerous goods which may be sent as *Limited Quantities,* an entry in column 7 of the DGL shows the quantities permitted in any inner packaging. For goods which are not permitted under these provisions the word "None" appears in column 7. In a few instances the Limited Quantity provision is controlled by a Special Provision (e.g. UN 1950).

Marine pollutants can change the quantity that can be carried. 3.4.8 limits inner packagings of marine pollutants to 5 litres for liquids or 5 kg for solids. Severe marine pollutants are limited to 500 ml for liquids or 500 gm for solids. These quantities override the limits in column 7 where the substance meets the marine pollutant criteria.

12.3 Packaging requirements

In all cases, dangerous goods shipped as Limited Quantities must be packed in inner packagings placed inside a suitable outer packaging: i.e. in combination packs.

The packagings must meet the general packing requirements of chapter 4.1 of the Code (see part 9 of this Compendium)(e.g. quality, product compatibility, ullage (for liquids) and venting) but they do not have to be tested and approved to the UN-specification standards (see part 10): i.e. they do not have to be UN-approved packages.

The total gross weight of any package must not exceed 30 kg (or the maximum gross weight permitted in the individual schedule for the goods concerned, if lower). Shrink-wrapped or stretch-wrapped trays are acceptable as outer packagings for *Limited Quantities,* but only up to a maximum gross weight of 20 kg.

There is no limit on the number of *Limited Quantities* packages that may be consigned together.

12.4 Mixed packing, segregation and stowage

Different dangerous goods may be packed together in the same outer packaging provided that they do not require segregation and will not interact dangerously in the event of leakage (see also part 9).

No segregation is required between packages containing Limited Quantities or in relation to other dangerous goods. All dangerous goods carried as Limited Quantities are allocated to stowage category A (see part 13).

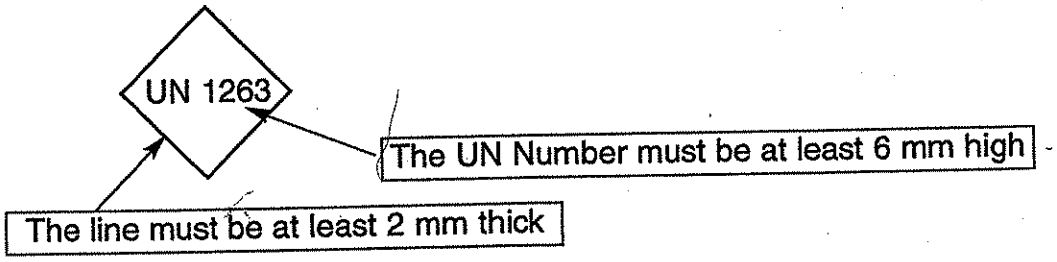
12.5 Consignment concessions

Limited Quantities packages do not have to be:

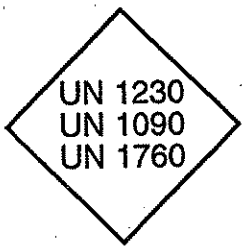
- labelled
- bear the marine pollutant mark
- show the proper shipping name.

However, packages must show the UN Number inside a diamond shape.

For a single substance



For a mixed package



The diamond must be big enough to include each number.

Limited Quantities consignments for personal or household use that are packed and distributed in a form or suitable for sale through retail agencies do not require any marks on the packages.

Cargo transport units (freight containers, vehicles, trailers, rail wagons) packed **only** with *Limited Quantities* do not have to be placarded. However, they must be marked with the words "LIMITED QUANTITIES" or "LTD QTY".

The standard documentation requirements apply to *Limited Quantities* consignments – see part 11. In addition to the other information required, the description of the consignment must include the words "Limited Quantity".

For aerosols (UN 1950) not exceeding 1000 cm^3 no division is assigned and the class can be shown as 2 on the dangerous goods transport document.

Part 13: Transport Operations

(Part 7 of the Code)

13.1 Introduction

Part 7 of the IMDG Code concerns transport operations. The provisions mainly affect the ship operator and members of the crew, but they are not for their exclusive use. There are a number of safety-related operational issues which need to be taken into account by consignors, shipborne staff and others (e.g. container base staff) when dangerous goods are transported by sea.

Chapter 7.1 of the Code details restrictions relating to stowage by the type of vessel ("cargo" or "passenger") which may be used and any particular requirements with respect to the location on board the vessel where the goods may be stowed, whilst chapter 7.2 sets out procedures designed to ensure that adequate separation (segregation) is maintained between incompatible dangerous goods.

Measures which need to be taken in the event of an incident involving dangerous goods or to minimize the risk of fire on board the vessel are highlighted in chapter 7.3.

Chapter 7.4 of the Code deals specifically with the transport of cargo transport units (including freight containers) on board ships, whilst chapter 7.5 addresses the packing of cargo transport units (generally the consignor's or his agent's responsibility) and identifies particular procedures which must be followed in order to ensure that any such movements are carried out safely.

Chapter 7.6 outlines a number of operational special or additional provisions relevant to the carriage of dangerous goods on shipborne barges and barge-carrying ships.

Chapter 7.7 addresses temperature control. Some substances, particularly in class 4.1 and 5.2, have to be carried at specific temperatures otherwise they can cause reactions.

Chapter 7.8 deals with wastes. This issue has been covered in part 8 of this Compendium.

Chapter 7.9 of the Code deals with Competent Authority approvals and provides details of appropriate contact points in individual countries.

Stowage

13.2 Stowage principles

Chapter 7.1 of the Code contains provisions for the stowage of dangerous goods. These provisions impose restrictions with respect to the type of ship on which goods may be transported and also the location on board the ship where the goods must be stowed during the voyage.

Whilst stowage procedures on board a ship are primarily the concern of the ship's master and crew, failure to take account of any relevant constraints, particularly where the dangerous goods are being shipped in a cargo transport unit such as a road vehicle or freight container, could result in the shipment being delayed.

For the purposes of stowage (except for the carriage of explosives in class 1 – see 13.5), the Code distinguishes between two types of ship: ships carrying not more than 25 passengers or 1 passenger per 3 metres of overall length, whichever is the greater, are deemed to be "cargo ships"; ships on which this limitation on passenger numbers is exceeded are designated as "passenger ships".

Column 16 of the DGL in volume 2 of the Code identifies a stowage category for the goods concerned; these categories range through the letters A to E. The letter code is fully explained in chapter 7.1.

7.1.1.2 Stowage categories

Substances, materials and articles should be stowed as indicated in the Dangerous Goods List in accordance with one of the categories specified below (see also appendix B).

7.1.1.2.1 ***Stowage category A***

Cargo ships or passenger ships carrying a number of passengers limited to not more than 25 or to 1 passenger per 3 metres of overall length, whichever is the greater number	ON DECK OR UNDER DECK
Other passenger ships in which the limiting number of passengers transported is exceeded	ON DECK OR UNDER DECK

7.1.1.2.2 ***Stowage category B***

Cargo ships or passenger ships carrying a number of passengers limited to not more than 25 or to 1 passenger per 3 metres of overall length, whichever is the greater number	ON DECK OR UNDER DECK
Other passenger ships in which the limiting number of passengers transported is exceeded	ON DECK ONLY

The various categories determine, according to the type of ship, whether the goods should be stowed *on deck* or *under deck;* in some cases, consignment on a passenger ship is prohibited.

There are special stowage categories for class 1 (explosives) – see 13.5 below.

Further guidance on the procedures which should be followed to ensure the safe stowage and securing of cargo transport units on board ships is provided in three IMO Assembly Resolutions. These may be found in the Appendix to the Supplement (see part 14).

13.3 General stowage requirements

Stowage *under deck* is recommended wherever possible because of the advantages it offers in terms of protection, whilst *on deck* stowage is prescribed in cases where constant supervision and/or ready accessibility is required or there is a significant risk of the formation of explosive gas mixtures, the development of highly toxic vapours or unobserved corrosion of the ship.

Packages susceptible to water damage should be stowed *under deck* unless they can be stowed *on deck* in a manner that ensures that they are protected at all times from exposure to weather or seawater.

There are guidelines on stacking methods and procedures for packaged dangerous goods – generally a 3 metre maximum stack height is recommended, although this may be increased at the discretion of the ship's master.

Drums should always be stowed upright unless otherwise authorized by the Competent Authority.

Goods must be stowed so that walkways and access routes to facilities necessary for the safe operation of the ship, such as hydrants and sounding pipes, are kept clear at all times.

13.4 Specific stowage requirements

In addition to identifying a general stowage category (A, B, C, D or E), column 16 of the DGL may indicate one or more specific additional stowage requirements which must be observed by the master and crew of the ship when determining appropriate stowage arrangements. Note that additional stowage guidance sometimes appears in column 17 – "Properties and Observations".

Proper Shipping Name (PSN) (2)	Stowage and segregation (16)	Properties and observations (17)	UN No. (18)
SELENIUM OXYCHLORIDE	Category E. Clear of living quarters.	Colourless, yellowish liquid. Reacts violently with water, evolving hydrogen chloride, an irritating and corrosive gas apparent as white fumes. In the presence of moisture, highly corrosive to most metals. Toxic if swallowed, by skin contact or by inhalation. Causes severe burns to skin, eyes and mucous membranes.	2879
CALCIUM HYPOCHLORITE, HYDRATED or CALCIUM HYPOCHLORITE, HYDRATED MIXTURE with not less than 5.5% but not more than 10% water	Category C. Cargo transport units should be shaded from direct sunlight and stowed away from sources of heat. Packaged in cargo transport units should be stowed so as to allow adequate air circulation throughout the cargo. Separated from powdered metals and their compounds, ammonium compounds, cyanides, hydrogen peroxides and liquid organic substances.	White or yellowish solid (powder, granules or tablets) with chlorine-like odour. Soluble in water. May cause fire in contact with organic material or ammonium compounds. Substances are liable to exothermic decomposition at elevated temperatures. This condition may lead to fire or explosion. Decomposition can be initiated by heat or by impurities (e.g. powdered metals (iron, manganese, cobalt, magnesium) and their compounds). Dust is irritating. Reacts with acids, evolving chlorine, an irritating, corrosive and toxic gas. In the presence of moisture, corrosive to most metals. Dust irritates mucous membranes.	2880

Specific guidance on stowage arrangements for each class of dangerous goods is given in 7.1.7 to 7.1.16. Some of these provisions are summarized below. In some instances the stowage requirements will be subject to the approval of the Competent Authority (e.g. UN 2814).

Stowage in relation to living quarters (7.1.2)
Special requirements apply to goods of classes 1 (explosives), 5.2 (organic peroxides) and 7 (radioactive materials), and substances of class 3 (flammable liquids) with a flashpoint of 23°C or less when carried in portable tanks.

