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VALIDATION OF MODEL TRAINING COURSES

Report of Drafting Group 2

Attached is annex 1 to the Report of Drafting Group 2 on Validation of model training courses (STW 44/WP.6).

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MODEL COURSE 7.03

OFFICER IN CHARGE OF A NAVIGATIONAL WATCH

ACKNOWLEDGEMENTS

This course for Officer in Charge of a Navigational Watch is based on material developed by Anglo Eastern Maritime Training Centre, Mumbai, India and Malaysian Maritime Academy for IMO under the guidance of GlobalMET.

IMO wishes to express its sincere appreciation to GlobalMET for its provision of expert assistance, valuable cooperation, and generous funding in support of this work.

Contents

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 instructors are the key components in the transfer of knowledge and skills to those being trained through IMO model course material.

Rather, this document should be used as a guide with the course duration given as indicative of the expected time required to cover the required outcomes. The parties may modify this course to suit their respective training schemes.

For those following planned training schemes approved by the administration, it is intended that this training may form an integral part of the overall training plan and be complementary to other studies. The training may be undertaken in progressive stages; for such candidates, it is not appropriate to specify the duration of the learning, provided achievement of the specified learning outcomes is properly assessed and recorded.

The educational systems and the cultural backgrounds of trainees in maritime subjects vary considerably from country to country. For this reason 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.

This is the second major revision to this Model Course. In order to keep the training programme up to date in future, it is essential that users provide feedback. New information will provide better training in safety at sea and protection of the marine environment. Information, comments and suggestions should be sent to the Head of the STCW and Human Element Section at IMO, London.

■ 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 objective, 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 area of learning. 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 carefully and may need to re-allocate the time required to achieve each specific learning objective or training outcome.

■ 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 is 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, by testing and evaluating the trainee's performance and achievements, that the trainee has attained each specific learning objective or training outcome. The syllabus is laid out in learning objective format and each objective specifies a *required performance* or, *what the trainee must be able to do* as the learning or training outcome. Taken as a whole, these objectives aim to meet the knowledge, understanding and proficiency specified in the appropriate tables of the STCW Code.

■ 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
- Suggested references, textbooks, technical papers, bibliography
- 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.

In certain cases, the requirements for some or all of the training in a subject are covered by another IMO model course. In these cases, the specific part of the STCW Code which applies is given and the user is referred to the other model course.

■ Course objective

This model course comprises three functions at the operational level. On successful completion of the training and assessment trainees should be competent to carry out safely the watchkeeping duties of an officer in charge of a navigational watch, both at sea and in port. In particular, they will be fully conversant with the basic principles to be observed in keeping a navigational watch as per STCW Regulation VIII/2 and STCW Code Chapter VIII.

The teaching schemes should be carefully scrutinized to ensure that all of the tabulated training outcomes are covered, that repetition is avoided and that essential underpinning knowledge at any stage has already been covered. A certain amount of duplication under different subjects will probably occur, provided it is not excessive, the different approaches can provide useful reinforcement of work already learned. Care should be taken to see that items not included in the syllabus or treatment beyond the depth indicated by the objectives have not been introduced except where necessary to meet additional requirements of the Administration. The teaching scheme should be adjusted to take account of those matters and the timing of any modular courses (such as training in Fire Fighting, Medical Care) which are to be included.

■ Entry standards

The minimum educational standards for entry to the profession may be prescribed by the Administration. In preparing this course it has been assumed that entrants will have successfully completed a minimum period of full-time general education of about 10 to 12 years. They should have reached a standard in mathematics and physical science which would enable them to undertake the learning as set out in the syllabuses for those subjects.

Where entrants have not reached the required standard in mathematics or physical science, it will be necessary to provide a preparatory course or courses to bring them to the desired level before starting the professional studies.

Conversely, topics which have been adequately covered during their general education can be omitted and the allotted time reduced accordingly.

No previous maritime training is assumed, but those entering the course should be following an approved programme of shipboard training.

■ Class intake limitations

Class sizes should be limited to not more than 24 in order to allow the instructor to give adequate attention to individual trainees. Larger numbers may be admitted if extra staff and tutorial periods are provided to deal with trainees on an individual basis. But in no case should the number of students exceed 40 in any class. In addition, for scheduling access to learning facilities and equipment, attention to strict time management is necessary. In large classes students should have their own reference books, unless sufficient copies can be provided in a central library. Classrooms should be big enough to seat all students so they can see and hear the instructor.
During practical sessions and group activities there will be additional restraints on class size. Where applicable, a recommendation on class size is contained in the frameworks for each of the individual functions.

■ Textbooks and bibliography

References to books and bibliography are made in the syllabuses of the individual subjects to aid both instructors and trainees in finding relevant information and to help in defining the scope and depth of treatment intended.

The mention of a particular textbook does not imply that it is essential to use that book, only that it appeared to be best suited to the course at the time of its design. In many instances there are a number of suitable books, and instructors are free to use whatever texts they consider to be most suited to their circumstances and trainees.

Every effort has been made to quote the latest editions of the publications mentioned but new editions are constantly being produced Instructors should always use the latest edition for preparing and running their courses.

Full use should be made of IMO documents, technical papers and other publications available from maritime and other professional organizations. Such papers contain new developments in techniques, equipment, design, management and opinion and are an invaluable asset to a maritime training establishment.

■ Computer applications

In view of the widespread use of computers aboard ship, it is recommended that an element of computer applications be included in the training for officers in charge of a navigational watch.

Particulars of the training will largely depend upon the computer facilities available. The following outline provides guidance on topics which could be included. It is not considered necessary to include the writing of programs.

- A brief description of the principles of operation of a computer; the hardware configuration including the connection of peripherals; setting up a printer, changing paper and ribbons.

- A brief explanation of the operating system, its purpose and how to use it for loading and running programs; storing, naming, renaming and deleting files; arrangement of the directory.

- The care and storage of floppy discs, CD-ROMs and tapes; use of utility programs for formatting and copying discs; keeping back-up copies of files; virus protection.

- The running and use of applications, including communications, word-processing, spreadsheet and database programs. Packages which can be run on a personal computer, making use of spreadsheets and databases in connection with ship's accounts, crew records, planned maintenance and stores inventory and control, are available.

- The use of other relevant programs, such as those for cargo loading, stability and stress calculations and navigational problems.

The use of multi-media applications can enhance learning in topics such as COLREGS, stability, radar, signalling and other areas of knowledge. Many of the IMO rules and Assembly Resolutions are available on CD-ROM. Up to date details may be found on the IMO web site at http://www.imo.org

Instructors should bear in mind that the internet can be a valuable source of information and teaching aids.

■ Training and the STCW 2010 Convention

The standards of competence that have to be met by seafarers are defined in Part A of the STCW Code in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended in 2010. This IMO model course has been revised and updated to cover the competences in STCW 2010. It sets out the education and training to achieve those standards.

In common with the Convention, the course is organised under the seven functions at three levels of responsibility. Specifically, this course covers the minimum standard of competence for officers in charge of a navigational watch on ships of 500 gross tonnage or more, see STCW Code Table A-II/1

For ease of reference, the course material is organised in three separate Functions as per the STCW Code. These functions are:

Function 1	Navigation at the operational level
Function 2	Cargo handling and stowage at the operational level
Function 3	Controlling the operation of the ship and care for the persons on board at the operational level.

Each function is addressed in 5 parts: Part A which is common for all functions, Part B Part C, Part D and Part E, which again addresses all the functions.

Part A provides the framework for the course with its aims and objectives and notes on the suggested teaching facilities and equipment. A list of useful teaching aids which includes videos, CBT, IMO references, textbooks and bibliography is included in function 1, which affects all the 3 functions.

Part B provides an outline of lectures, demonstrations and exercises for the course. No detailed timetable is suggested. From the teaching and learning point of view, it is more important that the trainee achieves the minimum standard of competence defined in the STCW Code than that a strict timetable is followed. Depending on their experience and ability, some students will naturally take longer to become proficient in some topics than in others.

Part C gives the Detailed Teaching Syllabus. This is based on the combined, theoretical and practical knowledge specified in the STCW Code. It is written as a series of learning objectives, in other words what the trainee is expected to be able to do as a result of the teaching and training. Each of the objectives is expanded to define a required performance of knowledge, understanding and proficiency. Suggested teaching aids including IMO references, textbook references, videos, CBT's and bibliography are integrated to assist the teacher in designing lessons.

Part D gives the Instructor Manual, which contains guidance notes for the Instructor and additional explanations. There are also new annexes accompanying Part D of Function 1, which provide the Instructor with a Sample Scheme of work for the topic of Plan and Conduct a Passage and Determine Position, a Sample lesson plan on the topic of Appraisal stage of Passage Planning, a Sample participant's handout, and a Sample powerpoint presentation. These entire Instructors' aids are provided for reference only.

Part E provides the Evaluation which addresses all the functions. A separate IMO Model course 3.12 also addresses Assessment of Competence. This course explains the use of various methods for demonstrating competence and criteria for evaluating competence as tabulated in the STCW Code, an excerpt of this model course is also included in Part E to aid the Instructors.

The Convention defines the minimum standards to be maintained in Part A of the STCW Code. Mandatory provisions concerning Training and Assessment are given in Section A-I/6 of the STCW Code. These provisions cover: qualification of instructors; supervisors as assessors; in-service training; assessment of competence; and training and assessment within an institution. The corresponding Part B of the STCW Code contains guidance on training and assessment.

The criteria for evaluating competence specified in the minimum standard of competence tables of Part A of the STCW Code are to be used in the assessment of all competences listed in those tables.

The STCW Code 2010 also addresses the training of seafarers which can be imparted through distance learning and e-learning. A substantial portion of the course, especially learning in the cognitive domain, can be delivered as computer based learning modules over the web or through software programmes.

Section B-I/6 of the STCW Code gives guidance on the training of seafarers which can be carried out by distance learning and e-learning in accordance with the standards of training and assessment set out in section A-I/6 of the STCW Code.

Administrations are encouraged to approve the use of e-learning. The code includes guidelines for how the e-learning shall be conducted, but it is up to each administration to approve any e-learning provider. The administration must register approved training providers.

Web-based course with material delivered via a combination of text, presentations, webinar, recorded events and expert tutor assistance can be used. Student can select online learning material, online quiz, assessment, online discussion forum with other students and tutor. Live interaction and replying questions with tutor via Webinar session are some of the advantages of this type of learning.

To improve the facilitation of the carriage of IMDG Code class 7 materials, including those in packaged form used in medical or public health applications, the IMO has prepared a class 7 e-learning package which is available for use by interested parties, free of cost, by clicking on the link www.class7elearning.com

As previously mentioned a separate model course 3.12 also addresses Assessment of Competence and use of the criteria for evaluating competence tabulated in the STCW Code.

■ Responsibilities of Administrations

Administrations should ensure that training courses delivered by colleges and academies are such as to ensure officers completing training do meet the standards of competence required by STCW Regulation II/1 paragraph 2.

■ Conventions, Regulations and Legislation

These are constantly being revised and updated. It is essential that the up to date version of these are being used and that all references to particular versions in this model course should be taken to include all future amendments and revisions.

■ Validation

The information contained in this document has been validated by the Sub-Committee on Standards of Training and Watchkeeping for use by technical advisers, consultants and experts for the training and certification of seafarers so that the minimum standards implemented may be as uniform as possible. *Validation* in the context of this document means that no grounds have been found to object to its content. The Sub-Committee has not granted its approval to the document, as it considers that this work must not be regarded as an official interpretation of the Convention.

Part A: Course Framework

■ Aims

This model course aims to meet the mandatory minimum requirements for the:

i) knowledge, understanding and proficiency in Table A-II/1 of STCW Code , for Function 1: Navigation at the Operational Level.

ii) knowledge, understanding and proficiency in Table A-II/1 of STCW Code for Function 2: Cargo Handling and Stowage at the Operational Level.

iii) knowledge, understanding and proficiency in Table A-II/1 of STCW Code for Function 3: Controlling the Operation of the Ship and Care for Persons on Board at the Operational Level.

■ Objectives

Function 1: Navigation at the Operational Level

This syllabus covers the requirements of the STCW Convention 1978, as amended Chapter II, Section A-II/1. This functional element provides the detailed knowledge to support the training outcomes related to Navigation at the Operational Level.

This section provides the background knowledge to support:

- planning and conducting of a passage and for determining position
- maintaining a safe navigational watch
- use of radar and ARPA to maintain safety of navigation*
- use of AIS to maintain safety of navigation*
- use of ECDIS to maintain the safety of navigation*
- responding to emergencies
- responding to a distress signal at sea
- use of the IMO standard marine communication phrases and use English in written and oral form
- transmission and receipt of information by visual signalling
- manoeuvring the ship.

Function 2: Cargo Handling and Stowage at the Operational Level

This syllabus covers the requirements of the STCW Convention 1978, as amended Chapter II, Section A-II/1. This functional element provides the detailed knowledge to support the training outcomes related to Cargo Handling and Stowage at the Operational Level.

This section provides the background knowledge to support:

- monitoring the loading, stowage, securing and unloading of cargoes and their care during the voyage.

- inspecting and reporting defects and damage to cargo spaces, hatch covers and ballast tanks.

This includes topics such as ship stability, deck cargoes, containers, bulk cargoes, grain, dangerous goods and oil tankers.

Function 3: Controlling the Operation of the Ship and Care for Persons on Board at the Operational Level.

This syllabus covers the requirements of the STCW Convention 1978, as amended Chapter II, Section A-II/1. This functional element provides the detailed knowledge to support the training outcomes related to Controlling the Operation of the Ship and Care for Persons on Board at the Operational Level.

This section provides the background knowledge to support:

- compliance with pollution-prevention requirements
- maintaining the sea-worthiness of the ship
- prevention, control and fighting of fires on board ship*
- operation of life-saving appliances*
- apply medical first aid on board ship*
- monitoring compliance with legislative requirements
- leadership and team working skills*
- contribution to safety of personnel and ship*

This function includes topics such as ship stability, carriage of cargoes on deck, heavy lifts, containers, bulk cargoes, grain, dangerous goods, oil tankers and the IMO conventions.

* These topics are covered in separate IMO model courses.

■ Entry standards

This course is principally intended for candidates for certification as officer in charge of a navigational watch. Those wishing to enter this course should be following an approved programme of shipboard training. Alternatively, trainees may complete approved seagoing service of not less than three years.

■ Course certificate

On successful completion of the course and assessments, a document may be issued certifying that the holder has successfully completed a course of training which meets or exceeds the level of knowledge and competence specified in Table A-II/1 of STCW Code, for each or all of the following functions

1. Navigation at the Operational Level.
2. Cargo Handling and Stowage at the Operational Level
3. Controlling the Operation of the Ship and Care for Persons on Board at the Operational Level

A certificate may be issued only by centres approved by the Administration.

■ Staff requirements

Instructors shall be qualified in the task for which training is being conducted and have appropriate training in instructional techniques and training methods (STCW Code Section A-I/6). Depending on the complexity of the exercises set, an assistant instructor with similar experience is desirable for certain practical exercises. Administrations shall ensure that the qualifications and experience of instructors and assessors are covered in the application of the quality standard provisions of section A-I/8. Such qualification, experience and application of quality standards shall incorporate appropriate training in instructional techniques, and training and assessment methods and practice, and shall comply with all applicable requirements of paragraphs 4 to 6 of Section A-I/6 of STCW Code.

■ Teaching facilities and equipment

A classroom equipped with an overhead projector and a blackboard (or whiteboard) or flipchart should be provided for teaching the theory of the course and holding group discussions.

Function 1- Navigation at the Operational Level

For chartwork exercises the trainees need desks, approximately 1.0 m long x 0.7 m deep.

The trainees should, for training purposes, have access to:

- a binnacle with magnetic compass and sighting device
- a gyro-compass and pelorus
- sextants

The following equipment may be required for each trainee including but not limited to:

- protractor and dividers
- parallel ruler
- pocket calculator with trigonometric functions and sufficient memory capacity to calculate altitude using the cosine formula and/or nautical (logarithmic) tables
- pre-computed altitude and azimuth tables
- Nautical Almanac

- large and small charts of both ocean and coastal areas
- ocean plotting sheet
- navigation triangles

COLREG - A set of table-top models, displaying proper signals or lights, or a magnetic board or navigation light simulator is required for teaching and exercising the collision regulations.

Meteorology - for training purposes it is desirable to have meteorological instruments such as a thermometer, hygrometer, and aneroid barometer. A facsimile receiver would also be useful if available.

Emergency procedures - either a dummy line-throwing apparatus or, if there is sufficient open space where one may safely be used, a complete working apparatus with a supply of rockets and lines.

Visual Signalling - A Morse key connected to a light, mounted high enough to be easily visible from all points of the room or a computer based system, should be provided. Blinds or curtains may be required to prevent direct sunlight interfering with reading the light.

International Code of Signals - for teaching the use of the Code, a set of rigid code flags with a mast to which they may be attached to represent hoists or computer based system is needed.

Manoeuvring - a set of models to represent ships, jetties, piers and other dock configurations, which can be used on a table top to illustrate ship berthing procedures, should be provided. Unless competence is to be demonstrated in ships during service or in a training ship, a suitable ship handling simulator or manned ship models will be required. A model showing the windlass and mooring arrangements should be provided for demonstrating anchoring and mooring procedures. The seamanship area should be equipped with lengths of ropes and wires, together with stoppers and various types of shackles, for purposes of illustration.

Function 2 - **Cargo Handling and Stowage at the Operational Level**

Teaching facilities and equipment

The following additional equipment is recommended:

- working models of derricks and cranes to illustrate different rigs in handling cargo models or drawings of various types of hatch cover and their operating and securing arrangements
- examples of head and heel cargo blocks
- schematic model of a product tanker, tanks and pump-room, showing piping and valves
- schematic model of a crude carrier, tanks and pump-room, showing piping and valves
- photographs, drawings and plans to illustrate different types of ship

- examples of cargo plans for various types of ship.
- cargo handling and liquid cargo handling simulators are not essential equipment but will greatly enhance trainee learning and the assessment of competence in this function.

Function 3- Controlling the Operation of the Ship and Care for Persons on Board at the Operational Level.

Teaching facilities and equipment

The following additional equipment is recommended:

- cut-away three-dimensional models showing the structure of parts of the ship
- photographs, drawings and plans illustrating various types of ship and constructional details
- a floating ship stability demonstration model and a flotation tank. The model should be capable of demonstrating the effects of adding or removing masses, shifting masses, suspending masses and free liquid surface.
- copies of approved stability information books and computer loading programmes from ships
- a marine hydrometer

■ Teaching aids (A)

The list of teaching aids and references are recommendations only and are intended to support the learning outcomes of the course.

A1 Instructor Guidance (Part D of this course)
A2 Catalogue of British Admiralty Charts and other Hydrographic Publications
A3 British Admiralty Notices to Mariners
A4 Chart
A5 Deviation Table
A6 British Admiralty List of Lights
A7 National List of lights and Buoyage System
A8 British Admiralty Tide Table of the area concerned
A9 National tide table
A10 Tidal stream atlas
A11 British Admiralty 'Pilot' book for the area concerned
A12 National sailing directions
A13 Star Finder and Identifier HO 21 01-D
A14 Nautical Almanac
A15 Pilot chart of the ocean concerned (US Hydrographic Office publication)
A16 IALA Maritime Buoyage System. British Admiralty NP735
A17 Ocean plotting sheet
A18 Distance Tables
A19 British Admiralty List of Radio Signals, Vol. 2: Radio Navigational Aids

A20 Admiralty List of Radio Signals, Vol. 6 (NP283) and Diagrams relating to Weather Reporting and Forecast Areas (NP283(a)). Taunton, Hydrographer of the Navy
A21 British Admiralty List of Radio Signals, Vol. 5: Radio Time Signals, Radio Nav.Warnings
A22 Ship's Log-book
A23 Nautical table (Norie's, Burton's or other)
A24 Star Chart
A25 Pre-computed altitude and azimuth table
A26 Pocket Calculator
A27 Loran-C receiver
A28 GPS Receiver
A29 Echo sounder
A30 Speed Log
A31 Magnetic Compass
A32 Gyro-Compass
A33 Automatic Pilot
A34 Cloud sheet 1986 (revised edition). Geneva, World Meteorological Organisation
A35 US Pilot Charts, (appropriate sheets). Washington D.C., Defence Mapping Agency
A36 Meteorological Office, Ship's Code and Decode Book : Incorporating the International Meteorological Codes for Weather Reports from and to Ships and the Analysis Code for Use of Shipping, (Met.0.509) London, HMSO,1996 (ISBN 0-11-400368-8)
A37 Video cassette player and/or DVD player
A38 Marlins Study Pack 1 & Study Pack 2. Edinburgh, Marlins 1997/1998 (ISBN 0 953 1748 08 and ISBN 0 953 1748 1 6)
A39 Differential GPS (DGPS) Receiver
A40 Enhanced Loran (eLoran) Receiver
A41 Automatic Identification System (AIS) Receiver
A42 Long Range Identification and Tracking (LRIT) Receiver
A43 Voyage Data Recorder (VDR) and Simplified Voyage Data Recorder (S-VDR)
A44 Bridge Navigational Watch Alarm System (BNWAS)
A45 Simulators (wherever applicable to enhance understanding of topics, especially, COLREGS and Ship Handling)

■ CDs and DVDs

V1 Ships' Routeing on CD, Version 5 (2010)
V2 IMO – Safe, Secure and Efficient Shipping on Clean Oceans on DVD (2011 Edition)

Available from: IMO Publications Section
4 Albert Embankment
London SE1 7SR, UK
Fax: +44 20 7587 3241
URL:www.imo.org

V3 Know the current rules (Code No.328)
V4 Bridge watchkeeping – Part 2 (Code No 497)
V5 Voyage planning (Code No. 758)
V6 Search and rescue: co-ordination (Code No 574)
V7 Man overboard (Code No 644)
V8 SAFER MOORING, Code No: 997
V9 Theory of Mooring – Edition 4 (Code No. 1104)
V10 Safe Mooring Practice – Edition 4 (Code No. 1105)
V11 Maintenance of Mooring Systems - Edition 4 (Code No. 1106)
V12 Basic instincts (Passenger Mustering & Crowd Control) (Code No 603)
V13 Navigational Charts & Associated Publications - Part 6, Code No: 639
V14 The Safe Use Of Electronic Charts, Code No: 705
V15 AIS - Automatic Identification Systems, Code No: 926
V16 Ship Handling - Part 1, Code No: 95
V17 Ship Handling - Part 2, Code No: 129
V18 Ship Handling - Part 3, Code No: 321
V19 Ship Handling in Restricted Waters - Ship Squat And Shallow Water, Code No: 697
V20 Ship Handling In Restricted Waters - Bank Effect & Interaction, Code No: 748
V21 Working With Tugs, Code No: 972
V22 Pilot on Board! Working Together, Code No: 945
V23 Working With VTS - Part 7, Code No: 640
V24 Anchoring Safely, Code No: 928
V25 Meteorology for Safe Navigation in Cyclones, Code No: 695
V26 Wind, Waves and Storms Part 1 - Understanding Weather System, Code No 738
V27 Wind Waves and Storms Part 2 - Coping With Hazardous Weather, Code No 743
V28 Collision Avoidance CD-Rom (Version 1.7), Code No: 819
V29 Helicopter Operations at Sea (Edition 2), Code No: 704
V30 Gyro Compass - Part 1, Code No: 9897
V31 Gyro Compass - Part 2, Code No: 9898
V32 Gyro Compass - Part 3, Code No: 9899
V33 Ship handling in head seas (Code No 661)
V34 Manoeuvring Characteristics of Special Car Carriers (Code No 696)
V35 Manoeuvring and Control Characteristics of Special Type Ships: Part 1 Focusing on the Wind Pressure Effect on A PCC (Code No 9985)
V36 Manoeuvring and Control Characteristics of Special Type Ships: Part 2 Anchoring And Mooring Of A PCC (Code No 9986)
V37 Tractor Tugs (Code No 165)
V38 Shiphandling With Tractor Tugs (Code No 359)
V39 Navigating In ICE (Code No 927)
V40 Margins Of Safety (Code No 73)
V41 Master/Pilot Relationship (Code No 498)
V42 Accident Prevention - The Human Factor (Code No 637)
V43 Emergency Procedures (Code No 638)
V44 Five Case Studies (Code No 781)
V45 Shipping Casualty Emergency Response (Code No 467)
V46 The Cold And Heavy Weather File (Code No 626)
V47 Target Tracking Devices (Code No 948)

V48 Watchkeeping In Port Code No: 659
V49 Dangerous Goods At Sea Series (Edition 5) (Code No 713)
V50 Dangerous Goods At Sea Series Part 2 (Edition 5) (Code No: 719)
V51 Centrifugal pumps - theory & operation (Code no: 9)
V52 Crude oil washing operations (edition 3) (code no: 707)
V53 Operation & maintenance of inert gas systems (edition 3) code no: 708
V54 The ship-shore interface (petroleum tankers) code no: 709
V55 Safe cargo stowage & securing code no: 747
V56 Ship to ship transfer - petroleum and liquid cargoes code no: 751
V57 Tank purging and line cleaning onboard chemical tankers code no: 752
V58 Introduction to liquified gas carriers (edition 2) code no: 753
V59 Safe log carrier operations code no: 760
V60 Successful reefer container operations code no: 788
V61 Bulk carriers - handle with care code no: 691
V62 Hatch covers - a practical guide code no: 938
V63 Chemical tank cleaning & inspection (edition 2) code no: 950
V64 Chemical tanker operations: safety and pollution prevention part 1 code no: 951
V65 Chemical tanker operations: safety and pollution prevention part 2 code no: 952
V66 Tank cleaning practice code no: 982
V67 Over and under pressurisation of tanks (edition 2) code no: 984
V68 Handling vegetable oils code no: 988
V69 Dangerous & difficult bulk cargoes code no: 1101
V70 Vapour émission control code no: 1118
V71 Ro-Ro safety and cargo operations code no: 162
V72 Fire fighting & safe cargo operations on car carriers code no: 540
V73 Don't gamble with safety on chemical tankers code no: 595
V74 Cargo loss prevention on board bulk carriers code no: 598
V75 Cargo lashing operations (ro-ro) code no: 631
V76 Safe use of rigging equipment code no: 700
V77 Manual handling techniques code no: 703
V78 Tanker practices series
Pumping cargo part 1 code no: 501
Pumping cargo part 2 code no: 502
Tank cleaning - part 3 code no: 503
Heating cargo - part 4 code no: 504
Measuring cargo - part 5 code no: 505
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T35 Taylor L.G. Cargowork, 12th ed. Glasgow, Brown, Son & Ferguson Ltd. 1992 (ISBN 978-0-85174-605-5)

T36 Cpt Thomas R.E., revised & rewritten by Rankin, K.S. Stowage Cpt G M Pepper, Thomas' Stowage: The Properties and Stowage of Cargoes, 3rd, 5th ed.Glasgow, Brown, Son & Ferguson, 1996 (ISBN 0-85174-625-x) 2008. (ISBN-13: 978-0-85714-798-8)

T37 Bryan Barrass & Capt D R Derrett, Ship Stability for Masters and Mates, 4th 6th ed. London Stanford Maritime Butterworth Heinemann, 1984 (ISBN 0-540-07388-1) 2006 (ISBN-13:978-0-7506-6784-5, ISBN-10:0-7506-6784-2)

T38 Hill, C. Maritime Law, 5th 6th ed. London, LLP Limited Lloyd's of London Press, 1998 2003 (ISBN 1-85978 836 X) (ISBN 1-84311-255-8)

T39 Capt P. Roberts, Watchkeeping Safety and Cargo Management in Port. London, The Nautical Institute, 1995 (ISBN-10: 1-870077-29-6)

T40 Samuel C. Certo, Modern Management, 8th Edition, Prentice Hall, London 2000, ISBN 0130133078)

T41 Kuo. Chengi., Safety Management and its Maritime Application, The Nautical Institute, London, 2007 (ISBN 1870077830)

T42 The Nautical Institute., The Nautical Institute on COMMAND, A Practical Guide, London, 2000 (ISBN 9781870077552)

Note:

The list of text books or reference books are for guidance purpose only and the textbooks / reference material from the local or other authors may be prescribed by the Administration

Officer in charge of a navigational watch

Function 1:

Navigation at the Operational Level

Officer in Charge of a Navigational Watch
Function 1: Navigation at the Operational Level

INDEX

Part B1: Course Outline

Timetable
No formal example of a timetable is included in this model course.

Development of a detailed timetable depends on the level of skills of the trainees entering the course and the amount of revision work of basic principles that may be required.

Lecturers must develop their own timetable depending on:

- the level of skills of trainees
- the numbers to be trained
- the number of instructors

and normal practices at the training establishment.

Preparation and planning constitute an important factor which makes a major contribution to the effective presentation of any course of instruction.

Lectures
As far as possible, lectures should be presented within a familiar context and should make use of practical examples. They should be well illustrated with diagrams, photographs and charts where appropriate, and be related to matter learned during seagoing time.

An effective manner of presentation is to develop a technique of giving information and then reinforcing it. For example, first tell the trainees briefly what you are going to present to them; then cover the topic in detail; and, finally, summarise what you have told them. The use of an overhead projector and the distribution of copies of the transparencies as trainees handouts contribute to the learning process.

Course Outline
The tables that follow list the competencies and areas of knowledge, understanding and proficiency, together with the estimated total hours required for lectures and practical exercises. Teaching staff should note that timings are suggestions only and should be adapted to suit individual groups of trainees depending on their experience, ability, equipment and staff available for training.

COURSE OUTLINE

Knowledge, understanding and proficiency	Total hours for each topic	Total hours for each subject area of required performance

Competence:

1.1 PLAN AND CONDUCT A PASSAGE AND DETERMINE POSITION

1.1.1	CELESTIAL NAVIGATION			
	.1	Solar system	4	
	.2	Celestial sphere and equinoctial system of co-ordinates	4	
	.3	Hour angle	4	
	.4	Daily motion and horizontal system of co-ordinates	6	
	.5	Sextant and altitude corrections	6	
	.6	Amplitude	2	
	.7	Time and equation of time	2	
	.8	Nautical Almanac	6	
	.9	Latitude by meridian altitude	3	
	.10	Pole Star observations	3	
	.11	Position fixing	20	60
1.1.2	TERRESTRIAL AND COASTAL NAVIGATION			
	.1	Definitions – Earth	7	
	.2	Charts	12	
	.3	Electronic Charts	4	
	.4	Datums	2	
	.5	Distances	3	
	.6	Position lines and positions	15	
	.7	Sailings	34	
	.8	Chartwork exercises	70	
	.9	Information from charts, lists of lights and other publications	44	
	.10	IALA Buoyage System	2	
	.11	Tides	18	
	.12	Keeping a log	3	214
1.1.3	ELECTRONIC SYSTEMS OF POSITION FIXING AND NAVIGATION			
	.1	Basic principles of terrestrial navigation systems	2	
	.2	Loran-C system	3	
	.3	eLoran	2	
	.4	Global navigation satellite systems	10	
	.5	GPS	10	
	.6	Augmented satellite systems	1	
	.7	GLONASS	1	
	8	GALILEO	1	
				30
1.1.4	ECHO-SOUNDERS			
	.1	Echo-sounders	9	
				9
1.1.5	COMPASS – MAGNETIC AND GYRO			
	.1	The magnetism of the earth and the ship's		

		deviation	6	
	.2	The magnetic compass	6	
	.3	The gyro-compass	6	
	.4	Compass corrections	3	
	.5	Errors of the compass and azimuths	13	
	.6	Fluxgate compass	1	
				35
1.1.6	STEERING CONTROL SYSTEMS			
	.1	Steering control systems	6	6
1.1.7	METEOROLOGY			
	.1	Shipborne meteorological instruments	5	
	.2	The atmosphere, its composition and Physical properties	4	
	.3	Atmospheric pressure	4	
	.4	Wind	8	
	.5	Cloud and precipitation	4	
	.6	Visibility	5	
	.7	The wind and pressure systems over the ocean	10	
	.8	Structure of depressions	12	
	.9	Anticyclones and other pressure systems	6	
	.10	Weather services for shipping	5	
	.11	Recording and reporting weather observations	6	
	.12	Weather forecasting	10	
				79

1.2 MAINTAIN A SAFE NAVIGATIONAL WATCH

1.2.1	THOROUGH KNOWLEDGE OF THE COLLISION REGULATIONS			
	.1	Content, application and intent of International Regulations for Preventing Collisions at Sea, 1972, as amended	100	100
1.2.2	PRINCIPLES IN KEEPING A NAVIGATIONAL WATCH			
	.1	Principles to be observed in keeping a navigational watch	6	
	.2	Keeping a watch in port		6
1.2.3	BRIDGE RESOURCE MANAGEMENT			
	.1	Bridge Resource Management	8	8
1.2.4	THE USE OF ROUTEING			
	.1	Weather routing	2	
	.2	Use of routeing in accordance with general provisions on ships' routeing	2	4
1.2.5	THE USE OF INFORMATION FROM NAVIGATIONAL EQUIPMENT FOR MAINTAINING A SAFE NAVIGATIONAL WATCH			
	.1	Speed measurement		8
	.2	Operational Use of AIS (*See IMO Model Course No 1.34)*		
1.2.6	KNOWLEDGE OF BLIND PILOTAGE TECHNIQUES			
	.1	Knowledge of navigational techniques used	2	2

for safe navigation in restricted visibility

1.2.7 THE USE OF REPORTING IN ACCORDANCE WITH THE GENERAL PRINCIPLES FOR A SHIP REPORTING SYSTEM AND WITH VTS PROCEDURES

.1	The use of reporting in accordance with the general principles for ship reporting systems and with VTS procedures	2	2

1.3 USE OF RADAR AND ARPA TO MAINTAIN SAFETY OF NAVIGATION

See IMO Model Course No. 1.07 and STCW Convention 1978, as amended, *Regulation I/12*

1.4 USE OF ECDIS TO MAINTAIN SAFETY OF NAVIGATION

See IMO Model Course 1.27

1.5 RESPOND TO EMERGENCIES

1.5.1 PRECAUTIONS FOR PROTECTION AND SAFETY OF PASSENGERS

.1	Contingency plans for response to emergencies	8	
.2	Precautions for protection and safety of passengers in emergency situations	1	
			9

1.5.2 INITIAL ACTION FOLLOWING COLLISION OR GROUNDING

.1	Precautions when beaching a vessel	1	
.2	Actions on stranding/grounding	1	
.3	Actions following a collision	1	
.4	Initial damage assessment and control	2	
.5	Means of limiting damage and salving ship following fire or explosion	2	
.6	Procedures for abandoning ship	2	
.7	Use of auxiliary steering gear and rigging jury steering arrangements	1	
.8	Arrangements for towing and being towed	1	
			11

1.5.3 RESCUING PERSONS FROM THE SEA, ASSISTING A SHIP IN DISTRESS AND PORT EMERGENCIES

.1	Rescue of persons from a vessel in distress	2	
.2	Actions for emergencies in port	1	
.3	Measures for assisting a vessel in distress	14	
			17

1.6 RESPOND TO A DISTRESS SIGNAL AT SEA

1.6.1	SEARCH AND RESCUE	2	
.1	IAMSAR Manual	2	
			4

1.7 ENGLISH LANGUAGE

See IMO Model Course 3.17

1.7.1 ENGLISH LANGUAGE

1.7.2 USE IMO STANDARD MARINE COMMUNICATION PHRASES

1.8 TRANSMIT AND RECEIVE INFORMATION BY VISUAL SIGNALLING

1.8.1	TRANSMIT AND RECEIVE SIGNALS BY MORSE LIGHT			
	.1	Signalling by Morse code	1	
				1
1.8.2	USE THE INTERNATIONAL CODE OF SIGNALS			
	.1	International Code of Signals	10	
				10

1.9 MANOEUVRE THE SHIP

1.9.1	SHIP MANOEUVRING AND HANDLING			
	.1	Turning circles and stopping distances	4	
	.2	Effect of wind and current on ship handling	2	
	.3	Manoeuvres for rescue of person overboard	2	
	.4	Squat, shallow water and similar effects	3	
	.5	Proper procedures for anchoring and mooring	4	
				15

Total for Function 1: Navigation at the Operational level 627 hours

Teaching staff should note that the hours for lectures and exercises are suggestions only as regards sequence and length of time allocated to each objective. These factors may be adapted by lecturers to suit individual groups of trainees depending on their experience, ability, equipment and staff available for teaching.

Part C1: 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 teaching 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 systematically organised 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[1].

In this Model Course there are three functions:

Function 1: Navigation at the Operational Level
Function 2: Cargo Handling and Stowage at the Operational Level
Function 3: Controlling the Operation of the Ship and Care for Persons on Board at the Operational Level.

The header of the first column denotes the **COMPETENCE** concerned. Each function comprises a number of competences. For example, the Function 1, Navigation at the Operational Level, comprises a total of eight COMPETENCES. Each competence is uniquely and consistently numbered in this model course.

[1] Morrison, W.S.G. Competent crews = safer ships. Malmo, WMU Press, 1997 (ISBN 91-973372-0-X)

The first competence is **Plan and Conduct a Passage and Determine Position.** It is numbered 1.1, that is the first competence in Function 1. 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 competence **Plan and Conduct a Passage and Determine Position** comprises a total of seven training outcomes. The first is in CELESTIAL NAVIGATION. Each training outcome is uniquely and consistently numbered in this model course. Celestial Navigation is numbered 1.1.1. For clarity training outcomes are printed in black 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 Celestial Navigation, there are 11 areas of performance. These are:

1.1.1.1 Solar system (4 hours)
1.1.1.2 Celestial sphere and equinoctial system of co-ordinates (4 hours)
1.1.1.3 Hour angle (4 hours)
1.1.1.4 Daily motion and horizontal system of coordinates (6 hours)
1.1.1.5 Sextant and altitude corrections (6 hours)
1.1.1.6 Amplitude (2 hours)
1.1.1.7 Time and equation of time (2 hours)
1.1.1.8 Nautical Almanac (6 hours)
1.1.1.9 Latitude by meridian altitude (3 hours)
1.1.1.10 Pole Star observations (3 hours)
1.1.1.11 Position fixing (20 hours)

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 1.1.1.1 Solar system, to meet the required performance, the trainee should be able to:

- describe the composition and dimensions of the solar system
- identify planets useful for navigation
- describe the earth's elliptical orbit, and state approximate perihelion and aphelion distances and dates and so on.

IMO references (Rx) are listed in the column to the right hand side. Teaching aids (Ax), videos (Vx) and textbooks (Tx) relevant to the training outcome and required performances are placed immediately following the title.

It is not intended that lessons are organised to follow the sequence of required performances listed in the Tables. The Syllabus Tables are organised to match with the competence in the STCW Code Table A-II/1. Lessons and teaching should follow college practices. It is not necessary, for example, for celestial navigation to be studied before terrestrial and coastal navigation. What is necessary is that all the material is covered and that teaching is effective to allow trainees to meet the standard of the required performance.

COMPETENCE 1.1	**Plan and Conduct a Passage and Determine Position**	**IMO Reference**

TRAINING OUTCOMES: STCW Code Table A-II/1

Demonstrates a knowledge and understanding of:

1.1.1 CELESTIAL NAVIGATION

1.1.2 TERRESTRIAL AND COASTAL NAVIGATION

1.1.3 ELECTRONIC SYSTEMS OF POSITION FIXING AND NAVIGATION

1.1.4 ECHO-SOUNDERS

1.1.5 COMPASS – MAGNETIC AND GYRO

1.1.6 STEERING CONTROL SYSTEMS

1.1.7 METEOROLOGY

COMPETENCE 1.1 Plan and Conduct a Passage and Determine Position **IMO Reference**

1.1.1 CELESTIAL NAVIGATION

Textbooks: T8, T9
Teaching aids: A1, A4, A13, A14, A17, A21, A23, A24, A25, A26

Required performance:

1.1 Solar system (4 hours)

- describes the composition and dimensions of the solar system
- names inferior and superior planets
- describes the earth's elliptical orbit, and states approximate perihelion and aphelion distances and dates
- explains the eccentricity of the earth's orbit
- describes the inclination of the earth's axis to the plane of the orbit and the stability of the axis (ignoring precession) and its effect on the seasons
- states the dates of the solstices and equinoxes
- explains the concept of the earth's axial rotation giving day and night
- explains the varying length of daylight through the year
- explains daylight and darkness conditions in various latitudes at the solstices and equinoxes
- describes the significance of the tropics of Cancer and Capricorn and of the Arctic and Antarctic Circles

1.2 Celestial sphere and equinoctial system of co-ordinates (4 hours)

- describes the celestial sphere
- explains the apparent annual motion of the sun and the concept of the ecliptic
- defines 'celestial poles', 'celestial meridians', 'equinoctial' and the 'obliquity of the ecliptic'
- states that the equinoctial as a fixed reference plane and the direction of the First Point of Aries as a reference direction (ignoring the effect of precession)

- describes the equinoctial system of co-ordinates and defines sidereal hour angle, declination and polar distance
- extracts information from the star diagrams in the Nautical Almanac or equivalent star finding device

1.3 Hour Angle (4 hours)

- describes the concept of the earth's axial rotation causing change in the hour angle of bodies
- defines 'Greenwich Hour Angle (GHA)', 'Local Hour Angle (LHA)' and longitude, and explains their relationship
- describes the rate of change of GHA of the sun and Aries
- identifies the tabulation of SHA, GHA, and declination (and 'd' and 'v' corrections) in the Nautical Almanac for all celestial bodies
- determines the geographical position of a body for any given GMT

1.4 Daily Motion and Horizontal System of Co-ordinates (6 hours)

- defines 'rational horizon', 'zenith' and 'nadir'
- defines 'vertical circle' and 'prime vertical circle'
- defines 'elevated pole' and 'depressed pole'
- proves that the altitude of the elevated pole is equal to the observer's latitude
- defines the observer's upper and lower celestial meridian
- identifies the apparent daily path of all bodies
- defines 'true altitude', 'azimuth', and 'true zenith distance'
- explains the relationship between azimuth, quadrantal bearings and 360° notation bearing
- recognizes rising and setting points and defines amplitude
- explains the meaning of the term circumpolar and describes the conditions necessary for a body to be circumpolar
- describes the condition necessary for a body to cross the prime vertical
- recognizes the parts of the PZX triangle
- draws figures on the plane of the rational horizon and of the observer's celestial meridian, using the equidistant projection to illustrate navigational problems and principles

1.5 Sextant and Altitude Corrections (6 hours)

- defines 'sextant altitude'
- describes the parts of a sextant
- demonstrate how to retrieve and return a sextant into the storage box
- demonstrates how to read a sextant
- shows how to correct a sextant into which has been introduced one or more of error of perpendicularity, side error or index error

- demonstrates how to find the index error of the sextant by the horizon
- describes how to find the index error of the sextant by the sun
- uses the sextant for taking vertical and horizontal angles
- describes the purpose of altitude correction
- defines 'visible', 'sensible' and 'rational' horizons
- defines 'observed altitude' and 'true altitude'
- defines 'dip', 'refraction', 'semi-diameter' and 'parallax', and explains their causes
- applies index error
- applies the corrections for the items listed in 2.5.10 and explains the factors determining their magnitude
- illustrates the effect of terrestrial refraction on the dip and distance of the sea horizon
- demonstrates the use the altitude correction tables in the Nautical Almanac, including reference to critical tables, interpolation tables and low-altitude correction tables
- obtains the true zenith distance from the true altitude of the body

1.6 Amplitude (2 hours)

- determines the observed altitude of the sun when the true altitude is zero
- explains the effect of latitude on the accuracy of amplitude observations
- calculates the LAT and LMT of the theoretical and visible rising and setting of the sun
- extracts information from the tabulation of the rising and setting of the sun in the Nautical Almanac

1.7 Time and Equation of Time (2 hours)

- describes the apparent solar day and states the relationship between LHA (sun) and LAT
- defines 'sidereal day' and states that it is a fixed time interval
- explains the reasons for the sun's irregular rate of change of SHA and hence the necessity to adopt the astronomical mean sun for timekeeping purposes
- describes the equation of time (ET) and its components
- determines the ET from the Almanac and its sign of application
- defines GMT, LMT and longitude

- defines zone times and standard time
- explains how to alter the ship's time during a passage with increasing or decreasing longitude
- demonstrates the use of time signals
- determines the error of a chronometer or watch

1.8 Nautical Almanac (6 hours)

- describes the information contained in general in the Nautical Almanac (NA) and in detail in the daily pages
- uses the tables of corrections and incremental corrections in the Nautical Almanac
- finds the LHA of a body, given the date, GMT and longitude of the observer
- explains the importance of the First Point of Aries
- finds the LHA of Aries, given the date, GMT and longitude of the observer
- explains what is meant by the sidereal hour angle of a star and obtains it from the Nautical Almanac
- derives the LHA of a star from the LHA of Aries and the SHA of the star
- demonstrates the uses the information in the Nautical Almanac to obtain the LMT of the meridian passage of a body to the nearest minute and interpolates for the observer's longitude when necessary

1.9 Latitude by Meridian Altitude (3 hours)

- applies the true zenith distance of a body when it is on the observer's meridian to the declination of the body, to obtain the observer's latitude
- applies these correctly when the declination and latitude have the same name
- applies these correctly when the declination and latitude have different names
- describes the relationship between the altitude of the elevated pole and the latitude of the observer
- explains what is meant by a circumpolar star, and the terms upper and lower transit
- finds the value of the polar distance of the body, using its declination
- applies the polar distance to the true altitude of a body at lower transit to find the altitude of the elevated pole and the latitude

- describes the direction of the position line through the observer when taking a meridian altitude

1.10 Pole Star Observations (3 hours)

- identifies certain major stellar constellations and navigational stars, describes their movement relative to Polaris and the movement of Polaris with change of latitude
- identifies Polaris
- identifies some major constellations
- describes the motion of the stars about Polaris
- describes the relationship between the altitude of Polaris and the observer's latitude
- deduces from 2.10.4 that the true altitude of Polaris can be used to find the latitude of the observer
- obtains the corrections, -1^{o}, $+a_o$, $+a_1$, $+a_2$, from Pole Star tables in the 'Nautical Almanac' and applies them to the altitude of Polaris to find the latitude of the observer
- finds the true azimuth of Polaris from the tables and the direction of the position line

1.11 Position Fixing (20 hours)

- combines the equinoctial and horizon system of co-ordinates to determine the centre and radius of a position circle and its direction in the vicinity of a selected position
- applies the principles of a method of enabling the navigator to draw a small part of the position circle in his vicinity to a practical problem
- explains the assumptions made when plotting celestial position lines and the circumstances in which they may become significant
- determines the direction of a position line through an observer and a position through which it passes
- defines and evaluates the co-latitude, polar distance and zenith distance and uses them as the sides of the PZX triangle
- solves the PZX triangle to find the calculated zenith distance of the body when it is out of the meridian

- applies this calculated zeníth distance to the true zenith distance of the body to find the intercept and the intercept terminal point

1.1.2 TERRESTRIAL AND COASTAL NAVIGATION

Textbooks: T1, T2, T3

Teaching aids: A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, A15, A16, A19, A22, A37, V5

Required performance:

2.1 Definitions - Earth (7 hours)

- defines 'great circle', 'small circle', 'spherical angle', 'spherical triangle', 'poles of a great circle'
- defines 'earth's poles', 'equator' and 'meridians'
- defines 'latitude' and 'parallels of latitude', 'prime meridian' and 'longitude'
- defines 'difference of latitude' and 'difference of longitude'
- describes the earth as an ellipsoid.
- defines 'compression', and states its value
- defines 'international nautical mile', 'cable' and 'knot'

2.2 Charts (12 hours)

- demonstrates basic knowledge of chart projections
- defines 'natural scale' of a chart
- describes the requirements of a chart appropriate for marine navigation
- identifies the Mercator chart as a mathematical projection and understands the principles of its construction.
- describes the properties of the chart and the degree to which it meets navigational requirements and also its limitations
- demonstrates the use of a chart catalogue
- demonstrates the correcting of charts according to Notices to Mariners

