MODEL COURSE 2.07

ENGINE-ROOM SIMULATOR

2017 EDITION

Electronic edition

IMO INTERNATIONAL MARITIME ORGANIZATION

MODEL COURSE 2.07

ENGINE-ROOM SIMULATOR

2017 EDITION

Electronic edition

INTERNATIONAL MARITIME ORGANIZATION
London, 2017

Print edition (ISBN 978-92-801-1676-2) published in 2017 by the
INTERNATIONAL MARITIME ORGANIZATION
4 Albert Embankment, London SE1 7SR
www.imo.org

Electronic edition 2017

IMO PUBLICATION
Sales number:

ACKNOWLEDGEMENTS

IMO wishes to express its sincere appreciation to the course developers Piri Reis University in Istanbul, Turkey, for their assistance and cooperation.

Contents

Page

Foreword

After the adoption of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978, the International Maritime Organization (IMO) recognized the need to provide guidance to maritime academies and training institutes to develop model training courses that are in compliance with STCW Convention requirements for certification of seafarers. Hence the IMO model course programme was introduced to provide guidance with a view to supporting maritime training providers and to assist maritime administrations responsible for the approval of STCW courses.

The model course programme has been a long-time success and IMO has developed a number of model courses to help in effectively implementing the STCW Convention and the Knowledge, Understanding and Proficiency (KUP) requirements of the STCW Code. I believe that the key to this success is adherence to the requirements of the Convention while, at the same time, these requirements are supplemented with industry best practices so that seafarers can be confident in carrying out the duties on board. The success of a course depends on the skills and competence of individual course facilitators. As part of the model courses, IMO has also developed guidance on the implementation of the model course, which may help those less experienced facilitators to make each course a success.

Whilst aiming to uniformly implement the requirements of the STCW Convention and Code, the model course programme is designed to provide flexibility so as to allow training providers to adjust the course programme to the needs of seafarers and trainees, based on their previous work experience and education.

I reiterate that IMO model courses are for the purpose of guidance only, and not to be regarded as an official interpretation of the STCW Convention. They can be of assistance to administrations to facilitate the process of approval of STCW course programmes, and could be used by maritime academies and training providers in the development of courses that satisfy the requirements set out in the STCW Convention and STCW Code.

This model course was validated by the IMO Sub-Committee on Human Element, Training and Watchkeeping at its fourth session (30 January to 3 February 2017) and I wish training providers and seafarers that the course makes the navigation of ships safer.

K. Lim
Secretary-General

Introduction

Purpose of the model courses

The purpose of the IMO model course is to assist maritime training providers and their teaching staff in organizing and introducing new training courses or in enhancing, updating or supplementing existing training material where the quality and effectiveness of the training courses may thereby be improved. This model course is particularly intended to assist trainers who utilize a simulator as a teaching aid for conducting training related to engine-room simulation described in the STCW Code.

It is not the intention of the model course programme to present instructors with a rigid "teaching package", which they are expected to "follow blindly". Nor is it the intention to substitute audiovisual or "programmed" material for the instructor's presence. 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. Training providers may modify this course to suit their respective training schemes.

As in all training, the knowledge, skills and dedication of the instructors are the key components in the transfer of knowledge and skills to those being trained using IMO model courses.

The educational systems and the cultural backgrounds of trainees vary considerably from country to country. Hence, 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 contents and levels of knowledge and skills necessary to meet the technical intents of IMO conventions and related recommendations.

Please note that this course only supplements training in specific areas of shipboard marine engineering and watchkeeping; it does not completely satisfy the STCW requirements for Engine-Room Resource Management, Leadership & Management or Leadership and Team-working Skills. However, portions of this course may be incorporated into these courses in order to enhance the learning experience.

In order to keep the training programme up to date in future, it is essential that users provide feedback. New information will provide better training in safety at sea and protection of the marine environment. Information, comments and suggestions should be sent to the Head of Maritime Training and Human Element in the Maritime Safety Division of IMO.

Use of the model course

The instructor should review the course plan and detailed syllabus, taking into account the information provided under the entry standards specified in the course framework. The actual level of knowledge and skills of the trainees should be kept in mind during this review. The level of prior knowledge and skills can be assessed to confirm the actual level that has been attained. To compensate for any differences between the actual trainee level and that assumed by the model course developers, the instructor is expected to adjust the content of the course accordingly.

For trainees who exceed the model course developers' assumptions the instructor is expected to delete from the course, or reduce the emphasis on, items dealing with the trainee's existing prior knowledge or skills. For trainees who do not meet the model course developers' assumptions the instructor is expected to 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.

Within the course plan, the course developers have indicated their assessment of the time that should be allotted to each area of learning. However, it must be appreciated that these allocations are for indication purposes only, and assume that the trainees have met all of the entry requirements for 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 address the requirements of Section A-I/12, paragraphs 6 and 7, related to engine-room simulator training to address the competences in tables A-III/1, A-III/2, A-III/4, A-III/6 and A-III/7.

Lesson plans

Instructors should develop lesson plans based on the detailed teaching syllabus and specifications of simulators. Instructors should pay due attention to the trainees' background and previous knowledge when adjusting the course content to suit the trainee intake and any revision of the course objectives. The detailed teaching syllabus describes required performances together with exercise scenarios in the appendices to be used to deliver the course.

Presentation

The presentation will be made in briefing and debriefing sessions, and the concepts and methodologies must be repeated in various ways until the instructor is satisfied that the trainees have attained the required proficiency to meet each specific learning objective. The detailed teaching syllabus is laid out in learning objective format, and each objective specifies the knowledge, understanding and proficiency the trainees shall have acquired after the exercise to meet the knowledge, understanding and proficiency specified in the appropriate tables of the STCW Code.

Evaluation or assessment of a trainee's progress

This course will involve all the trainees and instructors in an ongoing process of individual and group evaluation. However, formal evaluation is an important aspect of all simulator training because it provides the means to determine whether or not the trainees have achieved the prescribed standard of competence. This competence is needed during normal watchkeeping and operation, and can be vital in emergency situations. Formal evaluation should be emphasized and conducted as soon as the trainees are ready and always at the end of the simulator exercises.

Implementation

For the course to run smoothly and to be effective, considerable attention must be paid to thorough planning and preparation prior to each exercise concerning:

- teaching facility
- equipment
- exercises/training scenarios
- assignments and technical papers, and
- other reference material.

Properly qualified and trained instructors, support staff, observers and assessors are absolutely vital in order to achieve good end results.

Training and the STCW Code

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978, as amended, defines the minimum standards of competence that have to be met by seafarers in Part A of the STCW Code. This IMO model course has been revised and updated pursuant to the 2010 Manila Amendments to address:

- Table A-III/1: Specification of minimum standard of competence for officers in charge of an engineering watch in a manned engine-room or designated duty engineers in a periodically unmanned engine-room;

- Table A-III/2: Specification of minimum standard of competence for chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3,000 kW propulsion power or more;
- Table A-III/4: Specification of minimum standard of competence for ratings forming part of an engineering watch;
- Table A-III/6: Specification of minimum standard of competence for electro-technical officers; and
- Table A-III/7: Specification of minimum standard of competence for electro-technical ratings.

Each minimum standard of competence has Functions as follows:

- Marine engineering at the support level/operational level/management level
- Electrical, electronic and control engineering at the operational level/management level
- Maintenance and repair at the support level/operational level/management level
- Controlling the operation of the ship and care for the persons on board at the support level/operational level/management level

This model course covers three Functions from among the above mentioned other than "Controlling the operation of the ship and care for the persons on board at the support level/operational level/management level".

Mandatory provisions concerning qualifications of instructors, supervisors and assessors; in-service training; assessment of competence; and training and assessment within an institution are given in Section A-I/6 of the STCW Code. The corresponding Part B of the STCW Code contains guidance on training and assessment.

Structure of the course

This model course consists of the following:

Part A – Course framework

This provides the framework for the course with its aims and objectives and notes on the recommended teaching facilities and equipment.

Part B – Course outline

This provides an outline of exercises for the course. No detailed timetable is recommended. From the aspects of teaching and learning, it is more important that the trainees achieve the minimum standard of competence defined in the STCW Code than a strict timetable be followed.

Part C – Detailed teaching syllabus

This is based on the theoretical and practical knowledge specified in the STCW Code and is written as a series of learning objectives. Each of the objectives is expanded to define a required performance of knowledge, understanding and proficiency.

Part D – Instructor manual

This provides recommended key information for the instructor to design and conduct the course.

Part E – Evaluation and assessment

This provides prevalent notions of the evaluation for exercises. Each sample exercise in the appendices explains specific methods for demonstrating competence, and criteria for evaluating competence, as tabulated in the STCW Code. IMO model course 3.12 specifically addresses Examination and Assessment of Competence of Seafarers.

Part A: Course Framework

Scope

This model course describes guidelines for training using an engine-room simulator specified as one method of demonstrating competence in Column 3 of the tables A-III/1, A-III/2, A-III/4, A-III/6 and A-III/7, except the Function "Controlling the operation of the ship and care for the persons on board at the operational level/ management level".

The exercises, supervised by an instructor, will initially allow the trainees to become familiar with the machinery and controls used in the engine-rooms of modern merchant ships. Furthermore, the trainees should become skilled in the scanning of instrument displays when assessing the normal operational conditions of a propulsion plant.

Each exercise should be preceded by a briefing session and followed up by a group debriefing, which will analyse the actions and decisions made by the trainees.

Note: It should be emphasized that this course does not provide the equivalent of the experience acquired from actual watchkeeping service in the engine-room on board a ship.

Objective

To provide knowledge and skills related to operation, supervising and monitoring the safe operation and control of ship's machinery in accordance with A-III/1, A-III/2, A-III/4, A-III/6 and A-III/7 of the STCW Code.

In particular, the trainees will be able to have:

- familiarization with the use of instrumentation and controls used in the engine-rooms of modern merchant ships
- an awareness of the need for proper pre-planning, the use of checklists and of the timescale involved in starting up propulsion plant machinery
- experience in identifying operational problems and troubleshooting
- the ability of logical decisionmaking which promotes operational safety.

Entry standards

Entry to the course is open to trainees with basic background and knowledge of engine-room machinery and to marine engineers who wish to improve their knowledge and understanding of the operation of the machinery of a modern merchant ship.

Course intake limitations

The course intake limitation will, to some extent, depend on the facilities provided by the type of simulator used and the target activity will regulate the number of trainees who can use the simulator at any given time. Trainees must therefore be subdivided into groups as necessary and activities should be phased so that all trainees can receive the same period of training on the simulator. In such a case, the briefing and debriefing sessions can be carried out as main group or sub-group activities, according to circumstances. Ideally, instructor to trainee ratio for class room lectures is recommended as 1:24.

Staff requirements

Both the assessor and the instructor should be qualified according to Section A-I/6 of the STCW Code.

The instructor should have good knowledge in the following subject areas in order to support trainees' learning in a proper way:

- simulator's model and the instructor system
- pedagogical experience about teaching
- subject area of Marine engineering.

Teaching aids

TA1 Instructor Manual (Part D of this course) and Appendices

IMO references

R1 Chapter III, International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, (STCW) 1978 as amended)

R2 Chapter III, Part A and Chapter VIII, Part A and B, of the Seafarers Training, Certification and Watchkeeping (STCW) Code

R3 STCW regulation I/12; Section A-I/12

STCW Section B-I/12 on the main and auxiliary machinery operation simulation performance standard

R4 STCW tables A-III/1, III/2, III/4, III/6 and III/7

R5 IMO model courses

6.09 – Training course for instructors

6.10 – Train the Simulator Trainer and Assessor

7.02 – Chief Engineer Officer and Second Engineer Officer

7.04 – Officer in charge of an Engineering Watch

7.08 – Electro-Technical Officer

Textbooks

T1 Instruction books of simulators

Bibliography

B1 Taylor, D.A. Introduction to Marine Engineering. 2nd ed. London, Butterworth. 1990 (ISBN 07-50-6253-9)

B2 Diesel Engines for Ship Propulsion and Power Plants, Volumes I & II. K. Kuiken Target Global Energy (ISBN 978-90-79104-02-4)

B3 Pounder's Marine Diesel Engines and Gas Turbines, 8th edition (ISBN 0-7506-5846-0)

B4 McGeorge H.D., Marine Auxiliary Machinery, Seventh Edition, Butterworth-Heinemann, 1995 (ISBN 0 7506 4398 6)

B5 Application of Automatic Machinery and Alarm Equipment in Ships; R. G. SMITH; Institute of Marine Engineers (ISBN: 0900976152)

Teaching facilities and equipment

In general, an engine-room simulator is a training tool which is able to represent static and dynamical characteristics of ship's propulsion plant machinery illustrating its machinery installations and indicating running parameters, and represent changes in the running parameters responding to the machinery characteristics and inputs entered by trainees.

As far as training using the engine-room simulators is concerned, some provisions necessary for planning and implementing the training are described in regulation I/12 of the STCW Convention and the relevant sections A-I/12 and B-I/12 of the STCW Code.

The provisions of the STCW Code A and B concerned in the engine-room simulators imply performance of teaching facilities and equipment describing "General performance standards for simulators used in assessment of competence" (A-I/12) and "Recommended performance standards for non-mandatory types of simulation" (B-I/12) as follows:

General performance standards for simulators used in assessment of competence

STCW Code A-I/12 (paragraph 2)

2 Each Party shall ensure that any simulator used for the assessment of competence required under the Convention or for any demonstration of continued proficiency so required shall:

.1 be capable of satisfying the specified assessment objectives;

.2 be capable of simulating the operational capabilities of the shipboard equipment concerned to a level of physical realism appropriate to the assessment objectives, and include the capabilities, limitations and possible errors of such equipment;

.3 have sufficient behavioural realism to allow a candidate to exhibit the skills appropriate to the assessment objectives;

.4 provide an interface through which a candidate can interact with the equipment and simulated environment;

.5 provide a controlled operating environment, capable of producing a variety of conditions, which may include emergency, hazardous or unusual situations relevant to assessment objectives; and

.6 permit an assessor to control, monitor and record exercises for the effective assessment of the performance of candidates.

Main and auxiliary machinery operation simulation

STCW Code B-I/12 (paragraph 73)

73 Engine-room simulation equipment should be capable of simulating a main and auxiliary machinery system and incorporate facilities to:

.1 create a real-time environment for seagoing and harbour operations, with communication devices and simulation of appropriate main and auxiliary propulsion machinery equipment and control panels;

.2 simulate relevant sub-systems that should include, but not be restricted to, boiler, steering gear, electrical power general and distribution systems, including emergency power supplies, and fuel, cooling water, refrigeration, bilge and ballast systems;

.3 monitor and evaluate engine performance and remote sensing systems;

.4 simulate machinery malfunctions;

.5 allow for the variable external conditions to be changed so as to influence the simulated operations: weather, ship's draught, seawater and air temperatures;

.6 allow for instructor-controlled external conditions to be changed: deck steam, accommodation steam, deck air, ice conditions, deck cranes, heavy power, bow thrust, ship load;

.7 allow for instructor-controlled simulator dynamics to be changed: emergency run, process responses, ship responses; and

.8 provide a facility to isolate certain processes, such as speed, electrical system, diesel oil system, lubricating oil system, heavy oil system, seawater system, steam system, exhaust boiler and turbo generator, for performing specific training tasks.

A simulator is a useful tool to provide training for seafarers of all grades, it gives a possibility to both training technical skills and groups. Some of the basic functions of a simulator are:

- To understand and give possibility to exercise real life systems
- To give a vision of which system interacts with others
- To be used in advanced exercises with engine systems
- To study real life cases in a reliable environment
- Real equipment know-how
- Regulatory understanding
- Operational experience
- External interfaces
- Visualization
- E-learning
- User interface
- Physical modelling
- Training & Exercises
- Software architecture
- Assessment & Evaluation

The simulators could be divided into four different groups:

Category 1 – Full Mission

The full mission simulators can be divided into different groups and could differ due to classification societies' performance standards. The full mission simulator is capable of simulating most of the different machinery operations both in the engine control room and machinery spaces. The panels could be both hardware and touch screen.

Category 2 – Multi Task

A multi task simulator should have most of the class 1 simulator functions, but less functions in the machinery spaces, and will need less physical space.

Category 3 – Limited Task

Fewer functions and a limited task simulator capable of simulating some machinery operations mainly in the engine control room.

Category 4 – Single Task

Often set up as a lecture hall with dual screens, the instructor has flexibility and the possibility to conduct proper exercises. It could also be recommended to provide each part task station with a computer to use websites and learning platforms to support the learning.

Part B: Course Outline

Course outline

Any simulator training shall consist of briefing, implementation and debriefing including evaluation. This model course provides sample exercises of simulator training in the Appendix. The sample exercises can be used as examples and the instructor should develop exercises based on their own simulators in order to suit individual groups of trainees, depending on their experience, ability, equipment and staff available for training.

Lectures

As far as possible, briefing and debriefing lectures should be presented within a familiar context and should make use of practical examples. They should be well illustrated with diagrams and photographs, and be related to matter learned during simulator exercises.

As far as simulator training is concerned, it is essential not to miss the specific purpose of the exercises, and instructors should allow trainees to perform simulations with awareness of what they are doing. For this reason, the instructors should present their briefing and debriefing in a specific manner of describing tasks to be done during their performance of the simulation.

Timetable

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

Instructors must develop their own timetable depending on:

- level of skills of trainees
- numbers to be trained
- number of instructors
- simulator facilities and equipment available

and normal practices at the training establishment.

Application to the tables

The following tables show recommended applications of training using "Engine-room simulator" to "Competence" and "Knowledge, understanding and proficiency (KUP)" with "approved simulator training, where appropriate" as an option of "Methods for demonstrating competence" described in Tables A-III/1, A-III/2, A-III/4, A-III/6 and A-III/7 of the STCW Code. (Competences without "approved simulator training, where appropriate" are omitted.)

B1. Table A-III/1: Specification of minimum standard of competence for officers in charge of an engineering watch in a manned engine-room or designated duty engineers in a periodically unmanned engine-room

Function: Marine engineering at the operational level

Competence	Knowledge, understanding and proficiency	Subject area
Maintain a safe engineering watch	Thorough knowledge of principles to be observed in keeping an engineering watch, including: .1 duties associated with taking over and accepting a watch .2 routine duties undertaken during a watch .3 maintenance of the machinery space logs and the significance of the readings taken .4 duties associated with handing over a watch	3.1
	Safety and emergency procedures; change-over of remote/automatic to local control of all systems	3.2
	Safety precautions to be observed during a watch and immediate actions to be taken in the event of fire or accident, with particular reference to oil systems	3.3
	Engine-room resource management Knowledge of engine-room resource management principles including: .1 allocation, assignment, and prioritization of resources .2 effective communication .3 assertiveness and leadership .4 obtaining and maintaining situational awareness .5 consideration of team experience	
Operate main and auxiliary machinery and associated control systems	Basic construction and operation principles of machinery systems, including: (Omitted) Safety and emergency procedures for operation of propulsion plant machinery, including control systems	----
	Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems: .1 main engine and associated auxiliaries .2 steam boiler and associated auxiliaries and steam systems .3 auxiliary prime movers and associated systems .4 other auxiliaries including refrigeration, air-conditioning and ventilation systems	2.5, 2.10 2.4 2.3, 2.6 2.1, 2.2, 2.7
Operate fuel, lubrication, ballast and other pumping systems and associated control systems	Operational characteristics of pumps and piping systems including control systems	----
	Operation of pumping systems: .1 routine pumping operations .2 operation of bilge, ballast and cargo pumping systems Oily water separators (or similar equipment) requirements and operation	2.8 2.9

Function: Electrical, electronic and control engineering at the operational level

Competence	Knowledge, understanding and proficiency	Subject area
Operate electrical, electronic and control systems	Basic configuration and operation principles of the following electrical, electronic and control equipment:	
	.1 electrical equipment	
	.a generator and distribution systems	----
	.b preparing, starting, paralleling and changing over generators	4.1
	.c electrical motors including starting methodologies	----
	.d high-voltage installations	4.2
	.e sequential control circuits and associated system devices	----
	.2 electronic equipment	
	.a characteristics of basic electronic circuit elements	
	.b flowchart for automatic and control system	
	.c functions, characteristics and features of control systems for machinery items including main propulsion plant operation control and steam boiler automatic controls	----
	.3 control systems	
	.a various automatic control methodologies and characteristics	
	.b Proportional–Integral–Derivative (PID) control characteristics and associated system devices for process control	

B2. Table A-III/2: Specification of minimum standard of competence for chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3,000 kW propulsion power or more

Function: Marine engineering at the management level

Competence	Knowledge, understanding and proficiency	Subject area
Manage the operation of propulsion plant machinery	Design features, and operative mechanism of the following machinery and associated auxiliaries:	
	.1 marine diesel engine	
	.2 marine steam turbine	
	.3 marine gas turbine	----
	.4 marine steam boiler	
Plan and schedule operations	*Theoretical knowledge*	
	Thermodynamics and heat transmission	
	Mechanics and hydromechanics	
	Propulsive characteristics of diesel engines, steam and gas turbines including speed, output and fuel consumption	1.1

Competence	Knowledge, understanding and proficiency	Subject area
Plan and schedule operations *(Cont.)*	Heat cycle, thermal efficiency and heat balance of the following: .1 marine diesel engine .2 marine steam turbine .3 marine gas turbine .4 marine steam boiler	 1.2 ---- 1.2
	Refrigerators and refrigeration cycle	----
	Physical and chemical properties of fuels and lubricants Technology of materials Naval architecture and ship construction, including damage control	----
Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery	*Practical knowledge* Start up and shut down main propulsion and auxiliary machinery, including associated systems	2.1
	Operating limits of propulsion plant	2.2
	The efficient operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery	2.3
	Functions and mechanism of automatic control for main engine	2.4
	Functions and mechanism of automatic control for auxiliary machinery including but not limited to: .1 generator distribution systems .2 steam boilers .3 oil purifier .4 refrigeration system .5 pumping and piping systems .6 steering gear system .7 cargo handling equipment and deck machinery	----
Manage fuel, lubrication and ballast operations	Operation and maintenance of machinery, including pumps and piping systems	

Function: Electrical, electronic and control engineering at the management level

Competence	Knowledge, understanding and proficiency	Subject area
Manage operation of electrical and electronic control equipment	*Theoretical knowledge* Marine electrotechnology Electronics Power electronics Automatic control engineering and safety devices	
	Design features and system configurations of automatic control equipment and safety devices for the following: .1 main engine .2 generator and distribution system .3 steam boiler Design features and system configurations of operational control equipment for electrical motors	----
	Design features of high voltage installations	3.1
	Features of hydraulic and pneumatic control equipment	
Manage troubleshooting, restoration of electrical and electronic control equipment to operating condition	*Practical knowledge* Troubleshooting of electrical and electronic control equipment Function test of electrical, electronic control equipment and safety devices Troubleshooting of monitoring systems Software version control	----

Function: Maintenance and repair at the management level

Competence	Knowledge, understanding and proficiency	Subject area
Detect and identify the cause of machinery malfunctions and correct faults	*Practical knowledge* Detection of machinery malfunction, location of faults and action to prevent damage	4.1
	Inspection and adjustment of equipment Non-destructive examination	----

B3. Table A-III/4: Specification of minimum standard of competence for ratings forming part of an engineering watch

Function: Marine engineering at the support level

Competence	Knowledge, understanding and proficiency	Subject area
For keeping a boiler watch: **Maintain the correct water levels and steam pressures**	Safe operation of boilers	2.1

B4. Table A-III/6: Specification of minimum standard of competence for electro-technical officers

Function: Electrical, electronic and control engineering at the operational level

Competence	Knowledge, understanding and proficiency	Subject area
Monitor the operation of electrical, electronic and control systems	Basic understanding of the operation of mechanical engineering systems, including: .1 prime movers, including main propulsion plant .2 engine-room auxiliary machineries .3 steering systems	3.1
	.4 cargo handling systems .5 deck machineries .6 hotel systems	----
	Basic knowledge of heat transmission, mechanics and hydromechanics	----
	Knowledge of: Electro-technology and electrical machines theory Fundamentals of electronics and power electronics	----
	Electrical power distribution boards and electrical equipment	3.1
	Fundamentals of automation, automatic control systems and technology	3.2
	Instrumentation, alarm and monitoring systems Electrical drives Technology of electrical materials Electro-hydraulic and electro-pneumatic control systems Appreciation of the hazards and precautions required for the operation of power systems above 1,000 volts	----
Monitor the operation of automatic control systems of propulsion and auxiliary machinery	Preparation of control systems of propulsion and auxiliary machinery for operation	3.1
Operate generators and distribution systems	Coupling, load sharing and changing over generators Coupling and breaking connection between switchboards and distribution panels	2.1
Operate and maintain power systems in excess of 1,000 volts	*Theoretical knowledge* High-voltage technology Safety precautions and procedures	----
	Electrical propulsion of the ships' electrical motors and control systems *Practical knowledge* Safe operation and maintenance of high-voltage systems, including knowledge of the special technical type of high-voltage systems and the danger resulting from operational voltage of more than 1,000 volts	4.1

Function: Maintenance and repair at the operational level

Competence	Knowledge, understanding and proficiency	Subject area
Maintain and repair automation and control systems of main propulsion and auxiliary machinery	Appropriate electrical and mechanical knowledge and skills *Safety and emergency procedures* Safe isolation of equipment and associated systems required before personnel are permitted to work on such plant or equipment Practical knowledge for the testing, maintenance, fault finding and repair Test, detect faults and maintain and restore electrical and electronic control equipment to operating condition Knowledge of the principles and maintenance procedures of navigation equipment, internal and external communication systems	----
Maintain and repair bridge navigation equipment and ship communication systems	*Theoretical knowledge* Electrical and electronic systems operating in flammable areas	
	Practical knowledge Carrying out safe maintenance and repair procedures	
	Detection of machinery and electrical malfunctions, location of faults and action to prevent damage	5.1 & 5.2

B.5 Table A-III/7: Specification of minimum standard of competence for electro-technical ratings

Function: Maintenance and repair at the support level

Competence	Knowledge, understanding and proficiency	Subject area
Contribute to the maintenance and repair of electrical systems and machinery on board	Safety and emergency procedures Basic knowledge of electro-technical drawings and safe isolation of equipment and associated systems required before personnel are permitted to work on such plant or equipment	----
	Test, detect faults and maintain and restore electrical control equipment and machinery to operating condition	2.1
	Electrical and electronic equipment operating in flammable areas Basics of ship's fire-detection system Carrying out safe maintenance and repair procedures	----
	Detection of machinery malfunction, location of faults and action to prevent damage	2.2
	Maintenance and repair of lighting fixtures and supply systems	----

Course Outline

Subject Area		Hours
A-III/1		**49**
1	**Familiarization**	6
1.1	Plant arrangement	
1.2	Instrumentation	
1.3	Alarm system	
1.4	Controls	

Subject Area		Hours
2	**Operation of plant/machinery**	
2.1	Operational procedures	
2.2	Operation of main and auxiliary machinery and systems	
2.3	Operation of diesel generator	20
2.4	Operation of steam boiler	
2.5	Operation of main engine and associated auxiliaries	
2.6	Operation of steam turbo generator	
2.7	Operation of fresh water generator	
2.8	Operation of pumping system	
2.9	Operation of oily water separator	
2.10	Fault detection and measures	
3	**Maintain a safe engineering watch**	19
3.1	Thorough knowledge of principles to be observed in keeping an engineering watch	
3.2	Safety and emergency procedures; changeover of remote/automatic to local control of all systems	
3.3	Safety precautions to be observed during a watch and immediate actions to be taken in the event of fire or accident, with particular reference to oil systems	
3.4	Knowledge of engine-room resource management principles	
4	**Operate electrical, electronic and control systems**	4
4.1	Operation of main switch board	
4.2	High-voltage installations	
A-III/2		**22**
1	**Plan and schedule operations**	6
1.1	Propulsive characteristics of diesel engines and steam turbines including speed, output and fuel consumption	
1.2	Heat cycle, thermal efficiency and heat balance	
2	**Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery**	
2.1	Start up and shut down main propulsion and auxiliary machinery	8
2.2	Operating limits	
2.3	Performance assessment	
2.4	Functions and mechanism of automatic control for main engine	
3	**Manage operation of electrical and electronic control equipment**	2
3.1	Design features and system configurations of high-voltage installations	
4	**Detect and identify the cause of machinery malfunctions and correct faults**	6
4.1	Detection of machinery malfunctions, location of faults and action to prevent damage	
A-III/4		**7**
1	**Familiarization**	5
1.1	Plant arrangement	
1.2	Instrumentation	
1.3	Alarm system	
1.4	Controls	

Subject Area		Hours
2	**Maintain correct boiler water levels and steam pressures**	2
2.1	Safe operation of boilers	
A-III/6		**19**
1	**Familiarization**	6
1.1	Plant arrangement	
1.2	Instrumentation	
1.3	Alarm system	
1.4	Controls	
2	**Operate generators and distribution systems**	2
2.1	Coupling and breaking connection between switchboards and distribution panels	
3	**Monitor the operation of electrical, electronic and control systems**	5
3.1	Basic understanding of the operation of mechanical engineering systems	
3.2	Fundamentals of automation, automatic control systems and technologies	
4	**Operate and maintain power systems in excess of 1,000 volts**	2
4.1	Electrical propulsion ship	
5	**Maintain and repair automation and control systems of main propulsion and auxiliary machinery**	4
5.1	Detection of machinery malfunctions, location of faults and action to prevent damage	
5.2	Detection of electrical malfunction, location of faults and action to prevent damage	
A-III/7		**7**
1	**Familiarization**	3
1.1	System arrangement	
1.2	Instrumentation	
1.3	Alarm system	
2	**Contribute to the maintenance and repair of electrical systems and machinery on board**	4
2.1	Test, detect faults and maintain and restore electrical control equipment and machinery to operating condition	
2.2	Detection of machinery malfunctions, location of faults and action to prevent damage	

Part C: Detailed Teaching Syllabus

The detailed teaching syllabus has been written in "Required performance" format. It describes what the trainees must do to demonstrate that the specified knowledge or skill has been achieved.

All the required performances are prefixed by the words, "The expected learning outcome is that the trainees should be able to …."

In order to assist the instructor, references are shown beside the learning objectives to indicate IMO references and publications, textbooks, and teaching aids. The instructor may wish to use them for preparing and presenting course materials. The material listed in the course framework has been used to structure the detailed teaching syllabus:

IMO/STCW references (indicated by R),
Textbooks (indicated by T), and
Bibliography (indicated by B).