Where an instruction to stow goods *clear of living quarters* is listed, it means that consideration should be given to the possibility of leaking vapours penetrating accommodation, work areas or machinery spaces through entrances, bulkhead openings or ventilation ducts.

Stowage in relation to undeveloped films and plates, and mailbags (7.1.3)
Radioactive material (class 7) must be stowed away from undeveloped films and plates, as well as mailbags (which should be assumed to contain them), in accordance with the provisions outlined in 7.2.9.2, 7.2.9.8 and 7.2.9.9.

Stowage of marine pollutants (7.1.4)
Where stowage *on deck or under deck* is permitted, the goods should preferably be stowed *under deck* unless there is a weather deck that provides equivalent protection.

Where *on deck only* stowage is required, preference should be given to stowage on well-protected decks or inboard in sheltered areas of exposed decks.

Stowage in relation to foodstuffs (7.1.5)
In order to avoid the possibility of contamination, toxic (class 6.1, PG I or II, or class 2.3), infectious (class 6.2), corrosive (class 8), radioactive (class 7) and corrosive (class 8) substances, materials and articles must be stowed so that they are adequately separated from any foodstuffs (e.g. 7.1.13.1).

Minimum separation distances are specified according to circumstances. These are explained in chapter 7.2 of the Code.

Stowage of solutions and mixtures (7.1.6)
Solutions or mixtures shipped under a generic or N.O.S. entry must be stowed in accordance with the stowage instructions assigned to that entry, as identified on the schedule page for the goods concerned in the DGL.

Stowage of containers
Particular requirements apply to the stowage and securing of containers loaded with dangerous goods on different types of vessel. Full details are provided in chapter 7.4 of the Code (see 13.10). These cover matters such as:

- restrictions on the stowage of containers loaded with flammable gases or liquids, or temperature-controlled CTUs in the same cargo spaces as refrigerated or heated CTUs, the heating equipment or coolant of which could provide a potential source of ignition;
- safe stowage directions for CTUs loaded with marine pollutants;
- procedures for ensuring the safe stowage of dangerous goods on open-top containerships.

Full details are provided in chapters 7.2 and 7.4 of the Code.

13.5 Stowage of explosives

Special stowage requirements apply to the carriage of explosives (class 1).

With the exception of explosives in division 1.4, compatibility group S, there are strict limitations on the type and quantity of explosives which may be carried on different categories of vessel. *On deck* stowage is usually preferred.

A number of specific special stowage requirements are set down in part 7.1.7 for class 1 explosives consignments and these must always be taken into account in addition to any other requirements on the schedules.

For class 1 stowage purposes, ships with up to 12 passengers are classed as "cargo ships" and ships on which this limitation on passenger numbers is exceeded are designated as "passenger ships".

There is a separate set of stowage categories for explosives – numbered 01 to 15. These categories are explained in 7.1.7.2. The applicable stowage category for any particular explosive substance or article appears in 7.1.7.3 of the Code, where the categories are numbered (e.g. "Stowage category 01") and this number appears in column 16. Having identified the category, the list explains what it means in relation to cargo and passenger ships.

It should also be noted that, with the exception of explosives in division 1.4, compatibility group S, there are strict limitations on the type and quantity of explosives that may be carried on passenger ships. These are explained in 7.1.7.5.

Segregation

13.6 Segregation principles

Chapter 7.2 of the Code sets out procedures designed to ensure that adequate separation (segregation) is maintained between incompatible dangerous goods.

Different dangerous goods are considered incompatible if their stowage together may result in undue hazards in the case of leakage, spillage or any other accident.

Whilst segregation requirements are often based on incompatibility problems between different hazard classes (e.g. flammable liquids (class 3) and oxidizing substances (class 5.1)), there are circumstances where substances, materials or articles in the same hazard class need to be segregated from each other.

The segregation provisions in 7.2 apply to all cargo spaces *on deck* or *under deck* in all types of ships and to cargo transport units (CTUs).

Segregation is achieved by maintaining minimum separation distances between incompatible dangerous goods or by requiring one or more bulkheads or decks between them, or a combination thereof.

The following standard segregation terms are used for the purposes of determining segregation requirements when dangerous goods are being transported by sea:

- "Away from";
- "Separated from";
- "Separated by a complete compartment or hold from";
- "Separated longitudinally by an intervening complete compartment or hold from".

However, different interpretations are applied to these terms according to the context in which segregation decisions are being made. For example, the term "Away from" has a different meaning when applied to the segregation of packaged goods stowed in the hold of a vessel than when applied to the segregation of freight containers loaded on board a containership.

These interpretations are fully explained in the sub-sections of chapter 7.2, which detail the segregation requirements applicable to the various modes of carriage by sea.

These sub-sections cover:

- Segregation of packages (7.2.2);
- Segregation of cargo transport units on board containerships (7.2.3);
- Segregation of cargo transport units on board ro-ro ships (7.2.4);
- Segregation in shipborne barges and on board barge-carrying ships (7.2.5);
- Segregation between bulk materials possessing chemical hazards and packaged dangerous goods (7.2.6);
- Segregation of goods of class 1 (7.2.7), classes 4.1 and 5.2 (7.2.8) and class 7 (7.2.9).

Further guidance on the general procedures to be followed when determining segregation needs is provided in 13.7 and specific interpretations in 13.8.

13.7 General segregation requirements

When determining segregation requirements, there are three important points to address from the DGL:

1 *The class of the substance and any subsidiary risk (columns 3 and 4)*
The primary rule that applies to segregation is that incompatible classes are not placed together. It is therefore necessary to know the primary risk. Chapter 7.2 also requires that subsidiary risks are taken into account.

2 *Any additional comments contained in column 16 of the DGL (stowage and segregation)*
Column 16 contains "Stowage and Segregation" information. The main part of this column identifies the stowage category (see 13.2), and any additional instructions relevant to segregation decisions. In many instances additional information is included. For example, "Away from acids". There can be a problem identifying other acids. In order to help many users of the Code who will not be chemists and do not have the chemical knowledge to determine whether a particular substance is an acid the IMO have introduced "Segregation Groups". These sixteen segregation groups (e.g. acids, azides, bromates etc.) are listed in 7.2.1.7.2. Chapter 3 (3.1.4) (in volume 2 of the Code) provides a detailed list of substances falling under each group; thus the list for "acids" includes not only common acids such as hydrochloric acid but other less common acids like octyltrichlorosilane. The list only includes pure substances with UN Numbers (i.e. not N.O.S or generic entries).

Example
UN 1504 sodium peroxide. In column 16 it states that the substance must be "separated from powdered metals and permanganates". A consignor wishes to send titanium sponge powders (UN 2878) with UN 1504 and he is not be sure whether UN 2878 is a metal powder; reference to the list in 3.1.4 of the Code will confirm that it is a metal powder.

3 *Any comments in column 17 of the DGL (Properties and observations)*
Under properties and observations will be found information regarding the chemical properties that may influence segregation e.g. "reacts vigorously with sulphuric acid".

For class 1 (explosives) particular segregation instructions exist for:

- substances and articles within class 1
- between class 1 items and dangerous goods in other classes; and
- between class 1 items and non-dangerous goods.

For class 4.1 (flammable solids) and class 5.2 (organic peroxides) there are specific instructions for calculating segregation requirements for dangerous goods with an explosive subsidiary risk.

For class 7 (radioactive materials) these are specific segregation directions for class 7 items.

Segregation table
Once any specific segregation directions found in the DGL have been taken into account, the segregation table in chapter 7.2.1.16 of the Code provides the basis for segregation decisions.

By reference to the hazard class and, where applicable, subsidiary risk of each of the dangerous goods, the table identifies any relevant segregation requirements.

The segregation decision must be based on the most stringent requirements for any of the dangerous goods concerned.

CLASS		1.1 1.2 1.5	1.2 1.6	1.4	2.1	2.2	2.3	3	4.1	4.2	4.3	5.1	5.2
Explosives	1.1, 1.2, 1.5	*	*	*	4	2	2	4	4	4	4	4	4
Explosives	1.3, 1.6	*	*	*	4	2	2	4	3	3	4	4	4
Explosives	1.4	*	*	*	2	1	1	2	2	2	2	2	2
Flammable gases	2.1	4	4	2	X	X	X	2	1	2	X	2	2
Non-toxic, non-flammable gases	2.2	2	2	1	X	X	X	1	X	1	X	X	1
Poison gases	2.3	2	2	1	X	X	X	2	X	2	X	X	2
Flammable liquids	3	4	4	2	2	1	2	X	X	2	1	2	2
Flammable solids (including self-reactive and related substances and desensitized explosives)	4.1	4	3	2	1	X	X	X	X	1	X	1	2

An "X" in the table in the box where the column and row for the classes being compared intersect indicates (in the absence of any instructions to the contrary in columns 16 and 17 of the DGL) that no segregation is required between the goods concerned, whilst a number code 1, 2, 3 or 4 indicates a particular level of segregation, as follows:

1 = "Away from"
2 = "Separated from"
3 = "Separated by a complete compartment or hold from"
4 = "Separated longitudinally by an intervening complete compartment or hold from"

As explained above, any specific requirements identified in the DGL for the goods concerned take precedence over instructions in the table.

The extent of the segregation identified by the number code varies according to the mode of carriage for which the calculation is being made (e.g. whether it concerns the separation of packaged goods in the hold of a vessel, the distance required between containers on a containership or the separation of vehicles on a ro-ro ferry).

Consequently, once the applicable number code has been established, reference must be made to the appropriate modal carriage section of chapter 7.2 in order to interpret the exact implications – see 13.8.

An example of the segregation procedure for a sample consignment is provided at the end of 13.8.

Subsidiary risks
Where the Code requires packages to bear a single subsidiary risk label, the segregation appropriate to this subsidiary risk must be applied when it is more stringent than that required for the class (primary) hazard: i.e. the calculation explained above must be done twice.

Segregation requirements for packages bearing more than one subsidiary risk label are always highlighted in the DGL.

However, dangerous goods of the same hazard class may be stowed together without regard to any segregation required by subsidiary hazards, provided that the goods concerned are compatible.

13.8 Specific segregation procedures

The manner in which segregation directions are interpreted for different shipment methods is explained below.

Segregation of packages
Chapter 7.2.2 of the Code identifies how segregation directions are to be interpreted and applied where packaged dangerous goods are carried in the hold of a vessel or in a cargo transport unit (see part 11) (or a combination thereof, both on the same ship).

Whilst the basic procedure for determining segregation is as outlined under 13.7, there are variations in the manner in which the standard segregation directions are interpreted for such cargoes; these are explained in detail and illustrated in diagramatic form in 7.2.2 of the Code.