2.3 Electronic Charts (4 hours)

- demonstrates knowledge of electronic charts (See also section 1.5)
- describes the differences between Vector and Raster electronic charts

- explains the major characteristics of ECDIS and ECS data such as data term and definition; data contents; data structure; attribute; data quality and it accuracy
- describes the terms and definitions used in the context of ECDIS and ECS
- describes ECDIS and ECS display characteristics
- explains the scope and selection of chart data display categories

2.4 Datums (2 hours)

-- explains the rotation of the earth about its axis
-- describes the directions on the earth's surface
-- describes the direction of the ship's head on a gyro-compass (gyro course)
-- describes the direction of the ship's head on a magnetic compass (compass course)

2.5 Distances (3 hours)

- describes the approximate polar and equatorial circumferences of the earth
- demonstrates how to measure the distance between two positions on a Mercator chart based on the latitude of the two positions

2.6 Position Lines and Positions (15 hours)

- defines a position
- gives the radar distance off a charted object and plots its position circle on a chart
- plots a position on the chart from simultaneous cross bearings and from bearing and distance off
- explains the methods used to obtain simultaneous cross bearings with least error
- defines 'dead reckoning position (DR)', 'estimated position (EP)' and 'fixed position'
- plots a dead reckoning position on the chart and marks accordingly
- plots an estimated position on the chart and marks accordingly
- plots position lines - straight line, circle, hyperbola
- finds a position line by bearing, horizontal angle, vertical sextant angle~~,~~ and transit line

- determines a position by a combination of bearing, distance and the methods in the above objective
- finds a position by simultaneous bearings of two objects
- finds the distance that the ship will pass off a given point when abeam
- constructs a position line to clear a navigational danger by a given distance

2.7 Sailings (34 hours)

- defines 'departure' and states the relationship to difference of longitude
- defines 'true course' and 'rhumb line'
- derives the plane sailing formulae
- explains the relationship between departure and difference of longitude in cases involving a change of latitude, by using mean latitude
- uses the parallel sailing formula:

  $$\frac{\text{departure}}{\text{diff. of longitude}} = \text{cosine of latitude}$$

- calculates the distance between two positions on the same parallel of latitude
- calculates the difference of longitude for a given distance run along a parallel of latitude
- derives the final position after sailing along a parallel of latitude
- demonstrates the uses of the plane sailing formulae
- understands the meaning of, and can derive, mean latitude
- calculates the correct departure to use in a plane sailing problem
- calculates the course and distance between two positions, using the plane sailing formula
- calculates a DR position or an estimated position by using the plane sailing formula, given compass course and compass error, distance by log, estimated speed, tidal and current information and leeway
- describes the layout of a traverse table
- derives the information required in a parallel or plane sailing problem, using a traverse table or calculator
- solves problems of plane sailing
- solves problems of DR and fixing positions, using plotting charts
- states the Mercator sailing formula

- uses the Mercator formula to calculate course and distance between two positions
- uses the Mercator formula to calculate the final position, given the initial position, course and distance
- demonstrates understanding of great circle sailing including composite and limited latitude great circles
- calculates initial course and distance of a great-circle track
- calculates composite great circles
- demonstrates the use of gnomonic charts for plotting the great circle between two points
- transfers a great circle from a gnomonic to a to a Mercator chart

2.8 Chartwork Exercises (70 hours)

- defines 'course' and 'distance'
- lays off true course between two positions and marked with appropriate symbol
- finds the distance between two positions
- calculates the speed between two positions
- defines 'set', 'rate', 'drift' and 'leeway' due to wind
- describes 'ship's speed', 'effective speed', 'course and 'distance made good', 'applied leeway'
- finds the course and distance made good with a tidal stream or current
- finds the course to steer, allowing for tidal stream or current
- finds the set and rate of tidal stream or current from charts or tables
- explains the term 'running fix' and uses the method to plot a position
- finds positions by running fix in a tidal stream or current
- calculates the actual set and rate of tidal stream or current from DR and fixed positions

2.9 Information from Charts, Lists of Lights and Other Publications (44 hours)

- recognises and demonstrates the use of the symbols and abbreviations on a chart, especially lighthouses, buoys, beacons, radio beacons and other navigational marks
- identifies the characteristics and range of lights
- calculates the distances of sighting lights and dipping distances
- identifies the symbols for chart depths and nature of the bottom and explains the use of soundings
- recognises coastlines, coast and radar-responsive targets
- interprets coastline contours, bottom topography, depths and nature of bottom
- uses the tidal information given on a chart
- recognises traffic lanes and separation zones
- explains the danger of placing implicit reliance upon floating navigational aids
- explains the danger of approaching navigational aids too closely
- obtains and appraises information from navigational publications including sailing directions, notices to mariners, radio navigational warnings and ship's routeing information.
- demonstrates simple passage planning and execution including use of sailing directions, tide tables, radio navigational warning and ship's routeing information within parameters established by the Master
- explains the use of clearing marks and horizontal and vertical danger angles
- recognises suitable passages, approaches and anchorages in clear weather and thick weather, using radar-responsive targets demonstrate planning of a passage between two ports from berth to berth using the procedures for passage planning as per the Guidelines for Voyage Planning provided by IMO in Resolution A.893(21)

2.10 IALA Maritime Buoyage System (2 hours)

- explains the principles and rules of the International Association of Lighthouse Authorities (IALA) Maritime Buoyage System, Systems "A" and "B"
- recognises the lights and shapes displayed on lateral and cardinal marks
- recognises the lights and shapes displayed on other types of buoys in the system

2.11 Tides (18 hours)

- explains the basic theory of tides

- defines 'spring tides', 'neap tides', 'height of tide' 'high water' and 'low water', 'mean high water springs', 'mean high water neaps', 'mean low water springs', 'mean low water neaps', 'range', 'chart datum', "highest astronomical tide"
- calculates the spring and neap ranges for standard and secondary ports
- finds the predicted time and height of high and low water at standard and secondary ports
- finds the time of a desired height of tide

2.12 Keeping a Log (3 hours)

- describes the rules, regulations and common practice regarding keeping of a navigational log and voyage records
- describes the proper keeping of different kinds of log during ocean passages, coastal navigation and in port in line with the requirement in the company's ISM Safety Management System

1.1.3 ELECTRONIC SYSTEMS OF POSITION FIXING AND NAVIGATION

Textbooks: T17, T25, T27
Training aids: A1, A27, A28

Required performance:

3.1 Basic Principles of Terrestrial Navigation Systems (2 hours)

- describes, with reference to position fixing, the nature of a hyperbola
- draws a hyperbolic pattern associated with two foci, with the baseline divided into an exact number of equal divisions
- explains the principles of the hyperbolae being position lines
- describes the causes of ambiguity and reduced accuracy in the baseline extension area
- combines two hyperbolic patterns to illustrate the method of ascertaining position

3.2 Loran-C System (3 hours)

- describes the basic Loran-C and eLoran system
- draws a block diagram of a Loran-C receiver, showing how time differences are measured

- describes how ambiguity in a position line is resolved
- explains why third-cycle matching is used
- explains how the use of sky waves affects the measured time difference
- describes typical radii of coverage areas
- identifies the Loran chart and the additional information printed thereon
- switches on equipment; selects chain and relates the time differences obtained to the correct station pair
- recognises warnings which indicate that the system may be faulty

3.3 Enhanced Loran (e-Loran) (2 hours)

- describes the basic operating principles of eLoran
- describes the principal difference between eLoran and traditional Loran-C system.
- explains the use of eLoran when satellite services are disrupted.
- states that each user's eLoran receiver will be operable in all regions where an eLoran service is provided .
- describes the control, operating and monitoring systems of eLoran. .
- states that eLoran transmissions are synchronized to an identifiable, publicly-certified, source of Coordinated Universal Time (UTC) by a method wholly independent of GNSS
- explains the view mode and signal tracking of eLoran.
- describes the advantages and limitations of eLoran

3.4 Global Navigation Satellite Systems (10 hours)

- describes the principles of operation of global navigation satellite systems
- states that the system will provide continuous world-wide position-fixing capabilities
- describes the intended level of accuracy of the system

3.5 GPS Systems (10 hours)

- describes the basic principles of the Global Positioning System (GPS)
- describes the system configuration

- states the frequencies that are used
- describes the C/A & P codes
- describes how the basic line measurement is obtained
- describes the Dilution of Precision (DOP)
- describes the various DOPs that are used
- describes the various errors of GPS
- describes the reasons for selective availability and the effect it may have on the accuracy of a fix
- describes differential GPS
- describes the accuracy obtainable with GPS and how the accuracy can be downgraded
- explains WGS 84
- explains why a fix obtained from the GPS receiver cannot be plotted direct onto a navigational chart
- explains datum shifts
- describes the advantages and limitations of GPS

3.6 Augmented Satellite Systems (1 hour)

- describes the basic principle of Differential GPS
- describes how DGPS stations can transmit the corrections
- describes the Regional Satellite Navigation Systems such as China's BeiDou (COMPASS) Navigation Satellite System, India's Indian Regional Navigational Satellite System (IRNSS), Japan's Quasi-Zenith Satellite System (QZSS) and France's Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS).
- escribes the limitation of the DGPS receiver

3.7 GLONASS(1 hour)

- describes the principle on which the GLONASS works

- explains the different satellite constellation configurations under GLONASS and GPS respectively

- describe the advantage of the receiver capable of operating both GLONASS and GPS "combined GPS/GLONASS receiver equipment"

- describes the limitation of the GLONASS system receiver

3.8 Galileo (1 hour)

- explains the principle of Galileo as the European satellite navigation system.

- describes that Galileo comprises 30 medium earth orbit (MEO) satellites in 3 circular orbits.

- states the satellite geometry and dual atomic clocks in the Galileo system.

- states that atomic clock signal information is used to calculate the position of the receiver by triangulating the difference in received signals from multiple satellites.

- describes the limitations of the Galileo system receiver

1.1.4 ECHO-SOUNDERS (9 HOURS)

Textbooks: T17, T25
Training aids: A1, A29, A30

Required Performance:

4.1 Echo-Sounders (9 hours)

- describes the basic principles of marine echo-sounding equipment

- identifies the main components on a simple block diagram of an echo-sounder, and states the function of each

- describes the accepted value of the velocity of sound in seawater and the limits within which the true value may lie

- describes the physical factors which affect the velocity sound in seawater

- operates a typical echo-sounder and demonstrates an ability to carry out basic user maintenance, e.g. clean platen, change paper, change and adjust stylus

- differentiates between range and phase, and demonstrates an awareness of the dangers of using the wrong phase

- distinguishes between inaccuracies caused by instrument and scale error and those caused by false echoes

- explains the causes of inaccuracies to instrument or scale error and states their likely magnitude and measures that may be taken to eliminate them

- recognises the various types of "false" echo that may be observed, describes their formation and states the possible action to remove them from the trace

- describes the potential errors due to trim, heel and transducer separation

1.1.5
OMPASS - MAGNETIC AND GYRO (26 hours)

Textbooks: T2, T8, T15, T17, T20, T25, T35
Training aids: A1, A4, A5, A14, A23, A26, A31, A32

Required Performance:

5.1 The Magnetism of the Earth and the Ship's Deviation (6 hours)

- explains the theory of magnetism as applied to ferromagnetic materials
- describes a simple magnet, its poles and the law of attraction and repulsion
- describes the magnetic field around a magnet
- describes qualitatively flux density and field strength
- describes magnetic induction and differentiates between 'hard' and 'soft' iron
- explains the meaning of the terms:
  - intensity of magnetization
  - permeability
  - magnetic susceptibility(no mathematical formula required)
- describes the magnetic field of the earth
- defines 'magnetic poles' and 'magnetic equator'
- defines 'angle of dip'
- explains how the earth's total field can be split into horizontal and vertical components
- defines 'magnetic variation' and explains why it is a slowly changing quantity
- states that a compass needle which is constrained to the horizontal can respond only to the horizontal components of the earth's field and the field due to the ship's magnetism

- describes the effect of introducing a disturbing magnetic force into the vicinity of a compass needle
- states that the direction and strength of a magnetic field may be represented by a vector
- uses a vector diagram to find the field at a point resulting from two given fields
- states that a compass needle will align itself with the resultant field
-

5.2 The Magnetic Compass (6 hours)

- describes the construction of a liquid card magnetic
- sketches a section through the compass to show the float chamber, the pivot support and the arrangement of magnets
- xplains how the card is kept practically horizontal in all latitudes
- escribes the composition of the liquid and explains how allowance is made for changes in volume of the liquid
- describes how to remove an air bubble from the compass bowl
- describes how to check that the card is turning freely on its pivot
- explains how the compass bowl is supported in the binnacle
- describes the marking of the lubber line and its purpose
- describes a binnacle and the arrangement of correcting devices provided
- defines 'deviation' and states how it is named
- illustrates with sketches the deviations on various headings produced by permanent magnetism with a pole or poles lying in the plane of the compass card
- explains the need for care in the placing of portable items of magnetic material, including spare corrector magnets, or electrical equipment in the vicinity of compasses
- explains the need for regular checking of the compass error
- explains why compass error should be checked after a major alteration of course
- xplains why regular comparisons of standard compass, steering compass and gyro-compasses should be made
- xplains that the approximate error of the standard compass can be obtained by comparison with the gyro-compass if no other means is available

– emonstrates taking bearings of celestial bodies and landmarks

5.3 The Gyro-Compass (6 hours)

- describes a free gyroscope and its gimbal mountings
- states that in the absence of disturbing forces the spin axis of a free gyroscope maintains its direction in space
- explains what is meant by gyroscopic inertia and precession
- describes the precession resulting from a torque about axes perpendicular to the spin axis
- explains that friction at gimbal pivots produces torques which give rise to precession
- states that the rate of precession is proportional to the applied torque
- states that 'tilt' as movement of the spin axis in the vertical plane
- states that 'drift' as the apparent movement of the gyroscope in azimuth resulting from the earth's rotation
- describes non-mathematically the apparent movement of a free gyroscope on the earth's surface, given its position and initial attitude
- uses the apparent motion of a celestial body in the direction of the gyro axis to aid the description above
- explains how a free gyroscope can be made north-seeking by the use of gravity control and describes the resulting oscillations of the axis
- describes the use of damping in azimuth and damping in tilt to cause settling of the axis and thus produce a gyro-compass
- explains that control and damping can be achieved by replacing the ballistic elements with electrical signals, provided by tilt sensors, to produce torques about the vertical and horizontal axes
- describes a familiar gyro-compass with particular reference to:
    - the method of support
    - – ontrol and damping arrangements
    - – the method of maintaining the heading indication in line with the axis of the gyro
    - -- the transmission of heading to repeaters

- demonstrates the starting of the gyro-compass and explains how to minimize settling time by slewing and levelling it to the correct heading
- explains the necessary time for the compass to settle after switching on prior to sailing
- lists the settings to be made or adjusted while the compass is in use
- explains how the repeater system is switched on and aligned with the master gyro-compass
- describes how gyro heading input is supplied to a radar installation
- describes the alarms fitted to a gyro-compass

5.4 Compass Course and Bearing Corrections (6 hours)

- defines true, magnetic and compass north

- finds deviation and variation from tables and charts
- calculates true course from compass course
- calculates compass course from true course
- measures compass error, using a transit bearing
- applies compass error to the ship's head and compass bearings to convert to true
- takes a compass bearing of a charted object and lays the true bearing off on the chart

5.5 Errors of the Compass and Azimuths (13 hours)

- obtains the error of the magnetic compass or gyro compass by comparing the compass bearing of the body with the true azimuth of the body obtained at the time of observation

- obtains the azimuth of the body from tables, or by formula or calculation using GMT of observation, information from the Nautical Almanac, LHA of the body and the observer's DR position
- obtains from tables or by calculation, using the observer's DR position and information from the Nautical Almanac, the true bearing of a heavenly body on rising or setting, i.e. solves an amplitude problem

- obtains the magnetic variation for the observer's position, using isogonal lines or other information on the chart

- applies variations to the error of the magnetic compass to find the deviations for the direction of the ship's head

- calculates compass error and gyro error, from transit or charted range bearings and bearings to distant fixed objects

5.6 Fluxgate Compass (1 hour)

- Defines singles axis and dual axis
- Explains basic operation
- Explains TMC
- Describes solid state type

1.1.6. STEERING CONTROL SYSTEMS

Textbooks: T17, T25
Training aids: A1, A33

Required performance:

6.1 Steering Control Systems (6 hours)

- explains the principle of an automatic pilot system

- explains the functions of the manual settings
- describes the procedures for change-over from automatic to manual steering and vice versa
- explains what is meant by an adaptive automatic pilot and briefly explains how it functions
- describes the course monitor and the off-course alarm
- describes the operation of the course recorder log
- lists the other alarms fitted to the system
- states that the automatic pilot should be included in the steering gear testing prior to the ship's departure
- explains the regulation regarding the use of the automatic pilot
- explains in the recommendation on performance, standards for automatic pilots
- explains the need for regular checking of the automatic pilot to ensure that it is steering the correct course
- states that the automatic pilot should be tested manually at least once per watch
- describes the factors to take into account regarding the change-over to manual control of steering in order to deal with a potentially hazardous situation

1.1.7 METEOROLOGY (79 hours)

Textbooks: T19, T21, T22
Training aids: A1, A20, A34, A35, A36

Required Performance:

7.1 Shipborne Meteorological Instruments (5 hours)

- describes the basic principle of an aneroid barometer
- reads the atmospheric pressure from an ordinary aneroid barometer and precision aneroid barometer if available
- reads the temperature from a thermometer
- describes the function of a hygrometer
- the basic principles of wind sensors and demonstrates ordinary readings of wind speed

7.2 The Atmosphere, its Composition and Physical Properties (4 hours)

- describes the composition of the earth's atmosphere, mentioning dry air and its constituents, water vapour and aerosols

- draws a typical vertical temperature profile through the lower 100 km of the earth's atmosphere
- defines 'troposphere', 'tropopause', 'stratosphere', 'stratopause', 'mesosphere', 'mesopause' and 'thermosphere'
- describes the main features of the troposphere
- describes the importance of the sun as the principal energy source for atmospheric processes
- describes the nature of solar radiation, (scattering, reflection and absorption)
- explains the effect on insolation of a variation in latitude
- explains the effect on insolation of a variation in the sun's declination
- explains the effect on insolation of a variation in the length of daylight
- defines 'water vapour'
- describes the properties of water vapour in the atmosphere
- defines 'evaporation', 'condensation', 'latent heat of vaporization'
- defines 'saturated air'
- describes the processes of mixing, cooling and the evaporation of water vapour, by which a sample of air may be brought to saturation
- defines 'dewpoint', 'absolute humidity', 'relative humidity', 'vapour pressure'

7.3 Atmospheric Pressure (4 hours)

- states that pressure equals force per unit area
- states that the atmosphere exerts a pressure on any surface placed within it
- states that the atmospheric pressure on a unit area of a surface is equal to the weight of the "air column" extending from that surface to the outer fringes of the atmosphere
- states that atmospheric pressure decreases with height above sea level
- states that atmospheric pressure acts in all directions

- states that the basic unit of pressure is N/m^2
- states that 1 millibar = 10^{-3} bar = 10^2 N/m^2
- states that the atmospheric pressure at sea level normally varies between about 940 mbar and 1050 mbar
- states that the average pressure at sea level is 1013.2 mbar
- states that the surface pressure rises if air is added to the 'column' above the surface, and vice versa
- defines 'isobar'

7.4 Wind (8 hours)

- defines 'wind'
- describes the Beaufort scale of wind force
- explains qualitatively the pressure gradient force
- explains qualitatively the Coriolis (geostrophic) force
- explains the surface wind circulation around high and low-pressure centres
- inserts surface wind directions on a map showing pressure distribution and indicates relative wind speeds at various places within the pressure field
- explains Buys-Ballot's Law
- explains the method of estimating the strength of the wind from the appearance of the sea surface, using the Beaufort wind scale
- lists the factors, other than the wind speed, which affect the appearance of the sea surface
- explains three difference between apparent and true wind
- determines the true wind velocity by using a vector diagram, given the apparent wind and the ship's course and speed
- describes the method of estimating the wind direction from the appearance of the sea surface

- demonstrates the use of a geostrophic wind scale

7.5 Cloud and Precipitation (4 hours)

- states that clouds form when air containing water vapour rises, cools adiabatically and becomes saturated
- describes the need for and defines condensation nuclei
- states that a cloud can consist of ice crystals, supercooled water droplets, water droplets or any combination of these
- lists and describes the ten basic cloud types
- describes the probable base heights of the ten principal cloud types
- defines 'precipitation'
- defines 'rain', 'drizzle', 'hail', 'snow' and 'sleet'

7.6 Visibility (5 hours)

- states that visibility is reduced by the presence of particles in the atmosphere, near the earth's surface
- defines 'fog', 'mist', 'haze'
- applies the concept of processes leading to supersaturation to a classification of fogs as mixing, cooling or evaporation fogs
- explains qualitatively the formation of radiation fog, mentioning areas, seasons and reasons for its dispersal
- describes the effect of pollution on the formation of radiation fog
- explains qualitatively the formation of advection fog, mentioning areas, seasons and reasons for dispersal
- explains qualitatively the conditions leading to the formation of sea smoke, and typical areas where sea smoke may be encountered
- describes methods of estimating the visibility at sea, by day and by night, and the difficulties involved

7.7 The Wind and Pressure Systems over the Oceans (10 hours)

- explains qualitatively, with the aid of sketches, the circulation cells which would exist on a rotating earth, not inclined to its orbit of rotation around the sun, and with a homogeneous surface

- draws the mean surface pressure and wind distribution over the earth's surface in January and July

- describes the characteristics and location of the doldrums, intertropical convergence zone, trade winds, sub-tropical oceanic highs, westerlies and polar easterlies

- describes a monsoon regime

- lists the areas which experience a true monsoon regime

- applies previous concepts to a qualitative explanation of the causes of monsoon regimes

- applies previous concepts to a qualitative explanation of the weather associated with the January and July monsoons of the Indian Ocean, China Sea, north coast of Australia, west coast of Africa and the north east coast of Brazil

- applies the concept of horizontal temperature differences to a qualitative explanation of the formation of land and sea breezes

- explains the formation of anabatic and katabatic winds

- lists the regions of occurrence of anabatic and katabatic winds

- provides examples of local winds

7.8 Structure of Depressions (12 hours)

- defines 'air mass'

- explains the formation of an air mass

- defines 'source region'

- explains the characteristics required of a source region

- describes the source-region characteristics of arctic, polar, tropical and equatorial air-mass types

- defines 'warm front', 'cold front'

- knows the symbols for warm and cold fronts and identifies them on a weather map

- describes, with the aid of a diagram, the weather experienced during the passage of an idealized warm front

- describes, with the aid of a diagram, the weather experienced during the passage of an idealized cold front

- defines 'depression'

- identifies a depression on a surface synoptic or prognostic chart

- describes the stages in the life cycle of a polar front depression

- describes a family of depressions

- draws a diagram of a polar front depression, for both northern and southern hemispheres, showing isobars, warm and cold fronts, wind circulation and warm sector

- draws a cross-section through a polar front depression, on the poleward and equatorial side of the centre, showing fronts, cloud and precipitation areas

- describes the usual movement of a polar front depression

- applies previous concepts to an explanation of the weather changes experienced when a frontal depression passes with its centre on the poleward side of an observer in the northern hemisphere and in the southern hemisphere

- describes the process leading to the occlusion of a polar front depression

- identifies a trough of low pressure on a surface synoptic or prognostic chart

- describes the weather associated with the passage of a trough

7.9 Anticyclones and Other Pressure Systems (6 hours)

- defines 'anticyclone'

- draws a synoptic pattern of an anticyclone, for both northern and southern hemispheres, showing isobars and wind circulation

- identifies an anticyclone on a surface synoptic or prognostic chart

- describes the weather associated with anticyclones

- describes a ridge of high pressure

- draws a synoptic pattern for a ridge, showing isobars and wind directions

- describes a typical weather sequence during the passage of a ridge between depressions across the observer's position

- describes a col or a void between a convergence of pressure systems

- draws a synoptic pattern for a col or a void between a convergence of pressure systems, showing isobars and wind directions

- describes the weather associated with a col or a void between a convergence of pressure systems

- identifies ridges and cols or voids between the convergence of pressure systems on a surface synoptic or prognostic chart

7.10 Weather Services for Shipping (5 hours)

- describes the organization, functions and objectives of the World Meteorological Organisation

- describes the sources of weather information available to shipping including internet and email

- describes the information flow between merchant ships and Meteorological Offices

- describes the services provided for shipping by Meteorological Offices

- describes the appropriate weather bulletin and the contents of each of its sections

- describes the types of information received by facsimile machine

- describes the services provided for storm warnings

7.11 Recording and Reporting Weather Observations (6 hours)

- explains the need for meteorological codes

- uses the Ship's Code and Decode Book to code a ship's full report

- uses the Ship's Code and Decode Book to decode a reduced report from a shore station

- uses Beaufort letter abbreviations for present and past weather and total cloud amount

- interprets a ship or shore station plot

7.12 Application of Meteorological Information (10 hours)

- applies previous concepts to the interpretation of symbols and isobaric patterns on weather charts and facsimile charts

- applies previous concepts to the interpretation of synoptic and prognostic charts to ascertain wind directions, areas of strong winds, cloud and precipitation areas, fog areas, ice, and areas of fine weather

- explains how weather observations at a ship can be used to improve the forecast derived from synoptic and prognostic charts

- evaluates the weather forecast information received

COMPETENCE 1.2 Maintain a Safe Navigational Watch	**IMO Reference**

TRAINING OUTCOMES: STCW Code Table A-II/1

Demonstrates a knowledge and understanding of:

1.2.1 THOROUGH KNOWLEDGE OF THE COLLISION REGULATIONS

1.2.2 PRINCIPLES IN KEEPING A NAVIGATIONAL WATCH

1.2.3 BRIDGE RESOURCE MANAGEMENT

1.2.4 THE USE OF ROUTEING

1.2.5 THE USE OF INFORMATION FROM NAVIGATIONAL EQUIPMENT FOR MAINTAINING A SAFE NAVIGATIONAL WATCH

1.2.6 KNOWLEDGE OF BLIND PILOTAGE TECHNIQUES

1.2.7 THE USE OF REPORTING IN ACCORDANCE WITH THE GENERAL PRINCIPLES FOR A SHIP REPORTING SYSTEM AND WITH VTS PROCEDURES

COMPETENCE 1.2 Maintain a Safe Navigational Watch **IMO Reference**

1.2.1 THOROUGH KNOWLEDGE OF THE COLLISION REGULATIONS

Textbooks: T6, T11, T14, T19, T22, T24
Training aids: A1, A37, V3

Required Performance:

1.1 The Content, Application and Intent of the International Regulations for Preventing Collisions at Sea, 1972, as amended (100 hours)

- explains the application of the rules as set out in Rule 1
- defines the term 'traffic separation scheme'
- describes the responsibility to comply with the rules as set out in Rule 2
- cites examples of precautions which may be required by the ordinary practice of seamen or by the special circumstances of the case
- gives examples of circumstances which may make a departure from the rules necessary
- describes the general definitions which apply throughout the rules
- explains the term 'vessel constrained by her draught'
- distinguishes between 'under way' and 'making way'
- explains 'a proper look-out' and interprets the intent of 'full appraisal of the situation and the risk of collision'
- explains the use of radar in the context of Rule 5:
    - explains what is meant by a safe speed
    - describes, with reference to court cases, how 'proper and effective action' and 'within a distance appropriate to the prevailing circumstances and conditions' may be interpreted
    - describes the factors to be taken into account in determining a safe speed
    - explains how the use of radar affects the determination of safe speed
- explains what is meant by risk of collision:

- describes the proper use of radar equipment in determining whether a risk of collision exists

- explains the dangers of making assumptions on the basis of scanty information, citing examples from clear weather as well as the use of radar

- illustrates, using examples from court cases, how failure to plot may lead to a lack of appreciation of a developing situation

- illustrates, using examples from court decisions, the following actions to avoid collision referred to in Rule 8:
  - positive action in ample time large enough to be readily apparent
  - alteration of course alone
  - passing at a safe distance
  - checking the effectiveness of action taken
  - reduction of speed
  - taking all way off

- demonstrates an understanding of Rule 9 by:
  - defining the terms 'narrow channel' and 'fairway'
  - describing how to proceed along the course of a narrow channel
  - describing the navigation of small craft and sailing vessels in a narrow channel
  - stating the restrictions on crossing the channel or fairway describing the conduct of vessels engaged in fishing
  - stating the procedure for overtaking in a narrow channel
  - describing the actions to be taken on nearing a bend in a narrow channel or fairway

- defines 'traffic lane', 'separation line', 'separation zone', 'inshore traffic zone'
- describes how to navigate in a traffic separation scheme with reference to:
  - entering and leaving the traffic separation scheme
  - entering and leaving traffic lane
  - crossing lanes
  - the use of inshore traffic zones

- crossing separation lines or entering separation zones other than when crossing, joining or leaving a lane

- describes the requirements for vessels:
  - navigating in areas near the terminations of traffic separation schemes
  - anchoring
  - not using a traffic separation scheme
  - engaged in fishing

- states that a vessel of less than 20 metres in length or a sailing vessel must not impede the safe passage of a power-driven vessel following a traffic lane

- states that the exemptions for vessels restricted in their ability to manoeuvre when engaged in an operation for the:
  - maintenance of safety of navigation
  - laying, servicing or picking up of a submarine cable

- explains the meaning of 'precautionary area'
- defines 'deep water route' and describes for whom such a route is intended
- explains what is meant by 'vessels in sight of one another'
- demonstrates, with the use of models displaying proper signals or lights, a navigation light simulator or otherwise, the proper action to take to avoid collision with other vessels in sight
- explains how to decide when a vessel is an overtaking vessel
- compares and analyses the various avoiding actions which may be taken by an overtaking vessel
- explains the application of Rule 14, Head-on Situation
- explains why the give-way vessel in a crossing situation shall, if the circumstances admit, avoid crossing ahead of the other vessel
- explains the application of Rule 15 when crossing narrow channels and traffic lanes
- explains how Rule 16 and Rule 8 relate regarding **the** action by a give-way vessel
- explains the position of stand-on vessel in cases where a risk of collision exists between more than two vessels
- explains how to decide when to take avoiding action as stand-on vessel
- describes the actions which may be taken by the stand-on vessel
- describes the avoiding action which must be taken by the stand-on vessel
- states that a potential collision situation may be divided into the following four stages:

  - at long range, before risk of collision exists and both vessels are free to take any action
  - risk of collision applies, the give-way vessel is required to take action and the other vessel must keep her course and speed
  - the give-way vessel is not taking appropriate action
  - collision cannot be avoided by the action of the give-way vessel alone
- explains the responsibilities between vessels with reference to Rules 18 and 3
- explains the application of Rule 19
- compares Rule 6 and Rule 19 regarding the determination of safe speed
- explains how courts have interpreted 'a close-quarters situation'
- explains how courts have interpreted 'navigate with extreme caution'
- demonstrates, using a manoeuvring board or radar simulator, how to determine risk of collision and the proper action to take to avoid collision in restricted visibility
- describes the application of the rules concerning Lights and shape
- explains the definitions in Rule 21
- describes the visibility of lights as prescribed by Rule 22
- identifies the lights and shapes carried by any type of vessel and the operation or circumstances signified by them, including the additional signals for fishing vessels fishing in close proximity
- describes the positioning, spacing and screening of lights
- describes the shapes required by the rules
- describes the sound signals to be used by vessels in sight of one another
- describes the sound signals to be used by vessels in or near an area of restricted visibility
- describes the use of signals to attract attention
- lists the distress signals set out in Annex IV of COLREG 72

1.2.2 PRINCIPLES IN KEEPING A NAVIGATIONAL WATCH

Textbooks: T6, T11, T14, T19, T22, T24
Training aids: A1, A37, V4

Required Performance:

2.1 Keeping a Safe Navigational Watch (6 hours)

- states that the officer of the watch is responsible for navigating safely, with particular regard to avoiding collision and stranding

- describes the principles to be observed in keeping a navigational watch as set out in Section A-VIII of STCW Code regarding:
    - navigation
    - navigational equipment
    - navigational duties and responsibilities
    - handing over and taking over the watch
    - look-out
    - navigation with a pilot embarked
    - protection of the marine environment
    - Bridge Navigation Watch Alarm System
    - Blind pilotage technique
    - General principles for ship reporting systems and with VTS procedures

- describes the recommendation on operational guidance for officers in charge of a navigational watch contained in Chapter VIII, Section A-VIII/2 of the STCW Code:
    - maintenance of an efficient look-out
    - the use of engines and sound signalling apparatus
    - taking over the navigational watch
    - periodic checks of navigational equipment
    - compliance with SOLAS V/19 regarding the use of the automatic pilot and the change-over to manual steering and vice-versa
    - electronic navigational aids
    - the use of radar
    - navigation in coastal waters
    - conduct of the watch in clear weather
    - actions to take in restricted visibility
    - the circumstances in which the officer of the watch should call the master
    - navigation with a pilot embarked
    - briefing of watchkeeping personnel

- describes the duties of the officer of the watch while at anchor

- lists the entries which should be made in the log-book

(Note: The following knowledge is not required under Part A, Chapter II Table A-II/1 of the STCW Code. However it is recommended that the trainee has basic knowledge of the following:)

2.2 Keeping a Watch in Port

Keeping an Effective Deck Watch in Port under Normal Circumstances

- states that arrangements for keeping watch in port should:
  - ensure the safety of life, ship, cargo and port
  - observe international, national and local rules
  - maintain order and the normal routine of the ship

- describes taking over the watch and lists the information which the officer being relieved should pass to the relieving officer

- lists the matters on which the relieving officer should satisfy themselves before assuming charge of the watch

- describes how the watch should be kept and lists the points to which attention should be paid

- describes the actions to take on receiving a storm warning or in an emergency threatening the safety of the ship

- lists the entries which should be made in the log-book

Keeping a Safe Deck Watch in Port When Carrying Hazardous Cargo

- defines 'hazardous cargo'

- states that sufficient personnel should be readily available on board when carrying hazardous cargo in bulk

- states that special requirements may be necessary for special types of ships or cargo, particularly with respect to:

  - the number of crew required on board
  - the state of readiness of fire-fighting appliances and other safety equipment
  - special port regulations
  - communications with the shore in the event of an emergency arising
  - special precautions to prevent pollution of the environment

- states that the officer of the watch should be aware of the nature of the hazards and any special precautions necessary for the safe handling of cargo

- states that the officer of the watch should be aware of the appropriate action in the event of a spillage or fire

- describes the procedure for entry into enclosed spaces using a 'permit to work', and the monitoring of work in progress

- describes the arrangements and procedures for rescue from an enclosed space in an emergency

1.2.3 BRIDGE RESOURCE MANAGEMENT R1

Textbooks: T11, T24
Teaching aids: A37, V4

Required performance:

Bridge Resource Management (8 hours)

Note that this section is intended to ensure that trainees can apply the generic leadership, teamwork and resource management competence developed in Function 3 to the bridge environment.

- describes the basic principles of bridge resource management
- explains how responsibility for the safety is clearly defined at all times, including periods when the master is on the bridge and while under pilotage
- demonstrates clear, concise communications and acknowledgements (at all times) in a seaman-like manner
- demonstrates the allocation, assignment and prioritisation of resources
- demonstrates the importance of ensuring the effectiveness of communication between bridge team members
- explains the importance of ensuring the effectiveness of information exchange with pilot
- demonstrates effective information exchange
- defines "situational leadership"
- explains the relationship between assertiveness and leadership
- explains the importance of challenge and response
- explains the importance of obtaining and maintaining situational awareness
- demonstrates appropriate challenges and responses
- demonstrates the ability to maintain situational awareness in complex situations

1.2.4 THE USE OF ROUTEING R1, R33

Textbooks: T22, T26

Teaching aids:

Required Performance:

4.1 Weather Routeing (2 hours)

- explains the basic routines of weather routeing

- demonstrates the use of climatological information from routeing charts and sailing directions for route planning

- explains how meteorological forecasts, and synoptic and forecast charts are used to modify the route plan to utilise favourable conditions and mitigate adverse conditions

- states that with shore based services:
    - comprehensive meteorological information is available to personnel ashore who issue advice as to route planning and monitor the vessel's voyage, issuing forecasts and advice as to the utilisation of favourable conditions and mitigation of unfavourable conditions

    - states that comprehensive meteorological information and on board software may be available to the Master who plans the route and then monitors the vessel's voyage and uses forecasts and warnings to utilise favourable conditions and mitigate the effects of unfavourable conditions

    - states that when the ship is weather routed messages are received from the routeing service which may warn of adverse conditions (to be expected) and that these must be brought to the attention of the Master

4.2 Use of routeing in accordance with general provisions on ships' routeing (2 hours) R3

- uses published routing instructions in passage planning

1.2.5 THE USE OF INFORMATION FROM NAVIGATIONAL EQUIPMENT FOR MAINTAINING A SAFE NAVIGATIONAL WATCH

.1 Speed measurement
.2 Operational use of AIS (*See IMO Model Course No 1.34)*

1.2.6 KNOWLEDGE OF BLIND PILOTAGE TECHNIQUES

Textbooks / Bibliography:
Teaching aids:

Required Performance:

6.1 Knowledge of navigational techniques used for safe navigation in restricted visibility (2 hours)

- explains the importance of using parallel index techniques using Radar
- describes the provisions for using video mapping on radar / ARPA

1.2.7 THE USE OF REPORTING IN ACCORDANCE WITH THE GENERAL PRINCIPLES FOR A SHIP REPORTING SYSTEM AND WITH VTS PROCEDURES

Textbooks/ Bibliography:
Teaching aids:

Required Performance:

7.1 The use of reporting in accordance with the general principles for ship reporting systems and with VTS procedures (2 hours)

- describes the use of reporting in accordance with the general principles for ship reporting systems and with VTS procedures

COMPETENCE 1.3 Use of Radar and ARPA to Maintain Safety of Navigation	**IMO Reference**
NOTE: Training and assessment in the use of ARPA is not required for officers who serve exclusively on ships not fitted with ARPA, these limitations shall be reflected in the endorsements issued to the officer concerned.	STCW Code Table A-II/1

TRAINING OUTCOMES:

Demonstrates a knowledge and understanding of:

1.3.1. Knowledge of the fundamentals of Radar & Automatic Radar Plotting Aids (ARPA)

1.3.2. Ability to operate, and to interpret and analyse information obtained from radar, including the following:

- performance including:
  - factors affecting performance and accuracy
  - setting up and maintaining displays
  - detection of misrepresentation of information, false echoes, sea return etc., racons and SARTS
- use including:
  - Range and bearing, course and speed of other ships, time and distance of closest approach of crossing, meeting and overtaking ships
  - Identification of critical echoes, detecting course and speed changes of other ships, effect of changes in own ships course or speed or both
  - Application of the COLREGS 1972, as amended
  - Plotting techniques, relative and true motion concept
  - Parallel indexing

1.3.3. Principal types of ARPA, their display characteristics, performance standards and the dangers of over-reliance on ARPA

1.3.4. Ability to operate and to interpret and analyse information obtained from ARPA including:

- System performance and accuracy, tracking capabilities and limitations and processing delays
- Use of Operational warnings and system tests
- Methods of target acquisition and their limitations
- True and relative vectors, graphic representation of target information and danger areas
- Deriving and analysing information, critical echoes, exclusion areas and trial manoeuvres

Required performance:

As per IMO Model Course 1.07, for Radar Navigation – Operational level

COMPETENCE 1.4	Use of ECDIS to Maintain the Safety of Navigation	IMO Reference

STCW Code
Table A-II/1

TRAINING OUTCOMES:

1.4.1 DEMONSTRATES A KNOWLEDGE AND UNDERSTANDING OF ECDIS

Trainees should complete the training outlines in IMO Model Course 1.27. This includes:

- describes principal types of Electronic Chart System
- describes the differences between Vector and Raster Charts
- describes the terms and definitions used in the context of ECDIS
- explains the major characteristics of ECDIS data such as data term and definition; data contents; data structure; attribute; data quality and it accuracy
- describes the position reference system
- describes ECDIS display characteristics
- explains the scope and selection of chart data display categories
- explains the safety value available in ECDIS
- describes the automatic and manual functions of ECDIS
- explains various sensors, its accuracy requirement and state proper action to take in case malfunction
- describes the production and distribution of updates-manual, semi-automatic and automatic updating
- describes the route planning and route monitoring in ECDIS
- describes the route planning information; route planning calculation; calculation the voyage schedule; construction of a route; planned route checking for navigator safety; alternative route; optimization of route planning and ultimate route selection
- explains route and voyage monitoring; check route measurement and calculations; navigation in open sea, coastal and confined waters using ECDIS; current and wind effects

- demonstrates the uses of all specific functions and obtain all relevant information for route planning and monitoring for navigating and for the ship's safety:-

  -- sea area selection,
  -- route planning information,
  -- construction of a route,
  -- adjustment of a planned route,
  -- curve track planning,
  -- planning notes,
  -- safety values,
  -- check for navigational safety,
  -- Ultimate route, monitored area,
  -- vector time,
  -- check measurements,
  -- alarms,
  -- current and wind.

- explains the meaning of Status Indications, Indicators and Alarm relating to ECDIS

- explains the typical errors of interpretation and take proper action to avoid these errors

- explains the meaning of voyage recording, operate the corresponding functions and the reconstruction of past track

- describes the possible risk of over-reliance and complacency on ECDIS.

