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**MODEL
COURSE
1.37**

**CHEMICAL TANKER
CARGO AND BALLAST
HANDLING
SIMULATOR**

2007 Edition



MODEL COURSE 1.37 – CHEMICAL TANKER CARGO AND BALLAST HANDLING SIMULATOR

IMO T137E



Sales number: T137E

MODEL COURSE 1.37

Chemical tanker cargo and ballast handling simulator

2007 Edition



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Foreword

Since its inception, the International Maritime Organization (IMO) 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 maritime training facilities at national and regional levels. IMO has also responded to the needs of developing countries for postgraduate training for senior personnel in administrations, ports, shipping companies and maritime training institutes by establishing the World Maritime University in Malmö, Sweden, in 1983.

Following the adoption of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978, a number of IMO Member Governments suggested that 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 implementation of associated Conference and IMO Assembly resolutions.

In addition, it was appreciated that a comprehensive set of short model 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. With the generous assistance of the Government of Norway, IMO developed model courses in response to these generally identified needs and now keeps them updated through a regular revision process, taking into account any amendments to the requirements prescribed in IMO instruments and any technological developments in the field.

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

E. E. MITROPOULOS
Secretary General

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Introduction

■ Purpose of the 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 audio-visual 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 outline and detailed syllabus, taking into account the information provided under the entry standards specified in the course frame-work. The actual level of knowledge and skills and 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 objectives specified.

Within the course outline, Part B, the course designers have indicated their assessment of the time which should be allotted to each subject area. However, it must be appreciated that these allocations are arbitrary and assume that the trainees have fully met all the entry requirements of the course. The instructor should therefore review these assessments and may need to reallocate 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. An example of a lesson plan is included in the instructor manual in most model courses, but in this course, the exercise scenarios supplied as an appendix to the instructor manual serve this purpose. 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.

■ Evaluation or assessment of trainee progress

The nature of this course involves all the trainees and the instructors in an ongoing process of individual and group evaluation.

■ 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 and
- 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. A copy of this booklet is included as an appendix to this course.

Part A: Course Framework

■ Scope

The course is essentially a practical one and consists of a series of exercises structured around the operation of the cargo and ballast installation of a chemical tanker and carried out in conjunction with a simulator.

The exercises are controlled by an instructor and, initially, allow the trainees to become familiar with the layout of the cargo, ballast and deck tanks forming the system and the instrumentation and controls that are used.

The exercises continue with the simulation of the normal procedures and operations for the loading and discharging of cargo, the use of inert gas, ballasting and deballasting, tank cleaning, gas freeing, and, where the simulator design incorporates it, U-piece, Y-piece and jumper connections.

The importance of loading and discharging so as to avoid undue stressing of the hull are introduced at appropriate points of the simulator programme.

Each simulator exercise is preceded by a briefing lecture and followed up by a group discussion during which the actions and decisions of the trainees are analysed.

During the series of exercises the trainees will assume specific roles in the cargo or other operation that is being simulated, with one trainee taking the role of the officer in charge of the particular operation being simulated.

Note: Officers and ratings who are to serve aboard chemical tankers are required by paragraphs 1 and 2 of Regulation V/1 of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (as amended in 1995) to have appropriate experience aboard operational chemical tankers and to have completed approved shore-based specialized training related to chemical tanker operations.

It is not claimed that this course, using simulation of chemical tanker cargo and ballast operations, meets the requirements of paragraphs 1 and 2 of Regulation V/1 of STCW 1978 (as amended in 1995) in respect of service aboard ship and shore-based training.

The IMO Model Courses 1.01 and 1.04 have been designed to meet the requirement of Regulation V/1 of STCW 1978, as amended in 1995 in respect of shore-based training; this course, using simulation, would provide them with relevant support and enhanced learning.

■ Objective

The trainees who successfully complete the course will make a safer and more effective contribution to the operation and control of the cargo and ballast installation of a chemical tanker, which will improve ship safety and provide greater protection of the environment.

In particular, there will be:

- familiarization with the equipment, instrumentation and controls used for cargo handling on a chemical tanker
- a greater awareness of the need for proper pre-planning, the use of checklists and the time scales involved in the various cargo handling operations
- an enhanced awareness to apply proper and safe procedures at all times when carrying out the various operations on board a chemical tanker
- an acquisition of experience in identifying operational problems and solving them
- an improvement in the ability to make decisions which promote safety and protect the environment.

■ **Entry standards**

Entry to the course is open to those already holding relevant cargo endorsements (STCW Reg V/1-2) who wish to improve their knowledge and understanding of the operation and control of cargo and ballast operations, and other related operations on chemical tankers. The course is not restricted to those certified under STCW Reg II and III. Irrespective of the tanker endorsement criteria applied by different flag states, the candidates are expected to have undertaken relevant specialized tanker training courses.

■ **Course certificate, diploma or document**

On successful completion of this course, a document should be issued confirming that the holder has completed a short course on chemical tanker cargo and ballast handling using a simulator. Administrations which approve such training as satisfying any part of the requirements of Regulation V/1 of STCW 1978 (as amended in 1995) should make an appropriate endorsement to the document.