The abbreviations used are:

App.: appendix
Ex.: sample exercise
Ch.: chapter
Para.: paragraph
Reg.: regulation
Sect.: section
Ta.: table

C1. Table A-III/1: Specification of minimum standard of competence for officers in charge of an engineering watch in a manned engine-room or designated duty engineers in a periodically unmanned engine-room

Refer to model course 7.04 – Officer in charge of an Engineering Watch

Function: Marine engineering at the operational level

1 Familiarization

Subject area:

1.1 *Plant arrangement*

IMO/STCW Reference:
Textbooks and Bibliography: B1, B2
Teaching aids: T1, App. Ex. 1

Required performance:

1.1.1 identify purposes of each machinery system which forms the simulated propulsion plant

1.1.2 list the machinery and associated systems and equipment including key valves, tanks and other auxiliary machinery which form the simulated propulsion plant such as:

(Diesel engine)

- main machinery system
- electric power generation system
- steam generation system
- fuel oil supply system
- fuel oil treatment system
- fuel oil transfer system
- cooling fresh water system
- cooling sea water system
- feed water system
- steam system
- lubricating oil system
- compressed air system
- bilge treatment system

(Steam turbine)

- main steam system
- circulation system
- condensate water system
- feed water system
- gland steam system
- bleeding system
- makeup system
- vacuum system

1.1.3 describe how the machinery and associated systems and equipment are arranged and linked together to form the propulsion plant and compile a block diagram illustrating this

Subject area:

1.2 *Instrumentation*

IMO/STCW Reference:
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 2

1.2.1 identify instrumentation used in the simulated propulsion plant

1.2.2 describe purposes of the instrumentation

1.2.3 list the instrumentation and units used in the simulated propulsion plant such as:

- pressure
- temperature
- fluid level
- volume/mass (quantity)
- flow rate
- viscosity
- speed of rotation
- torque/power
- rudder angle
- voltage
- current
- frequency
- kW
- CO_2 content
- Indicator diagram

Subject area:

1.3 *Alarm system*

IMO/STCW Reference:
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 3

Required performance:

1.3.1 identify the alarms that are used to indicate malfunctions and faults

Subject area:

1.4 *Controls*

IMO/STCW Reference:
Textbooks and Bibliography: B5
Teaching aids: T1, App. Ex. 4

Required performance:

1.4.1 identify equipment used for automatic and remote controls in the simulated propulsion plant

1.4.2 state machinery which are remotely controlled from the control room and the bridge

1.4.3 state briefly automatic control methods applied to the machinery which form propulsion plant

1.4.4 demonstrate the use of controls from each location

2 Operation of plant/machinery

Subject area:

2.1 *Operational procedures*

IMO/STCW Reference: R4: A-III/1, R5: 7.04
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 5

Required performance:

2.1.1 state the importance of safe and cautious practice when preparing machinery and associated systems for start up and operation

2.1.2 list precautions for:

- opening and closing valves
- starting and running pumps
- operating cooling water systems
- admitting steam into a steam system
- firing up an oil-fired boiler
- filling oil tanks
- running bilge treatment system

2.1.3 state that as far as practicable a check list should be used for all machinery and associated systems when:

- preparing for use
- starting up
- entering normal operating mode
- shutting down

2.1.4 compile a check list for preparation, start up and operation of auxiliary machineries or systems used in the simulated propulsion plant

2.1.5 demonstrate the use of the compiled check list mentioned above

Subject area:

2.2 *Operation of auxiliary machineries and systems*

IMO/STCW Reference: R4: A-III/1, R5: 7.04
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 5

Required performance:

2.2.1 state procedures to establish auxiliary machinery systems from the cold ship such as:

- emergency generator system
- cooling sea water system
- cooling fresh water system
- compressed air system
- fuel oil treatment system

2.2.2 demonstrate preparation, start up and putting auxiliary machinery into the normal operating mode to establish the systems mentioned above

Subject area:

2.3 *Operation of diesel generator*

IMO/STCW Reference: R4: A-III/1, R5: 7.04
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 6

Required performance:

2.3.1 state procedures to start up and stop the diesel generator

2.3.2 list checking points necessary to make sure running conditions of the prime mover after the start up

2.3.3 state precautions and conditions before putting the generator into service

2.3.4 demonstrate preparation, start up and run the diesel generator

2.3.5 demonstrate connection of the diesel generator to BUS line

2.3.6 demonstrate disconnection of the diesel generator from BUS line and stop the diesel generator

2.3.7 demonstrate setting up standby conditions of the diesel generator

Subject area:

2.4 *Operation of steam boiler*

IMO/STCW Reference: R4 A-III/1, R5: 7.04
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 5

Required performance:

2.4.1 state procedures to start up and stop the steam boiler

2.4.2 list precautions before starting up the steam boiler from the cold condition

2.4.3 list precautions when raising steam to normal working pressure

2.4.4 list precautions before stopping the steam boiler from the running condition

2.4.5 list precautions before putting the steam boiler into service

2.4.6 demonstrate preparation for starting up the steam boiler and raise steam to normal working pressure

2.4.7 demonstrate putting the steam boiler into service

Subject area:

2.5 *Operation of main engine and associated auxiliaries*

IMO/STCW Reference: R4: A-III/1, R5: 7.04
Textbooks and Bibliography: B1, B2, B3, B4
Teaching aids: T1, App. Ex. 8

Required performance:

(Main diesel engine)

2.5.1 state essential sequence of preparation for starting up main diesel engine as follows:

- cooling fresh water system including warming up if necessary
- lubricating system
- fuel oil system
- cooling sea water system, if necessary

2.5.2 demonstrate preparation procedures applying the check list, including:

- checking the cooling water circulation and temperature through heat exchangers
- checking the lubricating oil circulation including piston cooling and temperature through engine and heat exchangers
- checking the fuel oil circulation through heater to injection pump inlet

(Main steam turbine)

2.5.3 state essential sequence of preparation for starting up main steam turbine as follows:

- preparation for warming up
- lubricating oil system
- circulation system
- condensate water system
- commencement of turning steam turbine
- warming up
- supply of gland steam
- start of vacuum pump
- supply of warming up steam
- preparation for start up
- increase of vacuum
- commencement of roll over

2.5.4 demonstrate preparation procedures applying the check list, including:

- checking the lubricating oil circulation and temperature through bearings, reduction gears and heat exchangers
- checking the cooling water circulation through main condenser
- checking condensate water circulation and level of hot well
- starting turning of main turbines

2.5.5 demonstrate warming up procedures, including:

- checking gland steam flow and pressure
- checking low vacuum inside main condenser
- supplying warming up steam and checking the steam flow

Subject area:

2.6 *Operation of steam turbo generator*

IMO/STCW Reference: R4: A-III/1, R5: 7.04
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 8

Required performance:

2.6.1 describe conditions necessary to start up the steam turbo generator

2.6.2 state procedures to start and stop the steam turbo generator

2.6.3 list precautions for starting up and stopping the steam turbo generator

2.6.4 describe special attentions to the steam turbine when handling it

2.6.5 demonstrate preparation, starting up, running and stopping of the steam turbo generator

2.6.6 demonstrate connection of the steam turbo generator to BUS line and parallel running including optimum load sharing between diesel and turbo generators

Subject area:

2.7 *Operation of Fresh Water Generator (FWG)*

IMO/STCW Reference: R4: A-III/1, R5: 7.04
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 8

Required performance:

2.7.1 state working principles of FWG

- immersed type
- flash type

2.7.2 state that FWG works as Cooling Fresh Water (CFW) cooler for diesel engine propulsion system

2.7.3 describe importance of FWG on steam turbine ships

2.7.4 describe precautions when starting up FWG

2.7.5 describe how to address high-salinity of generated water

2.7.6 demonstrate start and stop FWG

Subject area:

2.8 *Operation of pumping system*

IMO/STCW Reference: R4: A-III/1, R5: 7.04
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 9

Required performance:

2.8.1 demonstrate routine pumping operations

- transfer bunker oil
- transfer bilge, sludge, drain and separated oil
- send sea water for general use

Subject area:

2.9 *Operation of oily water separator*

IMO/STCW Reference: R4: A-III/1, R5: 7.04
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 9

Required performance:

2.9.1 state conditions on discharging bilge based on the relevant regulations and the convention

2.9.2 state procedures necessary for discharging bilge including:

- bilge to be discharged
- approximate quantity of bilge to be discharged
- area of sea
- notification to the bridge

2.9.3 demonstrate preparation for starting up the oily water separator including:

- starting bilge pump with sea water
- checking sea water flow and pressure of the separator
- checking separated oil tank level

2.9.4 demonstrate:

- alarm test
- changeover function at 15 ppm of the oil content meter
- check the ppm indication is in normal range

2.9.5 demonstrate operation of the separator checking:

- oily water flow and pressure
- indication of oil content monitor
- levels of bilge wells/tank
- make entries for transfer operations in the Oil Record Book as per the latest IMO guidelines

Subject area:

2.10 *Fault detection and measures*

IMO/STCW Reference: R4: A-III/1 and A-III/6, R5: 7.04
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 10

Required performance:

2.10.1 locate and demonstrate remedial action for the following malfunctions or faults:

- engine-room bilge well high level
- No. 1 fuel oil settling tank low level
- FWG high salinity
- auxiliary boiler low water level
- fuel oil purifier abnormal separation
- boiler flame failure
- boiler finance blowback

2.10.2 discuss possible causes of the malfunctions or faults

2.10.3 review the remedial actions taken for the malfunctions or faults

3 Maintain a safe engineering watch

Subject area:

3.1 *Thorough knowledge of principles to be observed in keeping an engineering watch*

IMO/STCW Reference: R2: Ch. VIII, Sect. A-VIII/1 Para 10, Sect. A-VIII/2 Part 4 Para 9~12, Part 4-2 Para 52~83, Part 5 Para 90~97, Part 5-2 Para 100~101, Part 5~4 Para 103~104, Sect. B-VIII/1 Para 6~9, Sect. B-VIII/2 Part 4-2 Para 6~8
R4: A-III/1, R5: 7.04
Textbooks and Bibliography: B1, B2, B3, B4, B5
Teaching aids: T1, App. Ex. 11

Required performance:

3.1.1 state duties associated with taking over and accepting a watch

- enter the machinery space 15 minutes before the change of watch
- inspect all operating machinery which is being simulated, noting operational conditions and any deviations from the normal mode including bilge levels, tank levels, operating status of the machinery
- note engine telegraph instruction and check engine control position and related speed
- ensure that the relieving watch members are capable of performing their duties
- examine the engine-room log book/alarm log
- check if any alarms have been reposed
- receive an oral report from the engineer officer in charge of the watch
- accept, if satisfied, responsibility for the machinery space operation

3.1.2 demonstrate taking over and accepting the watch

3.1.3 state routine duties undertaken during a watch

- inspect all operational machinery including steering gear at regular intervals, noting their operating conditions, correcting any deviations from the normal mode and paying special attention to bilges and any risk of fire
- following tasks to be carried out as necessary
  - start of the fuel oil purifier
  - bilge discharge
  - soot blowing to boiler and exhaust gas economizer
  - fuel oil transfer
  - drainage of air reservoirs
  - drainage of scavenging manifold and stuffing box

3.1.4 demonstrate routine duties as necessary

3.1.5 describe the significance of maintaining the machinery space logs and the readings taken

3.1.6 demonstrate maintenance of the machinery space logs with the readings taken

3.1.7 state duties associated with handling over a watch

- prepare an oral report to the relieving engineer officer in charge of the watch
- not hand over the watch to relieving officer if there is a reason to believe that the latter is not capable of carrying out the watchkeeping duties
- maintain the machinery space log

3.1.8 demonstrate handing over the watch

Subject area:

3.2 *Safety and emergency procedures; change-over of remote/automatic to local control of all systems*

IMO/STCW Reference: R4: A-III/1, R5: 7.04
Textbooks and Bibliography: B1, B2, B4, B5
Teaching aids: T1, App. Ex. 12

Required performance:

3.2.1 define emergencies which are likely to happen to the following machinery systems

- main machinery system
- electrical power generation system
- steam generation system
- steering system
- oil transfer system

3.2.2 state conditions of the aforementioned machinery systems to change-over the systems from remote/automatic to local control in an emergency

3.2.3 demonstrate procedures to the aforementioned machinery systems to change-over the systems from remote/automatic to local control in an emergency

Subject area:

3.3 *Safety precautions to be observed during a watch and immediate actions to be taken in the event of fire or accident, with particular reference to oil systems*

IMO/STCW Reference: R4: A-III/1, R5: 7.04
Textbooks and Bibliography: B1, B2, B4, B5
Teaching aids: T1, App. Ex. 13

Required performance:

3.3.1 state significance of due attention to conditions of the following:

- safety measures being taken for special purposes
- personnel who are working in the machinery space
- safety equipment maintained in the machinery space
- running machinery and safety devices
- fire-fighting appliances
- fire-detection system
- bilge levels
- water tight doors

3.3.2 demonstrate immediate actions to be taken to the following systems in the event of fire or accident related to oil systems

- emergency shutdown system for all ventilation fans
- emergency shutdown system for all oil pumps
- urgent closing system for all outlet valves attached to oil tanks
- cutting off electric power to fire breaking areas
- closing dampers of ventilation ducts
- making air tight of the engine-room in case of engine-room fire (water tight doors, skylight and other openings)
- starting up fire pump/emergency fire pump

Subject area:

3.4 *Knowledge of engine-room resource management principles*

IMO/STCW Reference: R2 Ch. VIII Sect. A-VIII/2, Part 3 Para 8, R4: A-III/1, R5: 7.04
Textbooks and Bibliography:
Teaching aids: T1, App. Ex. 14

Required performance:

3.4.1 state significance of the following engine-room resource management principles to be observed during an engineering watch:

- ensuring proper arrangements of personnel
- consideration of any limitation in qualification or fitness
- understanding of roles, responsibility and team roles
- utilizing information, equipment and personnel
- understanding of functions and operation of equipment

- understanding information and how to respond to information
- sharing information
- maintaining an exchange of appropriate communication
- notifying any doubt

3.4.2 state meanings of allocation, assignment and prioritization of resources

3.4.3 demonstrate appropriate personnel allocation and assignment through an engineering watch in the simulated engine-room and the control room

3.4.4 demonstrate appropriate prioritization of resources in terms of the following:

- qualification
- work load
- time constraint
- operational procedures

3.4.5 state the significance of effective communications necessary for an engineering watch

3.4.6 discuss inhibitory elements for effective communication in terms of the following

- needs of effective communication
- lack of understanding
- perceived notion
- class-consciousness
- different culture
- racial discrimination

3.4.7 demonstrate effective communication during an engineering watch in the simulated engine-room and the control room

3.4.8 define assertiveness and leadership

3.4.9 state the significance of assertiveness and leadership necessary for an engineering watch

3.4.10 discuss how assertiveness contributes to a safe engineering watch

3.4.11 demonstrate assertiveness and leadership through an engineering watch in the simulated engine-room and the control room

3.4.12 define situational awareness

3.4.13 state the significance of situational awareness necessary for an engineering watch

3.4.14 state precautions to obtain and maintain situational awareness in terms of the following:

- maintaining seaworthiness of the ship
- maintaining safety of personnel in the machinery space
- protecting marine environment

3.4.15 define consideration of team experience

3.4.16 state the significance of consideration of team experience

3.4.17 discuss how consideration of team experience contributes to a safe engineering watch

Function: Electrical, electronic and control engineering at the operational level

4 Operate electrical, electronic and control systems

Subject area:

4.1 *Operation of main switch board*

IMO/STCW Reference: R4: A-III/1 and A-III/6, R5: 7.04, 7.08
Textbooks and Bibliography: B1, B2, B4
Teaching aids: T1, App. Ex. 6

Required performance:

4.1.1 describe functions of synchronizing panel, generator panel and distribution panel on main switch board

4.1.2 describe functions of ACB on the generator panel

4.1.3 describe safety functions incorporated in ACB

4.1.4 state conditions for coupling generators

4.1.5 state precautions when coupling and uncoupling generators

4.1.6 demonstrate the following for diesel generators remote start and stop

- manual coupling and uncoupling
- automatic coupling and uncoupling generators
- selection of standby generator and priority

4.1.7 describe conditions for remote start of diesel generators

Subject area:

4.2 *High-voltage installations*

IMO/STCW Reference: R4: A-III/1, R5: 7.04, 7.08
Textbooks and Bibliography: B1, B2, B4
Teaching aids: T1, App. Ex. 7

Required performance:

4.2.1 Identify components/part of main switch board used for high-voltage distribution system

- low voltage compartment
  - protection and control unit
  - switch panel
- CB (Circuit Breaker) compartment
  - VCB
  - VCB draw in/out handling port
  - indicator of VCB position
  - emergency open mechanism
  - interlock key for de-excitation
  - earthing switch operating handle port

- BUS bar compartment
  - pressure relief flap
  - insulation bushing
  - main BUS bar
- cable compartment
  - surge arrester
  - current transformer
  - load BUS bar
  - power cable terminal
  - earthing switch
  - zero phase current transformer
  - voltage transformer

4.2.2 describe functions incorporated in a vacuum circuit breaker (VCB) used for high-voltage distribution system

- over current trip
- low voltage trip
- reverse power trip
- earthing switch

C2. Table A-III/2: Specification of minimum standard of competence for chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3,000 kW propulsion power or more

Function: Marine engineering at the management level

1 Plan and schedule operations

Subject area:

1.1 *Propulsive characteristics of diesel engines and steam turbines including speed, output and fuel consumption*

IMO/STCW Reference: R4: A-III/2, R5: 7.02
Textbooks and Bibliography: B2, B3
Teaching aids: T1, App. Ex. 15

Required performance:

1.1.1 discuss differences in propulsive characteristics of a main diesel engine and steam turbine in terms of relations between revolution speed, torque and output

1.1.2 collect necessary running parameters of the simulated main machinery and apply simple calculation to determine anticipated engine output to different engine speeds

1.1.3 define fuel consumption to engine revolution speeds

1.1.4 collect necessary running parameters of the simulated main machinery and apply simple calculation to compare fuel consumptions in different revolution speeds to same distance

Subject area:

1.2 *Heat cycle, thermal efficiency and heat balance*

IMO/STCW Reference: R4: A-III/2, R5: 7.02
Textbooks and Bibliography: B2, B3
Teaching aids: T1, App. Ex. 16

Required performance:

(Diesel engine)

1.2.1 illustrate the simulated main diesel engine with shaft output and thermal input and output (temperatures) by fuel, cooling water, lubricating oil, scavenging air and exhaust gas

1.2.2 calculate calorific value given to the simulated main diesel engine by fuel and loss by fluids

1.2.3 collect running parameters of the simulated main diesel engine and calculate its thermal efficiency

1.2.4 develop and discuss heat balance diagram of the simulated main diesel engine, determining quantity of losses by exhaust gas and cooling fluids

(Main steam turbine)

1.2.5 illustrate the simulated steam turbine plant with shaft output and thermal input and output (temperatures) by fuel, steam, cooling water and lubricating oil

1.2.6 calculate calorific value given to the simulated main boilers by fuel and loss by fluids

1.2.7 collect running parameters of the simulated steam turbine propulsion plant machinery and calculate thermal efficiency as follows:

– total thermal efficiency

- turbine efficiency
- boiler efficiency

1.2.8 develop and discuss heat balance diagram of the simulated steam turbine plant, determining quantity of losses by cooling fluids and others

2 Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery

Subject area:

2.1 *Start up and shut down main propulsion and auxiliary machinery*

IMO/STCW Reference: R4: A-III/2, R5: 7.02
Textbooks and Bibliography: B2, B3, B4
Teaching aids: T1, App. Ex. 17

Required performance:

2.1.1 describe significance of correct sequence for preparation procedures of starting up main propulsion machinery

2.1.2 describe significance of a check list for preparation in terms of ISM Code

2.1.3 describe references that the main propulsion machinery can be started in terms of the following:

(Main diesel engines)

- type of the machinery
- temperature of cooling water, lubricating oil, fuel oil and others
- unusual conditions

(Main steam turbine)

- vacuum of the main condenser
- temperature of turbine casing
- expansion of the turbine rotors
- unusual conditions

2.1.4 state precautions before starting up the main propulsion machinery

(Main diesel engine)

- engine turning gear is disengaged
- control air and starting air is available for starting engine
- engine cylinder lubrication is functioning
- no interlocking works
- no abnormal pressure concerned
- notification to the bridge
- starting the engine with slow starting arrangement or turning the engine with starting air for one/several revolutions with indicator valves open:
  - no water and oil from the indicator valves
  - no abnormal sound
  - smooth rotation
- close all indicator valves after turning on air is completed

(Main steam turbine)

- sufficient vacuum of the main condenser
- smooth rotation and no abnormal sound by automatic roll over/ spinning
- flow of lubricating oil
- no interlocking works

2.1.5 state checking points when the main propulsion machinery is started for the first time/engine trial when leaving a port

2.1.6 demonstrate start-up of the propulsion machinery

2.1.7 demonstrate maneuvering of the propulsion machinery following the bridge orders

2.1.8 demonstrate establishment of navigational full speed mode from harbour speed mode checking the running conditions

2.1.9 demonstrate establishment of harbour speed mode from navigational full speed mode checking the running conditions

2.1.10 state precautions when shutting down the main propulsion machinery according to types and conditions of the machinery

2.1.11 describe references that the main propulsion machinery can be completely shut down/cooled down

2.1.12 demonstrate shutting down/cooling down the main propulsion machinery

Subject area:

2.2 *Operating limits*

IMO/STCW Reference: R4: A-III/2, R5: 7.02
Textbooks and Bibliography: B2, B3
Teaching aids: T1, App. Ex. 18

Required performance:

2.2.1 define meaning of operating limits of main engines in terms of the following:

(Main diesel engine)

- engine revolution speed
- engine output
- engine torque
- mean effective pressure
- maximum pressure
- turbocharger revolution speed
- exhaust gas temperatures
- exhaust gas inlet to turbochargers
- cooling water temperature
- scavenging air pressure and temperature

(Main steam turbine)

- engine revolution speed
- engine output

- engine torque
- steam pressure
- condenser vacuum

2.2.2 discuss changes in running parameters of a main engine in terms of the following:

- weather condition
- loading condition
- rapid change in rudder angle

2.2.3 define torque rich/over torque on a main engine load diagram

2.2.4 demonstrate operational procedures to keep the running conditions within the operating limits through operation of the simulated main engine

Subject area:

2.3 *Performance assessment*

IMO/STCW Reference: R4: A-III/2, R5: 7.02
Textbooks and Bibliography: B2, B3
Teaching aids: T1, App. Ex. 19

Required performance:

2.3.1 record p-v diagram of the simulated main diesel engine and calculate Indicated Horse Power (IHP)/ Output by using "Ten divisions into equal method" given spring constant

2.3.2 collect running parameters of the simulated main engine and develop engine performance curves and discuss it, determining the most efficient running condition

2.3.3 identify the following on draw curves (pressure-stroke curves) of the simulated main diesel engine:

- compression pressure
- start of injection
- ignition lag
- time of ignition
- period of injection
- end of injection
- explosive combustion
- peak pressure (Pmax)
- controlled combustion
- combustion
- after burning
- expansion

Subject area:

2.4 *Functions and mechanism of automatic control for main engine*

IMO/STCW Reference: R4: A-III/2, R5: 7.02
Textbooks and Bibliography: B2, B3
Teaching aids: T1, App. Ex. 17

Required performance:

2.4.1 define the following functions used for main engine automatic control

- automatic start

- automatic revolution speed control
  - revolution speed control under standby
  - speed run-up programme by revolution, load and/or combination control
- crash astern
- wrong way
- VIT (Variable Injection Timing)
- FQS (Fuel Quality Setting)
- actuation of safety functions
  - automatic shutdown
  - automatic slow down
  - start failure
  - start impossible

2.4.2 list conditions for main engine automatic shutting down and slowdown

2.4.3 demonstrate the following automatic functions to the simulated main engine:

- automatic start
- automatic revolution speed control
- crash astern
- VIT
- FQS

2.4.4 describe mechanisms of automatic control for the main engine listing main components

2.4.5 state that safety functions have independent mechanism and functions/devices of automatic control cannot be used for safety functions

Function: Electrical, electronic and control engineering at the management level

3 Manage operation of electrical and electronic control equipment

Subject area:

3.1 *Design features and system configurations of high-voltage installations*

IMO/STCW Reference: R4: A-III/2, R5: 7.02, 7.08
Textbooks and Bibliography:
Teaching aids: T1, App. Ex. 20

Required performance:

3.1.1 describe handling features of marine high-voltage main switch board in comparison with low voltage main switch board

3.1.2 describe safety functions incorporated in high-voltage main switch board

3.1.3 state that high-voltage systems are normally earthed via a resistor

3.1.4 describe how the presence of earth faults is indicated in a high-voltage system with an earthed neutral

3.1.5 state safety precautions to be strictly observed to prevent accidents when working on high-voltage electrical equipment

Function: Maintenance and repair at the management level

4 Detect and identify the cause of machinery malfunctions and correct faults

Subject area:

4.1 *Detection of machinery malfunctions, location of faults and action to prevent damage*

IMO/STCW Reference: R4: A-III/2, R5: 7.02
Textbooks and Bibliography: B2, B3
Teaching aids: T1, App. Ex. 21, 22, 23

Required performance:

4.1.1 discuss causes on malfunctioning draw curves (pressure-stroke curves) of the simulated main diesel engine in terms of the following:

- leaking fuel injector
- lower injection pressure
- defective fuel valve or nozzle
- fuel injector nozzle clogged
- injector seized
- poorer fuel (poorer ignition properties)
- fuel pump leads less fuel (leaking or other reasons)
- incorrect exhaust valve timing
- overload of the engine
- leaking exhaust valve
- blow-by (broken/worn out piston rings, worn out liner)
- lower scavenging air pressure
- fouling of exhaust and/or air system
- incorrect fuel timing of the cams
- incorrect VIT setting (early/later)

4.1.2 locate and demonstrate remedial action for the following malfunctions or faults:

- heavy weather
- main engine automatic slowdown by thrust bearing high temperature
- fire in exhaust gas economizer
- main engine crank case oil mist high
- main engine under piston space temperature high

4.1.3 discuss possible causes on the malfunctions or faults mentioned above

4.1.4 review the remedial actions taken for the malfunctions or faults mentioned above

C3. Table A-III/4: Specification of minimum standard of competence for ratings forming part of an engineering watch

Function: Marine engineering at the support level

1 Familiarization

Subject area

1.1 *Plant arrangement*

IMO/STCW Reference:
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 24

Required performance:

1.1.1 understand purposes of each system which forms the simulated steam boiler plant

1.1.2 list the machinery and associated systems and equipment including key valves, tanks and other machinery which form the simulated boiler plant such as:

- feed water system
  - cascade tank
  - feed water pump
  - feed water control valve
- fuel oil system
  - fuel oil service tank
  - burning pump
  - fuel oil heater
  - Forced Draft Fan (FDF)
  - burner unit
  - igniter unit
- steam supply system
  - main stop valve
  - pressure regulating valve
  - auxiliary condenser

Subject area

1.2 *Instrumentation*

IMO/STCW Reference:
Textbooks and Bibliography: B1, B4, B5
Teaching aids: T1, App. Ex. 25

Required performance:

1.2.1 identify instrumentation used in the simulated boiler plant

1.2.2 describe purposes of the instrumentation

1.2.3 list the instrumentation and units used in the simulated boiler plant such as:

- steam pressure

- water level
- fuel oil temperature

Subject area:

1.3 *Alarm system*

IMO/STCW Reference:
Textbooks and Bibliography: B1, B4, B5
Teaching aids: T1, App. Ex. 26

Required performance:

1.3.1 identify the alarms that are used to indicate malfunctions and faults

Subject area

1.4 *Controls*

IMO/STCW Reference:
Textbooks and Bibliography: B5
Teaching aids: T1, App. Ex. 27

Required performance:

1.4.1 identify equipment used for automatic and remote controls in the simulated boiler plant

1.4.2 state what is automatically controlled

1.4.3 demonstrate the use of controls

2 Maintain correct boiler water levels and steam pressures

Subject area:

2.1 *Safe operation of boilers*

IMO/STCW Reference: R4: A-III/4
Textbooks and Bibliography: B2
Teaching aids: T1, App. Ex. 28

Required performance:

2.1.1 state types of a steam boiler and their simple features

2.1.2 describe the simulated steam boiler and its associated system machinery

2.1.3 state precautions for firing up the steam boiler from cold condition in terms of the following:

- water level
- valves attached to the boiler body
  - valves to be opened
  - valves to be closed
- time schedule for firing up
- fuel oil to be used
- boiler water circulation pump

2.1.4 describe functions of the following

- water gauge blow valves
- safety valve lifting gear
- soot blower

2.1.5 state procedures of igniting a burner

2.1.6 describe significance of pre-purge and post purge

2.1.7 state timing of closing air ventilation valve

2.1.8 demonstrate firing up the boiler in manual including lining up fuel oil system

2.1.9 demonstrate lining up feed water system and put it into service

2.1.10 demonstrate supply of steam to the service line

2.1.11 demonstrate procedures to put the boiler into automatic operation

C.4 Table A-III/6: Specification of minimum standard of competence for electro-technical officers

Function: Electrical, electronic and control engineering at the operational level

1 Familiarization

Refer to Subject area "1 Familiarization" of A-III/1

2 Operate generators and distribution systems

2.1 *Coupling and breaking connection between switchboards and distribution panels*

Refer to Subject area "4.1 Operation of main switch board" of A-III/1

3 Monitor the operation of electrical, electronic and control systems

Subject area:

3.1 *Basic understanding of the operation of mechanical engineering systems*

IMO/STCW Reference: R4: A-III/6, R5: 7.08
Textbooks and Bibliography: B1, B2, B4, B5
Teaching aids: T1, App. Ex. 29

Required performance:

3.1.1 describe machinery systems which construct diesel engine propulsion plant in terms of:

- main engine and associated auxiliaries
- electric power generation system
- steam generation system
- auxiliary machinery

3.1.2 list and describe briefly machinery to be started before leaving port

3.1.3 list and describe electrical, electronic and control equipment to be started before leaving port

3.1.4 list and describe main running parameters of main engine and associated auxiliaries

3.1.5 relate electric, electronic and control parameters of control equipment used for the plant machinery to mechanical running parameters of the machinery

3.1.6 list and describe control methods generally applied to the plant machinery and process values as follows:

- main engine
- electric power generation system
- steam generation and distribution system
- auxiliary machinery (air compressors, pumps, purifiers, fresh water generator)
- temperature, pressure, level and viscosity

3.1.7 describe how control parameters used for controlling the machinery and process values above are presented

3.1.8 describe how the control methods control the machinery and process values using actual examples of setting values, present values, controlling values and other detecting values for control

3.2 *Fundamentals of automation, automatic control systems and technologies*

IMO/STCW Reference: R4: A-III/6 R5: 7.08
Textbooks and Bibliography: B1, B2, B5
Teaching aids: T1, App. Ex. 30

Required performance:

3.2.1 describe functions of automatic control applied to main diesel engine as follows:

- automatic start
- automatic speed control
- wrong way
- crash astern
- speed run-up program
- automatic slow down
- automatic shut down

3.2.2 describe briefly control mechanisms / methods above

3.2.3 state safety function shall be activated by independent signals

3.2.4 describe functions of automatic control applied to auxiliary machinery as follows:

- automatic changeover (pumps)
- automatic start and stop (pumps, compressors)
- sequential control (diesel generator, boiler, purifier)
- sequential restart (pumps)

3.2.5 describe briefly control mechanisms / methods above

3.2.6 describe functions of automatic control applied to process control

3.2.7 describe functions of PID parameters

3.2.8 describe meanings of the following used for step response test:

- dead time
- overshoot
- time-lag
- settling time
- steady-state deviation

3.2.9 describe briefly how to find optimum PID parameters

4 Operate and maintain power systems in excess of 1,000 volts

Subject area:

4.1 *Electrical propulsion ship*

IMO/STCW Reference: R4: A-III/6, R5: 7.08
Textbooks and Bibliography:
Teaching aids: T1, App. Ex. 31

Required performance:

4.1.1 describe briefly speed control of propulsion motor:

- constant speed
- thyristor
- cyclo-converter

4.1.2 describe briefly the following:

- pulse width modulation (PWM)
- IGBT
- inverter
- back EMF

4.1.3 describe briefly propulsion systems using propulsion motors

- podded propulsion
- contra-rotating propeller
- contra-rotating geared propeller
- contra-rotating shaft propeller
- fixed pitch propeller

4.1.4 list equipment which construct electric propulsion system and describe briefly their functions

- high-voltage generator
- high-voltage main switch board
- transformer
- converter/inverter
- propulsion motor
- control unit
- operation unit

4.1.5 describe briefly "power management" applied to electric propulsion ship

4.1.6 list maintenance necessary for high-voltage equipment

- terminal screw and tightening
- VCB vacuum
- GCB gas density
- cooling system
- earthing mechanism

4.1.7 state running parameters to be monitored for propulsion motor

- revolution speed
- current
- voltage
- frequency
- power

- power factor
- stator temperature
- lubricating oil pressure and temperature
- vibration

4.1.8 demonstrate preparation for leaving a port

- start-up generators
- switch on VCB for propulsion motor
- supply cooling fluid to propulsion motor
- supply lubricating oil to propulsion motor

4.1.9 demonstrate start-up of propulsion motor

4.1.10 demonstrate maneuvering propulsion motor checking running parameters

Function: Maintenance and repair at the operational level

5 Maintain and repair automation and control systems of main propulsion and auxiliary machinery

5.1 *Detection of machinery malfunction, location of faults and action to prevent damage*

Refer to Subject area "2.10 Fault detection and measures" of A-III/1.