Required performance:
As per IMO Model Course 1.27, ECDIS

COMPETENCE 1.5 Respond to Emergencies	**IMO Reference**

TRAINING OUTCOMES: STCW Code Table A-II/1

Demonstrates a knowledge and understanding of:

1.5.1 PRECAUTIONS FOR PROTECTION AND SAFETY OF PASSENGERS IN EMERGENCY SITUATIONS

1.5.2 INITIAL ACTION FOLLOWING COLLISION OR GROUNDING

1.5.3 RESCUING PERSONS FROM THE SEA, ASSISTING A SHIP IN DISTRESS AND PORT EMERGENCIES

COMPETENCE 1.5	Respond to Emergencies	IMO Reference

1.5.1 PRECAUTIONS FOR PROTECTION AND SAFETY OF PASSENGERS IN EMERGENCY SITUATIONS

Textbooks: T16
Teaching aids: A1, A37

Required Performance:

1.1 Contingency Plans for Response to Emergencies (8 hours)

R1, R2

- lists the contents of a muster list and emergency instructions

- states that duties are assigned for the operation of remote controls such as:
  - main engine stop
  - ventilation stops
  - lubricating and fuel oil transfer pump stops
  - dump valves
  - CO2 discharge
  - watertight doors

  and operation of essential services such as:
  - emergency generator and switchboard
  - emergency fire and bilge pumps

- describes the division of the crew into a command team, all emergency team, a back-up emergency team and an engine-room emergency team

- explains the composition of emergency teams

- states that crew members not assigned to emergency teams would prepare survival craft, render first aid, assemble passengers and generally assist the emergency parties as directed

- states that the engine-room emergency team would take control of ER emergencies and keep the command team informed

- states that good communications between the command team and the emergency teams are essential

- describes the actions to take to deal with:
  - fire in specific areas such as galley, accommodation, engine-room or cargo space, including co-ordination with shore facilities in port, taking account of the ship's fire-control plan
  - rescue of victims in an enclosed space
  - heavy weather damage, with particular reference to hatches,

ventilators and the security of deck cargo
- rescue of survivors from another ship or the sea
- leakages and spills of dangerous cargo
- grounding
- abandoning ship

- explains the importance of drills and practices

1.2 Precautions for the protection and safety of passengers (1 hour)

- states that some crew members will be assigned specific duties for the mustering and control of passengers for vessels not classified as passenger vessels which may require specific training as specified under Chapter V of the STCW Code, lists the duties such as:
  - warning the passengers
  - ensuring that all passengers spaces are evacuated
  - guiding passengers to muster stations
  - maintaining discipline in passageways, stairs and doorways
  - checking that passengers are suitably clothed and that life jackets are correctly donned
  - taking a roll-call of passengers
  - instructing passengers on the procedure for boarding survival craft or jumping into the sea
  - directing them to embarkation stations
  - instructing passengers during drills
  - ensuring that a supply of blankets is taken to the survival craft

1.5.2 INITIAL ACTION FOLLOWING COLLISION OR GROUNDING

Textbooks:T7,T12
Teaching aids: A1

Required performance:

2.1 Precautions to be Taken When Beaching a Vessel (1 hour)
R1, R2

- describes the circumstances in which a vessel may be beached

- states that a gently shelving beach of mud, sand or gravel should be chosen if possible

- explains why beaching should be at slow speed

- states that wind or tide along the shore will quickly swing the ship broadside on to the beach

- describes measures which can be taken to prevent the ship driving further ashore and to assist with subsequent refloating

- states that all tanks and compartments should be sounded and an assessment made of damage to the ship

- states that soundings should be taken to establish the depth of water round the ship and the nature of the bottom

2.2 Actions to be Taken on Grounding (1 hour) R1, R2

- states that, on stranding, the engines should be stopped, watertight doors closed, the general alarm sounded and, if on a falling tide, the engines should be put full astern to see if the ship will immediately refloat

- states that the engineers should be warned to change to high-level water intakes

- states that a distress or urgency signal should be transmitted and survival craft prepared if necessary

- states that all tanks and compartments should be sounded and the ship inspected for damage

- states that soundings should be taken to establish the depth of water round the ship and the nature of the bottom

- describes measures which can be taken to prevent further damage to the ship and to assist with subsequent refloating

- explains how ballast or other weights may be moved, taken on or discharged to assist refloating

- describes the use of ground tackle for hauling off

- describes ways in which tugs may be used to assist in refloating

- describes the use of the main engine in attempting to refloat and the danger of building up silt from its use

2.3 Actions to be Taken Following a Collision (1 hour) R1, R2

- states that after impact the engines should be stopped, all watertight doors closed, the general alarm sounded and the crew informed of the situation

- states that in calm weather the colliding ship should generally remain embedded to allow the other ship time to assess the damage or prepare to abandon ship

- states that survival craft should be made ready for abandoning ship or assisting tile crew of the other ship

- states that a distress or an urgency signal should be made, as appropriate

- states that, if not in danger, own ship should stand by to render assistance to the other for as long as necessary

- states that all details of the collision an subsequent actions should be entered in the log-book

2.4 Initial Damage Assessment and Control (2 hours)
R1,R2

- states that damage to own ship should be determined
- describes measures to attempt to limit damage to salve own ship
- states that continuous watch should be kept on the damaged area and temporary repairs
- describes a steering arrangement using materials normally found aboard ship
- describes a means of constructing a rudder, where practicable

1.5.3 APPRECIATION FOR THE PROCEDURES TO BE FOLLOWED RESCUING PERSONS FROM THE SEA, ASSISTING A SHIP IN DISTRESS AND PORT EMERGENCIES

Textbooks:T7, T12, T13
Training aids: A1 ,A37, V7

Required performance:

3.1 Rescue of Persons from a Vessel in Distress or from a Wreck
(2 hours)
R1, R2

- states that it is preferable to wait for daylight when no immediate danger exists

- states that rescue boats or motor-lifeboats would be used if conditions permitted

- states that unnecessary equipment should be removed from the boats and be replaced by life jackets, lifebuoys, immersion suits, blankets and a portable VHF radio

- describes how both ships can spread oil in rough weather

- describes the preparations for taking survivors on board from the boats
- describes how to provide a lee and launch boats
- describes how boats should approach the wreck and pick up survivors
- describes the methods of recovery of boats and survivors
- describes methods of rescue which may be used when sea conditions are too dangerous to use boats

3.2 Actions which can be Taken When Emergencies Arise in Port (1 hour) R1, R2

- describes actions to take in the event of fire on own ship, with particular reference to co-operation with shore facilities
- states that a duplicate set of fire control plans is stored for the assistance of shore-side fire-fighting personnel
- describes actions to be taken when fire occurs on a nearby ship or adjacent port facility
- lists situations in which a ship should put to sea for reasons of safety
- describes the actions which can be taken to avoid a ship dragging anchor towards own ship in an anchorage

3.3 Measures for Assisting a Vessel in Distress (1 hour) R1, R2

- states that both vessels should have everything prepared and have agreed on communications before the arrival of the towing ship
- describes how to approach a disabled vessel and pass the first connection by line-throwing apparatus or other methods
- states that the tow normally passes a messenger, followed by a wire messenger, to the towing vessel to haul across the towing wire
- describes how to payout the towing wire under control
- describes methods of securing the towing wire at the towing ship
- explains why the wire is usually shackled to the anchor cable at the tow
- describes the preparations made by the disabled ship
- states that the towing wire should be protected from chafing at fairleads

- states that wires and cables should be inspected frequently and the nip freshened if any sign of wear or chafe is found

- states that the towed vessel should be steered to reduce yawing

- states that both ships should remain alert for signals from other vessel

- describes how to disconnect the tow on arrival at the destination

- describes the arrangements for emergency towing of tankers greater than 50,000 tonnes deadweight

- lists the information to be transmitted to the towing ship

COMPETENCE 1.6	Respond to a Distress Signal at Sea	IMO Reference

TRAINING OUTCOMES — STCW Code Table A-II/1

Demonstrates a knowledge and understanding of:

1.6.1 SEARCH AND RESCUE — R1, R2, R16

Textbooks:
Teaching aids: A1, A37, V6

Required performance:

1.1 Search and Rescue (2 Hours)

- The content and application of the International Aeronautical and Maritime Search and Rescue (IAMSAR) Vol III

COMPETENCE 1.7	Use the IMO Standard Marine Communication Phrases and use English in Written and Oral Form	IMO Reference

TRAINING OUTCOMES: STCW Code Tale A-II/1

Demonstrates a knowledge and understanding of:

1.7.1 ENGLISH LANGUAGE
See IMO model course 3.17, Maritime English

1.7.2 USE IMO STANDARD MARINE COMMUNICATION PHRASES

COMPETENCE 1.7	Use the IMO Standard Marine Communication Phrases and use English in Written and Oral Form	IMO Reference

1.7.1 THE ENGLISH LANGUAGE

Textbooks: T30
Teaching aids: A1, A38

Required performance:

1.1 English Language R1, R15

- use English in written and oral form to:
  - use charts and other nautical publications
  - understand meteorological information and messages concerning ship's safety and operation
  - communicate with other ships, coast stations and VTS centres
  - perform the officer's duties also with a multi-lingual crew

1.7.2 USE IMO STANDARD MARINE COMMUNICATION PHRASES

Textbooks: T31
Teaching aids: A1, A38

Required performance:

2.1 Standard Marine Communication Phrases

- use the IMO Standard Marine Communication Phrases

COMPETENCE 1.8	Transmit and Receive Information by Visual Signalling	IMO Reference

TRAINING OUTCOMES: STCW Code Table A-II/1

Demonstrates a knowledge and understanding of:

1.8.1 TRANSMIT AND RECEIVE SIGNALS BY MORSE LIGHT

1.8.2 USE THE INTERNATIONAL CODE OF SIGNALS

COMPETENCE 1.8	Transmit and Receive Information by Visual Signalling	IMO Reference

1.8.1 TRANSMIT AND RECEIVE SIGNALS BY MORSE LIGHT

Training aids: A1

Required performance:

1.1. Signalling by Morse code (1 hour)

- Identifies Morse symbols for the alphabet and numerals
- sends and receives the distress signal SOS by flashing light
- states the recommendations on sound signalling
- lists the single-letter signals which may be sounded only in compliance with the requirements of the International Regulations for Preventing Collisions at Sea

1.8.2 USE THE INTERNATIONAL CODE OF SIGNALS

Teaching aids: A1

Required performance:

2.1 International Code of Signals (10 hours)

- recognises all International Code flags and pendants
- explains the purpose of the International Code of Signals
- correctly uses substitute flags
- demonstrates how to call, using flags
- demonstrates the use of the answering pendant
- explains actions to take when signals are not understood
- describes how the end of a signal is indicated
- states that names in the text of a signal are to be spelt out in plain language
- explains the use of identity signals

- states that, in flag signalling, the answering pendant is used to indicate the decimal point in numbers

- demonstrates how to signal azimuth or bearing, course, date, latitude, longitude, distance, speed, time

- describes the arrangement of the Code into:
  - -- single-letter signals
  - -- two-letter signals for the General Section
  - -- three-letter signals beginning with 'M' for the Medical Section
- describes the use of complements and the tables of complements

- describes how to signal depths

- explains the significance of text in brackets

- states that cross-referencing of signals in the right-hand column is used to facilitate coding

- describes the meanings of single-letter signals

- states that there are single-letter signals for use between an ice-breaker and assisted vessels

- states that time of origin may be included codes and decodes messages, using the General Section codes and decodes messages, using the Medical Section and complements

- describes the International Code Signal of distress

COMPETENCE 1.9 Manoeuvre the Ship	**IMO Reference**

STCW Code
Table A-II/1

TRAINING OUTCOMES:

Demonstrate a knowledge and understanding of:

1.9.1 SHIP MANOEUVRING AND HANDLING

COMPETENCE 1.9 Manoeuvre the Ship	IMO Reference

1.9.1 SHIP MANOEUVRING AND HANDLING

Textbooks: T2, T18, T23
Teaching aids: A1, A37, V7, V8

Required performance:

1.1 The Effects of Various Deadweights, Draughts, Trim, Speed and Under-Keel Clearance on Turning Circles and Stopping Distances (4 hours)

- outlines the provision and display of manoeuvring information recommended in Assembly resolution A.601(15)

- defines the terms:
  - advance
  - transfer
  - drift angle
  - tactical diameter
  - track reach
  - head reach
  - side reach

- compares the turning circles of a ship in the loaded and ballasted conditions

- compares turning circles for differing speeds

- explains the use of the Rate of Turn Indicator to assist turning of vessel

- describes the accelerating turn

- states that the size of the turning circle increases as the under-keel clearance reduces

- describes how speed reduces during a turn under steady engine power

- compares the stopping distances of a ship in the loaded and ballasted conditions

- explains why a loaded ship carries her way longer than when in ballast

- states that the stopping distance for a loaded ship may be up to three times the stopping distance when in ballast

- states that in shallow water a ship will carry her way longer than in deep water

- defines 'directional stability'

- describes the steering behaviour of directionally stable and unstable ships

1.2 Effect of Wind and Current on Ship Handling (2 hours)

- states that the effect of wind on a given ship depends upon:
  - -- the wind strength
  - -- the relative direction of the wind
  - -- the above-water area and profile
  - -- the draught and trim
  - -- the ship's fore-and-aft movement

- describes the behaviour of a ship moving ahead with a wind from various directions

- states that, as a ship is slowed, a speed is reached at which the wind prevents maintaining course

- describes the effect of wind when making large turns

- describes the effect of wind on a ship making sternway

- describes the effect of current on the motion of a ship

- states that in rivers and narrow channels the current is usually stronger in the centre of a straight channel or at the outside of bends

- describes how to make use of different current strengths when turning in a channel

- describes how a current may be used to control lateral movement towards or away from a river berth

- explains how to use an anchor to dredge down with a current

- demonstrates the ability to manoeuvre the vessel in simple turning and anchoring manoueuvres in various conditions

1.3 Manoeuvres for the Rescue of a Person Overboard (2 hours)

- distinguishes between "immediate action", "delayed action" and "person missing" situations

- describes the single turn, Williamson turn and Scharnow turn manoeuvres

- explains the situations in which each turn is appropriate

- states that the standard manoeuvres are not guaranteed to return a ship into its wake because of the effects of particular ship characteristics and environmental conditions on the ship and the person in the water

- lists the sequence of actions to take when a person is seen to fall overboard

- lists the actions to take when a man-overboard report is received on the bridge

- demonstrates the ability to manoeuvre the vessel for the rescue of a person overboard

1.4 Squat, and Shallow-Water and Similar Effects (3 hours)

- states that shallow water as a depth of less than 2 x ship's draught

- states that shallow-water effects become more marked as depth decreases

- states that shallow-water effects as:
  - -- increased directional stability
  - -- a large increase in turning radius
  - -- the ship carrying her way longer and responding slowly to changes in engine speed
  - -- speed falling less during turns
  - -- squat increasing
  - -- trim changing, usually by the head for a full hull form
- states that 'squat' is defined as the reduction of under-keel clearance resulting from bodily sinkage and change of trim which occurs when a ship moves through the water

- states that squat is considerably reduced by a reduction of speed

- states that 'blockage factor' as the ratio of the cross-sectional area of the ship to the cross-sectional area of water in a channel

- states that squat and other shallow-water effects increase as the blockage factor increases

- states that excessive speed in shallow-water can ground a ship in water of sufficient depth to float it at slow speed

- states that approaching shoal patches or banks may give rise to an unexpected sheer

- states that reduced speed should be used in shallow water and narrow channels to reduce shallow-water effects and allow time to correct an unwanted sheer

- states that increased vibration may be experienced in shallow water

1.5 Proper Procedures for Anchoring and Mooring (4 hours)

- describes how anchors should be cleared away ready for use

- describes how the approach to an anchorage is made with regard to current and wind

- states that anchors should be walked back clear of the hawse pipes when approaching the anchorage

- describes the use of anchor buoys

- describes the safety measures to be taken by the anchor party

- describes the method of letting go and the amount of cable to veer initially

- describes the marking of the cable and the reports to be made to the bridge

- explains how to determine when the ship is brought up

- states that the lights or shape for a vessel at anchor should be displayed as soon as the ship is brought up

- describes the procedures for anchoring in water too deep to let the anchor go on the brake

- describes the securing of anchors on the completion of anchoring

- describes the preparation for and procedure during heaving up

(Note: The following knowledge is not required under Part A, Chapter II, Table A-II/1 of the STCW Code. This knowledge more directly relates to the seamanship in line-handling, mooring and anchoring and may also be included in the instruction for Able Seafarer. It is recommended that the trainee has basic knowledge of the following)

- explains how to handle cable safely in a non-self-stowing locker

- explains how to secure anchors and seal spurling pipes for a sea passage

- lists the preparations to be made for berthing alongside

- describes the use of head ropes, stern ropes, breast ropes and springs
- describes the safety measures to be taken when handling mooring ropes and wires
- describes how to join two mooring ropes together
- describes typical mooring arrangements
- demonstrates how to put a stopper on a rope or wire rope
- demonstrates how to make a mooring rope or wire fast to bitts
- describes the use of self-tensioning winches
- states the importance of keeping mooring lines clear of the propeller and notifying the bridge when the propeller is not clear
- describes how to make fast tugs on towing hawsers or lashed up alongside
- describes the use of fenders during berthing and when secured in position
- describes methods of mooring to a buoy
- explains how to use a messenger to pass a wire or chain to a buoy
- explains how to set up and secure a ship wire
- describes the method of securing ropes and wires to a buoy
- describes the procedures for singling up and letting go from berths and buoys
- explains how to slip a slip wire
- describes how to stow mooring ropes and wires for a sea passage
- explains how to rig and light the pilot ladder
- states what equipment should be at hand ready for use at the pilot ladder
- states that the rigging of the ladder and the embarkation and disembarkation of the pilot should be supervised by a responsible officer

Part D1: Instructor manual

The following notes are intended to highlight the main objectives or training outcomes of each part of the function. The notes also contain some material on topics which are not adequately covered in the quoted references.

This function covers the theory and practice of navigation necessary for the effective and safe navigation of the ship in coastal waters, including the use of charts, position fixing by terrestrial observations and the extraction of information from relevant documents. The use of electronic navigational aids is covered but proficiency in the use of radar forms the subject of a separate model course. It also deals with the theory and practice of the use of observations of celestial bodies for determining position lines and checking compass errors.

Trainees will gain a thorough knowledge of COLREG 1972 and be able to apply them when in charge of a navigational watch. They will be capable of keeping a safe and effective watch, both at sea and in port, taking into account the principles in the STCW Code Section A-VIII.

Function 1: **Navigation at the Operational Level**

On completion trainees will possess knowledge of the basic theory of magnetism and magnetic compasses. They will also know the basic theory of gyro compasses. Trainees will be familiar with the practical use of magnetic and gyro compasses and automatic pilots, their routine maintenance and the limitations of the instruments. Emphasis is placed on a knowledge of instrument errors, to allow for such errors, the importance of frequent checking and the ways of doing it.

Trainees will be aware of the need to make themselves familiar with contingency plans and their immediate duties in the event of an emergency arising. They will also know the procedures to be followed for the safety of life and the ship in various emergencies and the actions which will be expected from them as officers at operational level in response to those situations. Their knowledge of emergency procedures will also enable them to take charge of those parts of the operation for which they are responsible.

Trainees will have sufficient knowledge of the Morse code and correct procedures to enable them to transmit and receive the distress signal 'SOS' and single letter signals by Morse light. They will know the flags of the International Code of Signals (R17) and know the significance of the single letter signals and how to make use of that publication.

Sufficient understanding of meteorology is covered for watchkeepers to be able to apply it for the safe operation of the ship. This includes a knowledge of shipborne meteorological instruments and their application, knowledge of the characteristics of weather systems, reporting procedures and recording systems and the ability to

apply the met information available. In addition, the knowledge gained in this subject will serve as the basis for further training to the level of chief mate and master.

Trainees will be familiar with the manoeuvring information available on board ship with particular reference to turning circles and stopping distance and how they are affected by shallow water and the draught and trim of the ship. They will know the procedures and actions to take and the manoeuvres required for the rescue of a man overboard.

1.1 PLAN AND CONDUCT A PASSAGE AND DETERMINE A POSITION

1.1.1 CELESTIAL NAVIGATION 60 hours

Solar system
The trainee should possess a general and basic knowledge of the solar system, the earth's orbit and rotation around its axis, and how these motions lead to the phenomena of seasons and day and night. The distinction between inferior and superior planets may be explained but it is more important that the students can identify the planets that are of use for navigation.

Celestial sphere and equinoctial system of co-ordinates
Precise definitions are necessary. Extensive use of figures is very helpful. Prepared transparencies can be used, but it is considered better to draw one's own during a lecture because trainees can follow the construction and are motivated to draw their own figures.

Hour angle
The trainee should be set exercises as soon as possible. To promote a thorough understanding, the initial exercises should be illustrated by figures.

Daily motion and horizontal system of co-ordinates
This subject area represents the theoretical approach to position computations, with a celestial body on and off the meridian. It is important to deal with the theoretical background for the computations in steps. One possible way is to compute latitude by using first the sun and then Polaris. Next, one may treat the PZX triangle with a celestial body off the meridian and compute the altitude and direction of the position line.

Sextant and altitude corrections
The trainee should first practise measuring the altitude of the sun, reading a sextant and applying index error. Secondly, the trainee should do exercises in correcting a sextant. Regarding altitude corrections, it is optional whether the Nautical Almanac or an appropriate nautical table is used. It is recommended that the trainee does sufficient simple exercises in altitude corrections to master such problems thoroughly.

At low altitudes the correction for refraction is significant. The trainee should understand this effect and be able to explain it.

Amplitude
This subject area forms the theoretical approach to calculating compass error by means of celestial bodies.

Time and equation of time
The trainee should have a basic understanding of the concept of time, with emphasis on practical time problems. Time is not treated in textbook T8; an abstract from T9 may be used.

Nautical Almanac
The Nautical Almanac contains much information absolutely essential to the watchkeeping officer. The different parts of this subject area should be taught in connection with those subject areas where the information from the Nautical Almanac is necessary. A Nautical Almanac must be available to each trainee. The almanacs need not be of the latest issue, but the same issue should be used by all members of the class.

Latitude by meridian altitude
Time of meridian passage is not covered in textbook T8. As a text for this part, an abstract from T9 may be used. The method used to calculate 'time of meridian passage is optional. The method starting from local hour angle being zero may be preferable because the procedure is the same for all bodies.

The determination of the latitude by meridian altitude is, because of its simplicity, widely used, and the noon observation of the sun is a daily occurrence on a ship at sea.

Pole Star observations

Reference will be made, to the fact that the altitude of the celestial pole is equal to the latitude of the observer. Because Polaris is so close to the celestial pole, the star describes a small circle with an angular radius of less than 1 °, and the latitude of the observer can be derived by making small adjustments to the altitude.

Position fixing
The theoretical approach to position fixing using astronomical position lines could be treated a part at a time, in parallel with the position calculations on which the trainees are working.

To compute the altitude of the celestial body, three methods are available:

- the cosine formula and a pocket calculator
- the haversine formula and logarithmic tables
- pre-computed altitude and azimuth tables.

Which of these should be chosen is optional. After having introduced these methods, it is recommended to select one of them and specialize on that particular method. These days, with easy access to inexpensive pocket calculators, the first method may be preferable.

The Marcq St. Hilaire method of position fixing is universal and can be utilized for any celestial body in any direction, the body in the meridian included. It is recommended that position fixing using celestial bodies out of the meridian is restricted to this method.

The importance of doing exercises in altitude computations and position fixing by combining position lines cannot be overestimated.

Fixing positions should be carried out as geometrical problems preferably on an ocean plotting sheet or the navigation chart used (if scale permits).

1.1.2 TERRESTRIAL NAVIGATION 214 hours

Definitions - Earth
The main object of this section is to give the trainee a basic knowledge of the shape of the earth, its co-ordinate systems and units of distance measurement. The section gives the theoretical background for dead-reckoning sailing.

Charts
The trainee should have a basic and practical knowledge of how the spheroid is projected on to a plane chart. The trainee is to have knowledge of other types of projection. The use of charts of appropriate scale for various purposes is very important and should be stressed. It is also important to have charts of the latest issue or latest update. The trainee should therefore be familiar with the procedures for correction of charts and publications including chart catalogues and Notices to Mariners,worldwide and national.

ECDIS
The advent of Electronic Chart Display and Information Systems (ECDIS) and other electronic chart systems for the maritime industry was recognized at the time of the revision of STCW. Reference to 'ECDIS systems' is included in Table A-II/1 of the STCW Code. Performance standards for electronic chart systems have been adopted by IMO. Resolution A.817 provides that compliant systems fulfill the requirements of SOLAS V/20 for the carriage of charts. Trainees should undertake the training contained in the revised IMO model course 1.27 in relation to electronic charts.

Familiarisation with a particular ship's electronic chart equipment, its controls, facilities and characteristics, will usually be achieved through onboard training, reference to the operator's manual, or by means of training courses. It is important that trainees understand that this this familiarisation training is essential in being able to apply the knowledge and skills from the generic model course to the equipment on board any vessel they serve.

Datums
The intention is to define different systems for measuring and computing, define the origin and direction of the co-ordinate system and the units of measurement. The origin of the co-ordinate system on the earth's surface is the crossing between the equator and the Greenwich meridian; the units are degrees and minutes of arc. The

origin of direction depends upon whether direction is measured by magnetic compass or by gyro. Relations between these directions and calculations are dealt with in required performance 1.1.5.4

Distances
The trainee should be familiar with the origin of the nautical mile and be well practiced in measuring distances on a Mercator chart. In measuring distance off from the chart, the trainee must know the limitations of the Mercator Chart projection so as to ensure the accuracy of the measurement.

Position lines and positions
The trainee should have a basic knowledge of geometry prior to starting on position-line problems. It is important to have a thorough understanding of the idea of position lines. The trainee must learn that the geometric principle of combining position lines is the same irrespective of which kind of position line is used. It would not be educationally sound to use too many types of combinations to begin with.

Sailings
The plane sailing formula has sufficient preciseness for distance within a 24-hour period. It is optional whether traverse tables or a calculator is used. These days, with low-priced calculators, the latter is recommended. Once the computing method has been chosen, it is recommended to continue practicing, using that method. It is important to stress the importance of a well-arranged layout for the sailing computations. This subject area requires previous knowledge of trigonometry. Exercises of this kind could well be treated in the subject of mathematics.

The ability to determine courses and distances by Mercator sailing for rhumb line passages of greater distance is important for operational level officers of the watch to support voyage planning and conduct.

At this level, only basic knowledge and the ability to find the initial course and distance by calculation is required in the area of great-circle sailing. Trainees should be able to plan great circle sailings using gnomonic charts and the transfer of positions to mercator charts

In addition to computing sailing problems, the trainee must practice sailings on charts and ocean plotting sheets.

Chartwork exercises
When doing chartwork exercises, it is recommended to bring in one problem at a time in the starting phase. When the trainee has gained more experience, the exercises may gradually be made more complex.

In the classroom, each trainee should work on his/her own chart. Group activity is, however, recommended; for instance, in such a way that two trainees have their desks put together and work individually, but on the same exercise and with the opportunity to discuss problems as the work is going on. Textbooks, manuals, sailing directions, etc. should be available. Individual attention can be given by the instructor to trainees who need assistance.

More complex exercises (sailings) may be carried out on a training vessel and/or bridge simulator, if available.

Information from charts, lists of lights and other publications
This subject area is primarily concerned with reading information from charts and appraising information from nautical publications. It is essential for a nautical officer to understand fully the signs and symbols on charts, with special emphasis on buoys and beacons. Thus, the trainee should be familiar with the IALA Maritime Buoyage System for all regions.

It takes some time to become familiar with a chart, its huge amount of information, use and limitations. Therefore, it is important to give the trainees time for chart exercises, including, if possible some aboard a training vessel.

Tides
The variation of water level can be interpreted as made up of two components, the astronomical component (tide) and the meteorological component. The tide is predicted to a reasonable accuracy for different ports around the world. The meteorological component cannot be predicted, at least not for longer periods than normal weather prediction. This latter component is added to or subtracted from the predicted height. It is therefore important to emphasize that the predicted height of seawater is not an accurate value and trainees are advised to keep in mind the requirement of specific under-keel clearance.

Keeping a Log
Various log-books and voyage records need to be kept on a ship. The intention of this subject area is first to draw attention to national and international law and practice, and secondly to provide the trainee with a certain amount of practice in the complete and proper keeping of log-books and other voyage records. Reference to the company's ISM Safety Management System is to be made on the types and information to be logged in the log-books

1.1.3 ELECTRONIC SYSTEMS OF POSITION FIXING AND NAVIGATION

30 hours

Basic principles of terrestrial navigation
This subject area is an introduction to the general theory of hyperbolic position lines. The topic should not be given a mathematical approach, but a basic understanding of the nature of hyperbolic position lines is important. Graphic representation should be used.

Demonstration should be given of how the position lines diverge as distance from the foci (stations) increases, how intersection between position lines varies and how these facts influence the accuracy.

Loran-C system
The main points in this subject area should be the practical use of the instrument, position fixing using Loran-C, coverage area, possible errors and accuracy. The

trainee should be able to explain how various external factors may effect accuracy of position data.

Global navigation satellite system
GPS (Navstar) is the primary satellite system, although reference should be made to GLONASS, GALLILEO and other systems.

The principles of Pseudo Range and Differential GPS should be discussed.

Reference should be made to types of errors due to the system and those which may be caused by the use of different datums in the system and the chart in use. The trainee should be reminded that a position obtained from GPS is not the sole source of information and, if available, clearly identifiable terrestrial landed objects should be the main priority as sources of position fixing reference.

1.1.4 ECHO-SOUNDERS 9 hours

Echo-sounders
Again, practical use, operation and handling should form the main part of the training programme. The importance of the echo-sounder as a navigational aid for safe navigation should not be underestimated. The trainee must also be aware of the instrument limitation and accuracy when using this tool.

1.1.5 COMPASS – MAGNETIC AND GYRO 35 hours

The magnetism of the earth and the ship's deviation
Trainees should be familiar with the basic theory of the earth's magnetism, the ship's magnetism and conditions that lead to errors in the indication of heading. From that knowledge they will realize that the procedures for frequent checking of compasses are important.

The magnetic compass
Trainees should undertake practical exercises in the use of compasses for normal day-to-day watchkeeping. Emphasis should be placed on the limitations of the instrument and the need for regular and frequent checking of the compass error.

The intention in this objective is that the trainee should be able to deal descriptively with the deviation produced on various headings by a magnet or soft iron rod in a given position, relative to the compass, in an otherwise non-magnetic vessel. This should be used to draw attention to the dependence of deviation upon heading and to emphasize the importance of determining the deviation immediately after any large alteration of course. Trainees should not be expected to deal with the P, Q, R fields or the soft iron rods.

The gyro-compass
The importance of regular and frequent checking of the gyrocompass against magnetic compasses, of repeaters against the master gyro and of gyro-compass error should be emphasized.

The IMO/ILO Document for Guidance, 1985, recommends that courses should be conducted by the makers of each type of gyro-compass and, if possible, that deck officers should attend the course appropriate to the gyro-compass they will use, although the general theory and use of gyro-compasses will have been covered in their certificate examination.

Use of a particular make and model will be necessary in order to show how support, control, damping and heading indication are achieved in a practical gyro-compass and to provide trainees with experience in operating a compass. The manufacturer's handbook and maintenance instructions for the compass used should be available.

Compass course and bearing corrections
Compass correction is basic knowledge for a watchkeeping officer. It is very important that the officer understands and can apply such corrections. The trainee should be given numerous exercises on this. In addition to classroom exercises, training in compass correcting as a cadet or on a training vessel would be very useful. The training should be as close to practical watchkeeping duties as possible, taking magnetic variations from charts and deviations from a table of deviations. In addition, the trainee should be trained in finding gyro error and compass deviation by taking bearings and making compass course and bearing calculations.

Errors of compasses - Azimuths
The compass can be checked by transit bearing, bearing to a distant object or azimuth of a celestial body. Checking by means of the amplitude method is the simplest and therefore the most common way of compass checking using celestial bodies. The comparison of compasses, for instance of gyro-compass against magnetic compasses, should be a normal checking procedure. The importance of frequent checks should be stressed. It is important to emphasise that compass error should be obtained at every watch and at every large alteration of course.

1.1.6 STEERING CONTROL SYSTEMS 6 hours

Different procedures for change-over from automatic to manual steering, and vice versa, are required with different types of equipment and the trainees should be aware of the importance of early familiarization and knowledge of various steering control systems on first meeting the equipment. The trainee should also be familiar with testing the steering equipment and emergency steering systems.

The instructor should explain that mandatory requirements concerning the use of autopilot and manual steering are given in Section A-VIII/2 Part 4-1 paragraphs 34 and 35.

1.1.7 METEOROLOGY 79 hours

Shipborne meteorological instruments
Normal shipborne instruments should be available for training purposes. It is a good idea to arrange for trainees, individually or in groups, to make regular observations and keep a weather log during the training period. Details of instruments are contained in the Marine Observer's Handbook (T21).

The atmosphere, its composition and physical properties
The trainee should have a basic knowledge of the structure of the atmosphere and its properties so as to be able to understand the weather systems. The distribution of water vapour and its behaviour in the atmosphere are particularly important. .

Atmospheric pressure
Keeping a log of barometer readings or barograph records will provide trainees with a practical approach to the understanding of weather systems. Diurnal variation and pressure changes during the passage of depressions can be observed.

Wind
Reading instruments and logging observations provides valuable practice. As part of their training, trainees should estimate the wind force according to the Beaufort scale from observations of the sea state where possible. They should be encouraged to relate the observed winds to the isobars on the surface synoptic charts for the area, where these are available.

Trainees should be able to find the true wind, given the ship's course and speed and the apparent wind as parameters. They should also be aware that readings from a ship's anemometer may be distorted considerably by the effects of the ship's movement.

Cloud and precipitation
No single observation tells more about the weather than cloud formations. Observation of clouds is both important and difficult. Trainees should make use of the WMO Cloud Sheet (A34) for identification of cloud types. Photographs of cloud types can also be found in the Marine Observer's Handbook (T21).

Visibility
It should be stressed that estimation for visibility is very important for the purposes of safe navigation. Trainees should be reminded that the radar range at which objects or lights are first sighted can give a good estimation of visibility, particularly at night.

The wind and pressure systems over the oceans
The trainee should have a basic knowledge of the relationship between pressure distribution and wind circulation, including the doldrums, trade winds, monsoon areas and seasons, winds of the temperate zone and the more important local winds, There are good world climatic charts in The Mariner's Handbook (T26) in addition to those in the textbooks.

Structure of Depressions
Observations and recordings of weather made by the trainees should be used to reinforce the theory. It is particularly helpful to relate the weather experienced to the synoptic charts of the system producing it.

Waves
The mechanics of wave generation should be understood together with the factors of duration of generating wind, fetch, and lee and weather shores.

Weather services for shipping
Details of radio weather services are contained in the Admiralty List of Radio Signals, volume 3. Forecast areas and weather reporting areas are contained in NP 283(a), (A20) and diagrams relating to Weather Reporting and Forecast Areas.

During the period of the course, the trainee should receive a number of radio weather bulletins which are also available via Navtex and, if the equipment is available, synoptic charts by facsimile.

Recording and reporting weather observations
Trainees should practice coding observations into the form required for transmission by radio. They should also be able to decode station reports and plot the information on a weather map in standard form. The Ship's Code and Decode Book (A36) contains the international codes and procedures. Trainees should not be expected to memorize the codes.

Weather forecasting
On occasions, the observations taken do not agree with the forecasts or prognostic charts as the result of a system having a speed or direction of movement different from that expected. Trainees should be able to use their observations and knowledge of the weather expected in different parts of the system to revise the original forecast.

Trainees should recognise the term Tropical Revolving Storm (TRS) as an intense depression which is a potential threat to safety of navigation and one needing to be avoided. A full treatment of TRS is covered at the management level.

1.2 MAINTAIN A SAFE NAVIGATIONAL WATCH (100 hours)

The content, application and intent of International Regulations for Preventing Collisions at Sea, 1972 as amended

A large proportion of the time allocated to this subject will be used for training in the recognition of lights and shapes, using rule-of-the-road models or magnetic boards. Trainees should be able to recognize the type of vessel, aspect and any special significance of the signals and, given that the compass bearing is not appreciably changing, state what action they would take, if any, and what signals should be made. They should also be able to state the lights or shapes to be displayed by various types of vessel in any circumstances and describe fully the characteristics of the lights. Question-and-answer sessions should include the use of sound signals and actions to take in fog, bearing in mind that the use of radar for collision avoidance is also dealt with in simulator-based training.

It is important that trainees at this level recognize circumstances in which they should call the master and some situations should be presented to them in which calling the master is one of the proper actions to take. It should be impressed upon them that until such time as the master formally takes over from them they remain in

charge of the watch and should continue to take all actions necessary for the safety of the ship.

Attention should be drawn to regulations referring to navigation with a pilot embarked. The presence of a pilot on board does not relieve the officer in charge of the watch from his duties and obligations for the safety of the ship. Responsibility for the watch can only be handed over to the master or to another of the ship's watchkeeping officers and on no account should the pilot be left alone on the bridge.

A Guide to the Collision Avoidance Rules provides accounts of collisions together with court judgements, which should be used as appropriate to illustrate how the various rules should be applied. They are particularly useful when dealing with subjective concepts such as 'proper look-out', 'full appraisal', 'safe speed' and 'positive action in ample time'.

Keeping a safe navigational watch
This should be based on the requirements set out in the appropriate regulations and recommendations, see R1, Section A-VIII/1 and A-VIII/2 of the STCW Code.

The book 'Strandings and their Causes' provides details of strandings which became the subject of official investigations. In most cases, a failure to keep an adequate navigational watch caused or contributed to the accident. These, and cases described in ref. T6 where collision resulted partly from the same cause, should be used to emphasize the importance of following the guidance given. Particular attention should be drawn to the recommendation to fix the ship's position by more than one method whenever possible. The tendency to rely entirely on radar fixes in coastal waters should be discouraged.

1.2.1 PRINCIPLES IN KEEPING A NAVIGATIONAL WATCH 6 hours

Principles to be observed in keeping a navigational watch

(Note: The following knowledge is not required under Part A, Chapter II Table A-II/1 of the STCW Code. However it is recommended that the trainee has basic knowledge of the following:)

Keeping a Watch in Port
Keeping an effective deck watch in port under normal circumstances
In addition to the recommendations in the most recent resolutions, see R1, Section A-VIII/2 Part 4 of the STCW Code, the instructor should deal with national rules or regulations concerning such things as the rigging and lighting of gangways, fencing of openings, provision of safe walkways on deck, safety of cargo operations, the normal work of the deck crew and supervision of repair work regarding the safety of the ship. Guidance on safe working practices should be given. Reference should also be made to any national code of safe working practice concerning a deck officer's responsibilities in port. See T32 for a code with principles and guidance applicable to UK flag ships and ports.

Keeping a safe deck watch in port when carrying hazardous cargo

Particulars of safety measures required in oil, chemical and liquefied gas tankers are dealt with in specialized courses required to be taken by those serving in such ships. This section should deal with those precautions which are common to many hazardous cargoes of differing types. Trainees should know how to establish whether a given cargo is hazardous and where to find details of the hazard it presents and any special precautions for its safe handling and carriage. Typical precautions which may be required include: prohibition of smoking and use of naked lights, ensuring that specified means of fire extinguishing are ready for immediate use, restriction of access to the ship to authorized persons, ensuring that special absorbents are available for dealing with small spills, special first-aid requirements, protective clothing, prohibiting the use of radio or radar transmitters, keeping main engines ready for use at short notice and establishing special signals or communications for alerting shore authorities in the event of an emergency.

A description of the 'permit to work' system for controlling potentially hazardous tasks, in particular for entry into enclosed spaces, should be included (T32)

Note that Section A-VIII/2 Part 4-5 of the STCW Code covers mandatory requirements for watch in port on ships carrying hazardous cargoes.

1.2.3 BRIDGE RESOURCE MANAGEMENT (8 hours)

Bridge Resource Management
All ship's personnel who have bridge navigational watch duties are part of the bridge team. The master and pilot, as necessary, will support the team, which comprises the watchkeeping officer, helmsman and lookout.

The watchkeeping officer is in charge of the bridge and the bridge team for that watch, until relieved.

It is important that the bridge team works together closely, both within a particular watch and across watches, since decisions made on one watch may have an impact on another watch.

The bridge team also has an important role in maintaining communications with the engine room and other operating areas on the ship.

When the master has arrived on the bridge, his/her decision to take over control of the bridge from the OOW must be clear and unambiguous.

Duties should be clearly assigned, limited to those duties that can be performed effectively, and clearly prioritised.

Team members should be asked to confirm that they understand the tasks and duties assigned to them.

The positive reporting on events while undertaking tasks and duties is one way of monitoring the performance of bridge team members and detecting any deterioration in watchkeeping performance.

The ability of ship's personnel to co-ordinate activities and communicate effectively with each other is vital during emergency situations. During routine sea passages or port approaches the bridge team personnel must also work as an effective team.

A bridge team which has a plan that is understood and is well briefed, with all members supporting each other, will have good situation awareness. Its members will then be able to anticipate dangerous situations arising and recognise the development of a chain of errors, thus enabling them to take action to break the sequence. (See T11)

1.2.4 THE USE OF ROUTEING 4 hours

Use of routeing in accordance with general provisions on ships' routeing Instructors should refer to reference R3 for guidance on this topic.

1.2.5 THE USE OF INFORMATION FROM NAVIGATIONAL EQUIPMENT FOR MAINTAINING A SAFE NAVIGATIONAL WATCH

.1 Speed measurement
.2 Operational Use of AIS (*See IMO Model Course No 1.34)*

1.2.6 KNOWLEDGE OF BLIND PILOTAGE TECHNIQUES

1.2.7 THE USE OF REPORTING IN ACCORDANCE WITH THE GENERAL PRINCIPLES FOR A SHIP REPORTING SYSTEM AND WITH VTS PROCEDURES

1.3 USE OF RADAR AND ARPA TO MAINTAIN SAFETY OF NAVIGATION

See IMO Model Course No. 1.07, Radar Navigation - Operational Level and STCW Convention 1978, as amended Regulation I/12

1.4 USE OF ECDIS TO MAINTAIN SAFETY OF NAVIGATION

See IMO Model Course 1.27.

1.5 RESPOND TO EMERGENCIES

By their nature, emergencies are unique incidents calling for individual methods of dealing with them. However, all accidents of a particular type will have certain things in common and the response to them will require certain actions in all cases. It is those parts which should be dealt with in this subject.

Much of the subject can usefully be covered by class discussion with the aim of encouraging trainees to suggest the actions they would take in response to the various emergencies, to consider the likely results of those actions and to weigh them against possible alternatives. If a trainee has actual experience of any of the topics covered, he should be asked to describe the occurrence and the measures taken to the remainder of the class. The instructor will lead the discussions and

should point out any suggested actions which are definitely wrong and give his reasons.

1.5.1 PRECAUTIONS FOR THE PROTECTION AND SAFETY OF PASSENGERS 9 hours

Contingency plans for response to emergencies

Trainees should be aware of the regulations regarding the preparation and display of muster lists and instructions and the duties which will be included. In addition to knowing what their own specific duties are, they should know the overall procedure for dealing with any emergency so that they could take over the duties of someone else who is missing or injured, if necessary. That involves knowing what might happen and what to do if the situation arises.

Under a requirement of MARPOL every vessel over 500gt is required to have a shipboard oil pollution emergency plan (SOPEP) and this plan should be periodically exercised. The trainees understand their likely roles in the ship's plan.

Precautions of the protection and safety of passengers in emergency situations

The SOLAS regulations list the duties related to passengers which must be assigned to members of the crew. Other duties may be necessary, depending upon the circumstances and the design of the ship.

This training is for vessels not classified as passenger vessels which may require specific training as specified under chapter V of the Code.

1.5.2 INITIAL ACTION FOLLOWING COLLISION OR GROUNDING 5 hours

Precautions to be taken when beaching a vessel

Beaching is an emergency measure, normally undertaken to prevent a ship from foundering. With the ship aground, there is a chance that temporary repairs can be made and the ship refloated. In any case, salvage operations will be simpler than for a submerged ship. Additionally, the transfer of passengers and crew from a beached vessel can be organized much more safely than the abandonment of a sinking ship.

Although a gently shelving beach of mud, sand or gravel is ideal, in many cases the urgency of the operation will dictate that the nearest beach is used regardless of the nature of the bottom. Similarly, the state of tide can seldom be chosen.

Dropping bower anchors during beaching is of doubtful value. If dropped too early they may prevent the ship from getting firmly ashore, if dropped too late they are ineffective for hauling the ship off. The ship may end up resting on the anchors, resulting in further damage to the bottom.

An anchor or anchors leading offshore from the stern are required to prevent the ship being driven further ashore by strong onshore winds. They will also assist in refloating the ship when repairs have been completed. A small ship could carry out a kedge or spare bower anchor, using her boats. A larger ship with a heavier anchor, particularly if equipped with totally enclosed GRP boats, would need the assistance of a tug or salvage craft.

Overall the trainee should be able to explain the factors to be taken into consideration before deciding on beaching a vessel and be able to make plan for actions before, during and after beaching.

Actions to be taken following grounding
Many of the actions to take after beaching a ship apply also to stranding.

Grounding may range from running aground on a soft bottom while manoeuvring to a sheltered estuary to striking an exposed rocky coast at full sea speed. The response necessary clearly depends upon the severity of the accident, and a range of possibilities should be discussed during lectures.

Actions to be taken following a collision
Where collision has resulted in the release of flammable or toxic gases, the ships should not remain embedded but be separated as quickly as possible. They should also be separated in conditions of rough sea or swell as the working together of the ships may cause further serious damage.

When checking for damage following a collision, the whole ship should be examined as far as possible. Decks, hatch coamings and covers and side plating may be cracked or distorted at points well removed from the point of impact.

Initial damage assessment and control

Trainees should consider what can be done to plug holes, make temporary repairs and shore up damage, using materials which can be expected to be available aboard ship.

Trainees should be asked to consider what actions they would take in the event of some survival craft being unusable as a result of fire or a very heavy list, for example.

Trainees should be restricted to using material which would be available aboard ship when answering questions on steering arrangements or rudders.

1.5.3 RESCUING PERSONS FROM THE SEA, ASSISTING A SHIP IN DISTRESS AND PORT EMEGENCIES 4 hours

Rescue of persons from a vessel in distress or from a wreck
Unless the situation is critical, conditions should be assessed carefully and a plan prepared before initiating rescue action. If the survivors are in no immediate danger, and existing conditions make rescue hazardous, consider delaying the rescue until

weather conditions have improved or until daylight. Try to establish communications with the survivors to obtain information about their condition and to inform them of the intended method of rescue.

Direct transfer of survivors from a wreck to the ship requires nearly calm conditions and normally rescue boats or motor lifeboats will be used.

During the launching of boats, lifelines, lifebuoys, ladders and nets should be ready in case somebody falls overboard or a boat overturns.

Going alongside a wreck may be difficult. On the lee side the approach may be obstructed by wreckage and if the wreck is drifting quickly the boat will have difficulty getting away from the side. Sea conditions may make it impossible to approach from the weather side and, since the wreck will probably drift faster than the boat, it will be difficult to remain close enough to transfer survivors. An approach from the weather side is the only possibility when the wreck is on fire or releasing toxic fumes, in which case survivors may have to jump into the water to be picked up by the boats.

If weather conditions make the use of boats too hazardous and it is not possible to wait for conditions to moderate, a liferaft on a stout line may be towed or floated to the wreck or may be hauled out to the wreck after making connection by line-throwing apparatus. The painter fitted to the liferaft is not heavy enough to be used in this manner.

At the rescue ship, preparations for the transfer of survivors include the provision of a boat rope, nets, ladders, lines and crew standing by to assist. The use of a liferaft alongside as a landing stage releases the boat quickly if it is necessary to make several journeys. Survivors who have been in the sea or survival craft for some time may be suffering from cold, fatigue and sea-sickness and be unable to do much to help themselves.

Actions which can be taken when emergencies arise in port

Actions to take in the event of fire in port are mentioned in the references. It some ports there is an obligation to call the local fire service as soon as any fire is discovered on board. This may also be a shipping company standing instruction. Not calling for shore assistance until it is apparent that the fire cannot be controlled by the ship's equipment can result in a much more serious situation for the fire service and the ship.

The decision to put to sea for reasons of safety rests with the master, but the officer in charge of the watch should be aware of the circumstances in which to call the master.

Measures for assisting a vessel in distress

Some practical aspects of this topic are fully covered in the model course, 1.23 Proficiency in Survival Craft and Rescue Boats other than Fast Rescue Boats.

The need for agreement on the method of tow and the preparations necessary should be emphasised. The yawing of the towed vessel increases the stress on the

towing arrangements and reduces the speed. The towed vessel should be steered to reduce the yaw to a minimum, although it will probably prove impossible to prevent it altogether.

Disconnecting the tow, particularly in confined waters at a port approach, can be a critical operation and should be planned with the same care as connecting the tow. (See R16.)

1.6 RESPOND TO A DISTRESS SIGNAL AT SEA

1.6.1 SEARCH AND RESCUE 2 hours

IAMSAR
The syllabus for training in search and rescue is contained in the IMO model course, Maritime Search and Rescue Co-ordinator Surface Search. That course is designed to provide a thorough knowledge and understanding of the International Aeronautical and Maritime Search and Rescue (IAMSAR) Volume III such that trainees will be able to use it effectively when faced with a search and rescue situation.

Model course 2.02 satisfies the requirements concerning search and rescue at the level of master and chief mate. When the syllabus is used as part of the model course for officers in charge of a navigational watch, the aim should be to provide trainees with an overall knowledge and understanding of the contents of IAMSAR and how a search and rescue operation would be conducted. The depth of treatment of those parts, such as search planning, which are specifically the master's responsibility needs only to be sufficient to complete the overall view of the operation.

The entry standards for the course stipulate experience in plane navigation and plotting, the interpretation of weather maps and familiarity with emergency communications procedures. Account should be taken of those prerequisites when deciding where to introduce this subject into the course.

1.7 ENGLISH LANGUAGE

English Language
The requirements for English language knowledge are specified in STCW Code in Table A-II/1 and noting the guidance in the Code Section B-IV/2 paragraph 36.1 and B-VI/1 paragraph 7 which states that English language, both written and spoken is necessary for the exchange of communications relevant to the safety of life at sea.

IMO model course 3.17 on Maritime English is based on a clearly defined entry standard in general English, deals with maritime terminology and the use of English for the purposes of using charts and other nautical publications, understanding meteorological information and communicating with other ships or coast stations concerning ship's safety and operation, including the use of the IMO Standard Marine Communications phrases.

The course also includes the vocabulary needed to make use of and understand manufacturers' technical manuals and specifications to converse with technical shore staff concerning ship and machinery repairs.

1.8 TRANSMIT AND RECEIVE INFORMATION BY VISUAL SIGNALLING

1.8.1 TRANSMIT AND RECEIVE SIGNALS BY MORSE LIGHT 1 hour

Signalling by Morse Code
The signalling facilities should be available for trainees who wish to practice in their own time.

The instructor should ensure that each trainee can send and receive the distress signal SOS and single letter signals by Morse

1.8.2 USE THE INTERNATIONAL CODE OF SIGNALS 10 hours

International Code of Signals
As an aid to learning, trainees can be encouraged to produce for themselves sets of cards showing a flag or pendant on one side with the letter or numeral and single-letter meaning on the other. Alternatively, commercially made "flash cards" may be purchased. These can be used for individual learning or self-testing.

Sufficient exercises in coding and decoding should be provided to ensure that trainees are thoroughly familiar with the use of the Code. Particular attention should be paid to the use of the medical section and its tables of complements.

Trainees should be aware that single-letter signals for use between an ice-breaker and assisted vessel are provided in Chapter XIII but they should not be expected to remember the signals.

1.9 MANOEUVRE THE SHIP

1.9.1 SHIP MANOEUVRING AND HANDLING 15 hours

The effects of various deadweights, draughts, trim, speed and under-keel clearance on turning circles and stopping distances
Point out to trainees that the greater turning circle and stopping distance experienced in shallow water should be one of the factors considered when deciding on a safe speed.

Effect of wind and current on ship handling
Where a training vessel or ship handling simulator is available, the effects of wind and current can be demonstrated to trainees. Exercises in anchoring, or positioning the vessel as if for anchoring, are particularly suitable for trainees to practice. They can be combined with exercises in the use of navigational aids. Trainees should be

asked to act as a bridge team to follow a prepared approach to the anchoring position. Their roles in the bridge team should be rotated in subsequent exercises.

Manoeuvres for the rescue of a person overboard
The wheelhouse poster may show headings at which to put the wheel over different from those shown in the man-overboard manoeuvres in IAMSAR. The headings shown on the wheelhouse poster should be used as they have been determined for that ship, whereas IAMSAR gives only a general indication of when to shift the helm. Man-overboard procedures can be practiced, using a training vessel, (V7).

Squat and shallow-water and similar effects
Squat is not easily measured, so the information supplied to a ship consists of estimated values. The actual squat experienced may differ somewhat from those values in the prevailing circumstances.

In any case, since squat is proportional to the square of the speed, a reduction in speed effectively reduces the resulting sinkage and change of trim. See reference T29.

Proper procedures for anchoring and mooring
This section covers the knowledge required by an officer at operational level for the supervision of anchoring or mooring operations. Attention should also be drawn to any national code of safe working practices relating to these operations. Guidance on safety measures to be taken during anchoring and the handling of mooring ropes and wires is contained in the references.

It is recommended that, when using portable radio apparatus, the ship's name should be included in orders to the officer in charge of anchoring to avoid possible confusion with orders from nearby ships.

Function 2:

Cargo Handling and Stowage at the Operational Level

Officer in Charge of a Navigational Watch
Function 2: Cargo Handling and Stowage at the Operational Level

INDEX

Part B2: Course Outline

Timetable
No formal example of a timetable is included in this model course.

Development of a detailed timetable depends on the level of skills of the trainees entering the course and the amount of revision work of basic principles that may be required.

Lecturers must develop their own timetable depending on:

.1 the level of skills of trainees
.2 the numbers to be trained
.3 the number of instructors

and normal practices at the training establishment.

