VALIDATED MODEL TRAINING COURSES

Draft new model course on Ratings as able seafarer engine in a manned engine-room or designated to perform duties in a periodically unmanned engine-room

Note by the Secretariat

| SUMMARY |
|------------------|----------------------------------------------------------------------------------|
| Executive summary: | This document provides the draft new model course on Ratings as able seafarer engine in a manned engine-room or designated to perform duties in a periodically unmanned engine-room |
| Strategic direction, if applicable: | 1 |
| Output: | 1.3 |
| Action to be taken: | Paragraph 2 |
| Related document: | HTW 5/3/7 |

General

1. The draft new model course on Ratings as able seafarer engine in a manned engine-room or designated to perform duties in a periodically unmanned engine-room referred to in document HTW 5/3/7 is set out in the annex.

Action requested of the Sub-Committee

2. The Sub-Committee is invited to consider the draft new model course on Ratings as able seafarer engine in a manned engine-room or designated to perform duties in a periodically unmanned engine-room, as set out in the annex, together with the report of the Review Group, as set out in document HTW 5/3/7, and take action, as appropriate.

***
ANNEX

DRAFT NEW IMO MODEL COURSE ON RATINGS AS ABLE SEAFARER ENGINE IN A MANNED ENGINE-ROOM OR DESIGNATED TO PERFORM DUTIES IN A PERIODICALLY UNMANNED ENGINE-ROOM

Model Course

X.XX

RATINGS AS ABLE SEAFARER ENGINE IN A MANNED ENGINE-ROOM OR DESIGNATED TO PERFORM DUTIES IN A PERIODICALLY UNMANNED ENGINE-ROOM

2018 Edition

IMO

INTERNATIONAL MARITIME ORGANIZATION
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Foreword

[To be inserted by the Secretariat]

KITACK LIM
Secretary-General
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Introduction

■ Purpose of the model courses

The purpose of 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 whereby the quality and effectiveness of the training courses may 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 instructors' presence. As in all training endeavours, the knowledge, skills, competence and dedication of the instructors are the key components in the transfer of knowledge and skills to those being trained through utilization of IMO model courses.

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. Parties may modify this course to suit their respective training programmes.

For those following planned training programmes 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 and 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.

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

■ Use of the model course

To use the model course, the instructor should review the course plan and detailed syllabus, taking into account the information provided under the entry standards specified in Part A of 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. Also, 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 either delete from the course, or reduce the emphasis on, items dealing with knowledge or skills already attained by the trainees. The instructor 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 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 only suggestions and assume that the trainees have fully met all entry requirements of the course. The instructor should, therefore, review these assessments and may need to reallocate the time required to achieve each specific learning objective or training outcome accordingly.

■ Aims

This model course aims to meet the mandatory minimum requirements for the knowledge, understanding and proficiency in table A-III/5 of the STCW Code at the support level, for:

- Function 1: Marine engineering
- Function 2: Electrical, electronic and control engineering
- Function 3: Maintenance and repair
- Function 4: Controlling the operation of the ship and care for persons on board

■ Lesson plans

Having adjusted the course content to suit the trainee intake and any revision of the course objectives, instructors 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 consist of the detailed syllabus with keywords or other reminders added to assist the instructor in preparing the presentation of the material.

■ Presentation

Instructors must be satisfied that trainees have attained each specific learning or training objective. In order to achieve these objectives, it may be necessary for the instructor to repeat the presentation of concepts and methodologies in varying ways. 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 table A-III/5 of the STCW Code.

■ Implementation

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

- Properly qualified instructors;
- Support staff;
- Classrooms and other learning spaces;
- Simulators and other relevant equipment;
- Suggested references, textbooks, technical papers; and
- Other applicable reference materials.
Thorough preparation is the key to successful implementation of the course. IMO "Guidance on the implementation of IMO model courses", deals with this aspect in greater detail.

In certain cases, the requirements for some or all of the training in a subject may be 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 four functions at the support level, and on successful completion of the training and assessment trainees should be competent to carry out safely the duties of ratings as able seafarer engine (AB engine).

The learning outcomes should be carefully scrutinized to ensure that the knowledge, understanding and proficiency in table A-III/5 of the STCW Code are effectively covered. 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.

■ Entry standards

The minimum educational standards for entry to the course will be approved 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 within secondary level. They should have reached a standard in mathematics, physical science and English language which would enable them to undertake the learning as set out in the syllabuses for those subjects.

Where entrants have not reached the required level of knowledge to be able to follow this course, it may be necessary to provide a preparatory course or courses to update their standard to the desired level before starting the course. It is a pre-requisite for those entering the course to meet the requirements of section A-III/4 of the STCW Code for ratings forming part of an engineering watch.

IMO Model Course 3.17 on Maritime English provides guidance to assist administrations in developing their own training programmes to achieve the standards of competency in Maritime English and effective communication, set out in the STCW Code. Noting the wide range of seafarers working in different capacities on board ships, the relevant sections from Model Course 3.17 on Maritime English may be selected to suit the seafarers' individual needs as per their related duties on board.

■ Course intake limitations

Class sizes should be limited to not more than 24 in order to allow instructors to give adequate attention to individual trainees. Larger manageable numbers may be admitted if extra staff and tutorial time can be provided to meet the individual needs of trainees. In addition, for scheduling access to learning facilities and equipment, attention to strict time management is necessary.

The instructor-to-trainee ratio for classroom lectures is recommended as 1:24 and for practical sessions as 1:8. Teaching staff should note that the ratios are suggestions only, and should be adapted to suit individual groups of trainees depending on their experience, ability and equipment available. However when a class exceeds 24 trainees, an assistant instructor would be required.
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 either essential to use that book, or that it has been approved by IMO. It may have appeared to be best suited to the course at the time of its design. In many instances there may be 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 publications. However, instructors should always endeavour to use the latest edition for preparing and presenting their courses.

Full use should be made of IMO documents, technical papers and other publications available from maritime and other professional organizations. Such documents contain new developments in techniques, equipment, design, management and opinion, and are an invaluable asset to a maritime training establishment. IMODOCS provides useful learning resources, and instructors must visit this site to ensure that the latest editions are available and used.

Computer applications

In view of the widespread use of computers aboard ships, it is recommended that an element of computer applications be included in the training of ratings as able seafarer engine. The use of multimedia applications can enhance learning in topics such as SOLAS, the International Convention for the Prevention of Pollution from Ships (MARPOL), basic crane, winch and hoist signals and other areas of knowledge. Up-to-date details may be found on the IMO website at http://www.imo.org and on IMODOCS. Instructors should bear in mind that the Internet can be a valuable source of information and teaching aids.

Training and the STCW Convention

The minimum standards of competence that have to be met by seafarers are defined in Part A of the STCW Code. This model course provides guidance to achieve the minimum standards of competence that have to be met by seafarers for the functions of Able Seafarer Engine, which are specified in table A-III/5 of the STCW Code.

The course is organized under the four functions at support level to cover the minimum standard of competence of ratings as able seafarer engine on ships of 750 kW or more, as set out in table A-III/5 of the STCW Code, as follows:

Function 1 - Marine engineering;
Function 2 - Electrical, electronic and control engineering;
Function 3 - Maintenance and repair; and
Function 4 - Controlling the operation of the ship and care for persons on board.
Each function is addressed in five parts:

**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 IMO references and textbooks is included in Function 1, which affects the four 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 trainees will naturally take longer to become proficient in some topics than in others.

**Part C** provides the Detailed Teaching Syllabus, which is based on the combined theoretical and practical knowledge specified in the STCW Code. It is written in learning objective format in which the objective describes what the trainee must do to demonstrate that knowledge has been transferred. Each of the objectives is expanded to define required performance of knowledge, understanding and proficiency. Suggested teaching aids, including IMO references, textbook references and bibliography, are provided, where applicable, to assist the teacher in designing lessons.

**Part D** provides 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, a sample lesson plan, a sample trainee's handout and a sample presentation. These entire instructors' aids are provided for guidance only.

**Part E** provides guidance on Evaluation which addresses all the functions. A separate IMO Model course 3.12 on Assessment, Examination and Certification of Seafarers addresses Assessment of Competence, which explains the use of various methods for demonstrating competence and criteria for evaluating competence in the STCW Code.

Mandatory provisions concerning Training and Assessment are given in section A-I/6 of the STCW Code that cover: qualification of instructors and assessors; in-service training; assessment of competence; and training and assessment within an institution. Part B of the STCW Code contains guidance on training and assessment.

### Validation

The guidance contained in this document has been validated by the Sub-Committee on Human Element, Training and Watchkeeping for use by Administrations and training providers for the training of ratings to facilitate uniform implementation of the minimum standards in the STCW Code. Validation in this context means that the Sub-Committee has found no grounds to object to the contents of this model course, but has not granted approval to the document, as the Sub-Committee does not consider any model course to be an official interpretation of IMO Instruments.
Part A: Course Framework for all Functions

■ Scope

This model course aims to meet the mandatory minimum requirements for knowledge, understanding and proficiency in table A-III/5 of the STCW Code, for the function Marine Engineering at the support level.

■ Objectives

Function 1: Marine engineering at the support level

The syllabus of this section covers the requirements and provides the detailed knowledge to support the training outcomes for the following competencies of STCW Code, section A-III/5 related to Marine engineering at the support level:

- Contribute to a safe engineering watch;
- Contribute to monitoring and controlling of an engine-room watch;
- Contribute to fuelling and oil transfer operations;
- Contribute to bilge and ballast operations; and
- Contribute to the operation of equipment and machinery.

Function 2: Electrical, electronic and control engineering at the support level

The syllabus of this section covers the requirements and provides the detailed knowledge to support the training outcomes for the following competency of the STCW Code, section A-III/5 related to Electrical, electronic and control engineering at the support level in the Safe use of electrical equipment.

Function 3: Maintenance and repair at the support level

The syllabus of this section covers the requirements and provides the detailed knowledge to support the training outcomes for the following competencies of STCW Code, section A-III/5 related to Maintenance and repair at the support level to contribute to shipboard maintenance and repair.

Function 4: Controlling the operation of the ship and care for persons on board at the support level

The syllabus of this section covers the requirements and provides the detailed knowledge to support the training outcomes for the following competencies of STCW Code, section A-III/5 related to Controlling the operation of the ship and care for persons on board at the support level.

- Contribute to the handling of stores;
- Apply precautions and contribute to the prevention of pollution of the marine environment;* and
- Apply occupational health and safety procedures.

*These topics are covered by the IMO model course 1.38 on Marine Environmental Awareness
I. Course certificate

On successful completion of the course and assessments, a document should be issued certifying that the holder has successfully completed a course of training which meets the level of knowledge and competence specified in table A-III/5 of the STCW Code.

A certificate of proficiency shall be issued only by the Administration.

II. Staff requirements

Instructors shall be qualified in the tasks for which training is being conducted and have appropriate training in instructional techniques and training methods (STCW Code, section A-I/6). The qualifications and experience of instructors and assessors shall be covered in the provisions of the quality standard system pursuant to STCW Code, section A-I/8.

III. Teaching aids (A)

Suitable learning spaces and workshops for lectures, discussions, individual and group training should be used, and provided with appropriate and relevant training aids including multimedia equipment and a simulator, if available.

Function 1 - Marine engineering at the support level

It is recommended that the trainees have access to the following additional equipment for training purposes:

- Photographs, drawings and plans to illustrate different types of main and auxiliary machinery and plants;
- Working models of two-stroke- and four-stroke-engines, heat exchangers, purifiers, air compressors and related auxiliary machinery;
- Drawings, plans, sketches and photographs of the following tanks and piping systems together with related installations of:
  - ballast water;
  - bilge;
  - fuel (oil);
  - lubrication oil;
  - sewage; and
  - steam
- Drawings, plans, sketches and photographs of the bunker stations, fuel (oil) and lubrication oil transfer systems together with related installations and equipment, e.g. bunker hose, sampling flange, emergency stop device, plugs for scuppers, Ship Oil Pollution Emergency Plan (SOPEP) equipment, internal communication devices, tank level measurement devices;
- Working models and examples of different pumps and valves together with related equipment;
– Working models and examples of different hoists and lifting equipment;
– Working models and examples of different hatches, watertight doors and ports together with related equipment;
– Simulators (wherever applicable to enhance understanding of topics); and
– Working models or computer based training on a typical layout of an engine-room.

Function 2 - Electrical, electronic and control engineering at the support level

The trainees should have access to the following for training purposes:

– Drawings, plans, sketches and photographs of the typical electrical installations on board of modern ships, e.g.:
  ▪ main switchboard;
  ▪ emergency switchboard;
  ▪ electrical grid with the different voltages;
  ▪ generators;
  ▪ electrical consumers, e.g. lighting, emergency lighting, electric motors, transformers, battery chargers and connections for electrical devices;
  ▪ different detectors, sensors, switches, plugs etc.; and
  ▪ different fuses.
– Working models and examples together with related equipment of:
  ▪ different electrical consumers, e.g. electric motors, transformers, battery chargers and connections for electrical devices;
  ▪ light;
  ▪ different detectors, sensors, switches, plugs etc.; and
  ▪ fuses.
– Schematic model of a starter panel and/or distribution panel;
– Personal protective equipment, e.g. glove for low-voltage fuses, helmet with visor, insulating coat;
– Insulated tools;
– Measurement equipment, e.g.
  ▪ Multimeter;
  ▪ voltage tester;
- current tester; and
- resistance tester.

- Simulators (wherever applicable to enhance understanding of topics); and
- Working models or computer based training of a main switchboard.

**Function 3 - Maintenance and repair at the support level**

The trainees should have access to the following for training purposes:

- Workshops;
- work benches with clamping device;
- manual tools, e.g. open wrench, box wrench, socket wrench, file, hammer, chisel, brush, hacksaw, pliers, cutter, Allen key, crowbar, screwdrivers;
- power tools, e.g. drilling machine, bench grinding machine, saw;
- portable electric and air driven tools, e.g. brush, grinder, cutter, needle hammer;
- additional tools, e.g. centre punch, twist drill, reamer, cutting disk;
- arc and gas welding equipment;
- gas cutting device;
- brazing device;
- working models of mooring winch, anchor winch, crane;
- different kinds of paints;
- pulleys and chain blocks; and
- wires and ropes.

**Function 4 - Controlling the Operation of the Ship and Care for Persons on Board at the support level**

It is recommended that trainees should have access to the following additional equipment for training purposes:

- 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;
- rigging loft with typical equipment and material;
- various additional personal protective equipment; and
use of oil dispersant chemicals and related equipment.

**IMO references (R)**

NOTE: Instructors should ensure that latest editions of references are used.

Up-to-date learning resources and their details may be found on the IMO website at [http://www.imo.org](http://www.imo.org) or on IMODOCS.

The following list provides the main Conventions, Regulations and Codes only. It is recommended to follow the link [http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Pages/Default.aspx](http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Pages/Default.aspx) to find the current status of resolutions. When in doubt, consult your national maritime administration.

- **R1** International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978, as amended
- **R2** International Convention for the Safety of Life at Sea (SOLAS), 1974 as amended (IMO Sales No. 110)
- **R3** International Convention for the Prevention of Pollution from Ships (MARPOL) (IMO Sales No. 520)
- **R4** International Safety Management Code (ISM Code) (IMO-186)
- **R5** IMO Model Course 3.17 on Maritime English
- **R6** IMO Model course 7.09 on Ratings forming part of engine watch
- **R7** Resolution A.1050(27) Revised recommendations for entering enclosed spaces aboard ships
- **R8** Maritime Labour Conventions (MLC)
- **R9** IMO Model Course 1.38 on Marine Environmental Awareness
- **R10** IMO Model Course 1.10 on Dangerous, Hazardous and Harmful Cargoes
- **R12** IMO Model Course 3.12 on Assessment, Examination and Certification of Seafarers

Details of distributors of IMO publications that maintain a permanent stock of all IMO publications may be found on the IMO website at [http://www.imo.org](http://www.imo.org).

**Bibliography (B)**

Note: The list of bibliography is recommendations only and are intended to support the learning outcomes of the course.

- **B1** Instructor Guidance (Part D of this course)
- **B2** Wall Chart: IMO Dangerous Goods Labels, Marks & Signs
- **B3** Code on Alerts and indicators
- **B4** Graphical Symbols for Fire Control Plans
- **B5** Ship's Engine Logbook
### Textbooks (T)

Note: The list of textbooks is for guidance purpose only. Other textbooks may be used as deemed fit by the instructors.

- **T1** *Accident Prevention on Board Ship at Sea and in Port*, International Labour Office
- **T2** *General Engineering Knowledge for Marine Engineers*, Jackson, L. and Morton T.D., Thomas Reed Publications
- **T3** *Engineering Thermodynamics in S.I. Units*, Joel, R., Longmann
- **T5** *Introduction to Marine Engineering*, Taylor, D.A., Butterworth
- **T6** *English for Maritime Studies*, Blakey, T.N., Hemel Hempstead, Prentice Hall International (UK) Ltd
- **T7** *Code of Safe Working Practices for Merchant Seafarers (UK)*, Maritime and Coastguard Agency
- **T8** *Ships’ Electrical Systems*, Borstlap, R. and ten Katen, H., (ISBN 90-7150-017-9)
- **T9** *Ship Knowledge*, Dokmar Publications
- **T10** *Shipboard Drills*, Witherby Seamanship
- **T11** *Onboard Safety*, Witherby Seamanship
- **T12** *Ships’ Electrical Systems*, Dokmar Publications
- **T13** *MarEngine English Underway*, Dokmar Publications
Rating as Able Seafarer Engine

Function 1: Marine engineering at the support level

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Part B1: Course Outline

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Lectures
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Part C1: Detailed Teaching Syllabus

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  1.1 Contribute to a safe engineering watch;
  1.2 Contribute to monitoring and controlling of an engine-room watch;
  1.3 Contribute to fuelling and oil transfer operations;
  1.4 Contribute to bilge and ballast operations;
  1.5 Contribute to the operation of equipment and machinery.

Part D1: Instructor Manual
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. However, the course outline suggests the minimum teaching hours for each topic, for guidance. Preparation and planning constitute an important factor which makes a major contribution to the effective presentation of any course of instruction.

Lecturers should develop their own timetables depending on the:

- level of skills of trainees;
- numbers to be trained; and
- number of instructors,

and take into account the normal practices at the training establishment.

■ 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 the experience gained in seagoing service.

An effective manner of presentation is to develop a technique of giving information and then reinforcing it. For example, share with 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 appropriate use of teaching aids such as multimedia equipment, and providing trainees with adequate course materials, including handouts, where necessary, will contribute to the learning processes.

■ Course Outline

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

1. 

<table>
<thead>
<tr>
<th>Knowledge, understanding and proficiency</th>
<th>Total hours of performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory</td>
</tr>
</tbody>
</table>

## Competence:

(28 hours)

1.1. Contribute to a safe engineering watch

1.1.1. Ability to understand orders and to communicate with the officer of the watch on matters relevant to watchkeeping duties (See Entry Standards)

| .1 familiar use of important technical marine engineering terms | (4 hours) | (1 hours) |

1.1.2. Procedures for the relief, maintenance and handover of a watch

| .1 stating the principles defining the watch arrangement | (2 hours) |
| .2 stating the purposes of the individual equipment in engine control room and engine-room and interpret the values displayed and integrate them in the tasks of watch duty | (6 hours) | (2 hours) |
| .3 stating watchkeeping duties under different conditions and areas | (2 hours) | (2 hours) |

1.1.3. Information required to maintain a safe watch

| .1 understand standing orders | (1 hour) |
| .2 record and report information of tank soundings and machinery parameters as required by Engineering Officer of the Watch (EOOW) | (1 hour) |
| .3 perform watch rounds to verify machinery performance | (2 hours) | (4 hours) |
| .4 describe unusual machinery condition | (1 hour) |

1.2. Contribute to the monitoring and controlling of an engine-room watch

(68 hours)

1.2.1. Basic knowledge of the function and operation of main propulsion and auxiliary machinery

| .1 working knowledge of the function and operation of propulsion diesel engine | (6 hours) | (8 hours) |
| .2 working knowledge of the function and operation of propulsion diesel engine auxiliary systems | (4 hours) | (8 hours) |
| .3 working knowledge of the function and operation of auxiliary diesel engines | (8 hours) | (8 hours) |
.4 working knowledge of the function and operation of auxiliary machinery (6 hours) (4 hours)
.5 working knowledge of the function and operation of auxiliary steam boiler (2 hours) (6 hours)

1.2.2. Basic understanding of main propulsion and auxiliary machinery control pressures, temperatures and levels

.1 recognize control pressures, temperatures and levels of main propulsion (3 hours) (1 hour)
.2 recognize control pressures, temperatures and levels of auxiliary machinery (3 hours) (1 hour)

1.3. Contribute to fuelling and oil transfer operations (10 hours)

1.3.1. Knowledge of the function and operation of fuel system and oil transfer operations, including

.1 preparations of fuelling and transfer operations (1 hour) (1 hour)
.2 procedures for connecting and disconnecting fuelling and transfer hoses (1 hour) (1 hour)
.3 procedures relating to incidents that may arise during fuelling or transferring operation (1 hour) (1 hour)
.4 Securing from fuelling and transfer operations (1 hour) (1 hour)
.5 ability to correctly measure and report tank levels (1 hour) (1 hour)

1.4. Contribute to bilge and ballast operations (10 hours)

1.4.1. Knowledge of the safe function, operation and maintenance of the bilge and ballast system, including reporting incidents associated with transfer operations

.1 explains with the help of a drawing the piping diagrams of the bilge and ballast systems (1 hour) (1 hour)
.2 demonstrates the safe operating procedure for operating the bilge system (1 hour) (1 hour)
.3 demonstrates the safe operating procedure for operating the ballast system (1 hour) (1 hour)
.4 demonstrates the maintenance associated with the bilge and ballast systems (1 hour) (1 hour)

1.4.2. Knowledge of the safe function, operation and maintenance of the bilge and ballast system, including ability to correctly measure and report tank levels

.1 demonstrates ability to measure and report bilge and holding tank levels during and on completion of the operation (1 hour) (1 hour)
1.5. Contribute to the operation of equipment and machinery (36 hours)

1.5.1. Safe operation of equipment, including

1. Valves and pumps (8 hours)
2. Hoist and lifts (6 hours)
3. Hatches, watertight doors, ports and related equipment (6 hours)

1.5.2. Ability to use and understand basic crane, winch and hoist signals

1. Ability to use and understand basic signals for the operation of equipment (2 hours)

Total for Function 1: Marine engineering at the support level 152 hours

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

IMO references (indicated by R);
Textbooks (indicated by T); and
Bibliography (indicated by B),

which will provide valuable information to instructors.

■ Explanation of information contained in the Syllabus Tables

The information on each table is systematically organized in the following manner. The table describes the Function to which the training is related. A FUNCTION means a group of tasks, duties and responsibilities as specified in the STCW Code. It describes related activities which make the tasks for which trainees will be responsible on board. In this model course there are four functions at the support level, namely:

Function 1: Marine engineering;
Function 2: Electrical, electronic and control engineering;
Function 3: Maintenance and repair;
Function 4: Controlling the operation of the ship and care for persons on board.

Each Function comprises a number of competences, and the first column of the Table denotes the COMPETENCE concerned. For example, Function 1, Marine engineering at the support level, comprises a total of five Competences, and each competence is uniquely and consistently numbered in this model course.

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 competence "Contribute to a safe engineering watch" comprises a total of three training outcomes. Each training outcome is uniquely and consistently numbered in this model course.
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 "Ability to understand orders and to communicate with the officer of the watch on matters relevant to watchkeeping duties", there is one area of performance.

Following each numbered area of required performance, there is a list of activities that the trainee should complete, which collectively specify the standard of competence that the trainee must meet. These are for the guidance of instructors in designing lessons, lectures, tests and exercises for use in the learning process.

IMO References (Rx), Textbooks (Tx), and Bibliography (Bx) relevant to the training outcome and required performances are placed immediately following the title.

The Syllabus Tables are organized to match the competences in table A-III/5 of the STCW Code. It is not intended that lessons are organised to follow the sequence of required performances listed in the tables. However, what is necessary is that all the material cover the required knowledge, understanding and proficiency for the competences related to the Functions, and that learning is effective to enable the trainees to meet the required performance standard.
### COMPETENCE 1.1
Contribute to a safe engineering watch **IMO Reference**

<table>
<thead>
<tr>
<th>TRAINING OUTCOMES:</th>
<th>STCW Code</th>
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<tbody>
<tr>
<td><strong>Demonstrates a knowledge and understanding of:</strong></td>
<td>Table A-III/5</td>
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1.1.1 **ABILITY TO UNDERSTAND ORDERS AND TO COMMUNICATE WITH THE OFFICER OF THE WATCH IN MATTERS RELEVANT TO WATCHKEEPING DUTIES** *(SEE ENTRY STANDARDS)*

1.1.2 **PROCEDURES FOR THE RELIEF, MAINTENANCE AND HANDOVER OF A WATCH**

1.1.3 **INFORMATION REQUIRED TO MAINTAIN A SAFE WATCH**

### COMPETENCE 1.1
Contribute to a safe engineering watch

1.1.1 **ABILITY TO UNDERSTAND ORDERS AND TO COMMUNICATE WITH THE OFFICER OF THE WATCH IN MATTERS RELEVANT TO WATCHKEEPING DUTIES** *(SEE ENTRY STANDARDS)*

**IMO references:** R1, R2, R3, R4, R5, R6

**Bibliography:** B1,

**Textbooks:** T2, T3, T4, T5, T6, T7, T13

**Required Performance:**

1.1 **familiar use of important technical marine engineering terms**

- states the purpose of general arrangement drawings (extended tasks on spatial understanding), maintenance regulations, and instructions in English;

- states the relevant terms used in engine-room and general onboard communications; and

- demonstrates the ability to communicate with a multilingual crew.

The minimum standard of competence in General Maritime English Level is required (reference to IMO Model course 3.17 on Maritime English) to be able to understand orders and to communicate with the officer of the watch in matters relevant to watchkeeping duties.
COMPETENCE 1.1  Contribute to a safe engineering watch

1.1.2 PROCEDURES FOR THE RELIEF, MAINTENANCE AND HANDOVER OF A WATCH

IMO references: R1, R2, R3, R4, R5, R6
Bibliography: B1,
Textbooks: T2, T3, T4, T5, T6, T7, T13

Required Performance:

2.1 stating the principles defining the watch arrangement
   – demonstrates the maintenance, handover and relief of the watch in conformity with accepted watchkeeping practices and procedures.