5.2 *Detection of electrical malfunction, location of faults and action to prevent damage*

IMO/STCW Reference: R4: A-III/6, R5: 7.08
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 32

Required performance:

5.2.1 describe meaning of cross current

5.2.2 describe how cross current is generated

5.2.3 describe how cross current is found

5.2.4 describe functions of governor for generator

5.2.5 describe working principles and mechanism of governor

5.2.6 describe how unstable governor control occurs

5.2.7 describe effects of unstable governor control

5.2.8 describe possible reasons for stator coil high temperature of generator

5.2.9 describe effects of space heater

5.2.10 describe the danger associated with lower insulation

C.5 Table A-III/7: Specification of minimum standard of competence for electro-technical ratings

Function: Maintenance and repair at the support level

1 Familiarization

Subject area

1.1 *System arrangement*

IMO/STCW Reference:
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 33

Required performance:

1.1.1 identify purposes of each system which forms the simulated power generation and distribution systems

- generators
  - diesel generator
  - turbo generator
  - emergency generator
- main switch board
  - generator panel
  - synchronizing panel
  - distribution panel
- transformer
- Group Starter Panel (GSP)
- battery charging and discharging panel
- emergency generator panel
- shore connection panel
- emergency power supply
- emergency lighting
- control panels
  - boiler
  - purifier

1.1.2 identify equipment/components incorporated in the simulated power generation system

- ACB and control switch
- governor control switch
- MCCB
- synchronizing indicators
- earthing indicator and test switch
- start and stop switch
- manual-auto changeover switch

Subject area:

1.2 *Instrumentation*

IMO/STCW Reference:
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 34

Required performance:

1.2.1 list the instrumentation and units used in the simulated power generation system such as:

- current
- voltage
- frequency
- power
- power factor
- synchronizing indicator

Subject area:

1.3 *Alarm system*

Refer to "1.3 Alarm system" of A-III/4

2 Contribute to the maintenance and repair of electrical systems and machinery on board

Subject area:

2.1 *Test, detect faults and maintain and restore electrical control equipment and machinery to operating condition*

IMO/STCW Reference: R4: A-III/7
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 35

Required performance:

2.1.1 describe meanings of the following

- blackout
- overcurrent trip
- low voltage trip
- BUS abnormal
- short circuit
- earth fault
- insulation failure
- megger test

2.1.2 state what dangers exist when handling electrical equipment

2.1.3 state the importance of safe and cautious practice when handling electrical equipment

Subject area:

2.2 *Detection of machinery malfunction, location of faults and action to prevent damage*

IMO/STCW Reference: R4: A-III/7
Textbooks and Bibliography: B1, B4
Teaching aids: T1, App. Ex. 36

Required performance:

2.2.1 demonstrate detection of the following malfunctions and action to prevent damage

- feed water pump abnormal stop
- fuel oil purifier abnormal separation
- diesel generator cooling fresh water high temperature
- main air reservoir low pressure

Part D: Instructor Manual

General

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

Whilst dealing with theoretical and mathematical subjects, instructors are advised to provide suitable practical examples, related to shipboard applications. This would enhance the trainees' achievement of a thorough understanding of the principles involved in the theory.

Although the notes given should be of value initially, course instructors should work out their own methods and ideas, refine and develop what is successful, and discard ideas and methods which may be considered, in their view, to be not quite suitable.

Briefing

Practical exercises constitute the main training components in the course, and they are carried out under supervision of the instructors. A briefing on important aspects of the exercise is advisable before each exercise begins. The briefing shall include clear information on the purpose of the exercise and the learning objectives to be achieved. If the briefing precedes an assessment session, the trainees shall be given a clear and concise description of criteria required to pass the evaluation. Provision has been made for this in the course structure.

From this aspect, any exercise scenario should include a briefing note and the note should be emphasized every time the instructor conducts the simulator training, since the note also contains summary of technical issues to be learned by the trainees.

The instructor should use practical examples involving real shipboard equipment and systems, referring to diagrams, technical drawings, photographs and the other related technical documents to supplement and reinforce the briefing and training session.

One effective technique is to outline what is to be done during the exercise and then explain in detail those aspects that are considered to be important. Finally, allow the trainees to summarize the exercise using key words and phrases.

There should always be a final discussion to make sure that trainees understand the role they will play, as well as what is to be done and achieved by the exercise.

Copies of the handouts used can be distributed to the trainees for reference purposes during the exercise.

Simulator exercise

Engine-room and propulsion plant machinery and systems may differ widely from ship to ship. Trainees with some previous experience may have different and varied knowledge and experience.

Before the exercise, the trainees should be encouraged to work together as a team towards a common goal. They must co-ordinate their activities, show initiative and proper attitude in order to bring the exercise to a successful conclusion.

Preparing and conducting exercise

When exercises are developed, they should not be so complicated that the trainees will have difficulty in carrying out their tasks and duties.

An exercise should start with simple activities, and step by step, proceed towards more complex activities. Split a lengthy exercise into two or more separate exercises to ensure that the learning process is effective.

The simulator is designed to provide training for normal, faulty and emergency machinery operation. It is important for the trainees to achieve a satisfactory level of competence under normal conditions before proceeding to exercises in which faults have been introduced or emergency situations are simulated.

The exercises should reflect realistic situations, as far as possible, in order to provide the trainees with the impression of actually being in an engine-room or control room aboard ship.

Development of simulator exercises

The STCW competence tables clearly specify the Knowledge, Understanding and Proficiency (KUP), Methods for demonstrating competence and Criteria for evaluating competence for each competency and "Approved simulator training" is listed in Column 3 "Methods for demonstrating competence" as one of the options.

This means the approved simulator training can be adopted for demonstrating competence (Knowledge, Understanding and Proficiency) specified in the competence tables and allow the trainees to achieve the standards.

Tasks to be performed

Tasks to be performed by trainees to meet the standards should be set up taking into account matching of simulator facilities and functions and prerequisite of target trainees. Scope, complexity and reality of the tasks vary according to the simulator facilities and functions, and the target trainees. In order to design more effective training courses, the tasks should be combined for a series of training process accordingly, and sometimes individual tasks should be set up for a particular requirement, as necessary.

Validity of simulator exercises

The series of tasks and the individual task can be a training programme and various combinations should be set up to address a training need; units of training programmes should be examined in terms of unambiguity of learning/training objectives, international and national regulations and recommendations, and duplication with other training programmes, in order to ensure validity of the simulator training exercises. The learning/training objective should be clearly specified with training outcomes at this stage and related to the competencies and requirements.

Design of simulator exercises

When designing simulator training exercises, elements to be included at least in the exercise format are:

- Exercise title
- Tasks to be included in the exercise
- Function and level
- Competence
- Requirements (K.U.P.)
- Estimated duration
- Outline of the training
- Initial condition for each task scenario/Performance condition and context
- Specific purpose/Outcome of the training
- Brief note for briefing and debriefing
- Implementation of the training.

(Example)

Course Title	Taking over an engineering watch
Task	Inspect plant machinery and take over the engineering watch
Function and Level	Marine engineering at the operational level
Competence	Maintain a safe engineering watch
Requirements (K.U.P.)	Thorough knowledge of principles to be observed in keeping an engineering watch, including: .1 duties associated with taking over and accepting a watch .2 routine duties undertaken during a watch .3 maintenance of the machinery space logs and the significance of the reading taken .4 duties associated with handing over a watch
Estimated Duration	1 hour
Outline of Training	Trainees perform an engine-room round inspecting machinery to make sure its running conditions in the engine-room and control room and take over the watch after briefing from the present watch officers
Initial Condition	Seagoing
Specific Purpose	The training allows the trainees to: – understand procedures for taking over an engineering watch – understand significance of making an engine-room round – understand meanings and significance of running parameters of plant machinery underway – discern deviations from normal running conditions/status – apply knowledge obtained to actual engineering watch
Briefing	Explain briefly the following: – outline of the training – why relieving watch officers enter the engine-room at least 15 minutes before taking over an engineering watch – how to make an engine-room round, inspecting effectively the machinery and other conditions within 15 minutes – a need to use five senses when making the engine-room round in an actual engine-room as signs of malfunctions such as leaking, smell, abnormal vibration and sound cannot be detected by monitoring system and the importance of detecting such signs to take measures at early stage before alarm sounds – significance of understanding correlations between running parameters of the machinery and hull conditions – a need to take over the engineering watch after you made sure running conditions of the plant machinery and satisfied transition briefing from the present watch officer – a need to ask the present watch officer questions if there is something unclear

Implementation	Start the simulation and let the trainees perform: – enter the engine-room – inspect the operational parameters of main machinery system, power generation system, steam generation system and other auxiliary machinery systems including the steering area (it is desirable to encourage the trainees to remember approximate values of critical operational parameters during the engine-room round) – if something abnormal were found during the engine-room round, jot down quickly the status – enter the control room – inspect conditions, status and control/operational mode of the machinery on the main console and main switch board – check the engine-room log, alarm log, standing orders and special orders from the chief engineer and other information if any (if there were special conditions of plant machinery, works done during the present watch, and information from bridge and others) – meet the present watch officer (instructor) in the control room and ask the officer for briefing before taking over the watch – receive the transition briefing from the officer – ask the officer questions about findings if any during the engine-room round – accept the engineering watch if satisfied The officer (instructor) being relieved lets the trainees answer the questions about results of the engine-room round in order to make sure/evaluate if the inspection was effective and sufficient as follows: – main running parameter of main engine, power generation system and steam generation system – status of auxiliary machinery (machinery in service, control mode, levels of FO tanks, levels of bilges, etc.) – works to be done during the watch – precautions to be observed if any
Debriefing	Explain briefly the following: – comments on performance made by the trainees – the time for the engine-room round before taking over the watch is not sufficient to inspect and figure out all the running conditions of the plant machinery, therefore the main running parameters of main systems, levels of tanks and bilge are to be at least confirmed and check quickly temperatures and pressures if they are within normal working range – the watch responsibility should be accepted after the watch officer fully figures out the plant condition and all doubts and concerns are solved – deviations from the normal operation if any

Table A-III/1: Specification of minimum standard of competence for officers in charge of an engineering watch in a manned engine-room or designated duty engineers in a periodically unmanned engine-room

Function: Marine engineering at the operational level

1 Familiarization

1.1 *Plant arrangement*

Instructors should prepare diagrams which present simulated propulsion plant for this subject to enable trainees to:

– identify machinery systems which form the simulated propulsion plant

– understand purposes of each system which forms the simulated propulsion plant and functions of machinery

– understand how the machinery and associated systems are arranged and linked together to form the propulsion plant

Instructors should explain, using diagrams of the simulated propulsion plant:

– construction of the simulated propulsion plant

– functions of each system and machinery

– main fluid flow of each system

1.2 *Instrumentation*

Instructors should prepare tabulated lists of instrumentation used for simulated propulsion plant for this subject to enable trainees to:

– identify instrumentation used in the simulated propulsion plant

– understand purposes of instrumentation used in the simulated propulsion plant

Instructors should explain, using the lists, units used for the instrumentation and their importance.

1.3 *Alarm system*

Instructors should prepare tabulated lists of audio and visible alarm patterns generally used for ships for this subject to enable trainees to:

– identify the alarms that are used to indicate malfunctions and faults of machinery

– understand how to identify alarms and stop buzzer and lamp flicker

Instructors should explain, using the lists, audio and visible alarm patterns and actions to be taken when an alarm sounds.

1.4 *Controls*

Instructors should prepare tabulated lists of controls used for simulated propulsion plant for this subject to enable trainees to:

– identify equipment used for automatic and remote controls in the simulated propulsion plant

– identify machinery which is automatically and/or remotely controlled

– understand controls applied to machinery systems

Instructors should explain, using the lists, automatic and remote controls applied to machinery systems.

2 Operation of plant/machinery

2.1 *Operational procedures*

Instructors should prepare check lists which present operational procedures and precautions to put simulated machinery into normal operating mode for this subject to enable trainees to:

– understand importance of correct sequence in operating machinery and equipment

– understand how to open and close valves, start and stop machinery such as pump, purifier, compressor, and change over these machinery

Instructors should explain, using the check lists, correct operational procedures and their theoretical backgrounds when starting and stopping machinery.

2.2 *Operation of auxiliary machineries and systems*

Instructors should prepare check lists which present operational procedures and precautions to put simulated auxiliary machinery systems into normal operating mode for this subject to enable trainees to:

- understand importance of correct sequence in establishing machinery systems
- understand how to establish:
  - emergency generator system
  - cooling sea water system
  - cooling fresh water system
  - compressed air system
  - fuel oil treatment system

Instructors should explain, using the check lists, correct operational procedures and their theoretical backgrounds when starting and stopping machinery systems.

2.3 *Operation of diesel generator*

Instructors should prepare check lists which present operational procedures and precautions to put simulated power generation system into normal operating mode for this subject to enable trainees to:

- understand correct procedures of starting and stopping diesel generator engine
- understand precautions and conditions to start diesel generator engine
- understand checking points to make sure normal running conditions after starting diesel generator engine

Instructors should explain, using the check lists, correct operational procedures and their theoretical backgrounds when starting and stopping diesel generator engine.

2.4 *Operation of steam boiler*

Instructors should prepare check lists which present operational procedures and precautions to put simulated steam boiler into normal operating mode for this subject to enable trainees to:

- understand correct preparations and procedures of starting and stopping steam boiler
- understand precautions when raising steam to normal working pressure
- understand precautions before putting steam boiler into service

Instructors should explain, using the check lists, correct operational procedures and their theoretical backgrounds when starting and stopping steam boiler.

2.5 *Operation of main engine and associated auxiliaries*

Instructors should prepare a handout and check lists which present specifications, operational procedures and precautions to operate simulated main engines and associated auxiliaries for this subject to enable trainees to:

- understand types of propulsion system and specifications of simulated main engines
- understand preparations for starting main engines differ according to their specifications
- understand correct preparation for operating the simulated main engines
- understand common principles of preparations for starting main engines
- understand conditions for operating the simulated main engines and associated auxiliaries

Instructors should explain, using the handout and check lists, correct operational procedures for preparations of starting main engine including their theoretical backgrounds.

2.6 *Operation of steam turbo generator*

Instructors should prepare check lists which present operational procedures and precautions to put simulated steam turbo generator into normal operating mode for this subject to enable trainees to:

- understand correct procedures of starting and stopping the turbo generator
- understand precautions and conditions to start the turbo generator
- understand checking points to make sure normal running conditions after starting the turbo generator

Instructors should explain, using the check lists, correct operational procedures and their theoretical backgrounds when starting and stopping the turbo generator.

2.7 *Operation of fresh water generator*

Instructors should prepare check lists which present operational procedures and precautions to put simulated fresh water generator into normal operating mode for this subject to enable trainees to:

- understand correct procedures of starting and stopping the fresh water generator
- understand precautions and conditions to start the fresh water generator
- understand checking points to make sure normal running conditions after starting the fresh water generator

Instructors should explain, using the check lists, correct operational procedures and their theoretical backgrounds when starting and stopping the fresh water generator.

Instructors should explain various types of fresh water generator and their specific characteristics and usage.

2.8 *Operation of pumping system*

Instructors should prepare tabulated lists of pumping systems used for simulated propulsion plant which present operational procedures and precautions to put simulated pumping systems into normal operating mode for this subject to enable trainees to:

- understand correct procedures of starting and stopping the pumping systems
- understand precautions and conditions to start the pumping systems
- understand checking points to make sure normal running conditions after starting the pumping systems
- understand controls applied to the simulated pumping systems

Instructors should explain, using the tabulated lists, correct operational procedures and their theoretical backgrounds including automatic controls applied when starting and stopping the pumping systems.

2.9 *Operation of oily water separator*

Instructors should prepare check lists which present operational procedures and precautions to put simulated oily water separator into normal operating mode for this subject to enable trainees to:

- identify machinery used for bilge treatment system
- understand correct procedures of starting and stopping the oily water separator
- understand precautions and conditions to start the oily water separator
- understand checking points to make sure normal running conditions after starting the oily water separator
- understand controls applied to the oily water separator

Instructors should explain, using the check lists, correct operational procedures and their theoretical backgrounds including automatic controls applied when starting and stopping the oily water separator.

2.10 *Fault detection and measures*

Instructors should prepare tabulated lists which present some of the alarming values and malfunctions applied to simulated propulsion plant machinery for this subject to enable trainees to:

- identify alarming values applied to the machinery/machinery systems
- understand remedy actions to be taken for alarms and malfunctions
- understand possible causes for alarms and malfunctions

Instructors should explain, using the tabulated lists, meanings of alarming values, remedy actions and their theoretical backgrounds.

3 Maintain a safe engineering watch

3.1 *Thorough knowledge of principles to be observed in keeping an engineering watch*

Instructor should prepare workflow and lists of precautions for an engineering watch which can be applied to simulators based on the STCW Code Ch. VIII for this subject to enable trainees to understand:

- workflow of the engineering watch
- how to make an engine-room round of simulated propulsion machinery
- duties to be done during the engineering watch
- how to take over the engineering watch
- how to hand over the engineering watch

Instructors should explain, using the workflow and lists, how to carry out the engineering watch, emphasizing importance of the engine-room round.

3.2 *Safety and emergency procedures; changeover of remote/automatic to local control of all systems*

Instructors should prepare tabulated lists which present emergency procedures applied to simulated propulsion plant machinery for this subject to enable trainees to:

- identify emergencies
- understand emergency procedures applied to simulated propulsion plant
- how to change-over controls of vital machinery from remote/automatic to local

Instructor should explain the tabulated lists, emphasizing immediate actions to be taken for the emergencies including changeover of controls of machinery such as main engine, steam/thermal fluid boilers, generators, purifiers, compressors and pumps from remote/automatic to local.

3.3 *Safety precautions to be observed during a watch and immediate actions to be taken in the event of fire or accident, with particular reference to oil systems*

Instructors should prepare tabulated lists which present safety functions, safety devices/ systems and precautions applied to ships for this subject to enable trainees to:

- identify safety functions and devices/systems for machinery and machinery space
- understand precautions necessary for safety functions and devices/systems
- understand immediate actions to be taken in the event of fire or accident

Instructor should explain the tabulated lists, emphasizing immediate actions to be taken for fire or accidents.

3.4 *Knowledge of engine-room resource management principles*

Instructors should prepare a handout which presents "Engine-room resource management principles" described in STCW Code Ch. VIII and descriptions on human elements described in Table A-III/1 as Engine-room resource management (ERM) requirements (KUP) for this subject to enable trainees to:

- understand significance of ERM principles
- identify human elements described in Table A-III/1
- understand how the human elements should be applied to ERM
- understand how ERM should be applied to an engineering watch

Instructors should explain meanings and significance of ERM principles and how the human elements such as communication, leadership and others should be applied in practising ERM during the engineering watch.

Function: Electrical, electronic and control engineering at the operational level

4 Operate electrical, electronic and control systems

4.1 *Operation of main switch board*

Instructors should prepare a handout which presents arrangement of simulated main switch board (MSB) and operational procedures to put the simulated MSB (Electrical power generation and distribution system) into normal operation mode for this subject to enable trainees to:

- identify names and functions of switches and indication lamps on MSB
- understand conditions to couple/uncouple generators and their theoretical backgrounds
- understand functions incorporated in ACB

Instructor should explain the handout, emphasizing conditions to couple/uncouple generators and their theoretical backgrounds.

4.2 *High-voltage installations*

Instructors should prepare tabulated lists of simulated high-voltage installations and their components with illustrative diagrams for this subject to enable trainees to:

- identify equipment and components used for high-voltage installations
- understand functions of equipment and components
- understand structures of the installations

Instructor should explain, using the tabulated lists, functions and structures of the high-voltage installations.

Table A-III/2: Specification of minimum standard of competence for chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3,000 kW propulsion power or more

Function: Marine engineering at the management level

1 Plan and schedule operations

1.1 *Propulsive characteristics of diesel engine and steam turbines including speed, output and fuel consumption*

Instructors should prepare a handout which presents specifications of simulated main engines and diagram of propeller/load curve for this subject to enable trainees to understand:

- characteristics of propeller/load curve and running points of the main engines
- movement of the running points of the main engines under different hull conditions
- characteristics of constant torque engine and constant output engine

- the following relations between:
  - ship's speed and engine revolution speed
  - engine output and engine revolution speed
  - fuel consumption and engine revolution speed
  - fuel consumption and engine output
  - fuel consumptions at different ship's speed for the same distance run

Instructor should explain, using the handout, characteristic of propeller curve including running points and relations between engine speed, engine output and fuel consumption.

1.2 *Heat cycle, thermal efficiency and heat balance*

Instructors should prepare a handout which presents:

- specifications of simulated main engines
- data collection tables for calculation of thermal efficiency
- calculation tables
- calculation guidance
- example of heat balance diagram of the simulated main engine
- h-s diagram and /or T-s diagram and steam table (steam turbine)

for this subject to enable trainees to understand:

- running parameters necessary to calculate thermal efficiency
- how to calculate thermal efficiency of main diesel engine and steam turbine and their theoretical backgrounds
- how to develop heat balance diagram and their meanings

Instructors should explain, using the handout, how to calculate thermal efficiency and to develop heat balance diagram. Instructors should give appropriately trainees assumptions and data necessary other than data obtained from the simulated main engines such as:

- calorific value of fuel oil
- mechanical efficiency
- specific heats of cooling fresh water, lubricating oil and air
- various conversion coefficients

2 Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery

2.1 *Start up and shut down main propulsion and auxiliary machinery*

Instructors should prepare check lists which present operational procedures and precautions for this subject to enable trainees to understand:

- operations procedures to put simulated main engines and associated auxiliaries into normal operating mode
- theoretical background of changing the operating mode
- reference for starting up the main engines
- starting mechanism of main engines
- reference for changing the operating mode
- special precautions to be observed in changing the operating mode

Instructors should explain, using the check lists, correct procedures of changing the operating mode from start up of the main engines to normal/navigational operating mode and vice versa.

2.2 *Operating limits*

Instructors should prepare operating limits of simulated main engines developed on propeller curve/load curve and tabulated lists of other operating limits for this subject to enable trainees to understand:

(Diesel engine)

- operating limits of engine output, speed and torque
- limits of mean effective and maximum cylinder pressures
- limits of turbo charger revolution speed
- limits of temperatures (exhaust gas, cooling water, lubricating oil, scavenging air)
- limits of pressures (lubricating oil, scavenging air)

(Steam turbine)

- operating engine output, speed and torque
- limits of temperatures (main steam, sea water)
- limits of pressures (main steam, main condenser)

Instructors should explain operating limits and other limits of various running parameters, and their theoretical backgrounds.

2.3 *Performance assessment*

Instructors should prepare a handout which presents the following of simulated main engines:

- p-v diagrams and "Ten divisions into equal method" to calculate IHP (diesel engine)
- pressure draw curves (diesel engine)
- engine performance curve developed by the data from the collection tables used for calculation of thermal efficiency

for this subject to enable trainees to understand:

- how to calculate IHP by using "Ten divisions into equal method"
- identify combustion process of diesel engine
- various performance curves to present engine characteristics

Instructors should explain, using the handout, "Ten divisions into equal method", combustion process of diesel engine, and most effective running condition of the main engines from the performance curves.

2.4 *Functions and mechanism of automatic control for main engine*

Instructors should prepare tabulated lists which present automatic controls and safety functions for simulated main engines for this subject to enable trainees to:

- identify automatic controls applied to the simulated main engine
- understand functions of automatic controls applied to the main engine
- understand mechanism of automatic controls to the main engine
- identify safety functions applied to the main engine
- understand acting mechanism of safety functions

Instructors should explain, using the tabulated lists, automatic controls and safety functions applied to the simulated main engine, emphasizing their acting mechanism.

Function: Electrical, electronic and control engineering at the management level

3 Manage operation of electrical and electronic control equipment

3.1 ***Design features and system configurations of high-voltage installations***

Instructors should prepare system configurations of simulated high-voltage installations and tabulated lists of functional and handling features of the installations for this subject to enable trainees to understand:

- handling features of marine high-voltage main switch board (MSB)
- safety functions incorporated in the MSB
- earthing system for MSB
- safety precautions

Instructors should explain the system configuration and the tabulated lists, high-voltage power generation and distribution systems emphasizing safety precautions.

Function: Maintenance and repair at the management level

4 Detect and identify the cause of machinery malfunctions and correct faults

4.1 ***Detection of machinery malfunctions, location of faults and action to prevent damage***

Instructors should prepare a handout which presents malfunctioning draw curves (pressure-stroke curves) and operational procedures of simulated main diesel engine to be taken for malfunction and faults for this subject to enable trainees to understand:

- causes for malfunctioning draw curves of diesel engine and remedy actions
- operational procedures for the event of malfunctions or faults of main engine

Instructors should explain, using the handout, possible causes and remedy actions based on the draw curves and operational procedures and their theoretical backgrounds for events of malfunctions and faults.

Table A-III/4: Specification of minimum standard of competence for ratings forming part of an engineering watch

Function: Marine engineering at the support level

1 Familiarization

1.1 ***Plant arrangement***

Instructors should prepare diagrams which present simulated steam boiler plant for this subject to enable trainees to:

- understand purposes of each system which forms the simulated steam boiler plant
- identify feed water, fuel oil system and steam supply systems, and their machinery

Instructors should explain, using diagrams of the simulated steam boiler plant, steam boiler plant and functions of machinery.

1.2 ***Instrumentation***

Instructors should prepare tabulated lists of instrumentation used for simulated steam boiler plant for this subject to enable trainees to:

- understand purposes of the instrumentation
- identify instrumentation used for the simulated steam boiler plant

Instructor should explain, using the tabulated lists, instrumentation, units used for instrumentation and their importance.

1.3 *Alarm system*

Instructors should prepare tabulated lists of audio and visible alarm patterns generally used for ships for this subject to enable trainees to identify the alarms that are used to indicate malfunctions and faults

Instructor should explain alarm patterns and their importance as necessary.

1.4 *Controls*

Instructors should prepare tabulated lists of controls used for simulated propulsion plant for this subject to enable trainees to:

– identify equipment used for automatic and remote controls in the simulated boiler plant

– identify machinery which is automatically controlled

Instructors should explain, using the tabulated lists, functions of automatic and remote-control applied to simulated steam boiler plant.

2 Maintain correct boiler water levels and steam pressures

2.1 *Safe operation of boilers*

Instructors should prepare diagrams which present simulated steam boiler plant for this subject to enable trainees to:

– understand types of a steam boiler and their simple features

– identify simulated steam boiler and its associated system machinery

– understand precautions and procedures for firing up the steam boiler from cold condition including significance of pre-purge and post purge

– understand functions of key valves and ancillary equipment such as water gauge blow valves, safety valve lifting gear and soot blower

Instructors should explain, using diagrams of the simulated steam boiler plant, operational procedures and precautions for starting and shutting down the simulated steam boiler.

Table A-III/6: Specification of minimum standard of competence for electro-technical officers

Function: Electrical, electronic and control engineering at the operational level

1 Familiarization

Refer to "1 Familiarization" of A-III/1

2 Operate generators and distribution systems

2.1 *Coupling and breaking connection between switchboards and distribution panels*

Refer to "4.1 Operation of main switch board" of A-III/1

3 Monitor the operation of electrical, electronic and control systems

3.1 *Basic understanding of the operation of mechanical engineering systems*

Instructors should prepare a handout and check lists which present arrangements of simulated propulsion plant, electrical power generation system and steam generation system, and check lists for mechanical running parameters of the simulated plant machinery and electrical, electronic and control parameters of control equipment for this subject to enable trainees to:

– understand arrangements of main engine and associated auxiliaries, electrical power generation system and steam generation system

– understand main mechanical running parameters of the plant machinery

– relate electrical, electronic and control parameters to the main mechanical running parameters
– understand how the control equipment control the plant machinery and process values
– understand parameters used for controlling machinery

3.2 *Fundamentals of automation, automatic control systems and technologies*

Instructors should explain fundamentals of the following control methodologies

– program control
– PLC (programmable logic control)
– PID control
– sequential control
– ON-OFF

Instructor should also explain general usage of control methods above and how they are applied to propulsion plant machinery.

4 Operate and maintain power systems in excess of 1,000 volts

4.1 *Electrical propulsion ship*

Instructors should prepare a handout and check lists which present specifications of simulated propulsion plant, system diagrams, operational procedures and precautions to operate the plant for this subject to enable trainees to understand:

– electrical propulsion types and specifications of simulated main electric motors such as working voltage and power distribution system
– correct sequences of preparation for operating the simulated main motors and their theoretical backgrounds
– operating conditions for the simulated main motors such as methods of speed control and their elements
– how to maneuvre the simulated main motors

Instructors should explain, using system diagrams of the simulated propulsion plant and the check lists:

– variety of electrical propulsion systems
– how the simulated propulsion plant is constructed
– operational procedures and functions of machinery
– methodologies of speed control and running parameters

Function: Maintenance and repair at the operational level

5 Maintain and repair automation and control systems of main propulsion and auxiliary machinery

5.1 *Detection of machinery malfunctions, location of faults and action to prevent damage*

Refer to "2.10 Fault detection and measures" of A-III/1

5.2 *Detection of electrical malfunctions, location of faults and action to prevent damage*

Instructors should prepare a handout which presents electrical malfunctions which likely occur in electrical power generation and distribution system machinery taking up the simulated electrical power generation and distribution systems as example.

Instructor should also explain how we should address electrical malfunctions and precautions for measures to be taken.

Table A-III/7: Specification of minimum standard of competence for electro-technical ratings

Function: Maintenance and repair at the support level

1 Familiarization

1.1 *System arrangement*

Instructors should prepare system diagrams which present simulated electric power generation and distribution systems for this subject to enable trainees to:

– understand purposes of each system which forms the simulated electric power generation system

– identify the system machineries

– understand functions of the machinery

Instructors should explain, using the system diagrams, the electric power generation and distribution systems and functions of machinery.

1.2 *Instrumentation*

Instructors should prepare tabulated lists of instrumentation used for simulated electric power generation and distribution systems for this subject to enable trainees to:

– understand purposes of the instrumentation

– identify instrumentation used for the power generation and distribution systems

Instructor should explain, using the tabulated lists, instrumentation, units used for the instrumentation and their importance.

1.3 *Alarm system*

Refer to "1.3 Alarm system" of A-III/4

2 Contribute to the maintenance and repair of electrical systems and machinery on board

2.1 *Test, detect faults and maintain and restore electrical control equipment and machinery to operating condition*

Instructors should prepare tabulated lists of terms used for simulated electric power generation and distribution systems for this subject to enable trainees to understand:

– meanings of main terms used for the electric power generation and distribution systems

– dangers when handling electric equipment

– safe practice for test, fault detection, maintain and restore

Instructor should explain, using the tabulated lists, meanings of terms and safe practice emphasizing dangers when handling electric equipment.

2.2 *Detection of machinery malfunctions, location of faults and action to prevent damage*

Instructors should prepare tabulated lists which present some of machinery abnormal and malfunctions applied to simulated propulsion plant machinery for this subject to enable trainees to:

– identify abnormal applied to the machinery/machinery systems

– understand remedy actions to be taken for machinery abnormal and malfunctions

– understand possible causes for abnormal and malfunctions

Instructors should explain, using the tabulated lists, meanings of machinery abnormal, remedy actions.