For the purposes of determining segregation distances between packaged dangerous goods stowed conventionally in the hold and those packed in a cargo transport unit, a distinction is made between *closed* (contents totally enclosed by permanent structures) and *open* cargo transport units. More stringent requirements apply where the cargo transport unit is of an *open* design.

If any level of segregation is required between particular dangerous goods, the goods concerned must not be loaded in the same cargo transport unit. The only exception to this rule is where the minimum segregation level of "Away from" is specified, in which case the goods may be carried together with the prior approval of the Competent Authority (see 13.10).

Segregation of freight containers on board containerships
7.2.3 of the Code identifies how segregation directions are to be interpreted and applied in the case of freight containers carried on board containerships, or on the decks or in holds and compartments of other types of ships fitted with permanent container stowage facilities.

Whilst the basic procedure for determining segregation is as outlined under 13.7 above, there are variations in the manner in which the standard segregation directions are interpreted and applied for such cargoes.

Their practical application is based on a number of factors: the type of vessel; the type of containers – whether they are of a *closed* (with permanent structures totally enclosing the contents) or *open* design type; their location on the vessel – *on deck* or *under deck;* and the nature of the segregation being considered – vertical or horizontal, "fore and aft" or "athwartships".

Segregation of cargo transport units on board ro-ro ships
7.2.4 of the Code identifies how segregation directions are to be interpreted and applied where cargo transport units loaded with dangerous goods are carried on ro-ro ships or in ro-ro cargo spaces, either *on deck* or *under deck.*

Whilst the basic procedure for determining segregation is as outlined under 13.7 above, there are variations in the manner in which the standard segregation directions are interpreted and applies for such cargoes. Their practical application is based on a number of factors: the type of units – whether they are of a *closed* (with permanent structures totally enclosing the contents) or *open* design type; their location on the vessel – *on deck* or *under deck;* and the nature of the segregation being considered – "fore and aft" or "athwartships".

Segregation in shipborne barges and on board barge-carrying ships
7.2.5 of the Code identifies how segregation directions are to be interpreted and applied where dangerous goods are carried in a shipborne barge or a number of such barges are conveyed on a ship specially designed and equipped for their carriage.

Whilst the basic procedure for determining segregation is as outlined under 13.7 above, there are variations in the manner in which the standard segregation directions are interpreted for such cargoes.

Segregation between bulk materials possessing chemical hazards and packaged dangerous goods
The segregation requirements on ships loaded with both bulk hazardous chemicals and packaged dangerous goods are identified in 7.2.6.

Segregation decisions for such cargoes are based on the use of the special segregation table in sub-section 7.2.6 of the Code, taking account of any specific segregation directions in the DGL.

Segregation example
The following procedures would be necessary to establish whether a consignment of packaged dangerous goods comprising ethyl chloroacetate (UN 1181), a toxic liquid (class 6.1) with a flammable (class 3) subsidiary risk, and aluminium carbide (UN 1394), which is classified as dangerous when wet (class 4.3), may be carried together in the same freight container (CTU).

There are no relevant segregation directions in columns 16 or 17 of the DGL for either of these items that are relevant to this combination of goods or in the relevant class introductions.

This being the case, the hazards of the two substances, including the subsidiary risk, must be cross-checked in the segregation table in 7.2.1.16 (see 13.7) to determine any segregation requirements.

When class 4.3 is checked against class 6.1 the table indicates "X": no segregation is required. However, when class 4.3 is checked against the class 3 subsidiary risk of the toxic liquid, the table indicates "1": these two hazards must be segregated "Away from" each other.

As indicated under "Segregation of packages" above, goods requiring any level of segregation, even the minimum level of "Away from" (as in this example), must ***not*** *be loaded together in the same CTU unless Competent Authority approval has been granted.*

In the absence of any such approval, the goods concerned are not permitted in the same cargo transport unit (e.g. freight container).

13.9 Actions to be taken in the event of incidents involving dangerous goods and fire precautions

Chapter 7.3 deals with emergency action procedures and fire prevention. It contains some general emergency procedures and some specific directions for incidents involving class 6.2 (infectious) and class 7 (radioactive) cargoes.

With respect to fire prevention, there is a list of eight general precautions applicable in all circumstances. In addition, the seafarer is advised to study the individual class sections of 7.3 and applicable instructions in the DGL, especially the Emergency Schedule (EmS) in column 15. The practical application of the EmS instructions is explained in the section headed "Emergency Procedures for Ships Carrying Dangerous Goods" in the Supplement to the Code.

13.10 Cargo transport units

Chapter 7.4 identifies a number of specific requirements which must be met when dangerous goods are to be transported by sea in a cargo transport unit (CTU).

The term "cargo transport unit (CTU)" covers freight containers used for the transport of packaged dangerous goods, bulk packagings used for solid dangerous goods, road freight vehicles, railway freight wagons, road tank vehicles, rail tank wagons or portable tanks. Portable tanks are dealt with in more detail in part 9.

A *freight container* is defined as an article of transport equipment that is of permanent character, strong enough to be suitable for repeated use, specially designed to be transported by one or more modes of transport without intermediate reloading and designed and fitted to enable proper securing and ready handling. Vehicles or packagings are not regarded as freight containers.

Freight containers and road or rail vehicles into which solid dangerous goods are loaded without any intermediate form of containment are regarded as *bulk packagings.*

CTUs used for the transport of packaged goods or as bulk packagings for solid dangerous goods must be strong enough to meet the normal conditions of transport under which they will be used and, with the exception of those used for offshore operations, "containers" must be approved in accordance with the International Convention for Safe Containers (CSC).

Competent Authority approval is required for offshore containers. The approval plate on such

containers must be clearly marked with the words "Offshore Container".

Permitted shipments
Dangerous goods which require segregation from each other must not be carried in the same CTU. The only exception to this rule is where the minimum segregation level of "Away from" is specified, in which case the goods may only be carried together with the prior approval of the Competent Authority.

Containers carried under fumigation
Special preparation and carriage conditions apply to the transport of containers under fumigation: measures must be taken to minimize the escape of fumigant; a minimum time period of 24 hours (or any shorter period specified by the Competent Authority) is required between the application of the fumigant and the loading of the container onto the ship; prior notification must be given to the ship's master; fumigant detection equipment and instructions for its use must be carried.

DANGER

THIS UNIT IS UNDER FUMIGATION
WITH (XXXXXXXXXX) APPLIED ON
DATE _____
TIME _____

DO NOT ENTER

Ro-ro ships
There are some alternative and/or additional provisions which must be met when dangerous goods are transported on ro-ro vessels. These arise mainly because of structural differences between ro-ro and conventional vessels.

A *ro-ro (roll-on/roll-off) ship* means a ship which has one or more decks, either closed or open, which are not sub-divided in any way and normally run the entire length of the vessel, carrying goods which are normally loaded and unloaded in a horizontal direction.

13.11 General handling, stowage and segregation

Due to the very particular nature of ro-ro operations, a number of specific provisons apply to the loading, carriage and unloading of ro-ro traffics. These provisions, which are fully detailed in section 17 of the Code, relate to matters such as:

- *loading/unloading operations:* all such operations must carried out under the surveillance of officers/crew members or responsible persons appointed by the master of the ship

- *prevention of access to decks:* passengers and other unauthorized persons must be excluded from vehicle decks where dangerous goods have been loaded; access doors to such decks must be securely closed and notices prohibiting access must be clearly displayed; an authorized crew member must accompany any unauthorized person requiring access to such a deck during the voyage
- *prevention of vapour spread:* the closing arrangements for doors or openings between cargo spaces and machinery and accommodation spaces must be such that the risk of vapours entering such areas is minimized

The requirements are detailed in full in chapter 7.4 of the Code.

- *safety of electrical systems:* where there is a possibility of flammable vapours being released, electrical systems on vehicle decks must be designed so as to preclude the possibility of explosion
- *ventilation systems:* closed ro-ro cargo spaces and special category cargo spaces intended for the carriage of vehicles with fuel in their tanks must be mechanically ventilated where dangerous goods which require such ventilation are being carried
- *temperature-controlled containers or vehicles:* there are restrictions on the operation of mechanically or electrically operated temperature-controlled containers or vehicles on ro-ro vessels
- *safety inspections:* vehicle decks must be regularly inspected by an authorized crew member during the voyage

Units loaded with dangerous goods must be stowed so as to be accessible at all times, especially for fire fighting.

A unit is defined as a vehicle, container, tank, intermediate bulk container (IBC), unit load or receptacle.

Particular stowage directions apply to containers (both freight containers and portable tanks) – see 13.3 – and to any units loaded with marine pollutants – see 13.4.

Details of the segregation requirements both within and between units carrying dangerous goods are provided in 13.8.

All units carrying dangerous goods must be securely fastened to the ship with lashings or other suitable means which ensure that they cannot shift during the voyage.

13.12 Container packing of cargo transport units (CTUs)

Where packages are carried in a CTU, there are a number of measures which should be taken to ensure safety during the journey. These are set down in chapter 7.5 of the Code.

For example, both the CTU and the packages should be visually examined to ensure that there is no damage likely to affect safety; packages should be tightly packed or adequately braced or secured so as to prevent their movement and minimize the possibility of damage; where possible, dangerous goods consigned as a part load should be packed so as to be accessible from the doors; any locking system must be designed so that the doors can be opened without delay in an emergency; any irrelevant markings or placards etc., must be removed from the container before loading.

Further detailed guidelines on safe loading procedures are contained in the IMO/ILO/UN ECE Guidelines for Packing Cargo Transport Units which are reproduced in the Supplement to the Code (see part 14).

Containers carried under fumigation: special preparation and carriage conditions apply to the transport of containers under fumigation: measures must be taken to minimize the escape of fumigant; a minimum time period of 24 hours (or any shorter period specified by the Competent Authority) is required between the aplication of the fumigant and the loading of the container onto the ship; prior notification must be given to the ship's master; fumigant detection equipment and instructions for its use must be carried.

DANGER

THIS UNIT IS UNDER FUMIGATION
WITH (XXXXXXXXXX) APPLIED ON
DATE _____
TIME _____

DO NOT ENTER

13.13 Shipborne barges

Chapter 7.6 of the Code identifies the procedures which must be followed when packaged dangerous goods or solid bulk materials possessing chemical hazards are being transported on a barge-carrying ship or being transferred to or from such a ship on a barge feeder vessel.

A *barge-carrying ship* is a vessel specially designed and equipped to carry shipborne barges.

A *shipborne barge* or *barge* is an independent, non-self-propelled vessel which is specially designed and equipped to be lifted in a loaded condition and stowed aboard a barge-carrying ship or barge feeder vessel.

A *barge feeder vessel* is one which is specially designed and equipped to transfer shipborne barges to or from a barge-carrying vessel/ship.

The design and construction of shipborne barges is subject to Competent Authority approval.