2.2 stating the purposes of the individual equipment in engine control room and engine-room and interpret the values displayed and integrate them in the tasks of watch duty
   – has basic knowledge of the purposes of equipment and interprets the displayed values of, e.g.:
     • main engine
     • auxiliary engine
     • boilers
     • valves
     • pumps
     • motors
     • compressors
     • purifiers
     • filters

2.3 stating watch keeping duties under different conditions and areas
performs an engineering watch during/while:
   • shipboard emergencies
   • stand-by engines
   • restricted visibility
   • coastal and congested waters
   • ship at anchor
   • ship in port
<table>
<thead>
<tr>
<th>COMPETENCE 1.1</th>
<th>Contribute to a Safe Engineering Watch</th>
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<tbody>
<tr>
<td>1.1.3 INFORMATION REQUIRED TO MAINTAIN A SAFE WATCH</td>
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</tbody>
</table>

IMO references: R1, R2, R3, R4, R5, R6
Bibliography: B1,
Textbooks: T2, T3, T4, T5, T6, T7, T13

Required Performance:

**3.1 understand standing orders**

- states typical standing orders
- demonstrates understanding of standing orders
- describes what is required by the standing order

**3.2 record and report information of tank soundings and machinery parameters as required by EOOW**

- states how to check the current operational parameters and condition of all machinery
- Reports to the EOOW any machinery not functioning properly, expected to malfunction or requiring special service
- demonstrates how to make logbook entries
- describes the routine of recording and reporting to EOOW

**3.3 perform watch rounds to verify machinery performance**

- states the watch round routine in the engine-room and the locations where the parameters are checked
- demonstrates watch rounds verifying machinery performance
- describes the following duties:
  - taking over and accepting a watch;
  - routine tasks undertaken during a watch;
  - maintenance of the machinery space logbook and the significance of readings taken; and
  - handing over a watch.
3.4 **describe unusual machinery conditions**

- demonstrates condition inspection of machinery installations during rounds in the engine-room using the following senses:
  
  - hearing;
  
  - touch;
  
  - smell; and
  
  - sight.
COMPETENCE 1.2 | Contribute to the monitoring and controlling of an engine-room watch | IMO Reference

TRAINING OUTCOMES:

Demonstrates a knowledge and understanding of:

1.2.1 BASIC KNOWLEDGE OF THE FUNCTION AND OPERATION OF MAIN PROPULSION AND AUXILIARY MACHINERY

1.2.2 BASIC UNDERSTANDING OF MAIN PROPULSION AND AUXILIARY MACHINERY CONTROL PRESSURES, TEMPERATURES AND LEVELS

COMPETENCE 1.2 | Contribute to the monitoring and controlling of an engine-room watch

1.2.1 BASIC KNOWLEDGE OF THE FUNCTION AND OPERATION OF MAIN PROPULSION AND AUXILIARY MACHINERY

IMO references: R1, R2, R3, R4, R5, R6
Bibliography: B1
Textbooks: T2, T3, T4, T5, T6, T7, T13

Required Performance:

1.1 working knowledge of the function and operation of propulsion diesel engine

- describes the operating principles of two-stroke and four-stroke diesel engines;
- describes the functions of the major parts of two-stroke and four-stroke diesel engines;
- explains how to monitor the safe operation of the propulsion engine according to the parameters specified by the engine manufacturer and/or standing orders; and
- describes common malfunctions and understands threshold limits of various propulsion diesel engines.

1.2 working knowledge of the function and operation of propulsion diesel engine auxiliary systems

- explains using diagrams the operation of the propulsion machinery piping systems;
- states pressure, level and temperature ranges under normal operating conditions for the systems associated to the propulsion machinery;
describes the preparation of the main propulsion machinery for starting e.g.:

- pre-heating
- Priming
- slow turning
- visual check of any leakages, etc.,
- levels of expansion tanks
- levels of sump tanks
- engine telegraph
- stand by engine
- steering gear

- describes common malfunctions and understands lower and upper threshold limits of operational values of various auxiliary systems of propulsion diesel engines

1.3 **working knowledge of the function and operation of auxiliary diesel engines**

- states the layout and function of the diesel generator plant:
  - number of generator sets
  - combination with shaft generators

- describes a normal operational set-up for different conditions:
  - at sea
  - in port
  - during manoeuvring
  - during bad weather
  - during loading and discharge operation

- states pressure, level and temperature ranges under normal operating conditions

- describes the preparation of the auxiliary diesel engines for starting:
  - priming
  - slow turning
  - visual check for leakages, etc.,
  - check pressures, temperatures etc., after starting
1.4 working knowledge of the function and operation of auxiliary machinery

- describes the basic functions and operation of the auxiliary machinery in order to monitor their operational condition:
  - compressors
  - purifiers
  - heat exchangers
  - pumps
  - fresh water generators
  - cold store and air conditioning units
  - filters
  - boilers
- describes common malfunctions and understands lower and upper threshold limits of operation values of various auxiliary machineries

1.5 working knowledge of the function and operation of auxiliary steam boiler

- describes safety precautions in connection with safe operation of auxiliary steam boiler
- describes the safe operation of boilers:
  - procedure for starting boilers
  - checking fuel combustion for normal operation
  - ascertaining the correct water level
  - procedure for stopping the boiler
  - procedure for emergency stop
- describes common malfunctions and understands lower and upper threshold limits of operation values of various auxiliary steam boilers
COMPETENCE 1.2 | Contribute to the monitoring and controlling of an engine-room watch

1.2.2 BASIC UNDERSTANDING OF MAIN PROPULSION AND AUXILIARY MACHINERY CONTROL PRESSURES, TEMPERATURES AND LEVELS

IMO references: R1, R2, R3, R4, R5, R6
Bibliography: B1
Textbooks: T2, T3, T4, T5, T6, T7, T13

Required Performance:

2.1 **Recognize control pressures, temperatures and levels of main propulsion**
- states pressure, level and temperature ranges under normal operating conditions of main propulsion.
- describes common malfunctions and understands lower and upper threshold limits of operation values of various main propulsions.

2.2 **Recognize control pressures, temperatures and levels of auxiliary machinery**
- states pressure, level and temperature ranges under normal operating conditions of auxiliary machinery as listed in 1.2.1.4.
- describes common malfunctions and understands lower and upper threshold limits of operation values of various auxiliary machineries.
COMPETENCE 1.3
Contribute to fuelling and oil transfer operations

TRAINING OUTCOMES:

Demonstrates a knowledge and understanding of:

1.3.1 KNOWLEDGE OF THE FUNCTION AND OPERATION OF FUEL SYSTEM AND OIL TRANSFER OPERATIONS, INCLUDING

COMPETENCE 1.3
Contribute to fuelling and oil transfer operations

1.3.1 KNOWLEDGE OF THE FUNCTION AND OPERATION OF FUEL SYSTEM AND OIL TRANSFER OPERATIONS, INCLUDING

IMO references: R1, R2, R3, R4, R5, R6
Bibliography: B1
Textbooks: T2, T3, T4, T5, T6, T7, T13

Required Performance:

1.1 preparations of fuelling and transfer operations

- describes the layout of systems:
  - Fuel oil transfer systems
  - Bunkering stations
  - Lubrication oil transfer system

- explains with the use of a simple line diagram the fuel oil and lubrication oil transfer piping arrangements of a vessel

- explains the procedures for bunkering and transferring fuel and lubricants with regard to preparation of operations:
  - plugs for scuppers
  - oil spill containment equipment and materials
  - adaptors for hoses
  - sounding tapes
  - handheld radios and other internal communication devices
  - schedule of tanks to be loaded
  - common hand signals
  - emergency stopping device
  - fuel oil sampling device and corresponding equipment
1.2 procedures for connecting and disconnecting fuelling transfer hoses
   - explains the procedures for bunkering and transferring fuel and lubricants with regards to connecting and disconnecting transfer hoses and supporting equipment

1.3 procedures relating to incidents that may arise during fuelling or transferring operation
   - explains the procedures for bunkering and transferring fuel and lubricants with regards to actions to be taken in case of an incident, for example:
     - stop transfer immediately
     - inform bridge and duty engineer
     - inform bunker supplier
     - contain spilled oil

1.4 Securing from fuelling and transfer operations
   - explains fuel oil sampling
   - explains the procedures for bunkering and transferring fuel and lubricants with regards to securing materials and equipment at completion of the operation

1.5 ability to correctly measure and report tank levels
   - explains the procedures for bunkering and transferring fuel and lubricants with regards to correctly measuring and reporting tank levels during, and on completion of, the operation
   - demonstrates communication between the bunker supplier and the vessel
### COMPETENCE 1.4
Contribute to bilge and ballast operations

#### IMO Reference
STCW Code
Table A-III/5

**TRAINING OUTCOMES:**

Demonstrates a knowledge and understanding of:

<table>
<thead>
<tr>
<th>1.4.1</th>
<th>KNOWLEDGE OF THE SAFE FUNCTION, OPERATION AND MAINTENANCE OF THE BILGE AND BALLAST SYSTEM, INCLUDING REPORTING INCIDENTS ASSOCIATED WITH TRANSFER OPERATIONS</th>
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<tbody>
<tr>
<td>1.4.2</td>
<td>KNOWLEDGE OF THE SAFE FUNCTION, OPERATION AND MAINTENANCE OF THE BILGE AND BALLAST SYSTEM, INCLUDING ABILITY TO CORRECTLY MEASURE AND REPORT TANK LEVELS</td>
</tr>
</tbody>
</table>

**IMO references:** R1, R2, R3, R4, R5, R6
**Bibliography:** B1
**Textbooks:** T2, T3, T4, T5, T6, T7, T13

**Required Performance:**

1. **explains with the help of a drawing the piping diagrams of the bilge and ballast systems**
   - describes the operation of the pumps used in a bilge system
   - describes the operation of the pumps used in a ballast system

2. **demonstrates the safe operating procedure for operating the bilge system**
   - operates the valves and pumps in order to empty a bilge well
   - describes the action to be taken in case of an incident

3. **demonstrates the safe operating procedure for operating the ballast system**
   - operates the valves and pumps in order to transfer ballast water
   - measures and report tank levels during, and on completion of, the operation
   - describes the action to be taken in case of an incident

4. **demonstrates the maintenance associated with the bilge and ballast systems**
   - cleaning of filters
   - cleaning of ejectors
   - cleaning of bilge wells
COMPETENCE 1.4  Contribute to bilge and ballast operations

1.4.2 KNOWLEDGE OF THE SAFE FUNCTION, OPERATION AND MAINTENANCE OF THE BILGE AND BALLAST SYSTEM, INCLUDING ABILITY TO CORRECTLY MEASURE AND REPORT TANK LEVELS

IMO references:  R1, R2, R3, R4, R5, R6
Bibliography:  B1,
Textbooks:  T2, T3, T4, T5, T6, T7, T13

Required Performance:

2.1 demonstrates ability to correctly measure and report bilge and holding tank levels during, and on completion of, the operation

- states the importance of continuously monitoring the tank levels during operation
- demonstrates sounding of ballast water and bilge tanks
- describes how to read ullage soundings
COMPETENCE 1.5 | Contribute to the operation of equipment and machinery

TRAINING OUTCOMES: | IMO Reference

Demonstrates a knowledge and understanding of:

1.5.1 SAFE OPERATION OF EQUIPMENT, INCLUDING
1.5.2 ABILITY TO USE AND UNDERSTAND BASIC CRANE, WINCH AND HOIST SIGNALS

<table>
<thead>
<tr>
<th>COMPETENCE 1.5</th>
<th>Contribute to the operation of equipment and machinery</th>
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<tbody>
<tr>
<td>1.5.1 SAFE OPERATION OF EQUIPMENT, INCLUDING</td>
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</tbody>
</table>

Required Performance:

1.1 Valves and pumps
- identifies the various types of valves for shipboard application
- states the function/application of the various types of valves
- describes the safe operating procedures of the different type of valves
- lists the types of pumps found on board ships based on:
  - operating principle
  - application
- states the principle of operation of the various types of pumps (e.g. centrifugal pumps, positive-displacement pumps, eductor pumps and stripping pumps)
- describes the safe operating procedures for the various types of pumps:
  - starting
  - operation
  - stopping
- understands the conditions for which the pumps are being used
- explains the arrangement and use of:
  - deck lines
- drop lines
- stripping lines
- crossovers
- bypasses
- master valves
- tank suction valves
- sea suction valves
  - demonstrates emergency procedures and testing of emergency shutdown of pumps and associated valves under the supervision of the EOOW
  - demonstrates the use of portable pumps

1.2 **Hoists and lifting equipment**
  - explains the correct use and meaning of SWL
  - describes the safe operation of hoists and lifting equipment:
    - tackles
    - slings
    - chain blocks
    - shackles
  - states that defects in any lifting equipment and gears have to be reported immediately
  - demonstrates how to sling, lift and move different kind of cargo in a secure and safe manner

1.3 **Hatches, watertight doors, ports and related equipment**
  - describes the different types and function principles of hatches, ports and related equipment
  - describes the safety precautions to be applied in case hatch covers are opened, moved, secured and closed
  - states that every opening has to be secured as necessary
  - describes the different types of hatch covers seals, their function principle, function testing and maintenance
  - describes the different types, function principle and safe operation of watertight doors
- describes the safety hazards in opening/closing ramps, doors, freight elevators etc.,

- describes the effect on ship stability and watertight integrity, if doors are left unsecured
1.5.2 ABILITY TO USE AND UNDERSTAND BASIC CRANE, WINCH AND HOIST SIGNALS

IMO references: R1, R2, R3, R4, R5, R6
Bibliography: B1, Textbooks: T2, T3, T4, T5, T6, T7, T13

Required Performance:

2.1 Ability to use and understand basic signals for the operation of equipment

- states that in case of dead spots during stores operation additional signallers have to be available

- demonstrates commonly used hand signals for controlling of lifting appliances and winches, e.g. code of hand signals
Part D1: Instructor Manual

The following notes are intended to highlight the training objectives and learning 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 should be made aware of the need, and the practical measures required, when performing the following elements of shipboard operations:

- Contribute to a safe engineering watch;
- Contribute to monitoring and controlling of an engine-room watch;
- Contribute to fuelling and oil transfer operations;
- Contribute to bilge and ballast operations; and
- Contribute to the operation of equipment and machinery.

Function 1: Marine engineering at the support level

This function covers many different areas and trainees should be familiar with the STCW Code Chapter VIII Parts 4-2, 5-2 and 5-4 relating to: Principles to be observed in keeping an engineering watch; taking over the engineering watch; and performing the engineering watch.

On completion of training for this function, trainees should be able to provide effective support to the EOOW during the engineering watch.

1.1 Contribute to a safe engineering watch

In implementing this section of the course, instructors should ensure that trainees have prior training, competence and experience as ratings, and have demonstrated the ability to perform tasks required of ratings.

The trainees should have an understanding of the tasks to support the EOOW to fulfill the watchkeeping duties to the satisfaction of the Chief Engineer. Trainees must achieve an overall understanding of the duties and associated responsibilities required for the performance of an engineering watch.

1.1.1 Ability to understand orders and to communicate with the officer of the watch in matters relevant to watch keeping duties

1.1.1.2 Familiar use of important technical marine engineering terms

Instructors should refer to IMO model course 3.17 on Maritime English, to the IMO Marine Standard Communication Phrases, and to the references given in Part C1 of this course to familiarize trainees with the use of important technical marine engineering terms.

1.1.2 Procedures for the relief, maintenance and handover of a watch

On completion of the course, trainees should have a clear understanding of the at-sea and in-port watch systems, and that the maintenance, handover and relief of the watch should be in conformity with accepted practices and procedures.
1.1.2.1 Stating the principles defining the watch arrangement

Watchkeeping Schedule

The term "engineering watch" is used to mean either a group of seafarers (engineer officer and ratings) or an engineer officer having responsibility for the machinery spaces for a period of time during which their physical presence in the machinery space may, or may not, be required.

The system of watches adopted on board ships is usually a four hour on / eight hours off, or a six hours on / six hours off watchkeeping pattern, depending on the manning scales and company policies. In port, a system of six hours on / six hours off watch cycle may be adopted. On Offshore Support Vessels, a six hours on / six hours off cycle is normally adopted at all times.

Watchkeeping Responsibility

The EOOW shall be responsible for the inspection, operation and testing as required, of all machinery and equipment in the machinery spaces under the officer's responsibility.

The EOOW is the Chief Engineer Officer's representative, and the primary responsibility at all times shall be the safe and efficient operation and upkeep of machinery affecting the safety of the ship.

Ratings as able seafarer engine forming part of the engine-room watch

Under the general supervision of the EOOW, engine-room ratings shall be required to assist in the safe and efficient operation of propulsion machinery and all auxiliary equipment.

Watchkeeping tasks for Ratings forming part of the engine-room watch – A summary

1. At the commencement of the engineering watch: check the current operational parameters and condition of all machinery; and report to the EOOW any machinery not functioning properly, expected to malfunction or requiring special attention.

2. When the machinery spaces are in the manned condition, the Engineer Officer in charge of the watch shall at all times be readily capable of operating the propulsion equipment in response to needs for changes in direction or speed. When the machinery spaces are in the periodic unmanned condition, the designated Duty Engineer Officer in charge of the watch shall be immediately available and on call to attend the machinery spaces. The engine-room rating is to assist the EOOW in this duty.

3. All bridge orders shall be promptly executed. The EOOW shall ensure that the main propulsion unit controls, when in the manual mode of operation, are continuously attended under standby or manoeuvring conditions. Changes in direction or speed of the main propulsion unit shall be recorded. The engine-room rating is to assist the EOW in this duty.

4. The Chief Engineer Officer shall ensure that the EOOW is informed of all preventive maintenance, damage control or repair operations to be performed during the watch. The EOOW shall be responsible for the isolation, by-passing and adjustment, as required of all machinery under the EOOW's responsibility, and shall record all work carried out. The engine-room rating is to assist the EOW in this duty.
.5 Before being relieved of duty, the Engineer Officer in charge of the watch shall ensure that all tasks and observations related to the main and auxiliary machinery are suitably recorded. The engine-room rating is to assist the EOW in this duty.

**Watchkeeping Routines**

**At all times, Ratings should be familiar with watchkeeping routines and be of assistance to the EOW in these routines.**

.1 Duties associated with taking over and accepting a watch.

.2 Routine duties undertaken during a watch.

.3 Maintenance of the machinery space logbook and the significance of readings taken.

.4 Duties associated with handing over a watch.

**Unattended Machinery Space Operation**

The machinery space may be unattended during off-duty hours and on weekends.

The tour of inspection will be similar to that for a conventional watch with due consideration being given to the unattended mode of machinery operation. Trends in parameter readings must be observed, and any instability in operating conditions must be rectified, etc.

The main logbook readings will be taken as required while on a tour of inspection. The various routine duties such as fuel transfer, pumping of bilges, etc., should be carried out, and it remains the responsibility of the EOOW to ensure that they are done as required in a safe and timely manner.

**1.1.2.2 Stating the purposes of the individual equipment in engine control room and engine-room and interpret the values displayed and integrate them in the tasks of watch duty**

It is intended that the subject should be practical based, that is, containing sufficient theory to provide an adequate understanding of the principles to be applied to operational practices.

Wherever possible, actual equipment or training ships should be made available for trainees, to ensure a clear and full understanding of the principles and tasks involved.

In cases where it is not possible to make available actual equipment or training ships, the use of simulators, ship visits and multimedia training aids would suffice to provide some level of familiarity.

**1.1.2.3 Stating procedures for taking over the watch**

The following issues need to be informed to the relieving AB engine:

- Special orders related to any ship operation, control system or maintenance work;
- Standing orders from the Chief Engineer and/or the company; and
- Levels of important tank spaces such as bilge tanks, ballast tanks, sewage tanks, oil/fuel/water reserve tanks, slop tanks, fuel tanks, lube oil tanks or any other tank which requires attention.
- Condition and state of fire extinguishing equipment and systems, in case any specific section or fire alarm has been isolated.

- Special mode of operation in case of emergency situations, damage, icy or shallow waters, etc.

- Any type of maintenance work being carried out in the engine-room.

- Any potential hazard because of any ongoing maintenance work should be informed.

- Any equipment failures.

- Condition and important information regarding mode of operation of main engine, boiler and auxiliary engines.

- Any equipment which need to be monitored manually; and

- Condition and modes of all the important auxiliary machinery such as purifiers, fresh water generator, oily water separator, pumps, sewage treatment plant, etc.

It is to note that if the AB engine feels that the relieving AB Engine is not in a condition to carry out the watch duties efficiently, the former should not hand over the watch and should inform the EOOW.

1.1.2.4 Stating watchkeeping duties under different conditions and areas

Refer to STCW Regulation VIII/2 and STCW Code Chapter VIII of the STCW Convention.

The instructor shall address the following different conditions and areas:

- Restricted visibility
- Coastal and congested waters
- Ship at anchor
- In Port

1.1.3 Information required to maintain a safe watch

The Able Seafarer engine receives all appropriate instructions and information from the EOOW which will ensure the keeping of a safe engineering watch, e.g.:

- standing orders and special instructions of the Chief Engineer Officer relating to the operation of the ship's systems and machinery;
- the nature of all work being performed on machinery and systems, the personnel involved and potential hazards;
- the level and, where applicable, the condition of water or residues in bilges, ballast tanks, slop tanks, reserve tanks, fresh water tanks, sewage tanks and any special requirements for use or disposal of the contents thereof;
- the condition and level of fuel in the reserve tanks, settling tank, day tank and other fuel storage facilities;
- any special requirements relating to sanitary system disposals;
- condition and mode of operation of the various main and auxiliary systems, including the electrical power distribution system;
- the condition of monitoring and control console equipment, and which equipment is being operated manually;
- the condition and mode of operation of automatic boiler controls such as flame safeguard control systems, limit control systems, combustion control systems, fuel supply control systems and other equipment related to the operation of steam boilers;
- any potentially adverse conditions resulting from bad weather, ice, contaminated or shallow water;
- any special modes of operation dictated by equipment failure or adverse ship conditions; and
- the availability of fire-fighting appliances.

1.1.3.1 Understand standing orders

Every ship has a set of Chief Engineer’s standing orders, and all engine-room personnel must acknowledge the Chief Engineer’s standing orders by signing them prior to standing their [first] watch.

The following are examples of Chief Engineer’s standing orders:

- Watchkeepers must arrive on duty appropriately attired in work clothes and work shoes.
- Each watchkeeper shall arrive for their watch alert, sober and well rested.
- No watchkeeper will allow the relieving watchkeeper to stand a watch if it is suspected that they are under the influence of drugs or alcohol, or in the view of the watchkeeper, for some other reason, the relieving watchkeeper is considered to be unable to stand a safe and competent watch.
- The relieving watchkeeper must acknowledge and understand the Chief Engineer’s standing orders as well as any other night orders given.
- EOOW is to read and follow any Shipboard Oil Pollution Emergency Plans.
- EOOW in an unmanned machinery space is required to make a round of all engineering spaces at least once every hour during normal working hours, after the evening meal, and before retiring, to check all pressures, temperatures and machinery fluid levels.
- The EOOW should check bilge levels and verify that all gear is secure.
- More frequent rounds may be necessary in rough weather, or when monitoring potential problems.
- All necessary entries need to be made in the engine-room logbook during rounds.
- Watch turn-overs shall communicate verbally and record pertinent information in the daily tool box log.
- Any excessive pounding or slamming of the vessel will be reported to the bridge immediately to request a reduction in speed.
- Report any unusual engine-room noises or readings to the bridge immediately.
- Maintain good communications with the bridge with respect to operations.
- Demonstrate good engineering practices by being proactive in solving potential problems.
- Understand the location and usage of all safety and emergency equipment located in engineering spaces, and be aware of all emergency escape routes.
- Notify the Chief Engineer officer before performing any maintenance that is unassigned and that may affect the safe and efficient operation of the ship:
  - When in doubt, notify the Chief Engineer.
  - As watches are stood alone, do not take any unnecessary risk around machinery or on deck.
  - Check in with the bridge crew on watch to verify your presence and safety.
  - EOOW is also expected to have knowledge and offer assistance of non-vital equipment on board the ship.
  - The Chief Engineer must authorize the discharge of any fluids overboard while at sea or in port.
- It is the responsibility of the EOOW to log and record all necessary information into the Engine-room logbook, as well as any other records required by the Company.

1.1.3.2 Record and report information of tank soundings and machinery parameters as required by EOOW

During the watch, a log or record will be taken of the various parameters of main and auxiliary equipment. This may be a manual operation or provided automatically on modern vessels by a data logger.

Fuel consumption figures are used to determine the efficiency of operation, in addition to providing a check on the bunker quantities remaining on board.

Lubricating oil tank levels indicate engine oil consumption. The sump level is checked and recorded, and a gradual fall in level is acceptable as the engine consumes oil during operation.
If the sump level were to rise, this would indicate water leakage into the oil and an investigation into the cause must be made.

The engine exhaust temperatures should all read about the same to indicate an equal power output from each cylinder. The various temperature and pressure values for the cooling water and lubricating oil should be at, or near to, the manufacturer's designed values for the particular speed or fuel lever settings. Any high outlet temperature for cooling water would indicate a lack of supply to that point.

Various parameters for the main engine turbochargers are also logged. Various miscellaneous level and temperature readings are taken of heavy oil tanks, both settling and service, stern tube bearing temperature, sea water temperature, etc.

The operating diesel generators will have their exhaust temperatures, cooling water and lubricating oil temperatures and pressures logged in much the same way as for the main engine. Of particular importance will be the log of running hours since this will be the basis for overhauling the machinery.

Appropriate readings of other auxiliary machinery and equipment, such as heat exchangers, fresh water generator (evaporator), auxiliary boiler, air conditioning plant and refrigeration plant, will also have to be routinely recorded during a watch.

There will usually be summaries or daily account of consumption of heavy oil, diesel oil, lubricating oil and fresh water, which will be compiled at noon. Provision is also made for remarks or important events to be noted in the log for each watch.

The completed log is used to compile a summary sheet or abstract of information which is returned to the company head office for record purposes.

1.1.3.3 Perform watch rounds to verify machinery performance

Automation and alarm systems of machines are always helpful in detecting faults at an early stage. However, it is a fact that human vigilance is more capable of detecting and interpreting errors more accurately. When on engine-room inspection rounds, all machineries on all levels must be examined for proper operation.

1.1.3.4 Describe unusual machinery condition

The condition checking of all machinery installations is carried out during inspection rounds in the engine-room, and watchkeepers should use four of the five human senses.