■ **Course intake limitations**

The course intake is regulated by the number of trainees who can utilize the simulator for any given activity. For this reason the maximum number of trainees should normally be twelve. When circumstances demand it, the trainees can be split into two sub-groups of up to six in each group and activities be phased so that all students can receive the same period of training on the simulator.

The briefing and debriefing sessions can be carried out as main group or sub-group activities, according to circumstances.

■ Staff requirements

The instructor shall have appropriate training in instructional techniques and training methods (STCW Code, Section A-I/6). It is recommended that the instructor in charge of the course should hold a management level certificate of competency, and should have experience in the operation and control of cargo-handling operations on a chemical tanker, including the use of inert gas, cargo pumps and tank washing, with training and use of a simulator as a training aid. To operate the course successfully, at least one other instructor may be required, preferably with similar qualifications and experience as the instructor-in-charge.

■ Teaching facilities and equipment

The cargo-handling system being simulated by the training installation should be modelled on an authentic cargo-handling system of a modern chemical tanker, including its equipment, instrumentation and centralized cargo operations control centre, taking into account national, international and other requirements relating to safety and pollution prevention.

The simulator complex should comprise of a “deck pipeline area”, “cargo control room”, an “instructor unit”, and a space for briefing and debriefing, with tables and chairs, a blackboard and, where such audio-visual aids are to be used, an overhead projector.

The simulator unit should be based on a general-purpose computer system with real-time operating programs connected to the deck pipelines, cargo control centre and the instructor unit. Information print-out machines and visual display units should be incorporated into the system for trainees and instructors.

The cargo control centre should contain a number of consoles covering the cargo and related systems, each with its own mimic diagram showing the system layout. The consoles will cover pumps, valves, instrumentation, communication, alarms, etc. Various operations such as loading, discharging, ballasting, inert gas, cargo tank inerting and cleaning, cooling down, purging cargo tanks etc. will be set up and controlled from the centre.

The instructor unit should, preferably, be separate from the control centre and fitted with a window for observing and monitoring the trainee activity and progress.

The instructor unit will have an appropriate console for monitoring the various processes and operations being simulated, and be capable of introducing commands and specific malfunctions in accordance with the training programme.

Outline sketches on figures D1 and 3 of the instructor manual show the arrangement of a cargo-handling simulator installation and the tank arrangement of a chemical tanker.

■ Teaching Aids (A)

A1 Instructor manual and its appendix (Part D of the course)

A2 Liquid Cargo Handling Simulator (CHEMICAL)

A3 Videos

Chemical Tanker Operations Part 1: Cargoes, ships and legislation (Code No. 329.1)

Chemical Tanker Operations Part 2: Prevention of pollution
(Catalogue Code No. 329.2)

Permit to Work (Catalogue Code No. 621)

Available from: Videotel Marine International Ltd.
84 Newman Street
London W1P 3LD, UK
Tel: +44 171 299 1800
Fax: +44 171 299 1818
e-mail: mail@videotelmail.com
URL: www.videotel.co.uk

A4 CBT Modules

CD # 7 Inert Gas Generator
CD # 39 Chemical Tanker Training System
CD # 93 Wall Wash
CD # 96 Cargo Compatibility

Available from: Seagull AS
Gamleveien 36, PO Box 1062
N-3194 Horten, Norway
Tel: +47 33 047930
Fax: +47 33 046279
e-mail: seagull@sgull.com
URL: www.sgull.com

A5 Database

Miracle Tank Cleaning Database

Available from: ChemServe GmbH
Kiebitzberg 20
D 21394 Kirchgellersen
Germany
Tel: +49 4135 808630
Fax: +49 4135 808631
e-mail: info@chemserve-marine.com

■ IMO References (R)

- R1 International Convention for the Safety of Life at Sea, 1974 (SOLAS 1974) Consolidated Edition 1997 (IMO – 110)
- R2 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978/1995 (IMO – 938)
- R3 Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (BCH Code), as amended (IMO – 772)
- R4 International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code), as amended (IMO – 100)
- R5 Medical First Aid Guide for Use in Accidents involving dangerous goods (MFAG), as amended (IMO – 251)
- R6 MARPOL 73/78 (Consolidated edition, as amended) (IMO – 520)
- R7 IMO Model Course – 1.04 – Specialized Training for Chemical Tankers

■ Textbooks (T)

- T1 ICS, Tanker Safety Guide (Chemicals), (London, Witherby Marine Publishing, 1974) (ISBN 0-948691-50-6)
- T2 Tank Cleaning Guide. 4th ed. (Rotterdam, B.W. Chemical Laboratory “Dr. A. Verwey”, 1988)
- T3 U.S. Coast Guard, Chemical/Data Guide for Bulk Shipment by Water (Washington, D.C., U.S. Government Printing Officer, 1991)

■ Bibliography (B)