Preparation and planning constitute an important factor which makes a major contribution to the effective presentation of any course of instruction.

Lectures

As far as possible, lectures should be presented within a familiar context and should make use of practical examples. They should be well illustrated with diagrams, photographs and charts where appropriate, and be related to matter learned during seagoing time.

An effective manner of presentation is to develop a technique of giving information and then reinforcing it. For example, first inform the trainees about the objectives of the subject to be covered and what you are going to present to them; then cover the topic in detail; and, finally, summarize what you have told them. The use of an overhead projector and the distribution of copies of the transparencies as trainees handouts contribute to the learning process. For topics involving tanker operation, the use of a liquid cargo handling simulator would be encouraged to demonstrate the effect cargo operations on the ship.

Course Outline
The tables that follow list the competencies and areas of knowledge, understanding and proficiency, together with the estimated total hours required for lectures and practical exercises. Teaching staff should note that timings are suggestions only and should be adapted to suit individual groups of trainees depending on their experience, ability, equipment and staff available for training.

COURSE OUTLINE

Knowledge, understanding and proficiency	Total hours for each topic	Total hours for each subject area of Required performance

Competence

2.1 MONITOR THE LOADING, STOWAGE, SECURING, CARE DURING THE VOYAGE AND UNLOADING OF CARGOES

Note that the time allocated in the draught, trim and stability section is only realistic if trainees have previously completed the generic stability course requirements identified in Function 3.

2.1.1 THE EFFECT OF CARGO, INCLUDING HEAVY LIFTS ON THE SEA-WORTHHINESS AND STABILITY OF THE SHIP

.1	Draught, trim and stability	10	
.2	Securing cargoes	6	
.3	Deck cargo	4	
.4	Container cargo	2	
.5	Bulk cargo	3	
.6	Bulk grain cargo	2	
			27

2.1.2 SAFE HANDLING, STOWAGE AND SECURING OF CARGOES

.1	Cargo care	9	
.2	Dangerous, hazardous and harmful cargoes	8	
.3	Cargo handling equipment and safety	7	
.4	Oil tanker piping and pumping arrangements	4	
.5	Precautions before entering enclosed or contaminated spaces	2	
.6	Cargo calculations and cargo plans	5	
			35

2.2 INSPECT AND REPORT DEFECTS AND DAMAGE TO CARGO SPACES, HATCH COVERS AND BALLAST TANKS

.1	Cargo spaces inspection	3	
.2	Hatch covers inspection	3	
.3	Ballast tanks inspection	3	
.4	Damage report	3	
.5	Enhanced survey programme	3	
			15

Total for Function 2:

Cargo Handling and Stowage at the Operational Level 77 hours

Teaching staff should note that the hours for lectures and exercises are suggestions only as regards sequence and length of time allocated to each objective. These factors may be adapted by lecturers to suit individual groups of trainees depending on their experience, ability, equipment and staff available for teaching.

Part C2: 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 teaching 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 systematically organised 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.

In this Model course there are three functions:

Navigation at the Operational Level
Cargo Handling and Stowage at the Operational Level
Controlling the Operation of the Ship and Care for Persons on Board at the Operational Level.

The header of the first column denotes the **COMPETENCE** concerned. Each function comprises a number of competences. For example, the Function 2, Cargo Handling and Stowage at the Operational Level, comprises a single COMPETENCE. Each competence is uniquely and consistently numbered in this model course.

In this function the competence is **Monitor the Loading, Stowage, Securing, Care During the Voyage and the Unloading of Cargoes.** It is numbered 2.1, that is, the

first competence in Function 2. 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 a total of two training outcomes. The first is in SEAWORTHINESS AND STABILITY OF THE SHIP. Each training outcome is uniquely and consistently numbered in this model course. That concerned with seaworthiness and stability is uniquely numbered 2.1.1. For clarity training outcomes are printed in black 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 seaworthiness and stability, there are six areas of performance. These are:

2.1.1.1 Draught, trim and stability (10 hours)
It should be noted that the required performance in cargo specific draught, trim and stability elements above should be completed after or in conjunction with the generic stability course requirements identified in Function 3.

2.1.1.2 Securing cargoes (6 hours)
2.1.1.3 Deck cargo (4 hours)
2.1.1.4 Container cargo (2 hours)
2.1.1.5 Bulk cargo (3 hours)
2.1.1.6 Bulk grain cargo (2 hours)

For the training outcome concerned with safe handling, stowage and securing of cargoes, there are six areas of performance. These are:

2.1.2.1 Cargo care (9 hours)
2.1.2.2 Dangerous, hazardous and harmful cargoes (8 hours)
2.1.2.3 Cargo handling equipment and safety (7 hours)
2.1.2.4 Oil tanker piping and pumping arrangements (4 hours)
2.1.2.5 Precautions before entering enclosed or contaminated spaces (2 hours)
2.1.2.6 Cargo calculations and cargo plans (5 hours)

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 2.1.1.1 Draught, trim and stability, to meet the required performance, the trainee should be able to:

.1 define 'deadweight' and 'displacement tonnages'
.2 sketch a ship's load line indicating marks for various seasonal zones, areas and periods
.3 use a ship's hydrostatic particulars and give mean draughts to determine the approximate weight loaded or discharged use a deadweight scale to determine the change in mean draught resulting from loading or discharging a given tonnage and so on.

IMO references (Rx) are listed in the column to the right hand side. Teaching aids (Ax), videos (Vx) and textbooks (Tx) relevant to the training outcome and required performances are placed immediately following the TRAINING OUTCOME title.

It is not intended that lessons are organised to follow the sequence of required performances listed in the Tables. The syllabus tables are organised to match with the competence in the STCW Code Table A-II/1. Lessons and teaching should follow college practices. It is not necessary, for example, the effect of cargo, including heavy lifts on the sea-worthness and stability of the ship to be studied before safe handling, stowage and securing of cargoes. What is necessary is that all the material is covered and that teaching is effective to allow trainees to meet the standard of the required performance.

COMPETENCE 2.1	**Monitor the Loading, Stowage, Securing, Care During the Voyage and Unloading Of Cargoes**	**IMO Reference**

TRAINING OUTCOMES: STCW Code Table A-II/1

Demonstrates a knowledge and understanding of:

2.1.1 THE EFFECT OF CARGO, INCLUDING HEAVY LIFTS ON THE SEA-WORTHINESS AND STABILITY OF THE SHIP

2.1.2 THE SAFE HANDLING, STOWAGE AND SECURING OF CARGOES INCLUDING DANGEROUS, HAZARDOUS AND HARMFUL CARGOES AND THEIR EFFECT ON THE SAFETY OF LIFE AND OF THE SHIP

COMPETENCE 2.1	Monitor the Loading, Stowage, Securing, Care During the Voyage and Unloading Of Cargoes	IMO Reference

2.1.1 THE EFFECT OF CARGO INCLUDING HEAVY LIFTS ON THE SEA-WORTHINESS AND STABILITY OF THE SHIP

Textbooks: T16, T35, T36, T38
Teaching aids: A1

Required performance:

1.1 Draught, Trim and Stability (10 hours) R1, R2, R36

- defines 'deadweight' and 'displacement tonnages'
- sketches a ship's load line indicating marks for various seasonal zones, areas and periods
- uses a ship's hydrostatic particulars and given mean draughts to determine the approximate weight loaded or discharged
- uses a deadweight scale to determine the change in mean draught resulting from loading or discharging a given tonnage
- given the present draughts and the density of dock water, calculates the draughts in seawater
- given the draught amidships and dock-water density, calculates the amount to load to bring the ship to the appropriate load line in seawater
- uses hydrostatic data to find the position of the centre of flotation, MCT and TPC for a given draught
- calculates the change of trim resulting from loading or discharging a given weight at a specified position
- given the initial draughts, forward and aft, calculates the new draughts after loading or discharging a given quantity of cargo
- uses a trimming table or curves to determine changes in draughts resulting from loading, discharging or moving weights
- calculates final draughts and trim for a planned loading by considering changes to a similar previous loading

- calculates, by using moments about the keel, the position of G for a given disposition of cargo, fuel and water
- uses hydrostatic data to find the KM and thence the GM
- states that, for a cargo ship, the recommended initial GM should not normally be less than 0.15m
- uses KN curves to construct a curve of statical stability and from it reads the maximum righting lever and angle at which it occurs
- calculates the arrival of GM from the departure conditions and the consumption of fuel and water, including the loss of GM due to FSE
- plans the use of fuel and water to keep free surface effects to a minimum
- estimates the loss of GM resulting from absorption of water by deck cargo

1.2 Securing Cargoes (6 hours) R48

- explains the need for solid stow and securing of all cargoes
- states that cargo liable to slide during rolling, such as steel rails, should be stowed fore and aft
- describes methods of blocking, lashing, shoring, chocking and tombing cargo
- describes methods of securing cargo faces resulting from part discharge before making a sea passage
- describes methods of securing heavy loads and heavy lifts
- describes methods of stowing and securing vehicles and trailers
- states that unitized, containers, trailers, portable tanks and other cargo units should be secured in accordance with the ship's cargo securing arrangements manual
- describes passenger operations including passenger cargo, passenger comfort and safety

1.3 Deck Cargo (4 hours) R45, R47

- states that cargoes, other than in containers, commonly carried on deck are:
    - dangerous goods not permitted below decks
    - large units, difficult or impossible to stow below deck, which can safely be exposed to the elements
    - cargoes which can be exposed to the weather and which would occupy a very large space below decks
    - livestock in limited numbers
- explains why efficient securing of cargoes is essential for the safety of the ship as well as the cargo
- states that stowage and securing of deck cargo should be adequate for the worst conditions which could be experienced

- states that hatches should be securely closed and cleated before loading over them

- states that stowage should leave safe access to essential equipment and spaces needed to navigate and operate the ship such as:
    - sounding pipes to tanks and bilges
    - devices for the remote operation of valves
    - mooring arrangements
    - fire-fighting and life-saving equipment
    - crew accommodation and working spaces
    - protection for the crew

- states that deck cargo should not obstruct the view from the navigating bridge or overside at the bow

- states that the weight of deck cargo should not exceed the maximum permissible load on the deck or hatches

- describes how the effects of a concentrated load can be spread over a wider area by the use of dunnage and deck shoring taking into consideration the positioning of girders, transverses and longitudinals under the tank top

- explains the effect of deck cargo on stability with reference to:
    - its vertical moment about the keel
    - the absorption of water or accretion of ice
    - the clearing of water from the deck in heavy weather
    - increased reserve buoyancy of a timber deck cargo
- describes in outline the recommendations on the stowage and lashing of timer deck cargoes as set out in the IMO Code of Safe Practice for Ships Carrying Timer Deck Cargoes

- describes the guard lines or rails to be provided at the sides of a deck stow and at openings in the stow

- describes the provision of means of safe access between the deck and the top of the stow

- describes the method of safe stowage and securing of containers on deck on vessels not specially designed for the carriage of containers

- describes the safe loading/discharging of Ro-Ro cargoes

1.4 Container Cargo (2 hours)

- describes the arrangement of a container ship and explains how the position of a particular container is designated

- explains briefly the sequence of operations during discharging and loading at a terminal

- explains the factors involved in planning a container stow with reference to:
  - stability, trim and list
  - stresses
  - stack height and weight
  - dangerous goods
  - special stowage restrictions
  - out of gauge

- describes methods of securing containers on deck

- describes the types and sizes of container in use

1.5 Bulk Cargo (Other Than Grain) (3 hours) R43, R49

- describes in outline the contents of the IMO International Maritime Solid Bulk Cargo (IMBSC) Code

- defines:
  - angle of repose
  - cargoes which may liquefy - flow moisture point
  - flow state
  - transportable moisture limit

- describes in detail the preparation of cargo holds prior to loading bulk cargoes

- explains that separation between certain bulk cargoes and other than bulk cargoes or package of dangerous goods is required

- explains that some bulk cargoes may deplete the oxygen content of holds or produce toxic gases and describes the precautions to take before entry of holds

- describes the hazards associated with coal cargoes

- describes the importance of monitoring the temperature of the holds associated with carriage of coal cargoes

- describes the precautions to take during loading and discharging coal

- explains how coal should be ventilated

1.6 Bulk Grain Cargo (2 hours) R2, R54

- defines the following terms as used in the International Grain Code:
  - grain
  - filled compartment
  - partly filled compartment

- describes the cleaning and preparation of holds and decks for the carriage of grain

- states that a thorough check for insect or rodent infestation should be made

- describes the dangers associated with using insecticide in cargo holds

- explains the importance of trimming and states how it should be made

- distinguishes between the trimming of filled and partly filled compartments

- describes the use of fitting of shifting boards

- describes how saucers or bundles of bulk grain are arranged in the square of a hatch to reduce heeling moments resulting from a shift of grain

- describes how the surface of a partly filled compartment is secured against movement

- describes how to separate two different bulk grain cargoes loaded into the same compartment

2.1.2 SAFE HANDLING STOWAGE AND SECURING OF CARGOES

Textbooks:T14, T16, T34, T35, T36
Teaching aids: A1, V55, V88

Required performance:

2.1 Cargo Care (9 hours)

Inspection and Preparation of Holds

- outlines the reasons for a general inspection of holds

- lists items to be inspected

- explains the importance of cleaning holds before loading

- describes how to clean holds after discharge of a general cargo

- describes the reasons for using dunnage

- describes the types and sizes of material used for dunnage

- describes the methods of dunnaging a hold for various cargoes and how to dispose of old dunnage

- states that dirty dunnage may taint or contaminate the next cargo

- describes the fitting or spar ceiling and explains its purpose

- states that bilges or drain wells should be clean, dry and sweet-smelling disinfectants used

- explains how bilge suctions should be checked for efficient working scuppers and sounding pipes

- describes how limbers and drain well covers should be treated to prevent suctions being blocked by small debris, but ensuring free drainage to the suctions

- states that the ballast lines to deep tanks should be blanked when preparing to load dry cargo

- states that the use of a deodorizing wash for ozonator may be necessary to remove strong odours from a previous cargo

Segregation and Separation of Cargoes

- explains the need for the segregation of different cargoes with reference to:
  - dangerous goods
  - dry cargo
  - wet cargo
  - clean cargo
  - dirty cargo
  - delicate cargo
  - valuable cargo, e.g. bank notes, personal effects

- describes how the cargoes in the above objectives can be segregated

- explains that separation between parcels of cargo for different consignees or different ports of discharge is required

- describes methods of separating adjacent parcels of cargo

- describes the use of port marking to separate parcels for discharge at different ports

Ventilation and Control

- lists the factors involved in the control of sweat by ventilation

- distinguishes between ship's sweat and cargo sweat and explains the conditions in which each is experienced

- describes the system of natural ventilation and how it should be controlled to minimise the formation of sweat

- describes forced ventilation and humidity control for cargo holds and states the properties measured and recorded at the control panel

- explains how to operate the ventilation system described in the above objective
- states that ventilation is also required for the removal of heat, gases and odours

- gives examples of cargoes requiring special ventilation

Refrigerated Cargo

- explains how holds and lockers are prepared for loading

- explains the need for the pre-cooling of spaces and dunnage to be used

- describes the dunnaging requirements for refrigerated cargo

- gives examples of commodities carried chilled

- gives examples of frozen cargoes

- lists the inspections of the cargo which should be made before and during the loading

- describes the use of brine traps in compartment drains - before this stage

- explains the purpose of compartment temperature recordings

2.2 Dangerous, Hazardous and Harmful Cargoes (8 hours)

R37, R38, R39, R41

- explains the different types of containment covered by the term "packaged form"

- describes the classification of dangerous goods in the International Maritime Dangerous Goods (IMDG) Code

- explains the properties, characteristics and physical state of the different substances, materials and articles covered by the 9 classes of the IMDG Code

- identifies the marking, labelling and placarding of dangerous goods as required by the IMDG Code and DGs in limited quantities, e.g. schedule 18

- states that the duty officer should have information on the quantities, types of package, proper shipping names (correct technical names), classification, stowage and segregation of the dangerous goods to be handled

- states that the duty officer should have information on the special measures to be taken when a certain dangerous cargo is handled

- states that the measures to be taken in the event of an incident or accident should be made known and that any necessary equipment and sufficient crew to operate it should be available

- explain where to look for damage and defects most commonly encountered due to:
    - loading and unloading operation
    - corrosion
    - severe weather conditions

- explains that the actions to be taken are laid down in the IMO Emergency Procedures for Ships Carrying Dangerous Goods (EmS), the IMO Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG) and the International Medical Guide for Ships (IMGS)

- states that any incident or accident during the handling of dangerous goods should be reported immediately to the person in charge of the operation and all cargo operations to be ceased

- explains that the IMDG Code lays down the packing requirements

- states that any doubts about the suitability and integrity of packages should be reported to the master or chief mate

- states the fire precautions which should be taken when carrying dangerous goods

- describes the precautions which should be taken while loading or discharging explosives

- explains with the aid of diagrams, the meaning of the following stowage and segregation requirements for the different types of ships:
    - on deck only
    - on deck or under deck
    - away from
    - separated from
    - separated by a complete compartment or hold from
    - separated longitudinally by an intervening complete compartment or hold

2.3 Cargo Handling Equipment and Safety (7 hours)

Cargo Handling Equipment

- describes the care and maintenance of:
    - standing rigging
    - topping lifts, cargo runners, guys and preventers - cargo blocks and topping lift blocks

    - derrick heel fittings

- describes the rigging of derricks for loading and discharging cargo:
    - using married falls (union purchase)
    - by single swinging derrick

- explains how to set up guys and preventers for working with married falls

- states that gear should be set up in accordance with the ship's rigging plan and explains limitations and effect of angles between runners

- describes how to change the rig from single runners to gun tackles

- describes how to top and lower derricks safely

- describes means of securing derricks for sea

- describes the use of slings, snotters, canvas slings, trays, pallets, nets, chain slings, cant hooks, bale hooks and vehicle slings

- describes the precautions to take when lifting bales with hooks in the bale bands and damage caused by hooks generally

- describes the handling of common unitized and pre-slung loads

- compares the advantages and disadvantages of ship's cranes and derricks for handling cargo - types of derricks - Hallen, Stullen, Thompson, Velle etc.

- describes the precautions to be taken when fork-lift trucks or similar devices are used in the 'tween-decks or holds

Cargo Handling Safety

- states that all cargo gear should be visually inspected before the start of cargo operations each day and awareness of test certifications and registration

- describes the importance of having a Safe Working Load (SWL) for the cargo gear

- explains why the load on cargo gear should never exceed its safe working load

- states that all ropes and wires should come with the certificate of their properties

- states that ropes, wires, blocks and loose gear should be subject to frequent inspections while in use for cargo operations

- explains how to determine when a cargo runner needs replacing

- states that mechanically or hydraulically operated hatches should be opened or closed by the ship's crew under the supervision of a responsible person

- states that hatch covers should be secured by locking devices to prevent them moving accidentally

- states that beams and covers of partially opened hatches should be secured to prevent their accidental displacement

- states that hatch openings should be securely fenced to a minimum height of 1 metre

- states that it is the ship's responsibility to cover hatches when notice of completion of work for the day is given by the stevedore in charge

- states that no person should use a ladder in the square of a hatch while cargo is being hoisted or lowered in that square

- states that no person should stand or pass under a suspended load

- describes the provision of adequate lighting for working spaces, portable lights and precaution with dangerous cargoes, e.g. jute

- states that portable lights should be removed from cargo spaces as soon as they are no longer required

- states that unattended portable lights are potential fire hazards

- describes the importance of maintaining close communication with the shore during the loading and unloading stage

- describes the information that should be agreed between ship and shore before any loading or unloading operation

2.4 Oil Tanker Piping and Pumping Arrangements (4 hours)

(Specific training for tankers may be required as specified under Chapter V of the Code)

Tanker Arrangement

- describes, for crude carriers and product tankers, the general arrangement of:
    - cargo tanks
    - pump-rooms
    - segregated ballast tanks
    - slop tanks
    - cofferdams - peak tanks - deep tanks
    - accommodation
    - ventilators leading to accommodation and machinery spaces

Cargo Piping System

- describes the direct pipeline arrangement in crude carriers
- describes the ring-main system in a product tanker
- describes the piping arrangements in a pump-room
- describes the system of individual deep-well pumps for a product tanker
- explains the arrangement and use of:
  - deck lines
  - drop lines
  - stripping lines
  - crossovers
  - bypasses
  - master valves
  - tank suction valves
  - sea suction valves

Cargo Pumps

- describes the main operating features of centrifugal pumps
- explains why most cargo pumps are of centrifugal type
- describes the main operating features of the following positive-displacement pumps:
  - reciprocating
  - screw
- states the applications for which positive-displacement pumps are most suitable
- describes how eductors work and gives examples of their use
- describes the conditions for which the pumps are being used such as stripping
- describes the safe handling of chemical cargoes
- describes the safe handling of liquefied gas cargoes
- describes the used of ship/shore checklist
- describe the importance of setting the right pumping rate during the loading and unloading operation

2.5 Precautions Before Entering Enclosed or Contaminated Spaces (2 hours)

- lists potentially dangerous spaces, including:

  - cargo spaces
  - cargo, fuel and ballast tanks
  - pump-rooms
  - cofferdams
  - duct keels, peak tanks, double bottom tanks

- states that enclosed spaces should be entered only with authorization and after appropriate safety checks have been carried out
- states that an enclosed space may be lacking in oxygen or contain flammable or toxic gases
- states that the master or responsible officer must ensure that a space is safe for entry by:
  - ensuring that the space has been thoroughly ventilated
  - testing at several levels for oxygen content and the presence of harmful vapours
  - requiring breathing apparatus to be worn when there is any doubt about the adequacy of ventilation or testing

- states that the oxygen content should be 21 % by volume before entry is permitted
- defines TLV, TWA, and STEL, and gives examples of their value
- states that the concentration of harmful vapour should be below its threshold limit value (TLV)
- states that a space where the atmosphere is known to be unsafe should be entered only in an emergency, after safety checks have been carried out, and wearing breathing apparatus
- describes a permit-to-enter system using safety checklists to be followed by the responsible officer and the person(s) entering the space
- states that risk assessment must be carried out before the entry into enclosed spaces, with reference to T32
- lists the items appearing on the checklists
- describes the protective clothing and equipment which should be used by or be available to those entering the space
- states that mechanical ventilation should be maintained throughput the time persons are in an enclosed space
- explains why periodical tests of the atmosphere should be made by persons working in an enclosed space
- states that all safety checks should be repeated before re-entering a space after a break
- states that a permit-to-work system should only be for the specific duration of the work for that particular day and not valid for the following day
- states that after work is completed, the area must be closed and secured

2.6 Cargo Calculations and Cargo Plans (5 hours)

- distinguishes between bale capacity and grain capacity
- defines 'stowage factor'
- defines 'broken stowage' and states how an allowance for it is made

- given the capacity to hold and the stowage factor of the cargo, calculates the weight that the holds will contain
- given the weights and stowage factors of one or more cargoes, calculates the space required
- calculates the number of packages of given dimensions which can be loaded in a stated space, making allowance for broken stowage
- given the maximum permissible loading of a 'tween-deck, calculates the maximum height to which cargo of stated stowage factor can be loaded
- given the maximum permissible loading and height of a 'tween-deck, and the stowage factors of two commodities, calculates the depth of each required to fill the space at the maximum permitted deck loading.
- defines 'ullage'
- describes the use~~s~~ of tank calibration tables and given cargo density to calculate the weight in a tank
- corrects densities for temperature
- describes the use~~s~~ of tank calibration tables and given weights and densities of cargo to determine the ullages required
- determines the ullage to leave to produce a given minimum ullage after allowing for expansion of cargo
- extracts information from cargo plans of general cargo ships or container ships
- draws up a cargo plan from given information
- demonstrates the use~~s~~ of a hold capacity plan to estimate the depth of cargo in a hold or the area of 'tween-deck required for a given cargo
- demonstrates the use~~s~~ of a capacity plan to estimate the quantity of cargo which can be loaded in part of a 'tween-deck

COMPETENCE 2.2	Inspect and Report Defects and Damage to Cargo Spaces, Hatch Covers and Ballast Tanks	IMO Reference

TRAINING OUTCOMES: STCW Code Table A-II/1

Demonstrates a knowledge and understanding of:

2.2.1 INSPECT AND REPORT DEFECTS AND DAMAGE TO CARGO SPACES, HATCH COVERS AND BALLAST TANKS

COMPETENCE 2.2	Inspect and Report Defects and Damage to Cargo Spaces, Hatch Covers and Ballast Tanks	IMO Reference

2.2.1 INSPECT AND REPORT DEFECTS AND DAMAGE TO CARGO SPACES, HATCH COVERS AND BALLAST TANKS (15 hours)

Textbooks:T14, T16, T32
Teaching aids: A1,

Required performance:

2.1 Cargo Space Inspections

- Describes the possible causes of damage to the cargo space during cargo operation
- Describes the general layout of a cargo space for a bulk carrier
- Describes the general layout of the cargo space for an oil tanker
- Describes the general layout of the cargo space for a container vessel
- Describes the general layout of a general cargo ship
- Describes the defects that could arise due to the nature of cargo carried
- Describes the corrosion effect that could arise due to structural stress, uneven distribution of cargo, chemical reactions on the ship structure
- Lists the methods in use to prevent the occurrence of corrosion in cargo spaces
- Describes the damage to cargo space due to severe weather condition
- Identifies structural or parts to be inspected each time in order to cover all parts within a given period of time
- Describes the safety procedures before entry into the cargo tank for inspection

2.2 Hatch covers inspection

- Describes the working principles of a hatch cover
- Explains the construction of a hatch cover

- Identifies the difference between watertight and weathertight

- Identifies the critical components of the hatch cover that contribute to weathertightness

- Identifies the critical components of the hatch cover that contribute to watertightness

- Identifies the structural components of a hatch cover which are most likely to experience corrosion

- Describes the testing methods for a hatch cover

2.3 Ballast tanks inspection

- Describes the purpose of ballast tanks

- Reproduces the construction sketch of a ballast tank

- Identifies the parts in the ballast tanks which are most likely to experience corrosion

- Lists the period of interval for the inspection of ballast tanks

- Describes the corrosion prevention methods for ballast tanks

2.4 Damage report

- Lists the items that need to be taken into account where preparing a damage report

- Lists the evidence that needs to be collected in assisting the preparation of a damage report

2.5 Enhanced Survey Programme

- Describes the guidelines on the Enhanced Programme of Inspections during surveys of Bulk Carriers

- Describes the guidelines on the Enhanced Programme of Inspections during surveys of Oil Tankers

Part D2: Instructor manual

The following notes are intended to high light the main objectives or training outcomes of each part of the function. The notes also contain some material on topics which are not adequately covered in the quoted references.

Function 2: Cargo Handling and Stowage at the Operational level

On completion of training for this function, trainees will be able to use cargo plans and tables or diagrams of stability and trim data to calculate the ship's initial stability, draughts and trim for any given description of cargo and other weights. They will also be able to determine whether stresses on the ship are within permitted limits by the use of stress data or calculation equipment, or software.

The safety precautions before entering enclosed or potentially contaminated spaces will be understood.

Trainees should be able to supervise the preparation and dunnaging of holds and the operation of ships' cargo gear and will be aware of the importance of adequately securing cargo to prevent damage to the ship or cargo. Trainees will identify dangerous goods and know that they are stowed and separated according to requirements of the IMDG Code (R37, V51 and V52). They will also know the hazards related to some bulk cargoes and the precautions to take during their loading, carriage and discharge. Trainees will also have a basic knowledge of the piping and pumping arrangements of oil tankers.

2.1 MONITOR THE LOADING, STOWAGE, SECURING, CARE DURING THE VOYAGE AND UNLOADING OF CARGOES

2.1.1 THE EFFECT OF CARGO, INCLUDING HEAVY LIFTS ON THE SEAWORTHINESS AND STABILITY OF THE SHIP (27 hours)

Securing cargoes
Trainees should be made aware that shifting cargo can cause serious structural damage in addition to producing a possibly dangerous list. Examples are ventilators sheared off by deck cargo and 'tween-decks collapsed by overloading as a result of cargo shifting from the other side of the ship.

Considerable damage will also be done to fragile cargo which is thrown about by the ship's movement.

Deck cargo
The general principles of stowing and securing deck cargo so that it does not interfere with the safe operation of the ship and permits safe access to accommodation and working spaces should be dealt with as well as the particular requirements for timber deck cargoes.

Container cargo

The planning of loading of a container ship is normally undertaken ashore, but the officer in charge of the watch should keep an eye on the loading to detect errors in stowage which may occur. A particular watch should be kept for containers with dangerous goods placards to see that their stowage satisfies segregation requirements.

Other things to watch for are that container marked for underdeck stowage do not end up on deck and that refrigerated containers are loaded where they can be connected to the ship's power supply.

Finally, the officer in charge of the watch will check that the cargo is secured, using the correct fastenings, lashings or rods, and that they are set up as laid down in the ship's securing arrangements manual.

Bulk cargoes (other than grain)
The contents of the Code of International Maritime Solid Bulk Cargo should be covered in sufficient depth to ensure that trainees know what information is available and how to find the necessary details for the safe carriage of a particular cargo.

The officer of the watch should know the pre-planned loading procedure regarding quantities to be loaded in each space, the order of deballasting tanks and shifting the vessel under loading chutes. The procedure will have been worked out to keep stresses within acceptable limits and to finish with a satisfactory weight distribution and trim. The officer of the watch should see that the plan is followed, particularly at berths with only one loading chute, to avoid over-stressing the ship.

Bulk grain cargoes
Trainees should not be expected to know the details of the stability calculations for the issue of the document of authorization. They should be made aware that the calculations involve the depth of void spaces under decks, behind deck stringers and in hatchways of filled compartments. Efficient trimming is required to ensure that spaces are filled to the maximum possible extent so as to limit the void spaces to those used in the calculations. They should be able to supervise the construction of saucers or bundles for securing grain surfaces at hatchways and understand that satisfactory stability depends upon their being properly constructed.

Occasionally, different types of grain are loaded into the same hold. The denser grain is loaded first and trimmed level over the entire area of the hold. The surface is covered with separation cloths, allowing for ample overlaps. The cloths are carried well up the sides and ends of the compartment so that the next grain loaded will force them against the plating between the frames and stiffeners. The lighter grain should be loaded carefully at first to avoid displacing the separation cloths.

For bulk grain cargoes such as wheat, corn or any cargoes with a small angle of repose, the cleanliness of the holds is critical as any live insects or bugs could damage the cargo. For this reason, the holds are first sweep to avoid the cargo residual from choking the bilges during hold washing. After the hold is washed, all loose rust and paint must be scrapped and removed as this would provide potential hiding places for insects. The holds are rinsed with fresh water. After the holds are

dry, mild insecticide is sprayed and the hatches are closed. Ensure the holds are well ventilated before arrival at the port of loading.

2.1.2 CARGO HANDLING, STOWAGE AND SECURING OF CARGOES (35 hours)

Publications contain guidance on safety of cargo equipment and safe working practices during cargo handling.

Cargo Care

Inspection and preparation of holds
This section deals with the cleaning, dunnaging and general preparation of holds for loading dry cargoes. When dealing with inspection of holds, it should be impressed upon trainees that they should look for damage, missing fixed dunnage or anything else untoward whenever they visit a cargo space during their watch. Any damage or deficiencies should be noted and reported to the master or chief mate. It is particularly important to watch out for damage to hatch coamings and covers, access ladders to cargo spaces and damaged or missing fencing. Attention should also be paid to guards on moving parts of machinery or steam pipes on deck.

Segregation and separation of cargoes
The segregation of dangerous goods is dealt with in topic area 3. The segregation covered in this section is mainly concerned with protecting cargo from damage by other cargoes. Certain dangerous goods may need segregation from other cargoes which are not themselves dangerous; for example, goods which become dangerous when wet should not be stowed where drainage from wet hides could affect them.

Methods of separation and port marking, to minimize over-carriage, should also be considered.

Ventilation and control of sweat
The methods of minimising the formation of sweat when only natural ventilation is available should be covered

Refrigerated cargo
The cleanliness of cargo compartments for the transport of refrigerated foodstuffs is more important than for any other cargoes. Failure to clean properly can result in mould growth and rotting of fruit and vegetables. Spaces are swept down and all loose dirt removed. Any remaining residues of previous cargoes will have to be scraped or washed off. After cleaning, the spaces are sprayed with a mild disinfectant such as weak sodium hypochlorite solution, which also helps to remove odours. Alternatively, an ozoniser may be used for the same purpose, especially after the carriage of a strong-smelling cargo like oranges.

Holds and lockers are then cooled to carriage temperature. It is essential that any dunnage to be used is placed in the space before pre-cooling, since the use of warm dunnage could cause considerable damage. It is common practice to have holds and

refrigerating machinery inspected by an independent surveyor to certify that the ship is in a fit condition for the carriage of the intended cargo.

The cargo should be inspected ashore by the ship's officers before loading to see that it is in good condition and has been properly pre-cooled where that is required. A sample of the cargo should be thoroughly inspected for signs of mould or other damage and its temperature checked by inserting a steel-tipped thermometer into the product. A record of the inspection and temperatures recorded should be kept. Similar random inspections of the cargo should be made during the loading. Any damaged products or carcasses which have thawed should be rejected or loaded separately. They could cause spoiling of the remainder of the cargo which was in good condition.

The carriage temperatures are stipulated by the shipper of the goods and should be adhered to as closely as possible. Temperatures are taken and recorded at frequent regular intervals and entered in a log-book. Many ships are also equipped with thermographs, which provide a continuous record of compartment temperatures. In the event of claims for cargo damage, the records and thermograph charts will be required as evidence that the correct temperatures were maintained.

In general cargo ships with a limited amount of refrigerated space it is usual to arrange, as far as possible, for the refrigerated cargo to be loaded last and at its destination to be discharged first.

Dangerous, hazardous and harmful Cargoes
Trainees should be aware of the information contained in the IMDG Code and the classification of dangerous goods. They should also be able to identify the labelling and marking required by that Code.

The officer of the watch should have full details of any dangerous goods to be loaded or discharged, their stowage and the measures to be taken in the event of an incident. Trainees should know how to find the information on emergency procedures and first aid and be aware that such information should be known and any necessary equipment prepared for use before starting to handle the goods. They should also have the same information regarding dangerous goods already on board which are not for discharge at that port.

Damaged packages should not be accepted but be returned ashore for checking and repacking. Any incident occurring during the handling of dangerous goods should be reported immediately to the senior officer in charge of the operation.

Cargo-handling equipment and safety
The rigging and operation of derrick cranes of the Hallen, Valle or similar types should be included in this section.

The frequent inspection of ropes, wires, blocks and other cargo gear in use is made by the officer in charge of the watch during his rounds of the deck. If there is doubt about the condition of any of the gear, work should be stopped so that a more thorough inspection can be made and a replacement provided if necessary.

When opening or closing steel hatch covers, a check wire should be used to prevent the covers taking charge, if that is possible. No one should stand or walk on unsecured hatches.

Deep tank cargoes
The cargoes which used to be carried in deep tanks are now frequently carried in chemical tankers but some cargoes, principally cargoes that do not need a complete separation of compartment from the hull, may still be carried in deep tanks of cargo vessels.

Carriage temperatures are laid down by the shippers and should be adhered to. They may require a higher temperature at discharging to ensure suitable viscosities for handling after allowing for some cooling in piping and pumping systems. The maximum rise in temperature per day may also be stipulated, making it necessary to raise the temperature to that required for discharging over several days. Too rapid heating can result in scorching the oil in contact with the heating coils and lead to claims for cargo damage. Tank temperatures should be taken and recorded at regular intervals.

Oil Tanker Piping and Pumping Arrangements
This section is intended to familiarize trainees with the general arrangement of oil tankers and their piping and pumping arrangements, to act as a foundation for further training in tanker procedures at the chief mate and master level. It is recommended that, if available, the use of a liquid cargo handling simulator as part of the training aids to provide realism for the trainees.

A detailed treatment of tanker operations is not required since those officers who are to serve in oil tankers will undertake specialized courses, including basic safety, pollution-prevention precautions and operational procedures. Specific training may be required as specified under chapter V of the STCW Code.

Precautions before Entering Enclosed or Contaminated Spaces
It should be emphasized that collapse due to lack of oxygen can be very rapid, giving the victim no chance to clear out of the space. Similarly, a person can be overcome by toxic gases without realising that there is anything amiss (V88).

Measurements using the correct instruments must be made in a number of locations in the spaces to be entered if there is any possibility of a reduction in oxygen or the presence of toxic or flammable gases.

The sense of smell should never be relied upon; some gases are toxic at levels well below that at which they can be detected by smell; others, such as hydrogen sulphide, can temporarily destroy the sense of smell after the first breath. A lack of oxygen produces no smell.

Until a space has been thoroughly cleaned and ventilated there is a chance of the further production of dangerous levels of a toxic gas so periodic checks should be made while work is in progress and all the checks should be repeated before re-entry after an interval such as a meal break (T32).

Cargo calculations and cargo plans
The stowage factor, SF, of a cargo is the volume occupied by 1 tonne of the cargo. For a bulk liquid cargo it is the specific volume of the substance, i.e. the reciprocal of density.

With packaged goods, it may be impossible to fill the whole space due to the presence of pillars and ladders, curvature and flare of the sides of end holds or the height of 'tween-decks not suiting the package size. The resulting lost space is known as broken stowage and is usually expressed as a percentage of the total space. An average allowance, based on past experience, is included in the stowage factor.

Broken stowage must be taken into account when estimating the number of packages of given size which can be loaded into a space. For example, if an allowance for broken stowage of 15% is made, the available space for cargo is reduced to 85% of the total volume.

Deck loading
Details of the maximum permitted deck loadings may be supplied to the ship. They would normally be expressed in kg/m2 or tonnes/m2. When loading high-density cargo into a 'tween-deck, the height of cargo must be restricted to prevent overstressing the deck structure.

2.2 INSPECT AND REPORT DEFECTS AND DAMAGE TO CARGO SPACES, HATCH COVERS AND BALLAST TANKS (15 HOURS)

Cargo space inspection
Prior to commencement of loading, the cargo holds should therefore be

- inspected to ensure that they are clean, dry, free from smell, remnants of previous cargoes and insects

- checked for small holes and cracks in the steel work to adjacent tanks as leaks from ballast or bunker tanks can cause large scale damage/contamination

If deficiencies are found, it must be rectified immediately and a corresponding record made by completing the relevant maintenance or repair form.

Cargo space for dry bulk cargo are susceptible to damages due to the mode of loading and discharging, use of shore facilities to assist in loading and discharging, corrosion as well as damage due to severe weather condition.

Ship officers must carry out through inspection of the cargo space immediately after completion of discharging operation for dry bulk cargo space to detect any damages to the ship structure and report forwarded to the Chief Officer for further action.

Hatch covers inspection

The inspection of the vessel should include a special check on the condition of:
Watertight doors, ventilation heads, hatch covers, hold access covers, dogs and clamps, side ports, ramps and doors to the superstructure and, the condition of the rubber gaskets.

Damaged, worn or compressed parts must be replaced immediately. Drainpipes and gutters on the hatch covers and panels also require attention and need to be kept clean at all times.

On the vessel with hatch covers, if the vessel's cargo operations so allow, make a daylight test of the hatch covers to check whether they are tight. Hatch covers are the most vulnerable part of the vessel when it comes to water ingress during the voyage and can endanger the safety of both the vessel and the crew.

Hatch cover quick acting cleats should be in good working condition and rust free. Worn parts should be replaced.

Ballast tanks inspection
Due to the nature of trade and cargo carried, ballast tanks onboard are generally subjected various conditions of loading and discharging as well as sloshing effect or free surface effect. Even though the damage due to internal factor is minimal but due to the nature of its location which are generally next to the cargo space, the damage due to cargo operation must also take into consideration.

Another possible cause of damage for the ballast tanks is the corrosion where there existing of paint work defect.

Damage report
Damage to any part of the vessel may be caused by:

- stevedores during cargo operation
- shore terminal operators with cranes
- contractors during works
- truck drivers on ro-ro vessels

As in the case of any other damage it is important to collect the necessary evidence as soon and as complete as possible in order for the Company to be able to pursue the claim.

Enhanced Survey Programme
Reference to Guidelines on the Enhanced Programme of Inspections during Surveys of Bulk Carriers and Oil Tankers.

Function 3:

Controlling the Operation of the Ship and Care for Persons on Board at the Operational Level

Officer in Charge of a Navigational Watch
Function 3: Controlling the Operation of the Ship and Care for Persons on Board at the Operational Level

INDEX

Part B3: Course Outline

Timetable

No formal example of a timetable is included in this model course.

Development of a detailed timetable depends on the level of skills of the trainees entering the course and the amount of revision work of basic principles that may be required.

Lecturers must develop their own timetable depending on:

- the level of skills of trainees
- the numbers to be trained
- the number of instructors, and
- normal practices at the training establishment.

Preparation and planning constitute an important factor which makes a major contribution to the effective presentation of any course of instruction.

Lectures

As far as possible, lectures should be presented within a familiar context and should make use of practical examples. They should be well illustrated with diagrams, photographs and charts where appropriate, and be related to matter learned during seagoing time.

An effective manner of presentation is to develop a technique of giving information and then reinforcing it. For example, first tell the trainees briefly what you are going to present to them; then cover the topic in detail; and, finally, summarise what you have told them. The use of an overhead projector and the distribution of copies of the transparencies as trainees handouts contribute to the learning process.

Course outline

The tables that follow list the competencies and areas of knowledge, understanding and proficiency, together with the estimated total hours required for lectures and practical exercises. Teaching staff should note that timings are suggestions only and should be adapted to suit individual groups of trainees depending on their experience, ability, equipment and staff available for training.

COURSE OUTLINE

Knowledge, understanding and proficiency	Total hours for each topic	Total hours for each subject area of Required performance

Competence:

3.1 ENSURE COMPLIANCE WITH POLLUTION-PREVENTION REQUIREMENTS

3.1.1 THE PRECAUTIONS TO BE TAKEN TO PREVENT POLLUTION OF THE MARINE ENVIRONMENT

.1 MARPOL 73/78	14	
.2 Convention and legislations adopted by various countries	4	18

3.1.2 ANTI-POLLUTION PROCEDURES AND ASSOCIATED EQUIPMENT

.1 Control of discharge of oil	2	
.2 Oil Record Book (Part I – Machinery Space Operations) and Part II – Cargo/Ballast operations)	1	
.3 Shipboard Oil Pollution Emergency Plan (SOPEP) including Shipboard Marine Pollution Emergency Plans (SMPEP) for Oil and/or Noxious Liquid Substances and Vessel Response Plan (VRP)	1	
.4 Operating procedures of anti-pollution equipment, Sewage plant, incinerator, comminutor, ballast water treatment plant	1	
.5 Volatile Organic Compound (VOC) Management Plan, Garbage Management System, Anti-fouling systems, Ballast Water Management and their discharge criteria	3	
		8

3.1.3 PROACTIVE MEASURES TO PROTECT THE MARINE ENVIRONMENT

.1 Proactive measures to protect the marine environment	1	1

3.2 MAINTAIN THE SEAWORTHINESS OF THE SHIP

3.2.1 STABILITY, TRIM AND STRESS TABLES

.1 Displacement	4	

.2	Buoyancy	2	
.3	Fresh water allowance	3	
.4	Statical stability	3	
.5	Initial stability	4	
.6	Angle of loll	1	
.7	Curves of statical stability	4	
.8	Movement of centre of gravity	4	
.9	List and Its Correction	6	
.10	Effect of slack tanks	3	
.11	Trim and draft calculations	6	
.12	Actions to be taken in the event of partial loss of intact buoyancy	1	
.13	Stress tables and stress calculating equipment (Loadicator)	3	44

3.2.2 THE PRINCIPAL STRUCTURAL MEMBERS OF A SHIP

.1	Ship dimensions and form	12	
.2	Ship Stresses	8	
.3	Hull structure	11	
.4	Bow and stern regions	6	
.5	Fittings	10	
.6	Rudders and propellers	11	
.7	Load lines and draught marks	5	
			63

3.3 PREVENT, CONTROL AND FIGHT FIRES ON BOARD

See IMO Model Course 2.03 and STCW 2010 *Regulation VI/3*

3.4 OPERATE LIFE-SAVING APPLIANCES

See IMO Model Course 1.23, and STCW 2010 *Regulation VI/2 paragraph* 1-4

3.5 APPLY MEDICAL FIRST AID ON BOARD SHIP

See IMO Model Course 1.14 and STCW Regulation VI/4 paragraph 1-3

3.6 MONITOR COMPLIANCE WITH LEGISLATIVE REQUIREMENTS

3.6.1 BASIC WORKING KNOWLEDGE OF THE RELEVANT IMO CONVENTIONS CONCERNING SAFETY OF LIFE AT SEA, SECURITY AND PROTECTION OF THE MARINE ENVIRONMENT

.1	Introduction to Maritime Law	1
.2	Law of the Sea	5
.3	Safety: (27hours)	
	International Convention on load Lines, 1966	2

SOLAS, 1974 as amended	2
SOLAS - Subdivision and stability	2
SOLAS - Fire protection, detection and extinction	2
SOLAS - LSA and arrangements (LSA Code)	2
SOLAS - Radio communications	2
SOLAS - Carriage of grain	1
SOLAS - Carriage of dangerous goods	1
ISM Code	2
STCW, Convention, 1978, as amended	2
STP ships Agreement, 1971	1
SPACE STP, 1973	1
PAL, 1974	1
Tonnage 1969	1
BWM, 2004	1
AFS Convention, 2001	1
Guidelines on the Enhanced Programme of Inspections During Surveys of Bulk Carriers and Oil Tankers	1
Code of Safe Working Practices for Merchant Seamen	1
ISPS Code	1

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3.7 APPLICATION OF LEADERSHIP AND TEAMWORKING SKILLS

See IMO Model Course 1.39 and STCW 2010 Regulation I/ and Section A-VI/1 paragraph

3.8 CONTRIBUTE TO SAFETY OF PERSONNEL AND SHIP

See IMO Model Courses 1.13, 1.19, 1.20, 1.21, and STCW Regulation VI/1 and Section A-VI/1 paragraph 2

Total for Function 3:
Controlling the Operation of the Ship and Care for Persons on Board at the Operational Level 167 hours

Teaching staff should note that the hours for lectures and exercises are suggestions only as regards sequence and length of time allocated to each objective. These factors may be adapted by lecturers to suit individual groups of trainees depending on their experience, ability, equipment and staff available for teaching.

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 teaching 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 systematically organised 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.

In this Model course there are three functions:

Navigation at the operational Level
Cargo Handling and Stowage at the operational Level
Controlling the operation of the ship and care for persons on board at the operational Level.

The header of the first column denotes the COMPETENCE concerned. Each function comprises several competences. For example, the Function 3, Controlling the Operation of the Ship and Care for Persons on Board at the Operational Level, comprises a total of eight COMPETENCES. Each competence is uniquely and consistently numbered in this model course.

The first competence in FUNCTION 3 is **Ensure compliance with pollution prevention requirements** and it is numbered 3.1. The term competence should be understood as the application of knowledge, understanding, proficiency, skills, and 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 the PRECAUTIONS TO BE TAKEN TO PREVENT POLLUTION OF THE MARINE ENVIRONMENT. Each training outcome is uniquely and consistently numbered in this model course. That concerned with precautions to be taken to prevent pollution of the marine environment is uniquely' numbered 3.1.1. For clarity training outcomes are printed in black 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 precautions to be taken to prevent pollution of the marine environment, there are two areas of performance. They are as follows:

3.1.1.1 MARPOL 73/78 (14 hours)
Technical Annexes: Annex I to VI of MARPOL 73/78 in detail

3.1.1.2 Convention and legislations adopted by various countries (4 hours)

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:

- define for the purpose of MARPOL 73/78:a harmful substance, a discharge, and ship and an incident
- state that violations of the Convention are prohibited and that sanctions should be established for violations
- describes the inspections which may be made by Port State authorities and outlines actions which they may take and so on.