The sense of hearing is used to ascertain whether abnormal noise occurs during engine operation.

The sense of touch is used to feel accessible critical parts and pipe lines, etc., to determine whether the temperature of the relevant engine part is normal.

By using the sense of smell, it is often possible to detect leakages, overheating of bearings, excessive loads on electrical equipment and cables, etc.

The sense of sight enables: leakages to be noticed; observations to be made concerning the satisfactory working of cylinder lubricators; monitoring of thermometer and manometer readings; to ascertain that the vapour from the crankshaft casing breather pipe is normal (abnormal vapour will arise in the event of hot running of bearings or pistons, or if the lubricating oil contains water), and any other abnormal behaviours of all machinery and equipment in the machinery spaces.
1.2 Contribute to the monitoring and controlling of an engine-room watch

In implementing this section of the course, the instructor should ensure that the trainees have prior and adequate training and experience as ratings, and have demonstrated the ability to perform those tasks required of ratings.

1.2.1 Basic knowledge of the function and operation of main propulsion and auxiliary machinery

1.2.1.1 Working knowledge of the function and operation of propulsion diesel engine

*Describes the operating principles of two-stroke and four-stroke diesel engines*

Instructors should explain the various types, ranges and the operating principles of diesel engines which are installed on board ships as propulsion machinery, including engine configurations such as twin engines, use of gearboxes and controllable pitch propellers.

*Describes the functions of the major parts of two-stroke and four-stroke diesel engines*

Instructors should explain the various parts and functions of the major parts of two-stroke and four-stroke diesel engines, and the safe handling of spare parts.

*Explains how to monitor the safe operation of the propulsion engine according to the parameters specified by the engine manufacturer and/or standing orders*

Instructors should use engine manufacturers’ manuals and real shipboard data to explain how to monitor the safe operation of propulsion engines in accordance with the safe operating parameters specified by the engine manufacturer, and/or Chief Engineers’/Company standing orders.

1.2.1.2 Working knowledge of the function and operation of propulsion diesel engine auxiliary systems

*Explains using diagrams the operation of the propulsion machinery piping systems*

By using real shipboard piping diagrams the instructors should explain the lay-out and operation of the various piping systems connected to two-stroke and four-stroke diesel main engines. An engine-room simulator may assist in this regard.

Piping diagrams that should be discussed are:

- Starting air system
- Fuel oil system (both heavy fuel and diesel oil)
- Lubricating oil system
- High Temperature Fresh Water system
- Low Temperature Fresh Water system
- Sea water system
- Control air system
States pressure, levels and temperature ranges under normal operating conditions for the systems associated to the propulsion machinery

Instructors may use data from engine manufacturers, and when possible, real data from ships' engine-room logbooks, to explain this subject. Trainees should also be made aware of the reasons why these ranges should be maintained.

Describes the preparation of the Main propulsion machinery for Starting

To meet the optimum learning outcome, the trainees should be exposed to a real engine (situated in a laboratory, workshop or in an engine-room) or by using an engine-room simulator. Instructors may show checklists used on board as part of the SMS manual relating to the procedures for starting the main propulsion machinery.

1.2.1.3 Working knowledge of the function and operation of auxiliary diesel engines

Instructors should state and illustrate the layout and function of the diesel generator plant. The emphasis should not only be on the type of engines used for diesel generator sets, but also on the layout of the plant including shaft generators, and explain reasons why there are more generator sets installed on board ships.

States pressure, levels and temperature ranges under normal operating conditions

Instructors may use engine manufacturers’ manuals, and when possible, real data from ships' engine-room logbooks, to support learning of this subject.

Describes the preparation of the auxiliary diesel engines for starting

To meet the optimum learning outcome the trainees should be exposed to a real engine, if possible, or gain knowledge from the use of an engine-room simulator.

An example of a lesson is given in Appendix 1.

1.2.1.4 Working knowledge of the function and operation of auxiliary machinery

Describes the basic functions and operation of the auxiliary machinery in order to monitor their operational condition

Instructors should explain the basic function and operation of each type of auxiliary machinery. The trainees should be able to understand the normal operational conditions of the various machinery installations including the operational ranges and the various parameters concerned.

1.2.1.5 Working knowledge of the function and operation of auxiliary steam boilers

Describes the safe operation of boilers

In this section, instructors should emphasize the importance of gaining a working knowledge of the function and operation of auxiliary steam boilers, and items and parameters the trainees need to monitor during a watch.
1.2.2 Basic understanding of main propulsion and auxiliary machinery control pressures, temperatures and levels

1.2.2.1 Recognize control pressures, temperatures and levels of main propulsion

Instructors should refer to the references for further guidance on this topic.

1.2.2.2 Recognize control pressures, temperatures and levels of auxiliary machinery

Instructors should refer to the references for further guidance on this topic.

1.3. Contribute to fuelling and oil transfer operations

1.3.1 Knowledge of the function and operation of fuel system and oil transfer operations, including

1.3.1.1 Preparations of fuelling and transfer operations

*Explain the fuel oil and lubrication oil transfer piping arrangements of a ship using simple line diagrams*

By using real shipboard pipe line diagrams the instructor may explain the lay-out and operation of the fuel oil and lubrication oil transfer systems.

1.3.1.2 Procedures for connecting and disconnecting fuelling transfer hoses

*Explain the procedures for bunkering and transferring fuel and lubricants*

Instructors should explain the set-up of a bunkering station. Instructors should use checklists from an SMS manual and ship-shore checklists to explain the procedures of a bunkering operation, and for bunkering and transferring fuel and lubricants. The instructors should also explain the relevant MARPOL regulations which are to be followed during bunkering and transferring fuel oils.

In explaining the methods of determining the correct levels in bunker tanks the instructors should emphasize the density – volume ratio of fuel oil and lubricants.

1.3.1.3 Procedures relating to incidents that may arise during fuelling or transferring operation

Instructors should refer to the SMS and ship-shore-ship transfer procedures to explain the procedures to be followed relating to incidents that may arise during fuelling or transferring operations.

1.3.1.4 Securing from fuelling and transfer operations

Instructors should refer to the SMS and ship-shore-ship transfer procedures to explain the procedures to be followed when securing following fuelling and transfer operations.

1.3.1.5 Ability to correctly measure and report tank levels

Instructors should refer to procedures in the SMS and ships' transfer ullage measuring tables to explain the procedures to correctly measure and report tank levels.
1.4. **Contribute to bilge and ballast operations**

1.4.1. **Knowledge of the safe function, operation and maintenance of the bilge and ballast systems, including reporting incidents associated with transfer operations**

1.4.1.1 **Explains with the help of a drawing the piping diagrams of the bilge and ballast systems**

Instructors, where possible, should use actual ships’ drawings to explain the purpose of bilge and ballast systems on board ships.

1.4.1.2 **Demonstrates the safe operating procedure for operating the bilge system**

Instructors should emphasize the correct operating procedures, such as operating one bilge well suction at a time, as well as the need to prime the bilge pump. Instructors should also explain the MARPOL Convention's technical requirements related to the operation of bilge systems.

Instructors should explain the possible incidents that may occur with bilge systems and measures to be taken to prevent such incidents, and also discuss the options available in case a bilge pump fails.

1.4.1.3 **Demonstrates the safe operating procedure for operating the ballast system**

Instructors should explain the correct operating procedures to be followed when using a ballast system. The instructor may briefly mention the Ballast Water Management Plan that is required to be on board.

1.4.1.4 **Demonstrates the maintenance associated with the bilge and ballast systems**

Instructors should discuss the various components of bilge and ballast systems that require maintenance, and explain that the routine maintenance schedule for these systems are included in the SMS manual.

1.4.2. **Knowledge of the safe function, operation and maintenance of the bilge and ballast system, including ability to correctly measure and report tank levels**

1.4.2.1 **Demonstrates ability to correctly measure and report bilge and holding tank levels during and on completion of the operation**

Instructors should refer to the SMS and the ship's tank tables to explain the procedures to be followed to correctly measure bilge and holding tank levels and to report to the officer in charge during, and on completion of, the relevant operations.

1.5 **Contribute to the operation of equipment and machinery**

1.5.1. **Safe operation of equipment, including**

1.5.1.1 **Valves and pumps**
Valves

By using the various piping systems, discuss the various types of valves within piping systems and explain their functions. Instructors explain the operation of the valves and the materials used for the various parts of the valves in relation to the system in which they are fitted.

Instructors should also explain the various types of indicators that are commonly used and the methods to indicate the position of the valve.

Pumps

Instructors should list the different types of pumps fitted on board ships and explain their general operational principals. Instructors should discuss the starting, operating and stopping procedures of each type of pump. Operation of pumps in an engine workshop or simulator may strengthen the understanding of the subject.

1.5.1.2 Hoist and lifting equipment

Describes the Safe operation of hoists and lifting equipment

Instructors should explain to trainees the meaning of Safe Working Load (SWL), and they should be made to understand the need for regular inspection of all hoisting gear, and the influence on the load condition by incorrectly placing slings or chains at an angle.

Instructors should explain the definitions of the specific values of SWL, Working Load Limit (WLL) and Minimum Breaking Strength (MBS) as listed below, and identify the rules and procedures applicable to installations such as winches, windlasses, etc., together with mooring equipment, e.g. mooring wires, synthetic lines, etc.

**SWL:** It is generally considered to be the breaking load of a component divided by an appropriate factor of safety giving a 'safe' load that could be lifted or be carried. Safe working load is one sixth of breaking strength in general, and is one tenth or less of breaking strength when using it to hoist a person.

**WLL:** The maximum mass or force which a product is authorized to support in general service when the pull is applied in-line, unless noted otherwise, with respect to the centreline of the product. The WLL of a component is specified by the manufacturer.

**MBS:** MBS is the minimum amount of force required to break an object, often referred to as tensile strength or breaking strength.

The trainee should gain a working knowledge of the characteristics of different types of mooring and tug lines. The elasticity and breaking stress of various types of mooring lines vary based on the material of the mooring ropes.

Trainees should be made to understand that ships' movements could magnify the dangers associated with hoisting operations.

Instructors may use the publication "Safe Working Practices for Merchant Seafarers" for guidance when presenting this subject.
1.5.1.3 Hatches, watertight doors, ports and related equipment

**Safe operation of hatches, watertight doors, ports and related equipment**

Instructors should make trainees aware of the importance of maintaining watertight and weathertight integrity of the ship, as many incidents of ship capsizing and sinking are due to flooding of ships' cargo spaces resulting in loss of ship stability. All hatches, side/bow/stern doors and portholes, especially those below the main deck of the ship, have to be closed and be watertight/weathertight before departure, and should be maintained as such throughout the voyage. Operation of these equipment and fittings should be in accordance with the manufacturers' operation manuals.

1.5.2. Ability to use and understand basic crane, winch and hoist signals

1.5.2.1 Ability to use and understand basic signals for the operation of equipment

**Ability to use and understand basic crane, winch and hoist signals**

Instructors should refer to the Code of Hand Signals in the Code of Safe Working Practices for Merchant Seafarers for guidance when presenting this section to trainees.
Rating as able seafarer engine

Function 2: Electrical, electronic and control engineering at the support level

INDEX

Part B2: Course Outline
  - Timetable
  - Lectures
  - Course Outline

Part C2: Detailed Teaching Syllabus
  - Introduction
  - Explanation of Information Contained in the Syllabus
  - Tables
  - 2.1 Safe use of electrical equipment

Part D2: Instructor Manual
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. Preparation and planning constitute an important factor which makes a major contribution to the effective presentation of any course of instruction.

Instructors must develop their own timetable depending on the:

- level of skills of trainees;
- numbers to be trained; and
- number of instructors,

and taking into account the normal practices at the training establishment.

■ 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 experience and lessons learned during seagoing time.

An effective manner of presentation is to develop a technique of giving information and then reinforcing it. For example, instructors should share with the trainees briefly what they are going to present; then cover the topic in detail; and, finally, summarize what has been shared with the trainees. The appropriate use of teaching aids such as multimedia equipment and simulation (when available) and providing trainees with adequate course materials will contribute to the teaching and learning processes.

■ 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 for guidance 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

<table>
<thead>
<tr>
<th>Competence:</th>
<th>Total hours of performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory</td>
</tr>
<tr>
<td><strong>2.</strong> Safe use of electrical equipment</td>
<td></td>
</tr>
<tr>
<td><strong>2.1</strong> Safe use and operation of electrical equipment, including</td>
<td>(51 hours)</td>
</tr>
<tr>
<td>.1 Safety precautions before commencing work or repair</td>
<td>(24 hours)</td>
</tr>
<tr>
<td>.2 Isolation procedures</td>
<td>(2 hours)</td>
</tr>
<tr>
<td>.3 Emergency procedures</td>
<td>(3 hours)</td>
</tr>
<tr>
<td>.4 Different voltages on board</td>
<td>(6 hours)</td>
</tr>
<tr>
<td><strong>2.1.2</strong> Knowledge of the causes of electric shock and precautions to be observed to prevent shock</td>
<td>(16 hours)</td>
</tr>
<tr>
<td>.1 Describes the danger of electricity to the human body</td>
<td>(8 hours)</td>
</tr>
<tr>
<td>.2 Demonstrates how to act when a person is in contact with a live wire</td>
<td>(2 hours)</td>
</tr>
<tr>
<td>.3 Demonstrates how to apply medical first aid in case of electrical shock</td>
<td>(2 hours)</td>
</tr>
</tbody>
</table>

**Total for Function 2:** Electrical, electronic and control engineering at the support level 67 hours

Teaching staff should note that the hours for lectures and exercises are suggestions for indicative purposes only as regards sequence and length of time allocated to each learning 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 the knowledge that trainees should gain to be able 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 trainees are required to be proficient. The teaching syllabus shows the required performance expected of trainees in the tables that follow.

In order to assist instructors, 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:

IMO references (indicated by R);
Textbooks (indicated by T); and
Bibliography (indicated by B),

and will provide valuable information to instructors.

Explanation of information contained in the Syllabus Tables

The information in each table is systematically organized as follows. The table describes the FUNCTION to which the training is related. 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 the tasks for which trainees will be responsible on board.

In this model course there are four functions at the support level:

| Function 1:                  | Marine engineering; |
| Function 2:                 | Electrical, electronic and control engineering; |
| Function 3:                 | Maintenance and repair; |
| Function 4:                 | Controlling the Operation of the Ship and Care for Persons on Board. |

Each Function comprises a number of competences and the first column denotes the COMPETENCE concerned. For example, Function 2, Electrical, electronic and control engineering at the support level, comprises a single Competence. Each competence is uniquely and consistently numbered in this model course.

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, which are the areas of knowledge, understanding and proficiency that trainees should be able to demonstrate knowledge and understanding. Each competence comprises a number of training outcomes, for example, the competence Safe use of electrical equipment comprises a total of two training outcomes. Each training outcome is uniquely and consistently numbered in this model course.
Each training outcome embodies a variable number of required performances as evidence of competence. The instruction, training and learning should lead to the trainees meeting the specified required performance. For the training outcome related to Safe use and operation of electrical equipment, there are four areas of performance.

Following each numbered area of required performance there is a list of activities that trainees should complete and which collectively specify the standard of competence that the trainees are required to meet. These are for the guidance of instructors when designing lessons, lectures, tests and exercises to use for the learning process.

IMO References (Rx), Textbooks (Tx), and Bibliography (Bx) relevant to the training outcomes and required performances are placed immediately following the title.

The Syllabus Tables are organised to match the competences in table A-III/5 of the STCW Code. It is not intended that lessons are organised to follow the sequence of required performances listed in the Tables. However, what is necessary is that all the material is covered to cover the required knowledge, understanding and proficiency for the competences related to the Functions, and that learning is effective to enable the trainees to meet the standard of the required performance standard.
COMPETENCE 2.1 Safe use of electrical equipment

<table>
<thead>
<tr>
<th>TRAINING OUTCOMES:</th>
<th>IMO Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STCW Code Table A-III/5</td>
</tr>
</tbody>
</table>

Demonstrates a knowledge and understanding of:

2.1.1 SAFE USE AND OPERATION OF ELECTRICAL EQUIPMENT

2.1.2 KNOWLEDGE OF THE CAUSES OF ELECTRIC SHOCK AND PRECAUTIONS TO BE OBSERVED TO PREVENT SHOCK

COMPETENCE 2.1 Safe use of electrical equipment

2.1.1 SAFE USE AND OPERATION OF ELECTRICAL EQUIPMENT

IMO references: R1, R2, R4, R6
Bibliography: B1,
Textbooks: T5, T7, T8, T12, T13

Required Performance:

1.1 Safety precautions before commencing work or repair

- Describes the typical electrical installation on board of modern ships
- Demonstrates the reading of:
  - Voltage indicators / voltage meters / voltage testers
  - Ampere indicators / ampere meters / ampere testers
  - Kilo Watt (kW) meter / power indicators (power meters) in switch boards
  - Resistance meters / resistance meters / resistance testers
  - Earth fault meter
- Describes the functions of the components of a direct on line motor starter circuit:
  - fuses
  - main breaker
  - operating push buttons
  - signal lamps
  - main contactor
  - safety devices
  - ground wires
Demonstrates the safe operational procedures to start an electric motor circuit:

- at starting AC motor draws up to eight times more current than normal running;
- precautions are taken so that motor is not overloaded at starting e.g. centrifugal pump discharge valve needs to be closed when starting motor driven centrifugal pump; and
- Since it takes more current at starting, precautions must be taken to avoid overloading of generator while starting a large motor.

- States the importance of the Five Safety Rules, using the correct tools and personal protective equipment (PPE) when working on electrical systems

1.2 Isolation procedures

- States the importance of isolation procedures
- Follows shipboard work permit procedures
- Observes and fully applies the Five Safety Rules

1.3 Emergency procedures

- Describes emergency procedures for electrical equipment and circuits in different situations/incidents
- States how to detect and report electrical hazards and unsafe equipment

1.4 Different voltages on board

- States the nominal voltages used on board ships:
  - main systems
  - auxiliary systems
  - emergency systems
  - alarm system
- States the difference of ships with low voltage and ships with high-voltage installations
- Describes the dangers associated to High-Voltage Installations
COMPETENCE 2.1 Safe use of electrical equipment

2.1.2 KNOWLEDGE OF THE CAUSES OF ELECTRIC SHOCK AND PRECAUTIONS TO BE OBSERVED TO PREVENT SHOCK

IMO references: R1, R2, R4, R6
Bibliography: B1,
Textbooks: T5, T7, T8, T12, T13

Required Performance:

2.1 Describes the danger of electricity to the human body
   - describes the danger of touching open wire
   - understands the danger of conduction by moisture or water
   - describes the danger of defective insulation of electrical installations and equipment to the human body, e.g. electric motor with less than the mandatory minimum insulation resistance, defective or broken cable insulation
   - observes the precautions which shall be taken when handling electrical equipment
   - understands safety low-voltage for portable lighting and electrical hand tools
   - considers the threshold levels of current that will cause shock, loss of motor control, injury or death

2.2 Demonstrates how to act when a person is in contact with a live wire
   - ensures their own safety
   - raises an alarm, shouts for help
   - uses emergency stop or power off switch
   - removes victim using rescue hook
   - provides first aid
   - informs Officer in charge

2.3 Demonstrates how to apply medical first aid in case of electrical shock

Instructors should refer to IMO model course 1.14 on Medical First Aid for further guidance when presenting this section.
Part D2: Instructor Manual

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

Instructors should make trainees aware of the need for, and gain an understanding of, the practical measures required when performing shipboard operations related to the safe use of electrical equipment.

Function 2: Electrical, electronic and control engineering at the support level

This function covers the theory and practice of electrical, electronic and control engineering at the support level necessary for the safe use of electrical equipment on board a ship.

On completion of training for this function, trainees should be able to provide effective support to the EOOW during the engineering watch and communicate accordingly.

2.1 Safe use of electrical equipment

In implementing this section of the course, instructors should ensure that trainees have prior and adequate training, competence and experience as ratings, and have demonstrated the ability to perform tasks required of ratings.

2.1.1 Safe use and operation of electrical equipment

Trainees should have gained knowledge to achieve the competence to monitor the automated systems of a ship.

Trainees should be able to:

- determine, from circuit diagrams and other manufacturer's documentation, the control system components to be used as well as the sequence of operation for the controls of different tool technologies (electrical engineering, hydraulics and pneumatics);
- apply the principles and the safety regulations of electrical engineering, electrical machine building, and control technology and explain simple circuit diagrams (basic circuits) within the various tool technologies;
- measure and calculate electrical and physical value, and have knowledge of the types of errors and of protective measures in electrical circuits; and
- plan and understand the set-up and start-up procedures of the controls system, while ensuring safe working practices.

2.1.1.1 Safety precautions before commencing work or repair

Describes the typical electrical installations on board of modern vessels

Instructors should be able to use the general layout of a ship's electrical generating and distribution plant using single line electrical drawings, drawings, plans, sketches and photographs of typical electrical installations on board modern vessels when presenting this section.
Instructors should explain through theoretical and practical lessons, the basics of electro technology for trainees to be able to differentiate between Direct Current (DC) and Alternating Current (AC). Starting with simple electrical circuits, instructors should introduce conducting, non-conducting and dielectric material, direct voltage sources, switches and different power consumers, e.g. lamp, resistor, coil, capacitor.

Instructors should explain Ohm’s law to enable trainees to be able to assemble electric circuits, perform measurements and evaluate them. Following this, instructors should introduce alternating current and voltage sources.

Trainees should have knowledge and understanding to assemble electric circuits and perform measurements. During evaluation, trainees should be able to recognize that the above mentioned consumers except resistors show different operating behaviour.

These lessons should be continued with lectures on:

- generation of alternating voltage;
- diodes;
- electronic components; and
- function principle of a generator producing three-phase alternating voltage

**Demonstrates the reading of electrical meters and indicators**

As part of the lessons, instructors should explain the concepts of voltage, ampere and resistance. Instructors could use pictures/simulators/computer-based training to demonstrate to trainees how to obtain correct readings of the above, and it is highly recommended to use working models and examples of switchboards together with related equipment. In this context, trainees need to learn the application and safe use of handheld voltage, ampere and resistance meters.

Trainees should gain an understanding of the different devices and methods for the measurement of voltage, ampere, resistance and power, and the correct usage and adjustment of measurement devices to obtain correct results.

**Describes the functions of the components of a direct on-line electric motor starter circuit**

Instructors should explain the basic function of an asynchronous motor and further explain asynchronous motor starting systems, e.g.:

- star-delta starting
- slip-ring motor starting
- soft starter starting/slackening
- frequency converter starting

**Demonstrates the safe operational procedures to start a direct on-line electric asynchronous motor**
Instructors should explain how an asynchronous motor draws up to eight times more current during direct on-line starting than during normal operation.

The trainees should learn, through theoretical lessons, and practical exercises on a working model of an asynchronous motor driving a centrifugal pump, the necessary precautions to be taken to ensure that an electric motor is not overloaded at starting, for example:

- to close the discharge valve of a centrifugal pump before starting the asynchronous motor driving a centrifugal pump;
- to check the delivery pressure indicator; and
- to open the delivery valve slowly.

Since an asynchronous motor draws a high current at starting, different asynchronous motor starting systems are employed on board in order to prevent overloading of generators and ship’s grid while starting large motors.

States the importance of the Five Safety Rules, using the correct tools and PPE when working on electrical systems

Instructors must emphasize that:

- modern ship operations systems have established procedures and processes for risk analysis, briefing, de-briefing and issuance of work permits by the Officer in charge of the work;
- particular maintenance tasks are carried out observing the Five Safety Rules;
- responsibilities, duties, work location and sequence of working steps are defined clearly; and
- unauthorised crew members are not permitted to enter the work location.

2.1.1.2 Isolation procedures

Describe the isolation procedures and precautions to be taken before maintenance or repairs on electrical equipment or system can commence, such as:

- briefing of tasks involved by the Engineer in charge;
- relevant Work Permit issued by the Engineer in charge;
- activating stand-by installation;
- observing the Five Safety Rules during the isolation of low-voltage electrical equipment. Additional precautions have to be taken with regard to high-voltage (>1000 V) electrical equipment:
- disconnecting from the power supply the installation to undergoing maintenance;
- take the necessary precautions to prevent closing of the isolating switches, e.g.:
• post appropriate warning notices on the operating elements used for the disconnection
• lock the isolation switches by mechanical devices
• remove fuses using the appropriate tools and personal protective equipment, and store in a safe place

– test for the absence of voltage
– ground and short-circuit the parts of the electrical equipment to be maintained at the work location
– protect adjacent live parts with covers and barriers, and post suitable warning notices

State the reasons of earth bonding of the electrical equipment

Trainees should gain relevant knowledge and understanding in theoretical lectures and practical exercises to be able to effectively apply the Five Safety Rules.

2.1.1.3 Emergency procedures

Instructors should explain: how to detect and report electrical hazards and unsafe equipment; the typical visual checking procedure that every user of (electrical) equipment, tools etc., should perform; failures of equipment; and precautions to be taken when defects are identified in equipment.

Instructors should inform trainees about possible incidents and emergency situations relating to electrical equipment, such as:

– black out, but emergency generator does not start;
– fire next to installation;
– machinery running hot; and
– plant draws excessive current

Trainees should gain knowledge and understanding of, and the ability to, describe different emergency procedures in connection with electrical installations and equipment.

2.1.1.4 Different voltages on board

States the nominal voltages used on board ships

Instructors should explain the typical nominal voltages used on board ships:

– main switchboard
– emergency switchboard
– electrical grid with different voltages
– generators
– electrical consumers, e.g. lighting, emergency lighting, electric motors, transformers, battery chargers and connections for electrical devices
– various types of alarms systems
– various types of detectors, sensors, switches, plugs, etc.
– various types of fuses
States the difference of Low-Voltage and High-Voltage installations

Instructors should explain and illustrate the typical electrical installations on board merchant ships and passenger vessels, and low-voltage and high-voltage installations.

Trainees should have the ability to recognise Low-Voltage and High-Voltage installations, and have an understanding of basic functions of the different installations, and to adapt their working procedures according to the particular installation.

Describes the dangers associated to High-Voltage installations

Instructors should explain and illustrate the basic function of a high-voltage grid on board, together with the main parts of this installation.

Trainees should understand the means of protection against electric shock that are fitted as part of the installation.

Trainees should have a clear understanding of the strict rules for the work on high-voltage installations, and that any maintenance has to be done after an appropriate briefing and the issuance of a work permit by the Officer in charge.