- B1 ICS/OCIMF/IAPH, International Safety Guide for Oil Tankers and Terminals. 5th ed. (London, Witherby Marine Publishing, 1996) (ISBN 0-948691062-X)
- B2 M. Grey (ed.), Chemical/Parcel Tankers. 3rd ed. (London, Fairplay Publications Ltd, 1984) (ISBN 0-905045-67-X) [Out of print 1999]
- B3 B. Bengtsson, Sea Transport of Liquid Chemicals in Bulk. 3rd ed. (Ockero, Sweden, B. Bengtsson and AB Inmar, 1982) (ISBN 91-970090-0-8)
- B4 ICS/OCIMF/IAPH/INTERTANKO/CEFIC/SIGTTO, Ship/Shore Safety Check List Guidelines. 1st ed. (London, Witherby Marine Publishing, 1982) (ISBN 0-854930-28-0)
- B5 ICS/OCIMF, Ship to Ship Transfer Guide (Petroleum), 3rd ed. (London, Witherby & co Ltd., 1997) (ISBN 0-948691-49-2)
- B6 N. I. Sax and R. J. Lewis, Sr., Hawley’s Condensed Chemical Dictionary. 11th ed. (New York Van Nostrand Reinhold, 1987) (ISBN 0-442-28097-1)
- B7 Bureau VERITAS. Gas and Chemical Ships Safety Handbook. 1st ed. (London, Lloyd’s of London Press Ltd., 1986) (ISBN 1-85044-089-1)
- B8 Drager – Tube Handbook. 11th ed. (Drager Sicherheitstechnik GmbH, Revalstrasse 1, D-23560 Lubeck, Germany 1998) (ISBN 3-926762-06-3)
- B9 ICS, Safety in Chemical Tanker (International Chamber of Shipping, London, 1977)
- B10 U.S. Coast Guard, CHRIS Manual 2, Hazardous Chemical Data. (Washington D.C., U.S. Government Printing Office)
- B11 CFR title 46, Volume 5 part 150, US Government Printing Office, via GPO Access (<http://www.access.gpo.gov/nara/cfr/>)

Part B: Course Outline and Timetable

Course Outline

Subject Area	Approximate Time (Hours)	
	Lecture/ Discussion	Practical
1 Familiarization 1.1 Type of ship (chemical) 1.2 Type of tanks 1.3 Tank arrangement (general) 1.4 Pipeline arrangement 1.5 Pipe system control valves, ESDS 1.6 Pumps 1.7 Instrumentation 1.8 Controls 1.9 Basic operations and procedures	1.5	4.5
2 Special operations and procedures 2.1 Tank atmosphere evaluation 2.2 Use of inert gas/nitrogen etc. 2.3 Cleaning of cargo tanks depending on next cargo types, compatibility 2.4 Gas freeing 2.5 Steaming of tanks (deodorization) 2.6 Tank cleaning in various atmospheres 2.7 Tank cleaning with chemicals	3	3
3 Ballast operations 3.1 General provisions 3.2 Ballasting 3.3 Deballasting	1	3
4 Cargo operations 4.1 General provisions (cargo planning, cargo and slop discharge programme, CDP and SDP) 4.2 Loading (pre-wash operation) 4.3 Discharging (pre-wash operation) 4.4 Cargo conditioning	1.5	8.5
5 Operational problems/difficulties 5.1 Cargo and related operations – normal working 5.2 Introduction of system faults, malfunctions, accidents 5.3 Remedial actions	1	3
SUBTOTAL	8	22
TOTAL	30	

Course Timetable

Period/day	Day 1	Day 2	Day 3	Day 4	Day 5
1st Period (1.5 hours)	1. Familiarization 1.1 Type of ship (chemical) 1.2 Type of tanks 1.3 Tank arrangement 1.4 Pipeline arrangement	2. Special operations and procedures 2.1 Tank atmosphere evaluation	3. Ballast operations 3.1 General provisions	4.1 General provisions (cargo planning) (cont.)	4.3 Discharging cargo (cont.)
Break					
2nd Period (1.5 hours)	1.5 Pipe system control valves, ESDs 1.6 Pumps	2.2 Use of inert gas 2.3 Cleaning of cargo tanks	3.1 General provisions (cont.) 3.2 Ballasting 3.3 Deballasting	4.2 Loading cargo	4.4 Cargo conditioning 5. Operational problems/difficulties 5.1 Cargo and related operations – normal working
Lunch break					
3rd Period (1.5 hours)	1.7 Instrumentation 1.8 Controls	2.4 Gas freeing 2.5 Steaming of cargo tanks (deodorization)	4. Cargo operations	4.2 Loading cargo (cont.)	5.2 Introduction of system faults, malfunctions, accidents
Break					
4th Period (1.5 hours)	1.9 Basic operations and procedures	2.6 Tank cleaning in various atmospheres 2.7 Tank cleaning with chemicals	4.1 General provisions (cargo planning)	4.3 Discharging cargo	5.3 Remedial actions

Note: Teaching staff should note that timetables are suggestions only as regards sequence and length of time allocated to each objective. These factors may be adapted by instructors to suit individual groups of trainees depending on their experience, ability and equipment and staff available for training.

Part C: Detailed Teaching Syllabus

The detailed teaching syllabus indicates the contents of the course and appropriate references and teaching aids.

■ Learning objectives

The detailed teaching syllabus has been written in learning objective format in which the objective describes what the trainee must do to demonstrate that knowledge has been transferred. This format is an appropriate teaching and assessment tool to express:

- The depth of understanding of a subject and the degree of familiarization with a subject on the part of the trainee.
- What capabilities the trainee should really have and be able to demonstrate.