Part E: Evaluation and Assessment

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 and 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 and assessment is to:

- assist trainee learning
- identify trainees' strengths and weaknesses
- assess the effectiveness of a particular instructional strategy
- assess and improve the effectiveness of curriculum programmes
- assess and improve teaching effectiveness.

The different types of evaluation/assessment can be classified as:

Initial/Diagnostic assessment

This should take place before the trainees commence a course/qualification to ensure they are on the right path. Diagnostic assessment is an evaluation of a trainee's skills, knowledge, strength and areas for development. This can be carried out during an individual or group setting by the use of relevant tests.

Formative assessment

It is an integral part of the teaching/learning process and hence is a "continuous" assessment. It provides information on the trainee's progress and may also be used to encourage and motivate them.

The 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 trainee's achievement against defined objectives and targets. It may take the form of an exam or an assignment and takes place at the end of a course.

The purpose of summative assessment is to:

- pass or fail a trainee
- grade a trainee.

Evaluation for Quality assurance

Evaluation can also be required for quality assurance purposes

The purpose of assessment with respect to quality assurance is to:

- provide feedback to instructors on trainee's learning
- evaluate a module's strengths and weaknesses
- improve teaching.

Assessment Planning

Assessment planning should be specific, measurable, achievable, realistic and time-bound (SMART). Some methods of assessment that could be used depending upon the course/qualification are as follows and should all be adapted to suit individual needs:

- Observation (in Oral examination, Simulation exercises, Practical demonstration)
- Questions (written or oral)
- Tests
- Assignments, activities, projects, tasks and/or case studies
- Simulations (also refer to section A-I/12 of the STCW code 2010).
- CBT.

Validity

The evaluation methods must be based on clearly defined objectives, and they must truly represent what is meant to be assessed, for example only the relevant criteria and the syllabus or course guide. There must be a reasonable balance between the subject topics involved and also in the testing of trainees' Knowledge, Understanding and Proficiency of the concepts.

Reliability

Assessment should also be reliable (if the assessment was done again with a similar group/learner, would you receive similar results). We may have to deliver the same subject to different groups of learners at different times. If other assessors are also assessing the same course, there is a need to ensure that all make the same decisions.

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

If the instructors are going to assess their own trainees, they need to know what they are to assess, and decide how to do this. The 'what' will come from the standards/learning outcomes of the course they are delivering. 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 our learners, whether this will be formative and/or summative and how the assessment will be valid and reliable.

All work assessed should be valid, authentic, current, sufficient and reliable; this is often 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
- 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 matters to be tested for the assessment of competence.

Care should therefore be taken to select the most appropriate method for 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 job at sea.

STCW Code

The training and assessment of seafarers, as required under the Convention, are administered, supervised and monitored in accordance with the provisions of section A-I/6 of the STCW Code.

Column 3 – Methods for demonstrating competence and Column 4 – Criteria for evaluating competence in the following tables of STCW Code, set out the methods and criteria for evaluation. Instructors should refer to these tables when designing the assessment.

A-III/1: Specification of minimum standard of competence for officers in charge of an engineering watch in a manned engine-room or designated duty engineers in a periodically unmanned engine-room

A-III/2: Specification of minimum standard of competence for chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3,000 kW propulsion power or more

A-III/4: Specification of minimum standard of competence for ratings forming part of an engineering watch

A-III/6: Specification of minimum standard of competence for electro-technical officers

A-III/7: Specification of minimum standard of competence for electro-technical ratings

Assessment is also covered in detail in IMO model course 3.12; however, to assist and aid the instructors, some extracts from that model course are used to explain in depth.

Conduct of evaluation

With regard to evaluation forms, as far as possible, the responsible evaluator should collect comments or evaluations made by other evaluators, and evaluate the trainees' marks on the evaluation form. The marking of the evaluation form should be done in a cautious, objective and dispassionate manner.

The evaluation form should be developed by instructors in accordance with simulator facilities and functions and the form should include:

- Performance standard
- Performance Criteria
- Evaluation Criteria for Performance
- Evidence of Evaluation
- Technical and behavioural markers

(Example)

Exercise Title	Takeover of an engineering watch
Task	Inspect plant machinery and take over the engineering watch
Function and Level	Marine engineering at the operational level
Competence	Maintain a safe engineering watch
Requirements (K.U.P.)	Thorough knowledge of principles to be observed in keeping an engineering watch, including: .1 duties associated with taking over and accepting a watch .2 routine duties undertaken during a watch .3 maintenance of the machinery space logs and the significance of the reading taken .4 duties associated with handing over a watch

Performance standard	The trainees need to: – enter the engine-room at least 15 minutes before taking over the engineering watch – make sure the status and running condition of the plant machinery one by one in the correct order – (In the simulated engine-room, the trainees inspect generally the machinery from main engine running conditions such as control position, status of control modes, revolution speed, shaft output and torque, fuel notch, temperatures, pressures, viscosity and move to steering system, power generation system, steam generation system and other systems such as fuel supply and treatment system, cooling water system, compressed air system, and bilge treatment system that process values are to be inspected) – jot down matters considered to be unusual or wrong – enter the control room at least 3 minutes before taking over the engineering watch – make sure ship's navigational conditions (speed, wind force and direction) and main running conditions and parameters of main engine and power generation system by inspecting main console and main switch board – check engine-room log, alarm log, standing orders and special orders from the chief engineer and other relevant information – meet the present watch officer and ask for transition briefing – receive the transition briefing and ask questions about doubts/findings – state finally taking over the watch
Performance Criteria	Through the engine-room round: – determine/inspect status or conditions of main and auxiliary machinery and their control systems including the steering systems – report and record the status or conditions of main and auxiliary machinery and their control systems including the steering systems as necessary Through the inspection in the control room: – determine/inspect status or conditions of main and auxiliary machinery and their control systems including the steering systems – report and record the status or conditions of main and auxiliary machinery and their control systems including the steering systems as necessary – check the engine-room log, alarm log, standing orders and special orders from the chief engineer and other information Through communication with the present watch officer: – receive transition briefing from the officer – ask the officer questions about the findings/ determinations/doubts obtained from the inspection or checks – take over the watch
Evaluation Criteria for Performance	– Correctly and effectively determine/inspect status or conditions of main and auxiliary machinery and their control systems including the steering systems – Correctly and effectively report/answer the questions about the status or conditions of main and auxiliary machinery and their control systems including the steering systems and record them as necessary – Correctly check the engine-room log, alarm log, standing orders and special orders from the chief engineer and other information – Correctly ask the present officer questions as necessary

Evidence for Evaluation	Performance on the engine-room round and inspection in the control room Reports and/or questions from the trainees Answers to the questions from the instructor

(Sample evaluation form 1: Technical and behavioural markers)

Date and Hour			
Exercise Title	Takeover of an engineering watch		
Task	Inspect plant machinery and take over the engineering watch		
Observation		**T**	**Marks**
1	Inspection of machinery (Engine-room round) (Sequence of inspection was effective, Determination of running parameters and confirmation of various status of the plant were satisfactory, Inspection of vital machinery and systems were not missed)	T 1	A B C D
		T 2	A B C D
		T 3	A B C D
		T 4	A B C D
		T 5	A B C D
2	Inspection in the control room (Data and information concerning ship's navigational conditions, main engine, power generation system and status of the plant obtained from main console and main switch board were correctly inspected)	T 1	A B C D
		T 2	A B C D
		T 3	A B C D
		T 4	A B C D
		T 5	A B C D
3	Engine-room log and other information (Engine-room log, alarm log, standing orders and special orders from the chief engineer and other information noted by the present watch officer were correctly checked and understood)	T 1	A B C D
		T 2	A B C D
		T 3	A B C D
		T 4	A B C D
		T 5	A B C D
4	Findings (E/R, C/R, Engine-room log, etc.) (Malfunctions of the plant machinery and control systems were found, Deviations from normal operation range were found, Unusual status of the plant were found, Findings were cleared up in an appropriate manner)	T 1	A B C D
		T 2	A B C D
		T 3	A B C D
		T 4	A B C D
		T 5	A B C D
5	Takeover of the engineering watch in oral form (Transition briefing was completely understood, Communication with the present watch officer was clear, effective and confident, Takeover of the watch was clearly declared)	T 1	A B C D
		T 2	A B C D
		T 3	A B C D
		T 4	A B C D
		T 5	A B C D

Trainee's Name and Final Marks			T3		A B C D
T1		A B C D	T4		A B C D
T2		A B C D	T5		A B C D

Remarks and Observations of examiner:

Note: A – Very good, B – Good, C – Fair and D – Poor

(Sample evaluation form 2: Behavioural markers for non-technical skills)

Trainee's Class	
Instructor attended	
Training Title/Scenario	Engine-room Resource Management (ERM)
Date of Training	

Trainee's Name & Final Marks

T1		A B C D	T6		A B C D
T2		A B C D	T7		A B C D
T3		A B C D	T8		A B C D
T4		A B C D	T9		A B C D
T5		A B C D	T10		A B C D

Item		**T**	**Mark**
1	Understanding of roles and responsibilities in operating plant machinery as a part of an engineering watch (If performance/operation made by the trainee was satisfactory depending on their positions assigned and based on the correct knowledge on plant machinery)	T1	A B C D
		T2	A B C D
		T3	A B C D
		T4	A B C D
		T5	A B C D
		T6	A B C D
		T7	A B C D
		T8	A B C D
		T9	A B C D
		T10	A B C D
2	Instruction, report, answerback and other communication patterns (If all communication patterns were clearly recognized and oral communication were clear, effective and timely depending on their positions assigned)	T1	A B C D
		T2	A B C D
		T3	A B C D
		T4	A B C D
		T5	A B C D
		T6	A B C D
		T7	A B C D
		T8	A B C D
		T9	A B C D
		T10	A B C D

3	Leadership and assertiveness (If leadership and/or assertiveness were exerted depending on their positions assigned. Initiative in a small group may be also regarded as leadership)	T1	A B C D
		T2	A B C D
		T3	A B C D
		T4	A B C D
		T5	A B C D
		T6	A B C D
		T7	A B C D
		T8	A B C D
		T9	A B C D
		T10	A B C D
4	Situational awareness and notification of any doubt (If situational awareness was exerted depending on their positions assigned. If there was notification of any doubt or a similar event)	T1	A B C D
		T2	A B C D
		T3	A B C D
		T4	A B C D
		T5	A B C D
		T6	A B C D
		T7	A B C D
		T8	A B C D
		T9	A B C D
		T10	A B C D

Depictive evaluation in respect to behaviour as a team member	
T1	
T2	
T3	
T4	
T5	
T6	
T7	
T8	
T9	
T10	

Signature of evaluator

Note: A – Very good, B – Good, C – Fair and D – Poor

Debriefing

The time for debriefing session should be occupied by contents of the trainings but it is better to make debriefing sessions as short as possible. The instructor should summarize the training to let the trainees ensure what they have learned through the training.

The instructor should refer to the notes taken during the exercise, raise important points and lead the discussion among the trainees, and they should be encouraged to examine their performance critically. Instructors should not impose their own views, but ensure that the trainees have the right attitude and are encouraged to use correct procedures at all times.

Appendix 1 (to Part D):
Examples of Exercises

Note: The values mentioned in the exercises are based on a particular type of engine. These values may vary depending on the types of engine being simulated. The instructor should accordingly set the values appropriate to the engine being simulated.

D1 Sample exercises for table A-III/1

Sample exercise 1 (A-III/1) and (A-III/6)

Exercise Title	**Familiarization 1**
Task	Trace machinery and pipeline layout in the machinery space
Function and Level	Marine engineering at the operational level
Competence	----
Requirements (K.U.P.)	----
Estimated Duration	2 hours
Outline of Training	Individual trainee works on tracing propulsion plant machinery and piping lines presented on the illustrating/mimic panel
Initial Condition	Not in operation
Specific Purpose	The training allows the trainees to: – understand how the propulsion plant is constructed – understand machinery systems which construct the plant – understand how the systems and machinery are connected – understand meaning/significance of piping lines
Briefing	Explain briefly the following: – this training gives understanding of construction of propulsion system and preliminary knowledge for plant operation – this training has no direct connection to K.U.P. of the competence tables – outline of the training – propulsion plant is mainly constructed by main machinery, power generation system, steam generation systems and other auxiliary machinery – importance of understanding roles of these machinery systems and machinery which construct each system – a need to understand how these systems are connected by piping lines

Exercise Title	**Familiarization 1**
Implementation	Let the trainees: – trace main machinery and its associated systems such as fuel supply, lubricating oil supply, cooling water circulation, air supply and exhaust gas systems with tanks, main valves, pumps, heaters and coolers – trace power generation system and its associated systems such as generators, prime movers, fuel supply/steam supply, cooling water circulation systems with tanks, main valves, pumps and coolers – trace steam generation system and its associated systems such as exhaust gas economizer, fuel supply, feed water, steam supply and condensate water systems with tanks, main valves, pumps, cooling water circulation, heaters and coolers – trace fuel transfer and treatment systems with tanks, main valves, pumps, purifiers and heaters – trace cooling fresh water and sea water systems with tanks, main valves, pumps, fresh water generator and coolers – trace compressed air systems with air compressors, air reservoirs and main valves – trace lubricating oil treatment system with lubricating oil purifiers and heaters – trace bilge treatment system with separator, incinerator, tanks, bilge wells, pumps and main valves – trace stern tube lubricating oil system with stern tube gravity tanks high and low, stern tube aft and fwd seal tanks, drain tank, pumps and cooler – trace sewage plant system pipelines and connection to sea water system
Debriefing	Explain briefly the following: – functions and features of piping lines – functions and features of tanks, particularly FW expansion tank – installations fitted on the piping lines and various types of valves and their correct operation – differences between local control, remote control and automatic control – control methodologies applied to the machinery

Sample exercise 2 (A-III/1) and (A-III/6)

Exercise Title	**Familiarization 2**
Task	Operate instrumentation system to measure the running parameters of the main engine/auxiliary machinery
Function and Level	Marine engineering at the operational level
Competence	----
Requirements (K.U.P.)	----
Estimated Duration	2 hours
Outline of Training	Individual trainee works on a check list reading indication meters of the simulated plant machinery on the mimic panel or illustrating panel and observing displays of instruments on the main console and main switch board
Initial Condition	Harbour transit

Exercise Title	**Familiarization 2**
Specific Purpose	The training allows the trainees to: – get to know names and functions of instrumentations used to indicate running parameters and status of the plant machinery – understand difference between an analogue meter and digital indicator and their advantages and disadvantages – get familiar with reading indicators including unit – observe indicator diagrams displayed on the screen of an engine power meter or monitoring system
Briefing	Explain briefly the following: – this training gives understanding of instrumentation used in a ship's propulsion plant – this training has no direct connection to K.U.P. of the competence tables – outline of the training – various instrumentation is used to indicate various process values that are running parameters of the machinery – the importance of reading correctly these indications to ensure proper judgement of the running condition
Implementation	Start the simulation and let the trainees enter the engine-room and: – start reading indications of various meters on the mimic panel or illustrating panel following the check list The instructor lets the trainees enter the control room and: – start reading indications of various meters on the main console and main switch board The instructor stops the simulation and creates standby engine as an initial condition and lets the trainees: – operate main engine maneuvering lever in turn and observes p/v diagrams and draw curves of the main diesel engine on the display of monitoring system or engine power meter unit
Debriefing	Explain briefly the following: – almost all running parameters can be seen on the display of monitoring system in an actual ship – actual thermometers, pressure gauges, level gauges and other process indicators are installed in an actual ship – usually there is a difference in indication values between actual meters and the monitoring system in an actual ship – the importance to remember approximate values of running parameters

Sample exercise 3 (A-III/1) and (A-III/6)

Exercise Title	**Familiarization 3**
Task	Operate alarm system used to indicate malfunctions and emergency
Function and Level	Marine engineering at the operational level
Competence	----
Requirements (K.U.P.)	----
Estimated Duration	1 hour
Outline of Training	Individual trainee performs operation of alarm system identifying malfunction in turn
Initial Condition	Seagoing
Specific Purpose	The training allows the trainees to: – get to know difference between general alarm/emergency alarm and engine alarms – understand pattern of machinery alarms – understand how to respond to an alarm sound – meaning of alarm sound, lamp indications and lamp flicker – understand how to change alarm setting values – understand basic functions of monitoring system
Briefing	Explain briefly the following: – how to respond to machinery alarms of instrumentation used in a ship's propulsion plant – basic functions of a monitoring system used for propulsion plant machinery – difference between general alarm and machinery alarms – meaning of buzzer stop button, reset/flicker stop button and alarm indication lamps
Implementation	Start the simulation and let the trainees: – perform buzzer test and lamp test in turn – respond to an alarm entered by the instructor – press buzzer stop button to stop the alarm sound – make sure what was alarmed and the malfunction machinery with lamp flicker – press reset/flicker stop button and make sure the lamp becomes continuous lighting – make sure the alarming value of parameter/status of the machinery – make sure that the alarm lamp lights until the alarmed parameter becomes normal – make sure that the alarm was recorded in the event printer/alarm printer with time of occurrence and stored in the monitoring systems until the alarmed parameter becomes normal (Instructor makes alarms one after another until the trainees become familiar with the response) – make changes in alarm setting value of running parameters for the monitoring system such as temperature, pressure, level and time-lag for alarming
Debriefing	Explain briefly the following: – summary of the training – meanings of audible and visible alarm – an alarming system cannot be used in principle for a safety system – three categories of alarm that are emergency alarm, primary alarm and secondary alarm

Sample exercise 4 (A-III/1) and (A-III/6)

Exercise Title	**Familiarization 4**
Task	Identify equipment used for controls
Function and Level	Marine engineering at the operational level
Competence	----
Requirements (K.U.P.)	----
Estimated Duration	1 hour
Outline of Training	Individual trainee works on a check list for identifying equipment used for controls in the simulated propulsion plant
Initial Condition	Not in operation
Specific Purpose	The training allows the trainees to: – understand what machinery is remotely and/or automatically controlled – understand what process values are automatically controlled – identify what equipment is used for controls
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – differences between remote control and automatic control – control methods applied to main machinery
Implementation	The instructor lets the trainees identify equipment used for controls following the check list: – remote-automatic control – main engine control stand/panel in the engine-room and control room – main engine maneuvering lever in the engine-room and control room – auxiliary blower control switch – generator control panel on main switch board and main console – synchronizing panel on main switch board – auxiliary boiler control panel – purifier control panel – remote control – group starter panels (G.S.P.) – automatic control – temperature controllers – level controllers – pressure controllers – viscosity controllers – control valves – start and stop in group starter panels
Debriefing	Explain briefly the following control methods applied to: – actual main engine, power generation system and boiler controls – actual automatic control for temperature, level and other process values – actual automatic start and stop of auxiliary machinery

Sample exercise 5 (A-III/1)

Exercise Title	**Operation of plant machinery**
Task	Line up and establish auxiliary machinery systems
Function and Level	Marine engineering at the operational level
Competence	Operate main and auxiliary machinery and associated control systems
Requirements (K.U.P.)	Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems .1 main engine and associated auxiliaries .2 steam boiler and associated auxiliaries and steam systems .3 auxiliary prime movers and associated systems .4 other auxiliaries including refrigeration, air conditioning and ventilation systems
Estimated Duration	3 hours
Outline of Training	4 ~ 5 trainees establish a group and the group performs operations of the following machinery in the engine-room: – start and stop emergency generator – start, stop and change over CSW pumps and LTFW pumps – start, stop and change over main air compressors – start and stop control air compressor – start, stop and change over oil purifiers The trainees may refer to a procedure manual prepared by instructors All operations should be principally carried out in manual. This training is not for plant operation but for operation of each machinery, therefore same procedures may be sometimes repeated
Initial Condition	Cold ship (FW, FO and LO are loaded, No machinery is in service, All valves are principally closed)
Specific Purpose	The training allows the trainees to: – understand how to start, stop and changeover auxiliary machinery – acquire knowledge on preparations and procedures for starting, operating and stopping machinery and their procedural theories
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – purposes of starting each machinery and establishing systems – procedures for starting, operating and stopping each machinery and their procedural theories applied to the machinery – significance to keep correct sequence of the procedures to prevent damage – needs to check running condition in terms of sounds, vibration, heat and leakage when starting machinery although these cannot be detected on the simulator

Exercise Title	**Operation of plant machinery**
Implementation	Start the simulation and let the trainees: (Start and stop emergency generator) – make procedures to start the emergency generator – check running parameters and voltage established – connect the generator to BUS line – disconnect the generator from BUS line – stop the generator (Start, stop and change over CSW pumps and LTFW pumps) – air purge in CSW pumps suction side – start No. 1 CSW pump checking pressure – change over No. 1 CSW to No. 2 CSW pump in a correct manner – change over No. 2 CSW to No. 3 CSW pump if any – set No. 1 CSW pump as a running pump and Nos. 2 and 3 to auto standby – open valves on No. 1 LTFW pump suction line and start No. 1 LTFW pump – open delivery valve of No. 1 LTFW checking pressure – change over No. 1 LTFW pump to No. 2 in a correct manner – change over No. 2 LTFW pump to No. 3 if any – set No. 1 LTFW pump as a running pump and Nos. 2 and 3 to auto standby (Start, stop and change over main air compressors) – open valves on LTFW line to Nos. 1 and 2 main air compressors (coolers) – open valves on compressed air line to No. 1 main air reservoir from No. 1 compressor – start No. 1 main air compressor and supply No. 1 main air reservoir with compressed air checking pressure and discharging drain manually – start No. 2 main air compressor and supply No. 1 main air reservoir with compressed air in parallel – after filling up No. 1 main air reservoir, stop Nos. 1 and 2 main air compressors and close supply valve to No. 1 main air reservoir – open supply valve to No. 2 main air reservoir and start No. 2 main air compressors to fill up No. 2 main air reservoir – set No. 2 main air compressor to auto – shut down No. 1 main air compressor closing valves concerned in air and LTFW (Start and stop control air compressor) – same procedures as main air compressor and fill up control air reservoir with compressed air – set finally control air compressor to auto

Exercise Title	**Operation of plant machinery**
Implementation *(Cont.)*	(Start, stop and change over diesel generators) – open No. 1 main air reservoir outlet valve – check No. 1 diesel generator for CFW, LO and DO/FO – operation to start No. 1 diesel generator opening valves concerned in CFW, LO and DO/FO – start No. 1 diesel generator and confirm running parameters – connect No. 1 diesel generator to BUS line confirming voltage and frequency on MSB – restart No. 1 CSW pump and No. 1 LTFW pump, and stop the emergency generator if necessary – check No. 2 diesel generator for CFW, LO and DO/FO – operation to start No. 2 diesel generator opening valves concerned in CFW, LO and DO/FO – start No. 2 diesel generator and confirm running parameters – make manually parallel running of Nos. 1 and 2 diesel generators on MSB – make manually single running of No. 2 diesel generator on MSB – stop No. 1 diesel generator (Fire up auxiliary boiler and raise steam pressure including lining up steam system) – check water level of the boiler and feedwater/cascade tank for level – check the steam root valve closed and air vent valve opened – open valves concerned in DO supply line and start DO circulation – opened valves concerned in boiler water circulation line and start No. 1 boiler water circulation pump – set No. 2 boiler water circulation pump to auto standby – operation for manually lighting off the burner – operation for extinguishing the flame about 1 minute later – operation for manually lighting off the burner about 1 minute later – repeat the same procedures one more time (The instructor makes the simulation faster at this stage in order to facilitate the training saying that the simulation runs faster although we must raise the steam pressure according to the specific standard for the boiler) – close air vent valve when the steam pressure reaches to 0.05 ~ 0.1 Mpa/0.5 ~ 1 bar – lighting off the burner accordingly again – line up the feed water line and start No. 1 feed water pump – supply feed water control system with control air if necessary – set No. 2 feed water pump to auto standby – stop No. 1 boiler water circulation pump and close valves concerned – open steam supply valves on steam line when the steam pressure reaches to 0.4 Mpa/4 bar – start heating FO service tank, FO settling tanks and FO bunker tanks – change fuel oil of the boiler from DO to FO and turn on FO heater when the temperature of FO service tank reaches to the setting valve – set the boiler to auto

Exercise Title	**Operation of plant machinery**
Implementation *(Cont.)*	(Start, stop and changeover oil purifiers) – check No. 1 FO purifier for operating water tank level and LO level – open valves concerned in FO and the operating water and start No. 1 FO purifier – supply FO heater with heating steam – supply it with FO and checking running parameters when No. 1 FO purifier reaches to operational revolution speed – changeover No. 1 FO purifier to No. 2 FO purifier about 3 minutes later – check running parameters after changing over to No. 2 FO purifier – set No. 2 FO purifier to automatic operation – stop No. 1 FO purifier – check No. 1 LO purifier for operating water level and LO level – open valves concerned in LO and the operating water and start No. 1 LO purifier – supply LO heater with heating steam – supply it with LO when No. 1 LO purifier reaches to operational revolution speed
Debriefing	Explain briefly the following: – significance of correct sequence of starting and stopping machinery to avoid damage – theoretical aspects for sequence of starting and stopping machinery

Sample exercise 6 (A-III/1) and (A-III/6)

Exercise Title	**Diesel generator operation**
Task	Carry out starting, paralleling and changing over generators
Function and Level	Electrical, electronic and control engineering at the operational level
Competence	Operate electrical, electronic and control systems
Requirements (K.U.P.)	Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment .2 preparing, starting, paralleling and changing over generators
Estimated Duration	2 hours/4 ~ 5 trainees
Outline of Training	The trainees perform the following operations on MSB: – starting and stopping remotely operated diesel generators – making parallel running of diesel generators automatically and manually – making single running of diesel generator automatically and manually – selecting priority of standby generators – setting optimum load sharing/number of generators 4 ~ 5 trainees stand in front of MSB and one trainee performs the operation in turn. Other trainees observe his/her performance. The instructor gives the trainee tasks to be done one by one These operations should be performed by an individual trainee and the trainee should come to be well-versed in making parallel and single running of diesel generators
Initial Condition	In port

Exercise Title	**Diesel generator operation**
Specific Purpose	The training allows the trainees to: – understand meaning of parallel running of generators – understand conditions for parallel running of generators – understand how to change over the generators
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – functions and arrangements of MSB – conditions to put a generator into service and to make parallel running of the generators – automations incorporated in the MSB for controlling generators – precautions to be observed when handling MSB
Implementation	Start the simulation and let the trainees: (Initial condition: In port and No. 1 diesel generator is in service and lets one trainee stand in front of MSB. The other trainees observe his/her performance from behind keeping a reasonable distance) (Instruction 1) – start No. 2 diesel generator remotely and make manually parallel running of Nos. 1 and 2 diesel generators (Instruction 2) – make manually single running of No. 2 diesel generator and set No. 1 diesel generator to second standby/priority condition, stopping it remotely (Instruction 3) – start No. 3 generator remotely and make automatically parallel running of Nos. 2 and 3 diesel generators (Instruction 4) – automatically stop No. 2 diesel generator making single running of No. 3 diesel generator and setting No. 2 diesel generator to second standby/priority condition (Instruction 5) – make full automatically single running of No. 1 diesel generator and set first standby/priority for No. 2 diesel generator and second standby/priority for No. 3 diesel generator (This is end of the first performance and the instructor lets the trainee change off to the next trainee. The training is kept up in the same manner until all the trainees complete performance; however, operation patterns/combination may be changed by instructor's discretion)
Debriefing	Explain briefly the following: – conditions necessary for making parallel running of generators – mistaken or misunderstanding if any during the performance – why parallel running is necessary – when parallel running is used – automations applied to generator control – functions incorporated in MSB relevant to automatic control of generators such as preference trip, large motor start blocking and others

Sample exercise 7 (A-III/1) and (A-III/6)

Exercise Title	**High-voltage installation**
Task	Identify high-voltage installations
Function and Level	Electrical, electronic and control engineering at the operational level
Competence	Operate electrical, electronic and control systems
Requirements (K.U.P.)	Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment .2 high-voltage installations
Estimated Duration	2 hours/3 ~ 4 trainees
Outline of Training	3 ~ 4 trainees establish a group and the group perform simulation programme following instructions by the programme on high-voltage installations for the purposes of: – identifying what equipment construct high-voltage system – understanding characteristics of high-voltage system equipment – understanding structural features of high-voltage system equipment – identifying main components which construct high-voltage system equipment
Initial Condition	----
Specific Purpose	The training allows the trainees to: – understand configuration of high-voltage system – understand structural features of high-voltage installations – understand differences between high-voltage and low voltage installations when handling them – understand what dangers exist in high-voltage machinery systems
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – safety functions, features and arrangements of the simulated high-voltage systems – all operations have to be done in remote control and no one can approach the high-voltage installations – induced electromotive force
Implementation	Start the simulation and let the trainees perform the simulation programme for identifying and understanding: – system equipment used for high-voltage power distribution – high-voltage generator – high-voltage main switch board – low voltage main switch board – high-voltage transformer – converter – high-voltage synchronous motor for propulsion and pumps

Exercise Title	**High-voltage installation**
Implementation *(Cont.)*	– system configuration of high-voltage power distribution – functions of system equipment – structure of high-voltage main switch board – low voltage compartment – protection and control unit – switch panel – CB (Circuit Breaker) compartment – VCB – VCB draw in/out handling port – indicator of VCB position – emergency open mechanism – interlock key for de-excitation – earthing switch operating handle port – BUS bar compartment – pressure relief flap – insulation bushing – main BUS bar – cable compartment – surge arrester – current transformer – load BUS bar – power cable terminal – earthing switch – zero phase current transformer – voltage transformer – structures of vacuum circuit breaker (VCB) and gas circuit breaker (GCB) – safety functions of VCB/GCB – over current trip – low voltage trip – reverse power trip – earthing switch – precautions when handling high-voltage installations
Debriefing	Explain briefly the following: – precautions and differences between high and low voltages when handling high-voltage installations – advantages of high-volt installations

Sample exercise 8 (A-III/1)

Exercise Title	**Preparation of propulsion plant for departure port**
Task	Establish navigational mode
Function and Level	Marine engineering at the operational level
Competence	Operate main and auxiliary machinery and associated control systems
Requirements (K.U.P.)	Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems .1 main engine and associated auxiliary
Estimated Duration	4 hours
Outline of Training	4 ~ 5 trainees establish a group and the group performs, under the direction of the leader, operations of starting up main engine including warming up and establish navigational mode including starting up fresh water generator and turbo generator All operations should be principally carried out in manual
Initial Condition	In port
Specific Purpose	The training allows the trainees to: – acquire knowledge on procedures for starting up main diesel engine, fresh water generator, turbo generator and steam turbine and their procedural theories
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – purposes of warming up – meaning of navigational mode – significance to keep correct sequence of the procedures to prevent damage

Exercise Title	**Preparation of propulsion plant for departure port**
Implementation	Start the simulation and let the trainees: (Main diesel engine) – carry out preparation for starting up – check the main engine for LO level, CFW expansion tank level and others – line up HTFW line using FW Heater – open the suction valve of No. 1 HTFW pump and start the pump – set No. 2 HTFW pump to auto standby – open delivery valve of No. 1 HTFW pump and confirm the pressure and temperature – commence warming up the main engine supplying FW Heater with heating steam – set setting value of FW temperature controller to appropriate level – line up LTFW line for coolers concerning the main engine – line up LO line for the main engine, Turbo charger and Stern tube – start No. 1 LO pump/s and set No. 2 LO pump/s to auto standby – line up DO supply line – open suction and delivery valves of FO supply and FO booster pumps – start No. 1 FO supply pump and Booster pump confirming pressure and set No. 2 pumps to auto standby – check HTFW temperature – check all indicator valves opened and engage turning gear – commence turning of the main engine by turning motor and check current vale – stop turning and disengage turning gear several minutes later – stop supply of heating steam to FW Heater and open bypass valve closing inlet and outlet valves when HTFW temperature reaches to the desired level – make parallel running of main air compressors – drain Nos. 1 and 2 main air reservoir – line up starting air line opening outlet valve of No. 1 main air reservoir – carry out start-up – carry out air running of the main engine with all indicator valves opened – close all indicator valves – manually start and stop the main engine several times within harbour speeds following engine orders – finally, set the engine speed to harbour full – increase manually the engine revolution until navigation speed after a while