Permitted shipments
The standard requirements relating to the design, construction and approval of packages and portable tanks (see parts 9 and 10) apply equally when dangerous goods are transported on barge-carrying vessels.

There are restrictions on the carriage of certain commodities in shipborne barges, and these are indicated as appropriate, on the individual schedule pages; other commodities may only be carried with Competent Authority approval under specified conditions.

13.14 Barge loading, stowage and segregation

Packages, portable tanks, freight containers and any other goods within a shipborne barge must be properly immobilized by stowage and adequately braced so as to prevent their movement and minimize the possibility of damage.

Shipborne barges should be visually examined for hull or hatch cover damage which could impair watertight integrity. If there is evidence of such damage, the barge should not be loaded.

Packages should be examined and any found to be damaged, leaking or sifting should not be loaded.

Where solid bulk materials possessing chemical hazards are carried in shipborne barges, the cargo must at all times be evenly distributed, properly trimmed and secured.

The DGL or manifest and stowage plan (see part 11) should clearly identify all shipborne barges loaded with dangerous goods and show their location on board the ship. The total quantity of each dangerous substance should also be shown.

Stowage decisions must be based on the direction given on the individual schedule page in the DGL for the dangerous goods concerned.

When a shipborne barge is loaded with more than one substance and the individual schedule pages for the substances relevant entries in the DGL indicate different stowage locations – i.e. some require *on deck* stowage and others *under deck* stowage – the barge should be stowed *on deck*.

Particular stowage directions apply to barges loaded with marine pollutants – see 13.4.

Shipborne barges should be securely fastened to the ship with lashings or other suitable means so as to prevent shifting during the voyage.

Details of segregation requirements in shipborne barges and on barge-carrying ships are provided in 13.8.

The following safety issues should be taken into account when dangerous goods are transported on shipborne barges:

- *ventilation:* where specific ventilation requirements apply to the goods concerned, measures must be taken to ensure that the barge is adequately vented;
- *condensation:* account must be taken of potential condensation problems where barges are loaded with substances in class 4.3 (dangerous when wet), materials hazardous only in bulk (MHB) having similar properties or substances liable to spontaneous heating;
- *leakage of vapours or fumes:* when removing hatch covers, the possibility that leakage may have caused an unsafe concentration of toxic or flammable vapours or produced an oxygen-rich or oxygen-depleted atmosphere should be taken into consideration;
- *fire protection:* shipborne barges loaded with significant quantities of dangerous goods should be stowed as far as practicable from accommodation and navigational areas.

Where barge-carrying ships are fitted with fixed fire-fighting systems or fire detection systems which can be linked to individual barges, care should be taken to ensure that these systems are attached and operational.

- *barges loaded with goods under fumigation:* special preparation and carriage conditions apply where barges are loaded with goods under fumigation: measures must be taken to minimize the escape of fumigant; a minimum time period of 24 hours (or any shorter period specified by the Competent Authority) is required between the application of the fumigant and the loading of the barge onto the ship; prior notification must be given to the ship's master; fumigant detection equipment and instructions for its use must be carried

13.15 Temperature control

Chapter 7.7 of the Code details how the temperatures should be controlled and particular requirements to be followed, including stowage requirements, where several substances with different self-accelerating decomposition temperatures (SADT) are loaded into the same containers cargo transport unit.

Certain substances, mainly organic peroxides of class 5.2 and self-reactive substances of class 4.1, must be carried at low temperatures.

Chapter 7.7 also addresses substances that must be stabilized by means of temperature control.

The DGL identifies such substances with their UN Number (e.g UN 3114: organic peroxide Type C, solid, temperature controlled).

Where applicable, the entries in column 17 identify the need to check table 2.4.3.3.2.3 of the Code (for self-reactive substances) or 2.5.3.2.4 (for organic peroxides) in order to ascertain full details of the temperature requirements.

Where a substance has to be temperature controlled, there are three temperatures levels to be established:

- *control temperature:* the maximum temperature at which the substance should be carried
- *emergency temperature:* the temperature at which emergency procedures should be implemented
- *self-accelerating decomposition temperature (SADT):* the lowest temperature at which self-accelerating decomposition occurs

If a substance has an SADT of 30°C the control temperature would be 15°C and the emergency temperature 20°C.

If the SADT is not provided or known, it must be ascertained by testing in accordance with the latest edition of the UN Manual of Tests and Criteria. The other temperatures can be determined once this is known. The procedure is explained in 7.7.2.

Ships' masters must have instructions for the operation of the refrigeration system.

13.16 Transport of wastes

Chapter 7.8 of the Code explains the relationship between the IMDG Code and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. The Convention sets down the rules for the international movements of all wastes (not only dangerous goods). Notifications and approvals from and to Competent Authorities (these are not usually the maritime authorities) are required.

The classification procedures for dangerous wastes follow the UN system (see part 7 of this Compendium).

13.17 Competent Authorities

Chapter 7.9 lists the names and addresses of designated national "Competent Authorities".

The term "Competent Authority" means the national government department responsible for interpreting and enforcing the provisions of the IMDG Code in a particular country, or any agency or organization which has been delegated by that government department to carry out certain functions e.g. the testing and approval of packagings.

Where applicable, details of any such agencies or organizations are included in the above mentioned list of national Competent Authorities.

13.18 Competent Authority approvals

Where there is a reference in the provisions of the Code to "Competent Authority approval" or an indication that a particular action or procedure is "subject to the approval of the Competent Authority", an application must be made to the appropriate Competent Authority for the necessary authorization.

Any such authorizations – which will be in the form of written approvals, permits or certificates – issued by a Competent Authority, or by a duly authorized organization acting under its responsibility, should be recognized by all other countries.

Approvals, permits or certificates should at least comply with the requirements of the International Convention for the Safety of Life at Sea, 1974 (SOLAS); the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78); and the standards of the IMDG Code.

Part 14: IMDG Code Supplement

14.1 Supplement contents

The Supplement to the IMDG Code contains seven distinct sections each containing guidance on specific issues and procedures relevant to the safe transport of dangerous goods by sea. Its contents comprise a number of separate annexes and supplements which relate to the Code.

These concern:

- Emergency response procedures on board ships – EmS Guide
- First aid procedures on board ships – Medical First Aid Guide (MFAG)
- Reporting procedures following incidents
- Safe packing procedures for cargo transport units
- Safe use of pesticides in ships
- Carriage of nuclear materials (INF Code)
- Appendix of relevant resolutions and circulars

The guidance contained in the various sections of the Supplement is summarized below.

Emergency response procedures for ships carrying dangerous goods (EmS Guide)

14.2 Emergency response procedures (EmS Guide)

Note: This summary should never be used instead of the EmS Guide.

The use of emergency procedures involves a course in its own right. The following notes are intended to explain the purpose of the emergency response procedures and how they should be used.

For consignors of dangerous goods there is no requirement to provide this information to the shipping line or to the ship, which will have a Code and will be able to determine the correct schedule to use in the circumstances from column 15.

In order to assist vessels with advice regarding the actions to be taken on board in emergencies involving dangerous goods (fire or spillage), IMO has published a guide, *Emergency Response Procedures for Ships Carrying Dangerous Goods* (EmS Guide).

This document has been completely revised from Amendment 31 to the Code.

The EmS Guide is divided into two sections:

- Fire
- Spillage

This style is reflected in the DGL where column 15 shows two codes:

"F-?" indicates the schedule for firefighting (e.g. F-H which deals with fires involving substances which are oxidizers with explosive potential). There are 10 firefighting schedules.

"S-?" indicates the schedule for spillages (e.g. S-P concerns spills involving substances which are dangerous when wet (class 4.3)). There are 26 spillage schedules.

Each part of the Guide has a general introduction dealing with common issues. In the introduction to the firefighting schedules there are sections concerning:

- identification of the goods;
- general effects of fire and chemicals;
- firefighting media – types of extinguishants;
- personal protection and first aid.

These general sections are followed by some guidance on the effects of fire with chemicals of the nine classes: e.g. for class 1 they explain that divisions 1.2, 1.3, 1.4 and 1.6 are unlikely to explode *en masse*, while for class 3 the guide warns against directing jets of water on to flammable liquids as this can lead to the spread of fire.

A similar introduction applies to spillages.

The various schedules follow a common pattern: each schedule has on the facing page a list of UN Numbers applicable to it. Below is F-A with part of the list of UN Numbers.

FIRE SCHEDULE Alfa

F – A
GENERAL FIRE SCHEDULE

This fire schedule is applicable to the following UN Numbers:

UN 1312, UN 1313, UN 1314, UN 1318, UN 1324, UN 1326, UN 1328, UN 1327, UN 1334, UN 1336, UN 1341, UN 1345, UN 1346, UN 1350, UN 1352, UN 1353, UN 1365, UN 1369, UN 1372, UN 1373, UN 1374, UN 1379, UN 1381, UN 1382, UN 1431, UN 1437, UN 1438, UN 1444, UN 1448, UN 1451, UN 1454, UN 1463, UN 1474, UN 1477, UN 1479, UN 1486, UN 1487, UN 1488, UN 1492, UN 1493,

FIRE SCHEDULE Alfa

F – A
GENERAL FIRE SCHEDULE

General comments		In a fire, exposed cargoes may explode or their containment may rupture. Fight fire from a protected position from as far away as possible.
Cargo on fire on deck	Packages	Create water spray from as many hoses as possible.
	Cargo Transport Units	
Cargo on fire under deck		Stop ventilation and close hatches. Use cargo space fixed fire-extinguishing system. If this is not available, create water spray using copious quantities of water.
Cargo exposed to fire		If practicable, remove or jettison packages which are likely to be involved in fire. Otherwise, keep cool using water.
Special cases: UN 1381, UN 2447		After extinguishing the fire, treat immediately as for spillage (see relevant EmS SPILLAGE SCHEDULE).

It should be noted that at the bottom of each schedule there is space for special cases where additional information is required.

Where special cases are shown in the schedule the entry in column 15 of the DGL has the schedule underlined to indicate that special additional rules appear in the Schedule (e.g. UN 2447 in column 15 will show F-A).

The following conditions are of particular importance when using the guide:

Documentation
Detailed knowledge of dangerous goods carried on board is, of course, essential and this is covered by the following stipulation in the SOLAS Convention (chapter VII, regulation 5, item 5).

"Each ship carrying dangerous goods shall have a special list or manifest setting forth, in accordance with the classification set out in regulation 2, 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 a special list or manifest. A copy of one of these documents shall be made available before departure to the person or organization designated by the port state authority."

In a number of schedules under "spillage – on deck", the recommended action is to wash overboard with copious quantities of water; in certain cases the jettisoning of packages is considered necessary. For marine pollutants and other goods which may have a harmful effect on the marine environment this may seem odd, but regulation 7, item 1 of Annex III of MARPOL states:

"Jettisoning of harmful substances carried in a packaged form shall be prohibited except where necessary for the purpose of securing the safety of the ship or saving life at sea."