Trainees should also understand that the Five Safety Rules that apply to high-voltage installations should be observed when particular maintenance tasks are carried out, and responsibilities, work location and sequence of working steps should be defined clearly, and unauthorised crew members should not be permitted to enter the work location.

Trainees should also understand that any incorrect actions may lead to consequences such as severe burning, death, explosion and fire due to the resulting high-voltage arc flashes.

An example of a lesson is given in appendix 1.

2.1.2 Knowledge of electrical shock and precautions to be observed to prevent shock

2.1.2.1 Describes the danger of electricity to the human body

The effect of electric shock can lead to severe injuries and could also be fatal, e.g.:

- Burns due to the warmth at the entrance and exit site of the current;
- Chemical effects of electricity can lead to the decomposition of electrolytes such as blood, sweat or saliva; and
- Electricity impacts muscles when flowing through a human body. Muscle cramps usually start at a shock current level of 20 mA; as a consequence, the concerned person will not be able to free his or her hand from the electrical source device. The final effect of a shock current that flows through a human body will be a ventricular fibrillation.

Some typical sources that could trigger possible electric shocks in working areas could be:

- perspiration of crew members due to high engine-room temperatures;
- wet deck surfaces; and
- metal plating of ships.
Explain the different kinds of protection equipment and protective measures in electrical devices on board.

2.1.2.2 Demonstrates how to act when a person is in contact with a live wire

Instructors should explain to trainees, and observe their performance of, exercises of common safe working procedures and possible action when a person comes in contact with a live wire.

2.1.2.3 Demonstrates how to apply medical first aid in case of electrical shock

Instructors should refer to Model Course 1.14 on Medical First Aid and table A-VI/4-1 of the STCW Code, when presenting this section.

Instructors should further explain that any person who has suffered an electric shock has to be:

- monitored closely because the impact of the electric shock on the body and especially on the heart often shows hours after the accident; and

- examined soonest by a doctor in the next port of call.
Rating as able seafarer engine

Function 3: Maintenance and Repair at the support level

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Part D3: Instructor Manual
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. Preparation and planning constitute an important factor which makes a major contribution to the effective presentation of any course of instruction.

Instructors must develop their own timetables depending on the:

- level of skills of trainees;
- numbers to be trained; and
- number of instructors,

and taking into account the normal practices at the training establishment.

■ 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 experience and lessons learned during seagoing time.

An effective manner of presentation is to develop a technique of giving information and then reinforcing it. For example, instructors should share with the trainees briefly what they are going to present to the trainees; then cover the topic in detail; and, finally, summarize what has been shared with the trainees. The appropriate use of teaching aids such as multimedia equipment and simulation (when available), and providing trainees with adequate course materials, will contribute very much in the teaching and learning processes.

■ 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 for guidance only, and should be adapted to suit individual groups of trainees depending on their experience, ability, equipment and staff available for training.
## COURSE OUTLINE

### 3.

<table>
<thead>
<tr>
<th>Knowledge, understanding and proficiency</th>
<th>Total hours of performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory</td>
</tr>
</tbody>
</table>

#### Competence:

3.1. Contribute to shipboard maintenance and repair

3.1.1. Knowledge of surface preparation techniques

- .1 Prepare steel for coating (3 hours) (3 hours)

3.1.2. Ability to use painting, lubrication and cleaning materials and equipment

- .1 Clean and maintain paintwork and engine surfaces (2 hours)
- .2 Use of rust removers
- .3 Understands different coating sequences (1 hour)
- .4 Prepare and apply paint or protective coatings (2 hours)
- .5 Select and use correct fluids, lubricants or grease (6 hours) (2 hour) (1 hour)

3.1.3. Ability to understand and execute routine maintenance and repair procedures

- .1 Understand maintenance schedules and maintain equipment on engine (4 hours)
- .2 Join and secure components (1 hour)
- .3 Stow equipment and leave working areas clean, tidy and safe (1 hour)

3.1.4. Understanding Manufacturer’s safety guidelines and shipboard instructions

- .1 Understand typical shipboard safety regulations (1 hour)
- .2 Use personal protective equipment (1 hour)
- .3 Use of chemicals on board (1 hour)
- .4 Ventilate interior and enclosed spaces during and after painting (1 hour)

3.1.5. Knowledge of safe disposal of waste materials

- .1 Understand there are strict rules for the prevention of pollution covering disposal at sea applicable to all ships (2 hours)
- .2 Follow correct procedures for disposal of paint residues, solvents, sweepings and other chemicals in use (1 hour)
- .3 Operate waste handling equipment as required (1 hour)

3.1.6. Knowledge of the application, maintenance and use of hand and power tools and measuring instruments and machine tools

- .1 Correct use of equipment (2 hours) (2 hours)
- .2 Selection and use of appropriate measuring equipment (4 hours)
- .3 Select correct hand-, power- or machine tools (4 hours) (22 hours)
- .4 Use of welding equipment (4 hours) (20 hours)
3.1.7. Knowledge of metalwork 

- .1 Metals and their properties (2 hours)
- .2 Technical drawing (4 hours) (8 hours)
- .3 Metrology (4 hours) (10 hours)
- .4 Fits and tolerances (2 hours)
- .5 Laying out (2 hours) (3 hours)
- .6 Bench work tools (4 hours)
  - Bench work exercises (76 hours)
- .7 Principles of mechanical cutting (3 hours)
- .8 Drilling (3 hours) (5 hours)
- .9 Cutting threads with taps and dies (1 hour) (3 hours)
- .10 Sharpening tools (1 hour) (3 hours)
- .11 Cutting with power tools (1 hour) (3 hours)
- .12 Welding 
  - Common welding processes (2 hours)
  - Welding processes in various positions (4 hours) (40 hours)
  - Identification of welding defects (2 hours) (2 hours)
- .13 Oxy-acetylene cutting (1 hour) (3 hours)
- .14 Brazing (1 hour) (3 hours)

Total for Function 3: Maintenance and Repair at the support level 288 hours

Teaching staff should note that the hours for lectures and exercises are suggestions for guidance only, as regards sequence and length of time allocated to each objective. These factors may be adapted by instructors to suit individual groups of trainees depending on their experience, ability, 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 the knowledge the trainee must gain to be able 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 trainees are required to be proficient. The teaching syllabus shows the required performance expected of trainees in the tables that follow.

In order to assist instructors, 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:

- IMO references (indicated by R);
- Textbooks (indicated by T); and
- Bibliography (indicated by B),

which will provide valuable information to instructors.

Explanation of information contained in the Syllabus Tables

The information on each table is systematically organized in the following way. 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 professional tasks and responsibilities on board.

In this Model Course there are four functions at the support level:

Function 1: Marine engineering;
Function 2: Electrical, electronic and control engineering;
Function 3: Maintenance and repair; and
Function 4: Controlling the operation of the ship and care for persons on board.

The first column denotes the COMPETENCE concerned. Each function comprises several competences. For example, Function 3, Maintenance and repair at the support level, comprises a single Competence. Each competence is uniquely and consistently numbered in this model course.

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 seven training outcomes. Each training outcome is uniquely and consistently numbered in this model course.
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 knowledge of surface preparation and painting techniques there is one area of performance.

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 instructors in designing lessons, lectures, tests and exercises for use in the teaching process.

IMO References (Rx), Textbooks (Tx) and Bibliography (Bx) relevant to the training outcome and required performances are placed immediately following the title.

The Syllabus Tables are organised to match the competences in table A-III/5 of the STCW Code. It is not intended that lessons are organised to follow the sequence of required performances listed in the Tables. However, what is necessary is that all the material addresses the required KUPs for the competences related to the Functions, and that learning is effective to enable the trainees to meet the standard of the required performance standard.
<table>
<thead>
<tr>
<th>COMPETENCE 3.1</th>
<th>Contribute to shipboard maintenance and repair</th>
<th>IMO Reference</th>
</tr>
</thead>
</table>

TRAINING OUTCOMES:  

Demonstrates a knowledge and understanding of:

3.1.1  KNOWLEDGE OF SURFACE PREPARATION TECHNIQUES  
3.1.2  ABILITY TO USE PAINTING, LUBRICATION AND CLEANING MATERIALS AND EQUIPMENT  
3.1.3  ABILITY TO UNDERSTAND AND EXECUTE ROUTINE MAINTENANCE AND REPAIR PROCEDURES  
3.1.4  UNDERSTANDING MANUFACTURER'S SAFETY GUIDELINES AND SHIPBOARD INSTRUCTIONS  
3.1.5  KNOWLEDGE OF SAFE DISPOSAL OF WASTE MATERIALS  
3.1.6  KNOWLEDGE OF THE APPLICATION, MAINTENANCE AND USE OF HAND AND POWER TOOLS  
3.1.7  KNOWLEDGE OF METALWORK
COMPETENCE 3.1  Contribute to shipboard maintenance and repair

3.1.1  KNOWLEDGE OF SURFACE PREPARATION TECHNIQUES

IMO references:  R1, R2, R4, R6,
Bibliography:  B1
Textbooks:  T2, T5, T7

Instructors could refer to Paint manufacturers' manuals when presenting this section.

Required Performance:

1.1  Prepare steel for coating

- states the importance of proper surface preparation for coating;
- describes the function of the tools used for surface preparation from manual chipping hammer up to powered scaling equipment;
- demonstrates the maintenance of the tools used for surface preparation;
- demonstrates the use of the tools used for surface preparation; and
- demonstrates personal protective equipment.
COMPETENCE 3.1   Contribute to shipboard maintenance and repair

3.1.2 ABILITY TO USE PAINTING, LUBRICATION AND CLEANING MATERIALS AND EQUIPMENT

IMO references: R1, R2, R4, R6,
Bibliography: B1
Textbooks: T2, T5, T7

Instructors could refer to Paint manufacturers' manuals when presenting this section.

Required Performance:

2.1 Clean and maintain paintwork and engine surfaces
   - states that cleaning and degreasing agents are harmful and may be corrosive;
   - describes product data sheets and uses PPE; and
   - describes cleaning and maintenance of paintwork and engine surfaces.

2.2 Use of rust removers
   - states that rust removers are harmful, acidic and corrosive;
   - describes the properties of the chemicals;
   - describes product data sheets and strictly follows the instructions; and
   - demonstrates the use of PPE with additional and eye and skin protection.

2.3 Understand different coating sequences
   - describes different coating sequences; and
   - states the importance of following manufacturers’ instructions.

2.4 Prepare and apply paint or protective coatings
   - states the importance of preparing the paint before application;
   - describes the application of paint;
   - demonstrates application by brush;
   - demonstrates application by roller;
   - demonstrates application by spray painting equipment; and
   - states that certain parts in engine-room may not be painted.
2.5 Select and use correct fluids, lubricants or grease

- describes selection and use of correct fluids, lubricants or greases;
- describes typical lubrication plans;
- demonstrates selecting and using grease gun or lubricating equipment;
- demonstrates the understanding that certain moving parts may not be painted or greased;
- checks oil levels using dipsticks, sight glasses etc., before starting engines or plants and on regular basis;
- fills up the right lubrication oil as necessary after consulting the Officer in charge; and
- demonstrates the understanding of the negative effects of too low or too high lubrication oil level.
COMPETENCE 3.1 | Contribute to shipboard maintenance and repair

3.1.3 ABILITY TO UNDERSTAND AND EXECUTE ROUTINE MAINTENANCE AND REPAIR PROCEDURES

IMO references: R1, R2, R4, R6,
Bibliography: B1
Textbooks: T2, T5, T7

Required Performance:

3.1 Understand maintenance schedules and maintain equipment in engine-room

− describes the different schedules applicable for inspection, lubrication and overhaul of lifting and mechanical equipment;
− demonstrates visual inspection before using equipment;
− describes procedures for testing of lifting appliances and mechanical equipment;
− describes assembly drawings, general arrangement drawings and parts lists;
− learns about the assembly and function of relevant machinery;
− describes the relevant systems of tolerances and fits;
− demonstrates the selection and use of appropriate machines and tools according to the task and taking into account functional and technological criteria;
− demonstrates selection of appropriate materials for carrying out particular tasks; and
− demonstrates work steps including cutting and welding.

3.3 Join and secure components

− describes securing components with screws, nuts and locking elements;
− states that material and strength of screws and nuts have to be selected as necessary;
− describes the use of torque wrenches; and
− describes the maintenance of threads

3.4 Stow equipment and leave working areas clean, tidy and safe

− describes stowing equipment and clean up working site on completion of work.
### COMPETENCE 3.1  Contribute to shipboard maintenance and repair

#### 3.1.4 UNDERSTANDING MANUFACTURER’S SAFETY GUIDELINES AND SHIPBOARD INSTRUCTIONS

IMO references:  R1, R2, R4, R6,
Bibliography:  B1
Textbooks:  T2, T5, T7

**Required Performance:**

#### 4.1 Understand typical shipboard safety regulations
- describes safety guidelines on board;
- describes ship’s permit to work system; and
- describes enclosed space entry routines.

#### 4.2 Use personal protective equipment
- demonstrates knowledge of personal protective equipment and their standards;
- describes the need to use correct personal protective equipment; and
- demonstrates choosing correct personal protective equipment.

#### 4.3 Use of chemicals on board
- states that paints may contain toxic or irritant substances and their hazards;
- states that chemicals may give rise to flammable and potentially explosive vapours;
- describes the stowage of the chemicals on board; and
- describes product data sheets and uses PPE.

#### 4.4 Ventilate interior and enclosed spaces during and after painting
- describes the importance of ventilation of interior spaces during and after painting;
- describes the importance of ventilation of enclosed spaces during and after painting with special regard to the enclosed spaces procedures on board; and
- demonstrates the choosing and installation of portable ventilation equipment with regard to safety.
COMPETENCE 3.1  Contribute to shipboard maintenance and repair

3.1.5  KNOWLEDGE OF SAFE DISPOSAL OF WASTE MATERIALS

IMO references:  R1, R2, R4, R6,
Bibliography:  B1
Textbooks:  T2, T5, T7

Required Performance:

5.1  Understand there are strict rules for the prevention of pollution covering disposal at sea applicable to all ships

– states the rules for proper disposal of waste materials; and
– demonstrates the proper disposal of defective parts and used auxiliary materials, taking into account of environment protection (recycling) regulations.

5.2  Follow correct procedures for disposal of paint residues, solvents, sweepings and other chemicals in use

– describes the correct procedures for proper disposal of waste materials.

5.3  Operate waste handling equipment as required

– describes the procedures for operating waste handling equipment; and
– demonstrates the precautions to be taken during these operations.

Instructors should refer to Model Course 1.38 on Marine Environmental Awareness for further information when presenting this section.
**COMPETENCE 3.1**

Contribute to shipboard maintenance and repair

3.1.6 KNOWLEDGE OF THE APPLICATION, MAINTENANCE AND USE OF HAND AND POWER TOOLS AND MEASURING INSTRUMENTS AND MACHINE TOOLS

IMO references: R1, R2, R4, R6,
Bibliography: B1
Textbooks: T2, T5, T7

Required Performance:

6.1 **Correct use of equipment**

- describes assembly drawings, general arrangement drawings and parts lists;
- demonstrates an understanding of the assembly and function of the machinery;
- demonstrates the selection and use of the machine tools according to the task taking into account functional and technological criteria; and
- states that defective machine tools must be taken out of use, marked and reported to the responsible officer.

6.2 **Selection and use of appropriate measuring equipment**

- demonstrates the selection and use of appropriate measuring equipment; and
- describes the relevant systems of tolerances and fits.

6.3 **Select correct hand-, power- or machine tools**

- demonstrates the selection and use of machine tools according to the task taking into account functional and technological criteria;
- demonstrates the selection and use of correct types of drill bits, cutting blades, abrasive wheels, etc.;
- demonstrates safe working practices for using power tools;
- demonstrates the preparations for manufacturing of components that are typical of their profession by means of hand-operated tools; and
- demonstrates the preparations for manufacturing of components that are typical of their profession by means of machine tools.

6.4 **Use of welding equipment**

- demonstrates correctly setting-up and operating welding equipment;
- describes the safety precautions when operating welding equipment especially with regard to fire prevention;
- selects materials (ferrous metals, non-ferrous metals and plastics) and auxiliary materials considering their specific characteristics and assign them to the respective components; and

- demonstrates work steps for cutting and welding and assesses the results.
COMPETENCE 3.1  Contribute to shipboard maintenance and repair

3.1.7  KNOWLEDGE OF METALWORK

IMO references:  R1, R2, R4, R6,
Bibliography:  B1
Textbooks:  T2, T5, T7, T14

Required Performance:

7.1  Metals and their properties

- Classification of metals;
- Identification of metals;
- Properties of metals; and
- Shapes and sizes of metal.

7.2.  Technical Drawing

- Introduction to technical drawing;
- Types of lines;
- Drawing paper with title block;
- Basic rules; and
- Drawing in three elevations.

7.3.  Metrology

- Metric measurement system;
- Imperial measurement (inches) system;
- Introduction to metrology;
- Common measuring tasks; and
- Measuring equipment.

7.4.  Fits and ISO tolerances

- Limits and fits; and
- Classes of fits.

7.5.  Laying out

- Laying-out tools and accessories; and
- Laying-out procedures.
7.6. **Bench work tools**
- Work bench;
- Bench vice;
- Hand hacksaw;
- Chisel tools;
- Files; and
- Hammer.

7.7. **Principles of mechanical cutting**
- Classification of metal cutting processes; and
- Cutting tool angles.

7.8. **Drilling**
- Drill presses;
- Twist drills;
- Different drill press operations; and
- Drill press safety rules.

7.9. **Cutting threads with taps and dies**
- Main parts of a screw thread;
- Hand tapping; and
- Threading dies.

7.10. **Sharpening tools**
- Bench grinder or pedestal grinder;
- Sharpening tools; and
- Safety precautions while using bench grinder or pedestal grinder.

7.11 **Cutting with power tools**

7.12 **Welding**
- Common welding processes;
- Welding processes in various positions; and
- Identification of welding defects.

7.13 **Oxy-Acetylene Cutting**

7.14 **Brazing**
Part D3: Instructor Manual

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

This function covers the theory and practice of maintenance and repair at the support level, including knowledge and skill of:

- Surface preparation techniques;
- Painting, lubrication and cleaning materials and equipment;
- Routine maintenance and repair procedures;
- Manufacturer's safety guidelines and shipboard instructions;
- Safe disposal of waste materials;
- Knowledge of the application, maintenance and use of hand and power tools, measuring instruments and machine tools; and
- Knowledge of metalwork.

Function 3: Maintenance and Repair at the support level

In addition to the task description, the following aspects are important within the framework of the training:

- Application of relevant norms and legal provisions as well as work safety regulations;
- Specific focus on the safety of the ship, work safety, health protection, and first-aid measures; and
- Environmental protection and efficient use of energy and materials as well as the communication and nautical terminology during the ship's operation as part of the learn areas in an integral manner.

On completion of training for this function, trainees should be able to carry out safely and efficiently shipboard maintenance and repair tasks such as:

- Surface preparation by chipping and painting;
- Maintenance of windlass, winches, blocks, chocks and other moving parts on engine;
- Executing routine maintenance and repair procedures;
- Understanding manufacturer's safety guidelines and shipboard instructions;
- Operating waste handling equipment disposing waste materials;
- Selecting and using hand and power tools and measuring instruments and machine tools correctly;
- Maintaining hand and power tools and measuring instruments and machine tools; and
- Carrying out metalwork, arc welding, gas welding, gas cutting and brazing.
3.1 Contribute to shipboard maintenance and repair

3.1.1 Knowledge of surface preparation techniques

3.1.1.1 Prepare steel for coating

**Understanding the importance of proper surface preparation for coating**

Proper surface preparation is essential for the success of any marine coating system. The proper application of any paint coating is directly dependent upon the correct and thorough preparation of the surface prior to coating. The most expensive and technologically advanced coating system will fail if the surface preparation is incorrect or incomplete. The importance of removing oil, grease, old coatings, rust and other surface contaminants cannot be overstressed.

**Having working knowledge of the tools used for surface preparation**

Loosely adhering rust and old paint coatings may be removed from steel by hand wire brushing, sanding, scraping and chipping with wire brushes scrapers, chipping hammers etc. These methods may leave a layer of tightly adhering rust on the steel surface. Power tool cleaning is generally more effective and less laborious than hand tool cleaning for the removal of loosely adhering paint and rust. Although, power wire brushes, impact tools (such as needle guns), grinders and sanders are all commonly used, the cutting actions of grinding discs would be the preferred choice.

**Having knowledge of personal protective equipment**

Many injuries are attributed to workers not wearing proper protective clothing when carrying out these duties. To expose the skin during chipping is also dangerous because rusts and chips of irons could spread at high speed. Even if it is hot, wear long-sleeved working wears. Always carefully read and completely follow the safety procedures and instructions recommended by manufacturers of surface preparation devices, application equipment, media or products and work site safety measures. Most commonly used personal protective equipment include:

- **Chipping goggles**: These are important to protect the eyes, especially for chipping work;
- **Dust mask**: It is used to prevent inhaling dust of a certain size, because the fine particles of 0.1 to 0.5 micron in size are harmful to lungs, particularly when an air hammer or air chisel is used;
- **Earplugs**: These are for noise preventive purposes. Earmuffs are a type of earplugs that cover the whole ears. Wearing both earplugs and earmuffs is highly effective; and
- **Vibration-proofing gloves**: Such gloves should always be worn when a vibrating device such as an air hammer is being used.

3.1.2 Ability to use painting, lubrication and cleaning materials and equipment

3.1.2.1 Clean and maintain paintwork and engine surfaces

**Basic knowledge of cleaning and maintenance of paintwork and engine surfaces**
The main purpose of marine paintwork is to protect the steel underneath. However, the paintwork itself should be protected in the first place. Impact and scratching would damage the physical structure of paintwork, scrubbing the surface or the use of an abrasive or strong cleaning agent also might burnish the paint surface and mar the paint finish, all of which should be avoided.

**Basic knowledge of cleaning and degreasing agents**

Cleaning agents are substances (usually liquids, powders or sprays) used to remove dirt, including dust, stains, bad smells and clutter on surfaces. Some of the cleaning agents are of a corrosive nature; their usage should be avoided or limited.

### 3.1.2.2 Use of rust removers

**Understand the properties of the chemicals**

Since paints, including rust removers, generally employ solvents with a low flash point, they emit flammable vapour at ambient temperature, and are in a state which combustion is liable to occur at all times. The vapour of solvents is heavier than air and accumulates at engine level.

Solvents have a property to irritate the skin or mucous membranes, and cause headaches. They also cause intoxication. Since solvents dissolve fats, they may cause dry skins or dermatitis, with risk of burns to eyes, skin and respiratory tract.

**Working knowledge of protective measures**

Precautions must be taken into account, as follows:

- Avoid contact with eyes, skin or clothing. In case of contact, rinse the area for at least 15 minutes. Remove contaminated clothing and shoes, wash thoroughly before reuse. Get immediate medical attention if irritation persists.

- Ensure adequate ventilation. When ventilation is limited, wear an appropriate breathing apparatus in order to avoid breathing solvent fumes.

- Do not eat, drink or smoke in work area. Wash hands thoroughly after use.

- Eye washers should be prepared with 1% to 2% boric acid solution so that the painters can wash their eyes at any time if necessary. If some foreign matter gets into the eye it should be removed by washing; rubbing does not clear it away. If the injury is slight, rinse your eyes in water and use eye ointment.

### 3.1.2.3 Understand different coating sequences

**Basic knowledge of coating sequences**

In a typical protective paint coating sequence, three types of coatings are used: a primer, an intermediate coat and a topcoat. Each coating 'layer' in any protective system has a specific function. Incorrect sequence of a paint coating will result in deteriorated protective function and reduced performance or complete failure of the paintwork.
Importance of following manufacturers’ instructions

Manufacturers have specified coating sequence for some coatings, and this should be ensured under such circumstances, so that the proper product is used for different layers of coatings, as instructed by the manufacturers.

3.1.2.4 Prepare and apply paint or protective coatings

Understanding the importance of preparing the paint before application

Trainees should gain knowledge of the preparation of the paint to be applied according to manufacturers’ instructions.

Having working knowledge of brush application

Application of paint by brushes is recommended for patch priming and repair work to ensure good wetting of the substrate. This is essential when painting over manually prepared surfaces.

The choice of brush will depend upon the required application and quality of finish to be achieved. Flat square-end brushes, often called wall brushes, are used on flat areas, while angular cut 'sash' brushes are used on narrow surfaces, and round or elliptical section brushes are used on irregular shapes such as nuts and bolts. Brushes with angled heads and long handles are used for painting the backs of stiffening bars and other inaccessible areas in tanks.

Brushes should not be dipped into the paint more than half the length of their bristles; the aim is to load the brush with enough paint to get some work done, but not too much so the paint drips and splatters. The applied paint should be spread evenly using smooth, steady strokes then smoothed by light parallel strokes to eliminate irregularities. On flat, vertical surfaces, it is best to finally lay off the paint in a vertical direction because this will reduce the tendency of the paint to run or sag. Particular attention should be paid in ensuring that the applied paint is brushed into the bottom of pitted areas of steel and that the edges of nuts etc., are well coated.

Having working knowledge of roller application

Rollers are useful for applying paint to large flat areas such as tank tops, vertical sides, walkways and engine areas. Roller application requires less skill from painters than brush application. The most common roller fabrics used are lambswool and mohair.

When applying paint, immerse the roller into the paint tray, roll it in the paint until fully saturated, and then roll it back and forth on the tray ramp to remove all excess material. This not only avoids the problems of drips and spatters, but ensures that the roller is fully wetted and that air is removed from the fibres. Pitted areas should be touched up by brush before roller application.

The following table gives a simple comparison between brush and roller paint application:

<table>
<thead>
<tr>
<th></th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brush</strong></td>
<td>Good for small, complex areas</td>
<td>They require more coats to achieve film thickness</td>
</tr>
<tr>
<td></td>
<td>Inexpensive equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minimal wastage</td>
<td></td>
</tr>
<tr>
<td><strong>Roller</strong></td>
<td>Faster than brushing</td>
<td>They require more coats to achieve correct film thickness</td>
</tr>
<tr>
<td></td>
<td>Good for large flat areas</td>
<td>Possibility of uneven film thickness</td>
</tr>
</tbody>
</table>
Gain working knowledge of spray application process

In spray application, the paint is atomized into fine droplets and projected onto the surface to be protected where the droplets join together to form a continuous film. The atomization can be accomplished in a number of ways.