Every instructor is encouraged to teach learning in an “objective-related” way instead of “material-related”. In this context, all objectives are understood to be prefixed by the words, “The expected learning outcome is that the trainee is able to...”.

To indicate the degree of learning outcome of this course, the learning objectives for the Detailed Teaching Syllabus can be classified in three “dimensions”:

- C (cognitive)
- A (affective)
- P (psycho-motor)

Within a dimension, they are hierarchized by increasing complexity (C1 to C6, A1 to A5, and P1 to P5) where the complexity (depth, familiarization) is expressed (following B. Bloom and others) by a typical verb as follows:

Cognitive dimension of learning objectives:

C1	Knowledge	describe, outline
C2	Comprehension	explain
C3	Application	apply, perform, operate
C4	Analysis	analyse
C5	Synthesis	synthesize, construct, plan
C6	Evaluation	assess

Affective dimension of learning objectives:

A1	Reception; notice	recognize
A2	Response	respond
A3	Value	value
A4	Organization	organize
A5	Value characterization	accept, appreciate

Psycho-motor dimension of learning objectives:

P1	Imitation	imitate
P2	Manipulation	manipulate
P3	Precision	move, mark
P4	Co-ordination	co-ordinate (operations, menus)
P5	Naturalization	automate, internalize

■ References and teaching aids

In order to assist the instructor, references are shown against the learning objective to indicate IMO references and publications, bibliographies, textbooks and other references, as well as additional teaching aids which the instructor may wish to use when preparing course material. The material is listed in the course framework. The following notations and abbreviations are used:

R	IMO reference
T	Textbook and other references
B	Bibliography
A	Teaching aid
Ap.	Appendix
An.	Annex
Ch.	Chapter
p.	Page
Para.	Paragraph
Sc.	Section

The following are examples of the use of references:

“R2” refers to International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978/1995;

“B1” refers to ICS/OCIMF/IAPH International Safety Guide for Oil Tankers and Terminals; and

“A1” refers to the instructor manual in Part D of this model course.

■ Instructor manual

The instructor manual (Part D) is included to provide additional information to instructors. It is designed to help further in structuring and organizing a specific course. The instructor is recommended to gain additional technical material from simulators' suppliers. Suppliers of simulators are also good sources of technical information.

The instructor should take pains to present the material within “a-use-at-sea” context. It is not just a matter of imparting technical knowledge.

Note

Throughout the course, safe working practices are to be clearly defined and emphasized with reference to current international requirements and regulations.

It is expected that the national institution implementing the course will insert references to national requirements and regulations as necessary.

■ Competence

The competence required by candidates may be expressed in terms of the Conventions as follows.

Plan and ensure safe loading, care during the voyage and unloading of chemical cargoes:

- Safely and efficiently perform the carriage of chemical cargo
- Control trim, stability and stress
- Monitor and control compliance with legislative requirements and measures to ensure safety of life and protection of the marine environment.

■ Training outcome (as stated in Table A-II/2)

The standard of knowledge, understanding and proficiency associated with the above competences is therefore considered to be tabulated below.

- Demonstrate knowledge of and ability to apply relevant international regulations, codes and standards concerning the safe handling and transport of chemical cargoes
- Plan and execute chemical tanker loading and unloading operations
- Demonstrate a practical knowledge of chemical tankers and chemical tanker operations
- Demonstrate knowledge of the carriage of methane, the precautions during loading and unloading and care during the voyage
- Demonstrate an understanding of the factors affecting trim, stability and stress as applicable to chemical tankers
- Demonstrate knowledge of and ability to monitor and control cargo and ballast operations in compliance with the relevant legislative requirements and measures to ensure the safety of chemical tanker personnel, cargo (chemical) and protection of the marine environment with especial regard to:
 - responsibilities under the requirements of the International Convention for Safety of Life at Sea/IBC Code
 - responsibilities under the International Convention for the prevention of Pollution from ships as applicable to Chemical tankers; and
 - responsibilities/recommendations under the Chemical tanker “industry best practices”

■ Detailed Teaching Syllabus

All objectives are understood to be prefixed by the words “The expected learning outcome is that the trainee is able to”.

Knowledge, understanding and proficiency	IMO Reference	Textbooks, Bibliography	Teaching Aid
1 Familiarization (6 hours) 1.1 Type of Chemical Tanker describe tank arrangement of the simulated chemical tanker 1.2 List tanks as: .1 cargo tanks .2 ballast tanks .3 heeling tanks 1.3 Show the tank arrangement on a simple line diagram .1 describe the features of a chemical tanker 1.4 Pipeline arrangement .1 show the pipelines of the simulated system on a simple line diagram .2 compare the line diagram with the simulated mimic diagram 1.5 Pipe system control valves .1 show on the line diagram developed for 1.4 the control valves and states their function .2 describe the control valves used in the systems and explains how they function 1.6 Pumps .1 list the pumps used in the system in terms of: .1.1 centrifugal submerged pumps .1.2 screw displacement pumps .1.3 reciprocating pumps .1.4 deep-well pumps .1.5 describes in simple terms, using line sketches where appropriate, the operation of cargo pumps used in the system	R2	B1, B2, B7, B9	A3 A2 A2 A2 A2 A1, A2