Emergency equipment
The use of the Guide implies that the vessel carries emergency equipment as required in SOLAS chapter II-2, regulation 54 (special requirements for ships carrying dangerous goods) and also as instructed in the Emergency Schedules concerned, under the heading "Special Emergency Equipment to be Carried".

Whenever the use of an inert absorbent material has been recommended, diatomaceous earth has been mentioned as an example. In practice a number of very efficient commercial absorbents exist, which could not be mentioned in the Guide.

It should be noted that whenever "full protective clothing" is recommended, this includes boots, coveralls, gloves, headgear and goggles. In cases where protection of the respiratory tract is necessary, "self-contained breathing apparatus" is recommended, which excludes the use of goggles. In such cases additional "protective clothing" may be recommended, comprising boots, coveralls, gloves and headgear.

A person wearing self-contained breathing apparatus and protective clothing when working will rapidly become exhausted, and therefore regular training is of great importance. Furthermore, a person should not work alone in an emergency situation, particularly not in enclosed spaces, and a relieving force should always be prepared to take over.

Stowage on board
When planning the stowage of the vessel, the possible need for emergency actions during the voyage should be kept in mind. Stowage of water-reactive substances under deck in vessels where only water-based firefighting media are available may be unsuitable, even if such stowage is allowed according to the IMDG Code.

In an emergency situation, the jettisoning of some commodities may have to be considered. The cargo should be stowed in such a way that it is accessible for such actions.

A number of commodities may cause structural damage to the vessel in case of leakage and it may be unsuitable to use the bilge pumping system. For such commodities stowage on deck may be preferable, even if stowage under deck is allowed.

The possible entrance of toxic gases or fumes into living quarters through ventilation systems etc. should be considered and avoided when planning stowage. Such gases or fumes may also be formed when the substance concerned comes into contact with water.

14.3 General procedures for using the Guide

Once the name of the substance concerned has been verified, the appropriate EmS No. can be determined by reference to the appropriate entry in the General Index in volume 1 of the IMDG Code.

Tank instructions			EmS	Stowage and segregation	Properties and observations	UN No.
IMO	UN	Provisions				
(12)	(13)	(14)	(15)	(16)	(17)	(18)
T3	T4	TP1	F – E S – D	Category E	Colourless, volatile liquid with an agreeable odour. Flashpoint: below-18°C c.c. Explosive limits: 1.6% to 10.4%. Miscible with water.	1088

(The use of the correct Proper Shipping Name in the dangerous goods transport document (see part 11) is essential if delays in taking appropriate actions are to be avoided.)

The procedure to be followed will depend on the incident, either the appropriate fire schedule or the spillage schedule.

It should be noted that some fire schedules refer also to the spillage schedule when dealing with the clear-up.

Examples of EmS procedures

Spillage
A distinct smell has been detected from one of the holds and personnel wearing self-contained breathing apparatus and full protective clothing have found a liquid leakage from a container. From the dangerous goods manifest it has been determined that it contains a 200 litre drum of acetic acid, glacial, together with non-dangerous non-liquid products. There is no doubt that the leakage consists of the acid.

If the crew member who discovers the leak has not recorded the UN Number, then the first step would be to use the alphabetical index of the Code to identify the correct UN Number.

The individual entry in the DGL, column 17, says the product has a flashpoint of +40°C and is corrosive to lead and most metals.

Therefore the master decides that the hold must be thoroughly ventilated and the spillage cleaned up as soon as possible before it penetrates the bilge pumping system and eventually causes damage to the ship's structure and other cargo in the vicinity.

The proper shipping name is ACETIC ACID, GLACIAL, UN 2789 and EmS No S–C is indicated in column 15.

SPILLAGE SCHEDULE Charlie

S – C
FLAMMABLE, CORROSIVE LIQUIDS

	spillage)	
Spillage under deck	Packages (small spillage)	Provide adequate ventilation. Do not enter deck without self-contained breathing apparatus. Check atmosphere before entering (toxicity and explosion hazard). If atmosphere cannot be checked, do not enter. Let vapours evaporate, keep clear. Liquids: Provide good ventilation of the space. Use water-spray on effluent in hold to avoid ignition of flammable vapours. Wash down to the bottom of the hold. Use copious quantities of water. Pump overboard. Solids: Collect spillage. Dispose overboard. Wash residues down to the bottom of the hold. Use copious quantities of water. Pump overboard.

S–C recommends the use of protective clothing and self-contained breathing apparatus when dealing with SPILLAGE or FIRE and the emergency team are equipped accordingly. The advice for the cleaning of a spillage under deck is shown above.

The vessel carries a number of bags of absorbent material and a limited number of salvage packagings, and in the meantime these are carried to the nearest entrance to the hold concerned.

The emergency team works two at a time and are relieved at regular intervals until the whole spillage has been taken care of, either by being washed away or absorbed. The ship's structure and other affected areas are checked for possible damage, and used salvage packagings are stowed safely for future disposal.

Due to the stowage location of the container concerned, the leaking drum cannot be reached, but since the period of time left till the ship reaches its destination is short, no further action is considered necessary. However, the hold will be continuously checked for further leakage during the remainder of the voyage.

Fire

On the weather deck of a ro-ro vessel smoke is detected from a tilt (canvas) trailer. It is determined that in addition to non-dangerous cargoes it contains the following dangerous substance: HYDROGEN PEROXIDE, AQUEOUS SOLUTION, stabilized, with 15% hydrogen peroxide, packed in metal cans in a wooden box. The gross mass of the box is 60 kg.

If the crew member who discovers the fire has not recorded the UN Number then the first step would be to use the alphabetical index of the Code to identify the correct UN Number. In this instance the 15% concentration data is very important in identifying the correct UN Number and EmS.

The DGL for UN 2984 refers to EmS F–H, S–Q.

FIRE SCHEDULE Hotel

F – H

OXIDIZING SUBSTANCES WITH EXPLOSIVE POTENTIAL

Cargo on fire on deck	**Packages**	**Create water spray from as many hoses as possible.**
	Cargo Transport Units	

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

14.4 Medical First Aid Guide

Note: This summary should never be used instead of the MFAG.

Introduction

A general guide for medical treatment on board ships, the *International Medical Guide for Ships (IMGS)*, has been published by the World Health Organization (WHO) in Geneva; the MFAG is regarded as the chemicals supplement to the IMGS.

The transport of dangerous goods is very specialized and in order to be able to take the proper actions in the event of accidents or incidents the ship's officers and crew must at all times know the identity of the commodities being carried and their stowage location on the vessel.

This is covered by the following stipulation in the SOLAS Convention (chapter VII, regulation 5, item 5):

> *"Each ship carrying dangerous goods shall have a special list or manifest setting forth, in accordance with the classification set out in regulation 2, 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 a special list or manifest. A copy of one of these documents shall be made available before departure to the person or organization designated by the port state authority."*

An important condition for the use of the MFAG is that the ship carries the proper medical equipment and the medicines referred to in the Guide (see section 11) in addition to corresponding requirements in the IMGS. These requirements are normally covered by national legislation.

It is also essential that officers and crew on board vessels which normally carry dangerous goods should be properly trained and continuously informed about the hazards involved and the procedures to be used in the event of an accident.

Modern communication methods also allow vessels to obtain assistance from various emergency response centres, shipowners, shippers, etc.

14.5 Structure of the MFAG

The MFAG for the 2000 edition of the Code has undergone fundamental changes from previous editions. In the past there were tables, similar to those in the EmS Guide, that provided first aid guidance for different substances. These were available in the IMDG Code and it was not unusual to see the relevant table quoted on the dangerous goods transport document.

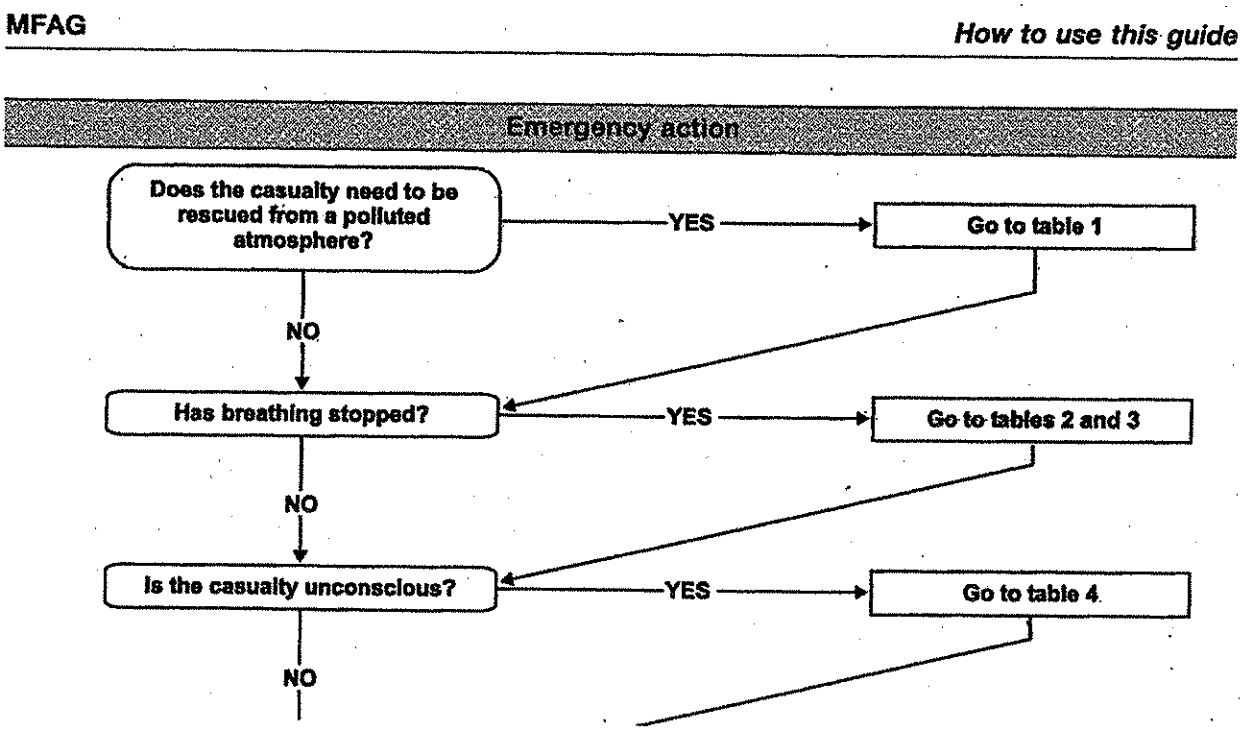
There is now a new approach. IMO experts decided that ships' crews should deal with medical emergencies on the basis of the incident and the symptoms shown by the patient and that direct relationships between the substance and the medical emergency were only necessary in a limited number of cases.