Exercise Title	**Preparation of propulsion plant for departure port**
Implementation *(Cont.)*	(Start and stop FWG) – line up ejector line and start ejector pump to establish vacuum inside the FWG – line up CSW line to the FWG – supply the FWG with feed water – supply Heater of the FWG with HTFW little by little when the vacuum reaches to the desired level – start distilled water pump opening supply line to filling tank when level of distilled water appears in the level gauge – check running parameters and opening of the HTFW temperature control valve – stop gradually supply of HTFW to Heater of FWG to avoid rapid change in temperature of HTFW – stop distilled water pump and close valves concerned – stop supply of feed water to Heater – stop supply of CSW to Condenser – stop the ejector pump and close valves concerned – slightly open vacuum breaker (Warming up, start and stop Turbo generator) – establish steam condenser system – establish Turbo generator (TG) LO system – establish TG steam system ensuring draining of steam and condensate lines – supply TG with sealing steam by opening TG sealing steam supply valve – start No. 1 condenser vacuum pump and set No. 2 to auto – start No. 1 condensate pump and set No. 2 pump to auto – carry out turning of TG by turning gear for several minutes – stop turning of TG – rest trip if any – start TG by slowly opening Emergency stop valve keeping low speed for about two minutes – increase revolution speed slowly until operational revolution speed – open TG Emergency stop valve to 100% – connect manually TG to BUS line on MSB – disconnect No. 1 diesel generator from BUS line manually – stop No. 1 diesel generator manually – set No. 1 diesel generator to auto – change over power generation from TG to diesel generator – stop TG at several minutes later

Exercise Title	**Preparation of propulsion plant for departure port**
Implementation *(Cont.)*	(Main steam turbine) – carry out preparation for warming up – line up lubricating oil system for LO purifier and start the purifier for bypass purifying – line up lubricating oil system for main steam turbine and reduction gear and start No. 1 LO pump – set No. 2 LO pump to auto-standby – set LO temperature controller to appropriate level – line up circulation system and start Main circulation pump setting overboard valve to 25% opening – check hot well for level and supply distilled water to the hot well if necessary – line up condensate water system with suction valve and pressure equalizing valve of No. 1 condensate water pump opened and start the pump – set No. 2 condensate water pump to auto-standby – open drain valves connected to the main steam turbine – start turning/roll over of the main steam turbine and check the current value – carry out warming up – line up gland steam system and set the pressure to appropriate level – supply gland steam to the main steam turbine – line up vacuum system and start No. 1 vacuum pump to make vacuum inside main condenser up to appropriate level – set No. 2 vacuum pump to auto-standby – line up warming up steam line to the main steam turbine and provide the main steam turbine with warming up steam – provide main steam piping with warming up steam opening bypass valves attached to main steam valves – carry out preparation for start-up – stop supply of warming up steam – increase vacuum of the main condenser more than appropriate level – line up main steam system – stop turning motor and disengage turning gear – start automatic roll over/spinning – set nozzle valves to condition for standby engine – carry out start-up – manually start and stop the main engine several times within harbour speeds following engine orders – finally, set the engine speed to harbour full – increase manually the engine revolution until navigation speed after a while
Debriefing	Explain briefly the following: – significance of correct sequence of starting and stopping machinery to avoid damage – theoretical aspects for sequence of starting and stopping machinery

Sample exercise 9 (A-III/1)

Exercise Title	**Routine pumping operations**
Task	Carry out pumping tasks
Function and Level	Marine engineering at the operational level
Competence	Operate fuel, lubrication, ballast and other pumping systems and associated control systems
Requirements (K.U.P.)	Operation of pumping systems: .1 routine pumping operations .2 operation of bilge, ballast and cargo pumping systems Oily water separators (or similar equipment) requirements and operation
Estimated Duration	3 hours
Outline of Training	4 ~ 5 trainees establish a group and the group performs the following pumping operation in the engine-room as routine pumping operations: – transfer bunker oil to FO settling tanks – transfer bilge, sludge, drain and separated oil – send sea water for general use – oily water separator operation The trainees may refer to a procedure manual prepared by instructors and all operations should be principally carried out in manual
Initial Condition	– In port – Seagoing
Specific Purpose	The training allows the trainees to: – acquire knowledge on preparations and procedures for starting, operating and stopping pumping systems and – procedural theories of the pumping systems
Briefing	Explain briefly the following: – outline and specific purpose of the training – how to carry on the training – procedures for starting and stopping pumps and their procedural theories applied to the systems – precautions to be observed when transferring fuel oil – significance to keep correct sequence of the procedures to prevent damage – needs to check running condition in terms of amperage, sounds, vibration, heat and leakage when starting the pumping systems – fill out oil record book with appropriate entries

Exercise Title	**Routine pumping operations**
Implementation (1st stage: In Port)	Start the simulation and let the trainees: (Transferring bunker oil) – transfer 5 m^3 of FO from No. 2 FO tank (P) to No. 1 FO settling tank using No. 1 FO transfer pump – transfer FO from No. 2 FO tank (S) to No. 2 FO settling tank until 90% in level using No. 2 FO transfer pump – transfer FO from No. 7 FO tank (C) to No. 1 FO settling tank using No. 1 FO transfer pump – transfer 20 m^3 of FO from No. 2 FO tank (P) to No. 2 FO tank (S) using Nos. 1 and 2 transfer pump – transfer 0.1 m^3 of FO drain from FO drain tank to No. 1 FO settling tank using No. 1 FO transfer pump (Transferring bilge, sludge and others) – transfer bilge from engine-room bilge well (P) to bilge tank using bilge pump – transfer bilge from cargo hold to bilge tank using bilge pump – transfer sludge from sludge tank to waste oil tank using waste oil transfer pump – transfer separated oil from the tank to waste oil tank using waste oil transfer pump – transfer drain from drain tanks to bilge tank using bilge pump (Supply sea water for general use) – start Fire/General service pump and supply sea water to fire main adjusting pressure by opening overboard valve (This is end of the 1st stage and stop the simulation)
Implementation (2nd stage: Seagoing)	Start the simulation and let the trainees: (Operation of Oily water separator) – turn on oil content monitor – line up bilge overboard discharge line – open sea water suction and delivery valves of Oily water separator bilge pump system – start Oily water separator bilge pump and fill up the line and separator with sea water – change over the suction valve of the pump to bilge from bilge tank and discharge 0.5 m^3 of bilge – change over the suction valve of the pump to bilge from engine-room bilge well until almost empty – change over the suction valve of the pump to sea water to replace bilge inside the system with sea water – stop the pump and close valves concerned – note transfer quantity for making entries in the Oil Record Book as per the latest IMO guidelines

Exercise Title	**Routine pumping operations**
Debriefing	Explain briefly the following – meaning of routine pumping operations – precautions for transferring heavy fuel oil – needs to pay due attention to level of FO tanks – purpose of bilge system and functions of tanks – differences between common bilge, direct bilge and emergency bilge – precaution for transferring bilge – features of pumps used for bilge systems

Sample exercise 10 (A-III/1) and (A-III/6)

Exercise Title	**Fault detection and measures**
Task	Address malfunction
Function and Level	Marine engineering at the operational level
Competence	Operate main and auxiliary machinery and associated control systems
Requirements (K.U.P.)	Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems: .1 main engine and associated auxiliaries .2 steam boiler and associated auxiliaries and steam systems .3 auxiliary prime movers and associated systems .4 other auxiliaries including refrigeration, air conditioning and ventilation systems
Estimated Duration	2 hours
Outline of Training	4 ~ 5 trainees establish a group and the group performs operations to address malfunctions of the machinery assessing running parameters and conditions under the direction of the group leader The instructor selects malfunctions and may advise the trainees of procedures to be taken to address the malfunctions as necessary Detail and specific procedures to be taken should be developed and prepared for the trainees according to specifications and functions of the simulator
Initial Condition	Seagoing and in port
Specific Purpose	The training allows the trainees to: – acquire knowledge on how to address malfunctions of machinery assessing running parameters and conditions
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – malfunctions and how to address the malfunctions

Exercise Title	**Fault detection and measures**
Implementation	Start the simulation and let the trainees perform operation to address the following malfunctions: (Engine-room bilge well high level) – confirm the alarm by pressing buzzer stop and reset button – assess the conditions – prepare for starting bilge pump and transfer the bilge to bilge tank (if there is no space in the bilge tank, discharge bilge in the bilge tank first and transfer the bilge to the bilge tank complying with the regulations concerned) – confirm the alarm indication becomes off (No. 1 FO settling tank low level) – confirm the alarm by pressing buzzer stop and reset button – assess the level, level of bunker tank in use, running parameter of FO transfer pump and status of valves concerned – take measures to increase the level – confirm the alarm indication becomes off (FWG high salinity) – confirm the alarm by pressing buzzer stop and reset button – assess value of salinity, distilled water level, HTFW temperature, opening of HTFW bypass valve, flow rate of feed water, vacuum, temperature of evaporation – adjust some of the running parameters to reduce the content of salinity – confirm the alarm indication becomes off (Auxiliary boiler low water level) – confirm the alarm by pressing buzzer stop and reset button – assess the level, opening of FWC valve, running parameters of feed water pump, cascade tank level, control parameters of FWC controller – take measures to increase the level – confirm the alarm indication becomes off (No. 1 FO purifier abnormal separation) – confirm the alarm by pressing buzzer stop and reset button – assess running parameters of the FO purifier, resetting the purifier – decide measures to be taken from the results of assessment as follows: – take measures to manually resume the operation of the purifier – take measures to stop the purifier and restart it as usual – take measures to change over the purifier to No. 2 FO purifier – confirm the alarm indication becomes off

Exercise Title	Fault detection and measures
Implementation *(Cont.)*	(Auxiliary boiler flame failure) – confirm the alarm by pressing buzzer stop and reset button – changeover the boiler control to manual – start post purge – confirm causes of flame failure and take remedy actions – flame eye – FO low pressure/temperature – low water level – FDF abnormal stop – power failure – reset combustion control – start pre-purge – light off the burner – changeover the boiler control to auto
Debriefing	Explain briefly the following: – importance of detecting malfunction before alarm sounds – there are several proximate causes for one malfunction – needs to be well-versed in handling machinery to address malfunctions (Case study on boiler flame failure) Explain briefly the following and let the trainees discuss them: – possible consequent incident in case of flame failure – importance of pre-purge and post purge – mechanism of boiler furnace blowback – safe procedures when faced with similar situations

Sample exercise 11 (A-III/1)

Exercise Title	Engineering Watch
Task	Maintain a safe engineering watch
Function and Level	Marine engineering at the operational level
Competence	Maintain a safe engineering watch
Requirements (K.U.P.)	Thorough knowledge of principles to be observed in keeping an engineering watch, including 1) duties associated with taking over and accepting a watch, 2) routine duties undertaken during a watch, 3) maintenance of the machinery space logs and the significance of the reading taken, 4) duties associated with handing over a watch
Estimated Duration	10 hours
Outline of Training	The trainees divided into two groups (A & B) and each group undertakes the engineering watch in turn. Roles of watch officer and ratings are assigned to the trainees of each group and the training is carried out in a manner of role playing Then each group performs watch duties as a team from an engine-room round, taking over the watch, routine duties and handing over the watch
Initial Condition	Seagoing

Exercise Title	**Engineering Watch**
Specific Purpose	The training allows the trainees to: – understand principles and procedures to be applied to the engineering watch – understand tasks to be done during watch period
Briefing	Instructor briefly explains: – outline of the training – how to carry on the training – roles of officer and ratings in the training as follows, the officer mainly: – figures out running condition of the propulsion plant as a whole – receives reports from persons in charge of the machinery – issues instructions of tasks to persons in charge of the machinery – makes entry of watch log at time of taking over the watch – briefs relieving watch personnel on information to be taken over the ratings mainly: – figure out the running condition of the machinery – fill out measurement tables of the machinery in charge – perform tasks instructed by the officer – report necessary information to the officer – follow instructions given by the officer
Implementation	Start simulation and let the group A take up the first position and let the trainees: (The group B observes performance being made by the group A in the briefing room) – make engine-room round – (the watch officer of the group A) confirm all other ratings (other trainees) are ready to undertake the watch duties – receive transition briefing from the present watch officer (instructor) – accept the watch if satisfied – (the officer of the group A) instruct the ratings to carry out routine duties and to report the results

Exercise Title	Engineering Watch
Implementation *(Cont.)*	(The following are examples of routine duties) – periodical changeover of auxiliary machinery from No. 1/2 to No. 2/1 such as Fuel oil purifier, LO purifier, CSW pump, CFW pump, LO pump, Fuel oil booster pump and so on – carrying out soot blowing for Auxiliary boiler and Exhaust gas economizer – carrying out blowing down Auxiliary boiler water – changing over generated fresh water supply tank – changing over fuel oil tank to be used – discharging the bilge water overboard through the oily-water separator – transferring bilge from bilge wells to bilge tank – discharging bilge of bilge tank overboard through oily water separator – incinerating waste oil – transferring fuel oil from bunker tanks to settling tanks – carrying out drainage from scavenging air manifold of the main engine, compressed air reservoirs and fuel oil settling tank and service tank – manual discharge of sludge on Fuel oil purifiers, LO purifiers if possible – test run of emergency fire pump and diesel generator – cleaning main engine turbocharger air and/or gas sides – (the officer) instruct the ratings to carry out an engine-room round and to report the results (The following is an example of reporting main engine) – the engine load is now almost standard to the present revolution speed – revolution speed of TC is also in standard range and highest exhaust gas temperature is 380 degree Celsius (°C), the lowest temperature is 335 degree Celsius (°C) – there is very little difference among all temperatures of CFW outlets at the standard value as well as Piston cooling LO and Bering LO – opening of the HTFW temperature control valve is now 10% cooler side – scavenging air temperature and pressure stay in standard values and pressure drop of the air in air coolers gets higher a little than previous watch records – no malfunction was found and running condition of the engine is stable

Exercise Title	**Engineering Watch**
Implementation *(Cont.)*	(All members of the group B1 enter the engine-room and make an engine-room round checking the running parameters indicated on the mimic panel, group starter panels, control stands and main engine maneuvering stand) – The officer of the group A fills out the form to be handed over to the relieving watch personnel with information obtained from his/her watchkeeping and the instructor as follows and prepares for handing over the watch: – sea water temperature – engine-room temperature – ship's speed – main engine average revolution speed – fuel notch of main engine – main engine output – fuel oil consumption during the watch – main engine exhaust gas highest and lowest temperatures – turbocharger revolution speed – tasks done – tasks to be done during the relieving watch, if any – instructions from C/E – information from the bridge (the instructor should give information relating to navigational conditions such as LOG distance, OG distance and so on) (The members of group B enter the control room and both groups A and B stand toe to toe) – The officer of group A gives orally all the members of group B transition briefing (The following is an example of the briefing) – the setting position of the main engine maneuvering lever is Navigation Full and Fuel Notch is 50 – the last one hour average revolution of the main engine was 100 min^{-1} – the turbo generator is currently used and setting pressure of the boiler is 0.7 Mpa and damper control of the exhaust boiler is set to auto – sea water temperature is 20 degree Celsius and the engine-room temperature is 35 degree Celsius – orders and/or instructions of Chief engineer, if the revolution of the main engine decreases until 95 min^{-1}, report it to the Chief engineer since a heavy weather is likely expected. If there is special information from the bridge, report it to the Chief engineer – regular and/or additional tasks completed during the watch period – we carried out soot blowing for the exhaust boiler – we have changed over generated fresh water supply tank from No. 1 port FW tank to No. 1 starboard FW tank – we have changed over fuel oil tank to be used from No. 3 Port FO tank to No. 3 starboard FO tank – we discharged the bilge water from bilge tank overboard (This is completion of the 1st period. Alter the plant condition and start 2nd period, letting the group B take up the first position in the same manner as the 1st period)

Exercise Title	**Engineering Watch**
Debriefing	Explain briefly the following: – results of the training comparing to an actual engineering watch in terms of the following: – running conditions of the propulsion plant were satisfactory figured out – reports to the leader were appropriate – tasks during the watch were effective – communications during the watch were sufficient – the instructor also emphasizes difference between the simulated engine-room and an actual engine-room and importance of engine-room rounds as follow

Main Engine Measurement Table (1/2)

Name:				Date: Time: ~				
Time				Temperature (°C)	Exhaust Gas	No.1 Out		
E/R Temp. (°C)						No.2 Out		
SW Temp. (°C)						No.3 Out		
						No.4 Out		
Handle Position						No.5 Out		
Governor Notch						No.6 Out		
Shaft Rev. (min^{-1})						No.7 Out		
Pump Notch						No.8 Out		
SHP (kW)						No.9 Out		
Torque (T-m)						No.10 Out		
Thrust (Ton)						No.11 Out		
TC Rev. (min^{-1})						No.12 Out		
Ship Speed (K't)						TC In		
						TC Out		
Scavenging air Temp					Piston Cooling LO	In		
FO In Temp.						No.1 Out		
FO Viscosity						No.2 Out		
FO Press. Cont. V						No.3 Out		
						No.4 Out		
LO In Temp.						No.5 Out		
LO Temp. Cont. V						No.6 Out		
						No.7 Out		
Temperature (°C)	Jacket CFW	In				No.8 Out		
		No.1 Out				No.9 Out		
		No.2 Out				No.10 Out		
		No.3 Out				No.11 Out		
		No.4 Out				No.12 Out		
		No.5 Out		Thrust bearing T (AHD)				
		No.6 Out		Thrust bearing T (AST)				
		No.7 Out		TC LO Out				
		No.8 Out		TC LO Temp. Cont. V(%)				
		No.9 Out		TC in Drop (mmAq)				
		No.10 Out						
		No.11 Out		Oil Mist Density				
		No.12 Out						

Main Engine Measurement Table (2/2)

Pressure (Mpa)				Temperature (°C)	Shaft Bearing LO			
	Bering LO					No. 1 Inter.		
	Camshaft LO					No. 2 Inter.		
	TC LO					No. 3 Inter		
	Piston Cool LO					Aft Most		
	Scavenging air					F-S/T Seal Oil		
	Control air					Stern Tube		
	LTFW							
	FO				S/T LO CLR	LO In		
	Jacket CFW					LO Out		
	VIT Position air					LTFW In		
	FO Vent. Tank					LTFW Out		
	FO Filter Diff.							
	LO Filter Diff.			F-S/T Seal Oil Press.				
	Air Cooler Drop			S/T Bearing LO Press.				
Air Cooler	Air In Temp.			Tank Level		LO Sump Tank		
	LTFW In Temp.					TC LO H/G Tank		
	LTFW Out Temp.					CFW Exp. Tank		
						Cyl. Oil Day Tank		
LO Cooler	LO In Temp.					S/T LO Sump Tank		
	LO Out Temp.					A-S/T Seal Oil Tank		
	LTFW In Temp.							
	LTFW Out Temp.			Cont. V (%)		Jacket CFW T.		
						LTFW Temp.		
FW Cooler	HTFW In Temp.					FO HTR STM		
	HTFW Out T							
	CSW In Temp							
	CSW Out Temp.							

Power Generation System Measurement Table

Name:				Date: Time: ~				
Time				Temperature (°C)	Exhaust Gas	No.1 Out		
Generator in use						No.2 Out		
						No.3 Out		
Main Switch Board (MSB)	Gen. Voltage (V)					No.4 Out		
	BUS Voltage (V)					No.5 Out		
	Gen. Freq. (Hz)					No.6 Out		
	BUS Freq. (Hz)					TC In 1		
	Current (A)					TC In 2		
	Power (kW)					TC In 3		
	Power Factor				Jacket CFW	In		
	Insulation (MΩ)					No.1 Out		
						No.2 Out		
Diesel Generator						No.3 Out		
Revolution (min^{-1})						No.4 Out		
Fuel Notch						No.5 Out		
Pressure (Mpa)	Starting air					No.6 Out		
	Boost air					Out		
	LO			Turbo Generator				
	Jacket CFW			Pressure (Mpa)		Steam In		
	LTFW					1st stage steam		
	FO					Exhaust space		
	LO Filter Diff.					Gland steam		
Jacket CFW Cont. V						LO In		
LO Level	LO Sump Tank			Aux. Cond. V (-kPa)				
	Gen. Bea. Fore			Temperature(°C)		Steam In		
	Gen. Bea. Aft					Exhaust space		
	Governor					Condensate water		
LO Cooler	LO In Temp.					Aux. Cond. SW In		
	LO Out Temp.					Aux. Cond. SW Out		
	LTFW In Temp.			Cond. Pump Suc. P				
	LTFW Out Temp.			Cond. Pump Del. P				
Air CLR	Air In			Cond. Water Level				
	Air Out			LO Sump Tank Level				
	CFW Out			LO CLR LO In Temp.				
Gen. Fore Bea. Temp				LO CLR LO Out Temp.				
Gen. Aft Bea. Temp				LO CLR LTFW In Temp.				
				LO CLR LTFW Out Temp.				

Steam Generation System Measurement Table

Name:				Date: Time: ~			
Time							
Auxiliary Boiler				Exhaust Boiler			
Press.(Mpa)	Steam			Steam Press.(Mpa)			
	FO Burning			Temperature (°C)	Economizer In		
	Draft (mmAq)				Economizer Out		
	Feed water				Evaporator In		
Boiler water Level					Evaporator Out		
FO Burner In Temp.					Superheater In		
FO Heater Out Temp.					Superheater Out		
Feed water Tank L					Exhaust Gas In		
Inspection Tank L					Exhaust Gas Out		
Aux. Cond.	Cond. Press.			Exh. Gas Drop P (mmAq)			
	Drain Temp.						
	LTFW In Temp.			Boiler Water Circ. Pump	In Use		
	LTFW Out T				Suc.		
					Dis		
FO Burning Pump	Suc.						
	Dis.						
FO Supply Pump	Suc.						
	Dis.						
Feed water Pump	In Use						
	Suc.						
	Dis.						

Auxiliary Machinery Measurement Table

Name:				Date: Time: ~			
Time							
				Fresh Water Generator (FWG)			
FO Boost Pump	In Use			Shell Vacuum			
	Suc.			Pressure (Mpa)	Feed water		
	Dis				Ejector		
FO Supply Pump	In Use				Dist. W PP Dis		
	Suc.				Ejector P Suc.		
	Dis				Ejector P Dis.		
LO Pump	In Use						
	Suc.			Temperature (°C)	Shell		
	Dis				Heater		
Crosshead LO Pump	In Use				Feed water		
	Suc.				HTFW In		
	Dis				HTFW Out		
Stern Tube LO Pump	In Use				CSW In		
	Suc.				CSW Out		
	Dis			Salinity (ppm)			
HTFW Pump	In Use			HTFW Out V Opening			
	Suc.			HTFW Bypass V Open			
	Dis						
LTFW Pump	In Use			Oil Purifier			
	Suc.			LO	Ampere (A)		
	Dis				Pressure (Mpa)		
CSW Pump	In Use				Pressure (Mpa)		
	Suc.				Temperature (°C)		
	Dis			FO	In Use		
Bilge Level	ER(P)				Ampere (A)		
	ER(S)				Pressure (Mpa)		
	ER(C)				Pressure (Mpa)		
	Aft				Temperature (°C)		
	Fore			DO	Ampere (A)		
	Cargo				Pressure (Mpa)		
Bilge Tank Level					Pressure (Mpa)		
Sep. Oil Tank Level					Temperature (°C)		
Sludge Tank Level							

Sample exercise 12 (A-III/1)

Exercise Title	**Changeover of remote/automatic to local control**
Task	Change over control systems of machinery from remote/automatic to local
Function and Level	Marine engineering at the operational level
Competence	Maintain a safe engineering watch
Requirements (K.U.P.)	Safety and emergency procedures; changeover of remote/automatic to local control of all systems
Estimated Duration	2 hours
Outline of Training	This training is conducted under ship's harbour full speed and the trainees perform the tasks to change over the control positions of the specific machinery such as main engine, diesel generators, boilers, oil purifiers, air compressor and steering gear according to the situations
Initial Condition	Harbour maneuvering l speed
Specific Purpose	The training allows the trainees to get familiar with changeover of control position/mode from remote/automatic control to local control for the following machinery and operate the machinery manually: – main engine – diesel generator – emergency diesel generator – steam boiler – oil purifier – air compressor – steering gear
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – roles of the trainees in charge of main engine, diesel generators, aux. boiler, purifier and steering gears – specific procedures to change over the control positions according to the specifications of the machinery
Implementation	Start the simulation and let the trainees perform: (main engine) – procedures to change over control position from the bridge to the control room – procedures to change over the control position from the control room to local – handle the main engine maneuvering lever to control the engine speed responding to the telegraph orders from the bridge (instructor room)

Exercise Title	**Changeover of remote/automatic to local control**
Implementation *(Cont.)*	(diesel generator) – procedures to change over the control mode of No. 1 generator to local control from automatic control – starting manually No. 1 generator – making manually parallel running of Nos. 1 and 2 generators – procedures to change over the control mode of No. 3 generator to local control from automatic control – starting manually No. 3 generator – making manually parallel running of Nos. 1, 2 and 3 generators – procedures to change over the control mode of No. 2 generator to local control from automatic control – removing manually No. 2 generator from the parallel running – stopping manually No. 2 generator – removing manually No. 1 generator from the parallel running – stopping manually No. 1 generator – procedures to change over the control mode of No. 3 generator to automatic control from local control – procedures to change over the control mode of Nos. 1 and 2 generators to automatic control from local control – select priority either No. 1 or No. 2 generators as 1st standby generator (Air compressor) – procedures to change over the control mode of No. 1 main air compressor to local/manual operation – starting and stopping manually No. 1 compressor discharging drain accordingly – procedures to change over the control mode of No. 1 main air compressor to automatic operation (Steam boiler) – procedures to change over the control mode of auxiliary boiler to local/manual control from automatic control – lighting off manually the burner to raise the steam pressure starting with pre-purge – stopping manually combustion and carrying out post purge – procedures to change over the control mode to automatic control (Oil purifier) – procedures to change over the control mode of LO purifier to local/manual control – procedures for starting manually LO purifier – carrying out total de-sludging – procedures to change over the control mode to automatic control (Steering gear) – procedures to change over the control mode of steering gears to local/manual – taking manually rudder angle at Port, Starboard, Hard port, Hard starboard and Mid-ship – procedures to change over the control mode to remote control from local control

Exercise Title	**Changeover of remote/automatic to local control**
Debriefing	Explain briefly the following: – precautions when changing over remote/automatic to local control, particularly when main engine is running in remote/automatic control – local controls or isolations of machinery are often used when starting up the plant from the port condition or cold condition

Sample exercise 13 (A-III/1)

Exercise Title	**Immediate actions to be taken in the event of fire or accident**
Task	Take measures to address fire or accident
Function and Level	Marine engineering at the operational level
Competence	Maintain a safe engineering watch
Requirements (K.U.P.)	Safety precautions to be observed during a watch and immediate actions to be taken in the event of fire or accident, with particular reference to oil systems
Estimated Duration	2 hours
Outline of Training	This training is conducted by establishing urgent standby engine when the ship is on passage. The trainees receive request for urgent standby engine from the bridge due to an accident such as a fire, a person overboard, oil spill and others, and perform plant operation under direction of the watch officer assigned to one of the trainees to establish urgently state of standby engine from the state of passage
Initial Condition	Seagoing
Specific Purpose	The training allows the trainees to: – understand how to address emergencies – understand a need for urgent standby engine under the emergencies – understand procedures for urgent standby engine
Briefing	Explain briefly the following: – how to carry on the training – specific procedures to establish the state of standby engine being simulated – this training cannot be applied to an individual emergency event such as firefighting, flooding, rescue of overboarded person, and oil spill – in case of the person overboard, the main engine must be urgently stopped first and the propulsion plant will be brought to the standby condition The instructor should emphasize: – during a watch, the watch officer must address any situations – standby engine request must be issued from the bridge in almost all the cases – after the standby engine, the watch officer must address an individual situation – it is quite essential for the watch officer to always keep the propulsion plant under control in any cases since responses to the emergencies vary according to the situations – when the standby engine is requested, usually all hands must enter the engine-room and the chief engineer must take an initiative according to the situations

Exercise Title	**Immediate actions to be taken in the event of fire or accident**
Implementation	Start the simulation and let the trainees: (Fire: The training starts with phone call to the control room saying that we have a fire in the officers' accommodation and request urgent standby engine) – respond to standby engine by engine telegraph – start the fire pump and send extinguishing water to the fire main – turn off the electric power to the fire area – stop air conditioning system for the officers' accommodation – start Nos. 1 and 2 diesel generator and FO circulation of auxiliary boiler – change over the power source from the turbo generator to the diesel generators keeping the turbo generator in hot condition – stop FWG and make parallel running of main air compressors – start auxiliary boiler – change over the control position of the main engine to the control room and decrease engine speed to harbour full speed – inform the bridge of completion of preparation for standby engine (A person overboarded: The training starts with phone call to the control room saying that the main engine was stopped suddenly at the bridge and "a person overboard" will be announced and request urgent standby engine) – respond to standby engine by engine telegraph – start Nos. 1 and 2 diesel generator and FO circulation of auxiliary boiler – change over the power source from the turbo generator to the diesel generators keeping the turbo generator in hot condition – stop FWG and make parallel running of main air compressors – start auxiliary boiler – change over the control position of the main engine to the control room – prepare for re-starting the main engine – inform the bridge of completion of preparation for standby engine – start the main engine responding to the telegraph order
Debriefing	Explain briefly the following: – meaning of emergency situation such as a fire, a person overboard, flooding, oil spill and others – responses to emergencies vary according to the situations – urgent standby engine must be requested in almost all the cases – specific preparations and procedures for urgent standby engine depend on specifications of the plant machinery – we must pay due attention to running parameters of the plant machinery; however, we sometimes have cases that we must ignore the range of running parameters/standards for the safety of lives even though it causes serious damage of the machinery

Exercise Title	Immediate actions to be taken in the event of fire or accident
Debriefing *(Cont.)*	As for response to individual emergency other than standby engine, the instructor lists measures to be taken by engine department in principle as follows: – A fire – starting fire pumps – cutting off power to the area – stopping ventilation fan and oil pumps – closing all outlet valves of oil tanks – preparing for all fire extinguishers – Oil spill – preparing for oil dispersant – preparing for oil preventive appliances – A person overboarded – preparing for a rescue boat – Flooding – starting bilge pump – discharging emergency bilge and direct bilge in case of engine-room flooding