Knowledge, understanding and proficiency	IMO Reference	Textbooks, Bibliography	Teaching Aid
2 Special operations and procedures (6 hours) 2.1 Tank atmosphere evaluation .1 state those operations such as loading and discharging cargo, tank washing and cleaning are hazardous because of the danger of fire, explosion, reactivity, corrosivity, toxicity .2 state that for reasons of safety the tank atmosphere should be maintained in a non-explosive condition .3 state that this may be an inert atmosphere or, alternately, one which is too lean or too rich for an explosion to take place .4 state that a mixture of chemical vapours and air will only burn, or explode, if the concentration of gas is within the flammable range .5 define: .5.1 lower flammable limit (LFL) .5.2 upper flammable limit (UFL) .6 state flammable range of chemical cargoes may be more than those of oil cargoes .7 state that all flammable cargo, ballast and tank washing operations in cargo tanks should take place in an inert atmosphere .8 state that if inert gas is not available, tank washing with water can take place provided the tank atmosphere has been made safe against explosion and that: .8.1 this could be done by washing tanks in a too-lean, uncontrolled or a too rich atmosphere .8.2 it is difficult to maintain a too-rich atmosphere and is not recommended .8.3 if the ship is so equipped, tank washing should be done in an inert atmosphere .9 explain that the ship's safety management system (SMS) requires special procedures to be followed if entering enclosed space .10 state that no one should enter a cargo tank unless their entry is sanctioned by a responsible officer .11 state that personnel should only enter empty tanks when they have been "gas free" and the atmosphere in the tank has been verified for: .11.1 O ₂ content .11.2 flammable vapour .11.3 toxic vapour .12 state those portable gas analysers are used to ensure that the tank atmosphere has been properly gas freed .13 state that the gas analysers are usually of three categories: .13.1 oxygen meters .13.2 combustible gas indicators or non-combustible gas indicators .13.3 chemical absorption tubes	R1	T1, T3, B1 B8	A3

Knowledge, understanding and proficiency	IMO Reference	Textbooks, Bibliography	Teaching Aid
.14 state that fixed oxygen analysers are used to monitor the oxygen content in the inert gas supply to the tanks .15 use the simulator to measure the oxygen in the tanks 2.2 Use of inert gas .1 define Inert Gas, and .2 list the conditions when I.G is used in cargo tanks: .2.1 to protect cargo from polymerization, oxidation and humidity .2.2 to replace air to prevent fire and explosion .2.3 incombustible (various metallic salts) .3 describe methods of production and supply of inert gas on Chemical Tanker .4 explain why N₂ is used instead of inert gas .5 set (prepare) the simulator system to produce inert gas and supply it according to the plan of operation .6 maintain a record (log) of the operation 2.3 Cleaning of cargo tanks .1 state tank cleaning can be done concurrently with cargo operation .2 state tank cleaning of chemical tanks has to be pre-planned .3 explain tank cleaning requires adequate shore reception facility for tank washing as per MARPOL ANNEX II rules and regulations .4 state for tank cleaning operation involving NLS, ships. Procedure and Arrangement Procedure and Arrangement (PA) manuals must be consulted .5 list the factors in planning of a tank cleaning programme: .5.1 last product .5.2 next product .5.3 reception facility and local regulations .5.4 environmental aspects .6 explain draining procedures .7 explain tank cleaning procedures – prewash, main wash, fresh water wash, spot wash, gas freeing, inspection/testing 2.4 Gas freeing and ventilation .1 state removal residues simplify tank cleaning .2 vapours released may pose dangers to human health and may be objected by port .3 describe ship ventilation systems .4 explain gas freeing equipment .5 fixed fans .6 portable fans .7 ejectors	R1 R6, R7 R3, R4	T1 T1, T2 T3 T1, B7 B10	A4 A1, A2, A4, A5 A2

Knowledge, understanding and proficiency	IMO Reference	Textbooks, Bibliography	Teaching Aid
.8 wind sails .9 explain ventilation and gas freeing depends on the weight of cargo and the shape of tanks .10 state verifying the tanks condition is done by checking the tank atmosphere 2.5 Steaming of tanks .1 state that steam should be introduced into the tank only after gas freeing the tanks .2 state that steaming may be done for loading next cargo which is odour sensitive to the last cargo .3 state that steaming may not be permitted in some coated tanks 2.6 Tank cleaning in various atmospheres .1 state tank cleaning may be carried out in the following atmospheres: .1.1 undefined .1.2 too rich .1.3 too lean .1.4 inerted .2 explain the different atmospheres .3 state the precaution for tank cleaning in port and at sea 2.7 Tank cleaning with chemicals .1 demonstrate the use of tank cleaning guide .2 explain the making of a tank cleaning plan using a tank cleaning guide .3 state chemical tank cleaning requirements depend on: .3.1 last cargo .3.2 next cargo .3.3 tank coating requirements .7 state use of chemicals in tank cleaning may require additional safety precautions to be taken 3 Ballast operations (4 hours) 3.1 General provisions .1 state that ballast operation will be governed by national, international and other appropriate rules and regulations in order to prevent marine pollution .2 use procedures at all times which promote safety and protect the environment .2.1 state that on a chemical tanker ballast is required during and after loading/unloading of cargo for: .2.1.1 maintaining the ship in the correct trim for discharge, draining and stripping	R3, R4 R1, R7 R6 R6, R7	T1, T2 T1, T2 B7 T1, T2	A4 A2, A4 A1 A1, A2, A3 A2, A3