Thus there are no tables and no means of referencing the MFAG.

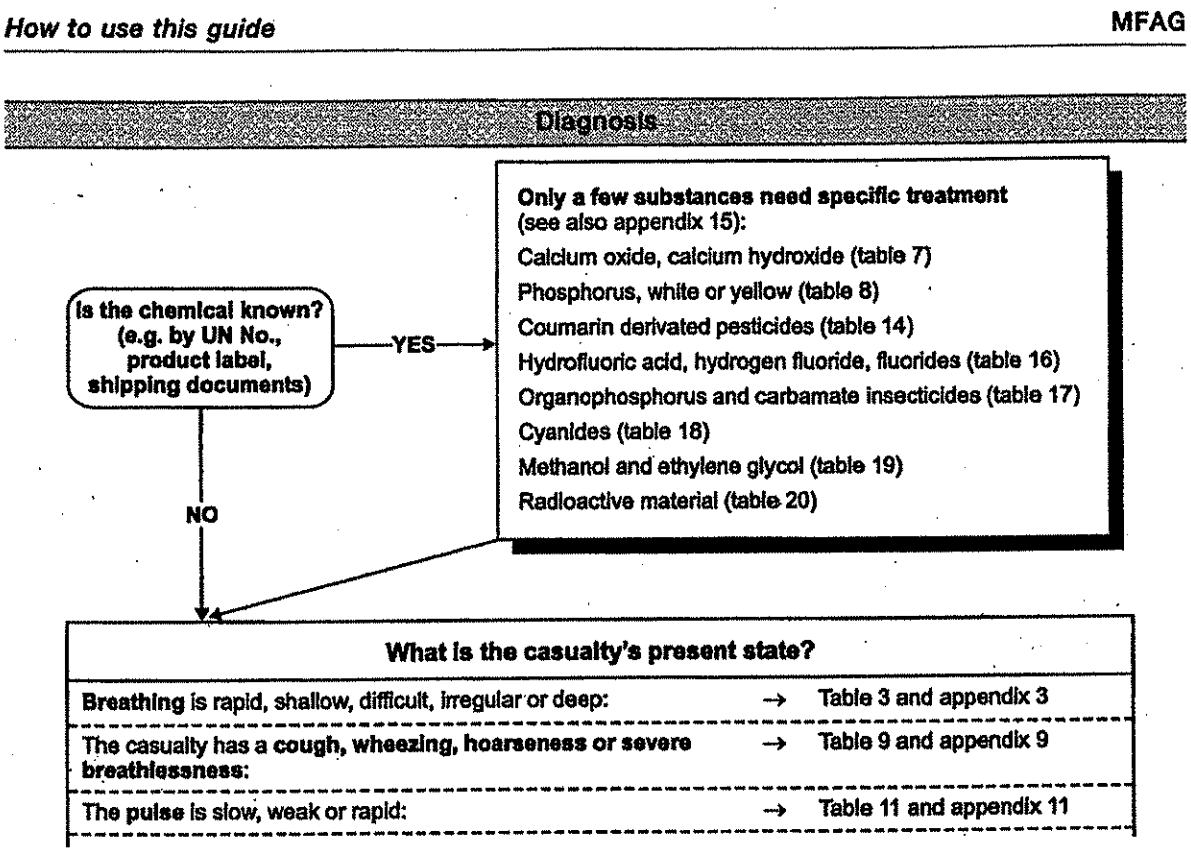
The MFAG assumes that the ship's master and crew are in compliance with the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) and that they have qualified first aiders in the crew. The MFAG takes a three-step approach:

1 Emergency actions and diagnosis

This stage consist of two flow charts. The first is the emergency action:



The second is the diagnosis:



2 Having determined from each table the symptoms and diagnosis, the tables provide the basic instructions, whilst

3 The appendices provide detailed information.

There are a few substances that need specific treatment and these are highlighted in the Diagnosis table above.

Reporting Procedures

14.6 General principles

The reporting of incidents involving harmful substances and/or marine pollutants is regulated under Protocol I of the International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78). This Protocol entered into force on 6 April 1987.

Recognizing that incidents at sea may give rise to the accidental discharge of substances which cause pollution, MARPOL 73/78 identifies the need for any such incidents to be reported to the appropriate coastal authorities as quickly and as fully as possible.

Resolution A.851(20), which supplements the requirements of Protocol I, outlines the general principles for ship reporting systems and contains detailed guidelines for reporting incidents involving dangerous goods, harmful substances and/or marine pollutants.

Protocol I and resolution A.851(20) are reproduced, respectively, in Appendix 1 and Appendix 2 of *Reporting Procedures* in the Supplement (see 14.8).

A number of general principles are laid down for ship reporting systems (see also 14.7). These cover matters such as:

- the need for reports to be presented in a standard format, using a standard vocabulary;
- the need to restrict reports to essential information and keep the number of reports to a minimum;
- the need to ensure that information can readily be made available to other systems when required for distress, safety or pollution prevention purposes;
- the requirement for updating reports to reflect changes in circumstances;
- the factors which should be taken into account by Governments when establishing reporting procedures, setting down operational guidelines for mariners and disseminating instructions to all relevant agencies.

Full details are provided in *Reporting Procedures*.

14.7 Guidelines for reporting incidents

Annexes 1 to 3 of *Reporting Procedures* contain detailed guidelines relating to the manner in which reports of incidents involving dangerous goods, harmful substances and/or marine pollutants should be made to coastal authorities and other interested parties.

Annex 1 – Procedures
This annex identifies the need for standard reports both prior to and during a voyage and allocates a coding system for their transmission.

Annex 2 – Standard reporting format and procedures
In addition to providing the format, this annex also indicates that where language difficulties may exist, the Standard Marine Communication Phrases or, alternatively, the International Code of Signals should be utilized for reports.

Annex 3 – Guidelines for detailed reporting requirements
This annex contains three sub-sections which specify the details that should be provided, respectively, in reports relating to incidents involving dangerous goods, harmful substances and marine pollutants. These cover matters such as: the proper shipping name, class and UN Number for the substance(s) involved; the name of the manufacturer, if known (or the consignor or consignee); details of the type of packages, tank, vehicle or freight container concerned; an estimate of the quantity involved; whether the lost goods floated or sank; whether the loss is continuing; the cause of the loss.

A fourth sub-section deals with circumstances where the probable discharge of a substance(s) is anticipated as a result of damage to a vessel. This identifies the factors which should be taken into account by the ship's master when deciding whether the submission of a report is required.

14.8 Appendices

There are three appendices to *Reporting Procedures.*

Appendix 1 reproduces Protocol I to MARPOL 73/78. The five articles of this protocol deal with: the general duty to report incidents, the type of incidents for which reports are required, the basic content of reports, the need for supplementary update reports and the manner in which reports should be submitted.

Appendix 2 reproduces resolution A.851(20), which supplements the requirements of Protocol I. This resolution identifies the need for the introduction of standardized incident reporting procedures and contains a recommendation to IMO Member Governments to introduce reporting systems in line with the general principles contained in the annex to the resolution.

Appendix 3 contains a list by country of the national operational contact points responsible for the receipt, transmission and processing of incident reports.

IMO/ILO/UN ECE Guidelines for Packing Cargo Transport Units

14.9 Scope and general conditions

This section of the Supplement contains extensive guidance on the procedures which should be followed by personnel responsible for packing and securing dangerous goods cargo in freight containers or vehicles (referred to as cargo transport units – CTUs) which are to be carried by sea. Guidance is also provided on the actions which should be taken on receipt of a CTU.

The transport of CTUs by sea may occur in a variety of circumstances leading to rough handling and disturbance involving pitching, rolling and other similar actions of the vessel which can exert very significant forces on the cargo; it should always be assumed that the weather will never be calm nor the sea smooth and that securing methods used for land transport may be inadequate at sea.

This guide is multimodal and comprehensive, incorporating illustrations and detailed explanations of the stresses that affect CTUs in transport journeys. It was developed by the IMO, UN Economic Commission for Europe and International Labour Organization.

14.10 Visual inspections prior to packing

The CTU should be inspected inside and outside before it is packed with cargo. Basic procedures for such inspections should ensure that the following actions are carried out:

Exterior inspections: checks should be carried out to ensure that the CTU is structurally sound and that there is no damage or distortion to walls, floor, roof, doors, corner posts and other fittings which could adversely affect its safety during transport. It should be capable of being securely closed and sealed.

A freight container should bear a current International Convention for Safe Containers (CSC) Safety Approval Plate.

All irrelevant labels, marks and placards should be removed or masked.

Interior inspections: the CTU should be weatherproof unless its construction is such that this is not possible. Previous patches or repairs should be checked for possible leakage. Potential leakage points may be detected by checking whether any light enters a closed CTU (ensuring when carrying out any such operation that nobody becomes locked inside).

There should be no major damage to the floor and no protrusions such as nails, bolts etc. which could cause injuries to people or damage to the cargo. Tie-down points and rings should be in good condition and well anchored. A vehicle should be fitted with points for securing it aboard ship.

The CTU should be clean, dry and free of residue and persistent odours from previous cargoes.

14.11 Stowage planning and packing/securing of cargo

The following checks, issues and procedures are of particular importance when CTUs are to be packed in preparation for transport by sea:

Packing location: the CTU to be packed should rest on level and firm ground and, in the case of a vehicle/trailer, the brakes should be securely applied and the wheels chocked.

Pre-planning: the packing operation and load configuration should be planned in advance, taking account of the nature and strength of packages and any compatibility problems.

It is essential to ensure that the load is tightly packed or well braced. When planning the packing of a CTU, account should be taken of potential problems which may be created when it is unpacked. Whenever possible, goods should be tightly packed from wall to wall, special care being taken when open-sided vehicles are concerned. Alternatively, consideration should be given to the use of dunnaging, folded cardboard, air bags or other suitable means to fill spaces and reinforce load stability.

Examination of packages: packages should be examined before being packed into the CTU; any damaged, leaking or sifting packages should not be packed. Packages showing evidence of staining etc. should not be packed without first determining that it is safe to do so. Water, snow, ice or other matter adhering to packages should be removed before packing. Liquids that have accumulated on drum heads should initially be treated with caution in case they are the result of leakage of the contents.

Part loads and palletized consignments: dangerous-goods consignments which form only part of the load of a CTU should, whenever possible, be packed adjacent to the doors with markings and labels visible. If dangerous goods are palletized or otherwise unitized they should be compacted and secured in a manner unlikely to damage the individual packages. The materials used to bond a unit load should be compatible with the unitized substances and retain their efficiency when exposed to moisture, extremes of temperature and sunlight.