IMO references (Rx) are listed in the column to the right hand side. Teaching aids (Ax), videos (Vx) and textbooks (Tx) relevant to the training outcome and required performance are placed immediately following the TRAINING OUTCOME title.

It is not intended that lessons are organised to follow the sequence of Required performances listed in the Tables. The Syllabus Tables are organised to match with the competence in the STCW Code Table A-III/1. 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 the materials are covered and that teaching is effective to allow trainees to meet the standard of the Required performance.

COMPETENCE 3.1	Ensure Compliance with Pollution-Prevention Requirements	IMO Reference

TRAINING OUTCOME

Demonstrates a knowledge and understanding of: STCW Code Table A-II/1

3.1.1 THE PRECAUTIONS TO BE TAKEN TO PREVENT POLLUTION OF THE MARINE ENVIRONMENT

3.1.2 ANTI-POLLUTION PROCEDURES AND ALL ASSOCIATED EQUIPMENT

3.1.3 PROACTIVE MEASURES TO PROTECT THE MARINE ENVIRONMENT

COMPETENCE 3.1	Ensure Compliance with Pollution-Prevention Requirements	IMO Reference

3.1.1 THE PRECAUTIONS TO BE TAKEN TO PREVENT POLLUTION OF THE MARINE ENVIRONMENT

Required performance:

1.1 International Convention for the Prevention of Pollution from Ships,1973 and the Protocol of 1978 relating thereto (MARPOL 73/78)
Technical Annexes: Annex I to VI of MARPOL 73/78 in detail (14 hours)

- defines, for the purpose of MARPOL 73/78:
  - harmful substance
  - discharge
  - ship
  - incident
- states that violations of the Convention are prohibited and that sanctions should be established for violations, wherever they occur by the Administration of the ship concerned
- describes the inspections which may be made by port State authorities and outlines actions which they may take
- describes the provisions for the detection of violations and enforcement of the Convention
- states that reports on incidents involving harmful substances must be made without delay

Annex I-Oil

- defines, for the purposes of Annex I:
  - oil
  - oily mixture
  - oil fuel
  - oil tanker
  - combination carrier
  - nearest land
  - special area
  - instantaneous rate of discharge of oil content
  - wing tank
  - centre tank
  - slop tank
  - clean ballast
  - segregated ballast
- describes the surveys and inspections required under the provisions of MARPOL73/78
- describes the steps which may be taken if a surveyor finds that the condition of the ship or its equipment is unsatisfactory
- states that the condition of the ship and its equipment should be maintained to conform with the provisions of the Convention
- states that the certificate issued after survey is the International Oil Pollution Prevention (IOPP) Certificate

- states that the IOPP Certificate should be available on board the ship at all times
- lists the conditions under which oily mixtures may be discharged into the Sea from an oil tanker
- lists the conditions under which oily mixtures from machinery-space bilges may be discharged into the sea
- states that the provisions do not apply to the discharge of clean or segregated ballast
- describes the conditions under which the provisions do not apply to the discharge of oily mixtures from machinery spaces where the oil content without dilution does not exceed 15 parts per million
- states that residues which cannot be discharged into the sea in compliance with the regulations must be retained on board or discharged to reception facilities
- lists the special areas for the purposes of Annex I
- states that any discharge into the sea of oil or oily mixtures from an oil tanker or other ships of 400 tons gross tonnage and above is prohibited while in a special area
- describes the conditions under which an oil tanker may discharge oily mixtures through ODMCS
- describes the conditions under which a ship, other than an oil tanker, may discharge oily mixtures in a special area
- states that the regulation does not apply to the discharge of clean or segregated ballast
- describes conditions in which processed bilge water from machinery spaces may be discharged in a special area
- describes the exceptional circumstances in which the regulations on the discharge of oil or oily mixtures do not apply
- states that ballast water should not normally be carried in cargo tanks of tankers provided with segregated ballast tanks
- explains the exceptions in which ballast may be carried in cargo tanks
- states that every oil tanker operating with crude oil washing systems should be provided with an Operations and Equipment Manual
- states that, in new ships of 400 tons gross tonnage and above and in new oil tankers of 150 tons gross tonnage and above, no ballast water should normally be carried in any oil fuel tank
- explains that a new chapter 8 – STS operations has been added to MARPOL Annex 1 to prevent marine pollution during some ship-to-ship (STS) oil transfer operations
- states that as per the above amendment to Annex I of MARPOL, Tankers of 150 GT and above involved in STS operations are required to have on board by the date of the first periodical survey after 1st January 2011 (but not later than 1st April 2012) an STS operations plan approved by the ship flag administration, describing how STS operations are to be conducted

Annex II - Noxious Liquid Substances in Bulk

- describes the requirements of Annex II apply to all ships carrying noxious liquid substances in bulk
- states that noxious liquid chemicals are divided into four categories, X, Y, Z and OS such that substances in category X pose the greatest threat to the marine environment and those in category Z the least
- states that the conditions for the discharge of any effluent containing substances falling in those categories are specified
- states that more stringent requirements apply in special areas, which for the purposes of Annex II are the Antarctic area
- states that pumping and piping arrangements are to be such that, after unloading, the tanks designated for the carriage of liquids of categories Z do not retain more than certain stipulated quantities of residue

- states that the discharge operations of certain cargo residues and certain tank cleaning and ventilation, operations may only be carried out in accordance with approved procedures and arrangements based on standards developed by IMO
- states that each ship which is certified for the carriage of noxious liquid substances in bulk should be provided with a Procedures and Arrangements Manual
- states that the Manual identifies the arrangements and equipment needed to comply with Annex II and specifies the operational procedures with respect to cargo handling, tank cleaning, slops handling, residue discharging, ballasting and deballasting which must be followed in order to comply with the requirements of Annex II
- states that each ship should be provided with a Cargo Record Book which should be completed, on a tank-by-tank basis, whenever any operations with respect to a noxious liquid substance take place
- states that a surveyor appointed or authorized by the Government of a Party to the Convention to supervise any operations under this Annex should make an appropriate entry in the Cargo Record Book
- describes the surveys required for ships carrying noxious liquid substances in bulk
- states that the certificate issued on satisfactory completion of the survey is an international Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk

Annex III-Harmful Substances Carried by Sea in Packaged Forms, or in Freight Containers, Portable Tanks or Road and Rail Tank Wagons

- states that for the purpose of this annex, empty receptacles, freight containers and portable road and rail tank wagons which have been used previously for the carriage of harmful substances are treated as harmful substances themselves unless precautions have been taken to ensure that they contain no residue that is hazardous to the marine environment
- states that packaging, containers and tanks should be adequate to minimize hazard to the marine environment
- describes the requirements for marking and labelling packages, freight containers, tanks and wagons
- describes the notification procedures for loading/unloading harmful substances as per MARPOL Annex III
- describes the documentation relating to the carriage of harmful substances by sea
- states that certain harmful substances may be prohibited for carriage or limited as to the quantity which may be carried aboard any one ship
- states that jettisoning of harmful substances is prohibited except for the purpose of securing the safety of the ship or saving life at sea

Annex IV – Sewage

- states that Annex IV contains a set of regulations regarding the discharge of sewage into the sea, ships' equipment and systems for the control of sewage discharge, the provision of facilities at ports and terminals for the reception of sewage, and requirements for survey and certification
- describes the provisions regarding the discharge of sewage into the sea
- states that an International Sewage Pollution Prevention Certificate is issued by national shipping administrations to ships under their jurisdiction showing compliance
- States that the Annex requires ships to be equipped with either a sewage treatment plant or a sewage comminuting and disinfecting system or a sewage holding tank

- States that the discharge of sewage into the sea is prohibited, except when the ship has in operation an approved sewage treatment plant or is discharging comminuted and disinfected sewage using an approved system at a distance of more than three nautical miles from the nearest land; or is discharging sewage which is not comminuted or disinfected at a distance of more than 12 nautical miles from the nearest land

Annex V – Garbage

- defines, for the purposes of Annex V:
  - garbage
  - nearest land
  - special area
- states that the provisions of Annex V apply to all ships
- states that the disposal into the sea of all plastics is prohibited
- states the regulations concerning the disposal of other garbage
- states that the special areas for the purposes of Annex V as the Mediterranean sea, Baltic Sea, Black Sea, Red Sea, "Gulfs" area, North Sea, Antarctic area (south of latitude 60 degrees south), Wider Caribbean region including the Gulf of Mexico and the Caribbean Sea

Annex VI – Air Pollution

- defines, for the purposes of Annex VI:
  - continuous feeding
  - emission control area (ECA)
  - new installations
  - Nitrogen Oxide (NO_X) technical code
  - Ozone depleting substances
  - sludge oil
  - shipboard incineration
  - shipboard incinerator
  - particular matter (PM)
  - volatile organic compounds (VOCs)
- describes the types of inspection required under Annex VI
- describes the provision for the issuance of International Air Pollution Prevention certificate
- describes the duration of validity of the certificate
- describes the regulation regarding NOX in Regulation 13 of Annex VI
- describes the requirement for SOX emission control area (SECA)
- describes the requirement for fuel oil quality in Regulation 18 of Annex VI
- states that the special areas for the purposes of Annex VI as the Baltic Sea(SOx), North Sea(SOx), North American (SOx, NOx and PM), United States Caribbean Sea ECA (SOx, NOx and PM)

1.2 **Conventions and legislations adopted by various countries (4 hours)**

The trainee is expected to have a basic working knowledge of the conventions and legislations adopted by various countries such as, but not limited to:

- Convention of the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention) (LDC)

- International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969

- International Convention on Civil Liability for Oil Pollution Damage, 1969(CLC 1969)

- Oil Pollution Preparedness, Response & Cooperation Convention (OPRC) as amended (OPRCHNS Protocol)

- OPA – 90 and other U.S. legislation

3.1.2 ANTI－POLLUTION PROCEDURES AND ALL ASSOCIATED EQUIPMENT

Required performance:

2.1 Control of discharge of oil (2 hours)

- explains the control of discharge of oil as stated in Regulation 9 of MARPOL 73/78
- explains Particularly Sensitive Sea Areas (PSSA)
- explains methods for prevention of oil pollution and discharge provisions for oil and oily waste from machinery spaces outside special areas and within special areas
- explains bilge water holding tank
- explains Oily water separator
- explains Oil discharge monitoring and control system and oil filtering equipment as stated in Regulation 16 of MARPOL 73/78
- explains in brief the prevention of oil pollution as stated in Regulation 13F in the event of collision or stranding and Regulation 13G in the event of collision or stranding Measures for existing tankers of MARPOL 73/78
- explains the retention of oil on board as stated in Regulation 15 of MARPOL 73/78

2.2 Oil Record Book (Part I - Machinery Space Operations and Part II – Cargo/Ballast Operations) (1 hour)

- describes the requirements for the provision of Oil Record Books, which is, Oil tankers of 150 tons GT and every ship of 400 tons of GT and above other than an oil tanker to carry an Oil Record Book Part I (Machinery Space Operations)
- describes that every oil tanker of 150 tons GT and above shall also be provided with an Oil Record Book Part II (Cargo/Ballast Operations)
- describes the various operation when the Oil Record Book has to be completed
- lists the various entries that needs to be made in the Oil Record Book with respect to above for following operations:
- for machinery space operations (all ships)
- for cargo/ballast operations (oil tankers)
- describes the entries required for accidental or other exceptional discharge of oil
- explains that each completed operation shall be signed by the officer or officers in charge of the operations concerned and each completed page shall be signed by the master of ship
- states that the Oil Record Book should be kept on board readily available for inspection and should be preserved for a period of three years after the last entry has been made

- explains that the competent authority of the Government of a Party to the Convention may inspect the Oil Record Book on board any ship to which Annex I applies while the ship is in its port or offshore terminals and may make a copy of any entry in that book and may require the master of the ship to certify that the copy is a true copy of such entry

2.3 Shipboard Oil Pollution Emergency Plan (SOPEP) including Shipboard Marine Pollution Emergency Plans (SMPEP) for Oil and/or Noxious Liquid Substances and Vessel Response Plan (VRP) (1 hour)

- states that the Shipboard Oil Pollution Emergency Plan ("SOPEP") is to be seen as an information from the owners to the Master of a particular ship
- states it is an advice to the Master how to react in case of an oil spill to prevent or at least mitigate negative effects on the environment
- states that the Plan contains operational aspects for various oil spill scenarios and lists communication information to be used in case of such incidents
- states that it is compulsory for all ships of more than 400 Gross Tons (Oil tankers of more than 150 GT) to carry a SOPEP onboard
- states that the required contents is described in MARPOL Convention Annex I Reg. 26
- explains that "Guidelines for the Development of a Shipboard Oil Pollution Emergency Plan" are published by IMO under MEPC.54(32) 1992 as amended by MEPC.86(44) 2000
- states that the SOPEP forms an integral part of the IOPP certificate and its existence is verified in the Supplement to the IOPP Certificate
- describes that the Plan consists generally of 4 Sections with the mandatory contents and it's Appendices with additional information as contact addresses and data plus a set of certain drawings for easy reference for the Master
- describes that the SOPEP consists of the following Chapters:
    1. Ship identification data
    2. Table of Contents
    3. Record of Changes
    4. Section 1: Preamble
    5. Section 2: Reporting Requirements
    6. Section 3: Steps to control Discharges
    7. Section 4: National and Local Coordination
    8. Minimum Appendices:
        - List of Coastal State Contacts
        - List of Port Contacts
        - List of Ship Interest Contacts
    9. Ship's drawings:
        - General Arrangement Plan
        - Tank Plan
        - Fuel Oil Piping Diagram
    10. Further appendices on owners' decision
- explains that according to MARPOL following appendices should be added to the SOPEP:
- Coastal State Contacts (as annually published but quarterly updated in the Internet by IMO)
- Blank form for listing of Port Contact Addresses to be kept up-to-date by the Master
- Ship Interest Contact List (communication data incl. 24hours contact phone

numbers to owners/managers, data abt. charterer, insurance, P&I Club, etc.)

Shipboard Marine Pollution Emergency Plan (SMPEP)

- explains IMO has adopted a requirement for ships above 150 GRT certified to carry noxious liquid substances in bulk and that these ships shall carry an additional emergency plan called "Shipboard Marine Pollution Emergency Plan for noxious liquid substances"
- explains that this plan, is to be seen as an information from the owners to the Master of a particular ship advising the Master how to react in case of a spill of noxious liquid substances to prevent or at least mitigate negative effects on the environment
- explains that the Plan is compulsory since 1st January 2003
- describes that the Plan contains operational aspects for various spill scenarios and lists communication information to be used in case of such incidents
- explains that as the contents is mainly similar to the contents of the Shipboard Oil Pollution Emergency Plan (SOPEP) which is compulsory, IMO recommends to prepare a combined plan called "Shipboard Marine Pollution Emergency Plan" ("SMPEP")
- explains that such plan has to fulfill the requirements for the SOPEP and additionally for the Shipboard Marine Pollution Emergency Plan for noxious liquid substances according to the IMO Guideline
- states that the required contents is described in MARPOL 73/78 as amended Annex II Reg. 16
- explains that "Guidelines for the Development of a Shipboard Marine Pollution Emergency Plan for noxious liquid substances" are published by IMO under MEPC.85(44) adopted in March 2000
- explains that the Certificate of Chemical Fitness or Substances in Bulk respectively can only be issued if the said plan is available onboard
- explains that If a combined plan "Shipboard Marine Pollution Emergency Plan" (SMPEP) is carried, it has to be in accordance with the guidelines MEPC.85(44) and MEPC.54(32) as amended by MEPC.86(44)

Vessel Response Plan (VRP)

- explains that the VRP- Vessel Response Plan is a plan required for vessels trading to/from/in U.S.A and this U.S. Coast Guard's new regulations to improve pollution-response preparedness for vessels carrying or handling oil upon the navigable waters of the United States came into effect from 22nd February 2011
- explains that the Oil Pollution Act of 1990 (OPA-90) and the international treaty, MARPOL 73/78, require owners/operators of certain vessels to prepare Vessel Response Plans (VRP) and /or Shipboard oil Pollution Emergency Plans (SOPEP) and in addition, for certain vessels carrying noxious liquid substances a Shipboard Marine Pollution Emergency Plans (SMPEP), effective from 1st January 2003

2.4 Overview of anti-pollution equipment, Sewage plant, incinerator, comminutor, ballast water treatment plant (1 hour)

- describes the operating procedures of anti-pollution equipment such as:
- Sewage plant
- Incinerator
- Comminutor

- ballast water treatment plant

2.5 Volatile Organic Compound (VOC) Management Plan, Garbage Management System, Anti-fouling systems, Ballast Water Management and their discharge criteria (3 hours)

Volatile Organic Compound (VOC) Management Plan

- describes that Volatile Organic Compounds (VOC) are organic chemicals that easily vaporize at normal conditions and enter into the atmosphere
- explains that VOC may include a very wide range of individual substances, such as hydrocarbons (e.g. methane, ethane, benzene, toluene, etc.), oxidized hydrocarbons (or fuel oxygenates, such as methyl tert-butyl ether (MTBE)) and by-product organic compounds from chlorination in water treatment (such as chloroform)
- explains that VOC emissions from the fuel/petroleum industry sources occur during extraction of oil at the platform, tanker transportation of oil, loading and discharging at terminals, oil processing at refineries, tanking at filling stations and leakage from pipelines as well as oil spills
- explains that VOC emissions from ships can be due to incomplete combustion processes and include crankcase, exhaust and evaporation emissions
- explains that Tankers emit VOC during cargo loading and crude oil washing operations as well as during sea voyages
- explains that the amount of VOC emissions depends on many factors including the properties of the cargo oil, the degree of mixing and temperature variations during the sea voyage
- explains that to control this emission, there are four criteria that impact the extent and rate of evolution of gaseous non-methane VOC from crude oils and its subsequent release to the atmosphere. These are:
  - the volatility or vapor pressure of the crude oil
  - the temperature of the liquid and gas phases of the crude oil tank
  - the pressure setting or control of the vapor phase within the cargo tank
  - the size or volume of the vapor phase within the cargo tank
  - describes that Regulation 15.6 of MARPOL requires a tanker carrying crude oil shall have onboard and implement a VOC Management Plan (Management Plan) approved by the Administration in accordance with IMO Resolution MEPC.185(59) "Guidelines for the Development of a VOC Management Plan"
- explains that this VOC Management Plan is specific to each ship
- explains that the aim of the VOC Management Plan is to identify the arrangements and equipment required to enable compliance with Regulation 15.6 of the Revised Annex VI and to identify for the ship's officers the operational procedures for VOC emission control

Garbage Management Plan

- explains that as per MARPOL 73/78, Annex V, regulation 9 every ship of 400 gross tonnage and above and every ship which is certified to carry 15 persons or more are to be required to carry a garbage management plan which the crew are required to follow
- describes the content of the Garbage Management Plan

Garbage Record Book

- explains that every ship of 400 gross tonnage and above and every ship which is certified to carry 15 persons or more engaged in voyages to ports or offshore terminals under the jurisdiction of other Parties to the Convention and every fixed and floating platform engaged in exploration and exploitation of the sea-bed are to be provided with a Garbage Record Book
- describes the various operation when the Garbage Record Book has to be completed
- lists the various entries that needs to be made in the Garbage Record Book
- explains the disposal criteria for cargo residues/cargo hold washing water residues

Anti-fouling systems

- states that IMO adopted a new International Convention on the Control of Harmful Anti-fouling Systems on Ships, on 5 October 2001 which will prohibit the use of harmful organotins in antifouling paints used on ships and will establish a mechanism to prevent the potential future use of other harmful substances in anti-fouling system
- states that the convention entered into force on 17 September 2008

Ballast Water Management Convention 2004

- states that The International Convention for the Control and Management of Ships Ballast Water & Sediments (BWM convention) was adopted by consensus at a diplomatic Conference at IMO in London on Friday 13 February 2004 and expected to be ratified
- defines the following:
  - ballast water
  - ballast water management
  - sediments
- describes the application of this convention
- states that in order to show compliance with the requirements of the Convention each vessel shall have on board a valid Certificate, a Ballast Water Management Plan and a Ballast Water Record Book
- describes the conditions where the application of this convention may be exempted
- describes the management and control requirement based on Section B Regulation B1 to B6
- describes the Annex – Section A, B, C, D and E briefly
- describes the various methods of ballast exchange
- describes the standards that need to be observed in ballast water exchange
- states under Regulation B-4 Ballast Water Exchange, all ships using ballast water exchange should:
- Whenever possible, conduct ballast water exchange at least 200 nautical

miles from the nearest land and in water at least 200 metres in depth, taking into account Guidelines developed by IMO;

- In cases where the ship is unable to conduct ballast water exchange as above, this should be as far from the nearest land as possible, and in all cases at least 50 nautical miles from the nearest land and in water at least 200 metres in depth
- states as per Annex – Section B Management and Control Requirements for Ships:
- Ships are required to have on board and implement a Ballast Water Management Plan approved by the Administration (Regulation B-1). The Ballast Water Management Plan is specific to each ship and includes a detailed description of the actions to be taken to implement the Ballast Water Management requirements and supplemental Ballast Water Management practices.
- states that a new paragraph, 4, has been added with effect from July 1, 2010 to SOLAS Chapter V, Regulation 22 – Navigation bridge visibility. Some changes are operational and others introduce new requirements applicable to navigation records
- states that as a consequence of this amendment, any increase in blind sectors or reduction in horizontal fields of vision resulting from ballast water exchange operations is to be taken into account by the Master before determining that it is safe to proceed with the exchange
- states that as an additional measure, to compensate for possible increased blind sectors or reduced horizontal fields of vision, the Master must ensure that a proper lookout is maintained at all times during the exchange. Ballast water exchange must be conducted in accordance with the ship's ballast water management plan, taking into account the recommendations adopted by the IMO
- explains that in accordance with SOLAS Chapter V, Regulation28 – Records of navigational activities and daily reporting, the commencement and termination of the operation should be recorded
- explains that the navigational records generated during ballast water exchange may be reviewed during ISM Audits and port state control inspections

3.1.3 PROACTIVE MEASURES TO PROTECT THE MARINE ENVIRONMENT

Required performance:

3.1 Importance of proactive measures to protect the marine environment (1 hour)

- explains the need for taking proactive measures to protect the marine environment
- describes the proactive measures that can be taken on board the ships to protect the marine environment for shipboard operations, including:
  - bunkering
  - loading / discharging Oil, Chemicals and hazardous cargoes
  - tank cleaning
  - cargo hold washing
  - pumping out bilges (hold and engine room)
  - ballast water exchange
  - purging and Gas freeing
  - disposal of other garbage
  - discharge of sewage

COMPETENCE 3.2	**Maintain the Seaworthiness of the Ship**	**IMO Reference**

TRAINING OUTCOME

STCW Code
Table A－II/1

Demonstrates a knowledge and understanding of:

3.2.1 STABILITY, TRIM AND STRESS TABLES

3.2.2 THE PRINCIPAL STRUCTURAL MEMBERS OF A SHIP

COMPETENCE 3.2 Maintain the Seaworthiness of the Ship IMO Reference

3.2.1 STABILITY, TRIM AND STRESS TABLES

Required performance:

1.1 Displacement (4 hours)

- states that, for a ship to float, it must displace a mass of water equal to its own mass
- explains how, when the mass of a ship changes, the mass of water displaced changes by an equal amount
- states that the displacement of a vessel is its mass and it is measured in tonnes
- states that displacement is represented by the symbol Δ
- explains the relationship between the displacement and mean draught of a ship by using the graph or scale
- given a displacement/draught curve, finds:
  - displacements for given mean draughts
  - mean draughts for given displacements
  - the change in mean draught when given masses are loaded or discharged
  - the mass of cargo to be loaded or discharged to produce a required change of draught
- defines' light displacement' and 'load displacement'
- defines 'deadweight'
- uses a deadweight scale to find the deadweight and displacement of a ship at various draughts in seawater
- defines 'tonnes per centimetre immersion'(TPC)
- explains why TPC varies with different draughts
- uses a deadweight scale to obtain TPC at given draughts
- uses TPC obtained from a deadweight to find:
  - the change of mean draught when given masses are loaded or discharged
  - the mass of cargo to be loaded or discharged to produce a required change of draught
- defines 'block coefficient'(C_b)
- calculates C_b from given displacement and dimensions
- calculates displacement from given C_b and dimensions

1.2 Buoyancy (2 hours)

- explains what is meant by 'buoyancy'
- states that the force of buoyancy is an upward force on a floating object created by the pressure of liquid on the object
- states that the buoyancy force is equal to the displacement of a floating object
- describes reserve buoyancy
- explains the importance of reserve buoyancy
- explains how freeboard is related to reserve buoyancy
- explains the purpose of load lines
- explains the requirements for maintaining watertight integrity

- demonstrates an understanding of damage stability requirements for certain vessels
- explains reasons for damage stability requirements
- identifies damage stability requirements for Type A vessels, Type (B－60) and Type (B－100) vessels
- identifies equilibrium condition after flooding for Type A, and all Type B vessels
- identifies damage stability requirements for passenger vessels

1.3 Fresh Water Allowance (3 hours)

- explains why the draught of a ship decreases when it passes from fresh water to seawater and vice versa
- states that when loading in fresh water before proceeding into seawater, a ship is allowed a deeper maximum draught
- describes what it meant by the fresh water allowance (FWA)
- given the FWA and TPC for fresh water, calculates the amount which can be loaded after reaching the summer load line when loading in fresh water before sailing into seawater
- describes the uses a hydrometer to find the density of dock water
- describes the effect of changes of tide and rain on dock water density
- explains how to obtain the correct dock water density
- given the density of dock water and TPC for seawater, calculates the TPC for dock water
- given the density of dock water and FWA, calculates the amount by which the appropriate load line may be submerged
- given the present draught amidships and the density of dock water, calculates the amount to load to bring the ship to the appropriate load line in seawater

1.4 Statical Stability (3 hours)

- states that weight is the force of gravity on a mass and always acts vertically downwards
- states that the total weight of a ship and all its contents can be considered to act at a point called the centre of gravity (G)
- states that the centre of buoyancy (B) as being the centre of the underwater volume of the ship
- states that the force of buoyancy always acts vertically upwards
- explains that the total force of buoyancy can be considered as a single force acting through B
- states that when the shape of the underwater volume of a ship changes the position of B also changes
- states that the position of B will change when the draught changes and when heeling occurs
- labels a diagram of a midship cross－section of an upright ship to show the weight acting through G and the buoyancy force acting through B
- states that the buoyancy force is equal to the weight of the ship
- labels a diagram of a midship cross－section of a ship heeled to a small angle to show the weight acting through G and the buoyancy force acting through B
- describes stability as the ability of the ship to return to an upright position after being heeled by an external force
- states that the lever GZ as the horizontal distance between the vertical forces

acting through B and G
- states that the forces of weight and buoyancy form a couple
- states that the magnitude of the couple is displacement × lever, $\Delta \times GZ$
- explains how variations in displacement and GZ affect the stability of the ship
- on a diagram of a heeled ship, shows:
  - the forces at B and G
  - the lever GZ
- states that the length of GZ will be different at different angles of heel
- states that if the couple $\Delta \times GZ$ tends to turn the ship toward the upright, the ship is stable
- states that for a stable ship:
  $\Delta \times GZ$ is called the righting moment
  - GZ is called the righting lever

1.5 Initial Stability (4 hours)

- states that it is common practice to describe the stability of a ship by its reaction to heeling to small angles (up to approximately 10°)
- defines the transverse metacentre (M) as the point of intersection of successive buoyancy force vectors as the angle of heel increases by a small angle
- states that, for small angles of heel, M can be considered as a fixed point on the centreline on a diagram of a ship heeled to a small angle, indicates G, B, Z and M
- shows on a given diagram of a stable ship that M must be above G and states that the metacentric height GM is taken as positive
- shows that for small angles of heel, $GZ = GM \times sin?$
- states that the value of GM is a useful guide to the stability of a ship
- describes the effect on a ship's behaviour of:
  - a large GM (stiff ship)
  - a small GM (tender ship)
- uses hydrostatic curves to find the height of the metacentre above the keel (KM) at given draughts
- states that KM is only dependent on the draught of a given ship
- given the values of KG, uses the values of KM obtained from hydrostatic curves to find the metacentre heights, GM
- states that, for a cargo ship, the recommended initial GM should not normally be less than 0.15m

1.6 Angle of Loll (1 hour)
- shows that if G is raised above M, the couple formed by the weight and buoyancy force will turn the ship further from the upright
- states that in this condition, GM is said to be negative and $\Delta \times GZ$ is called the upsetting moment or capsizing moment
- explains how B may move sufficiently to reduce the capsizing moment to zero at some angle of heel
- states that the angle at which the ship becomes stable is known as the angle of loll
- states that the ship will roll about the angle of loll instead of the upright
- states that an unstable ship may loll to either side
- explains why the condition described in the above objective is potentially dangerous

1.7 Curves of Statical Stability (4 hours)

- states that for any one draught the lengths of GZ at various angles of heel can be drawn as a graph
- states that the graph described in the above objective is called a curve of statical stability
- states that different curves are obtained for different draughts with the same initial GM
- identifies cross curves (KN curves and MS curves)
- derives the formula $GZ = MS + GM\ sin\theta$
- derives the formula $GZ = KN - KG\ sin\theta$
- derives GZ curves for stable and initially unstable ships from KN curves
- from a given curve of statical stability obtains:
  - the maximum righting lever and the angle at which it occurs
  - the angle of vanishing stability
  - the range of stability
- shows how lowering the position of G increases all values of the righting lever and vice versa
- states that angles of heel beyond approximately 40°are not normally of practical interest because of the probability of water entering the ship at larger angles

1.8 Movement of the Centre of Gravity (4 hours)

- states that the centre of gravity (G) of a ship can move only when masses are moved within, added to, or removed from the ship
- states that:
  - G moves directly towards the centre of gravity of added masses
  - G moves directly away from the centre of gravity of removed masses
  - G moves parallel to the path of movement of masses already on board
- calculates the movement of G ($GG_{1)}$ from:

$$GG_1 = \frac{mass\ added\ or\ removed\ \times\ distance\ of\ mass\ from\ G}{new\ displacement\ of\ the\ ship}$$

$$GG_1 = \frac{mass\ moved\ \times distance\ mass\ is\ moved}{displacement\ of\ the\ ship}$$

- performs calculations as in the above objective to find the vertical and horizontal shifts of the centre of gravity resulting from adding, removing or moving masses
- states that if a load is lifted by using a ship's derrick or crane, the weight is immediately transferred to the point of suspension
- states that if the point of suspension is moved horizontally, the centre of gravity of the ship also moves horizontally
- states that if the point of suspension is raised or lowered, the centre of gravity of the ship is raised or lowered
- calculates, by using moments about the keel, the position of G after loading or discharging given masses at stated positions
- calculates the change in KG during a passage resulting from:
  - consumption of fuel and stores
  - absorption of water by a deck cargo
  - accretion of ice on decks and superstructures given the masses and their positions

1.9 List and its Correction (6 hours)

- shows on a diagram the forces which cause a ship to list when G is to one side of the centreline
- states that the listing moment is given by displacement × transverse distance of G from the centreline
- shows on a diagram that the angle of list (θ) is given by $tan\theta = \frac{GG_1}{GM}$ where GG_1 is the transverse shift of G from the centerline
- states that in a listed condition the range of stability is reduced
- given the displacement, KM and KG of a ship, calculates the angle of list resulting from loading or discharging a given mass at a stated position, or from moving a mass through a given transverse distance
- explains, with reference to moments about the centreline, how the list may be removed
- given the displacement, GM and the angle of list of a ship, calculates the mass to load or discharge at a given position to bring the ship upright
- given the displacement, GM and angle of list of a ship, calculates the mass to move through a given transverse distance to bring the ship upright
- given the draught, beam and rise of the floor, calculates the increase in draught resulting from a stated angle of list

1.10 Effect of Slack Tanks (3 hours)

- states that if a tank is full of liquid, its effect on the position of the ship's centre of gravity is the same as if the liquid were a solid of the same mass
- explains by means of diagrams how the centre of gravity of the liquid in a partly filled tank moves during rolling
- states that when the surface of a liquid is free to move, there is a virtual increase in KG, resulting in a corresponding decrease in GM
- states that the increase in KG is affected mainly by the breadth of the free surface and is not dependent upon the mass of liquid in the tank
- states that in tankers the tanks are often constructed with a longitudinal subdivision to reduce the breadth of free surface

1.11 Trim and draught calculations using trim tables (6 hours)

- states that "trim" is the difference between the draught aft and the draught forward
- states that trim may be changed by moving masses already on board forward or aft, or by adding or removing masses at a position forward of or abaft the centre of flotation
- states that 'centre of flotation' is the point about which the ship trims, and states that it is sometimes called the tipping centre
- states that the centre of flotation is situated at the centre of area of the waterplane, which may be forward of or abaft amidships
- demonstrates the uses hydrostatic data to find the position of the centre of flotation for various draughts
- states that a trimming moment as mass added or removed × its distance forward or aft of the centre of flotation; or, for masses already on board, as mass moved × the distance moved forward or aft
- states that the moment to change trim by 1 cm (MCT 1cm) as the moment about the centre of flotation necessary to change the trim of a ship by 1 cm

- demonstrates the uses hydrostatic curves or deadweight scale to find the MCT 1cm for various draughts
- given the value of MCT 1cm, masses moved and the distances moved forward or aft, calculates the change in trim
- given the value of MCT 1 cm, the position of the centre of flotation, masses added or removed and their distances forward of or abaft the centre of flotation, calculates the change of trim
- given initial draughts and the position of the centre of f1otation, extends the calculation in the above objective to find the new draughts
- given initial draughts and TPC, extends the calculation in the above objective to find the new draughts
- given initial draughts and TPC, extends the calculation to find the new draughts
- demonstrates the uses of a trimming table or trimming curves to determine changes in draughts resulting from loading, discharging or moving weights
- states that in cases where the change of mean draught is large, calculation of change of trim by taking moments about the centre of flotation or by means of trimming tables should not be used
- calculates final draughts and trim for a planned loading by considering changes to a similar previous loading

1.12 Actions to be Taken in the Event of Partial Loss of Intact Buoyancy (1 hour)

- states that flooding should be countered by prompt closing of watertight doors, valves and any other openings which could lead to flooding of other compartments
- states that cross－flooding arrangements, where they exist, should be put into operation immediately to limit the resulting list
- states that any action which could stop or reduce the inflow of water should be taken

1.13 Stress tables and stress calculating equipment (Loadicator) (3 hours)

- states that each ship above a specified length is required to carry a loading manual, in which are set out acceptable loading patterns to keep shear forces and bending moments within acceptable limits
- states that the classification society may also require a ship to carry an approved means of calculating shear forces and bending moment at stipulated stations
- demonstrates the basic knowledge and use of a stress tables
- demonstrates the basic knowledge and use of a stress calculating equipment (loadicator)
- states the information available from loadicator
- states that the loading manual and instrument, where provided, should be used to ensure that shear forces and bending moments do not exceed the permissible limits in still water during cargo and ballast handling
- describes the likelihood of overstressing the hull structure when loading certain bulk cargoes

3.2.2 THE PRINCIPAL STRUCTURAL MEMBERS OF A SHIP

Required performance:

The trainees should have knowledge of the principal structural members of a ship and the proper names of the various parts. Their knowledge should be such that they are capable of intelligent observation during the ordinary course of their work and could make adequate reports describing the location and nature of faults or minor damage discovered.

2.1 Ship dimensions and form (12 hours)

- illustrates the general arrangement of the following ship types:
  - general cargo
  - oil, chemical and gas tankers
  - bulk carriers
  - combination carriers
  - container
  - RO-RO
  - passenger
- sketches an elevation and plan views of various ship types such as a general cargo ship, crude oil carrier, and bulker showing the arrangement and illustrate a general knowledge of the primary structural members and indicate the proper names for the various parts to include holds, engine－room, peak tanks, double－bottom tanks, hatchway, tween deck and position of bulkheads, cofferdams, pump－room, cargo tanks, slop tank and permanent ballast tanks:
  - camber
  - rise of floor
  - tumblehome
  - flare
  - sheer
  - rake
  - parallel middle body
  - entrance
  - run
  - defines:
  - forward perpendicular(FP)
  - after perpendicular (AP)
  - length between perpendiculars(LBP)
  - length on the waterline (LWL)
  - length overall (LOA)
  - base line
  - moulded depth, beam and draught
  - extreme depth, beam and draught

2.2 Ship Stresses (8 hours)

- describes in qualitative terms shear force and bending moments
- explains what is meant by 'hogging' and by 'sagging' and distinguishes between them
- describes the loading conditions which give rise to hogging and sagging stresses
- describes how hogging and sagging stresses are caused by the sea state
- explains how hogging and sagging stresses result in tensile or compressive

forces in the deck and bottom structure
- describes water pressure loads on the ship's hull
- describes liquid pressure loading on the tank structures
- calculates the pressure at any depth below the liquid surface, given the density of the liquid
- describes qualitatively the stresses set up by liquid sloshing in a partly filled tank
- describes racking stress and its causes
- explains what is meant by 'pounding 'or 'slamming' and states which part of the ship is affected
- explains what is meant by 'panting' and states which part of the ship is affected
- describes stresses caused by localized loading
- describes corrosion
- describes the causes of corrosion onboard
- describes the various methods that being used to minimize the effect of corrosion

(Note: The following knowledge is not required under Part A, Chapter II, Table A – II/1 of the STCW Code. However , it is recommended that the trainee have basic knowledge of the following :)

2.3 Hull Structure (11 hours)
- identifies structural components on ships' plans and drawings:
  - frames, floors, transverse frames, deck beams, knees, brackets
  - shell plating, decks, tank top, stringers
  - bulkheads and stiffeners, pillars
  - hatch girders and beams, coamings, bulwarks
  - bow and stern framing, cant beams, breasthooks
- describes the types of materials that are used in the construction of a ship
- describes and illustrates standard steel sections:
  - flat plate
  - offset bulb plate
  - equal angle
  - unequal angle
  - channel
  - tee
- describes with aids of sketches the longitudinal, transverse and combined systems of framing on transverse sections of the ships
- sketches the arrangement of frames, webs and transverse members for each system
- illustrates double－bottom structure for longitudinal and transverse framing
- illustrates hold drainage systems and related structure
- illustrates a duct keel
- sketches the deck edge, showing attachment of sheer strake and stringer plate
- sketches a radiused sheer strake and attached structure
- describes the stress concentration in the deck round hatch openings
- explains compensation for loss of strength at hatch openings
- sketches a transverse section through a hatch coaming, showing the arrangement of coamings and deep webs
- sketches a hatch corner in plain view, showing the structural arrangements
- sketches deck－freeing arrangements, scuppers, freeing ports, open rails
- illustrates the connection of superstructures to the hull at the ship's side
- sketches a plane bulkhead, showing connections to deck, sides and double bottom and the arrangement of stiffeners

- sketches a corrugated bulkhead
- explains why transverse bulkheads have vertical corrugations and for－and－aft bulkheads have horizontal ones
- describes the purpose of bilge keels and how they are attached to the ship's side

2.4 Bow and Stern Regions (6 hours)

- describes the provisions of additional structural strength to withstand pounding
- describes and illustrates the structural arrangements forward to withstand panting
- describes the function of the stern frame
- describes and sketches a stern frame for a single－screw ship
- describes and illustrates the construction of a transom stern, showing the connections to the stern frame

2.5 Fittings (10 hours)

- describes and sketches an arrangement of modern weather－deck mechanical steel hatches
- describes how watertightness is achieved at the coamings and cross joints
- describes the cleating arrangements for the hatch covers
- describes the arrangement of portable beams, wooden hatch covers and tarpaulins
- sketches an oiltight hatchcover
- describes roller, multi－angle, pedestal and Panama fairleads
- sketches mooring bitts, showing their attachment to the deck
- sketches typical forecastle mooring and anchoring arrangements, showing the leads of moorings
- describes the construction and attachment to the deck of tension winches and explains how they are used
- describes the anchor handling arrangements from hawse pipe to spurling pipe
- describes the construction of chain lockers and how the bitter-ends are secured in the lockers
- explains how to secure anchors and make spurling pipes watertight in preparation for a sea passage
- describes the construction and use of a cable stopper
- describes the construction of masts and Sampson posts and how they are supported at the base
- describes the construction of derricks and deck cranes
- describes the bilge piping system of a cargo ship
- states that each section is fitted with a screw-down non-return suction valve
- describes and sketches a bilge strum box
- describes a ballast system in a cargo ship
- describes the arrangement of a fire main and states what pumps may be used to pressurize it
- describes the provision of sounding pipes and sketches a sounding pipe arrangement
- describes the fitting of air pipes to ballast tanks or fuel oil tanks
- describes the arrangement of fittings and lashings for the carriage of containers on deck

2.6 Rudder and Propellers (11 hours)

- describes the action of the rudder in steering a ship
- reproduces drawings of modern rudders: semi balanced, balanced and spade

- explains the purpose of the rudder carrier and pintles
- explains how the weight of the rudder is supported by the rudder carrier
- describes the rudder trunk
- describes the arrangement of a watertight gland round the rudder stock
- explains the principle of screw propulsion
- describes a propeller and defines, with respect to :
  - boss
  - rake
  - skew
  - face
  - back
  - tip
  - radius
  - pitch
- compares fixed－pitch with controllable－pitch propellers
- sketches the arrangement of an oil－lubricated sterntube and tailshaft
- describes how the propeller is attached to the tailshaft
- sketches a cross－section of a shaft tunnel for water cooled and oil cooled type
- explains why the shaft tunnel must be of watertight construction and how water is prevented from entering the engine－room if the tunnel becomes flooded

2.7 Load Lines and Draught Marks (5 hours)

- explains where the deck line is marked
- defines 'freeboard'
- explains what is meant by 'assigned summer freeboard'
- draws to scale the load line mark and the load lines for a ship of a given summer moulded draught, displacement and tonnes per centimetre immersion in salt water
- explains how the chart of zones, areas and seasonal periods is used to find the applicable load line
- demonstrates how to read draughts
- explains that the freeboard, measured from the upper edge of the deck line to the water on each side, is used to check that the ship is within its permitted limits of loading
- lists the items in the conditions of assignment of freeboard
- describes why the height of sill are varies between different type of vessels based on Load Line Rules

COMPETENCE3.3	**Prevent, Control and Fight Fires on Board**	**IMO Reference**

TRAINING OUTCOME

Demonstrates a knowledge and understanding of:	STCW Code Table A-VI/3
3.3.1 FIRE PREVENTION	
3.3.2 ORGANISING FIRE DRILLS	
3.3.3 CHEMISTRY OF FIRE	
3.3.4 FIRE-FIGHTING SYSTEMS	
3.3.5 THE ACTION TO BE TAKEN IN THE EVENT OF FIRE, INCLUDING FIRES INVOLVING OIL	
See IMO Model Course 2.03 and the requirements of STCW Table A－VI/3 for Competence in Advanced Fire-fighting	STCW Code Table A-VI/3

COMPETENCE 3.4	Operate life－saving Appliances	IMO Reference

TRAINING OUTCOME

Demonstrates a knowledge and understanding of

3.4.1 ORGANIZING ABANDON SHIP DRILLS AND THE OPERATION OF SURVIVAL CRAFT AND RESCUE BOATS, THEIR LAUNCHING APPLIANCES AND ARRANGEMENTS,THEIR EQUIPMENT, INCLUDING RADIO LIFE－SAVING APPLIANCES, SATELLITE EPIRBs, SARTs, IMMERSION SUITS AND THERMAL PROTECTIVE AIDS	STCW Code Section A-VI/2 para 1-4
3.4.2 SURVIVAL AT SEA TECHNIQUES	
See IMO Model Course 1.23, and the requirements of STCW Table A－VI/2－1 for Competence in Survival Craft and Rescue Boats other than Fast Rescue Boats	STCW Code Table A-VI/2-1

COMPETENCE 3.5	Apply Medical First Aid on Board Ship	IMO Reference

TRAINING OUTCOME

Demonstrates a knowledge and understanding of

3.5.1 PRACTICAL APPLICATION OF MEDICAL GUIDES AND ADVICE BY RADIO, INCLUDING THE ABILITY TO TAKE EFFECTIVE ACTION BASED ON SUCH KNOWLEDGE IN THE CASE OF ACCIDENTS OR ILLNESSES THAT ARE LIKELY TO OCCUR ON BOARD SHIP	STCW Code Section A-VI/4 Para 1-6
See IMO Model Course 1.14 and the requirements of STCW Table A-VI/4-1 for Proficiency in Medical First Aid	STCW Code Table A-VI/4

COMPETENCE 3.6	Monitor Compliance with Legislative Requirements	IMO Reference

TRAINING OUTCOME

STCW Code Table A-II/1

Demonstrates a knowledge and understanding of:

3.6.1 IMO CONVENTIONS CONCERNING SAFETY OF LIFE AT SEA, SECURITY AND PROTECTION OF THE MARINE ENVIRONMENT

COMPETENCE 3.6	Monitor Compliance with Legislative Requirements	IMO Reference

3.6.1 IMO CONVENTIONS CONCERNING SAFETY OF LIFE AT SEA, SECURITY AND PROTECTION OF THE MARINE ENVIRONMENT

Required performance:

1.1 Introduction to Maritime Law (1 hour)

- states that maritime law is based partly on generally accepted customary rules developed over many years and partly on statute law enacted by states
- states that matters of safety, protection of the marine environment and conditions of employment are covered by statute law
- states that the main sources of maritime law are international conventions
- states that the adoption of international conventions and agreements is intended to provide uniform practice internationally
- states that a convention is a treaty between the States which have agreed to be bound by it to apply the principles contained in the convention within their sphere of jurisdiction
- states that, to implement a convention or other international agreement, a State must enact national legislation giving effect to and enforcing its provisions
- states that recommendations which are not internationally binding may be implemented by a State for ships flying its flag
- lists the main originators of international conventions concerned with maritime law are:
  - International Maritime Organization (IMO)
  - International Labour Organization (ILO)
  - Comite Maritime International (CMI)
  - United Nations
- describes:
  - flag State jurisdiction
  - coastal State jurisdiction
  - port State jurisdiction
- describes main elements of relevant IMO Conventions, e.g. SOLAS, MARPOL and STCW
- explains the significance of the 'no more favourable treatment' clause in the SOLAS, MARPOL, STCW and ILO Minimum Standards in Merchant Ships Conventions
- distinguishes between private and public international law
- explains that public maritime law is enforced through:
  - surveys, inspection and certification
  - penal sanctions (fines, imprisonment)
  - administrative procedures (inspection of certificates and records, detention)
- states that the operation of a ship is governed by the national laws and regulations of the flag State, including those laws and regulations giving effect to international conventions
- states that differences of detail usually exist in the national laws of different states implementing the same convention

- states that, when serving in a ship flying a foreign flag, it is essential that the master and chief mate familiarize themselves with the laws and regulations of the flag State
- states that, when in port, a ship must also comply with the appropriate laws and regulations of the port State
- describes the importance of keeping up to date with developments in new and amended legislation

1.2 Law of the Sea (5 hours)

Conventions on the Law of the Sea
Territorial Sea and the Contiguous Zone
International Straits
Exclusive Economic Zone and Continental Shelf
High Seas
Protection and Preservation of the Marine Environment

1.3 Safety (27 hours)

International Convention on Load Lines, 1966 (LL 1966), as amended (2 hours)