Knowledge, understanding and proficiency	IMO Reference	Textbooks, Bibliography	Teaching Aid
.2.1.2 establishing the required displacement and trim for manoeuvring and making a sea voyage .2.2 state that ballast/deballast of cargo tanks after NLS carriage should be done in accordance with the ship's P and A manual, thereby ensuring compliance with Annex II Marpol 73/78 .3 state that segregated ballast tanks may not be used for cargo .4 state that ballast carried in cargo tanks will be contaminated with cargo residues .5 state that responsible officer to monitor distribution of cargo and ballast to ensure that at no time there is excessive stress on the ship's hull .6 explain U and L ballast tank can create stability problem .7 state compliance of local regulations to be followed with ballasting/deballasting .8 ballasting: .8.1 construct a checklist covering the ballasting operation .8.2 compile a ballast operation plan given the desired draught and trim for sea passage and taking into account: .8.3 the tanks to be used .8.4 the segregated ballast capacity .8.5 the stability of the ship .8.6 the induced stresses in the hull structure .8.7 the discharging programme .8.8 set (prepare) the simulator system and carry out the operation .8.9 maintain a record (log) of the operation 3.2 Deballasting .1 state that deballasting may be carried out at sea prior to loading cargo and during loading operations .2 constructs a plan for the deballasting operation, given the trim conditions needed for draining and taking into account: .2.1 the tanks containing ballast .2.2 the segregated ballast capacity .2.3 the stability of the ship .2.4 induced stresses in the hull .2.5 the loading programme .3 set (prepare) the simulator system and carry out the operation, applying strict measures and control to prevent pollution .4 maintain a record (log) of the operation			A2

Knowledge, understanding and proficiency	IMO Reference	Textbooks, Bibliography	Teaching Aid
4.3 Unloading .1 plan the unloading of different parcels using a checklist .2 list the function test of all equipment to be carried out .3 explain how drying or inerting requirement for the tank atmosphere are to be dealt with .4 explain need for sampling during unloading: – sample taken prior unloading – sample taken at manifold at unloading .5 state cargo with high vapour pressure may necessitate tank pressurizing .6 state some pumping systems have special stripping arrangements viz. the pump well has inert gas cofferdam for creating discharge head so as to avoid the necessity of pressurizing the tank .7 state requirements to monitor tank pressure so that it is always maintained within the relief valve settings .8 explain that unloading of Noxious Liquid Substances (NLS) shall be done in accordance with mandatory regulation pertaining to each pollution category as described in Annex II of MARPOL	R5, R6	T1, T3, B1, B4, B5	A2, A3
4.4 Cargo conditioning .1 state the term “conditioning” refers to: .1.1 maintaining cargo quantity without undue losses during transportation passage .1.2 maintaining cargo quality specification .1.3 maintaining cargo temperature as instructed .1.4 inerting, padding, drying conditions are maintained .2 explain transport requirement of veg. oils, animal oils, and fats	R7	T1, T3	A2
5 Operational problems (4 hours)			
5.1 Cargo and related operations – normal working .1 use the simulator system to obtain one or more operational situations as specified in the syllabus section 2, 3, or 4, to serve as a starting point for the introduction of faults, malfunctions or accidents .2 state examples of such operational situations as: .2.1 taking of heavy weather ballast in a cargo tank .2.2 examining valves in a cargo tank on ballast voyage .2.3 attaining the draught required for going along side on arrival .2.4 loading cargo tanks to 98% of capacity with different density cargoes .2.5 loading multiple tanks with a grade of cargo using single/twin manifold	R6	T1, T3	A2, A3

Knowledge, understanding and proficiency	IMO Reference	Textbooks, Bibliography	Teaching Aid
.2.6 pollution control .2.7 considerations of stability and hull stresses taking into account the effect of free surface .2.8 fire prevention .3 ship making a loaded voyage to a discharge port with all cargo tanks full of small cargo parcels taking into account: .3.1 after going alongside, all cargo is to be discharged .3.2 two cargo tanks are to be pre washed as per the requirements stated in the tank cleaning procedures of MARPOL Annex II .3.3 required draught and trim for draining and making a ballast voyage .3.4 pollution control – such as spill prevention measures .3.5 considerations of stability and hull deflection 5.2 Introduction of system faults, malfunctions, accidents .1 state that during cargo handling, ballasting and other associated operations, visual vigilance must be maintained, with instrument and meter readings being kept under constant scrutiny in order that any variation from the normal working conditions can be detected quickly .2 state that any deviation from the normal must be followed up to determine what is happening .3 state those considerations of safety and pollution prevention are paramount when normal becomes excessive 5.3 Remedial actions .1 with visual observation and/or instrument and meter readings indicating a deviation from normal operational conditions, action must be taken to: .1.1 identify what is happening as quickly as possible. Follow a logical reasoning process .1.2 bring the operational conditions back to normal by alteration of settings if this is possible .1.3 slow the operation down, or shut the operation down if a hazard involving safety and pollution is imminent .1.4 investigate the possible causes for the deviation from normal and take remedial action once the cause has been properly established	R6	T1	A2
		T1	A2