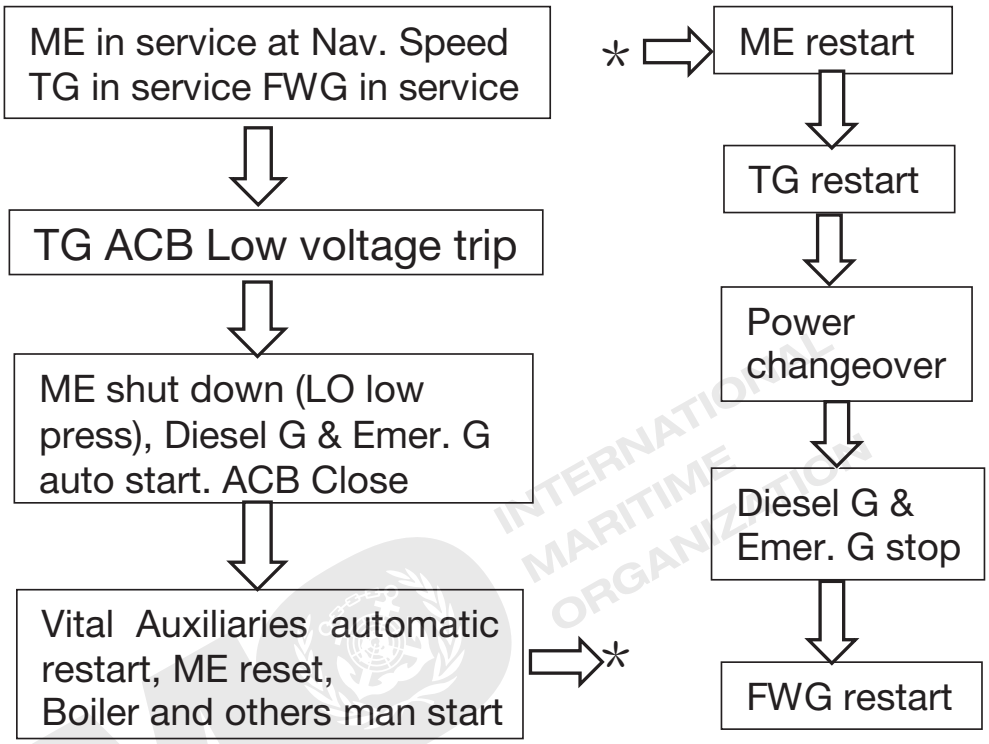
Sample exercise 14 (A-III/1)

Exercise Title	Engine-room Resource Management (ERM)
Task	Practice ERM
Function and Level	Marine engineering at the operational level
Competence	Maintain a safe engineering watch
Requirements (K.U.P.)	Knowledge of engine-room resource management principles including 1) allocation, assignment and prioritization of resources 2) effective communication 3) assertiveness and leadership 4) obtaining and maintaining situational awareness 5) consideration of team experience
Estimated Duration	5 hours
Outline of Training	This training aims at understanding ERM requirements through teamwork in operating plant machinery as parts of an engineering watch. Namely, process of plant operation is discussed and analysed in terms of the ERM requirements. For teamwork, roles of C/E, 1/E, 2/E, 3/E and ratings are assigned to 3 ~ 4 trainees accordingly and plant operation (leaving a port and recovery of blackout) is carried out under the direction of C/E Communication system equipment must be used for communication between the instructor room, control room and engine-room during the training, and it is desirable to use English for communication Instructor should prepare a procedure manual of plant operation from the port condition to the state of passage. The C/E and/or 1/E of the group may refer to the manual as necessary during the training in order to issue his/her instructions to the other trainees (officers and ratings)
Initial Condition	1st stage: In port (One diesel generator is in service) 2nd stage: Seagoing (Turbo generator and Fresh water generator are in service)
Specific Purpose	The training allows the trainees to: – demonstrate and understand ERM requirements as much as possible through two kinds of plant operation – discuss and analyse processes and activities made as a teamwork in operating plant machinery in terms of the ERM principles and requirements

Exercise Title	**Engine-room Resource Management (ERM)**
Briefing (for the first stage: Leaving a port)	Explain briefly the following: – outline of the training – how to carry on the training – roles of the C/E, 1/E, 2/E, 3/E and ratings as follows: the C/E mainly, – figures out the running condition of the propulsion plant as a whole – receives reports from officers – issues instructions to officers the 1/E assists the C/E the 3/E and ratings: – figure out the running condition of the machinery in charge – perform tasks instructed by the C/E – report to the C/E necessary information – follow instructions issued by the C/E Instructor should emphasize: – application of ERM requirements for the competence "Maintain a safe engineering watch" described in the Table III/1 is to maintain a safe engineering watch, exerting effective communication, leadership, situational awareness, assertiveness and effective utilization of personnel in various situations concerning the engineering watch – meanings of effective communication, leadership, situational awareness and assertiveness – communication includes instruction, answerback, report and dialogue and these communication patterns should be effectively carried out for maintaining the safe engineering watch
Implementation (for the first stage: Leaving a port)	Start the simulation (in port) and let the trainees take up the position assigned (Control room: C/E, 1/E, 2/E, Engine-room:3/E, Ratings) Use engine-room resource management in principle and carry out closed loop communications (Proceeding for leaving a port) (Warming up the main engine) – line up ME CFW system and start No. 1 HTFW pump – begin supply of warming up steam to ME – line up ME LO system and start No. 1 LO pump – line up FO supply system and start No. 1 FO supply and booster pumps – line up stern tube LO system and start No. 1 stern tube LO pump – start steering gear system and demonstrate its test run Steering gear test run: take the rudder angles "Port", "Starboard", "Hard port" and "Hard starboard" communicating with the bridge (Instructor room) – start ME turning and check current value of turning motor – start No. 2 generator at engine side and report the running condition – make parallel running of diesel generators Nos. 1 and 2 – switch on Bow thruster and Deck machinery

Exercise Title	Engine-room Resource Management (ERM)
Implementation (for the first stage: Leaving a port) *(Cont.)*	(ME trial run at the control room) – stop supply of warming up steam – start No. 1 boiler water circulation pump – make parallel running of main air compressors – stop ME turning and disengage ME turning gear – open starting air root valve of No. 1 air reservoir – make air running of ME – close all indicator valves – start auxiliary blowers and start ME in ahead direction – stop ME after several turns – start auxiliary blowers and start ME in astern direction – stop ME after several turns (Standby engine) – "Standby engine" is requested (telegraph gong sounds) – respond to the request (after responding to the request of standby engine, 2/E maneuvre the ME responding to telegraph orders) – "Full way engine" is requested – respond to the request – set maneuvering lever to "Navigation" (Navigational condition) – make steering gear single run – make single run of diesel generator – begin warming up TG – line up circulation, condensate, gland steam and LO systems of TG – begin supply of gland steam, starting turning – make No. 1 main air compressor single run – start ejector pump and prepare for starting FWG – start FWG after vacuum of FWG is established – start the turbo generator – change over electric power source to the turbo generator from diesel generator (This is completion of procedures from in port to state of passage and the instructor stops the simulation. The trainees move to the briefing room)

Exercise Title	**Engine-room Resource Management (ERM)**
Debriefing (for the first stage: Leaving a port)	This is an intersessional debriefing, so the training should be simply reviewed from the aspects of ERM principles and the requirements and this review should be conducted in a form of Q and A as follows in order to let the trainees consider significance of teamwork For the teamwork of leaving a port as a part of an engineering watch: – if allocations/arrangement of the personnel were appropriate – if assignments/roles and responsibility of the personnel were appropriate – if prioritization of the teamwork was appropriate – if utilization of information, equipment and personnel was effective – if functions of the equipment were satisfactory understood – if information was appropriately understood, responded and shared – if all communication patterns were clearly, effectively and timely carried out – if assertiveness was reflected – if leadership and situational awareness were exerted – if there was notification of any doubt – if there was consideration of team experience The instructor should emphasize the following, taking into account the aforementioned review: – when teamwork is necessary as parts of an engineering watch, personnel as a member of the team should understand their roles and responsibilities, and maintain effective communication in order to enhance performance of teamwork that contributes to a safe engineering watch – even if there were outstanding competent persons in the team, the teamwork does not always achieve higher performance – all the personnel therefore should be mindful on how we can build a good teamwork (probably there is no correct answer, but better answer exists) – the aforementioned review must be reflected in the next stage of ERM training

Exercise Title	**Engine-room Resource Management (ERM)**
Briefing (for second stage: Blackout)	Instructor should explain: – The task for the team as parts of an engineering watch is recovery of blackout which means watch personnel must resume the same plant condition as before the blackout. – Main flow of recovering blackout is as follows:  – The power must be resumed as quickly as possible, therefore, effective plant operation is required – For this purpose, a good leadership/initiative becomes more important than the first stage
Implementation (for second stage: Blackout)	Start the simulation and let the trainees take up the position assigned (Control room: C/E, 1/E, 2/E, Engine-room:3/E, Ratings) The instructor announces the following, using communication equipment to let all the trainees know at the same time: – all the trainees must confirm the plant conditions in 10 minutes such as ME control position (Bridge), ME output and other major running parameters, turbo generator output, steam pressure, state of auxiliary boiler, state of diesel generator, numbers of running auxiliaries and others – black out will occur in five minutes after your confirmation and the team must resume the plant conditions as they were before the blackout – the trainee assigned to 1/E issues instructions to any other members without the trainee assigned to C/E and the C/E must instruct 1/E-A as needed (10 minutes later) – now, your confirmation time was over, blackout occurs in 5 minutes

Exercise Title	**Engine-room Resource Management (ERM)**
Implementation (for second stage: Blackout) *(Cont.)*	(The instructor gradually closes Steam inlet valve/Shut off valve of the turbo generator from the instructor room and this causes Turbo generator ACB low voltage trip resulting in blackout) The blackout occurs and lightings of the control room and the engine-room turn off except an emergency lighting. ME must be shut down automatically due to LO low pressure At the same time, 1st standby diesel generator and emergency generator start and the power will resume approximately in 30 seconds (Proceeding for recovery of blackout) Let trainees: (Immediate actions to be taken) – open all drain valves on TG and check running conditions of No. 1 diesel generator and emergency generator – make procedures to change over the ME control position from the bridge to the control room and sets ME maneuvering lever to "Stop" position, changing over the control mode to manual – take necessary measures to FO and LO purifiers according to the situation and stop heating of FWG closing feed water valve (The power has resumed) – check restart of auxiliaries for ME and begin TG turning – change the supply lines of the purifiers to the circulation lines – check all the auxiliaries and steering gear automatically restarted – restart other manual starting machinery (Auxiliary boiler, FO and LO purifiers, ventilation fans, and others) – start preparation for restart of ME (reset ME shut down and any other failures) (Restart of ME) – start ME at "Slow ahead" responding to the telegraph order – increase ME revolution speed until "Harbour full ahead" step by step responding to the telegraph – set ME maneuvering lever to navigational speed responding to "Full way engine" order – begin preparation for restarting TG and FWG – check vacuum of the condenser and condensate system of TG – restart the ejector pump and begin supply of feed water – restart FWG beginning heating and supply of feed water and starting Dist. water pump – restart TG – stop TG turning motor and disengage the turning gear – establish the steam line opening drain valves – open steam Inlet valve/Emergency shut off valve slightly and make it full open closing all drain valves – change over the power source to TG from the diesel generator – stop the diesel generator and emergency generator – stop Auxiliary boiler – return the control position of ME to the bridge (This is end of the 2nd stage and stop the simulation)

Exercise Title	**Engine-room Resource Management (ERM)**
Debriefing (for the second stage: Blackout)	The process of recovering blackout should be reviewed first from the aspects of ERM principles and the requirements. For the teamwork of recovering blackout as a part of an engineering watch: – if allocations/arrangement of the personnel were appropriate – If not, what was wrong? – if assignments/roles and responsibility of the personnel were appropriate – If not, what should be corrected? – if prioritization of the teamwork was appropriate – If not, what was wrong? – if utilization of information, equipment and personnel was effective – If not, how was it done? – if functions of the equipment were satisfactory understood – if information was appropriately understood, responded and shared – if all communication patterns were clearly, effectively and timely carried out – if assertiveness was reflected – if leadership and situational awareness were exerted – If not, how should it be done? – if there was notification of any doubt – if there was consideration of team experience

Exercise Title	**Engine-room Resource Management (ERM)**
Debriefing (for the second stage: Blackout) *(Cont.)*	In light of the results of aforementioned analysis, the instructor should let the trainees discuss the significance of ERM as follows: (The instructor may cover some of the following according to the results of the analysis) – What resources do we have generally in machinery space? – What features does each resource have? – What makes it difficult to manage a human resource? – How can ERM principles be applied to plant operation/engineering watch? – How can ERM requirements as human elements be applied to plant operation / engineering watch? (Leadership, Situational awareness, Communication, Assertiveness) – What differences do exist between small group of two or three persons and group of ten persons in practising ERM? – Which operation instructions should be issued in terms of practising ERM? – Press start button of No. 1 HTFW pump – Start No. 1 HTFW pump – Establish HTFW system – What is expected as a leader in practising ERM? – What is expected as engineering watch personnel? – What relations do exist between building of a good teamwork and practice of ERM? – What is the most important element in practising ERM to maintain a safe engineering watch? The instructor should conclude the debriefing saying that the idea of ERM or ERM requirements should be applied to all the duties on board ships although we have discussed ERM from the aspect of an engineering watch

D2 Sample exercises for table A-III/2

Sample exercise 15

Exercise Title	**Propulsive characteristics of diesel engines**
Task	Development of engine revolution speed-output diagram
Function and Level	Marine engineering at the management level
Competence	Plan and schedule operations
Requirements (K.U.P.)	Propulsive characteristics of diesel engines, steam and gas turbines including speed, output and fuel consumption
Estimated Duration	3 hours
Outline of Training	4 ~ 5 trainees establish a group and the group performs increase of the simulated main engines and develops a graph that indicates engine speed, engine output and fuel oil consumption by collecting necessary running parameters at different engine speeds. The trainees discuss the graph and understand propulsive characteristics of the main engines The instructor needs to prepare engine speeds to collect the running parameters and measurement tables This training can be applied to different types of main engines
Initial Condition	Main engine standby condition

Exercise Title	**Propulsive characteristics of diesel engines**
Specific Purpose	The training allows the trainees to: – understand correlation of engine output and fuel consumption to different engine speeds/ship's speeds – come to be able to predict engine output and fuel consumption to different engine speeds/ship's speeds – understand differences in propulsive characteristics between main engines
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – specific purposes of the training – how to draw the graph obtaining necessary values
Implementation	Start the simulation and let the trainees: (The instructor may make simulation speed faster than usual in order to facilitate the training) – set main engine revolution speed and increase the speed as indicated in the table below – take readings following the measurement table at different speed under the stable conditions (The instructor stops the simulation when the measurement was completed)
Debriefing	The instructor lets the trainees discuss the diagram developed by the trainees and lets them understand: – correlations of engine out and fuel consumption to different speeds are in principle: output $\propto N^3$ fuel consumption $\propto N^3$ ship's speed $\propto N$ fuel consumption of same distance $\propto N^2$ (N: Revolution speed) – differences in output/propeller curves of lighter or heavier engine loads than the specific engine load – differences in propulsive characteristics of different types of main engines

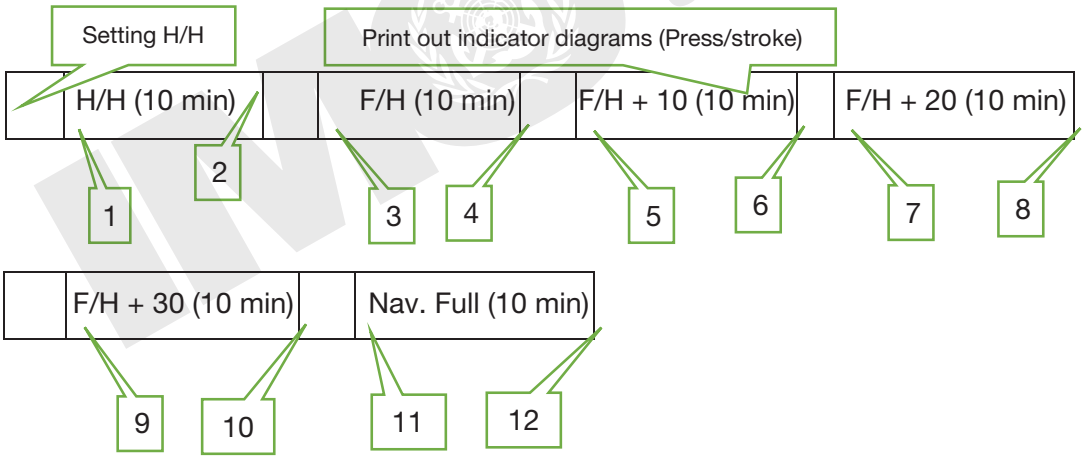
Measurement Table

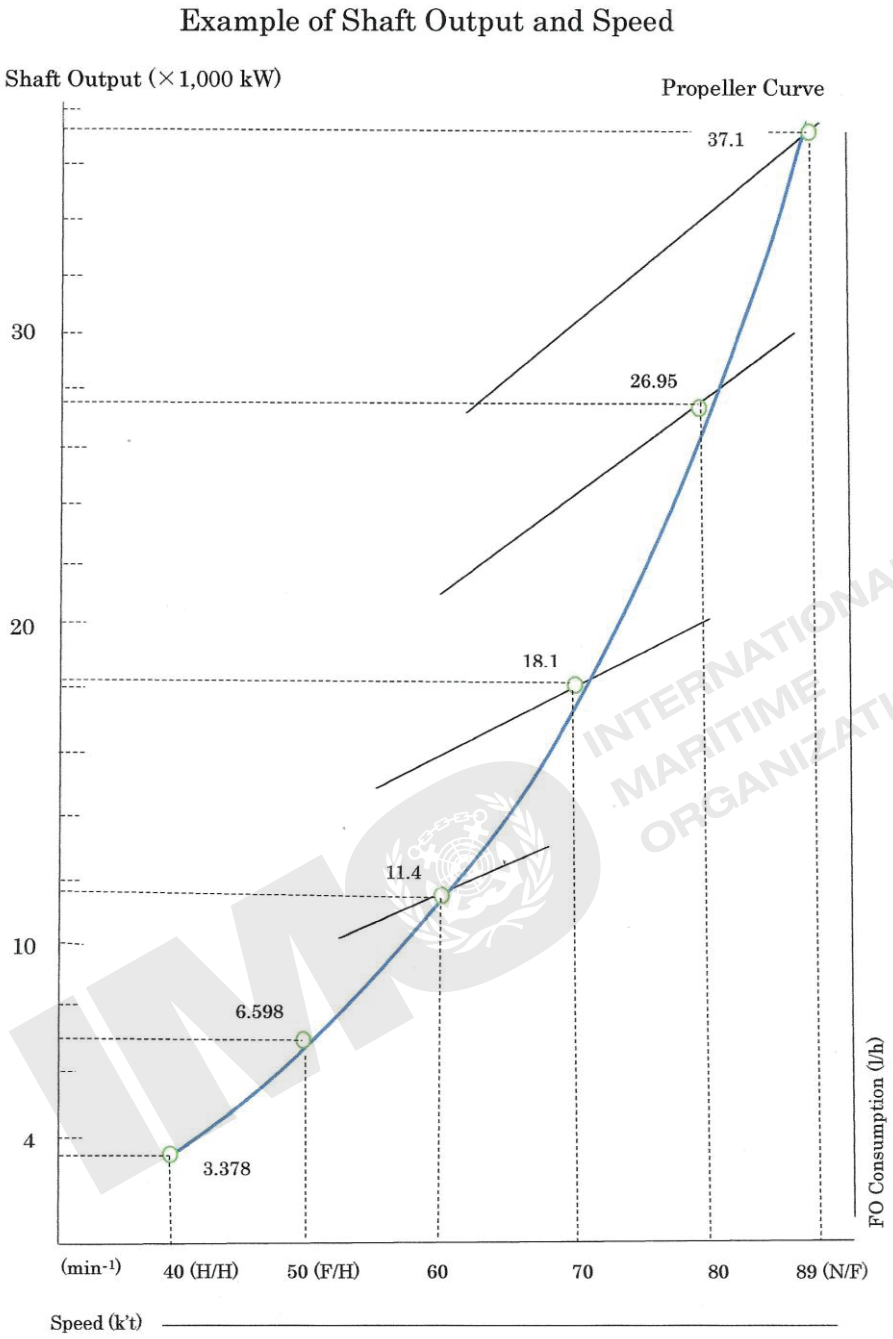
Date:

Ship's Particulars:

Sea condition: Wind: Load condition:

	Ship's speed		**Rev. counter**		**Shaft output**		**Torque**		**FO flow meter**	
1		Avg		min-1		Avg		Avg		l/h
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										





Sample exercise 16 (A-III/2)

Exercise Title	**Heat balance of main diesel engine/steam turbine**
Task	Determine thermal efficiency and develop heat balance diagram of the simulated main diesel engine and steam turbine
Function and Level	Marine engineering at the management level
Competence	Plan and schedule operations

Exercise Title	**Heat balance of main diesel engine/steam turbine**
Requirements (K.U.P.)	Heat cycle, thermal efficiency and heat balance of the following .1 marine diesel engine .2 marine steam turbine .3 marine gas turbine .4 marine steam boiler
Estimated Duration	3 hours
Outline of Training	8 ~ 10 trainees establish two groups (A and B) and the groups collect running data following data collection tables at four stable running conditions of the simulated main engines as 100%, 75%, 50% and 25% MCR and calculate thermal efficiency for each load. All the trainees calculate necessary calorific values by using collected data and develop heat balance diagrams by combining all results made by the trainees The instructor prepares data collection tables, calculation tables and guidance for the calculation The instructor sometimes needs to give the trainee condition settings/assumptions in order to simplify the calculation although their theories must be taught The instructor may make the simulation speed faster than usual to facilitate the training accordingly and conducts a review session on the issue on a different day, giving the trainees enough time for calculation and developing the diagrams This training can be applied to different main engines
Initial Condition	Seagoing
Specific Purpose	The training allows the trainees to: – acquire knowledge on calculation methods/process of the following and developing heat balance diagram (Main diesel engine) – total calorific value given to engines/boilers – calorific values of power output produced by engines including calculation of output/IHP by using p-v diagram printed out from the simulator and "Ten divisions into equal method" given appropriate "Spring constant" of the indicators – mechanical loss/efficiency by engines – fuel oil consumption rate – heat loss by cooling fluid and lubricating oil – heat loss by exhaust gas – thermal efficiency (Main steam turbine) – fuel oil consumption rate – total thermal efficiency – turbine effective efficiency – turbine internal efficiency – turbine mechanical efficiency – boiler efficiency – understand: – how much heat was used for propelling – what kinds of heat losses are contained in the heat cycle – how much heat losses are included in the heat cycle

<table>
<tr><td>Exercise Title</td><td>Heat balance of main diesel engine/steam turbine</td></tr>
<tr><td>Briefing</td><td>Explain briefly the following:
– outline of the training
– how to carry on the training
– specific purpose of the training
– precaution for collecting data
– data collection tables
– setting up revolution speed equivalent to engine loads</td></tr>
<tr><td>Implementation</td><td>The instructor starts the simulation and lets the trainees perform the following:

(The instructor sets up 100% MCR of the engine adjusting engine revolution speed and informs the trainees of that engine running condition will become stable in 5 minutes and your data collection must start 5 minutes later)

<table>
<tr><td></td><td>Performance</td></tr>
<tr><td rowspan="2">Group A</td><td>Data collection of 100% MCR</td></tr>
<tr><td>Reduction of engine speed to the revolution equivalent to 75% MCR</td></tr>
<tr><td rowspan="2">Group B</td><td>Data collection of 75% MCR</td></tr>
<tr><td>Reduction of engine speed to the revolution equivalent to 50% MCR</td></tr>
<tr><td rowspan="2">Group A</td><td>Data collection of 50% MCR</td></tr>
<tr><td>Reduction of engine speed to the revolution equivalent to 25% MCR</td></tr>
<tr><td>Group B</td><td>Data collection of 25% MCR</td></tr>
</table>
The group A takes readings of main engine revolution counter and fuel oil flow meter just at starting time of data collection

After taking readings of the counters, members of the group A work on collecting data on the mimic panel and data display of the simulator following the data collection tables

(The group B observes performance of the group A)

The group A takes reading of main engine revolution counter and fuel oil flow meter just at the time of 60 minutes later from the first reading

After taking the second readings of the counters, the group A performs operation to reduce engine speed until the revolution speed equivalent to 75% MCR

The group B prepares for data collection

The group B takes readings of main engine revolution counter and fuel oil flow meter just at the time of starting data collection

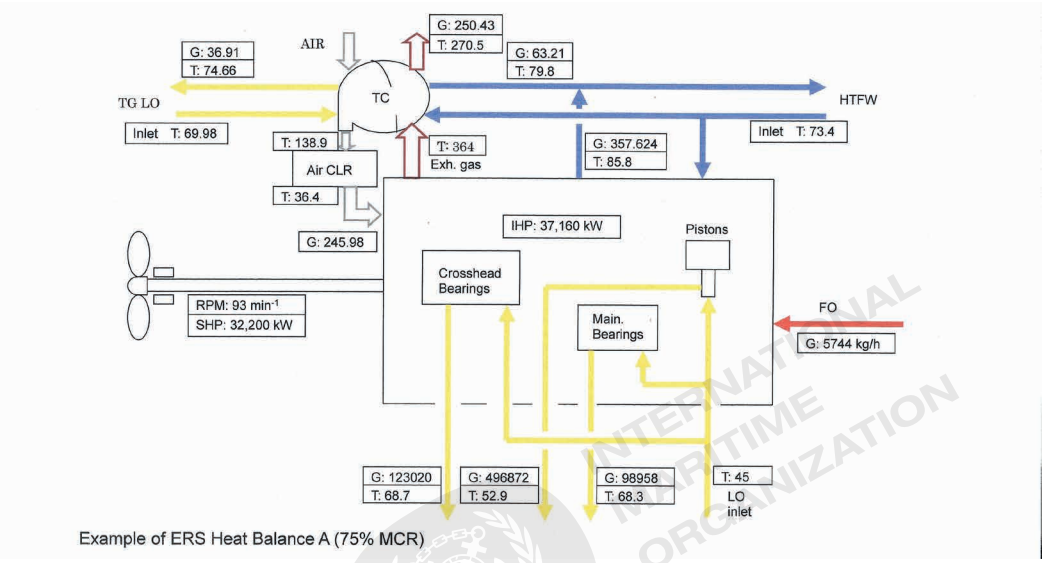
After taking readings of the counters, members of the group B work on collecting data on the mimic panel and data display of the simulator following the data collection tables

(The group A observes performance of the group B)

The group B takes reading of main engine revolution counter and fuel oil flow meter just at the time of 60 minutes later from the first reading

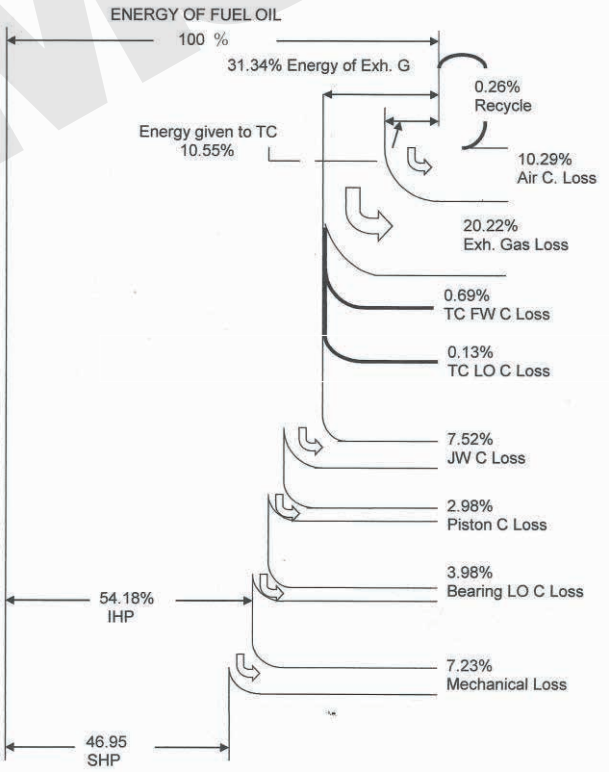
(Data collections are to be continued in the same manner as the first collection until completion of collecting data of 25% MCR. The instructor stops the simulator when the data collection is completed)</td></tr>
</table>

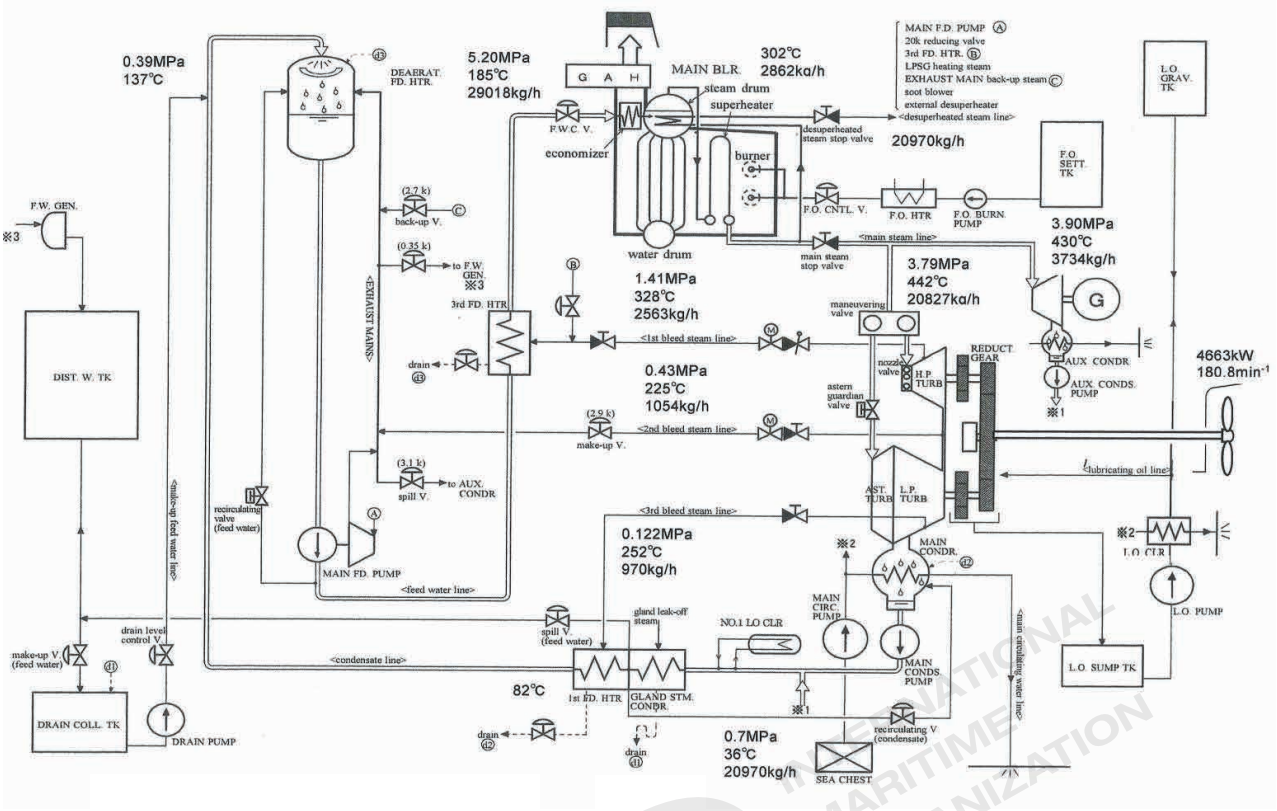
Exercise Title	**Heat balance of main diesel engine/steam turbine**
Debriefing	Explain briefly the following: – performance of the trainees as a whole – meaning of heat balance diagram need to share all data among the trainees – calculation methods The instructor gives the trainees an assignment to calculate the thermal efficiency and all the trainees develop heat balance diagram