- states that no ship to which the Convention applies may proceed to sea on an international voyage unless it has been surveyed, marked and provided with an international Load Line Certificate (1966) or an international Load Line Exemption Certificate, if appropriate
- explains to which ships the Convention applies
- describes the duration of validity of an International Load Line Certificate (1966)
- explains the circumstances in which an International Load Line Certificate (1966) would be cancelled by the Administration
- stales the control to which ships holding an international Load Line Certificate (1966) are subject when in the ports of other Contracting Governments
- describes for the purposes of the Regulations concerning:
  - freeboard
  - freeboard deck
  - superstructure
- describes the position, dimensions and marking of:
  - the deck line
  - the Load Line Mark
  - lines to be used with the Load Line Mark
- states that the circle lines and letters are to be painted in white or yellow on a dark ground or in black on a light ground and that they should be permanently marked on the sides of the ship
- states that the international Load Line Certificate (1966) will not be delivered to a ship until the surveyor has certified that the marks are correctly and permanently indicated on the ship's sides
- describes the requirements concerning the provision of closing appliances for ventilators
- states that means, permanently attached, should be provided for closing the openings of air pipes to ballast tanks and other tanks
- describes the provisions for the protection of the crew
- states that deck cargo should be so stowed as to allow for the closing of openings giving access to crew's quarters, machinery space and other parts

used in the necessary work of the ship

International Convention for the Safety of Life at Sea, 1974 as amended (SOLAS) －General Provisions (2 hours)

- states that unless expressly provided otherwise, the regulations apply only to ships engaged on international voyages
- defines 'international voyage'
- defines:
  - passenger
  - passenger ship
  - cargo ship
  - tanker
  - age of a ship
- explains who may carry out surveys for the enforcement of the provisions of SOLAS
- describes the powers of a nominated surveyor
- describes the procedures which apply if the surveyor finds that the ship does not comply with the provisions or is in such a condition that it is not fit to proceed to sea without danger to the ship or to persons on board
- lists the surveys to which a passenger ship must be subjected
- describes the extent of the surveys of passenger ships
- describes the requirements for surveys of life－saving appliances and other equipment of cargo ships, including mandatory annual surveys
- describes the requirements for surveys of radio and radar installations of cargo ships
- describes the requirements for surveys of hull, and their extent, machinery and equipment of cargo ships, including mandatory annual surveys
- describes the extent of the surveys of hull, machinery and other equipment of cargo ships
- states that the condition of the ship and its equipment must be maintained to conform with the provisions of the regulations
- states that after any survey of a ship required by SOLAS, no change should be made in the structural arrangements, machinery, equipment or other items covered by the survey without the sanction of the Administration
- states that any accident to a ship or defect affecting the safety of the ship or the efficiency or completeness of the life－saving appliances or equipment should be reported to the Administration or organization responsible for issuing the relevant certificate, who will decide whether a survey is required
- lists the surveys and their extent to which a passenger ship must be subjected
- states that an accident or defect should also be immediately reported, by the master or owner, to the appropriate authorities of the port State when the ship is in a port of another Party to the SOLAS Convention
- lists the certificates, including attachments and supplements, where appropriate, issued after survey to ships satisfying the requirements of SOLAS
- states the period of validity of each of the certificates
- states that no Exemption Certificate is not valid for longer than the period of validity of the certificate to which it refers
- states that no extension of the five－year period of validity of the Cargo Ship Safety Construction Certificate is permitted
- explains the circumstances under which other certificates may be extended and states the maximum extension permitted
- describes the circumstances in which certificates cease to be valid

- states that all certificates or certified copies of them should be posted up in a prominent and accessible place in the ship
- states that certificates issued under the authority of a contracting Government should be accepted by other contracting Governments
- states that a ship in the port of another Party is subject to control by officers authorized by that Government so far as verifying that the SOLAS Convention certificates are valid
- describes the procedures which may be followed by officers authorized by a port State in exercising control regarding SOLAS Convention Certificates or Load Line Convention Certificates
- states that the surveyor should also take into account the requirements of SOLAS reg. V/13 that all ships should be sufficiently and efficiently manned
- states that, at the conclusion of a control exercise the master should be provided with a document giving the results of the control exercise and details of any action taken
- states that Parties to the Protocol of 1978 to the SOLAS Convention, 1974, should apply the requirements of the Convention and Protocol as may be necessary to ensure that no more favourable treatment is given to ships of non-parties to the Convention and Protocol

SOLAS-Subdivision and Stability, Machinery and Electrical Installation (2 hours)

- defines, with reference to chapter II-1:
  - subdivision load line
  - deepest subdivision load line
  - length
  - breadth
  - draught
  - bulkhead deck
  - margin line
  - permeability of a space
  - machinery space
  - passenger spaces
  - watertight
- explains what is meant by 'floodable length'
- explains what is meant by 'factor of subdivision'
- explains the application of the factor of subdivision to a passenger ship's ability to withstand the flooding of adjacent main compartments
- describes the requirements regarding unsymmetrical flooding
- states that the master should be supplied with suitable information concerning the use of cross-flooding fittings
- describes the final conditions of the ship after assumed critical damage
- states that the master should be supplied with the data necessary to maintain sufficient intact stability under service conditions to enable the ship to withstand the critical damage
- states that the conditions of stability on which the calculations of heel are based should be supplied to the master of the ship
- states that excessive heeling might result should the ship sustain damage when in a less favourable condition
- states that water ballast should not in general be carried in tanks intended for oil fuel and describes the arrangement for ships which cannot avoid putting

water in oil fuel tanks

- describes the marking of subdivision load lines on passenger ships
- states that details of the subdivision load lines assigned and the conditions of service for which they are approved should be clearly indicated on the Passenger Ship Safety Certificate
- states that a ship should not be loaded so as to submerge the load line mark appropriate to the season and locality, as determined in accordance with the international Convention on Load Lines, whatever the position of the subdivision load line marks may be
- states that a ship should not be loaded so as to submerge the subdivision load line mark appropriate to the particular voyage and condition of service
- classifies watertight doors as;
  - class 1 – hinged doors
  - class 2 – hand–operated sliding doors
  - class 3 – sliding doors which are power–operated as well as hand–operated
- describes the provisions regarding the fitting of watertight doors in passenger ships
- states that watertight doors in bulkheads dividing cargo between deck spaces must be closed before the voyage commences and must be kept closed during navigation
- states that the time of opening between–deck doors in port and the time of closing them before leaving port should be entered in the log–book
- states that all watertight doors should be kept closed during navigation except when necessarily opened for the working of the ship, in which, case they should always be ready to be immediately closed
- states that in passenger ships carrying goods vehicles and accompanying personnel indicators are required on the navigating bridge to show automatically when each door between cargo spaces is closed and all door fastenings are secured
- states that sidescuttles the sills of which are below the margin line, should be of such construction as will effectively prevent any person opening them without the consent of the master
- states that certain sidescuttles in between–deck spaces must be closed watertight and locked before the ship leaves port and must not be opened before arrival at the next port
- describes the requirements for deadlights
- states that sidescuttles and deadlights which will not be accessible during navigation must be closed and secured before the ship leaves port
- states that the closing and locking of sidescuttles and deadlights in spaces used alternatively for the carriage of passengers or cargo should be recorded in a log–book when carrying cargo
- states the requirements for the closure of cargo loading doors in passenger ships
- describes the requirements for drills, operation and inspection of watertight doors and other openings in passenger ships
- states that valves, doors and mechanisms should be suitably marked to ensure that they may be properly used to provide maximum safety
- lists the entries which should be made in the log–book regarding the opening and closing of doors, sidescuttles and other openings and the drills and inspections required by the regulations
- states that every passenger ship and every cargo ship of 24 metres and upwards must be inclined upon its completion and the elements of its stability determined

- states that the master should be supplied with such information as is necessary to obtain accurate guidance as to the stability of the ship under varying conditions of service
- describes the contents of damage control plans for passenger ships
- states that booklets containing the damage control information should be made available to the ship's officers
- describes the recommendations on damage control for dry cargo ships
- describes the indicator system which must be provided on the navigating bridge of passenger ro-ro ships to show if shell doors, loading doors and other closing appliances are not fully closed or not secured
- states the requirements for the detection of water leakage through shell doors or vehicle loading doors which could lead to major flooding of special category spaces or ro-ro cargo spaces
- states the requirements for ro-ro cargo spaces to be monitored whilst the ship is under way

SOLAS -Fire Protection, Fire Detection and Fire Extinction (2 hours)

- outlines the basic principles of the regulations on fire protection
- explains briefly the properties of class 'A' and class 'B' divisions
- defines:
  - main vertical zones
  - accommodation spaces
  - public spaces
  - service spaces
  - cargo spaces
  - ro-ro cargo spaces, open and closed
  - special category spaces
  - machinery spaces of category A
  - control stations
- states that fire hoses should be used only for the purposes of extinguishing fires or testing the apparatus at fire drills and surveys
- outlines the content of the SOLAS training manual and maintenance manual
- describes the information included in fire control plans or booklets
- states that instructions concerning the maintenance and operation of all fire-fighting equipment and installations on board should be kept under one cover in an accessible position
- states that a duplicate set of fire control plans or booklet should be permanently stored in a prominently marked weathertight enclosure outside the deckhouse for the assistance of shoreside fire-fighting personnel
- states that all fire-extinguishing appliances must be kept in good order and available for immediate use at all times during the voyage
- states that passenger ships must at all times when at sea, or in port , be so manned or equipped that any initial fire alarm is immediately received by a responsible member of the crew
- states that a special alarm, operated from the navigating bridge or from the fire control station, should be fitted to summon the crew and should be capable of being sounded independently of the alarm to the passenger spaces
- states that an efficient patrol system must be maintained for ships carrying more than 36 passengers

- describes the training required by the fire patrol
- states that there are special requirements for ships carrying dangerous goods
- states that a ship should have a document provided by the Administration as evidence of compliance of construction and equipment with the requirements for the carriage of dangerous goods

SOLAS – Life – Saving Appliances and Arrangements (2 hours)

- defines with reference to chapter III of SOLAS
  - certificated person
  - float – free launching
  - inflatable appliance
  - inflated appliance
  - launching appliance or arrangement
  - rescue boat
  - survival craft
- states that life – saving appliances and arrangements required by chapter III of SOLAS must be approved by the Administration
- states the requirements for exhibiting muster lists
- describes the illustrations and instructions to be displayed in passenger cabins and other spaces
- lists the items to be included in muster lists and emergency instructions
- describes the provision of operating instructions for life – saving appliances
- explains how the crew should be assigned to survival craft to ensure satisfactory manning and supervision of survival craft
- states that the person in charge of a survival craft should have a list of its crew and should see that they are acquainted with their duties
- states the requirement, for the provision of training manuals
- lists the items which should be contained in the training manuals
- lists the items which should be contained in the maintenance manual
- describes the frequency of abandon ship drills and fire drills and how they should be conducted
- describes the guidelines for training crews for the purpose of launching lifeboats and rescue boats from ships making headway through the water
- describes the on – board training which should be given in the use of life – saving appliances and in survival at sea
- details the records which should be made of abandon ship drills and fire drills, other drills of life – saving appliances and on – board training
- states that before leaving port and at all times during the voyage, all life – saving appliances must be in working order and ready for immediate use
- describes the instructions for on – board maintenance of life – saving appliances which should be carried
- describes the regulation regarding the maintenance of falls
- describes the weekly and monthly tests and inspections required and the entries which should be made in the log – book
- describes the requirements regarding the periodic servicing of inflatable liferafts, inflatable lifejackets, inflated rescue boats and hydrostatic release gear
- describes the requirements for passenger muster stations
- states that, on passenger ships, an abandon ship drill and a fire drill must take place weekly

SOLAS – Radio communications (amended chapter IV) (2 hours)

- states that the 1988 amendments to the 1974 SOLAS Convention replace the existing Chapter IV with a new Chapter IV covering the global maritime distress and safety system (GMDSS)

- states that the amended Chapter IV applies to passenger ships, irrespective of size, and cargo ships of 300 tons gross tonnage and upwards engaged on international voyages

- states that every ship must comply with the regulations concerning NAVTEX and satellite EPIRB

- states that every ship constructed on or after 1 February 1995 must comply with all applicable requirements

- explains the applicability to ships built before 1 February 1995

- explains the meanings, for the purpose of the amended Chapter IV, of:
  - bridge to bridge communications
  - continuous watch
  - digital selective calling (DSC)
  - direct-printing telegraphy
  - general radiocommunications
  - international NAVTEX service
  - locating
  - maritime safety information
  - polar orbiting satellite service
  - sea area A1
  - sea area A2
  - sea area A3
  - sea area A4

- states that every ship, while at sea, must be capable of:
  - transmitting ship-to-shore distress alerts by at least two separate and independent means
  - receiving shore-to-ship distress alerts
  - transmitting and receiving ship-to-ship distress alerts
  - transmitting and receiving search and rescue co-ordinating communications
  - transmitting and receiving on-scene communications
  - transmitting and receiving signals for locating
  - transmitting and receiving maritime safety information
  - transmitting and receiving general radio-communications
  - transmitting and receiving bridge-to-bridge communications

- lists the radio equipment to be carried by all ships

- describes the requirements regarding the installation and operation of the satellite EPIRB

- lists the additional equipment required by ships engaged on voyages exclusively within sea area A1

- lists the additional equipment required by ships engaged on voyages within sea areas A1 and A2

- lists the additional equipment required by ships engaged on voyages within sea areas A1, A2, and A3

- states that equipment using the INMARSAT geostationary satellite service is not an acceptable alternative for ships engaged on voyages which include sea area A4

- states the requirements for maintaining watch on distress frequencies

- states that every ship, while at sea, must maintain a watch for broadcasts of maritime safety information

- describes how the availability of radio equipment required by the regulations is to be ensured

- states that every ship must carry personnel qualified for distress and safety radio communications purposes who hold certificates specified in the Radio Regulations

- states that one person is designated to have primary responsibility for radio communications during distress incidents

- states that a record must be kept of all incidents connected with the radio communication service which appear to be of importance to the safety of life at sea

SOLAS －Carriage of Grain (1 hour)

— lists the intact stability requirements for a ship carrying bulk
— lists the contents of the grain loading information referred to in the document of authorization

SOLAS －Carriage of Dangerous Goods (1 hour)

— states that the regulations concerning the carriage of dangerous goods in packaged form or in solid bulk form apply to all ships to which the SOLAS regulations apply and to cargo ships of less than 500 gross tons
— states that the provisions do not apply to ships' stores and equipment
— states that the carriage of dangerous goods is prohibited except in accordance with the provisions of the regulations
— states that the provisions should be supplemented by detailed instructions on safe packaging and stowage, which should include the precautions necessary in relations to other cargo, issued by each Contracting Government
— classifies dangerous goods according to the IMDG Code

- states that the correct technical name of goods, and not trade names, should be used in all documents relating to the carriage of dangerous goods
- states that the documents prepared by the shipper should include or be accompanied by a signed certificate or declaration that the shipment offered for carriage is properly packaged and marked and in proper condition for carriage
- states the requirements for a special list or manifest of dangerous goods on board and their location or a detailed stowage plan showing the same information
- outlines the stowage requirements for dangerous goods
- states that substances which are liable to spontaneous heating or combustion should not be carried unless adequate precautions have been taken to minimize the likelihood of the outbreak of fire
- lists the explosives which may be carried in a passenger ship
- defines:
  - International Bulk Chemical Code (IBC Code)
  - chemical tanker
- states that the regulations apply to chemical tankers constructed on or after 1 July 1986, including those of less than 500 gross tons
- states that a chemical tanker must comply with the survey requirements for a cargo ship and, in addition, be surveyed and certified as provided for in the IBC Code
- states that the IBC Code prescribes the design and construction standards of such ships, the equipment they should carry and marine pollution aspects
- states that the requirements of the IBC Code are mandatory and subject to port State control
- defines:
  - International Gas Carrier Code (IGC Code)
  - gas carrier

The International Safety Management (ISM) Code (2 hours) R91

- states that a Safety Management System in compliance with the ISM Code must be in place on board all passenger ships, tankers and bulk carriers of 500gt and upwards

- states that a Safety Management System in compliance with the ISM Code must be in place on board all vessels of 500gt and upwards from 1 July 2002

- states that the details of the ship's system may be found in the ship's Safety Management Manual

International Convention on Standards of Training, Certification and Watch keeping for Seafarers, 1978, as amended (STCW) (2 hours) R1

- explains the general obligations under the Convention

- defines, for the purpose of the Convention:

  - Certificate of Competency
  - Certificate of Proficiency

- certificated
- seagoing ship
- Radio Regulations

- explains the application of the Convention

- describes the issue of certificates and their endorsement by the issuing Administration

- describes the conditions under which dispensations may be granted

- states that ships, when in a port of a party to the Convention, are subject to control to verify that all seafarers serving on board who are required to be certificated are so certificated or hold a valid dispensation

- states that a ship which extends its voyage beyond what is defined as a near--coastal voyage by a Party must fulfill the requirements of the Convention without the relaxation allowed for near-coastal voyages

- describes the control which may be exercised by a duly authorized control officer

- describes the circumstances in which the control officer should supply written information to the master regarding deficiencies and the grounds under which the ship may be detained

- explains that the regulations contain:
  - mandatory minimum requirements for the certification of masters, officers, radiotelephone operators, able seafarers deck or engine and ratings forming part of a navigational watch or an engineering watch
  - mandatory minimum requirements for the training and qualifications of masters, officers and ratings of oil, chemical and gas tankers
  - mandatory minimum requirements to ensure the continued proficiency and updating of masters and deck, engineer, radio officers and ratings
  - basic principles to be observed in keeping navigational and engineering watches
  - mandatory minimum requirements for the issue of a Certificate of Proficiency in Survival Craft and Rescue Boats other than Fast Rescue Boats

Special Trade Passenger Ships Agreement, 1971, and Rules, 1971 (STP 1971) (1 hour) R82

- describes the application of the agreement

- defines, for the purpose of the rules:
  - Convention
  - special trades
  - weather deck
  - upper deck

- special trade passenger
- special trade passenger ship

- explains the issue of certificates

- states that certificates or certified copies issued under this agreement should be posted in a prominent and accessible place in the ship

- explains the qualification of certificates when the number on board is less than stated in the Special Trade Passenger Ship Safety Certificate

- describes the rule regarding the carriage of dangerous goods in special trade passenger ships

- states that ships to which the Agreement applies should comply with the International Health Regulations, having regard to the circumstances and nature of the voyage

Protocol and Rules on Space Requirements for Special Trade Passenger Ships, 1973 (SPACE STP 1973) (1 hour) R84

- describes the application of the Protocol

- states that a certificate called a Special Trade Passenger Ship Space Certificate is to be issued after inspection and survey of a special trade passenger ship which complies with the applicable requirements of these rules

- states that the Certificate or a certified copy of it should be posted up in a prominent and accessible place in the ship

- lists the spaces not suitable for the carriage of passengers

- states that spaces, including airing spaces, allotted for the accommodation or use of special trade passengers must be kept free of cargo

- states that ships to which the rules apply should comply with the International Health Regulations, having regard to the circumstances and nature of the voyage

- explains that the 1974 SOLAS Convention provides that special trade passenger ships may be exempted from full compliance with the requirements of chapters 11-1, 11-2 and III, provided they fully comply with the provisions of the Rules annexed to the Special Trade Passenger Ships Agreement, 1971, and to the Protocol on Space Requirements for Special Trade Passenger Ships, 1973

Athens Convention relating to the Carriage of Passengers and their Luggage by Sea (PAL 1974) (1 hour) R85

- defines, for the purposes of the Convention:
    - carrier
    - performing carrier
    - ship
    - passenger
    - luggage
    - cabin luggage
    - carriage
    - international carriage

- explains the application of the Convention

- describes when the carrier is liable for the damage suffered as a result of the death of or personal injury to a passenger and the loss of or damage to luggage

- describes the presumption of fault or neglect of the carrier, unless the contrary is proved

- explains the carrier's liability in respect of monies and valuables

- states that, in the case of contributory fault on the part of the passenger, the court hearing the case may exonerate the carrier wholly or partly from his liability

- states that limits of liability for personal injury and for loss of or damage to luggage are prescribed

- describes that if an action is brought against a servant or agent of the carrier arising out of damage covered by this Convention, such servant or agent, if he proves that he acted within the scope of his employment, will be entitled to the same defences and limits of liability as the carrier

- states that where entitlement to limit liability exists, the aggregate of the amounts recoverable from the carrier, or performing carrier, and a servant or agent must not exceed the prescribed limit of liability

- describes the circumstances in which the right to limit liability will be lost

- explains where an action arising under this Convention may be brought

- describes the invalidity of contractual provisions more favorable to the carrier than the provisions of this Convention

International Convention on Tonnage Measurement of Ships, 1969 (1 hour) R86

- defines, for the purposes of the Convention:
  - international voyage
  - gross tonnage
  - net tonnage
  - new ship
  - existing ship

- explains the applications of the Convention to new and existing ships

- states that an International Tonnage Certificate (1969) will be issued to every ship, the gross and net tonnages of which have been determined in accordance with the Convention

- explains the alterations in construction or use of spaces which would lead to the cancellations of the International Tonnage Certificate

- states that a ship flying the flag of a State the Government of which is a Contracting Government is subject to inspection, when in the ports of other Contracting Governments, for the purpose of verifying that the ship is provided with a valid International Tonnage Certificate and that the main characteristics of the ship correspond to the data given in the certificate

- states that certain ships, required to be measured under the 1969 Tonnage Convention, may be allowed by their Administrations to use the gross tonnage as measured by the national tonnage rules in effect prior to the coming into force of the Tonnage Convention, for the application of certain provisions of the SOLAS, MARPOL and STCW Conventions

- states that the tonnage as measured by the national rules appears only on the relevant certificates required by SOLAS and MARPOL, together with an explanatory note

International Convention for the Control and Management of Ship's Ballast Water and Sediments, 2004 (1 hour)

- defines the following:
  - ballast water
  - ballast water management
  - sediments

- describes the conditions where the application of this convention may be exempted
- describes the application of this convention
- describes the management and control requirement from Section B Regulation B1-B6
- describes the standards that need to be observed in ballast water exchange

International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001(1 hour)

- defines anti-fouling system
- describes the control of waste material in Annex 1 of the Convention

Guidelines on the Enhanced Programme of Inspections During Surveys of Bulk Carriers and Oil Tankers (1 hour)

- describes the application of the guidelines
- defines the following:
  - -- overall survey
  - -- close-up Survey
  - -- substantial corrosion
  - -- corrosion prevention system
  - -- critical structure areas
  - -- intermediate enhanced survey

- describes the requirement for enhanced survey carried out during periodical survey
- describes the requirement for enhanced survey carried out during annual survey
- describes the intermediate enhanced survey
  -

Code of Safe Working Practices for Merchant Seamen (1 hour)

- explains that this Code of Safe Working Practices or its equivalent is intended primarily for merchant seamen
- explains that there should always be an adequate number of copies to allow the Master, Safety Officer and any members of the Safety Committee to have their own, leaving at least one available for general reference
- explains that this Code is addressed to everyone on a ship regardless of rank or rating because the recommendations can be effective only if they are understood by all and if all cooperate in their implementation
- explains that the Code is arranged in sections which deal with broad areas of concern
- states that the introduction gives the regulatory framework for health and safety on board ships and overall safety responsibilities under that framework
- states that Section 1 is largely concerned with safety management and the statutory duties underlying the advice in the remainder of the Code. All working on board are required to be aware of these duties and of the principles governing the guidance on safe practice which they are required to follow
- states that Section 2 begins with a chapter setting out the areas that should be covered in introducing a new recruit to the safety procedures on board. It goes on to explain what individuals can do to improve their personal health and safety
- states that Section 3 is concerned with various working practices common to all ships
- states that Section 4 covers safety for specialist ship operation
- outlines and describes the contents of the COSWP for merchant seaman
- describes safe working practices and personal shipboard safety including:

  - working aloft
  - working over the side
  - working in enclosed spaces
  - permit to work systems such as:
    - hot work permit
    - cold work permit
    - entry in enclosed space pemit
    - working aloft permit
    - working overside permit
    - electrical isolation permit
  - line handling
  - lifting techniques and methods of preventing back injury
  - electrical safety
  - mechanical safety
  - chemical and biohazard safety
  - personal safety equipment
  - describes the role of a safety officer
- explains the topics discussed in the safety committee meeting
- explains the importance of personal health and hygiene on board
- describes the use of:
  - portable O_2 analysers,
  - explosimeter
  - multi gas detectors
  - other portable gas measuring instruments

The International Ship and Port Facility Security Code (ISPS Code) (1 hour)

- describes that the International Ship and Port Facility Security Code (ISPS Code) is a comprehensive set of measures to enhance the security of ships and port facilities, developed in response to the perceived threats to ships and port facilities in the wake of the 9/11 attacks in the United States
- explains that the ISPS Code is implemented through chapter XI-2 Special measures to enhance maritime security in the International Convention for the Safety of Life at Sea (SOLAS)
- explains that the Code has two parts, one mandatory and one recommendatory
- explains that the purpose of the Code is to provide a standardized, consistent framework for evaluating risk, enabling Governments to offset changes in threat with changes in vulnerability for ships and port facilities through determination of appropriate security levels and corresponding security measures
- explains that the ISPS Code is part of SOLAS so compliance is mandatory for the 148 Contracting Parties to SOLAS
- explains that International Code for the Security of Ships and Port Facilities contains mandatory provisions to which reference is made in chapter XI-2 of the International Convention for the Safety of Life at Sea, 1974 as amended
- describes the objectives of the ISPS code
- defines Ship security plan as a plan developed to ensure the application of measures on board the ship designed to protect persons on board, cargo, cargo transport units, ship's stores or the ship from the risks of a security incident
- defines Company security officer as the person designated by the Company for

ensuring that a ship security assessment is carried out; that a ship security plan is developed, submitted for approval, and thereafter implemented and maintained and for liaison with port facility security officers and the ship security officer

- defines Security level 1 as the level for which minimum appropriate protective security measures shall be maintained at all times
- defines Security level 2 as the level for which appropriate additional protective security measures shall be maintained for a period of time as a result of heightened risk of a security incident
- defines Security level 3 as the level for which further specific protective security measures shall be maintained for a limited period of time when a security incident is probable or imminent, although it may not be possible to identify the specific target
- explains that a ship that is compliant to the ISPS code should have an International Ship Security Certificate (ISSC)
- explains that the Declaration of Security addresses the security requirements that could be shared between a port facility and a ship (or between ships) and shall state the responsibility for each
- explains that contracting Governments shall determine when a Declaration of Security is required by assessing the risk the ship/port interface or ship to ship activity poses to persons, property or the environment
- outlines that a ship can request completion of a Declaration of Security when:
  1. the ship is operating at a higher security level than the port facility or another ship it is interfacing with;
  2. there is an agreement on a Declaration of Security between Contracting Governments covering certain international voyages or specific ships on those voyages;
  3. there has been a security threat or a security incident involving the ship or involving the port facility, as applicable;
  4. the ship is at a port which is not required to have and implement an approved port facility security plan; or
  5. the ship is conducting ship to ship activities with another ship not required to have and implement an approved ship security plan
- explains that the Declaration of Security shall be completed by:
  1. the master or the ship security officer on behalf of the ship(s); and, if appropriate,
  2. the port facility security officer or, if the Contracting Government determines otherwise, by any other body responsible for shore-side security, on behalf of the port facility
- explains that each ship shall carry on board a ship security plan approved by the Administration
- Lists that the ship security plan addresses, at least, the following:
  1. measures designed to prevent weapons, dangerous substances and devices intended for use against persons, ships or ports and the carriage of which is not authorized from being taken on board the ship;
  2. identification of the restricted areas and measures for the prevention of unauthorized access to them;
  3. measures for the prevention of unauthorized access to the ship;
  4. procedures for responding to security threats or breaches of security, including provisions for maintaining critical operations of the ship or ship/port interface;
  5. procedures for responding to any security instructions Contracting Governments may give at security level 3;
  6. procedures for evacuation in case of security threats or breaches of security;
  7. duties of shipboard personnel assigned security responsibilities and of other shipboard personnel on security aspects;
  8. procedures for auditing the security activities;

9. procedures for training, drills and exercises associated with the plan;
10. procedures for interfacing with port facility security activities;
11. procedures for the periodic review of the plan and for updating;
12. procedures for reporting security incidents;
13. identification of the ship security officer;
14. identification of the company security officer including 24-hour contact details;
15. procedures to ensure the inspection, testing, calibration, and maintenance of any security equipment provided on board;
16. frequency for testing or calibration of any security equipment provided on board;
17. identification of the locations where the ship security alert system activation points are provided; and
18. procedures, instructions and guidance on the use of the ship security alert system, including the testing, activation, deactivation and resetting and to limit false alert

- explains the role of Ship Security Alert System (SSAS) is to raise the alarm ashore in reaction to security threats or security incidents by notifying the flag State of the ship without alerting ships or coastal States in the vicinity or giving any indication on board
- explains that the use of the ship security alert system is a recognition that security is political and requires different response to a distress or emergency situation on board
- explains that Operation of AIS in certain sea areas would cause security concern because information broadcast through AIS could be collected by pirates or terrorists
- explains that because of this concern, the last Assembly adopted resolution A 956(23) ship masters are allowed to switch off the AIS in specific areas where threat of attack by pirates or terrorists are imminent

COMPETENCE 3.7 Application of leadership and teamworking skills **IMO Reference**

TRAINING OUTCOMES:

Demonstrates a knowledge and understanding of: STCW Code Table A-II/1

3.7.1 SHIPBOARD PERSONNEL MANAGEMENT AND TRAINING

3.7.2 RELATED INTERNATIONAL CONVENTIONS AND RECOMMENDATIONS, AND NATIONAL LEGISLATION
.1 Maritime Labour Convention (MLC), 2006

3.7.3 APPLICATION OF TASK AND WORKLOAD MANAGEMENT

3.7.4 EFFECTIVE RESOURCE MANAGEMENT

3.7.5 DECISION MAKING TECHNIQUES

See IMO Model Course 1.39 on Leadership and Teamwork Skills for all TRAINING OUTCOMES 3.7.1 through 3.7.5.

COMPETENCE 3.8 Contribute to the safety of personnel and ship IMO Reference

TRAINING OUTCOMES: STCW Code Section A-VI/1 para 2

Demonstrates a knowledge and understanding of:

3.8.1 KNOWLEDGE OF PERSONNEL SURVIVAL TECHNIQUES STCW Code Table A-VI/1-1

See IMO Model Course 1.19, and the requirements of STCW Code Table A-VI/1-1 for Competence in personal survival techniques

3.8.2 KNOWLEDGE OF FIRE PREVENTION AND THE ABILITY TO DISTINGUISH AND FIGHT FIRES STCW Code Table A-VI/1-2

See IMO Model Course 1.20, and the requirements of STCW Code Table A-VI/1-2 for Competence in fire prevention and fire fighting

3.8.3 KNOWLEDGE OF ELEMENTARY FIRST AID STCW Code Table A-VI/1-3

See IMO Model Course 1.13, and the requirements of STCW Code Table A-VI/1-3 for Competence in elementary first aid

3.8.4 KNOWLEDGE OF PERSONAL SAFETY AND SOCIAL RESPONSIBILITIES STCW Code Table A-VI/1-4

See IMO Model Course 1.21, and the requirements of STCW Code Table A-VI/1-4 for Competence in personal safety and social responsibility

Part D3: Instructor Manual

The following notes are intended to high light the main objectives or training outcomes of each part of the function. The notes also contain some material on topics which are not adequately covered in the quoted references.

Trainees will be aware of the need and the practical measures required by law to prevent pollution of the environment. They will understand the requirements of MARPOL, (R9) the technical annexes, control of oil from machinery spaces and the Oil Record Book (Part 1).

Function 3: Controlling the Operation of the Ship and Care for Persons on Board at the Operational Level

On completion of training for this function trainees will be able to use plans and tables or diagrams of stability and trim data to calculate the ship's initial stability, draughts and trim for any given disposition of cargo and other weights. They will also be able to determine whether stresses on the ship are within permitted limits by the use of stress data, calculating equipment or software. The fundamental actions to take in the event of partial loss of intact buoyancy will be understood.

They will have a knowledge of the principal structural members of a ship and the proper names of the various parts.

Training concerned with Advanced Training in Fire-fighting is covered in IMO model course 2.03.

Training concerned with proficiency in survival craft and rescue boats other than fast rescue boats is covered in IMO model course 1.23.

Training concerned with proficiency in medical first aid on board ship is covered in IMO model courses 1.14.

3.1 ENSURE COMPLIANCE WITH POLLUTION-PREVENTION REQUIREMENTS

3.1.1 THE PRECAUTIONS TO BE TAKEN TO PREVENT POLLUTION OF THE MARINE ENVIRONMENT

Prevention of Pollution
In implementing this section of the course, the instructor should bear in mind that any officer of the watch aboard tankers will have completed a tanker familiarization course which should include the relevant requirements on pollution prevention related to tanker operations. This section is intended to provide an outline knowledge of the MARPOL Convention. In the following sections, detailed treatment should be confined to those requirements of the Convention which apply to all ships.

MARPOL technical annexes
The annexes set out the rules for the construction and equipment of ships and for ships' operations which may result in marine pollution.

3.1.2 ANTI-POLLUTION PROCEDURES AND ASSOCIATED EQUIPMENT

Annex I
Oil is defined in Annex I as any mineral oil and includes petrochemical products other than those listed in Annex II.

Compliance with construction and equipment requirements is enforced through the International Oil Pollution Prevention (IOPP) Certificate and regular surveys to ensure that the ship continues to comply with the requirements of the certificate. Port States verify that a ship has a certificate and may, if necessary, carry out a survey and demand rectification of deficiencies. The Port State also inspects the Oil Record Book to check that the ship is adhering to the required operating procedures. Coastal States may enforce Annex I by regular air patrols which keep a watch for oil slicks.

Control of oil from machinery spaces
Waste oil is generated in lubricating oil and fuel oil purifiers. Under Annex I, discharge of this sludge into the sea is not permitted.

Oil and water leakages in machinery spaces give rise to oil and water mixtures in bilges which have to be disposed of from time to time to prevent them becoming a fire or stability hazard. Many ships have bilge-water holding tanks to enable bilges to be kept clean and dry in port. The contents of the tank can then be discharged at sea, using a separator. The separated oil is dealt with in the same way as other waste oil. The need to retain this on board until arrangements can be made for disposal requires the provision of a tank for oil residues. Annex I makes provision for this.

The equipment required for machinery spaces is set out in the regulations. The discharge provisions are similarly governed.

Oil Record Book (Part I, Machinery Space Operations)
The requirements for keeping records and the form of the Oil Record Book are set out in the relevant regulations.

Precautions which should be taken to prevent accidental pollution by oil
Officers who are to serve in oil, chemical or gas tankers will undertake specialised courses which include pollution-prevention precautions applicable to those specialised ships. The precautions in this section apply to bunkering and the discharge of oily wastes, which are operations common to all ships, and are similar to those to be taken when loading or discharging an oil cargo

Sewage
Under Annex IV ships are not permitted to discharge sewage within four miles of the nearest land, unless they have in operation an approved treatment plant. Between 4

and 12 miles from land, sewage must be comminuted and disinfected before discharge.

3.1.3 PROACTIVE MEASURES TO PROTECT THE MARINE ENVIRONMENT

Importance of proactive measures to protect the marine environment encourages engineer officers to observe regulations concerned in the actual tasks on board ships which give direct impacts on the marine environment. Trainees therefore, need to learn about that careful treatment of pollution substances is strictly required.

3.2 MAINTAIN THE SEAWORTHINESS OF THE SHIP

3.2.1 STABILITY, TRIM AND STRESS TABLES

A ship's hydrostatic information is given for the even keel condition, so the true mean draught should be used to enter the tables or graphs. Since a ship is rarely on an even keel when draughts are read, either a calculation to correct the arithmetical mean draught must be made or the arithmetical mean draught may be used as an approximation.

Unless trim angles are excessive, the errors resulting from using arithmetical mean draught are small. In cases where complex accuracy is essential, draught surveys for example, the calculations would not be left to the officer of the watch. For the purposes of this course the arithmetical mean draught may be used when working with hydrostatic curves or tables. Data suitable for the preparation of exercises are contained in the Annex to these guidance notes.

Displacement
Archimedes' law and the principles of flotation should have been covered in physical science before starting this subject.

Buoyancy
Buoyancy in general should have been covered in physical science. The concept of reserve buoyancy and its importance to the safety of the ship should be emphasized.

Fresh water allowance
This should be developed by considering the relationship between buoyancy and water density. Calculations on box-shaped vessels can be used to show how the TPC for fresh water or dock water is related to the tabulated value for seawater.

Statical stability
This section introduces the lever GZ as the horizontal separation between the equal and opposite forces through G and B. The tendency for a stable ship to return to the upright is shown to depend upon the resulting couple.

Initial stability
The transverse metacentre is introduced and the way in which GZ is related to the metacentric height for small angles of heel is derived. A comparison of the behaviour of stiff and tender ships in a seaway is included. A floating model can be used to demonstrate the effect on rolling period.

Angle of loll
The fact that an initial capsizing moment results if G is above M is to be shown. It may be possible to show an angle of loll by using a floating model although it is difficult to avoid large angles of list, due to slight displacement of the model's centre of gravity, confusing the experiment. Even so, the experiment demonstrates the unsatisfactory condition of a ship with a GM of nearly zero.

Curves of statical stability
Trainees should construct and appraise some curves of statical stability, using KN curves and given values of KG, including a curve for a ship with a negative GM.

Movement of the centre of gravity
Trainees should be able to deduce that adding masses above, or removing masses below, the original centre of gravity causes an increase in KG. Both processes can occur during a passage as water is absorbed by deck cargo and fuel is consumed from double-bottom tanks.

When dealing with the point of suspension, point out that lowering or raising the weight has no effect on the ship's centre of gravity. Only movement of the point of suspension, where the weight is acting, has any effect on KG.

List and its correction
Trainees should be reminded that the equation for angle of list applies only for small angles of list, up to about 10°, for which the position of M can be taken as fixed.

Effect of slack tanks
It should be pointed out that any free liquid surface, such as water trapped on the weather deck or water used for fire fighting, will cause a similar increase in the value of KG.

Trim
The calculation of trim and final draughts after large changes in deadweight is not included. The lecturer should explain why trim tables should not be used for large changes in deadweight. The theory behind a vessel's change in trim due to a change in water density may also be covered.

In tankers and bulk carriers, the quantity and disposition of cargo is often similar to that of a previous loading. When planning the loading of such a cargo, the final draughts and trim can be obtained by making the necessary small adjustments to the actual draughts recorded for the previous cargo.

Actions to be taken in the event of a partial loss of intact buoyancy
The immediate actions which should be taken by the officer in charge of the watch are aimed at limiting the volume of lost buoyancy to the minimum. At the same time, if cross-flooding arrangements are required, they should be put into operation immediately to restrict the angle of list. Whether anything can be done to stop or reduce the inflow of water will depend upon the circumstances. In the event of loss of buoyancy due to damage to a hatch cover, a prompt reduction in speed or alteration of course, or both, may be effective.

3.2.2 THE PRICIPAL STRUCTURAL MEMBERS OF A SHIP

The trainees should have a knowledge of the principal structural members of a ship and the proper names of the various parts. Their knowledge should be such that they are capable of intelligent observation during the ordinary course of their work and could make adequate reports describing the location and nature of faults or minor damage discovered.

Ship dimensions and form
Particulars of constructional details of the various ship types are not intended. A knowledge of the general arrangement of various ship types is also applicable to other areas, such as cargo work and pollution prevention.

Ship stresses
A mathematical treatment of shear force and bending moments is not required at this stage. A qualitative description to explain the forces which the ship must be designed to withstand and the parts mainly involved in resisting them is needed.

When dealing with liquid pressure in tanks, attention should be drawn to the high forces on tank tops resulting from filling tanks until there is a head of liquid in air pipes and sounding pipes.

Hull structure
This section deals with the main structure of the hull, the names of the principal parts and how they are connected. Models and three-dimensional drawings are valuable aids to understanding the various connections and stiffening arrangements shown on the usual plan and elevation drawings.

Bow and stern
Details of construction have been limited to the transom stern since that is the commonest construction at present.

Fittings
The closing of hatches with wooden covers and tarpaulins has been included because there are still a number of older ships with that arrangement or a similar one using pontoon covers.

When dealing with bilge or ballast piping systems, show how the non-return valves are placed to prevent flooding of adjacent spaces through fractured pipelines. When dry cargo is carried in deep tanks, the ballast lines have blanks fitted to prevent accidental filling of the tanks. A similar arrangement is provided in cargo holds which are connected to the ballast system.

Rudders and propellers
Knowledge of the method of operation of controllable-pitch propellers is not required. Trainees should be aware that the amount and direction of thrust are controlled by altering the pitch of the propeller. They should also realize that when going astern a controllable-pitch propeller acts as an opposite-handed propeller to when going

ahead. Many controllable-pitch propellers are made left-handed going ahead so that they behave in the same way as the usual right-handed propellers when acting astern.

Load lines and draught marks
It is not intended that trainees should know how the summer freeboard is assigned. They should know that it is the minimum freeboard permitted when loading in seawater in a summer zone and that it is assigned to the ship by, or on behalf of, the Administration in accordance with the Load Line Regulations. They should also know that the load line mark is placed at that distance below the deck line.

It should be impressed upon trainees that, when loading to the minimum permitted freeboard, checks should be made of the actual freeboard amidships on each side. Even a barely perceptible list can produce a difference of several centimetres in the readings from opposite sides.

3.3 PREVENT, CONTROL AND FIGHT FIRES ON BOARD

The requirements of the STCW Convention are covered by IMO model courses, Basic Fire Fighting and Advanced Fire Fighting. These courses are based on the recommendations set out in IMO Assembly resolution and the IMO/ILO Document for Guidance.

Trainees should undertake this course as soon as possible in their career, preferably during the pre-sea stage at a shore-based establishment.

IMO Assembly resolution states "Masters, officers and as far as practicable key personnel who may wish to control fire-fighting operations should have advanced training in techniques for fighting fire with particular emphasis on organization, tactics and command".

IMO model course, Advanced Training in Fire Fighting is suitable for this purpose and Administrations may wish this course to be completed before trainees qualify as officer in charge of a watch. See also IMO Model Course No 2.03.

3.4 OPERATE LIFE-SAVING APPLIANCES

The requirements of the STCW Convention are fully covered by IMO model course 1.23, Proficiency in Survival Craft and Rescue Boats other than Fast Rescue Boats, which is based on the requirements of the STCW Convention. Trainees who have successfully completed that course and have been issued with a certificate of proficiency in survival craft have demonstrated the ability and knowledge necessary to satisfy the requirements of the regulations.

3.5 APPLY MEDICAL FIRST AID ON BOARD SHIP

The requirements of the STCW Convention are covered by IMO model course 1.14.

3.6 MONITOR COMPLIANCE WITH LEGISLATIVE REQUIREMENTS

3.6.1 BASIC WORKING KNOWLEDGE OF THE RELEVANT IMO CONVENTIONS CONCERNING SAFETY, SECURITY AND PROTECTION OF THE MARINE ENVIRONMENT

The extent and depth of knowledge required of the IMO Conventions and implementation by flag state law is greater than was required by the 1978 Convention. A working knowledge of IMO Conventions concerning safety of life and protection of the marine environment is required. This includes Load Line, Tonnage, PAL, STP, SOLAS, MARPOL, STCW and ILO Minimum Standards in Merchant Ships Conventions. A knowledge of UNCLOS and international maritime law is also required.

Relatively new additions to maritime law should be noted including The ISM Code (R91) (incorporated as Ch IX of SOLAS, Management for the safe operation of ships); MARPOL 73/78 Annex 1, regulation26 that requires every oil tanker of 150gt and above and every ship other than a tanker of 400gt and above to have a shipboard oil pollution emergency plan and amendments to MARPOL Annex V that require garbage management plans to be in place.

Introduction to maritime law
Maritime questions are not confined to one country and therefore maritime law has always had an international bias. Historically, customary codes recognized in several countries were applied by the courts. In more recent years their place has been taken by international conventions, which are given force by national legislation enacted by the contracting States. Most maritime law is now statute law, particularly in the areas of safety and prevention of pollution.

Jurisdiction in public international law has been designed to allocate and delimit national sovereign powers. Each State has the right to legislate and enforce legislation on its own territory, subject to respecting other States' sovereignty and international law.

Ships spend much time on the high seas, over which no one has sovereignty, but these are treated as extensions of the flag State, which should exercise its jurisdiction and control in administrative, technical and social matters. The flag State has exclusive jurisdiction over those matters on the high seas. This is referred to as flag State jurisdiction. In general, international conventions specify the rights and duties of the flag State so that a State accepting a convention must enact legislation applicable to its own ships to give it the powers to enforce the provisions of the convention.

A State's power to control the activities of foreign ships in its territorial waters and contiguous zone is called coastal State jurisdiction. For example, a State may enforce rules regarding traffic separation schemes and anti-pollution measures

within its territorial waters. The International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969, gives a coastal State powers to take action in respect of a foreign ship on the high seas in special circumstances.

Port State jurisdiction refers to the power of a State to enforce rules and prosecute violations occurring within the jurisdiction of the port State. Many of the IMO conventions and a few ILO conventions include provisions giving rise to port State jurisdiction. The powers of the port State include inspection of certificates, inspection of the ship and in some cases detention of the ship.

The "no more favourable treatment" clause, mentioned in objective 3.6.1.1 provides that States parties are under the obligation to apply the relevant convention in the same manner to foreign ships flying the flag of a State which is not a party as to ships sailing under the flag of a State Party to the convention. The result is that ships flying the flags of non-party States will have to comply with the standards of those conventions when calling at ports of a State party.

Law of the sea - on the high seas
In 1958, four conventions were drawn up at the United Nations Conference on the Law of the Sea at Geneva. They were the Conventions on the Territorial Sea and the Contiguous Zone, on the High Seas, on the Continental Shelf, and on Fishing and Conservation of the Living Resources of the High Seas, all of which are currently in force.

The syllabus is concerned only with those parts of the first three of the conventions mentioned above which are relevant to the master in conducting a voyage.

The United Nations Convention on the Law of the Sea, 1982 (UNCLOS) embraces all aspects of the uses and resources of the oceans.

The Convention establishes a comprehensive framework for the regulation of all ocean space. Its provisions govern, amongst other things, the extent of national sovereignty or jurisdiction, the safety of navigation and the protection of the marine environment from pollution. It provides for the establishment of territorial seas up to 12 miles and an exclusive economic zone of up to 200 miles in breadth over which the coastal State has certain sovereign rights. Many States have given effect to these provisions. It also provides for special regimes that apply to navigation through straits and archipelagic waters.

The Convention entered into force on 16 November 1994. It will of course influence future international maritime conventions and recommendations to the extent that conflict with UNCLOS will be avoided and other measures may be introduced to give substance to certain of its provisions.

Force majeure is an exceptional circumstance which is irresistible, beyond anyone's power to resist even with foreknowledge. See the International Convention on Civil Liability for Oil Pollution Damage (1969), Article III, paragraph 2(a), which uses the expression "an act of war, hostilities, civil war, insurrection or a natural phenomenon

of an exceptional, inevitable and irresistible character." They would be examples of *force majeure,* but this list is not necessarily exhaustive.

The expression "generally accepted international regulations, procedures and practices", or one of several similar expressions, is used in a number of the provisions. The Convention on the Law of the Sea does not give formal definitions for these expressions, and no clear guidelines are provided as to how the "international regulations and rules, etc.", referred to in the articles, may be identified. However, it appears to be generally accepted that the international regulations and standards adopted by IMO constitute a major component of the "generally accepted" international regulations and standards in matters relating to safety of navigation and the prevention and control of marine pollution from ships and by dumping.

Formal and authoritative interpretations of the provisions of UNCLOS can only be undertaken by the States parties to that Convention or, in appropriate cases, by the judicial or arbitral tribunals envisaged for that purpose in the convention itself.

Safety
Of all the international conventions dealing with maritime safety the most important is the International Convention for the Safety of Life at Sea, better known as SOLAS which covers a wide range of measures designed to improve the safety of shipping.

The convention is also one of the oldest of its kind: the first version was adopted in 1914 following the sinking of the SS Titanic with the loss of more than 1,500 lives. Since then there have been four more versions of SOLAS. The present version was adopted in 1974 and entered into force in 1980.