Part D: Instructor Manual

■ General

This manual reflects the views of the course designer on methodology and organization, and what is considered relevant and important in the light of his experience as an instructor. Although the guidance given should be of value initially, the course instructor should work out his own methods and ideas, refine and develop what is successful, and discard ideas and methods which are not effective.

Preparation and planning constitute a major contribution to effective presentation of the course.

■ Lectures

The main training components in the course are the practical exercises carried out under supervision on the simulated cargo-handling plant, an example of which is shown in Fig.1. However, before each exercise commences, a briefing and discussion on important aspects of the exercise has been found effective, and provision has been made for this in the course structure.

As far as is possible, the briefing for the exercise should use practical examples involving real shipboard equipment and systems, referring to diagrams, layout plans, technical drawings, photographs and other related technical documents to supplement and reinforce the briefing. A typical example of a chemical tanker is shown in Fig. 3.

A technique which has proved effective is to outline what is to be done and achieved by the exercise, then explain in detail those aspects which are felt to be important, and finally, to summarize the exercise, using key words and phrases.

There should always be a final discussion to make sure that each trainee understands the role he will play and what is to be done and achieved by the exercise.

A useful teaching aid during the briefing is an overhead projector; copies of the transparencies can be distributed to the trainees for reference purposes during the exercises.

■ Simulator exercises

The cargo-handling plant and systems used aboard merchant ships which transport chemical products can differ in their layout and in the types of machinery unit and associated system, so that the trainees will have varied knowledge and experience of such plant.

It is important, therefore, to use the briefing period to explain precisely which machinery units and systems are being simulated in the exercise, as well as their function, how they interact with each other and the role of the trainees during the exercise.

The trainees should be encouraged to co-operate with each other, working together as a team during the exercise, and to show the initiative and enthusiasm that will bring the exercise to a successful conclusion.

An important aspect of cargo and ballast handling is safety, and it is vital to ensure that safe practices are used throughout the exercise. Safety should be stressed during the briefing. One major contribution to safety is the use of checklists, which should be prepared beforehand, possibly as part of the briefing procedure.

During an exercise it is useful if one trainee assumes the role of officer-in-charge, with the responsibility of ensuring that the requirements and activities of the exercise are properly carried out. Role playing is an important element in the learning process, and with a number of trainees taking part in the exercises on the simulator, this aspect could provide a stimulus to the process of gaining knowledge and understanding. This could be performed with the officer in charge being located in the cargo control room and the watchkeeping officer on deck control, the two communicating with each other via intercoms or walkie talkies.

■ Preparing and conducting exercises

If further exercises are to be developed, or the ones supplied in the course modified, it is important that they should not be too complex; otherwise the trainees might have difficulties in carrying out their tasks and duties within an allotted period of time.

An exercise should start with simple activities, making use of uncomplicated components such as valves, pumps, fluid systems, tanks, etc., and move step by step into more complex activities.

The aim of the training programme is to use a step-by-step process to introduce the trainees to the range of activities associated with the operations of loading and discharging an oil cargo.

For this reason a number of activities termed “Special Operations and Procedures” have been grouped together to form section 2 of the syllabus.

Of course, on board ship these operations would not be carried out in isolation, because they are all linked to other operations.

However, initially it is beneficial to study such operations in isolation, so that what is taking place can be observed and studied without reference to some other activity.

When the course has progressed to section 4 of the syllabus, all activities dealt with in sections 1, 2, and 3 will be used in the simulated activity of loading and discharging a cargo of various chemical parcels.

The simulator is designed to provide training for normal operational procedures and for the input of abnormal or malfunction conditions. It is important that the trainees achieve a satisfactory level of competence under normal conditions before proceeding to abnormal operations due to the introduction of faults.

The exercises should provide the trainees with the most realistic impression of actually being in a cargo control centre aboard ship. Realism is important for this type of learning process. For this reason, if the simulator has an associated sound system, it should be used.

■ Exercise scenarios

The content of a scenario is governed to a large extent by the units and systems that are being simulated.

The syllabus used for the course has been structured to provide some flexibility in this respect, and the scenarios can be prepared using those syllabus elements which match a specific simulator design.

For this course, scenarios should be designed to cover the operational areas contained in the syllabus; for example:

- Familiarization
- Special operations and procedures
- Ballast operations
- Cargo operations
- Operational problems.

The familiarization scenarios should aim at making the trainees not only feel “at home” with the units and systems being simulated, but should also provide some “hands-on” experience with the controls and some of the more basic equipment and operations, such as valves, pumps, pipe systems, instrumentation, filling and emptying tanks, etc.

The operational scenarios should aim at providing experience in preparing and carrying out the various tasks and procedures that are involved with the safe transportation of liquefied chemicals in bulk.