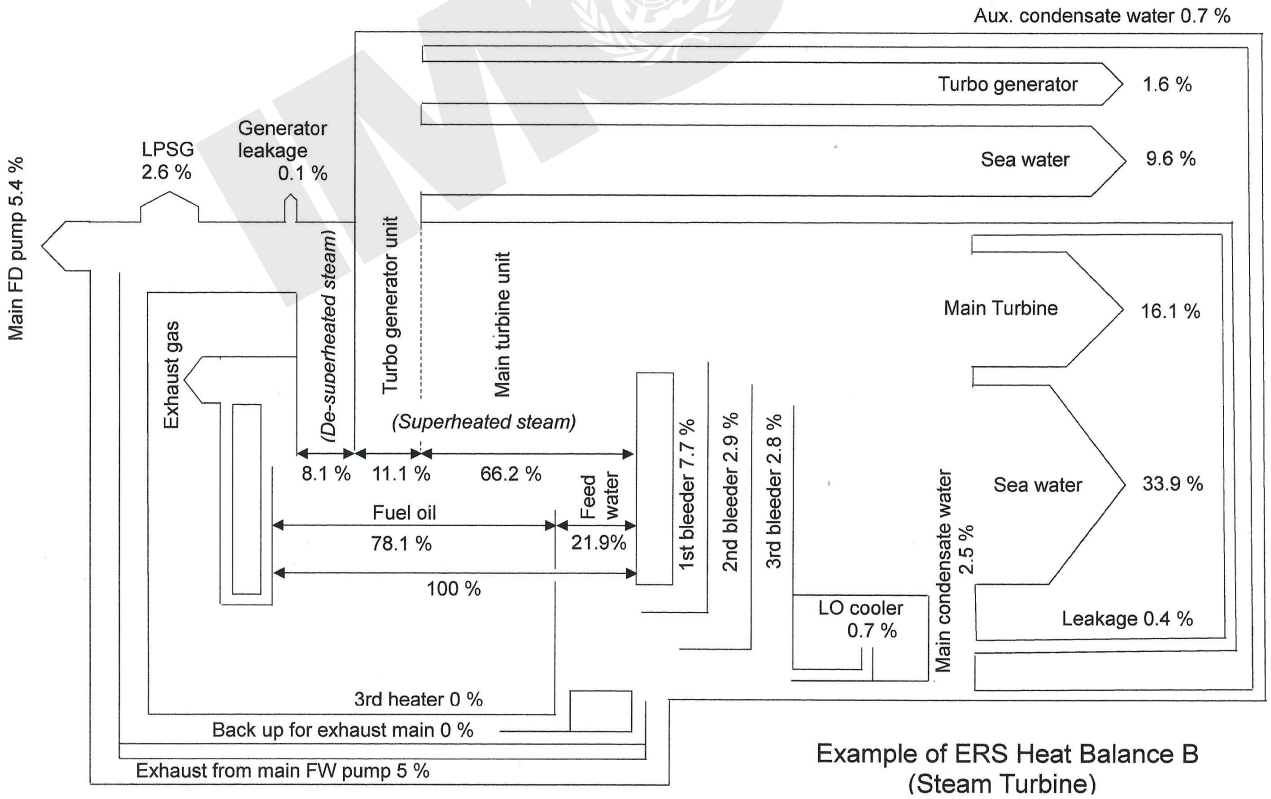
Example of ERS Heat Balance A (75% MCR)

Example of ERS Heat Balance B (75% MCR)





Example of ERS Heat Balance A (Steam Turbine)



Example of ERS Heat Balance B
(Steam Turbine)

Sample exercise 17 (A-III/2)

Exercise Title	**Operation of main propulsion and auxiliary machinery**
Task	Start up, maneuvre and shutting/cooling down main engines
Function and Level	Marine engineering at the management level
Competence	Operation, surveillance, performance and maintaining safety of propulsion plant and auxiliary machinery
Requirements (K.U.P.)	Start up and shut down main propulsion and auxiliary machinery, including associated systems
Estimated Duration	4 hours
Outline of Training	4 ~ 5 trainees establish a group and the group performs starting up, operation and shutting/ cooling down of main engines and each trainee maneuvres the main engines responding to the telegraph order The trainees may refer to a procedure manual prepared by instructors. (Specific procedures based on the simulated main engine should be developed and prepared for the trainees)
Initial Condition	In port (Completion of warming up)
Specific Purpose	The training allows the trainees to understand: – criteria for judgement of completing warming up and cooling down – conditions for starting up – checking point when main engines are started first for leaving a port – various automatic controls applied to main engines – operational procedures of main engines for starting up, navigational mode and shutting/cooling down main diesel engine – acquire skills on maneuvering the main engine
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – operational procedures for warming up, starting up, setting up navigational mode and shutting/cooling down the main engine – criteria for judgement of completing warming up and cooling down – need for trial run of main engines when leaving a port – what should be checked during trial run of main engines
Implementation (1st stage: warming up the main engine and leaving a port)	Start the simulation and let the trainees demonstrate: (Main diesel engine) – check the main engine for completion of warning up including; – level of LO sump tank – FW expansion tank – cylinder oil supply/daily tank – circulations of CFW, LO and FO – temperatures of CFW and LO – setting values of controllers – status of control system for the main engine

Exercise Title	Operation of main propulsion and auxiliary machinery
Implementation (1st stage: warming up the main engine and leaving a port) *(Cont.)*	– check auxiliary machinery for: – stern tube LO sump tank – status of main air compressors and pressure of air reservoirs – status of steering gears – status of power generation system – status of engine-room fans – abnormal conditions if any – preparation for starting up the engine – disengage turning gear and all indicator valves are open – line up starting air – reset abnormal if any – notify start up of the main engine to the bridge (instructor) – air running of the engine in the engine-room confirming revolution indicator – closing all indicator valves – manual start and stop of the engine in ahead and astern slow in the engine-room – changeover of the control position to the control room – remote-automatic start and stop of the engine in ahead and astern slow confirming: – starting and stopping auxiliary blower/s – rotation of the engine – timing of air cut – fuel notch (The instructor sets sub-telegraph to Standby Engine and issues 2 ~ 3 engine orders to the trainee for maneuvering and creates some special conditions such as: – start failure – start impossible – wrong way; and – crash astern) – maneuvering of the engine responding to the engine telegraph orders confirming: – automatic start and stop of auxiliary blowers – remote-automatic start and stop of the engine – timing of air cut – automatic revolution speed control – fuel notch – start failure – start impossible

Exercise Title	**Operation of main propulsion and auxiliary machinery**
Implementation (1st stage: warming up the main engine and leaving a port) *(Cont.)*	(The instructor issues Full way engine) – setting maneuvering lever to the position of sea going/navigation full checking load up programme activated – establishment of navigation mode including: – activation of speed run up/load up programme – changeover of fuel oil to HFO from DO – automatic control of FO viscosity – single running of main air compressor – adjustment of scavenging air temperature – application of VIT and/or FQS (Steam turbine) – check the main turbine for completion of warming up including; – level of LO sump tank and gravity tank – circulations of LO – temperatures of the turbine casing – main condenser vacuum – opening of circulation overboard valve – expansion of the turbine rotors – setting values of controllers – status of control system for the main turbine – check main boilers and auxiliary machinery for: – running conditions of FDF and GAH – status of ACC, FWC and STC – stern tube LO sump tank – status of steering gears – status of power generation system – abnormal conditions if any – preparation for starting up the main turbine including: – increasing vacuum of main condenser – disengage turning gear – opening drain valves attached to the main turbine and astern guardian valve – line up main steam system – commencement of automatic roll over/spinning – reset abnormal if any and no interlocking – notify start-up of the main turbine to the bridge (instructor) – manual start and stop of the turbine in ahead and astern slow in the engine-room – changeover of the control position to the control room

Exercise Title	Operation of main propulsion and auxiliary machinery
Implementation (1st stage: warming up the main engine and leaving a port) *(Cont.)*	– remote-automatic start and stop of the main turbine in ahead and astern slow confirming: – rotation of the propeller shaft – opening of the maneuvering valve – steam pressure – no abnormal vibration (The instructor sets sub-telegraph to Standby Engine and issues 2 ~ 3 engine orders to the trainee for maneuvering and creates some special conditions such as: – start impossible – wrong way; and – crash astern) – maneuvering of the main turbine responding to the engine telegraph orders confirming: – start impossible – remote-automatic start and stop of the engine – automatic revolution speed control (The instructor issues Full way engine) – setting maneuvering lever to the position of sea going/navigation full checking load up programme activated – establishment of navigation mode including: – setting number of nozzles to be used – activation of speed run up/load up programme – adjustment of circulation water overboard valve (vacuum) – commencement of bleeding and reheating when necessary – closing all drain valves and astern guardian valve (This is end of the 1st stage and the instructor stops the simulation)
Implementation (2nd stage: entering a port and shutting/ cooling down the main engine)	Start the simulation and let the trainees demonstrate: (Diesel engine) – establishment of standby mode including: – commencement of reducing engine speed – changeover fuel oil to DO when necessary – changeover of generator to diesel generator from turbo generator – stop of FWG – adjustment of FO viscosity, scavenging air temperature – parallel running of main air compressors and line up starting air supply line (When the engine speed reaches to standby full speed, the instructor sets sub-telegraph to Standby engine and issues several engine orders) – maneuvering the engine responding to the telegraph orders in remote-automatic control, checking running parameters

Exercise Title	**Operation of main propulsion and auxiliary machinery**
Implementation (2nd stage: entering a port and shutting/ cooling down the main engine) *(Cont.)*	(The instructor sets sub-telegraph to "Finish with engine") – procedures for shutting down the engine including: – open all indicators valves – change over the control mode to manual and carry out air running for 1 ~ 2 rotations – engage turning gear and commence turning of the engine providing the engine with cylinder oil – shutting down auxiliaries stop No. 1 boiler water circulating pump and close valves concerned – close starting air line to the main engine and set main air compressors to single run – stop No. 1 FO pump and close valves concerned – stop the turning of the main engine – stop No. 1 stern tube LO pump and close valves concerned – stop the turning of the main engine – stop No. 1 LO pumps and close valves concerned – stop No. 1 HTFW LO pump confirming the temperature and close valves concerned – stop LO purifier (Steam turbine) – establishment of standby mode including: – commencement of reducing engine speed confirming running condition of main boilers – stop bleeding and reheating when necessary – open drain valves and astern guardian valve – set number of nozzles to be used for standby engine (When the engine speed reaches to standby full speed, the instructor sets sub-telegraph to Standby engine and issues several engine orders) – maneuvering the main turbine responding to the telegraph orders in remote-automatic control, checking running parameters

Exercise Title	Operation of main propulsion and auxiliary machinery
Implementation (2nd stage: entering a port and shutting/ cooling down the main engine) *(Cont.)*	(The instructor sets sub-telegraph to "Finish with engine") – procedures for shutting down the main turbine including: – change over the control mode to manual – close main steam system and discharge remaining steam – commencement of tuning the main turbine – stop vacuum pump and close valves concerned – decrease vacuum of the main condenser step by step by opening and closing vacuum breaker – stop supply of gland steam at the vacuum 50 mmHg and close valve concerned – close LO supply valve to LO gravity tank – shutting down auxiliaries – stop main circulating pump and close valves concerned – stop condensate water pump and close valves concerned – stop LO purifier and close valves concerned – stop turning of the main turbine – stop LO pump confirming temperature and close valves concerned (This is end of the 2nd stage and stop the simulation)
Debriefing	Explain briefly the following: The instructor should brief on: – performance as a whole – procedural features of main diesel engines and steam turbine – important precautions to be observed by engineer officers at the management level when leaving and entering a port

Sample exercise 18 (A-III/2)

Exercise Title	Operating limits
Task	Set up operating limits of the simulated main diesel engine
Function and Level	Marine engineering at the management level
Competence	Operation, surveillance, performance and maintaining safety of propulsion plant and auxiliary machinery
Requirements (K.U.P.)	Operating limits of propulsion plant
Estimated Duration	2 hours
Outline of Training	4 ~ 5 trainees establish a group and the group performs operations on the simulated main engine and sets up operating limits by collecting running parameters and comparing the data with running standards of the simulated main diesel engine
Initial Condition	Seagoing
Specific Purpose	The training allows the trainees to identify and understand: – running parameters concerned in operating limits – a need to keep the running parameters within specific operating limits – possible damages caused by running the engine in out of operating limits

Exercise Title	**Operating limits**
Briefing	Explain briefly the following: – how to conduct the training – measurement tables of running parameters – operating limits usually come from the relation between engine output or torque and speed – however some of running parameters can be factors as an operating limit other than engine output, torque and speed – operating limits concerned in the simulated main engines
Implementation	The instructor sets the hull and weather conditions as follows and starts the simulation: – Light condition + calm weather – Loaded condition + calm weather – Loaded condition + heavy weather The trainees increase the main engine speeds under these conditions as follows: – harbour full + 20 min^{-1} or revolution speed equivalent to 50% MCR – harbour full + 30 min^{-1} or revolution speed equivalent to 65% MCR – harbour hull + 40 min^{-1} or revolution speed equivalent to 80% MCR – revolution speed equivalent to 100% MCR – revolution speed equivalent to 105% MCR The trainees move steering rudder within 10 ~ 15 degrees after the engine speed reaches to the desired speeds and keep the rudder position until measurement of running parameters completes. (The measurement should be started approximately 10 minutes later after the rudder position was changed) – running parameters to be taken (example) – log speed – engine/shaft output – engine torque/mean effective pressure – cylinder maximum pressure – engine revolution speed – turbocharger revolution – scavenging air pressure – exhaust gas temperature – exhaust gas economizer gas inlet pressure – pressure drop by suction filter inside turbocharger – pressure drop by air cooler – cooling water temperature After collecting the running parameters, the trainees set the rudder position at mid-ship and increase the revolution speed and record the parameters The instructor stops the simulation after all running parameters were taken and lets the trainees develop a revolution-output (load curve/propeller curve) and plot the specific load curve and torque lines and mark the recorded outputs on the graph The trainees develop a table of other running parameters taken and compare the parameters with specific data of the simulated diesel engine

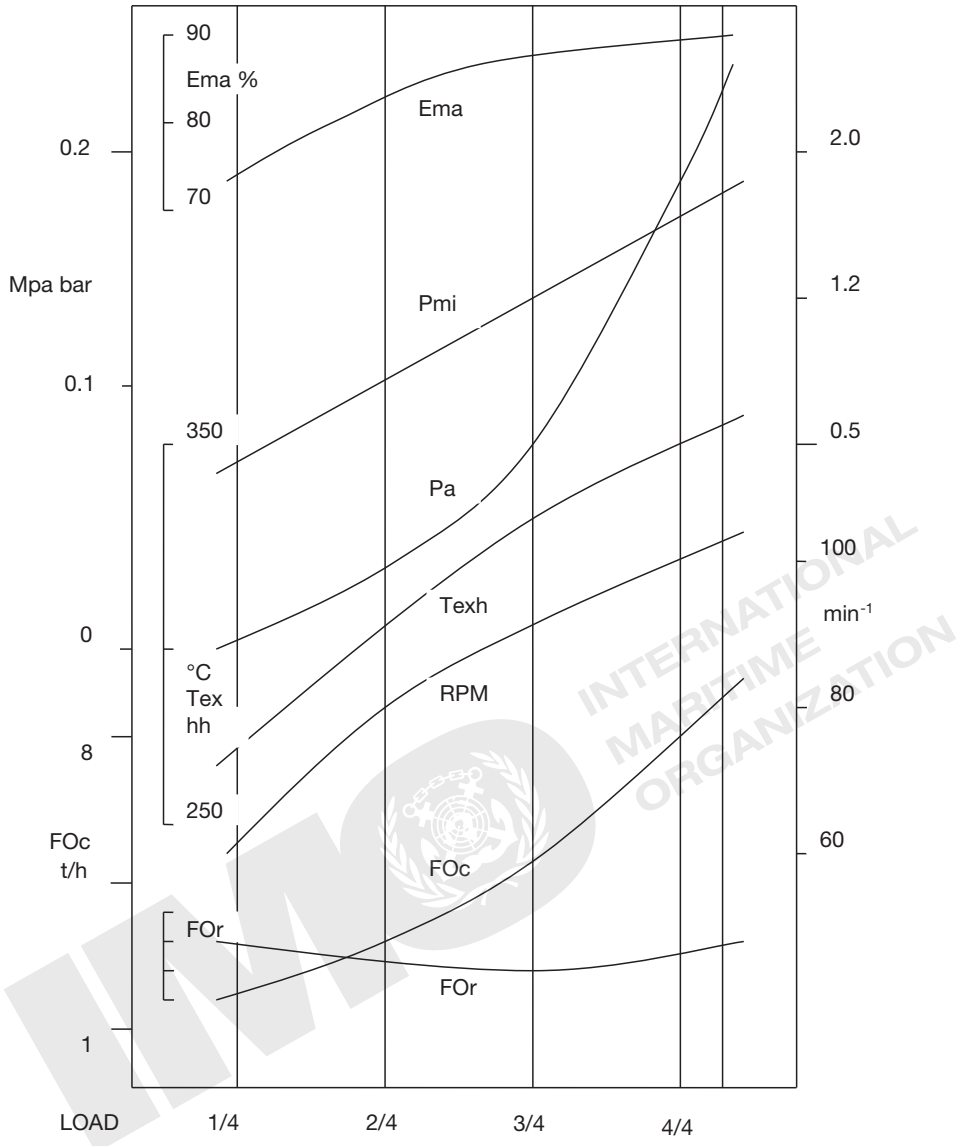
Exercise Title	Operating limits
Debriefing	Explain briefly the following and let the trainees discuss the operating limits of the simulated main diesel engine: – an engine has operating limits from various aspects – differences in characteristics of operating limits between diesel engine, steam turbine and gas turbine – any running parameter must be kept within the operating limits in principle – engine manufacturers provide an operation limits of engines delivered

Sample exercise 19 (A-III/2)

Exercise Title	Engine performance
Task	Assessment of main diesel engine and plant performances
Function and Level	Marine engineering at the management level
Competence	Operation, surveillance, performance and maintaining safety of propulsion plant and auxiliary machinery
Requirements (K.U.P.)	The efficient operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery
Estimated Duration	3 hours
Outline of Training	4 ~ 5 trainees establish a group and the group performs operations of the simulated main engine collecting necessary running parameters and assess the engine and plant performances in terms of collected running parameters such as p-v diagrams, pressure-stroke diagrams, engine output, revolution speed, fuel consumption and others Engine revolution speed: – harbour full (25% MCR) (two diesel generators are in service) – equivalent to 50% MCR (one diesel generator is in service) – equivalent to 75% MCR (one diesel generator and fresh water generator are in service) – equivalent to NSR (turbo generator and fresh water are in service) The trainees also develop an engine performance curve by using collected data and calculate quantity of fuel necessary for 100 miles in accordance with plant conditions The instructor prepares measurement tables and template of the performance curve in accordance with the specifications of simulated main engine and plant machinery
Initial Condition	Main engine harbour full
Specific Purpose	The training allows the trainee to understand: – how p-v diagram is assessed – how pressure-stroke diagram is assessed – meaning of performance curve – the most efficient operation
Briefing	Explain briefly the following: – how to conduct the training – measurement tables giving necessary information on the main engine – plant condition for measurements

Exercise Title	**Engine performance**
Implementation	Start the simulation setting the main engine to engine speed equivalent to quarter load/harbour full and let the trainees: (Measurements of fuel oil consumption and main engine revolution speed should be accurately done by reading flow and revolution counters) – collect running parameters following the measurement tables including print out the p-v and p-stroke diagrams for the first plant condition – increase the engine speed and set up the plant condition as 50% MCR and one diesel generator is in service – carry out the measurements in the same manner as the first plant condition – increase the engine speed and set up the plant condition as 75% MCR and one diesel generator and fresh water generator are in service – carry out the measurements in the same manner as the first plant condition – increase the engine speed and set up the plant condition as NSR and turbo generator and fresh water generator are in service – carry out the measurements in the same manner as the first plant condition The instructor stops the simulation and lets the trainees determine the following and develop the engine performance curve by using the collected data and results of calculations: – average engine revolution speed in min^{-1} – fuel consumption of the main engine, the diesel generators and the boiler – fuel consumption rate of the main engine – fuel consumption rate of the diesel generator – fuel consumption for 100 miles – propeller slip The instructor lets the trainees discuss p-v diagram, pressure-stroke diagram from the aspect of combustion taken place in the cylinder and the performance curve in comparison with the specification of the simulated main diesel engine
Debriefing	Explain briefly the following: – summary of the training – how p-v and pressure-stroke diagrams are obtained in actual ships – how p-v and pressure-stroke diagrams should be utilized for managing the main engine – causes of detective pressure-stroke diagram – how the performance curve should be utilized for managing the main engine

Example of ERS Main Engine Performance Curve



Ema:	Mechanical Efficiency	FOc:	Fuel Oil Consumption
Pmi:	Mean Indicated Pressure	For:	Fuel Oil Consumption Rate
Pa:	Scavenging Air Pressure	Texh:	Exhaust Gas Temperature

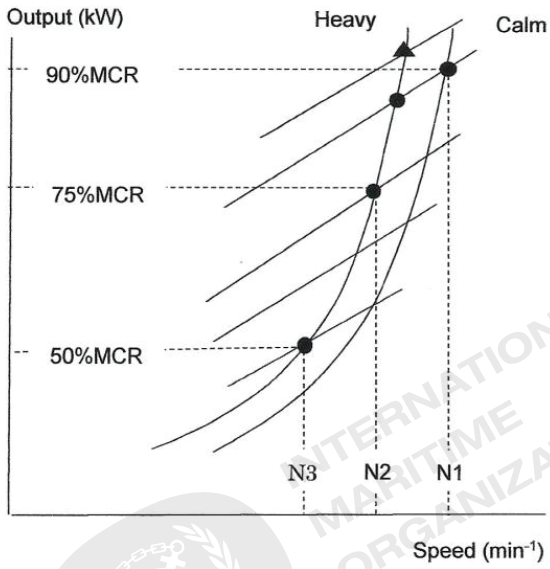
Sample exercise 20 (A-III/2)

Exercise Title	**High-voltage installation**
Task	Understanding design features of high-voltage installations
Function and Level	Electrical, electronic and control engineering at the management level
Competence	Manage operation of electrical and electronic control equipment
Requirements (K.U.P.)	Design features of high-voltage installations
Estimated Duration	2 hours/3 ~ 4 trainees
Outline of Training	3 ~ 4 trainees establish a group and the group perform simulation programme following instructions by the programme on high-voltage installations for the purposes of understanding design features of high-voltage installations as follows: – system configuration and isolation of high-voltage equipment – high-voltage generator – high-voltage main switch board – high-voltage transformer – convertor for controlling high-voltage motors – high-voltage motors – electrical propulsion system
Initial Condition	----
Specific Purpose	The training allows the trainees to understand design features of: – high-voltage generator – high-voltage main switch board – high-voltage transformer – convertor for controlling high-voltage motors – high-voltage motors – propulsion motors
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – effects of high-voltage on personnel – design features applied to high-voltage installations – characteristics and advantages of high-voltage motors

Exercise Title	**High-voltage installation**
Implementation	Start the simulation and let the trainees perform the simulation programme for identifying and understanding: – system configuration and isolation of high-voltage equipment – dual system – isolation – high-voltage generator – types and specifications – protection of terminal – design features applied to high-voltage main switch board – earthing switch on main BUS bar – arc detecting system – insulation distance – safety functions – high-voltage transformer – types of transformer – cooling system – convertor for controlling high-voltage motors – types of converter – cooling system – high-voltage motors – types of motors – cooling system – characteristic of propulsion motor
Debriefing	Explain briefly the following: – precaution to be strictly observed when handling high-voltage installations – characteristics of high-voltage installations – characteristics of electrical propulsion ship

Sample exercise 21 (A-III/2)

Exercise Title	**Heavy weather**
Task	Address heavy weather assessing running conditions of the main diesel engine
Function and Level	Maintenance and repair at the management level
Competence	Detect and identify the causes of machinery malfunctions and correct faults
Requirements (K.U.P.)	Detection of machinery malfunctions, location of faults and action to prevent damage
Estimated Duration	2 hours
Outline of Training	4 ~ 5 trainees establish a group and the group finds heavy load caused by heavy weather to the main engine and addresses the heavy load in accordance with specific load/propeller curve under the direction of the group leader The instructor creates heavy weather conditions and prepares specific load/propeller curve of the simulated main diesel engine.
Initial Condition	Seagoing
Specific Purpose	The training allows the trainees to: – acquire knowledge on how to address heavy weather – understand meanings of heavy load conditions – characteristics of main diesel engine – understand how engine output moves under heavy load conditions
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – changes in running parameters under heavier weather – specific load/propeller curve of the simulated main diesel engine

Exercise Title	**Heavy weather**
Implementation	Start the simulation and let the trainees: – confirm running conditions of the main engine and auxiliary machinery The instructor creates a heavy weather and lets the trainees: – check the engine revolution speed, output and other running parameters – assess the data and figure out the changes in engine load to the engine speed  – decide reduction of the engine load to avoid over torque – decrease the engine load to the predetermined speed – check the running parameters of the engine – check running condition of other systems such as power generation, fresh water generation FWG and steam generation systems – assess the running conditions of the engine in terms of output, P_{mi} (mean effective pressure), P_{max} (Maximum pressure) and exhaust gas temperature for the new revolution speed, and impacts on power generation system – decide further reduction of the engine load to avoid over torque – changeover power generation system to No. 1 diesel generator from Turbo generator (TG), keeping TG in hot condition – stop FWG keeping it in vacuum and start auxiliary boiler – decrease the engine load to the predetermined speed – check the running parameters of the engine – check the indicator diagram and draw curve – assess the running conditions of the engine in terms of output, P_{mi} (mean effective pressure), P_{max} (Maximum pressure) and exhaust gas temperature for the new revolution speed, and impacts on power generation system The instructor stops the simulation after the engine's output reaches its allowable MCR
Debriefing	Explain briefly the following: – how the engine output moves when hull condition becomes heavier due to some reasons – torque and over torque/torque rich – impacts on main engine under over torque/torque rich

Sample exercise 22 (A-III/2)

Exercise Title	**Main engine malfunction**
Task	Take remedy action to main engine malfunction
Function and Level	Maintenance and repair at the management level
Competence	Detect and identify the causes of machinery malfunctions and correct faults
Requirements (K.U.P.)	Detection of machinery malfunctions, location of faults and action to prevent damage
Estimated Duration	2 hours
Outline of Training	4 ~ 5 trainees establish a group and the group takes remedy action to the following malfunctions to prevent damage under the direction of the group leader: – automatic slowdown by thrust bearing high temperature – high oil mist condition in main engine crank case – fire in under piston/scavenging space
Initial Condition	Seagoing
Specific Purpose	The training allows the trainees to: – acquire knowledge on how to address main engine malfunctions in accordance with situations – understand meanings and possible causes of the malfunctions – understand what is necessary to avoid such cases
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – how to address the malfunctions
Implementation (1st stage)	(Main engine automatic slowdown by thrust bearing high temperature) Start the simulation and let the trainees: – confirm that the plant condition is in good order The instructor enters thrust bearing high temperature and the trainees: – confirm main engine automatic slow down with the alarm sound by pressing buzzer stop and reset button – take immediate procedures to change over the power generation system to No. 1 diesel generator from Turbo generator, keeping Turbo generator in a hot condition – start urgently auxiliary boiler and stop FWG accordingly – assess quickly main running parameters of the main engine – take measures to change over control position of the main engine to the control room from the bridge, keeping the revolution speed at Slow ahead and notifying the main engine automatic slowdown to the bridge

Exercise Title	Main engine malfunction
Implementation (1st stage) *(Cont.)*	– locate proximate cause of the automatic slowdown checking running parameters as follows or get to know alarming point: – LO temperature of the thrust bearing – LO pressure – LO flow rate – LO temperature control valve – control parameters of LO temperature controller – trouble of LO pumps – clogged LO strainer – fouled LO cooler – carry out remedy actions operations to recover the running condition – reset the abnormal and make procedures to resume the operation of the main engine – increase the engine speed by setting the maneuvering lever to the position as it was – make procedures to change over the power generation system to Turbo generator from No. 1 diesel generator as the speed is resumed – restart FWG and stop auxiliary boiler – confirm that the plant condition is resumed (This is end of the 1st stage and the instructor stops the simulation)
Implementation (2nd stage)	(High oil mist condition in main engine crank case) Start the simulation and let the trainees: – confirm that the plant condition is in good order The instructor enters bearing high temperature and the trainees: – confirm the bearing high temperature alarm by pressing buzzer stop and reset button – check oil mist detector for readings and find the section unit where the bearing high temperature occurred – request immediate engine stop informing the bridge of the situation – start standby diesel generator and change over the power generation system to the diesel generator from the turbo generator – make the engine speed slow instantly – stop heating of fresh water generator stopping distilled water pump – start auxiliary boiler and establish the standby condition of the propulsion plant – stop the main engine – open all indicator valve and carry out air running – start turning of the engine by turning motor for cool down and inspection (This is end of the 2nd stage and the instructor stops the simulation)

Exercise Title	**Main engine malfunction**
Implementation (3rd stage)	(Fire in under piston/scavenging space) Start the simulation and let the trainees: – confirm that the plant condition is in good order The instructor enters piston ring leaking and the trainees: – aware of rising under piston space temperature – request immediate engine stop informing the bridge of much higher temperature of under piston space than usual – start standby diesel generator and change over the power generation system to the diesel generator from the turbo generator – make the engine speed slow instantly – stop heating of fresh water generator stopping distilled water pump – start auxiliary boiler and establish the standby condition of the propulsion plant – stop the main engine – open all indicator valve and carry out air running – start turning of the engine by turning motor for inspection (This is end of the 3rd stage and the instructor stops the simulation)
Debriefing	Explain that we need to prioritize safety of hull (human life) rather than damage of machinery and briefly the following (1st stage) – remedy activities as a whole – causes of automatic slow down and shut down – possible sign of lubricating oil high temperature (2nd stage) – different situations under which a crankcase oil mist can originate – correct method of interpreting the machinery data and how to control and tackle such an incident – guidelines outlined in procedure for action to be taken in case of high oil mist (3rd stage) – knowledge and understanding in locating quickly a fire in the scavenging space of the main engine by analysing the machinery parameters – knowledge to control the severity of the fire – knowledge and understanding in the management of such a condition with a view to limit damage – general precautions to be observed in the avoidance of such incidents – procedures of action to be taken in case of fire in the scavenging space

Sample exercise 23 (A-III/2)

Exercise Title	**Fire in exhaust gas economizer**
Task	Diagnose the causes of fire in exhaust gas economizer and take remedial measures
Function and Level	Maintenance and repair at the management level
Competence	Detect and identify the causes of machinery malfunctions and correct faults
Requirements (K.U.P.)	Detection of machinery malfunctions, location of faults and action to prevent damage
Estimated Duration	2 hours
Outline of Training	4 ~ 5 trainees establish a group and the group, under the direction of the group leader, takes remedial measures to prevent burn out and other damages from exhaust gas economizer after the fire was detected
Initial Condition	Seagoing
Specific Purpose	The training allows the trainees to: – understand how to address fire in exhaust gas economizer – diagnose the causes of fire in exhaust gas economizer – discuss how to prevent fire in exhaust gas economizer
Briefing	Explain briefly the following: – how to conduct the training and positions assigned to the trainees – running conditions of the main engine – how fire in exhaust gas economizer occurs – how fire in exhaust gas economizer is detected – outline of addressing fire in exhaust gas economizer
Implementation	Start the simulation and let the trainees: (Enter the malfunction of fire in exhaust gas economizer and let the trainees perform remedial measures to the fire) – make sure occurrence of the fire in exhaust gas economizer detected with high temperature alarm of exhaust gas economizer outlet – supply extinguishing water into the exhaust gas economizer opening cleaning water drain valve – stop the main engine as soon as possible informing bridge of the situation – start standby diesel generator and change power generation system to the diesel generator from turbo generator – stop heating of fresh water generator stopping distilled water pump – start auxiliary boiler and establish the standby condition of the propulsion plant