In air spraying, the paint is atomized by mixing it with a stream of compressed air in a conventional spray gun. The paint can be either sucked into the air stream (as in the simple suction cup gun used for application to small areas) or fed to the spray gun under pressure from a pressure pot. For ideal application, careful adjustments of the spray nozzle and air pressures must be made by a skilled operator, according to the consistency and composition of the paint product and the film thickness required.

For airless spraying, the paint is hydraulically compressed and, on release through a small orifice in an airless spray gun, it is atomized and projected onto the surface. By changing the orifice size and shape and by varying the hydraulic pressure, atomization can be accomplished for a wide range of paint consistencies from thin to thick, to give a wide range of rates of deposition.

After operation, the paint spraying equipment should be treated as follows:

- Wash the unit by circulating fresh thinner slowly for about 15 to 20 minutes;
- Remove the suction filter and material filter, and clean them;
- Wash the nozzle sufficiently in the thinner. If it is expected to be used within a few days, it should be soaked in thinner; and
- When the system is not expected to be used for a long time, the valve ball of the material cylinder should be cleaned and oiled to prevent it from jamming.

Having basic working knowledge of applying paint

Never mix excessive thinner. Otherwise, in the case of painting of walls, paint tends to drip and prohibits obtaining a thick coat.

Distribute the paint well and even, and avoid applying too heavy a film thickness causing through-drying problems and wrinkling. It is always better to apply two thin coats than one thick coat.

The painting sequence should be from the far side to the near side, from top to bottom, and the complicated places should be painted first.

3.1.2.5 Select and use correct fluids, lubricants or grease

Working knowledge of lubricating moving parts of engine equipment

All engine equipment exposed to weather must be lubricated to ensure protection against wear and weather elements. All moving parts of the system must be working freely, and sufficiently greased or oiled. The maintenance and lubrication of heavy engine equipment, such as winches, cranes and anchor windlasses, should be carried out regularly.
Basic knowledge of selecting and using correct fluids, lubricants or grease

When selecting and using correct fluids, lubricants or grease, several factors should be taken into account, such as service temperature range, speed, extreme pressure, fretting etc. In general, the instructions of manufacturers of the equipment to be lubricated or greased must be followed.

Working knowledge of selecting and using grease gun or lubricating equipment

A grease gun is a common tool used for lubrication. The purpose of the grease gun is to apply lubricant through an aperture to a specific point, usually on a grease fitting or ‘nipple’. The channels behind the grease nipple lead to where the lubrication is needed. The aperture may be of a type that fits closely with a receiving aperture on any number of mechanical devices. The close fitting of the apertures ensures that lubricant is applied only where needed. The grease gun is charged or loaded with any of the various types of lubricants, but usually a thicker, heavier type of grease is used.

Different types of grease guns demand different ways of operation:

- Hand-powered, where the grease is forced from the aperture by back-pressure built up by hand cranking the trigger mechanism of the gun, which applies pressure to a spring mechanism behind the lubricant, thus forcing grease through the aperture.

- Hand-powered, where there is no trigger mechanism, and the grease is forced through the aperture by the back-pressure built up by pushing on the butt of the grease gun, which slides a piston through the body of the tool, pumping grease out of the aperture.

- Air-powered (pneumatic), where compressed air is directed to the gun by hoses, the air pressure serving to force the grease through the aperture.

Working knowledge of lubricating the wires

Wire rope is a flexible, tough, complex and versatile type of equipment made up of numerous strands of individual wires, used to transmit mechanical power. During normal usage, these wires are subject to torsion, bending, tension and compression stresses. To achieve maximum performance and life, lubrication of the wire rope structure must be maintained so that coordinated sliding action between individual wires permits equitable distribution of the stresses. Good lubrication offers protection against corrosion and minimizes metal-to-metal contact between individual wires while reducing wear on the rope, and on the drum and sheaves over which it operates.

All exposed wires must be covered with some surface coating for protection against the weather. Wire rope for running rigging, such as lifeboat falls, crane wires, winch runners and mooring wires, must be covered with a mixture that provides lubrication as well as protection against the weather. A preparation of graphite and grease makes an excellent covering for running wire if no prepared mixture is on hand.
3.1.3 Ability to understand and execute routine maintenance and repair procedures

3.1.3.1 Understand maintenance schedules and maintain equipment in engine-room

For schedules, requirements and other details, trainees should refer to ships’ planned maintenance systems. When the planned maintenance system indicates that a particular machine or item is due for attention, all routine maintenance such as greasing, testing etc., should be done.

Different schedules applicable for inspection, lubrication and overhaul of lifting and mechanical equipment

Trainees should gain knowledge through practical exercises and manufacturers’ manuals, as well as companies' planned maintenance systems, and perform typical maintenance procedures accordingly.

Working knowledge of procedures for testing of lifting appliances and mechanical equipment

Trainees should be able to describe typical testing procedures for lifting appliances and associated accessories.

3.1.3.3 Join and secure components

Basic knowledge of securing components with screws, nuts and locking elements

Trainees should gain knowledge through practical exercises and manufacturers' manuals, to be able to use different bolts, nuts and respective locking devices. With regard to bolted connections and locking elements, all securing devices must be certified according to manufacturer’s specific requirements and standards.

Be familiar with the use of torque wrenches

Trainees should gain knowledge through practical exercises and manufacturers’ manuals, to be able to use torque wrenches, hydraulic tools and other torque applying devices.

Be familiar with the maintenance of threads

Trainees learn in practical lessons using manufacturers' manuals for maintenance of screw threads, e.g.:

- Protect protruding threads from rust;
- Put securing caps tightly to the threaded sleeve on the receptacle to ensure full pin contact; and
- Apply copper paste, ceramic paste or MoS2 as necessary.
3.1.3.4  Stow equipment and leave areas clean, tidy and safe

**Basic knowledge of stowing equipment and clean up working site on completion of work**

Keeping work places and tool stores in good order is important not only for increasing work efficiency but also for preventing accidents. As a matter of principle, the following should be observed on completion of work:

- Check that the work area is clear, or clean up before leaving;
- Dispose waste materials safely;
- Check for slip/trip hazards;
- Check that tools are safe to use before returning them to the storage area or report defects for repair;
- Return safety equipment to the correct storage area;
- Protectors and detectors should be stored so that they can be rapidly used during an emergency;
- Isolate power supplies when not in use to eliminate the risk of electric shock, fire or equipment malfunction;
- Unnecessary equipment and tools should be removed, leaving the work area in a safe and tidy condition.

3.1.4  Understanding manufacturer’s safety guidelines and shipboard instructions

3.1.4.1 Understand typical shipboard safety regulations

**Safety guidelines on board**

Various references formulated by industry sectors, shipboard equipment manufacturers and international organizations, such as the International Labour Convention (Guidelines for Implementing Occupational Safety and Health Provisions) provide safety guidance for personnel working on board. These guidelines are based on practical experiences and lessons learned from ship-related accidents, incidents and near-miss reports, and therefore facilitate safe working practices on board.

**Knowledge of ship’s permit to work system**

The ISM Code requires the company to establish procedures for safety management systems on board, and relevant processes and guidance for safe practices in ship operation, and a safe working environment. This is commonly addressed by a permit-to-work system, which consists of an organized and pre-defined safety procedure.
A permit-to-work does not in itself make the job safe, but contributes to measures for safe working practices. The following points should be taken into account when formulating such a permit:

- The permit should:
  - be relevant and as accurate as possible. It should state the location and details of the work to be done, the nature and results of any preliminary tests carried out, the measures undertaken to make the job safe and the safeguards that need to be taken during the operation; and
  - specify the period of its validity (which should not exceed 24 hours) and any time limits applicable to the work which it authorizes;
- Only the work specified on the permit should be permitted and undertaken.
- Before signing the permit, the authorizing officer should ensure that all necessary measures specified have been taken.
- The authorizing officer retains responsibility for the work until either the permit is cancelled or formally transferred to another authorized person who should be made fully conversant with the situation. Anyone who takes over, either as a matter of routine or in an emergency, from the authorizing officer, should sign the permit to indicate transfer of full responsibility;
- The person responsible for carrying out the specified work should countersign the permit to indicate understanding of the safety precautions to be observed;
- On completion of the work, the person responsible for carrying out the specified work should notify the responsible officer and get the permit cancelled; and
- The person carrying out the specified work should not be the same person as the authorizing officer.

**Enclosed space entry routines**

Appropriate guidelines have been issued by the IMO (for safe entry into enclosed spaces, and to facilitate the selection of portable atmosphere testing instruments for enclosed spaces as required by SOLAS regulation XI-1/7) and the Standard P & I Club’s loss prevention programme for safety procedures for entry into enclosed spaces on board ships. This guidance will prove useful to plan the lessons on this topic.

They include guidance and information about enclosed space hazards, risk assessment, entry procedures, duties and responsibilities, securing the space for entry, ventilation, testing the atmosphere, entry and rescue equipment, entry permit, completion and permit closure, rescue from an enclosed space, training and checklists.

For more information on these publications, please visit IMODOCS at [www.imo.org](http://www.imo.org) or the Standard Club at [www.standard-club.com](http://www.standard-club.com/news-and-knowledge/publications/loss-prevention-publications/masters-guides/).
3.1.4.2 Use personal protective equipment

**Personal protective equipment**

Each crew member should use correct personal protective equipment (PPE) at work. PPE is equipment that will protect the user against health or safety risks at work. It can include items such as safety helmets, gloves, eye protection, high-visibility clothing, safety footwear and safety harnesses. It also includes respiratory protective equipment (RPE).

**Use the correct personal protective equipment**

Even where engineering controls and safe systems of work have been applied, some hazards might remain.

These hazards may include injuries to:

- Lungs, e.g. from breathing in contaminated air;
- Head and feet, e.g. from falling materials;
- Eyes, e.g. from flying particles or splashes of corrosive liquids;
- Skin, e.g. from contact with corrosive materials;
- Body, e.g. from extremes of heat or cold.

Therefore, personal protective equipment is necessary in these cases to reduce the risk.
# Choosing the correct personal protective equipment

The following table lists the factors to be taken into account when choosing the correct personal protective equipment.

<table>
<thead>
<tr>
<th>Hazards</th>
<th>Options</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eyes</strong></td>
<td>Chemical or metal splash, dust, projectiles, gas and vapour, radiation</td>
<td>Safety spectacles, goggles, face screens, face shields, visors</td>
</tr>
<tr>
<td><strong>Head and neck</strong></td>
<td>Impact from falling or flying objects, risk of head bumping, hair getting tangled in machinery, chemical drips or splash, climate or temperature</td>
<td>Industrial safety helmets, bump caps, hairnets and firefighters’ helmets</td>
</tr>
<tr>
<td><strong>Ears</strong></td>
<td>Noise – a combination of sound level and duration of exposure, very high-level sounds are a hazard even with short duration</td>
<td>Earplugs, earmuffs, semi-insert/canal caps</td>
</tr>
<tr>
<td><strong>Hands and arms</strong></td>
<td>Abrasion, temperature extremes, cuts and punctures, impact, chemicals, electric shock, radiation, vibration, biological agents and prolonged immersion in water</td>
<td>Gloves, gloves with a cuff, gauntlets and sleeve that cover part or all of the arms</td>
</tr>
<tr>
<td><strong>Feet and legs</strong></td>
<td>Wet, hot and cold conditions, electrostatic build-up, slipping, cuts and punctures, falling objects, heavy loads, metal and chemical splash, vehicles</td>
<td>Safety boots and shoes with protective toecaps and penetration-resistant, mid-sole wellington boots and specific footwear, e.g. foundry boots and chainsaw boots</td>
</tr>
<tr>
<td><strong>Lungs</strong></td>
<td>Oxygen-deficient atmospheres, dusts, gases and vapours</td>
<td>Respiratory protective equipment (RPE) Some respirators rely on filtering</td>
</tr>
</tbody>
</table>
**Whole body**

<table>
<thead>
<tr>
<th>Contaminants from workplace air. These include simple filtering face pieces and respirators and power-assisted respirators</th>
<th>Losing consciousness due to exposure to high levels of harmful fumes, only use breathing apparatus – never use a filtering cartridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat, chemical or metal splash, spray from pressure leaks or spray guns, contaminated dust, impact or penetration, excessive wear or entanglement of own clothing</td>
<td>Conventional or disposable overalls, boiler suits, aprons, chemical suits</td>
</tr>
<tr>
<td>The choice of materials includes flame-retardant, anti-static, chain mail, chemically impermeable, and high-visibility. Don't forget other protection, like safety harnesses or life jackets</td>
<td></td>
</tr>
</tbody>
</table>

Apart from the right choice of PPE and its careful maintenance, regular and realistic operator training is needed to facilitate proper use equipment such as compressed-air escape breathing apparatus, respirators and safety ropes or harnesses during emergencies.

### 3.1.4.3 Use of chemicals on board

It is important to know characteristics of each paint to be used in order to carry out painting effectively and safely. It is advisable to follow company instructions and/or paint maker’s instructions when using paint and thinner.

Since paints generally employ solvents with a low flash point, they emit flammable vapours at ambient temperature, and are in a state which combustion is liable to occur at all times. The vapour of solvents is heavier than air and accumulates at engine level. Solvents also have a property to irritate the skin or mucous membranes, causing headaches and even intoxication. Since solvents dissolve fats, they may cause dry skins or dermatitis.

Depending on the type of coating being applied, the solvent-based materials can pose more significant fire dangers.

### 3.1.4.4 Ventilate interior and enclosed spaces during and after painting

Solvent-based paints can pose a health and safety hazard if there is little or no ventilation during the application. People with allergies can be subjected to health related responses ranging from mild asthma to severe headaches over a relatively short period. This can even come about when using paints containing the weaker hydrocarbon solvents like Stoddard solvent and mineral spirits, which are found in most interior alkyls. Low odor solvents like paraffinic naphtha can be particularly dangerous as they are difficult to smell even at relatively high concentrations. Ventilation is also a method of keeping the concentration of potentially explosive vapours from paints below the lower explosive limit. Therefore, when applying paints on interior surfaces it is important to consider adequate ventilation and fresh airflow in the enclosed spaces.

To maximize safety and the film forming properties of a paint applied to an interior surface, a moderate air flow can be the least expensive tool.
3.1.5 Knowledge of safe disposal of waste materials

3.1.5.1 Understand there are strict rules for the prevention of pollution covering disposal of waste materials at sea applicable to all ships

Ships produce waste materials in normal operation and some may contain harmful or hazardous materials or pollutants. The waste materials produced by the engine department include dunnage, packaging and lashing materials, oil residues, residual paints or solvents and chemical cleaning agents, etc. The disposal of these waste materials should strictly follow the company SMS, relevant conventions such as MARPOL 73/78 Convention and IMDG Code, and applicable local regulations.

3.1.5.2 Follow correct procedures for disposal of paint residues, solvents, sweepings and other chemicals in use

Waste paints, solvents and chemicals are combustible and pollutants, and should not be stored freely or dumped into the sea. They should be collected for storage or recycled for re-use by specialized organizations ashore, in compliance with respective disposal procedures. For example, the disposal of ship trash or sweepings should strictly follow the regulations of Annex V of the MARPOL Convention.

3.1.5.3 Operate waste handling equipment as required

**Basic knowledge of operating waste handling equipment**

Trainees should gain practical knowledge of waste handling equipment using manufacturers’ manuals and ships’ equipment operational instructions.

Trainees should demonstrate the use of disposal equipment for ship waste materials, in particular, trash compactors and incinerators.

**Precautions**

Ventilation is essential to rid oil vapour inside before using incinerators to prevent explosion. When the chamber reaches a certain temperature, use waste oil pump to load waste oil and remaining oil into the incinerator. When the incinerator works well, stop tinder oil, otherwise use diesel oil to keep the burner working. No flammable goods should be introduced into the incinerator when it is running to prevent accidents. Ash from the incinerator is prohibited discharging into sea. The ash should be landed ashore, and record the quantity in the Garbage Record Book.

3.1.6 Knowledge of the application, maintenance and use of hand and power tools and measuring instruments and machine tools

3.1.6.1 Correct use of equipment

Trainees should gain knowledge of the properties of mechanical tools to ensure that the use of these tools should not exceed the designed purposes, and not cause damage to the tools or injury to personnel.
**Safe working practices for using hand tools**

Trainees should make preparations for turning out components by means of hand-operated tools. To do this, they should analyze general arrangement drawings and simple technical drawings (Assembly drawings, functional descriptions, and production plans).

Trainees should prepare, among other things, partial drawings and sketches for components of functional units and simple assemblies, and develop and amend lists of components and work plans, with the help of application programmes.

On the basis of the theoretical principles (Tolerances, general tolerances) of the technologies to be applied, trainees should plan the work steps with the necessary tools, materials (characteristics of metallic materials, ferrous metals), semi-finished products, and aids, and determine the technical data and carry out the necessary calculations.

Trainees should select suitable test media, operate them, and prepare the respective test certificates, and try out selected work steps (separate, reshape, calibrate, measure and test) and present their work results.

The safe working practice for using a hand tool depends on the type of tool being used. The following table lists the safe working practices for several commonly used hand tools.

<table>
<thead>
<tr>
<th>Type of tool</th>
<th>Description</th>
<th>Proper work practices</th>
</tr>
</thead>
</table>
| Wrenches     | Wrenches come in an endless variety of styles such as socket, open-end, combination, adjustable and torque, to name a few. Wrenches are designed to turn or hold bolts, nuts or multiple-threaded fasteners. They are sized to keep the leverage and load in an acceptable balance. | • Choose a wrench that properly fits the fastener you wish to turn. Use metric wrenches for metric bolts and American inch wrenches for inch-sized bolts; by using the correct size, the wrench is less prone to slip or round off the fastener corners.  
• Avoid using an extension to improve the leverage of a wrench  
• Do not use open-end or adjustable wrenches for final tightening or loosening frozen fasteners - These wrenches do not have the strength of a box-end or socket wrench  
• Apply penetrating oil on frozen fasteners before using a striking face box, socket or heavy-duty box wrench  
• Do not expose a wrench to temperatures that could weaken tool hardness  
• Always try to pull on a wrench (instead of pushing) in case the fastener loosens  
• Adjustable wrenches must be adjusted tightly to the fasteners and then pulled, putting the force on the fixed end  
• Turn power off and use electrically insulated wrenches when working on or around electrical components  
• Never alter a wrench  
• Do not over torque a fastener - Use a torque wrench to tighten the fastener to the exact torque required.  
• Inspect wrenches periodically for damage, such as cracking, severe wear or distortion |
<table>
<thead>
<tr>
<th>Type of tool</th>
<th>Description</th>
<th>Proper work practices</th>
</tr>
</thead>
</table>
| Pliers            | Pliers come in all shapes and sizes, such as lineman, diagonal cutting, needle nose, slip joint, locking tongue and groove. Plier uses include gripping, cutting, turning and bending. Pliers are a versatile tool, but must be used according to how they are designed. | - Always use non-sparking wrenches when in the presence of flammable vapours or dusts  
- Do not increase a pliers handle length to gain more leverage, instead choose larger sized pliers  
- Never subject pliers to temperatures that could decrease tool hardness  
- Cut hardened wire only with pliers designed for that purpose  
- Do not substitute pliers for a wrench when turning nuts and bolts  
- Be sure the pliers' jaws can grasp properly when bending rigid wire  
- Do not hammer with pair of pliers  
- Cut wire at right angles without bending wire back and forth against the cutting edge of a pliers  
- Always use non-sparking pliers when in the presence of flammable vapours or dusts |
| Hammers and Striking Tools | Hammers are one of the most used tools in our tool boxes. Nail, soft-face, ball-peen, chipping, sledge and setting are just a few of the hammers we use in the workplace and home. Many hammer types are specific to a particular industry, such as bricklayers, machinists and loggers. Each kind of hammer has a head that is tailored to work best for a particular application. Hammer handles are now made stronger, ergonomically shaped and transmit less shock to the user. | - Always use a hammer of the proper weight and size for the task  
- Do not strike the surface at an angle - the hammer face should contact the striking surface squarely, so the two are parallel  
- Do not use a hammer if the handle is damaged or loose  
- Use a hammer face that is 3/8" larger in diameter than the striking tool  
- Never weld, heat or regrind a hammer head  
- Remove from service any hammer exhibiting signs of excessive wear, cracks, mushrooming or chips  
- Do not use one hammer to strike another  
- Do not use the wrong hammer for the job: match the proper type of hammer to the task it is designed to perform  
- Always use non-sparking hammers in the presence of flammable vapours or dust |
| Screwdrivers      | Screwdrivers are intended for turning a variety of threaded fasteners, such as machine or wood screws, in or out of materials. Screwdriver tips come in a variety of different shapes and sizes. The slotted and Phillips tips are the most common, however, torx, | - Never use a screwdriver as a pry bar, chisel, punch, stirrer or scraper.  
- Always use a screwdriver tip that properly fits the slot of the screw  
- Throw away screwdrivers with broken or worn handles  
- Never expose screwdrivers to temperatures that could reduce tip hardness  
- Turn power off and use electrically insulated screwdrivers when working on or around electrical components  
- Straighten tips or redress rounded edges with file |
<table>
<thead>
<tr>
<th>Type of tool</th>
<th>Description</th>
<th>Proper work practices</th>
</tr>
</thead>
</table>
| hex, square and various others are also used. It is important to match the type of screwdriver you use to the type of job you’re doing. | • Never use pliers on a screwdriver for extra leverage; only use a wrench on screwdrivers specifically designed to accept them  
• Use magnetic or screw-holding screwdrivers to start fasteners in tight areas  
• Use both hands when using a screwdriver - one to guide the tip and the other to turn the handle. Final tightening requires both hands on the screwdriver handle  
• Always use non-sparking screwdrivers in the presence of flammable vapours or dusts | |

The type of PPE needed when using hand tools depends on the tool being used. As a minimum, protectors such as safety glasses or goggles must be worn at all times for eye protection. The simple act of snipping copper wire with side-cutting pliers, striking a nail with a hammer or sawing wood can propel small pieces of debris into the air.

It is also important to protect the hands from cuts, abrasion and repeated impact. Cut-resistant gloves made of stainless steel can help protect against the effects of a misplaced blade. Wearing standard cotton or leather gloves can help prevent wood splinters or skin abrasions from handling lumber. For tasks that require long periods of hammering, impact-resistant gloves with gel or rubber palms can reduce vibration. Safety shoes with a reinforced toe can help protect your feet from injury caused by a dropped tool. Safety footwear comes in a variety of styles and is widely available. Choose footwear that offers adequate traction for your work site.

**Safe working practices for using powered tools**

Portable power tools are designed for a wide variety of uses. Drills, hammer drills, sanders, grinders and numerous other power tools save us time and effort on the job. The growing popularity of cordless battery-operated tools is putting power tools to use in more places than ever before, heightening the need for awareness of the dangers they present if not operated properly.

Each type of tool has its own unique hazards, which must be taken into account. The following safety rules are common to all power tools:

- Read the manual to understand the tools proper applications, limitations, operation and hazards;
- Do not use electric power tools in the proximity of flammable vapours, dusts or construction materials. Also avoid using electric power tools in wet environments;
- Protect yourself from electric shock by insuring your tools are properly grounded; use a Ground Fault Circuit Interrupter for corded tools;
- Always check for hidden wires that may contact bladed tools;
- Select a tool based on the task for which it is designed;
Only use attachments specifically recommended for your power tools, and ensure their proper installation;

Inspect tools for damage including the cord, presence of guards, correct alignment, binding of components, or any condition that would affect the operation of the tool;

If a tool is damaged, or a condition develops while a tool is in use, have the tool fixed before using it again;

Avoid excessive force to make cutting tools cut faster; feed material only as fast as the tool is designed to accept to prevent excessive wear and decreased control;

Keep others away from the work area, or provide shields to stop flying debris and other distractions;

Do not operate power tools if personnel are under the influence of medications or alcohol, or if they are tired or distracted;

Verify that all tools are unplugged or that the power source is removed when changing blades, performing maintenance or when tools are not in use;

Keep tools in a secure location when not in use;

Avoid unintentional tool start-up by keeping your finger off of the power switch.

Power tools present more hazards than hand tools due to the speed at which they operate. There are distinct differences between the PPE suggested for use with hand tools and those recommended for safe power tool use.

Eye protection, such as safety glasses or goggles, is especially important when using power tools. The speed in which drills, saws, grinders, sanders and routers operate can propel small particles much faster and farther than do hand tools. Others working around the area where power tools are used should also wear protective eyewear. Certain power tools may require using a face shield, in addition to safety glasses or goggles. For example, a face shield is recommended while using a grinder, due to the amount of hot metal particles generated.

Along with PPE, proper attire is also important while using power tools. Tie back or cover long hair, wear loose fitting clothes and remove all jewellery to avoid being caught in moving blades.

**Basic knowledge of making a report and isolating idling equipment**

When defective or damaged equipment is found, it is necessary to report to the responsible Officer for appropriate disposal in accordance with the safety management system, including taking measures to warn of the abnormal state of the equipment to prevent injury or casualty, or damage to the equipment.

Idling equipment not in use should be isolated and its maintenance should be conducted in accordance with the specifications, and lashing and fixing should be rendered to ensure safety.

**3.1.6.2 Selection and use of appropriate measuring equipment**

Measuring equipment commonly used on board include pressure and temperature gauges, and gas measuring equipment, which are available onboard for checking the pressure, temperature of a specific location and the concentration of explosive or toxic gases or vapours.
All measuring equipment must be maintained in good working order and calibrated annually as per the planned maintenance system.

Personnel using measuring equipment should always follow instructions in the operation manuals on board and manufacturer's recommendations regarding its specific operation and maintenance.
3.1.6.3 Select correct hand, power or machine tools

**Principle of tool selection**

Tools commonly used on board include hand tools such as hammers and wrenches, and power tools such as pneumatic, hydraulic or electric equipment. The greatest hazards posed by those tools result from misuse and improper maintenance. Tools selected must be ergonomic, and a tool becomes “ergonomic” only when it fits the task you are performing and it fits your hand without causing awkward postures, harmful contact pressures or other safety and health risks. If you select and use a tool that does not fit your hand, or use the tool in a way it was not intended, you might develop an injury such as carpal tunnel syndrome, tendonitis or muscle strain. These injuries do not happen because of a single event, but result from repetitive movements performed over time. These repetitive movements may result in damage to muscles, tendons, nerves, ligaments, joints, cartilage, spinal discs or blood vessels.