Reference should be made to the International Safety Management (ISM) Code, which sets out the master's responsibility with regard to safety and environmental protection and in which the watchkeeping officer has a crucial role in discharge of these responsibilities.

International Convention on Load Lines
The load Lines Protocol of 1988 will enter into force on 3 February 2000.

SOLAS - LSA Code
Instructors should note that the International Life-Saving Appliance (LSA) Code was adopted in 1996 and is now in force and mandatory. The Code gives technical and other details of personal life-saving appliances, visual signals, survival craft, rescue boats and other life-saving appliances.

IMO has introduced amendments to harmonize the periods between surveys which will result in equal periods of validity of the different certificates in the near future. The Annex to these Guidance Notes shows bar diagrams of the harmonized system.

The first survey that a cargo ship undergoes by the flag State Administration is the initial survey. When the period of validity of a certificate expires, a renewal survey is required for the new certificate. The annual surveys have different names depending on the certificate involved.

In the future, the Cargo Ship Safety Construction, Safety Equipment and Safety Radio Certificates may be combined into the Cargo Ship Safety Certificate. This is an option under the SOLAS 1988 protocol which comes into force in February 2000.

Under 3.6.1.3, SOLAS sub-division and stability, trainees should only be expected to know the meaning and application of 'floodable length' and 'factor of subdivision', not the technical details of calculations.

In the section concerned with the SOLAS requirements for life-saving equipment, details of lifesaving appliances, their equipment and their use are covered in IMO Model Courses 1.19, Proficiency in Personal Survival Techniques, and 1.23, Proficiency in Survival Craft and Rescue Boats other than Fast Rescue Boats.

Amendments to the 1974 SOLAS Convention and its Protocol of 1978 were adopted in 1988 to introduce the global maritime distress and safety system. The amendments entered into force, under the 'tacit acceptance' provisions of the SOLAS Convention and its 1978 Protocol, on 1 February 1992. Training requirements for the GMDSS general operator's certificate, see STCW Reg IV/2, are covered in IMO model course 1.25.

SOLAS - Carriage of grain
In many countries, the ship must also obtain a grain loading certificate, attesting that the ship has been loaded in accordance with the regulations, before sailing. Such certificates would be issued by an organization authorized by the Administration.

SOLAS - Carriage of dangerous goods
Details of the IBC and IGC codes are not required, but trainees should be aware of the survey and certification requirements. Officers who are to serve in chemical tankers or gas carriers will undertake appropriate specialized training.

STCW Code
The regulations and recommendations regarding the keeping of safe watches are fully covered in the STCW Convention, Chapter VIII. Trainees should be aware of the requirements concerning the certificates needed by ship's officers and other personnel and the port State control which may be applied.

ITU Radio Regulations
The International Telecommunication Union (ITU) is the United Nations Specialized Agency charged with the responsibility for all telecommunication matters, including management of the radiospectrum. The use of the radiospectrum is governed by the provisions of the Radio Regulations.

IMO, in co-operation with ITU, the International Maritime Satellite Organization (INMARSAT), the COSPAS-SARSAT Partners, the World Meteorological Organization (WMO) and the International Hydrographic Organization (IHO), has developed a new system of maritime mobile radiocommunication services to replace the terrestrial Morse radiotelegraphy and radiotelephone-based system which in

various forms has served the shipping industry since the early part of the twentieth century.

The new system, known as the Global Maritime Distress and Safety System (GMDSS), was phased in between 1 February 1992 and 1 February 1999. The system uses both terrestrial and satellite communications and is highly automated. As a result, extensive changes were introduced with respect to the training of personnel who are to operate the system and also with respect to those who may be required to maintain the system.

Passengers
Both the Special Trade Passenger Ships Agreement and the Protocol on Space Requirements refer to the International Health Regulations. The relevant sections are Article 84 and Annex V.

The Athens Convention entered into force on 28 April 1987.

3.7 APPLICATION OF LEADERSHIP AND TEAMWORKING SKILLS

In today's highly demanding shipboard environment, the ship's officers are expected to act as managers and leaders to their crew and colleagues as well as interact with external parties. It is vital that they poses the knowledge and ability of managing people, plan and coordinate activities on board, as well as making the right decisions through proper judgment and analysis of the situation at the time. At the same time, the officers are required to ensure the company's objectives are achieved in a timely manner, thus he or she will require the knowledge and understanding of organizing and getting things done through others and in such instances the teamworking skills are important to ensure success.

Part E: Evaluation

The effectiveness of any evaluation depends to a great extent on the precision of the description of what is to be evaluated. The detailed teaching syllabus is thus designed, to assist the Instructors, with descriptive verbs, mostly taken from the widely used Bloom's taxonomy.

Evaluation/Assessment is a way of finding out if learning has taken place. It enables the assessor (Instructor), to ascertain if the learner has gained the required skills and knowledge needed at a given point towards a course or qualification.

The purpose of evaluation / assessment is to:

- To assist student learning.
- To identify students' strengths and weaknesses.
- To assess the effectiveness of a particular instructional strategy.
- To assess and improve the effectiveness of curriculum programs.
- To assess and improve teaching effectiveness.

The different types of evaluation/assessment can be classified as:

Initial / Diagnostic assessment

This should take place before the trainee commences a course/qualification to ensure they are on the right path. Diagnostic assessment is an evaluation of a trainee's skills, knowledge, strength and areas for development. This can be carried out during an individual or group setting by the use of relevant tests.

Formative assessment

Is an integral part of the teaching/learning process and is hence is a "Continuous" assessment. It provides information on trainee's progress and may also be used to encourage and motivate them.

Purpose of formative assessment

- To provide feedback to students.
- To motivate students.
- To diagnose students' strengths and weaknesses.
- To help students to develop self-awareness.

Summative assessment

It is designed to measure trainee's achievement against defined objectives and targets. It may take the form of an exam or an assignment and takes place at the end of a course.

Purpose of summative assessment

- To pass or fail a trainee
- To grade a trainee

Evaluation for Quality assurance

Evaluation can also be required for quality assurance purposes.

Purpose of assessment with respect to quality assurance

- To provide feedback to Instructors on trainee's learning.
- To evaluate a module's strengths and weaknesses.
- To improve teaching.

Assessment Planning

Assessment planning should be specific, measurable, achievable, realistic and time-bound (SMART).

Some methods of assessment that could be used depending upon the course/qualification are as follows and should all be adapted to suit individual needs.

- Observation (In Oral examination, Simulation exercises, Practical demonstration);
- Questions (written or oral);
- Tests;
- Assignments, activities, projects, tasks and/or case studies
- Simulations (also refer to section A-I/12 of the STCW code 2010);
- CBT;

Validity

The evaluation methods must be based on clearly defined objectives, and it must truly represent what is meant to be assessed, for example only the relevant criteria and the syllabus or course guide. There must be a reasonable balance between the subject topics involved and also in the testing of trainees' KNOWLEDGE, UNDERSTANDING AND PROFICIENCY of the concepts.

Reliability

Assessment should also be reliable (if the assessment was done again with a similar group/learner, would you receive similar results). We may have to deliver the same subject to different group of learners at different times. If other assessors are also assessing the same course/qualification as us, we need to ensure we are all making the same decisions.

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

If the Instructors are going to assess their own trainees, they need to know what they are to assess and then decide how to do this. The *what* will come from the standards/learning outcomes of the course/qualification they are delivering. The *how* may already be decided for them if it is an assignments, tests or examinations.

The instructors need to consider the best way to assess the skills, knowledge and attitudes of our learners, whether this will be formative and/or summative and how the assessment will be valid and reliable.

All work assessed should be valid, authentic, current, sufficient and reliable; this is often know as VACSR – "valid assessments create standard results".

- Valid – the work is relevant to the standards/criteria being assessed:
- Authentic – the work has been produced solely by the learner;
- Current – the work is still relevant at the time of assessment;
- Sufficient – the work covers all the standards/criteria:
- Reliable – the work is consistent across all learners, over time and at the required level.

It is important to note that no single methods can satisfactorily measure knowledge and skill over the entire spectrum of matters to be tested for the assessment of competence.

Care should therefore be taken to select the method most appropriate to the particular aspect of competence to be tested, bearing in mind the need to frame questions which relate as realistically as possible to the requirements of the officer's job at sea.

STCW Code 2010

The training and assessment of seafarers, as required under the Convention, are administered, supervised and monitored in accordance with the provisions of section A-I/6 of the STCW Code.

Column 3 - Methods for demonstrating competence and Column 4 - Criteria for evaluating competence in Table A-II/1 (Specification of minimum standard of competence for officers in charge of a navigational watch on ships of 500 gross tonnage or more) of STCW Code 2010, sets out the methods and criteria for evaluation.

Instructors should refer to this table when designing the assessment.

Instructors should also refer to the Guidelines for evaluating competence as given in Part B-II/1 of STCW code, as given below;

Evaluation of competence

17. The arrangements for evaluating competence should be designed to take account of different methods of assessment which can provide different types of evidence about candidates' competence, e.g.:

1. *direct observation of work activities (including seagoing service);*

2. *skills/proficiency/competency tests;*
3. *projects and assignments;*
4. *evidence from previous experience; and*
5. *written, oral and computer-based questioning techniques.*

18. One or more of the first four methods listed should almost invariably be used to provide evidence of ability, in addition to appropriate questioning techniques to provide evidence of supporting knowledge and understanding.

Assessment is also covered in detail in another IMO Model Course, however to assist and aid the Instructors, some extracts from the Model course is used to explain in depth.

When evaluation consists of calculations, the following should be taken into consideration:

Calculations

To carry out their duties, officers in charge of a navigational watch must be able to solve technical problems by performing calculations in various subject areas such as cargo work, ship stability and navigation.

The ability to perform such calculations and to resolve such problems can be tested by having the candidates carry out the calculations in their entirety. Since a large variety of technical calculations is involved and the time necessary for their complete solution is considerable, it is not possible to completely test the abilities of candidates within a reasonable examination time.

Resort must therefore be made to some form of sampling technique, as is the case with the assessment of knowledge, comprehension and application of principles and concepts in other subject fields.

In examinations conducted on a traditional essay-type basis, the sampling technique that is applied in respect of calculation requirements is to attempt to cover as much of the subject area as possible within the examination time available. This is frequently done by using questions involving shorter calculations and testing in depth on one or two topics by requiring the completion of more complex calculations. The employment of this 'gross sampling' technique reduces the reliability of the examination as compared with what can be achieved with a more detailed sampling technique.

A greater breadth of sampling can be achieved by breaking down calculations into the various computational steps involved in their solution. This technique can only be applied to calculations in which the methodology is standardized. Fortunately, most calculations follow a standard format; where alternative methods of solution exist, the examination can be developed so as to allow candidates an appropriate freedom of choice. Such freedom of choice must be a feature of examinations of all types, in any event.

In order to develop a series of 'step test items', covering an entire calculation, it is necessary to identify each intermediate step in each calculation involved by all methods which are accepted as being correct in principle. These questions, after they have been reviewed for clarity and conciseness, form the standard 'step test items' in that calculation topic.

This approach allows questions to be posed which sample the candidate's knowledge and ability to perform parts of various calculations, which process takes up less time than having him perform entire calculations. The assumption is made that if the candidate can or cannot correctly complete a calculation step leading to the solution, then he can or cannot successfully carry out the entire calculation. Such detailed sampling allows a larger number of questions to be answered by the candidate within the time allotted for the examination, thus allowing a broader sampling of the candidate's knowledge and abilities, thereby increasing the reliability of the examination.

It must be pointed out that because of the greater number of test items used more time will be spent by candidates in reading the questions and in appreciating the precise step which each question involves.

However, the ability to answer correctly questions that are based on each intermediate step leading to the solution does not necessarily indicate competence in the application of the calculation methodology nor in the interpretation of the intermediate or final results. Further questions must therefore be developed which are of a 'procedural' and principle nature.

Such 'step test' and 'procedural' items may be drawn up as 'essay-type' items, supply-type items or multiple-choice items. Marking or scoring is easier if multiple-choice test items are used, but in some cases difficulties may arise in creating plausible distracters.

Detailed sampling allows immediate identification of errors of principle and those of a clerical nature. It must be emphasized that this holds true, in general, only if the test item is based on a single step in the overall calculation. Multiple-choice items involving more than one step may, in some cases, have to be resorted to in order to allow the creation of a sufficient number of plausible distracters, but care must be exercised to ensure that distracters are not plausible for more than one reason if the nature of the error made (and hence the distracter chosen) is to affect the scoring of the test item.

Compiling tests

Whilst each examining authority establishes its own rules, the length of time which can be devoted to assessing the competence of candidates for certificates of competency is limited by practical, economic and sociological restraints. Therefore a prime objective of those responsible for the organization and administration of the examination system is to find the most efficient, effective and economical method of assessing the competency of candidates. An examination system should effectively test the breadth of a candidate's knowledge of the subject areas pertinent to the tasks he is expected to undertake. It is not possible to examine candidates fully in all

areas, so in effect the examination samples a candidate's knowledge by covering as wide a scope as is possible within the time constraints and testing his depth of knowledge in selected areas.

The examination as a whole should assess each candidate's comprehension of principles, concepts and methodology; his ability to apply principles, concepts and methodology; his ability to organize facts, ideas and arguments and his abilities and skills in carrying out those tasks he will be called upon to perform in the duties he is to be certificated to undertake.

All evaluation and testing techniques have their advantages and disadvantages. An examining authority should carefully analyse precisely what it should be testing and can test. A careful selection of test and evaluation methods should then be made to ensure that the best of the variety of techniques available today is used. Each test shall be that best suited to the learning outcome or ability to be tested.

Quality of test items

No matter which type of test is used, it is essential that all questions or test items used should be as brief as possible, since the time taken to read the questions themselves lengthens the examination. Questions must also be clear and complete. To ensure this, it is necessary that they be reviewed by a person other than the originator. No extraneous information should be incorporated into questions; such inclusions can waste the time of the knowledgeable candidates and tend to be regarded as 'trick questions'. In all cases, the questions should be checked to ensure that they measure an objective which is essential to, the job concerned.

SCORING TESTS

Scoring subjective tests

The assessment of seafarers is concerned with judging whether they are competent, in terms of meeting sufficient specified learning objectives, to perform the tasks required by the qualification they are seeking. That is, they should be tested against predetermined criteria rather than against the performance of other examinees or the norm for the group as a whole, as is the case in many examinations.

To achieve that end in subjective tests, an analytical scoring scheme should be draw up in which a complete model answers, which would attract full marks, is produced for each question. The model answer is then analysed for the definitions, facts, explanations, formulae, calculations, etc., contained in it and marks are allocated to each item, the aim being to make the scoring as objective as possible. A subjective element will still exist in the original allocation of marks to the various sections and, to some extent, in the scoring of incomplete or partially correct sections.

Either credit scoring or deductive scoring may be used. In credit 'scoring, marks are awarded, in accordance with the scoring scheme, for each correctly completed part of the answer, no marks being credited for incorrect parts or omissions. With deductive scoring, marks are deducted for errors and omissions from the total mark for the question or part question (where a question has been divided into two or

more sections). When applied to essay questions, the two methods should produce virtually the same score. Deductive scoring is usually confined to the marking of calculations.

Deductive scoring can be weighted to take account of the relative seriousness of different types of error. Errors are commonly classed and weighted as follows:

.1 errors of principle; for example, using the formula for righting moment in a calculation of list; deduct 50% of the mark for the question or part question;

.2 major errors; for example, extracting data for the wrong day or time from the Nautical Almanac; deduct 30% of the mark for the question or part question; and

.3 clerical errors; for example, transposition of numbers from tables or question paper, careless arithmetic; deduct 10% of the mark for the question or part question for each error.

In the case of clerical errors, only one deduction for a single error should be made. No deductions are made for incorrect answers which follow through from the original error.

If deductions exceed the total mark for a question or part question it is given a zero score; negative scores are not carried over to other parts.

The different types of error can be taken into account in credit scoring schemes by suitably weighting the marks allocated to method, to the extraction' of data and to clerical accuracy at each step of the calculation. The steps need to be smaller and more detailed than the division into parts used in deductive marking. As a result, the marks lost for errors of principle tend to be smaller in credit scoring than in deductive scoring.

A small percentage of the total mark, to be credited only for the correct final answer, is sometimes included in a credit scaring scheme. The answer must lie within stated accuracy limits to qualify for that credit. In deductive schemes, an answer that has otherwise been correctly calculated but which falls outside the accuracy limits are treated as a clerical error.

Where tests are to be marked locally at more than one test centre, a well-defined scoring scheme, which will give the same score when applied to the same paper by different markers, is essential for the uniform and fair treatment of candidates. To aid in any subsequent review of marks, possibly resulting from an appeal, the marker should make brief marginal notes on the paper to indicate, the reasons for deductions.

Guidance on the treatment of answers produced by pocket calculators is needed.
Examination rules usually warn candidates that all working must be shown to gain full marks for a question. The marks to deduct when insufficient working is shown but a correct answer is produced, or when all working is correctly shown but the answer is wrong, need to be known by the marker.

In papers in which all questions are to be answered, the marks may be weighted to reflect the importance or difficulty of individual questions or the length of time which will be needed to answer them. When this is done, it is usual to indicate: the mark for each question on the question paper. Optional questions should all be of similar standard and carry equal marks, so that the standard of the complete test is the same regardless of the questions chosen.

Use can be made of a compulsory and an optional section in the same paper.

Questions on which it is felt that all candidates should be tested can be placed in the compulsory section and suitably weighted, while the remainder of the paper offers a choice of questions each of similar standard.

A problem that arises with optional papers is how to deal with cases where more than the required number of questions is answered. Various solutions 'are adopted by different examining boards. Many mark all questions and discard the lowest marked question or questions; although that fact is not generally advertised as it may encourage candidates to attempt extra questions. Others take the requisite number of answers in the order in which they are on the question paper and ignore the remainder. A similar problem arises in papers in which candidates are required to answer a given number of questions and including at least some stated number from each of several sections.

The pass mark should be set at the lowest score for which sufficient skills and knowledge is demonstrated for competency in each subject. In practice, that score is difficult to determine exactly for an individual paper and could vary slightly from one examination to another. Such an arrangement would be difficult to administer and would be considered unfair by candidates, so the pass mark is fixed and published in the examination regulations. It is, therefore, essential when preparing papers to maintain as constant a standard as possible, such that the pass mark is an appropriate measure of competency.

The following instructions are typical of those produced for guidance of examiners on the marking of examinations:

In order to achieve uniformity in marking between the Examiners in various centres and to facilitate the review of papers, the following guidelines are to be used at all centres:

.1 When several candidates write the same examination, papers, other than multiple choice, should be marked question by question, that is to say, question 1 of paper 1 should be marked for all applicants before proceeding to question 2, etc. This gives more uniform marking.

.2 All questions should be marked even if it becomes apparent that the candidate cannot achieve the pass mark.

.3 Neatness and Orderly Layout of Work:

Where work is not properly laid out or is not neat, marks should be deducted without regard to correctness of the answer. The number of marks deducted should vary according to the quality of the work up to a maximum of 10% where the correct answer is obtained.

.4 Important Nautical and Technical Terms:

Where, in general calculations or general questions, an incorrect term is used and such a term is incidental to the work, the Examiner should exercise his judgment as to whether or not marks should be deducted, but in any case, a deduction should not exceed 10% of the allotted marks. This does not apply to direct answers involving definitions or in answers involving the naming of parts.

.5 Types of Errors:

Errors can be divided into 3 types:

(a) P - error in principle; 50% of marks allotted for the whole or part of the question should be deducted.

(b) C - clerical error; 10% of the marks allocated should be deducted for each such error.

(c) M - major error, 30% of the marks allotted for the question or part of the question should be deducted.

NOTE: Large mark questions should be considered in their main sections and percentages of the sections deducted. Candidates should be given the benefit of any doubt which may exist.

.6 Drawings:

Too much importance should not be attached to elaborate drawings. Often a simple sketch with captions is very explanatory and indicative of a good understanding.

.7 Incomplete Answers:

Where a problem or distinct section of a large problem is only partly worked and a step of principle remains to be made, marks allotted should not exceed 50% of the total marks or the split marks allotted as the case may be.

MARKING PAPERS:

.8 When marking papers, Examiners should enter appropriate marginal notes in brief showing why marks have been deducted, using abbreviations in Paragraph 5. The actual error should be ringed and marked with a brief statement of the reason for the error, e.g., 'wrong day'. A paper should be so

marked that any reviewing Examiner can see at a glance just what happened, including a marginal note to indicate award of a 'benefit of doubt'.

Accuracy:

The following is a general rule to Examiners of the degree of accuracy expected:

(a) in calculating a ship's position, ±0.5 minutes of arc and to the nearest second of time;
(b) for a position line, to within 0.5 of a mile of the true result;
(c) in calculating compass errors, bearings and courses, ±0.5 of a degree;
(d) distances within 0.5 of a mile and times of meridian passage, to the nearest minute;
(e) tidal prediction, to ± 15 cm.

.9 In the case of marginal failure, the paper concerned should be carefully reviewed.

This review is not to be regarded as having the purpose of passing the candidate, it is to ensure that the foregoing marking standards have been correctly applied and are consistent with those of other responses to the same examination. It may result in either an increase or a decrease in marks assigned. This review having been completed, the examiner should issue a fail result if it is still below the pass mark.

.10 Use of Calculators:

When a pocket, non-programmable calculator is used by a candidate in an examination, all necessary formulae and transpositions must be shown for full marks to be allotted. In the case of a correctly set out answer, or partial answer, which has an incorrect final result, 30% of the whole or part should be deducted on the major error rule.

When the evaluation consists of oral and practical tests, which, many topics as per the table A-II/1, column 2 Knowledge, understanding and proficiency, require, the following should be taken into consideration.

Advantages and disadvantages of oral and practical tests

It is generally considered advisable that candidates for certificates of competency should be examined orally. Some aspects of competency can only be properly judged by having the candidate demonstrate his ability to perform specific tasks in a safe and efficient manner. The safety of .the ship and the protection of the marine environment are heavily dependent on the human element. The ability of candidates to react in an organized, systematic and prudent way can be more easily and reliably judged through an oral/practical test incorporating the use of models or simulators than by any other form of test.

One disadvantage of oral/practical tests is that they can be time-consuming. Each test may take up about 1 to 2 hours if it is to comprehensively cover the topics concerned.

Equipment must also be available in accordance with the abilities that are to be tested. Some items of equipment can economically be dedicated solely for use in examinations.

APPENDIX 1

MATHEMATICS

■ Purpose

This syllabus covers the mathematics which is deemed necessary to obtain the depth of knowledge required under various competences of Section A-II/1 and Section A-II/2 of the STCW Code for a watchkeeping officer and for a master or a chief mate on ships of 500 gross tonnage or more.

Considerable relaxations in the syllabus in mathematics for the studies to the level of master of ships of less than 500 gross tonnage and to the level of officer in charge of a navigational watch may be granted.

For practical reasons this teaching is nevertheless been placed with that required under Regulation II/1 of the STCW Convention, Officer in Charge of a Navigational Watch, since the theory studies for the management level (Master and Chief Mate) will often be integrated with the studies for officer In charge of a navigational watch, at the operational level.

■ Training objectives

This competence provides the background knowledge to support:

Mathematical skills to perform calculations in navigation, cargo work, ship stability and other areas of their professional work

■ Entry standards

Trainees should be proficient in calculations involving the basic arithmetical operations of addition, subtraction, multiplication and division, including the use of fractions and decimal fractions. They should also be able to deal with arithmetical expressions involving the use of brackets.

The measurement of length and angle and the use of instruments to construct simple figures of given dimensions should have been covered. Trainees should also be able to calculate the perimeter and area of rectangles and the volume of rectangular figures. The angle sum of a plane triangle should be known as well as the properties of the angles formed by the intersection of two straight lines.

It will be expected the trainees have been introduced to algebra and are capable of solving problems leading to simple equations.

■ Guidance notes

These guidance notes provide additional information where appropriate.

1.1 Mathematics

1.1 Algebra

This section covers the standard algebraic manipulations leading to the transposition of equations and their solution. Problems in which trainees have to set up their own algebraic expressions should be included.

The instructor may wish to defer the solution of quadratic equations until their graphical solution has been covered in section 1.2.

1.2 Graphs

Trainees should be able to produce a graph of given or observed data and extract information from the graph. They should also be able to draw graphs of simple functions for a given range of the independent variable. Sketching the graphs of functions is not required.

1.3 Proportion, Variation and Interpolation

Many tables requiring linear interpolation are used by ship's officers. In addition, some tables have two arguments and their use involves interpolation for both arguments. It is essential that trainees learn to interpolate quickly and accurately, and can also perform inverse Interpolation. The arrangement and correct use of critical tables should also be covered.

1.4 Geometry

The emphasis is on the properties of figures, parallel lines and constructions to provide a basis for chart work, radar plotting and the use of figures in other subjects. For example, knowledge of co-ordinate geometry is a basis for ellipse and hyperbola used in electronic navigation systems. Formal proofs of theorems and constructions are not required.

1.5 Trigonometry

Trainees should be proficient in the use of trigonometrical functions of angles in any quadrant, since these will occur in navigational problems. The range of values of the inverse functions should be known. This is Important when Interpreting results from a calculator. Both notations arc sin and $\sin^{-1}$ are in common use and should be known by trainees.

The facility to convert between polar and Cartesian co-ordinates is provided on many calculators and can be used to simplify the working of certain navigational problems. Trainees should be aware that, in keeping with the normal mathematical convention for measuring angles, the x co-ordinate obtained is measured parallel to the

reference line from which the angle is measured. In navigational work, therefore, the x co-ordinate represents north-south distances and the y co-ordinate east-west distances.

It is not intended that trainees should convert equations between polar and Cartesian forms.

1.6 MensuratIon

Figures and solids reducible should be included in the problems.

1.7 Spherical triangles

The derivation and proofs of the formulae used are not required. Trainees will be aware from earlier work that arc length equals $r\theta^{\circ}$, or $\frac{\pi r\theta^{\circ}}{180}$

It should be pointed out that a unit of length equal to the length of arc subtending one degree or one minute could be chosen, thus fixing the size of the radius in terms of the chosen unit.

In navigational calculations the chosen unit is the length of arc subtending 1'at the centre of the sphere, with the result that the lengths of sides of spherical triangles can be expressed as angles alone.

1.8 Vectors

The graphical solution of sums and differences of vector quantities and the resolution of vector in given directions should be thoroughly covered. Solutions of vector problems by calculation should be confined to cases where they are resolved in two perpendicular directions.

It would be advantageous to include examples with shipboard applications, such as forces on cargo gear, relative motion and relative velocity, in the exercises for students.

1.9 Circle, Ellipse and hyperbola

The object of this section is to provide an elementary introduction to the properties of the circle ellipse and hyperbola which will aid the understanding of topics in navigation and navigational aids.

1.10 Statistics

Trainees should be proficient in the knowledge and application of basic statistics.
They should be able to collect, organize, analysis and interpret various data with this acquired knowledge of statistics.

■ Staff requirements

The Instructor should be qualified in mathematics or a subject involving the application of mathematics.

■ Teaching aids (A)

The following equipment is recommended:

A classroom equipped with a black/white board and an overhead projector is required for the theory of the course

A1 Instructor manual

A2 Calculators

- Scientific calculators with facilities for trigonometric functions, inverse trigonometric functions, inverse trigonometric functions, reciprocals, yx and memory

A3 Nautical tables

- To be used in place of mathematical tables.

A4 Ullage tables and deadweight scales

■ IMO references (R)

R1 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978 (2011) ISBN 978-92-801-15284

■ Textbooks

Except for the section on spherical trigonometry, there are very many textbooks which cover mathematics at the level of this syllabus. The choice of textbook is therefore left to the preference of the teacher.

APPENDIX 1 - SUPPORTING KNOWLEDGE OUTLINE

	Knowledge, understanding and proficiency	Total hours for lectures	Total hours for exercises
MATHEMATICS			
1.	Algebra	3	3
2.	Graphs	3	3
3.	Proportion. variation and interpolation	3	5
4.	Geometry	4	6
5.	Trigonometry	2	4
6.	Mensuration	1	5
7.	Spherical triangle	5	11
8.	Vectors	2	4
9.	Circle, Ellipse and Hyperbola	2	2
10.	Statistics	3	1
	Subtotals	28	44
	Total for Course	**72 hours**	

Teaching staff should note that the hours or lectures and exercises are suggestions only as regards sequence and length of time allocated to each objective. These factors may be adapted by lecturers to suit individual groups of trainees depending on their experience, ability and staff available for teaching

TRAINING OUTCOME:

STCW Code table A-II/1 and Table A-II/2
Demonstrates a knowledge and understanding of:

1.1.1 Mathematics.

1.1.1 MATHEMATICS

Teaching aids: A1, A2, A3, A4

Required performance:

1.1 **Algebra** (6 hours)

- forms sums, differences, products and quotients of simple algebraic expressions, including simple fractions
- expands the following:
  $(x + a)^2$
  $(x + a)^3$
  $(x + a)\ (x - a)$
  $(x + a)\ (x + b)$
  $x^3 + a^3$
  $x^3 – a^3$
- simplifies expressions by extracting common factors
- simplifies expressions in brackets and collects common terms
- solves problems leading to linear equations
- solves simultaneous linear equations in two unknowns
- solves quadratic equations by factorization or by formula (real roots only)
- explains the meaning of 'absolute error' and 'relative error'
- calculates percentage errors in areas and volumes, given the percentage error in linear measurements

1.2 **Graphs** (6hours)

- draws and labels axes
- defines 'origin', 'abscissa', 'ordinate', and describes how a point is identified by its Cartesian co-ordinates
- determines suitable scales from given data
- plots points, given their Cartesian co-ordinates
- draws a smooth curve through plotted points
- given the abscissa, reads the value of the ordinate and vice versa
- extracts values from graphs of ship's data
- draws graphs of given functions
- solves simultaneous equations graphically

1.3 Proportion, variation and interpolation (8 hours)

- defines the ratio of two quantities, and uses the notation $a : b = \frac{a}{b}$
- uses the notation a:b :: c:d and states that it is equivalent to $\frac{a}{b} = \frac{c}{d}$
- given any three quantities of a proportional equation, calculates the fourth
- explains that map and drawing scales are expressed as ratios
- solves problems involving scales
- states that two quantities which vary so as to maintain a constant ratio are said to vary directly
- states that a quantity is said to vary inversely as another when it varies directly as the reciprocal of the other
- states that a quantity is said to vary jointly as a number of others when it varies directly as their product
- solves problems on direct, inverse and joint variation
- explains what is meant by linear interpolation
- shows how linear interpolation is an application of proportion
- uses linear interpolation to find intermediate values in tables such as ullage tables and deadweight scales
- given intermediate values, performs inverse interpolation to find the value of the argument
- uses differences in inverse interpolation
- describes the arrangement and use of critical tables
- interpolates in tables with two arguments
- given the value of one argument, uses inverse interpolation to find the value of the other argument
- performs linear extrapolation
- explains, with the aid of a diagram, how the linear assumption may lead to error in the interpolated value
- states that the intervals of arguments used in navigational tables are sufficiently small that linear interpolation produces negligible errors

1.4 Geometry (10 hours)

- distinguishes, equilateral, isosceles, right-angled and scalene triangles
- defines acute, obtuse and reflex angles
- states the sum of the angles of a plane triangle
- proves the property of exterior angles
- explains what is meant by congruent triangles
- describes the properties of similar triangles
- constructs triangles from given data
- explains the ambiguous case, given two sides and a non-included angle
- states Pythagoras's theorem, without proof, and uses it to calculate one side of a right-angled triangle, given the other two
- states the relationships between angles formed by a transversal to two parallel straight lines
- defines an arc, a sector, a chord and a segment of a circle

- determines arc length, given radius and angle of sector
- states that angles subtended by a chord in the same segment of a circle are equal
- states that the angle subtended by a chord at the centre of a circle is twice the angle subtended at the circumference
- states that the angle subtended at the circumference by a diameter is a right angle
- defines a quadrilateral, a parallelogram, a trapezium and a rhombus
- calculates areas of sectors and segments of a circle
- explains and applies Simpson's first, second and five-eighth rule for their use in the computation of areas, volumes and centroids (no derivations required)
- constructs:
  - a perpendicular to a line from a given point
  - a perpendicular to a line at a given point on the line
  - a tangent to a circle
  - the perpendicular bisector of a line
  - the bisector of an angle
- divides a line into a given number of equal parts
- determines:
  - the circumcentre of a triangle
  - the in-centre of a triangle
- defines a median of a triangle
- defines the centroid of a triangle and determines centroids by construction
- given three points and the angles subtended by pairs of those points at a position, determines the position by plotting

1.5 Trigonometry (6 hours)

- describes the measurement of angle in degrees, minutes and seconds of arc
- describes the measurement of angle in circular measure and defines the radian
- states that 1 radian is approximately equivalent to 57.3°
- defines sine, cosine and tangent as ratios of the sides of a right-angled triangle
- defines the reciprocal ratios cosecant, secant and cotangent
- states the complementary pairs of ratios
- solves problems reducible to right-angled triangles
- states the values of trigonometrical functions for angles 0°, 30°, 45°, 60° and 90° (using scientific calculators)
- determines the trigonometrical functions for angles of any size
- draws graphs of the trigonometrical functions over the range -360° to 360°
- states the period of the functions sine, cosine and tangent
- uses trigonometrical formula $\sin^2 a + \cos^2 a = 1$ and $\frac{\sin a}{\cos a} = \tan a$ in solving simple identities
- solves problems involving the application of objectives on right angled

triangle /oblique plane triangles using the cosine and sine formulae
- explains the ambiguous case when using the sine formula

1.6 Mensuration (6 hours)

- revises calculations for the perimeters and areas of:
  - a square
  - a rectangle
  - a parallelogram
  - a trapezium
  - a rhombus
  - a triangle
  - a circle
- calculates the areas of sectors and segments of a circle
- calculates the surface areas and volumes of:
  - a cube
  - a rectangular and a triangular prism
  - a cylinder
  - a right circular cone
  - a sphere
- solves problems involving the application of objectives

1.7 Spherical Triangles (16 hours)

- defines a great circle, small circle, pole and a small circle
- defines a spherical triangle as a figure on the surface of a sphere bounded by arcs of three great circles
- defines the angle between two great circles as the angle between the planes in which they lie
- describes how the length of a side is measured as an angle
- states that the sum of the angles of a spherical triangle exceeds 180° but is less than 540°
- states that no side exceeds 180°
- explain right-angled spherical triangles and their properties
- explain napier's rule for right angled spherical triangles and quadrantal spherical triangles
- explain polar triangles and their application in the solution of spherical triangles
- given two parts of a right-angled spherical triangle, uses Napier's rules to solve for any other part
- states what is meant by a quadrantal triangle
- given two parts of a quadrantal triangle, uses Napier's rules to solve for any other part
- solves problems involving oblique spherical triangles by use of the cosine and sine formulae
- uses the haversine formula to solve right-angled spherical triangle and explains its advantage over the sine and cosine formulae
- solves problems on spherical triangles by dropping a perpendicular and solving the resulting right-angled triangles

1.8 Vectors (6 hours)

- states that vector quantities have direction as well as magnitude
- distinguishes between scalar and vector quantities and gives examples of each
- calculates the vector sum of two or more vectors by graphical methods
- calculates the difference between two vectors by graphical methods
- resolves a given vector into components in two specified directions by drawing
- resolves a given vector into components in two specified perpendicular directions by calculation
- calculates sums and differences of vectors by resolution into perpendicular directions
- derives average velocity vector from given position vectors
- derives average acceleration vector from given velocity vectors
- solves problems involving forces, velocities and accelerations

1.9 Circle, Ellipse and Hyperbola (4 hours)

- explains standard and general equations of circles, tangent to a circle and applications
- explains standard forms of equations of parabola, ellipse, hyperbola and its applications with regards to navigation
- explains what is meant by a locus
- defines an ellipse as the locus of a point which moves so that the sum of its distances from two fixed points is constant
- states that the fixed points are called the foci
- describes the major and minor axes of an ellipse
- defines a hyperbola as the locus of a point which moves so that the difference of its distances from two fixed foci is constant
- states that the locus of points for which the difference is zero is the perpendicular bisector of the line joining the foci

1.10 Statistics (4 hours)

- defines random experiments,
- explains and solves measure of central tendency, measures of dispersion,
- explains continuous distributions
- explains and solves correlation & regression
- explains linear regression, method of least squares, multiple linear regression, standard error of regression estimate and its application

APPENDIX 2

PHYSICAL SCIENCE

■ Purpose

This syllabus covers the teaching of physical science which is deemed necessary to obtain the depth of knowledge required for the competences of Section A-II/1 and Section A-II/2 of the STCW Code for a watchkeeping officer and for a master or a chief mate on ships of 500 gross tonnage or more.

Considerable relaxations in the syllabus for physical science for the studies to the level of master of ships of less than 500 gross tonnage and to the level of officer in charge of a navigational watch (Section A-II/3) may be granted.

For practical reasons this teaching is nevertheless been placed with that required under Regulation II/1 of the STCW Convention, Officer in Charge of a Navigational Watch, since the theoretical studies to the level of master without limitations will often be integrated with the studies to the level of officer in charge of a navigational watch.

A section on electronics has been provided, should the Administration wish to include this in the training for an officer in charge of a navigational watch.

■ Training objectives

This function provides the background knowledge to support an understanding of the physical principles underlying the behaviour of the ship and its environment and the functioning of equipment upon which to build in their professional studies. Students will also be better able to understand technical specifications, operating and maintenance instructions regarding equipment with which they are not familiar.

■ Entry standards

Trainees should be proficient in calculations involving the basic arithmetical operations of addition, subtraction, multiplication and division, including the use of fractions and decimal fractions. They should also have some knowledge of elementary algebra and be capable of solving problems leading to simple equations, including transposition of equations, if necessary.

Some previous study of a science subject, involving experimental work and the making recording and processing of measurements would be an advantage, but no specific level of attainment in physics has been assumed in the preparation of the course.

■ Guidance notes

These guidance notes have been included as additional information where appropriate.

2.1 General Physics

1.1 Mass, weight and force

The Important difference between mass and weight should be emphasized. At the same time, reference should be made to the fact that mass units are sometimes incorrectly used in technical data when force is involved. If the value is to be used in a calculation, it must be put into the correct units or a wrong result will be obtained.

The reasons for the variations in the value of 'g' could be postponed until circular motion has been covered.

1.3 Distance, velocity and acceleration

If ticker-tape timers and trolleys are available, an experiment to show that force is proportional to mass x acceleration can be performed.

Problems on uniformly accelerated motion should include cases in which the motion can be resolved into vertical motion under gravity and constant velocity in the horizontal direction.

1.4 Circular motion and rotation

This section provides an explanation of the relationship between orbital period and height of navigation and communications satellites.

Trainees will not have the mathematical skills to calculate moments of inertia of bodies, but the concept is introduced. The effect of applied torque on the direction of the angular momentum vector can best be shown with a demonstration gyroscope.

1.5 Statics

Exercises should include solutions by resolution into horizontal and vertical components in addition to the use of vector plotting.

1.6 Work, energy and power

Include cases in which the movement of the point of application of a force is not in the direction of the force.

1.7 Machines

Experiments using blocks and tackles can be performed by trainees. By using a range of loads and recording the effort required to raise them, graphs of mechanical advantage against load and of efficiency against load can be drawn. The results show the effects of friction and also how the mechanical advantage and efficiency vary with increasing load.

1.8 Density

Although 'relative density' is the generally accepted term, 'specific gravity' (SG) is still used and may be encountered by trainees. They should realise that they are alternative names for the same property.

1.9 Fluids

Trainees should understand that the pressure at any point in a liquid does not depend upon the size or shape of the container but only on the depth and density of liquid arid the pressure on the surface of the liquid. They should also be able to distinguish between absolute pressure and pressure In excess of atmospheric pressure (gauge pressure).

A simple manometer experiment consists of measuring the pressure of the laboratory gas supply. A water manometer capable of showing about 20 cm head of water should be sufficient.

The finding of centres of pressure is not required.

1.10 Principle, of Archimedes and flotation

The connection between fluid pressure and Archimedes principle can be established by considering the difference in thrust on the upper and lower surfaces of an immersed cube or cylinder with its sides vertical.

2 Heat

2.1 Temperature

Emphasize the fact that temperature is a measure of availability of the Internal energy of a body for transfer to other bodies. Heat is the name given to energy in the process of transfer from one body to another as the result of a temperature difference between them.

2.2 Expansion of solids and liquids

When dealing with the effect of expansion on the density of liquids, reference can be made to the temperature correction of readings from a mercurial barometer. The need for keeping ullage space to allow for expansion in a tank carrying liquid can be explained.

2.3 Gases

Trainees should be aware that the ideal gas equation holds for any change of pressure, volume and temperature of a fixed mass of gas, including adiabatic changes. By combining the two expressions they should be able to derive the temperature — volume and temperature — pressure relationships for adiabatic changes.

The behaviour of real gases closely follows that of an Ideal gas over the range of atmospheric pressures and temperatures.

2.4 Transmission of heat

A relevant example of temperature change resulting from transfer of work energy is the rise of temperature of a liquid in centrifugal pump acting against a closed discharge valve.

2.5 Change of state

Trainees should plot a curve of temperature against time for a suitable substance as it cools and solidifies, to verify that its temperature remains constant during the change of state.

2.6 Vapours

Mention can be made of the carriage of liquefied gases at atmospheric pressure. The liquid will reach the temperature at which its SVP is equal to atmospheric pressure and the liquid is boiling. No further temperature change will then take place providing the gas evolved is removed, so that the pressure in the tank does not rise.
The pressure in a closed liquefied-gas tank is equal to the SVP of the liquid at the prevailing temperature.

2.7 Refrigeration

The heat pump may be dealt with simply by considering the heat dissipated from the condenser as the useful output and the cooling of a heat source as a consequential effect.

3 Waves, Sound and Light

3.1 Waves

The reflection, refraction and diffraction of plane and circular waves can be demonstrated effectively by means of a ripple tank. By adjusting the position of a solid barrier in the tank, stationary waves may also be shown. Interference patterns can be produced by generating two circular waves or using plane waves and a barrier with two small openings in it.

3.2 Electromagnetic radiation

It should be emphasized that the division of the electromagnetic spectrum into regions is based on the different means necessary to detect various wavelengths and not on differences in their behaviour as waves.

3.3 Light

Trainees should cover the work on lenses and mirrors and the formation of images by experimental work as far as possible. A light-box, screen supports for lenses or mirrors and a metre rule are sufficient for these experiments; an optical bench is not necessary.

3.4 Sound

The term 'ultrasonic' is used for frequencies above the audible limit, which for most adults is about 15 kHz; 'supersonic' is used for speeds in excess of the speed of sound in the medium under consideration.

Beats can be demonstrated by sounding together two tuning forks of the same frequency, one of which has a paper-clip or similar small mass attached to one leg. If a microphone and amplifier are available, the resulting wave pattern can be shown on a cathode-ray oscilloscope.

4 Magnetism and Electricity

4.1 Magnetism

Although isolated magnetic poles do not exist, the concept is convenient in deriving expressions for the field strength due to a bar magnet.

A magnetometer can be used to investigate the deflection caused by a magnet when placed end-on or broadside-on to the needle at the same distance and also how the deflection varies with distance from the needle. Trainees should understand that the needle will settle so that it lies along the resultant field and that the magnetic moment of the needle does not affect the amount of deflection. Thus when, aboard ship, a damaged compass bowl is replaced by another similar one, possibly having a different magnetic moment, there will be no change in the direction indicated by it.

4.2 Electrical safety

The instructor should also state laboratory safety rules regarding the use of electrical apparatus. Ideally, low-voltage apparatus should be fitted with plugs which cannot be connected to the mains supply, to protect both the user and the apparatus. Particular care should be taken in experiments involving the use of liquids.

4.3 Electrical principles

Trainees should be aware of both conventional and true electronic flow. Although many books use conventional flow, there are others which use only true electronic flow. The various aids to memory for the direction of magnetic fields and movement of a current-carrying conductor in a magnetic field differ according to the system used. It does not matter which system is used but, to avoid confusion, teaching and supporting material should be in one consistent system.

4.4 The electric circuit

Trainees should verify the properties of simple circuits by practical measurements where possible.

4.5 Work, energy and power in an electric circuit

The use of the kilowatt-hour as a measure of energy and its conversion to joules should be included.

4.6 Electromagnetic Induction

Practical work can be set to illustrate the qualitative effects of electromagnetic induction.

4.7 Capacitors

Point out to trainees that one farad is an extremely large capacitance and that most practical capacitors have a capacitance of the order of microfarads or smaller.

In some applications (radar, for example) certain capacitors are charged to high voltages and, even after switching off the power, can retain sufficient charge to produce a considerable shock and cause burns.

4.8 Electric generators and motors

The nature of the output from a single-loop generator can be shown by connecting it to a suitable centre-zero galvanometer.

4.9 Alternating voltage and current

Calculations should include an example to show that, in conditions near resonance, the voltage across an inductor or a capacitor may be much greater than the voltage applied to the circuit.

4.10 Distribution and protective devices

In a high-voltage distribution system the current for a given power is much smaller than for a low-voltage system. Consequently, lighter distribution cables are required, which are cheaper and easier to install. Working voltages for power or lighting can be obtained by using local transformers, usually simple air-cooled ones which, having no moving parts, require practically no maintenance. Rectifiers are used where a D.C. supply is required. Despite the increased insulation required on account of the high voltage, the system is more economic.

4.11 Electrochemistry

Trainees should measure the potential difference between the terminals of a battery when delivering no current and when on load, and hence, determine its internal resistance.
The final part of this section is intended to provide the theoretical background for further treatment of corrosion and cathodic protection.

4.12 Instruments

It may be convenient to deal with ammeters, voltmeters and the cathode-ray oscilloscope at the points in the course where they are first used.

5 Electronics

Some Administrations may wish to include a section on electronics in the training for officer In charge of a navigational watch. This syllabus has been designed to cover those principles which will support the safe operation of equipment.

Training should include simple practical exercises or demonstrations where they will aid understanding. Simple circuits can be constructed using suitable circuit boards or strip boards and locally available components. The emphasis should be on how various circuits arid components function rather than on the technical details.

5.1 Passive components

The majority of passive components will have been dealt with in section 5.4. Those included in this section are mainly associated with electronic circuits.

5.2 Semiconductor devices

The properties of semi-conductor devices can be covered by practical exercises. When sizes of current are not required, LEDs can be inserted in circuits to show when conduction is taking place.

5.3 Amplifiers

Circuits for a single-transistor voltage amplifier and a class B push-pull power amplifier are sufficient to illustrate how amplification is achieved.

5.4 Feedback

The presence of stray capacitance and Inductive coupling should be mentioned and how those can lead to unwanted feedback

5.5 Integrated circuits

Integrated circuit operated amplifiers are readily available and their use could be included in practical exercises, either in control applications or as audio-amplifiers.

Trainees should be aware that repairs to integrated circuits are not possible. A new "chip", or circuit board must be fitted in place of the faulty one, after checking that its failure was not the result of a fault elsewhere in the equipment.

5.6 Power supplies

Point out to trainees that silicon rectifiers and thyristors capable of controlling the large currents associated with deck winches, cranes and pump motors are available. They require very large heat sinks or fan cooling to dissipate the heat generated in the devices.

5.7 Oscillators

Details of particular oscillator circuits are not needed; a simple LC oscillator with transformer- coupled feedback will illustrate the principle.

Most marine radio transmitters use crystal oscillators in order to maintain transmitted frequencies within the tolerances permitted by the Radio Regulations.

5.8 Radio transmission and reception

The way in which frequency affects propagation of radio waves is of Importance in the study of electronic navigational aids. It can be mentioned that other forms of modulation exist which are more suited to the transmission of digital data.

5.9 Photoelectric devices

Examples of the use of photoelectric devices on board ship are oil content meters and smoke detectors.

5.10 Digital circuits

Inexpensive digital integrated circuits containing logic gates and inverters are obtainable and can be used for practical exercises. A logic probe would be useful for testing logic levels at input and output pins.