The troubleshooting scenarios should be designed to provide experience in identifying malfunctions and faults, and applying remedial procedures. It should be noted that most simulator designs can introduce a large number of malfunctions and faults. In this course, the scenarios can only deal with a few faults because of time constraints. The course implementer is free to introduce additional faults if time allows, or to change the faults to comply with a particular simulator design.

Further details regarding the content of the scenarios are provided in the guidance notes (appendix of the instructor manual).

■ Monitoring the exercises

During the exercises the instructor should monitor the trainees' progress and record particular events which relate to safety or correct procedure in the exercise, making a summary for use in the debriefing period. However, even an experienced instructor may occasionally find things going wrong when trainees are trying to control all the parameters and actions involved in an exercise, and any resulting incidents should be noted and discussed at the debriefing.

If a second instructor is available, he should assist in monitoring the trainees in their work. His task will vary according to the trainees' abilities and competence. He will be involved not only in the briefing and debriefing activities, but also when the trainees become more experienced, assisting and guiding them in the use of the equipment. He should follow their work closely, but should avoid interrupting them and save important observations for the debriefing.

■ Debriefing

The time spent on debriefing should generally occupy between 10 and 15 % of the total time used for simulator exercises. Various facilities may be used in debriefing, such as playback (in which the whole exercise is recorded and any sequence is available for discussion), multi-channel recorder or data-logging equipment.

The instructor should refer to the summary made during the exercise, raise important points and direct the discussion among the trainees. He should encourage them to examine critically the actions taken during the exercises. He should try to avoid imposing his own views, but should ensure that the trainees have used safe and correct procedures at all times.

■ Guidance on specific subject areas

The guidance notes which follow contain advice on the treatment of the subject areas listed in the course outline. The instructor should develop a methodology based on his own experience, together with the advice and guidance provided with the simulator being used in the course.

Guidance notes

These notes contain advice on the content of the course as given in the course outline and the syllabus, and will provide a basis for the construction of suitable scenarios.

■ Familiarization

(6 hours)

Initially it is important that the trainees become familiar with what is being simulated and the simulator layout and controls.

Therefore the first briefing and discussion must cover at least:

- the cargo-handling plant, its systems and equipment in general arrangement and in specifics such as the cargo system and arrangements for ballast and inert gas generation
- the instrumentation being used and what parameters are indicated and recorded
- the controls that are used and where they are located
- the alarms that are fitted and what they protect
- the observance and use of safe practices and procedures at all times
- the importance of proper planning before undertaking any activity in the machinery spaces
- the use of checklists to ensure that actions and activities are safe and carried out in the correct sequence.

The practical exercises should start with simple activities involving such operations as:

- opening and closing valves
- starting and stopping pumps, compressors and vapourizers
- using a checklist to prepare the simulator for loading cargo and filling a cargo tank
- using a checklist to prepare the simulator for handling ballast and
- transferring ballast from one tank to another tank.

The trainees should note and record important instrument readings during the exercise.

The aim is to make everyone familiar with the layout of the plant, the instrumentation used, and the location and use of controls.

■ Operational exercises

(20 hours)

The aim of these exercises is to make the trainees familiar with the cargo-handling units and the associated systems that are being simulated, and to gain experience in the correct and safe procedures for preparation, start up, putting on line, and setting the normal operating mode.

Sufficient procedures and operations have been identified in the syllabus to cover most simulator designs, so that adequate practice can be obtained in the operations that are used in the transport of chemical cargo.

With the trainees becoming familiar with the simulator and the range of activities it can handle, scenarios can be constructed covering the various operations contained in the syllabus objectives, and specimen scenarios are provided as an appendix to the instructor manual.

It is important that the trainees become accustomed to making up and using checklists for each operation, so that all actions are carried through in the correct sequence and in a safe manner.

■ Troubleshooting (4 hours)

These exercises aim at developing skill and confidence in handling operational problems.

A number of possible faults can be listed, such as:

- discharge of contaminated water, because of:
 - defective monitoring instruments
 - ineffective control being exercised, or
 - wrongly set valves
- flow rate from pump insufficient, because of:
 - too much clearance between impeller and casing in a centrifugal pump (usually because of wear or corrosion), or
- leak developing in a discharge line
 - leaking of chemical from the gland of the pump

but the particular simulator design will determine which faults and malfunctions can be introduced.

It is important that the number of faults which are introduced can be dealt with in the time available.

Only one fault should be dealt with at a time, and the next fault should not be introduced until all the trainees are satisfied with the way they have handled the previous one.

The instructors should not intrude too much in these exercises, and should allow the trainees to sort the problem out for themselves.

It is essential to allow sufficient time in debriefing to explore thoroughly the way in which the fault was identified, located and dealt with.

Each simulator design will incorporate its own catalogue of faults and malfunctions, and the manufacturer's guidance should be used to construct appropriate scenarios.

■ Bibliography (B)

The detailed teaching syllabus together with the instructor manual and its guidance notes and the user guidance from the simulator manufacturer is all that is required to implement the course. However, if supplementary reading or reference is desired, the publications (as mentioned in the bibliography section)