Therefore, before picking up a tool and beginning to work, always think about the requirements of the job, and select tools designed for the intended and specific use purpose. Always avoid using a tool for something other than its intended purpose, and assess the work space to determine which tool will work efficiently and safely in that space.

**Selection of correct type of drill bit, cutting blade, abrasive wheel etc.**

The selection of correct drill bits, cutting blades and abrasive wheels, etc., is essential for accomplishing an intended specific task. Because different projects have different needs, drill bits, for example, come in a variety of shapes and are made from different materials based on the tasks they are designed to perform. Choosing the wrong drill bit can lead to structural flaws in the project, broken bits and even damaged drills. Selecting a bit that is made from the right material will help ensure the hole drilled has a smooth edge and that none of the equipment being used is damaged in the process. The best way to determine what drill bit is right for the job is to have an understanding of all the available types and make an informed decision based on that understanding.

3.1.6.4 Use of welding equipment

**Basic knowledge of correctly setting and operating welding equipment**

All welding and other equipment used for hot work should be carefully inspected before each use to ensure that it is in good condition. In principle, instructions in the welder's manual, which in general includes a chart for setting the heat (amperage) range for the thickness of the metal to be welded, should be strictly followed. If a wire feed welder is used, this chart will also suggest a wire speed setting. Minor adjustments for the best possible weld bead may be necessary. Some new welders automatically make the proper heat and wire speed settings once the operator dials in the thickness of the metal.

**Precautions when operating welding equipment**

When using welding equipment it should be ensured that:

- Existing supply wiring is adequate to carry the electrical current demand without overloading, where required, it must be correctly earthed;
- Insulation of the electric cables is in good condition;
- The welding return lead should be connected as near as practicable to the welding arc; and
Metal rails, pipes and frames should not be used as part of the welding circuit unless they are a part of the work piece itself.

3.1.7. Knowledge of metalwork

For further information instructors should refer to T14.

3.1.7.1 Metals and their properties

Classification of metals

Trainees shall divide metals into:
- ferrous metals;
- non-ferrous metals; and
- non-ferrous alloys.

Identification of metals

Trainees shall identify metals by one of the following four methods:
- their appearance;
- spark testing;
- manufacturer's stamp; or
- a colour code painted on the bar.

Properties of metals

Trainees should be familiar with the following metallic properties:
- Physical Properties;
- Mechanical-Technological Properties;
- Manufacturing-Technological Properties; and
- Chemical Property.
Shapes and sizes of metal

Metals are manufactured in a wide variety of shapes and sizes, and trainees should be familiar with the different shapes and sizes.

There is a method for specifying the sizes and dimensions of metal when ordering:

- **Flat-bar:** Thickness × Width × Length
- **Round-bar:** Diameter × Length
- **Square-bar:** Width × Length
- **Angle-bar:** Thickness × Width × Length
- **Hexagon-bar:** Diameter × Length (or Distance Across Flats × Length)
- **Pipe:** Diameter × Schedule × Length # 20 is thinner than # 40
- **Square-tubing:** Thickness × Width × Length
- **Channel-Bar:** Width × Height × Length
3.1.7.2. Technical drawing

For further information, exercises, pictures and details, instructors should refer to T14.

Trainees should be able to read and produce a technical drawing, and understand that a technical drawing is the language used for technical communication.
**Introduction into technical drawing**

Instructors should introduce trainees to:

- Basic drawing equipment;
- Drawing paper sizes; and
- Scale size.

**Types of lines**

Instructors should introduce the various standard line styles and widths.

**Drawing paper with title block**

Instructors should introduce the drawing with title block

![Drawing with title block](source: T14)

**Basic rules**

Trainees should learn that:

- Dimensions are entered in millimetres (mm) without measures;
- Dimension lines must have a distance of about 10 mm from the object edge and 7 mm from parallel dimension lines;
- The dimensions should be placed above the dimension lines and should be staggered;
- Dimensions must be either read from below or from the right;
- For small dimensions the arrows are placed outside;
- Symmetrical work pieces are dimensioned symmetrical to the centre line which extends 2 - 3 mm beyond the object edge;
- Simple work pieces are mostly drawn in front elevation only;
- If an elevation in which the area of a circle appears as a straight line is to be dimensioned, the diameter symbol is to be placed in front of the dimension figure;
- If the circle is shown in the elevation, then it is not necessary to draw the diameter symbol;
- The diameter is shown by two dimension arrows on the circumference or drawn on the extension lines of the circle. In these cases no diameter symbol will be used;
- A radius is symbolized by R and has only one dimension arrow at the circumference. The centre point is fixed by the crossing of centre lines;
- Concealed edges are drawn as dash lines;
- The length of each dash depends on the size of the drawing;
- Dash lines start and end with a dash at the object edges;
- If visible and concealed edges coincide, the visible edges are draw;
- Section views are used to show the interior form of an object that could not be shown clearly by conventional methods;
- The section areas are shaded, not the hollow spaces;
- The smaller the section area the closer the shading lines are;
- In order to insert dimension figures the shading has to be broken;
- The shading lines are thin unbroken lines, which are angled at 45 degrees to the centre line or angled to the base edge;
- Assembled work pieces are identified by opposite or varied shading;
- Section areas of one object are always shaded in the same direction;
- The outer diameter of a bolt thread is drawn as an object line, the core diameter as a thin unbroken line;
- The distance between the thick and thin lines represents the thread diameter;
- Looking in direction of the shaft end, the core diameter appears as a three-quarter circle in any position;
- The ends of screws are normally 45 degree chamfered;
The core diameter of the internal thread is drawn as an object line, the outer diameter as a thin unbroken line;

All lines of concealed thread are drawn as invisible edges. The thin three-quarter circle becomes a full circle shown in broken line; and

To be dimensioned are: Outer diameter (e.g. M 10 or UNC ¾) Useful length of thread Length of shaft with end, or respectively depth of core hole without drill cone.

**Drawing in three elevations**

Trainees should understand that sometimes it is necessary to draft work pieces in three elevations to show all important parts of it.

### 3.1.7.3. Metrology

For further information instructors should refer to T14.

**Metric measurement system**

The metric system uses the meter and linear units based on the meter as its standard of measure. All multiplies and subdivisions of the meter are directly related to the meter by a factor of ten. This makes it easy to use the decimal system for calculations involving metric units.

**Imperial measurement (Inch) system**

Unlike the Metric System, within the Imperial System there is no relationship of other linear units to the base inch unit. The values of yard, rod, mile, etc., have to be learned in order to use them. The inch can be dived in halves (1/2), quarters (1/4), eighths (1/8), sixteenth (1/16), thirty-seconds (1/32), sixty-fourth (1/64), tenth, hundreds, thousandth, ten-thousands etc.

**Introduction to metrology**

Trainees should understand that engineering metrology is defined as the measurement of dimensions: length, thickness, diameter, taper, angle, flatness, profiles and others.

An important aspect of metrology in manufacturing processes is dimensional tolerances. That is, the permissible variation in the dimensions of a part. Tolerances are important not only for proper functioning of products, they also have a major economic impact on manufacturing costs. The smaller we make the tolerances, the higher the production costs. These and related aspects of tolerances and tolerancing are described later on in this course.

**Common measuring tasks**

Instructors should introduce trainees to the common measuring tasks such as:

- Inside - Outside
- Height - Depth
- Diameter
- Distance
Trainees should understand that a modern industrial fabrication could not function without precise measuring equipment.

Proper care of measuring tools and instruments is very important to maintain the accuracy and quality of these tools. Precision measuring tools and instruments should be treated with care.

Instructors should introduce trainees to the following measuring equipment:

- Outside radius gauge
- Inside radius gauge
- Angle form gauge
- Limit snap gauge
- Thread gauge
- Angle form gauge
- Limit plug gauge
- Outside thread-ring gauge
- Inside thread-plug gauge
- Inside and outside calipers
- Vernier caliper
- Simple protractor
- Universal bevel protractor
- Dial caliper
- Digital caliper
- Digital micrometer
- Dial gauge
- Steel rule
Trainees should be familiar with the use of vernier calipers, which are precision measuring instruments used to make internal, external and depth measurements. Both metric and imperial systems are available.

The precision depends on the vernier scale. Common types provide an accuracy of either 0.05 mm or 0.02 mm.
The example below shows an accuracy of 0.05 mm.

How to read a Metric Vernier Caliper (accuracy 0.05 mm):

.1 The last numbered division on the bar to the left of the zero on the vernier scale represents the number of millimetres. In the example above the #2 (20 mm) is the last number left of the zero on the vernier scale.

.2 Count the graduations between the last number (#2) and the zero on the vernier scale. In the example above there are eight (8 mm) graduations between the #2 and the zero on the vernier scale.

.3 Locate the line on the vernier scale that aligns with a bar line. Divide the number below the line by 10. In the example above it is the line with #7 (7/10=0.7 mm).

.4 The measurement in the example above is 20 mm + 8 mm + 0.7 mm = 28.7 mm

3.1.7.4. Fits and tolerances

For further information, exercises, pictures and details, instructors should refer to T14.

Limits and fits

Trainees should understand that for all mating parts to fit each other, they should be fabricated within certain limits of nominal dimension.

Classes of fits

Instructors should introduce trainees to the following classes of fits:

- Force Fit (Interference Fit)
- Transition Fit
- Loose Fit (Clearance Fit)
3.1.7.5. Laying out

For further information, exercises, pictures and details, instructors should refer to T14.

Trainees should understand that laying out is the operation of scribing centre locations, straight lines, arcs, circles or contour lines on the surface of a piece of metal to show the machinist the finished size and shape of the part to be manufactured.

The information regarding the size and shape of parts is taken from a technical drawing. The care and accuracy of the layout plays an important role in determining the accuracy of finished parts, since the machinist uses these layout lines as a guide for machining.

**Layout tools and accessories**

<table>
<thead>
<tr>
<th>Tools &amp; Accessories</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Plate or Marking Table</td>
<td>Is a plate or a table made of cast iron or of granite. It must be adjusted horizontally. Its surface must be perfect plane to ensure accurate scribing. To bring work pieces to the correct position on the marking table there are some other devices like prism, angle plate, V-Blocks and Parallels.</td>
</tr>
<tr>
<td>Steel Rule</td>
<td>Steel rules are the most common linear measuring tools and are available in the metric or inch system. Metric rules are graduated in both millimetres and half-millimetres. Some rules are available with both inch and millimetre graduation.</td>
</tr>
<tr>
<td>Scriber</td>
<td>A scriber is a layout tool used for drawing layout lines on a work piece. They are made of tool steel with hardened and tempered points. It is important that the point of the scriber be as sharp as possible to produce clear, thin layout lines.</td>
</tr>
<tr>
<td>Centre Punch</td>
<td>Normally ground to an angle of 90 degree. Before drilling a hole, the centre must be punched. To make a line more visible for cutting or oxy-acetylene cutting it is helpful to punch the line.</td>
</tr>
<tr>
<td>Solid Square or Try-Square</td>
<td>Is used for laying out work piece in combination with steel rule and scriber. It is also used to check the angles and the surfaces for flatness.</td>
</tr>
<tr>
<td>Divider</td>
<td>The divider is used to transfer length or circles to the work piece. Dividers are available with and without fixing devices.</td>
</tr>
<tr>
<td>Protractor</td>
<td>A simple protractor has a measuring range from 0 to 180 degree. The measuring error is around one degree.</td>
</tr>
<tr>
<td>Surface Gauge or Vernier Height Gauge</td>
<td>Is normally used in combination with a surface plate and an angle plate to mark parallel lines. Using the simple type, the height can be adjusted with a steel rule.</td>
</tr>
<tr>
<td>Angle Plate</td>
<td>An angle plate is a precision L-shaped tool usually made of hardened steel. All its surfaces are ground to an accurate 90-degree angle, and are square and parallel. It is used to support work pieces on a 90-degree angle during the layout process.</td>
</tr>
<tr>
<td>V-Blocks or Prism</td>
<td>It is an accurate fabricated layout device to hold cylindrical work pieces during the layout process. They have one or more accurate 90-degree V-slots.</td>
</tr>
</tbody>
</table>

(Source: T14)
**Layout procedure**

Instructors should introduce trainees to the following layout procedure:

- Laying out with Try-Square and Steel Ruler
- Laying Out Circles with the Divider
- Laying out parallel lines
- Laying Out with Surface Gauge
- Laying Out with Protractor
- Centre Punch Procedure

### 3.1.7.6. Bench work tools

For further information, exercises, pictures and details, instructors should refer to T14.

Instructors should provide trainees with the necessary knowledge regarding bench work, which should include basic tools as well as their proper use.

**Work bench**

- The workbench should be sturdy and when possible fixed with the shop floor.
- It is advisable to use wood for the bench board.
- The height of the workbench should depend on the height of the craftsman.
- Keep the workbench clean. Put only the tools necessary for the work on it.
- Measuring tools should be all the time separated from the other tools. Place them accurately on the wooden tray board.

(Source: T14)
Bench vice

- The base of a bench vice is normally made of cast iron. The jaws are hardened. Clamping soft workpieces requires covering the jaws with an aluminium sheet cover.

- The size of the bench vice is measured by the width of the jaws and the maximum opening between the jaws.

- There are different types of bench vices available: With or without an anvil plate, with a pipe clamping device, machine vice for drill press, and adjustable in any position within 360 degrees.

The trainees should learn the practical use of the following tools together with the applicable work safety:

- Hand Hacksaw;
- Chisel Tools;
- Files; and
- Hammer.
3.1.7.7. Principles of mechanical cutting

For further information, exercises, pictures and details, instructors should refer to T14.

Classification of metal cutting processes

Trainees should understand the different metal cutting processes.

<table>
<thead>
<tr>
<th>Hand Cutting Processes</th>
<th>Machine Cutting Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Filing</td>
<td>• Drilling</td>
</tr>
<tr>
<td>• Chiselling</td>
<td>• Hacksawing</td>
</tr>
<tr>
<td>• Hand Hacksawing</td>
<td>• Turning</td>
</tr>
<tr>
<td>• Shearing</td>
<td>• Milling</td>
</tr>
<tr>
<td>• Hand Tapping</td>
<td>• Grinding</td>
</tr>
<tr>
<td>• Die−Tapping</td>
<td>• Shaping</td>
</tr>
<tr>
<td>• Hand Reaming</td>
<td>• Machine Threading</td>
</tr>
<tr>
<td></td>
<td>• Machine Reaming</td>
</tr>
</tbody>
</table>

(Source: T14)

Angles of tools

Trainees should understand that the wedge shape angle BETA is common to all cutting tools.

− To cut metals, the tool must be wedge-shaped, be resistant to abrasion and tenacious.
− For different cutting operations there is a need for different tool angles.
− Cutting tools with small wedge angles penetrate the material more easily, but also tend to break off more easily if the material is hard.

3.1.7.8. Drilling

For further information, exercises, pictures and details, instructors should refer to T14.

Drill press

Trainees should understand that a drill press is a machine used for drilling operations available in a wide variety of types and sizes to suit different types and sizes of work pieces. The most common machine type found in a metal shop is the floor-type drill press.

Twist drill

Trainees should understand that a twist drill is a cutting-tool used to produce a hole in a piece of metal or other material. The most common drill manufactured has two cutting edges (lips) and two straight or helical flutes.

The flutes provide the cutting edges with cutting fluid and allow the chips to escape during the drilling operation.
Instructors should provide trainees with the necessary knowledge regarding:

- Drill bit materials
- Twist drill parts and cutting angles
- Drill Sizes
- Setting the Spindle Speed

**Different drill press operations**

Instructors should provide trainees with the necessary knowledge regarding different drill press operations.

![Drilling, Pre-Drilling, Reboring, Spot-facing, Counter-sinking, Enlarging](Source: T14)

**Facts and problems**

Instructors should provide trainees with the necessary knowledge regarding the most common drill problems, such as:

- Excessive speed will cause wear at outer corners of drill. This leads to more regrinding of material.
- Excessive feed sets up abnormal end thrust that causes breakdown of chisel point and cutting lips. Failure included by this cause will be broken or split drill.
- Cutting with unequal angles will cause one cutting edge to work harder than the other. This causes poor tool life.
- Cutting lips unequal in length cause chisel point to be off centre with axis and will drill holes oversize by approximately twice the amount of eccentricity.
Drill press safety rules

Instructors should provide trainees with the drill press safety rules, such as:

- Never wear loose clothing around machinery.
- A hair net or cap must protect long hair to prevent it from becoming caught in the revolving parts of the drill press.
- Never wear rings, watches, bracelets or necklaces while working in a machine shop.
- Always wear safety glasses when operating any machine.
- Never set the speed, adjust or measure the work until the machine is completely stopped.
- Keep the work area and floor clean and free of oil and grease.
- Never clamp taper shank drills, end mills, or non-standard tools in a drill chuck.
- Never leave a chuck key in a drill chuck at any time.
- Always use the brush to remove chips.
- Always clamp work pieces when drilling holes larger than ½ in. (12.7 mm) in diameter.
- When drilling sheet metal, it is necessary to clamp the sheet on a piece of wood.
- Reduce drilling pressure as the drill breaks through the work piece.
- Always remove the burrs from a hole that has been drilled.
3.1.7.9. Cutting threads with taps and dies

For further information, exercises, pictures and details, instructors should refer to T14.

Trainees should gain knowledge of cutting threads with taps and dies.

**Main Parts of a screw thread**

(SOURCE: T14)

*Hand tapping*

Trainees should gain knowledge of cutting threads with a hand tap.

Hand taps are usually made in sets of three, because it is better to distribute all the cutting work during the thread-process to three taps:

- No. 1 (taper) tap: one ring on shank
- No. 2 (plug) tap: two rings on shank
- No. 3 (bottoming) tap: without ring

*Threading dies*

Trainees should gain knowledge of cutting external threads with a threading die.

3.1.7.10. Sharpening tools

For further information, exercises, pictures and details, instructors should refer to T14.

*Bench grinder or pedestal grinder*

Trainees should use bench grinders for the sharpening of cutting tools and the rough grinding of metal.
Sharpening tools

Trainees should gain knowledge for sharpening the following tools:

- Scriber
- Centre punch
- Chisel

Safety precautions while using bench grinder or pedestal grinder

Instructors should provide trainees with knowledge of safety precautions while using bench grinder or pedestal grinder, such as:

- When switching on the machine, stand beside, because a damaged wheel might burst during acceleration.
- Always use safety goggles when grinding.
- The tool rest should never have more than 2-3 mm distance to the grinding wheel.
- Small work pieces should be held with clamps or other suitable devices.
- Keep the metal cool by dipping it frequently in water.
- Stand comfortable and don’t give too much force to the work piece because in the case of slip off with the work piece you will grind your fingers or hand.
- While grinding, use only the face of the wheel.

3.1.7.11. Cutting with power tools

For further information, exercises, pictures and details, instructors should refer to T14.

Instructors should provide trainees with explanation on the use of power hacksaw and chop saw.

The trainees should undergo:

- practice exercises on cutting different shapes of metals
- hands-on training in maintaining tools using hacksaw blades and cutting discs

3.1.7.12. Welding

For further information, exercises, pictures and details, instructors should refer to T14.
Common welding processes

Instructors should provide information regarding the following common welding processes:

- **Shielded Metal Arc Welding (SMAW)**

  The electric arc is generated by touching the tip of a coated electrode against the work piece. The electrodes are in the shape of a thin long stick (stick welding). The heat generated melts a portion of the tip of the electrode, its coating and the base metal in the immediate area of the arc. Welded material will form the molten metal (a mixture of the work piece and the electrode metal) and substances from the coating of the electrode, solidifies in the weld area. The electrode coating deoxidizes and provides a shielding gas in the weld area to protect it from oxygen and nitrogen in the environment. Electrodes are available for welding most carbon, low alloy and stainless steels, some non-ferrous metals, and a wide range of maintenance and repair applications.

- **Oxy-Acetylene Welding**

  Oxy-acetylene welding is the most common gas welding process. It uses acetylene fuel. The proportions of oxygen and acetylene are an important factor. At a ratio of 1:1, the burning gases get a neutral flame. If the supply of oxygen is lower it becomes a reducing flame. With a greater oxygen supply it becomes an oxidizing flame.

  Filler metals are used to bring additional material to the weld zone during welding. They are available as rods or wire, coated and uncoated, and are made of metals compatible with those to be welded. Oxy-acetylene welding can be used with most ferrous and nonferrous metals for any thickness of work pieces, but the relatively low heat input limits the process economically to less than 6 mm. A variety of joints can be produced by this method. It is portable, versatile and economic for low quantity and simple work.

- **Gas Metal Arc Welding (GMAW)**

  GMAW was developed in the late 1940s and is also called MIG/MAG Welding. Since then it unfolded into becoming a major element in industry today. It is suitable for welding a variety of ferrous and nonferrous metals.

  The arc continuously melts the wire as it is fed in the weld puddle. The weld area is shielded by a flow of gas such as argon, helium, carbon dioxide or gas mixtures. The consumable bare wire is fed automatically through a nozzle into the weld area. Metal can be transferred into the weld-bead in three ways: Spray, Globular and Short circuiting. Each method has its own advantages and disadvantages.

  The process is rapid, versatile, economical and can easily be automated (continuous welding without electrode changing).

**SMAW electrodes**

Instructors should explain the different types of electrodes (mild steel, low hydrogen electrode)
**Welding processes in various positions**

Instructors should explain and demonstrate the following:

- Striking the arc;
- The most common types of joints (Butt, T, lap, corner, edge);
- The most common types of grooves (Square, bevelled, V, double V); and
- Welding positions (flat, horizontal, vertical, overhead).

Trainees should gain the understanding to:

- Set up the equipment;
- Weld with different types of mild steel electrodes;
- Prepare metal plates and grooves for welding; and
- Do at least SMAW and oxy-acetylene welding.

**Identification of welding defects**

Instructors should explain how to identify different welding defects, e.g.:

- incomplete penetration;
- slag inclusion;
- undercut; and
- spatters.

Trainees should gain an understanding of the need to analyze welding defects and correct them during the practical work.

**3.1.7.13. Oxy-Acetylene cutting**

For further information, exercises, pictures and details, instructors should refer to T14.

Instructors should explain:

- Types of gas for cutting metals
- Gas cylinder, gas flow meter and pressure regulator
- Cutting tools
- Cutting process

Trainees should be required to perform cutting exercises for evaluation by instructors.
3.1.7.14.  Brazing

Instructors should ensure that trainees gain a thorough understanding of the health and safety requirements of working with hazardous gases and knowledge of the components within an oxy-acetylene rig.

Trainees should develop the necessary skills to braze copper/copper joints and silver soldering of dissimilar metals such as copper to brass or steel, specifically:

- Working with different copper line diameters and brazing material.
- Current information and legislation on using new refrigerants and jointing methods.
Rating as able seafarer engine

Function 4: Controlling the Operation of the Ship and Care for Persons on Board at the support level

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4.3 Apply precautions and contribute to the prevention of pollution of the marine environment

Part D4: Instructor Manual
Part B4: 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. Preparation and planning constitute an important factor which makes a major contribution to the effective presentation of any course of instruction.

Instructors should develop their own timetables depending on the:

- level of skills of trainees;
- numbers to be trained; and
- number of instructors,

and taking into account the normal practices at the training establishment.

- **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 share with the trainees briefly what you are going to present to them; then cover the topic in detail; and, finally, summarise what you have shared with them. The appropriate use of teaching aids such as multimedia equipment and simulation, and providing trainees with adequate course materials, will contribute very much in the teaching and learning processes.

- **Course Outline**

The Syllabus Tables are organised to match the competences in table A-III/5 of the STCW Code. It is not intended that lessons are organised to follow the sequence of required performances listed in the Tables. However, what is necessary is that all the material addresses the required knowledge, understanding and proficiency for the competences related to the Functions, and that learning is effective to enable the trainees to meet the standard of the required performance standard.
COURSE OUTLINE

4.

<table>
<thead>
<tr>
<th>Knowledge, understanding and proficiency</th>
<th>Total hours of performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory</td>
</tr>
</tbody>
</table>

Competence:

4.1. Contribute to the handling of stores (12 hours)

4.1.1. Knowledge of procedures for safe handling, stowage and securing of stores

- .1 Ability to handle, stow and secure stores safely (3 hour) (1 hour)
- .2 Hoists and cranes (3 hour) (1 hour)
- .3 Access arrangements, hatches and hatch covers, ramps, side/bow/stern doors or freight elevators (3 hour) (1 hour)

4.2. Apply occupational health and safety precautions (30 hours)

4.2.1. Safe working practices and personal shipboard safety

- .1 working aloft (4 hours) (2 hours)
- .2 working in enclosed spaces (2 hours)
- .3 permit to work systems (1 hour)
- .4 lockout/tag-out (1 hour) (2 hours)
- .5 lifting techniques and methods of preventing back injury (1 hour)
- .6 electrical safety (4 hours) (2 hours)
- .7 mechanical safety (4 hours)
- .8 chemical and biohazard safety (2 hours)
- .9 personal safety equipment (2 hours)

4.3. Apply precautions and contribute to the prevention of pollution of the marine environment (18 hours)

4.3.1. Knowledge of the precautions to be taken to prevent pollution of the marine environment

- .1 Basic knowledge of MARPOL 73/78 (4 hours)
- .2 Proactive measures to protect the marine environment (4 hours)

4.3.2. Knowledge of the Use and operation of anti-pollution equipment

- .1 Operating procedures of anti-pollution equipment (3 hours) (1 hour)
4.3.3. Knowledge of approved methods for disposal of marine pollutants

.1 Disposal of garbage (4 hours)

.2 Exchange of ballast water (1 hour)

.3 Disposal of bilge water (1 hour)

**Total for Function 4: Controlling the operation of the ship and care for persons on board at the support level**  
60 hours

Teaching staff should note that the hours for lectures and exercises are suggestions for guidance only as regards sequence and length of time allocated to each objective. These factors may be adapted by instructors to suit individual groups of trainees depending on their experience, ability, equipment and staff available for teaching.
Part C4: Detailed Teaching Syllabus

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 instructors, 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,

IMO References (indicated by R);
Textbooks (indicated by T); and
Bibliography (indicated by B),

which will provide valuable information to instructors.

Explanation of information contained in the Syllabus Tables

The information on each table is systematically organized in the following manner. 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 that describe related activities which make up a professional discipline or task responsibility on board.

In this Model Course there are four functions at the support level:

Function 1: Marine engineering;
Function 2: Electrical, electronic and control engineering;
Function 3: Maintenance and repair;
Function 4: Controlling the operation of the ship and care for persons on board.