■ Staff requirements

The instructor should be suitably qualified to teach elementary physics

■ Teaching facilities and equipment

In addition to ordinary classroom facilities, which may be used for the teaching of theory, a laboratory suitably equipped with work benches and apparatus for practical work and demonstrations will be required.

The following apparatus is suggested as a minimum to allow trainees sufficient opportunities for practical work, and to provide for demonstrations.

Metre rules, straight edges, protractors, stopwatches, balances, spring balances, sets of masses, pulleys, springs, a demonstrations gyroscope, drawing boards, rectangular blocks of glass, prisms (including right-angled prisms), plane and spherical mirrors, light boxes and screens, sets of lenses of various focal lengths, Bunsen burners, stands, beakers, flasks and measuring flasks, thermometers, copper calorimeters, density bottles, manometers, a barometer, hydrometers, an apparatus for demonstrating the gas laws, a hygrometer, a ripple tank, a set of tuning forks, a resonance tube, bar magnets, plotting compasses, iron filings, a magnetometer, a safe source of DC and AC power, assorted wire, resistors, connectors, ammeters, voltmeters, a Wheatstone Bridge, a solenoid, transformers, variable reactor and capacitor, a demonstration electric motor and a generator, cut-away lead-acid and alkaline cells, working cells, a cathode-ray oscilloscope.

■ Teaching aids (A)

A classroom equipped with a black/white board and an overhead projector is required for the theory of the course

A1 Instructor Guidance.
A2 Scientific calculators with facilities for trigonometric functions, inverse trigonometric functions, reciprocal, yx and memory.
A3 Mathematical tables — see comments on maths.

■ IMO references (R)

R1 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978 (2011 Edition) ISBN 978-92-801-15284

■ Textbooks

There are many textbooks which cover physics at the level of this syllabus. The choice of textbook is therefore left to the discretion of the instructor.

APPENDIX 2 - SUPPORTING KNOWLEDGE OUTLINE

Knowledge, understanding and proficiency	Total hours for lectures	Total hours for exercises
PHYSICAL SCIENCE		
1 General Physics		
1. Mass, weight and force	3	3
2. Distance, velocity and acceleration	2	4
3. Circular motion and rotation	2	4
4. Statics	4	6
5. Work, energy and power	1	3
6. Machines	3	5
7. Density	1	2
8. Fluids	3	3
9. Principle of Archimedes and flotation	1	2
Subtotals	20	32
2 Heat		
1. Temperature	1	2
2. Expansion of solids and liquids	1	2
3. Gases	2	2
4. Transmission of heat	1	1
5. Change of state	1	1
6. Vapours	2	1
7. Refrigeration	1	0
Subtotals	9	9
3 Waves Sound and Light		
1. Waves	3	2
2. Electromagnetic radiation	1	1
3. Light	7	7
4. Sound	5	2
Subtotals	16	12
4 Magnetism and Electricity		
1. Magnetism	5	5
2. Electrical Safety	1	0
3. Electrical principles	2	0
4. The Electric circuit	2	4
5. Work, Energy and Power in an electric circuit	1	1
6. Electromagnetic induction	2	3
7. Capacitors	1	1

Knowledge, understanding and proficiency		Total hours for lectures		Total hours for exercises
8.	Electric generators and motors	3		2
9.	Alternating voltage and current	4		3
10.	Distribution and protective devices	2		0
11.	Electrochemistry	3		1
12.	Instruments	1		3
	Subtotals	27		23
	Totals for course	**72**		**76**
	Combined total		**148**	

5 Electronics (optional at the discretion of the Administration)

1.	Passive components	1		2
2.	Semiconductor devices	2		1
3.	Amplifiers	1		2
4.	Feedback	1		1
5.	Integrated circuits	1		0
6.	Power supplies	1		2
7.	Oscillators	1		1
8.	Radio transmission and reception	1		0
9.	Photoelectric devices	1		1
10.	Digital circuits	4		1
	Subtotals	14		11
	Course total Including electronics	**86**		**87**
	Combined total including electronics		**173**	

Teaching staff should note that the hours or lectures and exercises are suggestions only as regards sequence and length of time allocated to each objective. These factors may be adapted by lecturers to suit individual groups of trainees depending on their experience, ability and staff available for teaching

TRAINING OUTCOME:
STCW Code table A-II/1 and Table A-II/2
Reg II/1 para 2.5

Demonstrates a knowledge and understanding of:

2.1.1 Physical Science

2.1 GENERAL PHYSICS

IMO Reference: STCW Reg II/1, para 2.5

Teaching aids: A1, A2, A3

Required performance:

1.1 Mass, weight and Force (6 hours)

- states the S.I. units of mass, length and time
- states that the litre is a measure of fluid volume equal to 1 cubic decimetre and that 1 ml = 1 cm^3
- uses and states the meaning of prefixes for multiples and submultiples of units, including:
  giga, mega, kilo, deci, centi, milli, micro, nano and pico
- uses the correct abbreviations for prefixes
- explains what is meant by the mass of a body
- states that the mass of a body is unchanged by motion or change of place
- states the principle of conservation of mass
- defines 'force' as that which changes a body's state of rest or of uniform motion in a straight line
- states that the unit of force is the newton (N)
- defines the newton as the force required to give a mass of one kilogram an acceleration of one metre per $second^2$
- states that all bodies attract one another with a force which is proportional to the product of their masses and inversely proportional to the square of the distance between their centres of mass
- states that the attractive force between the earth and a body is called the gravitational force
- states that the gravitational force imparts an acceleration to a body which is free to fall, known as the acceleration due to gravity
- states that the acceleration due to gravity has a value of about 9.8 m/s^2 and is denoted by 'g'
- states that the force exerted by a body on its supports or the earth's surface is called its weight
- explains that weight is equal to the product of mass and the acceleration due to gravity, m x g
- describes how the rotation of the earth affects the value of g
- explains why the acceleration due to gravity reduces with increasing elevation
- states that the acceleration due to gravity at height h metres above sea level is $g(1 + \frac{h}{R})^{-2}$

  where: g is the value at sea level
  R is the earth's radius in metres
- explains why the weight of a given mass varies with the position of the mass
- states Newton's Third Law of Motion, "to every action there is an equal and opposite reaction", and gives examples
- states that friction is the name given to a force which opposes the relative motion of two surfaces in contact with each other
- states that frictional resistance to motion between solids, liquids or gases is always present

- describes in general terms factors affecting frictional resistance to motion
- defines 'elasticity' as the ability of a substance to recover its original shape and size after distortion
- states that a material for which the deformation is proportional to the applied force is said to obey Hooke's Law
- describes the application of Hooke's Law to the measurement of forces
- investigates Hooke's Law by plotting a graph of its extension against the load on a spring
- defines 'strain' as extension divided by original length
- defines the elastic constant as deformation divided by applied force
- determines the elastic constant of the spring in the above objective

1.2 Distance, velocity and acceleration (6 hours)

- distinguishes between distance and displacement
- distinguishes between speed and velocity
- defines velocity as change of displacement divided by the time interval
- expresses speed in m/s, km/h or knots and converts from one set of units to another
- explains what is meant by uniform velocity and uniform speed
- states that distance, s, travelled at uniform speed, u, in time, t, is given by $s = ut$
- defines acceleration as change of velocity divided by time interval
- explains what is meant by uniform acceleration
- states Newton's First Law of Motion
- defines the momentum of a body as the product of its mass and velocity
- states Newton's Second Law of Motion
- explains that force is equal to mass x acceleration when expressed in S.I. units
- states the law of conservation of momentum
- uses Newton's laws and the law of conservation of momentum to solve simple problems

1.3 Circular motion and rotation (6 hours)

- explains that change of direction at uniform speed involves a change of velocity which requires a force to cause it
- states that for a body moving at uniform speed in a circle, the required force, in newtons, is equal to $\frac{mv^2}{r}$, directed to the centre of the circle,

  where: m is the mass of the body in kg
  v is the velocity in m/s
  r is the radius of the circle in metres

- states that in the case of an orbiting satellite the force is provided by gravitational attraction
- defines the angular momentum of a body as $I\omega$

  where: I is the moment of inertia about the axis of rotation
  ω is the angular velocity of rotation in radians/second

- states that, in the absence of external forces, angular momentum is conserved
- describes how angular momentum can be represented by a vector
- describes how an applied torque changes the angular momentum vector
- states that the stability of a gyroscope is a consequence of the conservation of angular momentum
- states that change of the angular momentum vector of the gyroscope resulting from an applied torque is known as precession
- given the direction of rotation of a gyroscope and the direction of an applied torque, describes the resulting precession

1.4 Statics (10 hours)

- uses vector methods to find the resultant of two or more forces
- states the condition for equilibrium for three forces acting at a point
- constructs a polygon of forces and states the conditions for equilibrium for forces acting at a point
- defines the moment of a force about a point
- states that when a body is in equilibrium, the sum of the anticlockwise moments about any point is equal to the sum of the clockwise moments
- finds the resultant moment about a point of a number of parallel forces
- defines a couple and states the moment of a couple
- states that a couple cannot be reduced to a single force and can only be balanced by an equal and opposite couple
- states the conditions for a number of parallel forces to be in Equilibrium
- defines 'centre of gravity'
- uses a plumb line to find the centre of gravity of a lamina
- resolves a single force into components acting in two given directions
- resolves a single force acting on a body into a force acting at the centre of gravity and a couple
- explains the factors which govern the stability and overturning of a box
- describes the conditions of stable, unstable and neutral equilibrium
- solves simple numerical and graphical problems involving forces, moments of forces and equilibrium conditions
- defines 'shear force'
- defines 'bending moment'
- calculates the reaction at the supports of a simply supported beam, with or without a load
- plots curves of shear force and bending moment for a simply supported beam, with or without a load
- plots curves of shear force and bending moment for a cantilever beam, with or without a load

1.5 Work, energy and power (4 hours)

- defines work as the product of force and the distance moved in the direction of the force
- states that the unit of work is the joule (J) and is the work done when the point of application of a force of 1 newton moves through 1 metre in the direction of the force
- defines energy as the capacity to perform work and states that it is

measured in joules

- states that the unit of energy is the kilowatt hour (kWh) which is equivalent to one kilowatt (1 kW) of power expended for one hour (1 h) of time
- defines 'potential energy'
- defines 'kinetic energy' and states that $KE = \frac{mv^2}{2}$

  where: m is mass in kg
  v is the velocity in m/s

- describes conversion between potential and kinetic energy
- states the law of conservation of energy
- explains what happens to mechanical energy lost in impacts
- states that rotational energy is another form of mechanical energy
- defines power as the rate of transfer of energy or rate of doing work
- uses the equation average power = work done/time taken
- states that the unit of power is the watt (W) and that 1 W = 1 J/s
- solves simple problems involving work, energy and power

1.6 Machines (8 hours)

- describes what is meant by a machine
- defines the mechanical advantage of a machine as the ratio of the load moved to the effort expended
- defines the velocity ratio as the ratio of the distance moved by the effort to the distance moved by the load in the same time
- defines the efficiency of a machine as the ratio of the useful work done by the machine to the total work put into it
- shows that efficiency = mechanical advantage/velocity ratio
- explains why the efficiency of real machines is always less than 1
- solves problems on the following machines:
  - lever
  - moving pulley
  - block and tackle
  - inclined plane
  - wheel and axle
  - gears
  - screw jack

1.7 Density (3 hours)

- defines the density of a substance as its mass per unit volume
- defines 'relative density'
- converts relative density to density
- states what is meant by 'specific volume' and states its relationship with density
- makes simple measurements of mass and volume to determine density

1.8 Fluids (6 hours)

- explains what is meant by a 'fluid' and a 'liquid'

- defines 'pressure' as the force acting normally per unit area
- states that the unit of pressure is the newton per metre^2 (N/m^2), called the pascal (Pa)
- states that pressure = $\frac{\text{thrust}}{\text{area}}$
- states that pressure at any point in a fluid acts equally in all directions
- calculates the pressure and thrust on tanks subject to a head of liquid
- describes a manometer and explains how it is used for measuring pressure
- describes a simple barometer and explains how it is used to measure atmospheric pressure
- describes an aneroid barometer and how it measures atmospheric pressure
- states that the meteorological unit of pressure is the bar, equal to 105 Pa (1 millibar = 100 Pa)
- sketches and describes the action of a lift pump and a force pump
- explains the limitation on the height through which the lift pump can operate
- describes how pressure can be transmitted in a hydraulic system and its application to the hydraulic press
- calculates the mechanical advantage and the velocity ratio of a hydraulic press from given dimensions
- defines the viscosity of a fluid as its internal resistance to flow
- states that the frictional resistance to a body moving through a fluid depends upon its viscosity
- compares the viscosity of liquids experimentally
- describes the effect of temperature on the viscosity of liquids
- describes applications of viscosity to liquid damping
- given Bernoulli's equation, calculates the change in pressure resulting from a change in velocity of liquid flow
- explains that Bernoulli's equation is a statement of conservation of energy
- states that it applies strictly to non-turbulent, non-viscous flow
- describes applications of Bernoulli's equation to Venturi meters and eductors

1.9 Principle of Archimedes and flotation (3 hours)

- states Archimedes' principle
- verifies the principle by simple experiments
- explains how to measure the relative density of solids and liquids by Archimedes' principle
- states that a floating body displaces its own weight of liquid
- solves problems related to the above objectives
- explains the principle and construction of a hydrometer
- uses a hydrometer to measure relative densities of liquids

2.2 Heat (18 hours)

Temperature

- distinguishes between the temperature of a body and the internal energy

possessed by it
- describes the construction of a liquid-in-glass thermometer
- states how the thermometer is graduated, using upper and lower fixed points, and states what fixed points are used
- states the values of the fixed points in the Celsius scale
- describes the thermodynamic scale and states that 0^oC is equal to 273^oK
- explain the relationship between Celsius, Kelvin and Fahrenheit scale
- states that the kelvin is of the same size as the degree Celsius
- defines 'heat capacity' and 'specific heat capacity' of a substance and states the units in which they are measured
- states that heat energy is transmitted from hotter to cooler substances in contact until a common temperature is reached
- explains that, providing no transfer of work is involved, heat gained by one substance equals the heat lost by the other
- explains why water has its minimum volume and maximum density at 4°C
- State at what temperature the water freezes and understand the effect of the salinity on the freezing point of water

Expansion of Solids and Liquids

- describes the effect of temperature changes on the physical dimensions of solids and liquids
- defines linear expansivity and states the units in which it is expressed
- explains the behaviour of a bimetallic strip during temperature changes
- gives examples of the practical use of bimetallic strips
- defines volumetric expansivity and distinguishes between real and apparent expansion of liquids
- describes the effect of expansion on the density of a liquid
- describes the variations in volume and density of water for temperatures in the range -5 to 15^oC
- solves simple problems involving linear and volumetric expansivity

Gases

- states Boyle's Law and identifies the equation pV = constant with it
- sketches a volume-temperature curve illustrating charles's law and extrapolates it to cut the temperature axis
- sketches a p-V curve illustrating Boyle's Law
- states Charles's Law and identifies the equation $\frac{V}{T}$ = constant with it,
- where T is thermodynamic temperature
- states the pressure law and identifies the equation $\frac{P}{T}$ = constant with it
- states that the gas laws can be combined to give the ideal gas equation, $\frac{P^v}{T}$ = constant
- states that the constant in the ideal gas equation depends upon the mass and the particular gas
- solves simple numerical calculations involving the gas laws
- states that expansion or compression of a gas at constant temperature is

called isothermal and that the gas obeys Boyle's Law
- explains that heat must be supplied or removed from a gas during an isothermal change
- states that expansion or compression of a gas with no transfer of heat between the gas and its surroundings is called adiabatic
- states that during an adiabatic change the gas follows the law

  pV^n = constant, where n depends upon the gas (n = 1.4 for air)

- gives examples of adiabatic heating and cooling
- explains that the Mollier diagram is useful when analyzing the performance of adiabatic steady-flow processes
- explains that a gas does work on its surroundings during expansion and that work must be done on a gas during compression
- states that the increase in internal energy equals the heat supplied to the gas minus the work done by it
- with reference to internal energy, explains why adiabatic expansion gives rise to cooling and adiabatic compression to warming

Transmission of Heat

- describes the transmission of heat by conduction
- gives examples of good and bad conductors of heat
- describes the transmission of heat by convection in fluids
- explains why heating coils are placed at the bottom of a tank
- describes the transmission of heat by radiation
- describes how the nature of the surface of a body affects the rate of heat transmission
- states that good radiators of energy are also good absorbers
- states that all bodies radiate and absorb radiation continuously
- states that temperature changes are produced when internal energy is changed by transfer of work to or from a body
- gives examples of temperature changes resulting from transfer of work energy

Change of state

- states that substances can exist in three states; solid, liquid or vapour
- states that energy transfer is involved during change of state and that temperature remains constant during the change
- defines 'specific latent heat of vaporization'
- defines 'specific latent heat of fusion'
- solves problems involving change of state and latent heat
- explains how evaporation gives rise to cooling
- explains basic formation of "superheated steam" and its applications, hazards and precautions

Vapours

- explains what is meant by saturated and unsaturated vapour
- defines 'saturated vapour pressure' (SVP)

- states that SVP depends only on temperature and is independent of Volume
- explains what is meant by boiling and defines boiling point
- describes the effect of pressure on boiling temperature
- defines 'dewpoint'
- defines relative humidity and explains that it can be written:

$$\text{relative humidity} = \frac{\text{SVP of water at dewpoint}}{\text{SVP of water at prevailing temperature}}$$

- reads a wet- and dry-bulb hygrometer and uses tables to determine the relative humidity

Refrigeration

- describes the vapour-compression refrigeration cycle
- explains why the refrigerant should have a high specific latent heat of vaporization
- describes the arrangement to dissipate heat rapidly from the condenser coils
- describes the use of brine or air circulation for refrigerating large spaces
- describes how the vapour-compression cycle can be used as a heat pump
- sketches and describes a simple refrigeration circuit

2.3 Waves, Sound and Light (28 hours)

- defines period, as the time taken for the particle to complete one oscillation, that is, the time taken for the particle to move from its starting position and return to its original position. and is generally given the symbol *T*
- explains the basic concept of simple harmonic motion(S.H.M) as, the acceleration causing the motion *a* of the particle or object is proportional and in opposition to its displacement *x* from its equilibrium position, thus the formula:

$$a(t) \propto -x(t)$$

- uses the above formula of S.H.M to do simple calculations
- distinguishes between free and forced vibrations of a particle
- explains what is meant by resonance
- defines amplitude as the maximum displacement of a particle from its rest position
- defines frequency as the number of oscillations per second and states that the unit is the hertz (Hz)
- defines period as the time taken for one oscillation

Waves

- deduces that $T = \frac{1}{f}$

  where: T is the period in seconds
  f is the frequency in hertz

- distinguishes between transverse and longitudinal waves and gives examples of each
- explains what is meant by 'phase'
- defines 'wavelength' as the distance between two points on successive waves which are in phase
- states that the speed of a wave depends upon the medium in which the wave is travelling
- uses the wave equation: velocity = frequency x wavelength
- explains what is meant by a wave front
- sketches and describes the reflection of a plane wave at a plane surface
- sketches and describes the refraction of a plane wave at a plane surface
- shows that a wave which is slowed due to change in medium, is refracted towards the normal to the boundary at which refraction occurs
- sketches and describes the diffraction of a plane wave at a wide and at a narrow opening in a barrier
- explains what is meant by constructive and destructive interference
- sketches the interference pattern formed by two circular waves
- explains what stationary or standing waves are
- explains how standing waves may be formed by interference between incident and reflected waves at a plane boundary

Electromagnetic Radiation

- defines electromagnetic radiation as radiation consisting of waves of energy associated with electric and magnetic fields resulting from the acceleration of an electric charge

- states that electromagnetic waves require no medium for transmission
- states that the electric and magnetic fields associated with the radiation are at right angles to each other and to the direction of propagation
- states that electromagnetic waves travel through space with a speed of approximately 3×10^8 m/s
- uses the relationship between speed, wavelength and frequency to calculate the wavelength for a given frequency and vice versa
- draws a diagram of the electromagnetic spectrum showing the approximate range of wavelengths occupied by:
  - radio waves
  - infra-red radiation
  - visible light
  - ultra-violet radiation
  - X rays
  - gamma rays

Light

- explains the concept of a ray of light and its reversibility
- explains the formation of shadows, umbra and penumbra
- states the laws of reflection
- distinguishes between specular and diffuse reflection
- locates images in a plane mirror experimentally
- describes the position and nature of the image in a plane mirror

- draws a ray diagram to show the formation of the image in a plane mirror
- proves that the reflected ray rotates through twice the angle through which a plane mirror is rotated
- sketches a sextant, showing the arrangement of mirrors, the paths of rays to the observer's eye and how the angle between two objects is measured
- explains what is meant by the terms 'centre of curvature', 'axis', 'pole', 'principal focus' and 'focal length' of a spherical mirror
- explains the formation of real and virtual images
- distinguishes between converging and diverging mirrors
- shows that the principal focus of a spherical mirror is located on the axis at half the radius of curvature from the pole
- draws scale diagrams to find the position and size of the image in a spherical mirror
- defines linear magnification
- states the laws of refraction
- defines the refractive index of one medium with respect to another as the value of the constant $n = \frac{\sin i}{\sin r}$

  where: i is the angle of incidence
  r is the angle of refraction

- states that refractive index is also equal to speed in the first medium divided by speed in the second

- describes the phenomenon of apparent depth and explains how it is related to true depth and refractive index
- describes total internal reflection at an optically less dense medium and explains what is the 'critical angle'
- describes the use of prisms as total internal reflectors
- explains total internal reflection ducting
- explains with diagrams the causes of atmospheric refraction phenomenon's such as Mirages (on land) and looming (mirages at sea)
- explains how total internal reflection is used to convey light through optical fibres
- describes the various types of spherical converging and diverging lenses
- draws a ray diagram of binoculars, showing how prisms are used to produce an erect image
- states that dispersion is the cause of coloured fringes on images formed by lenses in optical instruments using them
- sketches a sextant showing the arrangement of mirrors, the paths of rays to the observer's eye and how the angle between the two objects is measured
- explains why wheelhouse windows are required to be inclined

Sound

- defines sound as a longitudinal wave motion set up by a vibrating object in a material medium
- states the approximate range of frequency of audible sound

- states that sound at frequencies above the upper audible limit is known as ultrasound

- states that the velocity of sound is proportional to

$$\sqrt{\frac{\text{modulus of elasticity}}{\text{density}}}$$

and depends upon the transmitting medium

- states that velocity in air is proportional to $\sqrt{\frac{\text{pressure}}{\text{density}}}$

- explains why change of pressure has no effect on velocity in air
- explains that velocity in air is proportional to $\sqrt{T}$, where T is the temperature on the Kelvin scale
- states that the velocity in air increases with increasing humidity
- states that sound obeys the laws of reflection and refraction and is diffracted in the same way as other waves
- states that the velocity of sound in seawater is about 1500 m/s and increases with temperature, pressure and salinity
- states that both reflection and transmission take place at a boundary between different media
- describes the application of reflection to the measurement of depth by echo-sounder and to the ultrasonic crack detector generally used for checking hatch weather tightness
- performs calculations involving the speed of sound and echoes in air and in water
- describes the production of sound in pipes, including the formation of standing waves, resonance and the position of nodes and antinodes
- describes the effect of atmospheric temperature, humidity gradient and the wind on the audibility of sound at a distance
- explain the characteristics of sound: intensity, loudness, decibel, pitch and frequency
- states the approximate range of the frequency of audible sound and how audibility and range of ship's whistle is defined
- describes the Doppler effect on the frequency heard when there is relative motion between the source and the receiver

2.4 **Magnetism and Electricity** (50 hours)

Magnetism

- defines a magnetic field as any space in which a magnetic effect can be detected
- describes how a magnetic field can be investigated, using a plotting compass or iron filings
- sketches and describes the field round a bar magnet
- states that the points in the magnet to which the field converges are called the poles
- states the laws of magnetism: like poles repel; unlike poles attract

- sketches and describes the field round two bar magnets with:
  - like poles towards each other
  - unlike poles towards each other
- sketches the magnetic field of a short dipole and states that the earth's field approximates to that of a dipole
- describes the domain theory of magnetism
- explains how a magnet may be made
- distinguishes between magnetically hard and soft iron
- describes the magnetization of soft iron by induction
- sketches the magnetic field round a soft iron bar lying along the earth's field
- describes the magnetic field surrounding a current-carrying conductor
- states that magnetic field strength is proportional to the current
- states that the current is taken as a measure of magneto-motive force (m.m.f.)
- explains that, for a coil, m.m.f. equals current x number of turns
- states that the magnetic field strength or magnetic intensity is given by magneto-motive force divided by the length of the flux path and is expressed in amps/metre
- explains the terms 'remanent flux density', 'coercive force', 'remanence' and 'coercivity'
- determines the deflection caused by a magnet of a magnetized needle lying in the earth's horizontal field
- given the periods of oscillation at two places, calculates the ratio of the field strengths at the two places
- describes magneto-striction and how this property can be used to provide a source of high-frequency ultrasound

Electrical Safety

- states that the hazards associated with the use of electrical energy make it essential to observe and apply:
  - appropriate national electrical regulations
  - regulations of the Institution of Electrical Engineers (IEE)
  - electrical regulations of the appropriate classification society
  - safe working practices
- states that safe working practices include:
  - the effective isolation of electrical apparatus from the supply before any work is carried out
  - testing to ensure that a circuit or apparatus is "dead" before commencing work on it
  - the use of tools and equipment designed for use with electrical equipment
  - the clear and permanent marking of the approved voltage, current, frequency, etc. on all electrical apparatus and equipment
- explains the effects of electric shock and why an alternating voltage is more dangerous than an equal direct voltage
- describes the conditions which increase the risk of electric shock
- explains the dangers associated with portable apparatus with flexible leads
- describes the periodic checks which should be made on portable

apparatus and flexible cables
- lists various types of electric cables and their uses
- explains the term 'earthing' and 'bonding'
- explains the term "intrinsically safe"
- explains heating effects of electric current and its application
- explains the use of insulated materials (hand tools, insulation tape and insulated footwear
- describes the types and specifications of electrical wire when making requisitions
- explains the dangers of wet surfaces and importance of proper connections in various joints

Electrical Principles

- states that the smallest particle of matter which can exist in the free state is the molecule
- states that molecules consist of atoms, which are the smallest particles which can take part in chemical reactions
- states that atoms consist of particles called:
  - protons
  - neutrons
  - electrons

- states that the protons and neutrons form the central nucleus of an atom around which the electrons move in orbits
- states that a proton and an electron carry equal but opposite electrical charges
- states that neutrons are electrically neutral
- states that in a stable atom, the electrical charges carried by the protons and electrons are balanced
- states that atoms of some substances have electrons in the outermost orbit which are easily displaced
- states that a molecule which has lost one or more electrons is called an ion and carries a positive charge
- states that a molecule which has gained one or more electrons is a negatively charged ion
- states that materials which have electrons which can easily be moved are called conductors, and lists examples
- states that materials which have electrons which are difficult to move are called insulators, and lists examples
- describes an electric current as a flow of electrons along a conductor produced by difference of electrical pressure between its ends
- states that electrons flow from negative to positive potential
- explains that conventional current flow is from positive to negative
- states that the opposition to flow experienced by the electrons is called resistance
- states that the unit of quantity of electricity is the coulomb (C), equal to 6.29×10^{18} electrons
- states that the unit of current is the ampere (A), equal to a rate of flow of 1 coulomb/second
- states that the unit of potential difference is the volt (V)

- states that the unit of resistance is the ohm (Ω)

Electric Circuit

- describes an electric circuit as a system consisting of conductors connected to components which use electron flow for their operation
- states that a circuit must form a closed path for the electron flow
- explains what is meant by the electro-motive force (e.m.f.) of a source in an electrical circuit
- states that the e.m.f. is produced by chemical action in a battery or conversion of mechanical energy in a generator
- states that the electrical "force gradient" over any part of a circuit is called the potential difference (p.d.)
- states Ohm's Law: $I = V/R$,
  where:
  I is current in amps
  V is potential difference in volts
  R is resistance in ohms
- states that the resistance of a conductor depends upon the material, is proportional to its length and inversely proportional to its cross-sectional area

- calculates the equivalent resistance of resistors in series and in parallel
- uses Ohm's Law to calculate values in simple circuits
- uses an ammeter and voltmeter to measure current, p.d. and resistance in simple circuits
- uses a Wheatstone bridge to measure resistance
- describes the effect of temperature on resistance
- defines the temperature coefficient of a resistor
- uses the temperature coefficient to calculate the resistance of a conductor at a given temperature
- describes the resistance thermometer
- describes the arrangement of cells in series, parallel and series-parallel batteries
- given the e.m.f. and internal resistance of an individual cell, calculates the p.d. and current when a battery is connected to a resistive circuit
- states Kirchhoff's laws for electrical networks as:
  - in any network the algebraic sum of the currents in all the wires meeting at a point is zero
  - in any closed path in a network the algebraic sum of the IR products is equal to the e.m.f. in that path
- applies Kirchhoff's laws to simple networks, including the Wheatstone bridge, to calculate up to three unknown currents
- demonstrates the procedure of 'soldering"

Work, Energy And Power in An Electric Circuit

- states that electrical energy is measured in joules
- states that work done or energy expended in an electrical circuit is given by $W = VQ$

where: W is the work done in joules
V is the potential difference in volts
Q is the quantity of electricity in coulombs

- states that work done in a purely resistive circuit is wholly converted to heat
- performs calculations involving work, energy and power

Electromagnetic induction

- states that, whenever the magnetic flux associated with a circuit changes, an e.m.f. is induced in the circuit while the flux is changing
- states that the change of flux can be produced by:
  - relative movement between a conductor and a magnetic field
  - a changing current in a circuit (self and mutual induction)
- states Lenz's Law; when an e.m.f. is induced in a circuit, the current that is set up opposes the motion, or the change in current, which produces it
- explains the use of Lenz's law on board ships such as alternators
- determines the direction of induced e.m.f. in a moving conductor
- states that, for a moving conductor, the induced e.m.f. is equal to the flux cut per second
- states that self-induced e.m.f. is proportional to the rate of change of current
- states that the unit of inductance is the henry (H) and that a circuit has an inductance of 1 henry when current changing at a rate of 1 A/s induces an opposing e.m.f. of 1 volt
- describes how the form of a circuit affects its inductance
- describes the arrangement of non-inductive wiring
- explains how inductance can give rise to arcing at switchgear when breaking a heavy current
- states that two circuits are said to have mutual inductance when a change of current in one circuit induces an e.m.f. in the other
- states that when a current changing at a rate of 1 A/s in one circuit induces an e.m.f. of 1 volt in the other, the circuits have a mutual inductance of 1 henry
- describes how the mutual inductance between two circuits can be increased
- describes the magnetic fields produced by current-carrying coils and solenoids
- indicates the direction of the field produced by a coil or solenoid
- describes the effect of winding a solenoid on a soft iron core
- describes the induced e.m.f. resulting from moving a magnet into and out of a coil
- calculates the equivalent inductance of inductors in series and in parallel
- performs simple calculations, making use of the definitions in the above objectives
- describes a simple electro-magnet
- describes a transformer and explains what is meant by the primary and secondary coils
- states that, neglecting flux leakage,

$$\frac{\text{secondary e.m.f.}}{} = \frac{\text{number of turns in secondary coil}}{}$$

$$\frac{\text{primary e.m.f.}}{\text{number of turns in primary coil}}$$

- states that, neglecting losses, power in the secondary coil is equal to power in the primary coil
- lists the main losses as:
  - heat (I^2R) losses in the windings
  - eddy-current losses in the core
  - hysteresis losses in the core
  - flux leakage between primary and secondary coils
- performs calculations on transformers, assuming no losses

Capacitors

- describes a capacitor as any two conductors between which an electric field may be maintained
- describes a parallel-plate capacitor
- states that a charge Q is stored on each plate when a voltage V is applied across the plates
- states that the unit of capacitance, the farad (F), is the capacitance which requires a potential difference of 1 volt to maintain a charge of 1 coulomb, or:

$$\text{capacitance} = \frac{\text{charge in coulombs}}{\text{p.d. in volts}} = \frac{Q}{V}$$

- states that the space between the plates is called the dielectric
- states that the use of certain insulating materials as dielectric instead of air increases the capacitance by a factor known as the relative permittivity of the material
- calculates the equivalent capacitance of capacitors in series and in parallel
- performs simple calculations based on the above objectives

Electric Generators And Motors

- describes the e.m.f. induced in a loop of wire rotated in a magnetic field indicates on sketches the direction of rotation of the loop and the direction of the induced e.m.f. in the sides of the loop
- explains how the value of the e.m.f. can be increased
- sketches the arrangement of a commutator and brushes to provide direct current
- explains how a smoother D.C. output is obtained by using a number of coils, each connected to its own commutator segments
- states that the magnetic field is produced by field coils wound onto iron pole pieces
- describes the arrangement of series-, shunt- or compound-wound field coils
- explains why the armature is constructed of thin discs of iron insulated from each other
- describes the arrangement of slip rings to provide an alternating e.m.f.
- sketches the alternating e.m.f. and relates the curve to the position of a

coil

- states that the frequency of the alternator depends upon the speed of rotation of the armature
- states that large alternators have fixed coils, called the stator, surrounding the rotor, which provides a rotating field
- describes the force on a current-carrying conductor in a magnetic field and states the direction of the force for given directions of the current and magnetic field
- sketches the magnetic field round a current-carrying conductor perpendicular to a magnetic field
- describes a simple direct-current motor and the function of the commutator
- describes series-, shunt- and compound-wound motors and states the advantages of each
- explains what is meant by the back e.m.f. of a motor
- describes the measures taken to protect a motor from excessive armature currents during starting or when stalled

Alternating Voltage And Current

- states that a plot of alternating e.m.f. or current against time is approximately a sine curve
- defines frequency (f) and period (T) and states that $T = 1/f$
- states that the usual frequency aboard ship is 60 Hz
- states that the average value of voltage or current taken over an integral number of cycles is zero
- states that current is measured by the root mean square (RMS) value, which is $\sqrt{}$ mean value of (current)2
- states that the RMS current is equal to the D.C. current which, flowing through the same resistance, does work at the same rate as the A.C. current
- states the RMS current $I = \frac{I_m}{\sqrt{2}} = 0.707\ I_m$, approximately,

  where I_m is the maximum or peak value of the current

- states the similar relationship for e.m.f.

  $$E = \frac{E_m}{\sqrt{2}} = 0.707\ E_m$$

  where E_m is the maximum or peak e.m.f.

- explains what is meant by the phase between two alternating quantities of the same frequency
- sketches two sine curves to illustrate the phase difference and explains the terms leading and lagging
- states that the sum of two sine curves of the same frequency with a phase difference is another sine curve with the same frequency
- states that, in a purely resistive circuit, current is in phase with the applied voltage, Ohm's Law can be applied to the RMS values and the power is

given by VI, where V and I are RMS voltage and current respectively

- states that inductance and capacitance oppose the flow of alternating current and that this opposition is called reactance (X) and is measured in ohms
- states that inductive reactance $X_c = 2 \pi f_L$ ohms

  where: f is the frequency of applied e.m.f.
  $_L$ is the inductance

- states that the current leads the voltage by 90° in a purely capacitive circuit
- states that total reactance in a series circuit is the difference between the inductive and capacitive reactances
- states that total opposition to current flow in a series circuit, called impedance (Z), is given by $Z = \sqrt{R^2 + (X_L \quad X_C)^2}$, expressed in ohms
- states that $I = \frac{V}{Z}$

  where: V is the applied voltage
  Z is the impedance

- states that the phase difference (θ) between the applied e.m.f. and the current is given by: $\tan \theta = \frac{R}{Z}$

  and that the current lags the e.m.f. if X_L is greater than X_C

- states that the voltage across any part of the circuit is given by V = IZ, where Z is the impedance of that part of the circuit
- states that the power dissipated by the circuit is given by:

  power = VI cosθ

  where: V and I are RMS values of e.m.f. and current
  θ is the phase angle between e.m.f. and current

- states that cos θ is called the power factor
- explains that when $X_L = X_C$, the impedance reduces to the ohmic resistance R and the circuit is said to be in series resonance
- shows that the resonant frequency is given by $f = \frac{1}{2 \pi \sqrt{LC}}$
- sketches a graph of current against frequency for a series circuit containing resistance, inductance and capacitance
- performs calculations on series A.C. circuits, using the above objectives
- explains, without calculations, resonance in a parallel circuit
- sketches a graph of current against frequency for a parallel circuit

Distribution And Protective Devices

- describes briefly 3-phase generation and distribution
- explains the advantages of high-voltage A.C. generation and distribution compared with D.C. systems
- explains that local transformers are used to reduce the voltage to working level for supply to motors and lighting circuits

- states that rectifiers are used where a DC supply is required
- draws a circuit diagram and explains how half-wave rectification is achieved by using a semiconductor diode
- draws a circuit diagram and explains how full-wave rectification is achieved by using four diodes in a bridge circuit
- explains the purpose and functioning of the following:
  - fuses
  - short-circuit trips
  - overload trips
  - preferential-overload trips
  - reverse-power trips
  - no-volt trips
  - circuit breakers
- describes the effect of an open circuit in one phase of a 3-phase system
- describes the effect of an earth fault and why it is necessary to rectify the fault as soon as possible
- shows diagramatically the main and emergency switchboards, emergency generator, back-up batteries and the circuits supplied by them

Electro-chemistry

- describes the action of a simple cell consisting of zinc and copper plates dipped into dilute sulphuric acid
- explains what is meant by polarization
- describes the construction and action of a dry cell
- distinguishes between primary and secondary cells
- describes the construction and action of a lead-acid cell
- describes the care of lead-acid cells and the precautions to take in battery lockers and during charging
- explains how the capacity of lead-acid cells is given in ampere-hours and what is meant by the 10-hour rate
- describes the construction and action of alkaline cells
- compares the advantages of lead-acid and alkaline cells
- defines electrolysis as a process by which a substance is decomposed by the passage of an electric current
- defines 'electrolyte', 'anode' and 'cathode'
- describes the electrolytic action between two connected dissimilar metals immersed in an electrolyte
- explains the formation of corrosion cells on steel plating immersed in seawater

Instruments

- describes a moving-coil galvanometer and the principle on which it works
- describes a moving-iron galvanometer and explains its action
- explains why a moving-iron instrument can be used with alternating or direct current, whereas a moving-coil instrument can only be used with direct current
- explains how a galvanometer is used as:
  - an ammeter
  - a voltmeter

- explains how ammeters and voltmeters should be connected in a circuit
- describes the use of shunts and multipliers to vary the range scale of meters
- describes the use of instrument transformers and explains why they are used

Electronics (25 hours)

Passive components

- explains what is meant by a transducer and gives examples
- distinguishes between active and passive components
- describes a capacitor-resistor coupling (CR coupling)

- states that the time constant for a CR coupling is T = CR

  where: T is time (s)
  C is capacitance (F)
  R is resistance (Ω)

- describes how the time constant affects the output for a square-wave input
- describes that a printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks or signal traces etched from copper sheets laminated onto a non-conductive substrate

Semiconductor Devices

- explains what is meant by a semiconductor
- states that, in the presence of a potential difference, electrons move towards the positive source and holes towards the negative source of potential
- states that the resulting conduction is called intrinsic conduction
- states that intrinsic conduction is usually an unwanted effect and is increased by a rise in temperature
- states that most semiconductor devices are made from silicon because of its lower intrinsic conduction
- explains how small additions of impurities (doping) can increase the conductivity of a silicon crystal
- explains the formation of a depletion layer at the junction
- explains what is meant by forward and reverse bias
- describes the rectifying action of a junction diode
- uses the circuit symbol for a diode and indicates the anode and the cathode
- defines the breakdown or Zener voltage of a reverse-biased diode
- explains that Zener diodes are designed to have specified values of breakdown voltage and are used in reverse-bias mode
- uses a circuit symbol for a Zener diode
- describes how a Zener diode may be used for voltage stabilization or for

surge limiting
- uses the circuit symbols for junction transistors
- explains how the base-emitter current controls the collector-emitter current
- describes the use of a junction transistor in common-emitter mode for voltage amplification
- states that a junction field-effect transistor (FET) consists of a channel of either n- or p-type silicon sandwiched between two regions of the opposite type, known as gates
- states that connections to the channel are called source and drain
- explains that, for a given voltage across drain and source, the current flow is controlled by the reverse bias voltage applied between the gate and the source

Amplifiers

- states that the output from transducers is usually too small to operate indicating devices directly
- explains that amplifiers are used to increase the signal strength to a suitable level
- states that amplifiers can be divided into voltage amplifiers and power amplifiers
- explains that voltage amplifiers are intended to magnify small input voltages with the minimum distortion of the input waveform
- states that power amplifiers are intended to deliver sufficient power to operate output devices such as loudspeakers, servo-motors and indicating devices
- states that a number of amplifier stages may be connected in series (called a cascade) so that the output from one stage provides the input to the next
- defines the transfer characteristic as the relationship between input and output voltages
- defines distortion as a change of waveform between input and output terminals
- shows how curvature of the transfer characteristic leads to distortion
- states that distortion is also caused by variations in the gain of an amplifier with frequency
- explains why a single-stage amplifier produces a phase shift of 180° between input and output terminals

Feedback

- states that feedback occurs when part of the output voltage of an amplifier is added to, or subtracted from, the input signal
- states that, when a fraction of the output is added to the input, it is termed 'positive' feedback
- states that, when a fraction of the output is subtracted from the input, it is termed 'negative' feedback
- states that for electronic circuits:
  - positive feedback of voltage produces an uncontrolled gain and leads to oscillations
  - negative feedback of voltage reduces distortion and noise but reduces

the gain

- states that the reduction of distortion and noise is important in circuits where amplification is involved
- states that the phase of input and output signals must be displaced by 180^{o} to produce negative feedback
- states that negative feedback increases the range of frequencies for which the gain is reasonably constant
- states that operational amplifiers are very stable amplifiers using negative feedback and working over a narrow band of low frequencies extending to direct current
- states that operational amplifiers were designed to perform mathematical functions in analogue computers but are frequently used in analogue control systems
- states that they are usually produced as integrated circuits and draws the circuit symbol
- states that operational amplifiers have two inputs, inverting and non-inverting, and that negative feedback is taken to the inverting input
- explains that, in control systems, operational amplifiers are commonly arranged to produce an output voltage proportional to:
  - the sum or difference of the input voltages
  - the rate of change of input voltage
  - the integral of the input voltage
  - the difference between a reference voltage and a signal voltage

Integrated circuits (IC)

- states that an electronic circuit will be constructed from a number of components such as diodes, transistors, resistors and capacitors
- states that these components have to be inter-connected in the correct sequence to form the complete circuit
- states that developments such as printed circuit boards led to the assembly of the components into the complete circuit by such techniques as ultrasonic bonding on to the printed portion of the board
- states that circuits produced in this way were called 'hybrid' integrated circuits
- states that advances and developments in crystal technology can produce a single block of crystal (usually silicon) within which are incorporated (and properly inter-connected) the individual components forming the entire circuit
- states that circuits produced in this way are very compact and are called 'monolithic' integrated circuits
- states that the monolithic form of IC is now the type in common use and usually takes the form of a plastic bar into which the IC is embedded, with a protruding double row of connection pins
- states that a typical IC has dimensions of 30 mm x 6 mm x 3 mm, with a row of connection pins on each side
- states that the application of integrated circuits can be classified as 'digital' or 'analogue'
- states that digital ICs generally make use of transistors for on/off switching and are widely used in logic systems and computers
- states that analogue ICs have a main characteristic that the output is a

linear function of the input over their operational range and are widely used where amplification is needed, for example in communications (radio, TV, etc.) and in the measurement of physical quantities (pressure, temperature, etc.)

Power Supplies And Thyristors

- describes half-wave, full-wave and bridge rectifiers using semiconductor diodes
- states that for many applications the rectified output must be smoothed
- describes the use of a capacitor input filter to remove mains ripple
- describes the main constructional features of a thyristor
- states that a thyristor is a solid-state switch controlled by a low-level signal voltage applied to the gate electrode
- explains that, when reverse biased, both the anode and cathode junctions are reverse biased and current flow is blocked
- explains that, when forward biased, the gate junction is reverse biased, preventing conduction until triggered by a voltage pulse at the gate
- states that the gate has no influence once conduction has started
- states that a thyristor will return to a non-conducting state only when the supply voltage is interrupted or the current falls below the maintaining current
- explains how a thyristor can be used as a switch in a D.C. alarm circuit
- explains how a thyristor can be used to control alternating current
- explains that the triac can be triggered into conduction with either polarity of main terminals and can, therefore, control alternating current
- uses the circuit symbols for thyristor and triacs
- explains the need for, and describes, heat sinks on power devices

Oscillators

- describes how oscillations with damped sinusoidal waveform occur in an LC resonant circuit (tank circuit)
- explains that oscillations can be maintained by using a feedback amplifier with positive feedback
- states that the frequency of oscillations depends upon the values of inductance and capacitance of the tank circuit
- explains that the frequency will drift as a result of changes in values caused by temperature changes and stray inductance and capacitance
- states that the use of quartz crystal in place of a tuned circuit produced a much more stable frequency
- describes the piezo-electric property of quartz and how that is used to maintain a stable frequency
- states that part of the losses from a high-frequency oscillator consists of electromagnetic radiation
- states that non-sinusoidal waveform include:
  - square waves, used in computers and micro-processor control systems
  - sawtooth waves, used for timebases in cathode-ray oscilloscopes, radar and television

Radio Transmission and Reception

- explains the characteristics of various frequency bands such as VLF, MF, HF, VHF and UHF waves and their use on board ships
- describes the different type of antennas

Photoelectric Devices

- classifies photoelectric devices as:
  - photoemissive cells
  - photoconductive cells (light-dependent resistors)
  - photovoltaic cells
- states that certain metals emit electrons when subjected to visible or ultra-violet light
- describes how the emission of electrons is increased by a photo-multiplier tube
- describes the action of a photoconductive cell (light-dependent resistor)
- describes the action of a photovoltaic cell
- states that a photovoltaic cell converts light energy directly into electrical energy
- explains how a photovoltaic cell can be used with reverse bias as a photoconductive device
- defines a phototransistor as a device that combines the photovoltaic effect with transistor amplifying action
- states that the photovoltaic cell is formed by the collector-base junction
- uses circuit symbols for the photoelectric devices above

Digital Circuits

- states that digital circuits process signals which consist of only two significant voltage levels, named 'logic 0' and 'logic 1'
- states that most systems are based on positive logic in which 'logic' is represented by a near-zero voltage and 'logic 1' by a higher voltage
- states that components act as electronic switches to control the pattern of pulses through the system
- explains that logic gates are used to produce a required output for given inputs
- uses truth for two-input AND, OR, NAND, NOR, and X-OR gates
- describes how a transistor with a single input acts as an inverter as a NOR gate
- uses the American circuit symbols for gates
- states the data in the form of coded patterns of binary digits(bits) can be held and manipulated by registers consisting of sets of bistable circuits (flip-flops)
- states that a chain of bistable can be used for counting and performing binary arithmetic
- states that binary results are converted by a decoder to operate indicating devices
- lists indicating devices as printers, visual display units and seven-segment displays using light-emitting diodes (LED) or liquid crystals (LCD)

- states that LEDs are made from semiconductor compounds which emit light when conducting a small current with forward bias
- describes how numbers are shown by using a seven-segment display
- describes how a seven-segment LCD functions
- explains what is meant by random access memory (RAM)
- states that data in RAM are held in bipolar cells which can be read or written to
- states that RAM is volatile; i.e. the data is lost when the power is switched off
- explains what is meant by read-only memory (ROM)
- states that ROM is dedicated to a specific task, cannot be altered by the user and is non-volatile
- describes the function of multiplexers and demultiplexers