Fire prevention: suitable measures should be taken to prevent fires, including the prohibition of smoking in the vicinity of dangerous goods.

Condensation: temperature and humidity changes can give rise to condensation, which may cause damage such as rust, discoloration, dislodging of labels, collapse of fibreboard packages or mould formation.

In order to minimize the risk of condensation, every effort must be made to ensure that the moisture content of packaging and securing materials within a CTU is kept as low as possible.

Weight factors and load distribution: the planned load should not exceed the maximum payload of the CTU. In the case of a freight container, this will ensure that the permitted maximum gross weight (which includes the payload) marked on the International Convention for Safe Containers (CSC) Safety Approval Plate will never be exceeded.

The load should be evenly distributed over the entire floor area of the CTU. In cases where a CTU is only part loaded, it may be necessary to utilize timber baulks or other methods to achieve an even weight distribution. The centre of the weight of the packed cargo should be at or near the mid-length of the CTU and in no case should more than 60% of the load be concentrated in less than half the length of the unit measured from one end.

Heavy goods should not be placed on top of lighter goods and liquids should not be placed on top of solids. The centre of gravity should be below the half-height of the cargo space of the unit.

Prevention of overloading: potential overloading problems should be properly addressed prior to commencing CTU packing operations. Packing should be carried out under the supervision of trained competent personnel who have adequate information about the cargo to be packed and sufficient authority to control the operation and prevent overloading.

To prevent overloading, measures must be taken to ensure that:

- the cargo is properly packed, blocked, braced and secured;
- the load is arranged and distributed so that the centre of gravity is reasonably central to the length, breadth and height of the CTU;
- the maximum gross weight of the CTU is not exceeded.

Where possible, a weight declaration or weighbridge certificate should be included in or with the container documentation. Where practicable, load detection devices should be fitted to CTU handling equipment (e.g. fork-lift trucks).

Checks on completion of packing: during the final stages of packing, care should be taken to ensure that the cargo is secure enough to prevent "fall-out" when the doors are opened. Where necessary, additional strapping or timber braces should be utilized.

Checks should be made to ensure that any timber within the CTU (e.g. that used for securing the load or in the packages comprising the load) complies with any wood treatment quarantine regulations in the country of destination. Ideally, a wood treatment certificate should be secured in a conspicuous place on the CTU.

After closing the doors, all closures should be fully engaged and secure and any sealing procedures properly carried out.

When dry ice or any other expendable refrigerant is used for cooling purposes, a warning label should be posted on the outside of the doors – see also Marking and Placarding of CTUs below.

Marking and placarding of CTUs: the CTU must display appropriate marks, placards and, in certain circumstances, other signs indicating the dangers of the load. Full details are provided in part 11.

Container/Vehicle packing certificate: the person responsible for the CTU packing operation must complete a certificate or declaration confirming that the procedure has been properly carried out. Full details are provided in part 11.

14.12 Actions on receipt of CTUs

Persons opening a freight container or vehicle should be aware of the risk of cargo falling out. Doors, when opened, should be secured in the fully opened position.

Where expendable refrigerants or fumigants have been used in a CTU, there is a potential risk of a dangerous atmosphere (e.g. asphyxiant or toxic), and the CTU should be ventilated by leaving the doors open for a sufficient time before allowing personnel to enter. Where flammable goods are concerned, there should be no sources of ignition in the vicinity.

If there is a particular reason to suspect danger, for example because of damage to packages or the presence of fumigants, expert advice should be sought before the unpacking operation commences.

After a CTU has been unpacked, particular care should be taken to ensure that no hazard remains. Special cleaning may be required, particularly if a toxic spillage has occurred or is suspected.

When the CTU offers no further hazard, the dangerous goods placards, orange plates, marks and signs should be removed, masked or otherwise obliterated.

Safe use of pesticides in ships

14.13 Recommendations on the Safe Use of Pesticides in Ships

The *Recommendations on the Safe Use of Pesticides in Ships* were first issued by the IMO Maritime Safety Committee in 1971. Subsequent revisions have been issued in 1984, 1993, 1995 and 1996.

The Recommendations provide guidance on the measures which should be taken on board ships and in cargo units loaded on ships to control and eradicate pests (insects and rodents) and thus prevent damage to equipment or cargo, food contamination, or the spread of disease and infection.

The guidance contained in the Recommendations covers the following issues:

Prevention of infestation: the importance of adequate maintenance and sanitation in the prevention of infestation is highlighted, as are the main sites where infestation may be anticipated.

Chemical control of insect infestation: this section identifies the need for some form of chemical toxicant to control pests and the factors which should be taken into account with respect to both the choice of appropriate chemical agents and the manner of their application; appropriate disinfestation methods for different areas of the ship and/or cargo spaces and the cargo itself; the conditions under which fumigants should be used and the manner of their use both prior to loading and during a voyage.

Control of rodent pests: this section covers the use of fumigants, poisoned baits (acute or chronic) or trapping as means of controlling rodents, and identifies the safety precautions which should be taken when such methods are being employed.

Regulations for the use of pesticides: this section highlights the need to ensure that pesticides are used in accordance with both the manufacturer's instructions and any national regulations applicable in the countries of loading, destination and registration of the ship. A number of commonly used pesticides are also identified (see *Annexes* below).

Safety precautions – general: the potential dangers of pesticides for humans are highlighted in this section, as are the general safety precautions which should be taken with respect to their storage and use and the actions which should be taken in the event of exposure.

Annexes: there are five annexes to the Recommendations: annex 1 lists a number of common pesticides suitable for shipboard use; annex 2 explains the application of the *Threshold Limit Value* (TLV) for vapours in air – a formula used to determine recommended maximum exposure levels for workers in contaminated environments; annex 3 illustrates the standard fumigation warning sign to be used on the outside of cargo units; annex 4 reproduces the class 9 schedule for cargo units under fumigation; and annex 5 comprises a model checklist for in-transit fumigation with phosphine.

Carriage of nuclear materials (INF Code)

14.14 INF Code

The INF Code is fully titled "International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships".

Nuclear fuel is essentially the range of both fissile and non-fissile radioactive material used to generate electricity in power stations. Irradiated nuclear fuel is such material after it has been employed in the process of power generation. It is highly radioactive. Such used fuels are valuable items that can be reprocessed to provide further fresh fuel stocks for the nuclear power generation industry.

Plutonium is part of the non-waste element resulting from the reprocessing operation. During the course of reprocessing, waste materials are separated from the fuel source. Some of these waste materials are highly radioactive and are known as high-level radioactive wastes. These materials are capable of generating extremely high levels of heat.

All ships carrying such materials are subject to the constraints of the INF Code in addition to the demands of the IMDG Code. The INF Code encompasses such matters as vessel construction and stability, on-board safety equipment, fire protection standards, temperature control systems, electrical systems, securing systems, radiological protection, emergency procedures, accident notification and crew training.

The degree of competency and performance in each of these areas is varied in relation to the aggregate radioactivity of the load being carried. The activity levels are split into three groups in ascending order of aggregate activity: class INF 1, class INF 2, class INF 3.

Class INF 3 covers ships which have no restriction upon the aggregate level of activity permitted. These would be vessels constructed to the highest control levels and could be effectively dedicated to the task of transporting nuclear material. Passengers are not permitted on such ships.

The appropriate level of control for each of the three INF levels is indicated in table 1 of the INF Code.

Appendix

14.15 Appendix to the Supplement

The Appendix to the Supplement comprises four separate but associated resolutions adopted by the IMO Assembly, two circulars issued by the Maritime Safety Committee and one circular issued by the Facilitation Committee.

The four resolutions are concerned with cargo stowage and securing measures on board ships.

Resolution A.489(XII), which was adopted in November 1991, provides guidelines on the safe stowage of cargo units and other entities in ships other than cellular containerships. The guidelines cover wheeled cargo, containers, flats, pallets, portable tanks, packaged units, vehicles etc., and any parts of loading equipment which belong to but are not fixed to the ship.

The resolution recommends that IMO Member Governments should issue the guidelines to all relevant ships entitled to fly their respective State flags and ascertain that any such vessel is provided with a *Cargo Securing Manual* which outlines safe procedures appropriate to the characteristics and dimensions of the ship, its intended service, anticipated weather and sea conditions in its trading area and the cargo composition (see also *MSC/Circ.385* below).

Resolution A.533(13), which was adopted in November 1983, invites IMO Member Governments to issue recommendations on the elements which should be taken into account when considering the safe stowage and securing of cargo units and vehicles in ships.

These recommendations are intended for the information and guidance of all parties involved in the transport chain: shipbuilders, shipowners, shipmasters, port authorities, shippers, forwarding agents, road hauliers, stevedores, cargo unit and vehicle manufacturers, insurers, railway operators, and packers of containers at inland depots.

With respect to shipowners and shipbuilders, the recommendations cover matters such as the number, location and strength of securing points, the provision of securing equipment and the preparation of the *Cargo Securing Manual* (see *Resolution A.489(XII)* above).

The recommendations for shipmasters highlight the importance of ensuring that decks and cargo units are in a satisfactory condition, that the securing gear on board the vessel is adequate and properly maintained, that both cargo units and the cargoes within are adequately stowed and secured, and that cargo spaces and securing arrangements are regularly inspected throughout the voyage.

Shippers, forwarding agents, road hauliers, stevedores and, where appropriate, port authorities are advised to ensure that the significant forces likely to be encountered during the voyage are properly taken into account when determining the suitability of cargo units, the adequacy of their securing points and the methods used to secure cargo within cargo units or vehicles. The need to ensure that a cargo unit or vehicle is clearly marked and that there is proper documentation indicating its gross weight and any necessary safety precautions, is also highlighted.

Resolution A.581(14), adopted on 20 November 1985, contains guidelines for the securing of road vehicles on ro-ro ships. The guidelines are intended to apply to ro-ro vessels which regularly carry road vehicles on either long or short international voyages in unsheltered waters.

The guidelines are aimed at shipowners and shipyards involved in designing and constructing ro-ro ships and at manufacturers, owners and operators of road vehicles which may be transported on such vessels. The term *road vehicle* encompasses all vehicles primarily intended for the carriage of goods, from 3.5 to 45 tonnes maximum permissible weight, and any type of trailer (semi-trailer or draw-bar design).

The guidelines cover matters such as:

- the provision of a *Cargo Securing Manual* (see also *Resolution A.489(XII)* above);
- the number, location and strength of securing points on both ship's decks and road vehicles;
- the design and strength of lashings used for securing vehicles and the manner in which they should be attached;
- the procedures which should be followed to ensure that road vehicles are safely and securely stowed, taking account of the particular characteristics of both the vehicle and the ship, the length of the voyage and the predominant weather conditions.