The first column denotes the COMPETENCE concerned. Each function comprises several competences. For example, Function 4: Controlling the Operation of the Ship and Care for Persons on Board, comprises a total of three Competences. Each competence is uniquely and consistently numbered in this model course.

The term competence should be understood as the application of knowledge, understanding and 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 competence “contribute to the handling of stores” comprises one training outcome. Each training outcome is uniquely and consistently numbered in this model course.
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.

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 for instructors when designing lessons, lectures, tests and exercises for use in the teaching process.

IMO References (Rx), Textbooks (Tx) and Bibliographies (Bx) relevant to the training outcome and required performances are placed immediately following the title.

The Syllabus Tables are organised to match the competences in table A-III/5 of the STCW Code. It is not intended that lessons are organized to follow the sequence of required performances listed in the Tables. However, what is necessary is that all the material addresses the required knowledge, understanding and proficiency for the competences related to the Functions, and that learning is effective to enable the trainees to meet the standard of the required performance standard.
COMPETENCE 4.1 | Contribute to handling of stores | IMO Reference
--- | --- | ---

TRAINING OUTCOMES: | STCW Code Table A-III/5

Demonstrates a knowledge and understanding of:

4.1.1 KNOWLEDGE OF PROCEDURES FOR SAFE HANDLING, STOWAGE AND SECURING OF STORES

COMPETENCE 4.1 | Contribute to the handling of stores

4.1.1 KNOWLEDGE OF PROCEDURES FOR SAFE HANDLING, STOWAGE AND SECURING OF STORES

IMO references: R1, R2, R3, R4, R6, R7, R10
Bibliography: B1
Textbooks: T1, T2, T7

Required Performance:

1.1 **Ability to handle, stow and secure stores safely**

- demonstrates the operation of the hoists/cranes used for handling the ship’s stores/spares;
- states that each handling gear has its capabilities and limitations;
- understands that all handling gear and equipment shall be visually inspected;
- states that all ropes and wires should come with the certificate of their properties;
- demonstrates basic visual checks of hoists, cranes and related equipment;
- understands the importance that any failure, damage or malfunction has to be reported to EOOW immediately;
- states that no person should stand, pass or work under a suspended load;
- describes the provision of adequate lighting for working spaces, portable lights and precaution with dangerous stores;
- describes the importance of maintaining close communication with the personnel on charge ashore during the handling of stores;
- demonstrates the basic signals for the operation of hoists and cranes;
- demonstrates commonly used hand signals for control of lifting appliances, e.g. Code of Hand Signals;
- understands that in case of dead spots during stores operation, additional signallers have to be available;
- identifies and explains SWL or WWL of equipment;
understands that a load greater than SWL shall not be lifted;
identifies SWL of shackles, chains and slings correctly;
demonstrates a working knowledge of different lashing techniques;
scopy, lashes and secures the stores/spares safely under supervision of duty officer;
understands the classification of dangerous stores;
understands the reason and need for segregation dangerous stores; and
describes procedures to follow in event of spillage of dangerous stores.

1.2 **Hoists and cranes**
- demonstrates a working knowledge of the different types and function principles of cranes, derricks and winches;
- demonstrates the performance of basic visual checks of cranes, derricks, winches and related equipment;
- understands the importance that any failure, damage or malfunction has to be reported to EOOW immediately;
- prepares and uses cranes, derricks and winches;
- understands and uses basic signals for the operation of hoists and cranes when used for engine maintenance;
- understands that in case of dead spots during cargo or stores operation, additional signallers have to be available;
- correctly identifies SWL of shackles, chains and slings; and
- demonstrates a working knowledge of the use of slings to lift and move different kinds of cargo/equipment in a secure and safe manner

1.3 **Access arrangements, hatches and hatch covers, ramps, side/bow/stern doors or freight elevators**
- understands the safety hazards during opening/closing of ramps, doors, freight elevators, etc.;
- demonstrates a working knowledge of operating ramps, doors, freight elevators, etc.;
- understands the need to report immediately any defects in lifting equipment and gear; and
- understands the effect of unsecured doors on the stability and watertight integrity of the ship.
COMPETENCE 4.2  
Apply Occupational Health and Safety Precautions  
IMO Reference

TRAINING OUTCOMES:

STCW Code
Table A-III/5

Demonstrates a knowledge and understanding of:

4.2.1 SAFE WORKING PRACTICES AND PERSONAL SHIPBOARD SAFETY

COMPETENCE 4.2  
Apply Occupational Health and Safety Precautions

4.2.1 SAFE WORKING PRACTICES AND PERSONAL SHIPBOARD SAFETY

IMO references: R1, R2, R3, R4, R6, R7, R10
Bibliography: B1, Textbooks: T1, T2, T7

Required Performance:

1.1 Safe working practices and personal shipboard safety when working aloft
  
  - demonstrates safe working practices while working aloft including the use of ladders;
  
  - demonstrates safe working practices while working over the side; and
  
  - demonstrates the use of all necessary safety equipment.

1.2 Safe working practices and personal shipboard safety when working in enclosed spaces

  - defines and understands the term enclosed space;
  
  - identifies typical enclosed spaces and potentially dangerous spaces on board;
  
  - states clearly the safety procedures to be followed with regard to entry into enclosed spaces and responsibilities that are defined;
  
  - demonstrates safe working practices with regard to entry into enclosed spaces; and
  
  - demonstrates the ability to use breathing apparatus when working in enclosed spaces.

1.3 Safe working practices and personal shipboard safety for the application of permit to work systems

  - describes the need for permit-to-work systems used on board;
  
  - defines in general the meaning of risk assessment;
state the safety procedures that have to be strictly followed on board when applying a permit to work system;

describes the construction, classification, visual and function checking and use of additional protective equipment; and

demonstrates the understanding that any failure, damage or malfunction of safety and protective equipment has to be reported to Officer in Charge immediately.

1.4 Safe working practices and personal shipboard safety during lockout/tag-out

Instructors should refer to 2.1.2.4 Part C2 Detailed Teaching Syllabus for further guidance when presenting this section.

1.4 Safe working practices and personal shipboard safety when applying lifting techniques and methods of preventing back injury

- demonstrates safe working practices and personal shipboard safety when applying lifting techniques and methods for preventing back injury;
- demonstrates safe working practices during manual lifting and carrying loads; and
- demonstrates correct manual handling techniques.

1.5 Safe working practices and personal shipboard safety for electrical safety

- demonstrates a working knowledge of electrical safety;
- describes the harmful effects of direct and alternating current on human's heart and body functions;
- demonstrates the Five Safety Rules;
- describes the function and principles of electric power operated tools and equipment;
- demonstrates safe working practices when using electric power operated tools and equipment;
- describes the function and principles of portable electric tools, portable lighting and portable electric equipment together with associated risks;
- states that for certain tasks portable lighting with safety extra-low voltage has to be used;
- demonstrates the basic visual and function checks on electric power operated tools, electric lighting and electric equipment; and
- states that any failure, damage or malfunction of electric power operated tools, electric lighting and electric equipment has to be reported to EOOW immediately.
1.6 Safe working practices and personal shipboard safety for mechanical safety

- describes the function and principles of mechanical tools and mechanical equipment;
- demonstrates safe working practices when using mechanical tools and mechanical equipment; and
- describes the risks associated with hydraulic and pneumatically operated mechanical tools and mechanical equipment.
1.7 Safe working practices and personal shipboard safety for chemical and biohazard safety

- states if product details and potential hazards are found in suppliers’ safety data sheet;
- describes how to comply with health, hygiene and safety requirements when handling hazardous substances;
- demonstrates the need to follow instructions and precautions when working with cleaning fluids, paints, toxic materials etc.;
- states that additional personal protective equipment has be used; and
- describes the need to seek advice if unsure of risks or hazards relating to materials.

1.8 Safe working practices and personal shipboard safety on the importance of personal protective equipment

- describes construction, material, classification, marking, visual and function checking and use of personal protective equipment;
- states the need to use personal protective equipment;
- states that any failure, damage or malfunction of personal protective equipment has to be reported to Officer in Charge immediately; and
- describes the meaning of prohibition, warning, mandatory and emergency safety and signage.
### COMPETENCE 4.3

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<tr>
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<th>Apply precautions and contribute to the prevention of pollution of the marine environment</th>
<th>IMO Reference</th>
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<td>TRAINING OUTCOMES:</td>
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<td>Table A-III/5</td>
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Demonstrates a knowledge and understanding of:

- **4.3.1** KNOWLEDGE OF THE PRECAUTIONS TO BE TAKEN TO PREVENT POLLUTION OF THE MARINE ENVIRONMENT

- **4.3.2** KNOWLEDGE OF THE USE AND OPERATION OF ANTI-POLLUTION EQUIPMENT

- **4.3.3** KNOWLEDGE OF THE APPROVED METHODS FOR DISPOSAL OF MARINE POLLUTANTS

Instructors should refer to Model course 1.38 on Marine Environmental Awareness for further guidance when presenting this section.
COMPETENCE 4.3  Apply precautions and contribute to the prevention of pollution of the marine environment

4.3.1 KNOWLEDGE OF THE PRECAUTIONS TO BE TAKEN TO PREVENT POLLUTION OF THE MARINE ENVIRONMENT

IMO references:  R1, R2, R3, R4, R6, R7
Bibliography:  B1,
Textbooks:  T1, T2, T7

Required Performance:

1.1 Basic knowledge of MARPOL 73/78

- states the need to protect the marine environment;
- states that marine pollutants must be safely disposed ashore in compliance with MARPOL;
- states that there are strict mandatory rules covering all ships for the disposal of oily water mixture;
- states that there are strict mandatory rules covering all ships for the disposal of noxious liquid substances;
- states that there are strict mandatory rules covering all ships for the disposal of harmful substances in packaged form;
- states that there are strict mandatory rules covering all ships for the prevention of pollution by sewage;
- states that there are strict mandatory rules covering all ships for the prevention of pollution by garbage; and
- states that there are strict mandatory rules covering all ships for the prevention of air pollution by ships

1.2 Proactive measures to protect the marine environment

- describes the use of deck scuppers for bunkering purposes;
- describes the assistance required during bunkering operations;
- describes the use of an emergency stop during bunkering; and
- demonstrates an understanding to recognize the need to seek advice if unsure of measures to be taken to protect the marine environment.
### COMPETENCE 4.3
Apply precautions and contribute to the prevention of pollution of the marine environment

#### 4.3.2 KNOWLEDGE OF THE USE AND OPERATION OF ANTI-POLLUTION EQUIPMENT

IMO references: R1, R2, R3, R4, R6, R7
Bibliography: B1,
Textbooks: T1, T2, T7

Required Performance:

#### 2.1 Operating procedures of anti-pollution equipment

- describes emergency response exercises for controlling spillage of oil on board
- demonstrates the duties assigned to the crew as per SOPEP
- describes drills for clean-up of hazardous cargo spillage
- demonstrates knowledge of operating garbage compactor units (where fitted)
<table>
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<tr>
<th>COMPETENCE 4.3</th>
<th>Apply precautions and contribute to the prevention of pollution of the marine environment</th>
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4.3.3. KNOWLEDGE OF THE APPROVED METHODS FOR DISPOSAL OF MARINE POLLUTANTS

IMO references: R1, R2, R3, R4, R6, R7  
Bibliography: B1,  
Textbooks: T1, T2, T7

Required Performance:

3.1 Disposal of garbage

- demonstrates knowledge of collecting and segregating waste and garbage;
- demonstrates knowledge of collecting and disposing of cargo sweepings; and
- states the need to segregate waste, record the amounts of waste and landing waste ashore for disposal.

3.2 Exchange of ballast water

- states the purpose of ballast water exchange

Instructors should refer to sections 1.4.1.1 and 1.4.1.3 Part C1 Detailed Teaching Syllabus

3.3 Disposal of bilge water

- states the correct method of disposing bilge water, waste oil and oily garbage

Instructors should refer to sections 1.4.1.1 and 1.4.1.2 Part C1 Detailed Teaching Syllabus
Part D4: Instructor Manual

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

Trainees should be aware of the need, and the practical measures required, to perform the following aspects of shipboard operations:

- Contribute to handling of stores;
- Apply occupational health and safety precautions; and
- Apply precautions and contribute to the prevention of pollution of the marine environment.

Function 4: Controlling the Operation of the Ship and Care for Persons on Board at this level

In implementing this section of the course, instructors should ensure that trainees have prior and adequate training and experience as ratings forming part of an engineering watch, and have demonstrated the ability to perform tasks required of ratings.

In addition to the task description, the following aspects are important within the framework of the training:

- Relevant norms, legal provisions and safety working principles and regulations that have to be applied where they are not explicitly mentioned;
- Specifically focussing on the safety of the ship, work safety, health protection and first-aid measures; and
- Environmental protection, efficient use of energy and materials, effective communication and using nautical terminology during the ship's operation.

On completion of training for this function, trainees should be able to safely and efficiently contribute to handling of stores.

Trainees should have adequate knowledge and be able to identify occupational hazards and take appropriate measures and precautions prior to undertaking shipboard operations such as working aloft, working over the side and especially working in enclosed spaces. Trainees should have knowledge of the need for working permits and the application, where appropriate, of proper working techniques.

Trainees should be:

- aware of the need and the practical measures required by law to prevent pollution of the environment; and
- able to demonstrate the proper use and operation of anti-pollution equipment and have knowledge of the approved methods for disposal of marine pollutants.
4.1 **Contribute to the handling of stores**

In implementing this section of the course, instructors should ensure that trainees have prior and adequate training, competence and experience as ratings, and have demonstrated the ability to perform tasks required of ratings.

The ship's safety management system should provide guidance on safe practices in ship operations and ensuring a safe working environment, with safeguards against all identified risks in compliance with the ISM Code.

In addition, engine equipment and machinery should be:

- suitable for the work to be carried out;
- properly adapted for that purpose; and
- capable of being operated without any risks to the health or safety of any worker.

### 4.1.1 Knowledge of procedures for safe handling, stowage and securing of stores

Instructors should refer to the references for further guidance on this topic.

4.1.1.1 **Ability to handle, stow and secure stores safely**

Stores are important for the operation of ships and need to be brought on board and stored properly, and could be handled with a variety of equipment. It is recommended that instructors inform trainees regarding the handling of stores and equipment.

Trainees should have knowledge of the working principles, operation, repair and maintenance of stores handling gear and associated equipment. With regard to the safe operation of this stores handling gear and associated equipment, trainees should gain an understanding of their use and their limitations.

It is very important that trainees achieve an understanding that only certified working gear and equipment may be used for stores handling.

Instructors should inform trainees about the risks involved and the common safety precautions and safe operation procedures when opening holds while handling stores.

4.1.1.2 **Hoists and cranes**

Instructors should explain and demonstrate to trainees the proper procedures for operating lifting gears and associated machinery when overhauling engines. The lifting gears and machinery should be operated in accordance with established safety practices as laid down in Code of Safe Working Practices (COSWP) and the relevant operating instructions.

Instructors should stress to trainees that there must be clear understanding between the lifting gear operator and the signalman regarding the type and meaning of the signals used. At the end of the training, trainees should be able to use and understand basic signals for the operation of equipment and machinery including cranes and hoists.
4.1.3 Access arrangements, hatches and hatch covers, ramps, side/bow/stern doors or freight elevators

Trainees should be made aware of the importance of maintaining watertight and weathertight integrity of the ship as many incidents of ship capsizing and sinking are due to flooding of ships’ spaces resulting in loss of ship stability. All hatches, side/bow/stern doors and portholes, especially those below the main deck of the ship, have to be closed watertight/weathertight integrity, as appropriate, before departure and throughout the voyage. Operation of these equipment and fittings should be in accordance with the manufacturers’ manuals.

4.2 Apply occupational health and safety precautions

With respect to health and safety of crew members working on board ships, employers, ship owners, company and ship managers must ensure the following:

- Avoidance of risks which by the replacement of dangerous practices, substances or equipment by safe practices, and using less dangerous substances and equipment; and

- Adaptation of work patterns and procedures taking into account the capacity of crew members, the equipment available and the prevailing circumstances during which the task is undertaken.

4.2.1 Safe working practices and personal shipboard safety

Instructors should stress that trainees are required to take reasonable care for their own health and safety, and that of others on board who may be affected by their acts or omissions. Trainees must carry out health and safety duties to the best of their capabilities. Proper use and operation of plant and machinery must be strictly observed and adhered to, and hazards and deficiencies identified must be reported immediately.

In all instances, risks to the health and safety of workers must be identified and assessed. It will often not be possible to remove all risks, but attention shall be given to control measures which make the working environment and working methods as safe as reasonably practicable.

COSWP T15 describes safe working practices and personal shipboard safety including:

4.2.1.1 Working aloft

4.2.1.2 Working in enclosed spaces

4.2.1.3 Permit to work system

Instructors should provide information and guidance to trainees on the need for, and usage of, safe working permits, such as:

- hot work permit;
- cold work permit;
- entry in enclosed space permit;
- working aloft permit;
- working overside permit; and
4.3 Apply precautions and contribute to the prevention of pollution of the marine environment

This section is intended to provide general knowledge of the MARPOL Convention. In the following sections, detailed treatment should be confined to general guidelines and precautions to be taken in the prevention of pollution of the marine environment, including the equipment and methods used for the disposal of marine pollutants relevant for the engine department.

Instructors should refer to Model Course 1.38 on Marine Environmental Awareness for further information when presenting this section.

4.3.1 Knowledge of the precautions to be taken to prevent pollution of the marine environment

4.3.1.1 Basic knowledge of MARPOL 73/78

Due to the international nature of the shipping industry, IMO has laid down rules and requirements for the prevention of pollution of the marine environment, which are set out in MARPOL. Because of the fine balance that exists between the environment and ourselves, careless and deliberate pollution of the atmosphere and sea will ultimately destroy animals, plants, sea life and humans. It is therefore important that all efforts should be made to protect the environment.

The annexes of MARPOL set out the rules for the construction and equipment of ships and for ships’ operations which may result in marine pollution.

Annexes of the MARPOL Convention are:

– Annex (1): Prevention of pollution by oil;
– Annex (2): Control of pollution by noxious liquid substances in bulk;
– Annex (3): Prevention of pollution by harmful substances carried by sea in packaged form;
– Annex (4): Prevention of pollution by sewage from ships;
– Annex (5): Prevention of pollution by garbage from ship; and
– Annex (6): Prevention of air pollution from ships

4.3.1.2 Proactive measures to protect the marine environment

The goal is to develop the mindset to achieve a sense of personal responsibility through:

– knowledge and comprehension of the importance and diversity of the marine environment;
– recognition of the impact of human activities on the environment; and
willingness to use solutions that lessen the impact of human actions. 

Instructors should request the trainees to list or identify the pollutants that are commonly found on board ships and within the shipping environment.

Preventative measures to protect the marine environment may include:

- Prevention of the spillage of cargo;
- Prevention of the spillage of fuel and oil;
- Controlling the emission of polluting gas and smoke;
- Policies and practices to minimize the spread and carriage of marine pests;
- Effective waste management and recycling processes;
- Effective management of ballast operations;
- Effective shipboard housekeeping;
- Measures to prevent run-off during slipping operations; and
- Clear and effective pollution control instructions

4.3.2 Knowledge of the use and operation of anti-pollution equipment

4.3.2.1 Operating procedures of anti-pollution equipment

Instructors should provide an overview of the anti-pollution equipment used on board ships and highlight on the equipment used in the engine department.

4.3.3 Knowledge of the approved methods for disposal of marine pollutants

Instructors should make trainees aware of the need for maintaining proper and accurate records of the respective activities related to incinerating, treating, dumping and disposal ashore, and creating an awareness of the types of waste that may be dumped at sea.

4.3.3.1 Disposal of garbage

Instructors should provide guidance to trainees on the relevant parts of Annex V of MARPOL 73/78 that are related to the safe disposal of garbage.

4.3.3.2 Exchange of ballast water

Instructors should teach trainees, taking into account the relevant parts of the Ballast Water Management Convention 2004.

4.3.3.3 Disposal of bilge water

Instructors should provide guidance to trainees on the relevant parts of MARPOL 73/78, Annex I that are related to the proper disposal of bilge water.
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:

- assist trainees' learning;
- identify trainees' strengths and weaknesses;
- assess the effectiveness of a particular instructional strategy;
- assess and improve the effectiveness of curriculum programs; and
- assess and improve teaching effectiveness.

The different types of evaluation/assessment may be classified as follows:

**Initial / Diagnostic assessment**

Diagnostic assessment is an evaluation of a trainee's skills, knowledge, strength and areas for development. This should take place before the trainee commences a course to ensure they are on the right path. This can be carried out in an individual or group setting by the use of relevant tests.

**Formative assessment**

Is an integral part of the teaching/learning process and hence is a “continuous” assessment process. It provides information on a trainee's progress and may also be used to encourage and motivate them.

Purpose of formative assessment is to:

- provide feedback to trainees;
- motivate trainees;
- diagnose trainees' strengths and weaknesses; and
- help trainees to develop self-awareness.

**Summative assessment**

It is designed to measure trainees' achievement against defined objectives and targets. It may take the form of an examination or an assignment and takes place at the end of a course.
Purpose of summative assessment:
- To assess if trainees are competent or not yet competent; and
- To grade trainees.

Evaluation for Quality assurance

Evaluation of the assessment process would be required for quality assurance purposes for compliance with the requirements of STCW Convention, regulation I/8.

Purpose of assessment with respect to quality assurance
- To provide feedback to instructors on a trainee's learning;
- To evaluate a module's strengths and weaknesses; and
- To improve teaching and course outcomes.

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 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; and
- Simulations (also refer to STCW Code, section A-I/12).

Validity

The evaluation methods must be based on clearly defined objectives, and 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

Assessments should be reliable (if the assessment was done again with a similar group/learner, would you receive similar results). Instructors may have to deliver the same subject to different groups of learners at different times. If other assessors are also assessing the same course/qualification, it is to be ensured that all assessors make similar decisions.

To be reliable, an evaluation procedure should produce reasonably consistent results no matter which set of question papers or version of the test is used.
If instructors are to assess their own trainees, they need to clearly understand what they are to assess and then decide how to do this, bearing in mind that, for the award of Certificates of Competency (CoC) or Certificates of Proficiency (CoP) instructors may not assess their trainees to be in compliance with the requirements of the Convention.

The "what" will come from the standards/learning outcomes of the course/qualification they will deliver. The "how" may already be decided for them if it is an assignment, test or examination. The instructors need to consider the best way to assess the skills, knowledge and attitudes of 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 known 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; and
- **Reliable** – the work is consistent across all learners, over time and at the required level.

It is important to note that no single method can satisfactorily measure knowledge and skill over the entire spectrum of subjects 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 tasks on board.

**STCW Convention 1978, as amended**

The training and assessment of seafarers, as required by the Convention, are administered, supervised and monitored in accordance with the provisions of section A-I/6 of the STCW Code.

The knowledge, understanding and proficiency in column 2, methods for demonstrating competence in column 3 and criteria for evaluating competence in column 4 of table A-III/5 of the STCW Code set out the methods and criteria for evaluation. Instructors should refer to the competence table when designing assessments.

**Evaluation of competence**

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.:

- direct observation of work activities;
- skills/proficiency/competency tests;
- projects and assignments;
Evidence from previous experience; and

- written, oral and computer-based questioning techniques.

One or more of the above methods listed could be used to obtain evidence of ability, in addition to appropriate questioning techniques to provide evidence of supporting knowledge and understanding.

For detailed guidance on Assessments, instructors should refer to Model Course 3.12 on Assessment, Examination and Certification of Seafarers; however, to assist instructors, some extracts from the Model Course 3.12 on Assessment, Examination and Certification of Seafarers are used to explain assessments in this section.

**Multiple choice questions**

Marking or scoring would be easier when 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 may establish 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 other constraints. 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 trainee’s knowledge, understanding and proficiency of the subject areas pertinent to the tasks the trainee is expected to undertake. It is not possible to examine candidates fully in all areas. In effect, the examination samples a candidate’s knowledge, understanding and proficiency by covering, as wide a scope as is possible, within the time constraints and testing the trainee’s depth of knowledge, understanding and proficiency in selected areas.

The examination as a whole should assess each candidate’s comprehension of principles, concepts and methodology; the trainee’s ability to: apply principles, concepts and methodology; organize facts, ideas and arguments; and the trainee’s abilities and skills in carrying out those tasks the trainee will be called upon to perform in the duties to be certificated to undertake.

All evaluation and testing techniques have their advantages and disadvantages. An examining authority should carefully analyze precisely what should be tested 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. In all cases, the questions should be checked to ensure that they measure an objective which is essential to the task concerned.
SCORING TESTS

Scoring subjective tests

Assessment of seafarers is carried out to evaluate whether they have met specified learning objectives to be competent of, to perform the tasks for which they will take responsibility on board. They should be assessed against predetermined assessment criteria and in accordance with criteria for evaluation set out in the tables of competence in the STCW Code.

To achieve this in subjective tests, an analytical scoring scheme and complete model answers and relevant mark schemes should be produced for each question. The model answer should then be analyzed for the definitions, facts, explanations, formulae, calculations, etc., contained in it and marks 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:

- 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;

- 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

- 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 errors 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 scoring 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 using calculators is needed.

Examination rules usually warn candidates that all working must be shown to gain full marks for questions. The marks to be deducted 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 standards.

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 three 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; and

(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.

.8 Marking papers:

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'.

.9 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; and

(e) tidal prediction, to ± 15 cm.

.10 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.

.11 Use of Calculators:

When a 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.

The evaluation could consist of oral and practical tests which many topics may require as per the table A-III/5 of the STCW Code, column 2 on Knowledge, understanding and proficiency. In such cases, the following should be taken into consideration:

1 Advantages and disadvantages of oral and practical tests

It is generally considered advisable that candidates for certificates of competency should also be examined orally. Some aspects of competency can only be properly judged by having the candidate demonstrate the 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, as each test may take up about one to two hours if it is to comprehensively cover the topics concerned. Relevant equipment would also need to be made available for the competences that are to be tested. Some items of equipment could be dedicated solely for use in examinations.

2 Feedback

In order to keep the training programme up to date in the future, it is essential for users to provide feedback. Objective and positive critical comments and new information would facilitate the enhancement of the quality of the model course, and would promote better training in safety and security at sea, and protection of the marine environment. Such feedback, information, comments and suggestions should be sent to the Head, Maritime Training and Human Element, IMO.
Appendix 1: Example Lessons

Instructors should refer to appendix 1 along with Part D - Instructor’s notes, when presenting this section.