Resolution A.854(20) of 27 November 1997 is concerned with the INF Code (see 14.4 above) and provides guidelines for developing shipboard emergency plans for ships carrying materials subject to the INF Code. The objective is to assist shipowners preparing plans for carrying INF materials and to assist responders to emergencies by providing information.

In addition to the above resolutions, the Appendix to the Supplement contains two circulars issued by the IMO Maritime Safety Committee.

MSC/Circ.385 of 8 January 1985 is concerned with the Cargo Securing Manual recommended under *Resolution A.489(XII)* (see above). The circular aims to ensure a uniform approach to the preparation, layout and content of such manuals.

The manual should provide: details of fixed securing arrangements and their locations; an inventory of portable securing equipment and details of its location and stowage; examples of correct application procedures for portable securing gear on different types of cargo units, vehicles etc.; and an indication of the various transverse, longitudinal and vertical forces to which cargo is likely to be subjected in different parts of the ship.

MSC/Circ.506/Rev.1 of 10 January 1990 is concerned with the provision of container packing certificates/vehicle packing declarations. It highlights the dangers that can arise when such a certificate/declaration is not issued and, as a consequence, the cargo unit is not placarded to indicate the danger(s) of its contents. The circular emphasizes the threat to safety that unmarked cargo units can pose on board ships, during inland transport movements and at container terminals and ports.

IMO Member Governments are urged to ensure that their national legislation requires container packing certificates/vehicle packing declarations to be provided by the packer of the cargo unit.

FAL.2/Circ.51 of 15 March 1999 supplements the information in part 5 of the Code (part 11 of this Compendium). Ships' masters need summaries of the information contained in the dangerous goods transport document and SOLAS and MARPOL require the ship to have a manifest of dangerous goods. This resolution provides a suggested format.

Part 15: Recommendations on the Safe Transport of Dangerous Cargoes and Related Activities in Port Areas

15.1 Introduction

The port area is the interface between modes of transport; it is where cargoes are placed on board ship or removed. These movements may involve straightforward transfers on/off a ship of a truck or rail wagon and its cargo, or at the other extreme the removal of cargo from a ship's hold and its loading onto a truck.

Irrespective of the nature of the operation, the port has to store a range of cargoes on a temporary basis. In the case of dangerous goods this may involve a number of different classes. The storage period may be as short as a few minutes or up to several days pending the arrival of the vessel or even longer if there are warehouses in the port area.

This short storage of dangerous goods can present a range of problems – ports are not only an interface for dangerous goods but also for general freight and very often passengers. This means that dangerous goods entering port areas must be subject to some control to protect everyone in the port.

To assist ports with this interface the IMO have published "Recommendations on the Safe Transport of Dangerous Cargoes and Related Activities in Port Areas". These Recommendations provide advice to countries on how to address the problems which arise when dangerous cargoes are transiting port areas. The Recommendations have been aligned as far as possible with the requirements of the IMDG Code.

The recommendations include a number of definitions including *"cargo interests"*, a term which does not appear in the IMDG Code itself. *Cargo interests* are those people or companies who are involved in classification, packaging, marking, labelling and documentation. They might include a shipper, carrier, forwarder or consolidator.

15.2 Warehouses, terminal areas and infrastructure

Port areas have to be defined: they usually extend beyond the docks and jetties where ships tie up. They often cover large areas of land, some parts of which may be utilized for activities not directly associated with the port (e.g. factories and chemical plants). Some parts of factories or plants may be within the port area whilst others may not.

Having defined the port area subject to control, the authority must decide the effect of allowing access for dangerous goods. To decide this, they will take into account matters such as the main activities of the port, its accessibility in the event of an emergency and the surrounding population. For example, some ports which can only be accessed through populated areas or which are located within a heavily populated area may restrict or prohibit explosives and other substances which have an explosive potential; alternatively, they may limit the quantity permitted within the port at any one time.

Where possible there should be designated areas for the parking/stowage of transport units containing dangerous goods.

15.3 Responsibility and training

The port authority will make bye-laws to deal with all aspects of the port operation, including specific rules concerning dangerous goods. The bye-laws or regulations will define specific responsibilities for the port, berth operators, cargo interests and ship operators.

Responsibilities will cover the control of ships in the harbour area and the control of incoming and outgoing ships, vehicles and rail wagons carrying dangerous goods.

For example, port authorities must be given prior notification of the impending arrival of dangerous goods, whether by road or rail from an inland location or by sea. Notifications must be provided in writing (e.g. by fax or e-mail). The port regulations will define the period of notice. In some ports it might be at least 24 hours, but it could be as short as a few minutes. Prior knowledge of the arrival of dangerous goods is essential: it enables the port authorities to determine how the goods should be handled (e.g. whether the vehicle concerned can safely be parked near other vehicles or whether it should be taken straight onto the vessel). A port operation is complex and for reasons of general safety and smooth operation the authorities need to know what is arriving and when.

In line with the above notification requirements, berth operators must ensure that they have procedures in place to handle and move the goods safely when they arrive. This will involve the carrying out of risk assessments and the establishment of emergency plans to deal with incidents.

The Recommendations require that personnel working in the port area should have relevant training in their responsibilities. Such training should include: dangerous goods general awareness/familiarization training, safety training and function-specific training.

15.4 General recommendations

The port authority, along with the regulators, must ensure they have in place a regulatory regime that will deal with all eventualities. In this respect the guide offers outline solutions on controlling dangerous goods in port areas.

Port authorities, along with regulatory authorities, should set down in their regulations:

- details of the dangerous goods which they will accept and the quantities – with the exception of classes 1, 6.2 and 7 there are no detailed recommendations;
- an overriding authority to prohibit or remove dangerous goods. In this respect a system of adequate communications is required along with defined areas for the loading and offloading of dangerous cargo;
- the period of notification which they require before the arrival of dangerous goods at the port;
- powers to direct where a ship should berth for dangerous goods;
- outline emergency procedures including the maintenance of safety equipment. There should be procedures to be followed in relation to fire prevention and hot work. There should be a system for reporting incidents.

The port controls are not only applicable to the person on the berth. They are also to be applied to the master of the ship, the crew and other cargo interests.

The master is required to have a suitable watch scheme whilst dangerous goods are on board and there must be suitable emergency procedures in place including firefighting.

Cargo interests must ensure they provide the correct documentation and they must ensure that the dangerous cargoes are properly classified, identified, packaged and labelled where necessary.

Specific recommendations for certain dangerous cargoes

15.5 Packaged dangerous goods

Ships built after 1 September 1984 must have a document of compliance and this will define the types of dangerous goods that can be carried on deck and in each compartment. The master should appoint responsible persons to oversee the loading and unloading of the ship and the master should be in possession of documentation relating to the dangerous goods.

15.6 National port regulations

Most ports have been in existence for hundreds of years. They may not always have been formal docks but natural harbours. The recommendations described above represent a set of principles which can be adopted by a government or a port authority which is writing or rewriting their ort regulations. Many ports have had regulations for a long time and they may have different rules until IMO Recommendations are adopted.

Students should investigate the rules for their own local ports.

Part 16: Updating the IMDG Code

16.1 Introduction

The 2000 edition of the IMDG Code was the first to be produced in two volumes. This was the first major revision since its first publication in 1965. Most of the editions had been in loose-leaf format and at least three and usually four or five volumes. In 1995/96 the UN Committee of Experts decided, recognizing that transport was multimodal, that their recommendations should be made into a "model regulation" for modal agencies and national governments to adopt into international or national law. IMO was asked to align its rules with the UN structure.

This monumental task took five years, but it now means that many users, particularly the chemical producers, can easily compare the requirements of land, sea and air transport. The European land regulations have been aligned and the air rules are largely aligned.

The Code is normally amended at two-year intervals and an edition is expected to be published in 2004 for implementation in 2005. This will be a replacement book.

16.2 Reasons for updating the IMDG Code

The Code needs to be updated to take account of:

Industry's changes in technology
The provisions of the Code need to reflect technological advances (e.g. new types of ships and handling methods); the "invention" by the chemical industry of new chemicals and mixtures which require classification to determine whether they can be carried safely; the development of new packaging methods.

Regulators' needs
Governments are required to enforce the Code. From time to time they may find that certain parts of the Code cannot be enforced. Occasionally there are accidents and incidents which lead to a need to change the provisions of the Code.

Developments in other modal regulations
Chemicals rarely move from a chemical plant to a ship without moving on other modes of transport (e.g. road, rail or air). The distribution of goods is a complex process and it is essential that the various modal rules should, as far as is practicable, be harmonized. Amendments to the Code therefore need to reflect changes to the ADR/RID and ICAO rules.

UN Committee of Experts on the Transport of Dangerous Goods
At the beginning of the Compendium it was explained that the UN would now normally consider issues concerning classification, packaging, marking and labelling **before** the modes. The UN have decided at present to make amendments at two-year intervals; to ensure that IMO remains aligned, IMO has to keep to these intervals.

16.3 IMDG Code amendments

IMO usually publishes amendments to the Code about three months before they are due to take effect. The amendment process takes two years through the IMO Committee structure. Industry can normally obtain information from national governments or trade associations on the main changes under consideration long before the text is published. There are a number of magazines which deal with shipping, cargo handling and dangerous goods, all of which report the changes that are likely to take place. Regular users of the Code should use as many of these sources as possible to ensure that they remain up to date.

Like many technical and complex documents it is often the case that errors and omissions are identified within the text and IMO issues errata sheets. Users of the Code should watch through the trade press and trade associations for notices of correction.

16.4 The importance of keeping up to date

Using out-of-date versions of the IMDG Code can in extreme cases be a dangerous practice. It is more likely, however, that goods will not be moved. If there is a discrepancy between what the shipper has said about his consignment and what the current version of the Code says, the agent and shipping line will not move the goods.

Students would be advised to note that the Code is normally updated at two-year intervals.

Normally the change is on 1 January of each year but there is often agreement that there should be a six-month transitional period during which either the old version or the new can be used. National governments occasionally set implementation dates in advance of those set by IMO but generally they are later, particularly where there is a need to translate the book into a national language.

Like all legislation, it can be difficult to keep up to date with all the changes. Trade associations, specialist magazines and attendance at training courses can help make personnel aware of current developments.

16.5 The new-format IMDG Code

For 2005, the main amendments are likely to be based on the 13th edition of the UN Recommendations. Changes expected to be completed in the biennium ending in December 2002 will include:

- criteria for environmentally hazardous substances which should help clarify many of the problems with the current MARPOL rules and the conflict with other modal regulations, particularly RID and ADR;
- new rules for cryogenic gases;
- transport of dangerous substances in bulk.

Readers wishing to know about future amendments through the UN can interrogate their web site at www.unece.org/trans/danger/danger.htm.