Teaching Unit 1: Working knowledge of the function and operation of auxiliary diesel engines

In earlier lessons, trainees have achieved knowledge of:

- Operating principles of two-stroke and four-stroke diesel engines;
- Engine configurations like twin engines in connection with gearbox and CPP;
- Function of the major parts of two-stroke and four-stroke diesel engines;
- Monitoring the safe operation of the propulsion engine according to the parameters specified by the engine manufacturer and/or standing orders;
- Using diagrams and drawings of the propulsion machinery piping systems, e.g.:
  - Starting air system;
  - Fuel oil system (both heavy fuel and diesel oil);
  - Lubricating oil system;
  - High Temperature Fresh Water system;
  - Low Temperature Fresh Water system;
  - Sea water system; and
  - Control air system.
- Pressure, level and temperature ranges under normal operating conditions for the systems associated to the propulsion machinery;
- Preparation of the main propulsion machinery for starting;
- The danger areas at different operations; and
- Safety procedures and PPE in different operations and tasks
This teaching unit comprises eight theoretical (T) and eight practical (P) lessons.

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Topic</th>
<th>Educational objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 + 2 (T)</td>
<td>Lay-out</td>
<td>The trainees state the layout and function of the diesel generator plant</td>
</tr>
<tr>
<td>3 + 4 (P)</td>
<td>Function</td>
<td>The trainees describe the preparation of the auxiliary diesel engines for starting, start the diesel generator plant and check pressures, temperatures etc., after starting</td>
</tr>
<tr>
<td>5 + 6 (T)</td>
<td>Starting</td>
<td>The trainees shall understand the different operational set-up for different conditions, they carry out the monitoring of the diesel-generator installation under different conditions and report to trainer</td>
</tr>
<tr>
<td>7 + 8 (P)</td>
<td>Operation of diesel generator plant in different conditions</td>
<td></td>
</tr>
<tr>
<td>9 + 10 (T)</td>
<td>Monitoring</td>
<td>The trainees describe common malfunctions, understand lower and upper threshold limits of operation values of various systems, prepare their own checklists, report to trainer and react to malfunction</td>
</tr>
<tr>
<td>11 + 12 (P)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 + 14 (T)</td>
<td>Common malfunctions</td>
<td>The trainees describe common malfunctions, understand lower and upper threshold limits of operation values of various systems, prepare their own checklists, report to trainer and react to malfunction</td>
</tr>
<tr>
<td>15 + 16 (P)</td>
<td></td>
<td></td>
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</tbody>
</table>
### Planned course of lessons no. 1 + 2 (T) and no. 3 + 4 (P)

<table>
<thead>
<tr>
<th>Length of time (min.)</th>
<th>Phase</th>
<th>Lesson plan</th>
<th>Teaching method</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Introduction</td>
<td>The trainer introduces the lesson plan. The trainer has prepared the real diesel engine and/or the engine-room simulator for this lesson.</td>
<td>Trainer's lecture Beamer</td>
</tr>
<tr>
<td>65</td>
<td>Theoretical Development</td>
<td>The trainees - draw and describe the layout of the (simulated) diesel generator plant in detail, e.g. - number of generator sets - combination with shaft generators - describe the function of the (simulated) diesel generator plant in detail, e.g.</td>
<td>Individual work Manuals Working sheets (Simulated) diesel generator plant</td>
</tr>
<tr>
<td>10</td>
<td>Summary</td>
<td>The trainees make notes and ask comprehension questions.</td>
<td>Dialogue</td>
</tr>
<tr>
<td>75</td>
<td>Practical Development</td>
<td>The trainees are assigned in groups of two. The teamwork partners compare the results of their individual work to each other. The trainees - compare their prepared drawings and descriptions to the (simulated) diesel generator plant - identify the location of the different indicators at the (simulated) diesel generator plant - prepare their own checklists.</td>
<td>Teamwork Manuals Working sheets (Simulated) diesel generator plant</td>
</tr>
<tr>
<td>15</td>
<td>Summary</td>
<td>The trainees compare their results and ask comprehension questions.</td>
<td>Dialogue</td>
</tr>
<tr>
<td>Length of time (min.)</td>
<td>Phase</td>
<td>Lesson plan</td>
<td>Teaching method</td>
</tr>
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</tr>
<tr>
<td>10</td>
<td>Introduction</td>
<td>The trainer introduces the lesson plan.</td>
<td>Trainer's lecture</td>
</tr>
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<tr>
<td>70</td>
<td>Theoretical Development</td>
<td>The trainees describe the preparation of the auxiliary diesel engines for starting and prepare checklists, e.g.: – priming; – slow turning; and – visual check for leakages etc.</td>
<td></td>
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</tr>
<tr>
<td>10</td>
<td>Summary</td>
<td>The trainees make notes and ask comprehension questions.</td>
<td>Dialogue</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>Practical Development</td>
<td>The trainer has prepared the real diesel engine and/or the engine-room simulator for this lesson. The trainees are assigned in groups of two. The teamwork partners compare the results of their individual work to each other. The trainees: - prepare the (simulated) diesel generator plant for starting; - start the (simulated) diesel generator plant; and - check pressures, temperatures etc., after starting and report them to the trainer.</td>
<td>Teamwork</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Summary</td>
<td>Trainer and trainees discuss results and starting (simulated) diesel generator plant. Trainees ask comprehension questions.</td>
<td>Dialogue</td>
</tr>
</tbody>
</table>
Planned course of lessons no. 9 + 10 (T) and no. 11 + 12 (P)

<table>
<thead>
<tr>
<th>Length of time (min.)</th>
<th>Phase</th>
<th>Lesson plan</th>
<th>Teaching method</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Introduction</td>
<td>The trainer introduces the lesson plan.</td>
<td>Trainer's lecture</td>
<td>Beamer</td>
</tr>
</tbody>
</table>
| 70                    | Theoretical Development    | The trainer introduces different diesel generator plant set-ups with regard to different operational conditions of the ship, e.g.:  
- at sea;  
- during manoeuvring;  
- in port;  
- during bad weather; and  
- during loading and discharge operation.  
The trainees understand the different operational needs and conditions. | Trainer's lecture     | Beamer               |
| 10                    | Summary                    | The trainees ask comprehension questions.                                                                                                                                                                   | Dialogue               |                      |
| 5                     | Introduction               | The trainer has prepared the real diesel engine and/or the engine-room simulator for this lesson.                                                                                                          |                       |                      |
| 70                    | Practical Development      | The trainee:  
- monitors the (simulated) diesel generator plant; and  
- reports to trainer                                                                                                                                                                                      | Individual work       | Checklists Working sheets (Simulated) diesel generator plant |
| 15                    | Summary                    | Trainer gives feedback to trainee.                                                                                                                                                                          | Trainer's lecture     | Dialogue             |
Planned course of lessons no. 13 + 14 (T) and no. 15 + 16 (P)

<table>
<thead>
<tr>
<th>Length of time (min.)</th>
<th>Phase</th>
<th>Lesson plan</th>
<th>Teaching method</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Introduction</td>
<td>The trainer introduces the lesson plan.</td>
<td>Trainer's lecture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Beamer</td>
</tr>
<tr>
<td>60</td>
<td>Theoretical Development</td>
<td>The trainer:</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- explains common malfunctions;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- explains lower and upper threshold limits of operation values of</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>various systems;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- explains need to report and possible urgent reactions to malfunctions.</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Summary</td>
<td>The trainees make notes and ask comprehension questions.</td>
<td>Dialogue</td>
</tr>
<tr>
<td>10</td>
<td>Introduction</td>
<td>The trainer has prepared the real diesel engine and/or the engine-room</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>simulator for this lesson.</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>Practical Development</td>
<td>The trainee:</td>
<td>Individual work</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- monitors the (simulated) diesel generator plant;</td>
<td>Checklists</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- reports to malfunction trainer; and</td>
<td>(Simulated) diesel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- reacts to malfunction.</td>
<td>generator plant</td>
</tr>
<tr>
<td>15</td>
<td>Summary</td>
<td>Trainer gives feedback to trainee.</td>
<td>Trainer's lecture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dialogue</td>
</tr>
</tbody>
</table>
Teaching Unit 2: Different voltages on board

In earlier lessons the trainees have achieved knowledge of “Safety precautions before commencing work or repair” (competence 2.1.1.1) and "Isolation Procedures" (competence 2.1.1.2), e.g.:

- typical electrical installation on board of modern ships;
- reading of different indicators and meters; and
- Five-Safety-Rules.

This teaching unit comprises six lessons.

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Topic</th>
<th>Educational objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 + 2</td>
<td>Main switchboard</td>
<td>The trainees shall differentiate the types of voltage or current used, and understand the general structure of a modern general electrical installation on board.</td>
</tr>
<tr>
<td>3 + 4</td>
<td>Main and emergency switchboard</td>
<td>The trainees getting familiar with the typical components of the electrical installation on board, their main features and the general structure of an emergency switchboard on board.</td>
</tr>
<tr>
<td>5 + 6</td>
<td>Main and emergency switchboard</td>
<td>The trainees prepare their own drawings of a typical main switchboard. The trainees getting familiar with the emergency shipboard procedures. The trainees prepare their own drawings of a typical emergency switchboard.</td>
</tr>
</tbody>
</table>
### Planned course of lessons no. 1 and 2

<table>
<thead>
<tr>
<th>Length of time (min.)</th>
<th>Phase</th>
<th>Lesson plan</th>
<th>Teaching method</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Introduction</td>
<td>The trainer introduces the lesson plan.</td>
<td>Trainer's lecture</td>
<td>Beamer</td>
</tr>
<tr>
<td>75</td>
<td>Development</td>
<td>The trainer continues to introduce the typical electrical installation on board.</td>
<td>Trainer's lecture</td>
<td>Beamer</td>
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<td></td>
<td>The trainees shall:</td>
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<tr>
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<td></td>
<td>- understand the general structure of a modern general electrical installation on board;</td>
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<td></td>
<td></td>
<td>- distinguish between low-voltage and high-voltage installations; and</td>
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<tr>
<td></td>
<td></td>
<td>- differentiate AC and DC current/supply.</td>
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</tr>
<tr>
<td>10</td>
<td>Summary</td>
<td>The trainees make notes and ask comprehension questions.</td>
<td>Dialogue</td>
<td></td>
</tr>
</tbody>
</table>
Example drawings for lesson no. 1+2

Fig. 1: Part of feeder panel, 6600 V
Fig. 2: Part of feeder panel, 440 V
Fig. 3: Part of emergency generator panel
Fig. 4: Part of emergency group starter panel

For further details, pictures and drawings, it is recommended that instructors should refer to T12.
Planned course of lessons no. 3 and 4

<table>
<thead>
<tr>
<th>Length of time (min.)</th>
<th>Phase</th>
<th>Lesson plan</th>
<th>Teaching method</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Introduction</td>
<td>The trainer introduces the lesson plan.</td>
<td>Trainer's lecture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The trainees are assigned in groups of two.</td>
<td>Beamer</td>
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<tr>
<td></td>
<td></td>
<td>The trainees prepare their own list and overview of the typical components of the electrical installation on board and their main features, e.g.:</td>
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<tr>
<td></td>
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<td>- Generators;</td>
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<td></td>
<td></td>
<td>- Transformers;</td>
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<td></td>
<td></td>
<td>- Electrical consumers;</td>
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<td></td>
<td></td>
<td>• Important electric consumers</td>
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<td></td>
<td></td>
<td>• Electric motors</td>
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<tr>
<td></td>
<td></td>
<td>• Electric lighting</td>
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<tr>
<td></td>
<td></td>
<td>- Fuses, switches;</td>
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<td></td>
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<td>- Plugs;</td>
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<td>- Alarm systems, detectors, sensors; and</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Battery chargers</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>Development</td>
<td>The trainer introduces the typical emergency switchboard. The trainees shall</td>
<td>Teamwork</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- understand the general structure of an emergency switchboard on board;</td>
<td>Working sheets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- be familiar with the typical components of an emergency switchboard and their main features, e.g.</td>
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<tr>
<td></td>
<td></td>
<td>• Emergency generator</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Emergency electrical consumers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• battery chargers</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Summary</td>
<td>The trainees compare their results with already prepared sample solutions.</td>
<td>Teamwork</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>10</td>
<td>Analysis</td>
<td>Instructor and trainees reflect tasks and results.</td>
<td>Dialogue</td>
</tr>
</tbody>
</table>
## Planned course of lessons no. 5 and 6

<table>
<thead>
<tr>
<th>Length of time (min.)</th>
<th>Phase</th>
<th>Lesson plan</th>
<th>Teaching method</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Introduction</td>
<td>The trainer introduces the lesson plan.</td>
<td>Trainer's lecture</td>
<td>Beamer</td>
</tr>
<tr>
<td>65</td>
<td>Development</td>
<td>The trainees are assigned in groups of two.</td>
<td>Teamwork</td>
<td>Working sheets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The trainees prepare their own drawings of a typical main switchboard.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>The Instructor informs about the use of the emergency switchboard. The trainees shall be familiar with:</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>– shipboard procedures after black out; and</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>– coupling of main switchboard and emergency switchboard.</td>
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<tr>
<td></td>
<td></td>
<td>The trainees prepare their own drawings of a typical main switchboard.</td>
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</tr>
<tr>
<td>10</td>
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<td>The trainees compare their results with an already prepared sample solution.</td>
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<td></td>
</tr>
<tr>
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<td>Analysis</td>
<td>Instructor and trainees reflect tasks and results.</td>
<td>Dialogue</td>
<td></td>
</tr>
</tbody>
</table>
Teaching Unit 3: Exercise Sheet 1

Task:

- Draw and dimension the object below using the given measurements.
- Use a piece of paper with a title block.

(Source: T14)
Teaching Unit 4: Exercise Sheet 2

Task:

- Draw and dimension the object below using the given measurements.
- Use a piece of paper with a title block.

(Source: T14)
Teaching Unit 5: Bench Work Exercise 1

Necessary material and tools for this exercise:

- 1 piece flatbar 200 mm × 102 mm × 10 mm
- steel rule 400 mm
- scribe
- centre punch
- hammer 200 g
- protractor
- try square
- combination square
- Vernier caliper 250 mm
- depth Vernier caliper
- hand hacksaw
- flat file 250 mm, rough and bastard
- triangular file 250 mm, rough and bastard
- different twist drills
- different screw taps
- different countersink
- letter stamps
- chisel
- PPE
Metal Plate – Working Step No. 1

1. Take a piece of flat bar with a measurement of 200 mm lengths and 105 mm width and 10 mm thickness.

2. Take the letter "A" stamp and stamp it as shown in the above drawing.

3. File surface of edge A even, and remove all rust and forging scale. First use a rough file, then for finishing the surface a bastard file. Control the evenness with the try square.

4. Layout lines from the left side as well as on the right side. Use edge A as a reference to put the try square and scribe the lines.

5. Centre punch the lines with at least 5 mm distance between the marking points.

6. Cut on the outer part of the lines using the hand hacksaw and leave at least 1mm allowance for filing.

7. File the surfaces of edges B and D in a right angle to surface A. File the 1mm excess to the size required.

8. File surface of edge C even and parallel to edge A to the size required. First use a rough file, then for finishing the surface a bastard file.
Metal Plate – Working Step No. 2

1. Take a combination square and set 135 degrees angle using a protractor.
2. Put the combination square at edge A.
3. Scribe a line with the scriber.
4. Centre punch the line with at least 5 mm distance between the marking points.
5. Cut on the outer part of the line using the hand hacksaw and leave at least 1 mm allowance for filing.
6. File the surface of edge B in an angle of 135° to surface A. File the 1 mm excess to the size required.

(Source: T14)
Metal Plate – Working Step No. 3

1. Take divider and steel rule for laying out the central point of radius = 40 mm.
2. For laying out, use surfaces "A" and "B" as basis.
3. Set the divider on 40 mm radius.
4. Scribe a circle on the left lower corner of the work piece.
5. Centre punch with at least 5 mm distance between the marking points along the line.
6. Cut on the outer part of the layout line leaving 2 mm allowance for filing.
Metal Plate – Working Step No. 4

1. Lay out using surface "A" and "B" as a basis, scribe and punch following the illustration given below on the right lower corner of the work piece.

2. Cut on the outer part of the layout line leaving 1 mm allowance for filing.

3. File the work piece and check if it is in the right measurement.
Metal Plate – Working Step No. 5

1. Lay out the two squares which are 30 mm × 30 mm and 20 mm × 20 mm as shown in the drawing above using surface "A" and "B" as a basis.
2. Mark the squares exactly as shown in the drawing above.
3. Centre punch the lines as shown in the drawing above.
4. Drill the punch mark of the inner square with an 8.5 mm twist drill.
Metal Plate – Working Step No. 6

.1 Cut the bridge between the wholes using chisel and hammer.
.2 File the outer square 30 mm × 30 mm using the necessary files.
.3 Check if the filed square is parallel to surfaces "A", "B", "C" and "D".
Metal Plate – Working Step No. 7

.1 Mark a border line for the height of the letters and vertical line for each letter. For the width, let approximately 1 mm clearance both sides.

.2 Adjust the letter stamp on the surface of the work piece.

.3 Strike the letter stamp using a 200 g hammer.
Metal Plate – Working Step No. 8

.1 Lay out the lines for drilling using the measurement given.

.2 Punch all the mark for drilling.
Metal Plate – Working Step No. 9

.1 Drill the holes with required twist drills.

.2 Countersink both sides of holes with countersink tool.

.3 Tap the threads with required screw taps.

.4 Check the specifications for holes "1" and "2" in the complete technical drawing of the work piece.
Teaching Unit 6: Bench Work Exercise 2

Necessary material and tools for this exercise:

- 1 piece flat bar 100 mm × 100 mm × 10 mm
- steel rule 400 mm and divider
- scribe
- centre punch
- hammer 200 g
- protractor
- try square and combination square
- Vernier caliper 250 mm
- hand hacksaw
- flat file 250 mm smooth and rough
- triangular file 250 mm smooth and rough
- square file 250 mm smooth and rough
- different twist drills
- different screw taps
- different countersink
- letter stamps
- chisel
Metal Plate – Working Step No. 1

.1 Take a piece of flat bar with a measurement of 100 mm lengths and 100 mm width and 10 mm thickness.

.2 The final dimension of the work piece should be 95 mm × 90 mm × 10 mm with a tolerance of plus 0.2 mm and minus 0.2 mm.

.3 Take the letter "A" stamp and stamp it as shown in the above drawing.

.4 File surface of side A even, and remove all rust and forging scale. First use a rough file, then for finishing the surface a smooth file. Control the evenness with the try square.

.5 Lay out lines from the left side as well as on the right side. Use side A as a reference to put the try square and scribe the lines.

.6 Centre punch the lines with at least 5 mm distance between the marking points.

.7 Cut on the outer part of the lines using the hand hacksaw and leave at least 1mm allowance for filing.

.8 File the surfaces of sides B and D in a 90 degree angle to surface A. File the 1mm excess to the size required.

.9 File surface of edge C even and parallel to side A to the size required. First use a rough file, then for finishing the surface a smooth file.
Metal Plate – Working Step No. 2

1. Take a combination square and set 135 degrees angle using a protractor.

2. Put the combination square at side A.

3. Scribe a line with the scribe.

4. Centre punch the line with at least 5 mm distance between the marking points.

5. Cut on the outer part of the line using the hand hacksaw and leave at least 1mm allowance for filing.

6. File the surface in an angle of 135° to surface A. File the 1mm excess to the size required.
Metal Plate – Working Step No. 3

.1 Take divider and steel rule for laying out the central point of radius = 40 mm.

.2 To lay out, use surfaces "A" and "D" as basis.

.3 Set the divider on 40 mm radius.

.4 Scribe a circle on the left lower corner of the work piece.

.5 Centre punch with at least 5 mm distance between the marking-points along the line.

.6 Cut on the outer part of the layout line leaving 2 mm allowance for filing.

.7 File the surface exactly following the marks.
Metal Plate – Working Step No. 4

.1 Lay out the two squares which are 30 mm × 30 mm and 20 mm × 20 mm as shown in the drawing above using surface “A” and “B” as your basis.

.2 Mark the squares exactly as shown in the drawing above.

.3 Centre punch the lines as shown in the drawing above.

.4 Drill the punch mark of the inner square with 8.5 mm twist drill.
Metal Plate – Working Step No. 5

1. Cut the bridge between the holes using chisel and hammer.
2. File the outer square 30 mm × 30 mm using the necessary files.
3. Check if the filed square is parallel to surfaces "A", "B", "C" and "D".
Metal Plate – Working Step No. 6

.1 Mark two lines for the height of the letters and vertical lines for each letter. For the width let approximately 1 mm clearance both sides.

.2 Adjust the letter stamp on the surface of the work piece.

.3 Strike the letter stamp using a 200 g hammer.
Metal Plate – Working Step No. 7

.1 Lay out the lines for drilling using the measurements given.

.2 Punch all the marks for drilling.
Metal Plate – Working Step No. 8

1. Drill the holes with required twist drills.
2. Countersink both sides of holes with countersink tool.
3. Tap the threads with required screw taps.
4. Check the specifications for holes "1" and "2" in the complete technical drawing of the work piece.
Appendix 2: Sample assessment

Any written examination or skills assessment should consist of a suitable number of questions that would be considered necessary to obtain sufficient evidence to confirm that trainees have acquired the knowledge or skills required for relevant competences in the table of in the STCW Code. An example of sample questions or practical skills demonstrations includes the following:

I. Example of practical assessment

Topic: Use of chain block to lift equipment

This practical assessment comprises for a group of eight candidates about 60 minutes

- Briefing = five minutes
- Practical exercise = 50 minutes
- Debriefing = five minutes

Resources

- Chain blocks of SWL 2 t which are duly tested and have valid test certificates;
- Weight of approximately 1 t;
- Shackles and slings as required of SWL 2t or greater;
- Guide ropes; and
- Safe securing points

Evaluating competence

The trainee should be able to demonstrate:

- Use of PPE;
- The correct procedure of rigging and operating a chain block;
- The application of the relevant rules of industry safe practice; and
- The hazards that could occur while rigging chain blocks, and the safety precautions to be considered.

Assessment Procedure

Carry out a risk assessment prior to lifting the load:

- Do not attempt lifting operations unless you understand the use of the equipment and the slinging procedures;
- Do not use defective blocks, slings or accessories, and never use the block chain as a sling;
– Check that the SWL of the chain block, slings and shackles exceed the weight of the load;

– Check the slinging arrangement that the block is safely rigged and that chains are not twisted, particularly in the case of multi fall blocks;

– Check the load is free to move before commencing the lift;

– Ensure suspension points and anchorages are adequate for the full imposed load;

– Check the load chain/wire rope is hanging freely and is not twisted or knotted;

– Position the hook over the centre of gravity of the load;
Check the operation of the brake before making the lift;
Ensure the slings are secure and load is free to be lifted;
Check the travel path is clear; and
Ensure the landing area is properly prepared.

Carry out the procedure to lift a load:

- Pull on the hauling chain to raise the load just clear, and then halt the lift to check the integrity of the block, slinging method etc. Check the travel path is clear and that the person has a clear view so as to avoid accidental hook disengagement;
- Keep fingers, toes etc., clear when lowering loads;
- Use guide ropes to keep the load steady and guide it to the lowering position; and
- Pull on the lowering chain to lower the load in the correct landing position

Ensure never to:

- Exceed the marked SWL;
- Use the load chain/wire rope as a sling;
- Shock load the block or other equipment;
- Lift on the point of a hook;
- Overcrowd the hook with fittings;
- Permit the load to swing out of control; and
- Leave suspended loads unattended.
II. Examples of theoretical assessments

The following theoretical questions have been provided as examples for indicative purposes only.

It is the instructor's task to prepare a set of theoretical questions that can provide different types of evidence about candidates' competence required for each function listed in table A-III/5 STCW Code.

Written assessments should comprise of a variety of different types of tasks, e.g. multiple choice questions, short essays, descriptive questions, tables and pictures to be completed with technical terms.

Pictures to be completed with technical terms

1. Fill in the blank.

The name of the object shown above is ______________.
2. Identify the parts of a globe valve

<table>
<thead>
<tr>
<th>Name</th>
<th>Alphabet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stem</td>
<td>A</td>
</tr>
<tr>
<td>Bonnet</td>
<td>B</td>
</tr>
<tr>
<td>Wheel</td>
<td>C</td>
</tr>
<tr>
<td>Union Bonnet ring</td>
<td>D</td>
</tr>
<tr>
<td>Body seat ring</td>
<td>E</td>
</tr>
<tr>
<td>Disk</td>
<td>F</td>
</tr>
<tr>
<td>Packing nut</td>
<td>G</td>
</tr>
<tr>
<td>Body</td>
<td>H</td>
</tr>
</tbody>
</table>

3. Identify the four strokes of a medium speed diesel engine.

FOUR STROKE CYCLE

- **inlet valve**
- **cylinder liner**
- **connecting rod**
- **fuel injector**
- **exhaust valve**
- **piston**
4. Fill up the boxes with the given line type

<table>
<thead>
<tr>
<th>Object line</th>
<th>Thin unbroken line</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<table>
<thead>
<tr>
<th>Hidden line</th>
<th>Center line</th>
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<td>= = = = = = =</td>
<td>= = = = = =</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimension line</th>
<th>Cross-section line</th>
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</thead>
<tbody>
<tr>
<td>60 mm</td>
<td></td>
</tr>
<tr>
<td>60 mm</td>
<td></td>
</tr>
</tbody>
</table>

(Source: T14)

Multiple Choice Questions

1. Select the best option.

What should you do on hearing general emergency alarm while sleeping in cabin at night?

a) Check with electrical officer the reason for alarm
b) Immediately rush to the engine-room
c) Quickly dress up using proper PPE and rush to the emergency muster station
d) Dress up in proper PPE and wait for further announcements on PA system

Examples of short essay or descriptive questions
With reference to four-stroke diesel engines:

a) Why is tappet clearance required?
b) How do you take accurate tappet clearance measurement?
.2 State the procedure to 'blow through' the water level gauge glass of a boiler.

Gauge Glass Blowing Through Procedure

- close the steam and water cock
- open the drain valve (water level should drop in gauge glass)
- open the steam cock (you should hear and see steam coming from drain)
- close the steam cock
- open the water side cock (you should hear and see water coming from drain)
- close the water side cock
- close the drain cock
- **FIRST** open the water side cock
- observe the rising water level
- **THEN** open the steam side cock
- water level comes down to actual level