Exercise Title	**Fire in exhaust gas economizer**
Implementation *(Cont.)*	– check the following keeping turbo generator and fresh water generator in idling: – temperature of exhaust gas economizer gas outlet – steam pressure – boiler water circulation pump pressure – auxiliary boiler feedwater flow rate – cascade tank level – when the temperature of exhaust gas economizer gas outlet goes down, stop supply extinguishing water and close cleaning water drain valve – keep the economizer as it is for a while to dry up – if no abnormal is found, start preparation for restart of the main engine – start the main engine informing the bridge – resume the plant conditions as they were, after the engine speed reaches to the navigation speed
Debriefing	Explain briefly the following: – summary of the training – envisaged damage of fire in exhaust gas economizer – shipping company issues a manual to avoid fire in exhaust gas economizer

D3 Sample exercises for table A-III/4

Sample exercise 24 (A-III/4)

Exercise Title	**Familiarization 1**
Task	Understand plant arrangement of steam generation system
Function and Level	Marine engineering at the support level
Competence	----
Requirements (K.U.P.)	----
Estimated Duration	2 hours
Outline of Training	Individual trainee works on tracing steam generation system and piping lines presented on the illustrating/mimic panel using check list
Initial Condition	Not in operation
Specific Purpose	The training allows the trainees to: – give knowledge on arrangement of steam generation system (auxiliary boiler system) on board diesel engine ships – understand how the steam generation system is constructed – understand functions of machinery which construct the system – understand how the machinery is connected

Exercise Title	**Familiarization 1**
Briefing	Explain briefly the following: – this training gives understanding of construction of steam generation system and preliminary knowledge for the operation – outline of the training – steam generation system is mainly constructed by feed water, fuel oil and steam supply systems – functions of main machinery which construct the system – how the machinery is connected by piping lines
Implementation	Let the trainees: – follow the check list, trace the steam generation system and its associated systems and briefly describe roles of the machinery/equipment/valves – feed water system – cascade tank – feed water pump – feed water control valve and its controller – pipe lines to cascade tank to boiler and cascade tank – fuel oil system – fuel oil service tank (HFO and DO) – changeover valve of fuel oil – fuel oil burning pump – fuel oil heater – Forced Draft Fan (FDF) – burning unit (burner, solenoid valves, air register, flame eye) – ignition unit (pilot burner pump, pilot burner, igniter) – control unit – steam supply system – main stop valve – pressure regulating valve and its controller – dumping valve – steam trap – auxiliary condenser – other key components and machinery – air ventilation valve – blowing down valve – soot blower – exhaust gas economizer – boiler water circulation pump

Exercise Title	**Familiarization 1**
Debriefing	Explain briefly the following using check list: – summary of the training – special features of machinery and piping and other main functions such as: – pressure regulating valve for the purpose of keeping constant temperature – dumping valve – recirculation line to cascade tank from feed water pump – structure of cascade tank – others – steam properties generated in the auxiliary boiler and exhaust gas economizer – saturated steam – superheated steam – pressure and temperature

Sample exercise 25 (A-III/4)

Exercise Title	**Familiarization 2**
Task	Operate instrumentation system to measure the running parameters of the steam generation system
Function and Level	Marine engineering at the support level
Competence	----
Requirements (K.U.P.)	----
Estimated Duration	1 hour
Outline of Training	Individual trainee works on check list reading indication meters of the simulated steam generation system on the mimic panel or illustrating panel and observing displays of instruments on the main console
Initial Condition	In port
Specific Purpose	The training allows the trainees to: – get to know names and functions of instrumentations used to indicate running parameters and status of the system machinery – understand difference between an analogue meter and digital indicator and their advantages and disadvantages – get familiar with reading indicators including unit
Briefing	Explain briefly the following: – this training gives understanding of instrumentation used in steam generation system – outline of the training – various instrumentations are used to indicate various process values that are running parameters of the machinery – importance of reading correctly these indications to ensure proper judgement of the running condition
Implementation	Start the simulation and let the trainees enter the engine-room to: – start reading indications of various meters on the mimic panel or illustrating panel following the check list The instructor lets the trainees enter the control room to: – start reading indications of various meters on the main console

Exercise Title	**Familiarization 2**
Debriefing	Explain briefly the following: – readings taken from indicators can be an important data for analysing running conditions of the machinery – importance to remember approximate values of running parameters from the aspects of detecting abnormal conditions quickly – actual analogue indicators/gauges and remote-indicators are installed in an actual ship and these two indications are generally different a little – therefore, difference in tow indications should be kept in mind

Sample exercise 26 (A-III/4) and (A-III/7)

Exercise Title	**Familiarization 3**
Task	Operate alarm system used to indicate malfunctions and emergency
Function and Level	Marine engineering at the support level
Competence	----
Requirements (K.U.P.)	----
Estimated Duration	1 hour
Outline of Training	Individual trainee performs operation of alarm system identifying malfunction in turn
Initial Condition	Seagoing
Specific Purpose	The training allows the trainees to understand: – difference between general alarm/emergency alarm and engine alarms – pattern of machinery alarms – how to respond to an alarm sound – meaning of alarm sound, lamp indications and lamp flicker
Briefing	Explain briefly the following – how to respond to machinery alarms of instrumentation used in the steam generation system – difference between general alarm and machinery alarms – meaning of buzzer stop button, reset/flicker stop button and alarm indication lamps
Implementation	Start the simulation and let the trainees: – perform buzzer test and lamp test in turn – respond to an alarm entered by the instructor – press buzzer stop button to stop the alarm sound – make sure what was alarmed and the malfunction machinery with lamp flicker – press reset/flicker stop button and make sure the lamp becomes continuous lighting – make sure that the alarm lamp lights until the alarmed parameter becomes normal – make sure that the alarm was recorded in the event printer/alarm printer with time of occurrence and stored in the monitoring systems until the alarmed parameter becomes normal Instructor makes alarms one after another until the trainees become familiar with the response

Exercise Title	**Familiarization 3**
Debriefing	Explain briefly the following: – summary of the training – meanings of audible and visible alarm – three categories of alarm that are emergency alarm, primary alarm and secondary alarm

Sample exercise 27 (A-III/4) and (A-III/7)

Exercise Title	**Familiarization 4**
Task	Identify equipment used for controls
Function and Level	Marine engineering at the support level
Competence	----
Requirements (K.U.P.)	----
Estimated Duration	1 hour
Outline of Training	Individual trainee works on check list for identifying equipment used for controls in the simulated steam generation system
Initial Condition	Not in operation
Specific Purpose	The training allows the trainees to: – understand what and how machinery is remotely and/or automatically controlled in the steam generation system – understand what process values are automatically controlled – identify what equipment is used for controls
Briefing	– Explain briefly the following: – outline of the training – how to carry on the training – differences between remote control and automatic control – control methods applied to main machinery
Implementation	The instructor lets the trainees identify equipment used for controls following the check list: – remote-automatic control – auxiliary boiler control panel (operation mode and others) – remote control – group starter panels (feed water pump, burning pump and pilot burner pump) – automatic control – temperature controllers (fuel oil) – level controllers (boiler water level) – pressure controllers (steam pressure) – control valves – start and stop in group starter panels (standby feed water pump automatic start)
Debriefing	Explain briefly the following: – differences between manual control, remote and automatic control – situations/cases which need changeover automatic control to manual control – all operations can be done in manual

Sample exercise 28 (A-III/4)

Exercise Title	**Safe operation of boiler**
Task	Maintain water level and steam pressure
Function and Level	Marine engineering at the support level
Competence	For keeping a boiler watch: Maintain correct water levels and steam pressure
Requirements (K.U.P.)	Safe operation of boilers
Estimated Duration	2 hours
Outline of Training	Individual trainee carries out manually igniting and extinguishing a burner of auxiliary boiler and take actions to keep boiler water level in normal range
Initial Condition	In port
Specific Purpose	The training allows the trainees to acquire: – skills on fundamental operation procedures on manually igniting and extinguishing a burner – skills on keeping boiler water level in normal range – knowledge on importance of safe practice
Briefing	Explain briefly the following: – how to carry out the training – specific purposes of the training – procedures for igniting and extinguishing a burner – actions to keep boiler water level in normal range – importance of safety practice when igniting a burner
Implementation	Start the simulation and let the trainee: – carry out ignition of a burner – change over the burner control to manual – confirm steam pressure down – start FDF for pre-purge – start burning pump – set fuel oil pressure to minimum – press ignition button and confirm ignition – monitor steam pressure rises – increase fuel oil pressure to rise the steam pressure faster – extinguish the burner by pressing the button – maintain FDF running for post purge – stop FDF – change over the burner control to automatic control

Exercise Title	**Safe operation of boiler**
Implementation *(Cont.)*	The instructor lets the trainee repeat the same procedures two or three times – take actions to keep the boiler water level in normal range – set Nos. 1 and 2 feed water pump to manual – start and stop manually No. 1 feed water pump and confirm discharge pressure observing opening of the feed water control valve – start No. 1 feed water pump and set both pumps to automatic changeover – set the feed water/level controller to manual and increase and decrease the setting valve observing opening of control valve – or increase and decrease the setting value of the controller in automatic control observing opening of the control valve – supply makeup water to the cascade tank accordingly – open the bypass valve of the feed water control valve – close the inlet valve to the feed water control valve – start and stop No. 1 feed water pump accordingly observing the boiler water level – start No. 1 feed water pump and open the inlet valve to the feed water control valve – close the bypass valve of the control valve
Debriefing	Explain briefly the following: – summary of the training – importance of pre-purge and post purge – meanings and causes of boiler furnace blowback and consequent incidents on personnel and the boiler – short water and consequent damage

D4 Sample exercises for table A-III/6

Sample exercise 29 (A-III/6)

Exercise Title	**Monitoring of propulsion plant**
Task	Monitor propulsion plant machinery
Function and Level	Electrical, electronic and control engineering at the operational level
Competence	Monitor the operation of electrical, electronic and control systems
Requirements (K.U.P)	Basic understanding of the operation of mechanical engineering systems Fundamentals of automation, automatic control systems and technology
Estimated Duration	3 hours / 4 ~ 5 trainees
Outline of Training	4 ~ 5 trainees establish a group and the group perform the monitoring procedures on propulsion plant for two modes of the plant: – check and collect values of electrical, electronic and control parameters and other main running parameters of the plant machinery, following the check lists prepared by instructors – adjust the parameters as necessary
Initial Condition	First stage: In port (Completion of preparation for leaving port) Second stage: Seagoing

Exercise Title	**Monitoring of propulsion plant**
Specific Purpose	The training allows the trainees to: – identify machinery to be started before leaving port – identify electrical, electronic and control equipment to be started for leaving port – understand meanings of electrical, electronic and control parameters concerned in operation of the plant machinery – understand correlations between electrical, electronic and control parameters and mechanical running parameters – understand control methods applied to the propulsion plant machinery
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – arrangements of the simulated propulsion plant – arrangements of the simulated power generation and distribution systems – electrical, electronic and control parameters concerned in operation of propulsion plant machinery – control methods applied to the machinery
Implementation (1st stage: In port)	Start the simulation setting up the initial condition as completion of preparation for leaving port and let the trainees: – identify machinery to be started for leaving port – identify electrical, electronic and control equipment to be started for leaving port – check and collect values of electrical, electronic and control parameters concerned in conditions to be met for starting up main engine following the lists as follows: – main and emergency power sources for control equipment – running parameters such as pressures, temperatures, levels and others – parameters in fault before starting up main engine – conditions and states on maneuvering equipment of main engine – check and collect values of electrical, electronic and control parameters concerned in states of machinery for power generation and distribution systems as follows: – running parameters of generators in service – states of control equipment for power generation system and main switch board (MSB) – states of generators in standby – states of emergency generator – parameters in fault – states of emergency power distribution panels – check and collect values of electrical, electronic and control parameters concerned in states of the following auxiliary machinery: – running parameters of auxiliary machinery in service for starting up main engine – states of auxiliary machinery in standby – states of auxiliary machinery in rest

Exercise Title	**Monitoring of propulsion plant**
Implementation (1st stage: In port) *(Cont.)*	– identify and list control methods applied to automatic controls of: – main engine – power generation system – steam generation system – pumps – purifiers – temperature, level, pressure and viscosity
Debriefing (1st stage)	Explain briefly the following: – machinery to be started for leaving port – electrical, electronic and control equipment to be started for leaving port – conditions for starting up main engine and main running parameters of the engine – conditions for standby generators and main running parameters of the generators
Implementation (2nd stage: Seagoing)	Start the simulation and let the trainees: – identify running machinery as follows: – main engine associated auxiliaries – generator in service – states of standby generators – steam generation system – steering system – auxiliary machinery (air compressors, pumps, purifier, fresh water generator) – check and collect main running parameters and modes as follow: – main engine and associated auxiliaries – electric power generation system machinery – steam generation system machinery – steering system – purifiers – fresh water generator – check and collect states of machinery in standby as follows: – generators for automatic start – oil fired boiler – pumps for automatic changeover – check and collect values of electrical, electronic and control parameters such as setting values, present values and controlling values applied to automatic controls of: – main engine – electric power generation system – steam generation system – purifier – temperature, pressure, level and viscosity controls

Exercise Title	Monitoring of propulsion plant
Implementation (2nd stage: Seagoing) *(Cont.)*	– relate controlling values to main running parameters or relations between setting values and present values as follows: – main engine output, fuel notch and revolution speed – cooling water temperature of main engine – fuel oil viscosity – water level of oil fired boiler – steam pressure of steam distribution line – others – adjust control parameters such as setting value and / or PID parameters and diagnose functions of control equipment as follows: – main engine – electric power generation system – steam generation system – temperature, pressure, level and viscosity controls
Debriefing (2nd stage)	Explain briefly the following: – summary of the training – relations between controlling parameters / range and running parameters of the simulated propulsion plant machinery in terms of control methods – discuss effects and characteristics of automatic control applied to machinery – possible adjustment in accordance with control methods – importance of optimum control

Sample exercise 30 (A-III/6)

Exercise Title	Automatic control
Task	Operate automatic control systems
Function and Level	Electrical, electronic and control engineering at the operational level
Competence	Monitor the operation of electrical, electronic and control systems
Requirements (K.U.P)	Fundamentals of automation, automatic control systems and technologies
Estimated Duration	2 hours / 4 ~ 5 trainees
Outline of Training	4 ~ 5 trainees establish a group and the group member performs operations of automatic control systems of main diesel engine and other control systems in turn. Detail and specific procedures to be taken should be developed and prepared for the trainees according to specifications and functions of the simulator
Initial Condition	In port (Completion of preparation for leaving port)
Specific Purpose	The training allows the trainees to: – understand fundamentals of automatic controls applied to propulsion plant machinery – understand main characteristics of automatic controls – acquire knowledge and skills to operate automatic control systems applied to the propulsion plant machinery

Exercise Title	**Automatic control**
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – automatic control applied to main diesel engine and auxiliary machinery – operation of main engine maneuvering system – operation of controllers used for automatic control systems
Implementation	Start the simulation and let the trainees perform the following operation: (Start up main diesel engine) Performance of starting up the engine using engine telegraph accordingly – confirm conditions for starting up main diesel engine are ready – set operation mode of the engine to manual and control position to engine side (engine-room) – make air running of the engine in ahead direction starting auxiliary blower at the engine side – close all indicator valves – start up the engine with air and fuel in ahead direction – stop the engine after several revolutions of the engine – start up the engine with air and fuel in astern direction – stop the engine after several revolutions of the engine – set operation mode of the engine to auto and control position to control room – start the engine in automatic mode in both directions and stop the engine – confirm automatic changeover of air running to fuel running (Maneuvre main diesel engine) Performance of maneuvering the engine in automatic control using engine telegraph accordingly Instructor creates conditions for main engine automatic control such as revolution speed, crash astern, wrong way, speed run-up programme and safety functions Instructors issue telegraph orders and let trainees maneuvre the engine in turn, responding to the telegraph orders and confirming: – automatic revolution control by setting maneuvering lever to the position which meets the telegraph orders – wrong way alarm is activated under specific conditions – crash astern programme is activated under specific conditions – speed run-up programme – automatic slow under specific conditions – automatic shut down under specific conditions

Exercise Title	Automatic control
Implementation *(Cont.)*	(Automatic changeover of auxiliary machinery) Instructors create abnormal stop of CFW pump and LO pump and let trainees confirm: – CFW pumps and LO pumps are in mode of automatic changeover – states of valves concerned – abnormal stop of No. 1 CFW pump / No. 1 LO pump – automatic start of No. 2 CFW pump / No. 2 LO pump – states of CFW pumps / LO pumps (Ignition of oil fired boiler) Instructors create stem pressure low and let trainees confirm: – start of FDF (Forced Draft Fan) for pre-purge – completion of pre-purge – ignition oil burner is ignited with start of ignition oil pump – ignition of burner with start of burning pump – rise in steam pressure – extinction of flame when the steam pressure reached setting pressure – start of FDF for post-purge – completion of post-purge (Water level of oil fired boiler) Instructors set level control of boiler water to manual and increase steam consumption. Instructors let the trainees maintain water level constant as follows: – confirm low water level – try to maintain water level constant by adjusting P and I parameters and observing: – dead time – overshoot – time-lag – settling time – steady-state deviation – controller output – opening of level control valve – actual water level (present value) – change over the control mode to auto from manual – observe change in control factors – confirm water level stably constant – confirm conclusive controller output and opening of level control valve
Debriefing	Explain briefly the following: – automatic controls applied to main diesel engine and other machinery – main features and characteristic of automatic controls applied to main engine and other machinery – functions of components and equipment used for automatic control and how they work – safety functions shall be independent

Sample exercise 31 (A-III/6)

Exercise Title	**Electrical propulsion**
Task	Operation of propulsion motor
Function and Level	Electrical, electronic and control engineering at the operational level
Competence	Operate and maintain power systems in excess of 1,000 volts
Requirements (K.U.P.)	Electrical propulsion of the ships' electrical motors and control systems Safe operation and maintenance of high-voltage systems, including knowledge of the special technical type of high-voltage systems and the danger resulting from operational voltage of more than 1,000 volts
Estimated Duration	2 hours/4 ~ 5 trainees
Outline of Training	4 ~ 5 trainees establish a group and the group perform the following operations on high-voltage installations for leaving a port: – preparation for leaving a port – start up electrical propulsion motors – maneuvering electrical propulsion motors
Initial Condition	In port
Specific Purpose	The training allows the trainees to: – understand procedures for leaving a port – understand precautions on maneuvering electrical propulsion motors – operational characteristics of electrical propulsion motors
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – arrangements of the simulated electrical propulsion system – operation procedures and precautions of the propulsion system
Implementation	Start the simulation and let the trainees: – carry out preparation for starting up additional generators including: – checking conditions of prime movers of generators – checking conditions of power distribution system – checking insulation resistances of the equipment – propulsion motor – VVVF – transformer – supply system of cooling fluid to propulsion motors – supply system of lubricating oil to propulsion motors – carry out preparation for starting up propulsion motors including: – coupling generators – VCB/GCB on for propulsion motors – test of propulsion motor – voltage – current – frequency – power – power factor

Exercise Title	Electrical propulsion
Implementation *(Cont.)*	– carry out maneuvering propulsion motor including: – checking electrical running parameters – checking cooling fluid and its conditions – temperature – pressure – quantity – properties
Debriefing	Explain briefly the following: – characteristics of electrical propulsion motors – precautions necessary for electrical propulsion system

Sample exercise 32 (A-III/6)

Exercise Title	Monitoring of electrical power generation system
Task	Address malfunctions
Function and Level	Maintenance and repair at the operational level
Competence	Maintain and repair automation and control systems of main propulsion and auxiliary machinery
Requirements (K.U.P)	Detection of machinery malfunctions, location of faults and action to prevent damage
Estimated Duration	2 hours / 4 ~ 5 trainees
Outline of Training	4 ~ 5 trainees establish a group and the group performs operations to address malfunctions of electrical power generation system assessing running parameters and conditions under the direction of the group leader The instructor creates malfunctions and may advise the trainees of procedures to be taken to address the malfunctions as necessary Detail and specific procedures to be taken should be developed and prepared for the trainees according to specifications and functions of the simulator
Initial Condition	In port
Specific Purpose	The training allows the trainees to: – acquire knowledge and skills to address malfunctions of electrical power generation system assessing running parameters and conditions
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – electrical power generation and distribution systems – automatic control applied to the systems – malfunctions and measures to be taken

Exercise Title	**Monitoring of electrical power generation system**
	Start the simulation and let the trainees perform operation to address the following malfunctions: (Cross current) – confirm "cross current" between Nos. 1 and 2 diesel generators in parallel running – set operation mode of generators to manual – start No. 3 generator and make parallel running of Nos. 1 and 3 generators – check No. 2 generator for voltage with no load – adjust exactly voltage of No. 2 generator – make parallel running of Nos.1, 2 and 3 generators – make parallel running of Nos. 2 and 3 generators – check No. 1 generator for voltage with no load – adjust exactly voltage of No. 1 generator – make parallel running of Nos. 1, 2 and 3 generators – make parallel running of Nos. 1 and 2 generators – confirm if no cross current exist (Defective fuel injection pump of No. 1 generator) – confirm unstable parallel running of Nos. 1 and 2 diesel generators – set operation mode of generators to manual – try to make stable load sharing using governor switch – confirm unstable governor control of Nos. 1 and 2 generators – start No. 3 generator and make parallel running of Nos. 1 and 3 generators – check parallel running of Nos. 1 and 3 generators for stable load sharing – confirm unstable parallel running of Nos. 1 and 3 generators – check No. 2 generator for governor control by increasing and decreasing engine speed using governor switch – confirm stable governor control of No. 2 generator – make parallel running of Nos. 1, 2 and 3 generators – make parallel running of Nos. 2 and 3 generators – check No. 1 generator for governor control by increasing and decreasing engine speed using governor switch – confirm unstable governor control of No. 1 generator due to defective movement of fuel injection pumps caused by low quality oil – stop No.1 generator – set operation mode of generators to auto

Exercise Title	**Monitoring of electrical power generation system**
Implementation *(Cont.)*	(Stator coil high temperature of No. 1 generator in parallel with No. 2 generator) – confirm No. 1 generator stator coil high temperature pressing buzzer stop and reset buttons – set load sharing to 30% for No. 1 generator – check stator coil temperature of No. 1 generator after a while – start No. 3 generator and make parallel running of Nos. 2 and 3 generators with even load – check stator coil high temperature of No. 1 generator with no load – confirm insulation degradation of No. 1 generator – stop No. 1 generator for measures
Debriefing	Explain briefly the following: – how cross current is generated – defective fuel injection pump and linkage of diesel generators cause defective movement of governor resulting in serious consequences such as over speed trip and blackout

D5 Sample exercises for table A-III/7

Sample exercise 33 (A-III/7)

Exercise Title	**Familiarization 1**
Task	Understand arrangement of power generation and distribution systems
Function and Level	Maintenance and repair at the support level
Competence	----
Requirements (K.U.P.)	----
Estimated Duration	1 hour
Outline of Training	Individual trainee works on tracing power generation and distribution systems and power lines presented on the illustrating/mimic panel using check list
Initial Condition	Not in operation
Specific Purpose	The training allows the trainees to: – give knowledge on arrangement of power generation and distribution systems on board diesel engine ships – understand how the power generation and distribution systems are constructed – understand functions of machinery which construct the systems – understand how the machinery is connected
Briefing	Explain briefly the following: – this training gives understanding of construction of power generation system and preliminary knowledge for the operation – outline of the training – power generation system and distribution systems are mainly constructed by generators, main switch board, transformer, distribution panels, group starter panels and control panels – flow of power generation and distribution systems

Exercise Title	**Familiarization 1**
Implementation	Let the trainees: – following the check list, trace the power generation and distribution systems and their associated systems and briefly describe roles of the machinery/equipment – generators – diesel generator – turbo generator – emergency generator – main switch board – generator panel – synchronizing panel – distribution panel – transformer – Group Starter Panel (GSP) – battery charging and discharging panel – emergency generator panel – shore connection panel – emergency power supply – emergency lighting – control panels – boiler – purifier
Debriefing	Explain briefly the following using the check list: – summary of the training – importance of power generation and distribution systems – meaning of dual systems – precautions when working on electrical systems

Sample exercise 34 (A-III/7)

Exercise Title	**Familiarization 2**
Task	Operate instrumentation system to measure the running parameters of the steam generation system
Function and Level	Maintenance and repair at the support level
Competence	----
Requirements (K.U.P.)	----
Estimated Duration	1 hour
Outline of Training	Individual trainee works on a check list reading indication meters of the simulated power generation and distribution systems on the mimic panel/illustrating panel, main switch board, group starter panels and others
Initial Condition	In port

Exercise Title	**Familiarization 2**
Specific Purpose	The training allows the trainees to: – get to know names and functions of instrumentations used to indicate running parameters and status of the system machinery/equipment – understand difference between an analogue meter and digital indicator and their advantages and disadvantages – get familiar with reading indicators including unit
Briefing	Explain briefly the following: – this training gives understanding of instrumentation used in power generation and distribution systems – outline of the training – various instrumentations are used to indicate various electrical values that are running parameters of the machinery – the importance of reading correctly these indications to ensure proper judgement of the running condition
Implementation	Start the simulation and let the trainees: – start reading indications of various meters on various panels following the check list
Debriefing	Explain briefly the following: – readings taken from indicators can be an important data for analysing running conditions of the machinery – importance to remember approximate electrical values from the aspects of detecting abnormal conditions quickly

Sample exercise 35 (A-III/7)

Exercise Title	**Fault detection of electrical system**
Task	Address faults
Function and Level	Maintenance and repair at the support level
Competence	Contribute to the maintenance and repair of electrical systems and machinery on board
Requirements (K.U.P.)	Test, detect faults and maintain and restore electrical control equipment and machinery to operating condition
Estimated Duration	2 hours
Outline of Training	4 ~ 5 trainees establish a group and the group performs operations to address faults of the electrical system equipment under the direction of the group leader The instructor selects faults and may advise the trainees of procedures to be taken to address the faults as necessary Detail and specific procedures to be taken should be developed and prepared for the trainees according to specifications and functions of the simulator
Initial Condition	In port
Specific Purpose	The training allows the trainees to: – acquire knowledge on how to address faults of electrical system equipment
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – faults and how to address the faults

Exercise Title	**Fault detection of electrical system**
Implementation	Start the simulation and let the trainees perform operation to address the following faults: (Motor abnormal stop) – confirm the alarm by pressing buzzer stop and reset button – confirm abnormal stop of the No. 1 CSW pump – confirm No. 2 CSW pump automatically started and its current value – check No. 1 CSW pump starter and confirm the overcurrent relay was activated – set Nos. 1 and 2 CSW pumps to manual – reset the overcurrent relay – turn off MCCB of No. 1 CSW pump – confirm the alarm indication became off (BUS low voltage) – confirm the alarm by pressing buzzer stop and reset button – confirm BUS low voltage – check running conditions of generator and BUS frequency – adjust AVR to increase voltage – confirm the alarm indication became off (BUS high frequency) – confirm the alarm by pressing buzzer stop and reset button – confirm BUS high frequency – check running conditions of the generator – adjust frequency by lowering generator speed using governor motor – confirm the frequency becomes normal – confirm the alarm indication became off (Earth fault) – confirm the alarm by pressing buzzer stop and reset button – confirm earth fault and test earth lamp – locate earthing fault by turning off MCCBs on the distribution board in a correct manner – confirm which MCCB has the defective line/the earthing fault – confirm the alarm indication became off, keeping the MCCB off (Blackout) – confirm blackout occurred – confirm the alarms by rapidly pressing the buzzer stop – confirm electric power resumes automatically – confirm main auxiliaries restart automatically one after another – restart auxiliaries one by one which need to start manually – confirm all the machinery became normal conditions – find the reason for the blackout – reset all generator operations to automatic control – select standby generator

Exercise Title	**Fault detection of electrical system**
Debriefing	Explain briefly the following: – summary of the training – importance of correct procedures for locating electrical faults – possible causes for earth faults – possible causes for motor abnormal stop – safety measures to be taken when working on electrical equipment

Sample exercise 36 (A-III/7)

Exercise Title	**Fault detection and measures**
Task	Address malfunction
Function and Level	Maintenance and repair at the support level
Competence	Contribute to the maintenance and repair of electrical systems and machinery on board
Requirements (K.U.P.)	Detection of machinery malfunctions, location of faults and action to prevent damage
Estimated Duration	2 hours
Outline of Training	4 ~ 5 trainees establish a group and the group performs operations to address malfunctions of the machinery under the direction of the group leader The instructor selects malfunctions and may advise the trainees of procedures to be taken to address the malfunctions as necessary Detail and specific procedures to be taken should be developed and prepared for the trainees according to specifications and functions of the simulator
Initial Condition	Seagoing and in port
Specific Purpose	The training allows the trainees to: – acquire knowledge on how to address malfunctions of machinery
Briefing	Explain briefly the following: – outline of the training – how to carry on the training – malfunctions and how to address the malfunctions
	Start the simulation and let the trainees perform operation to address the following malfunctions: (No. 1 boiler feed water pump abnormal stop) – confirm the alarm by pressing buzzer stop and reset button – confirm No. 2 pump starts automatically – set Nos. 1 and 2 pumps to manual – turn off MCCB of No. 1 pump starter – close suction and delivery valves of No. 1 pump – confirm the alarm indication became off

Exercise Title	**Fault detection and measures**
Implementation *(Cont.)*	(No. 1 FO purifier abnormal separation) – confirm the alarm by pressing buzzer stop and reset button – stop oil supply – change over control mode to manual – carry out manual sludge discharge – stop heating of FO – stop No. 1 FO purifier and close valve concerned – line up No. 2 FO purifier – start No. 2 FO purifier – start heating of FO – supply seal water – start supply of oil to No. 2 FO purifier – confirm the alarm indication becomes off (No. 1 diesel generator CFW high temperature) – confirm the alarm by pressing buzzer stop and reset button – confirm the temperature – confirm CFW pressure is normal – set the 1st standby generator (No. 2) to manual – start remotely No. 2 diesel generator – confirm the voltage established – couple No. 2 generator with No. 1 generator by pressing automatic synchronizing – uncouple No. 1 generator by pressing stop button – confirm running parameters of No. 2 generator are in normal range – set No. 2 generator to automatic control – confirm the alarm indication became off (No. 1 main air reservoir low pressure) – confirm the alarm by pressing buzzer stop and reset button – confirm the pressure – confirm No. 1 main air compressor in service – confirm No. 1 main air compressor CFW flow switch activated – set No. 1 to manual – turn off MCCB of No. 1 starter – close all valves concerned – open all valves concerned in No. 2 main air compressor – switch on MCCB and start No. 2 manually – confirm drain valves activated – set No. 2 to automatic control

Exercise Title	**Fault detection and measures**
Debriefing	Explain briefly the following: – importance of keeping normal operating conditions – maintenance and repair should be done keeping the normal operating conditions – importance of isolating defective machinery when keeping normal operating conditions as a whole

Appendix 2 (to Part A)

Sample of an engine-room simulator

Having considered the provisions aforementioned, this model course recommends two engine-room simulators "ERS I" and "ERS II" as teaching facilities and equipment in order to put the provisions of the STCW Code into practice, taking into account wide variety of engine-room simulators from the aspect of the equipment which constructs the engine-room simulators.

Concept of ERS I

ERS I is used for simulator training that cannot be conducted by ERS II. ERS I consists of display panel/panels, operation desk/console and instructor console/station. The display panel is available to display various diagrams and propulsion plant machinery systems with operation switches, indication lamps and indicators as necessary.

The operation desk/console equipment is available for trainees to perform simulation and to operate the plant machinery/systems through operation key boards/operation panels and/or the like.

The instructor console/station equipment is available for instructors to conduct and to control the trainings through operation key boards.

Figure 1 gives recommended arrangement of ERS I.

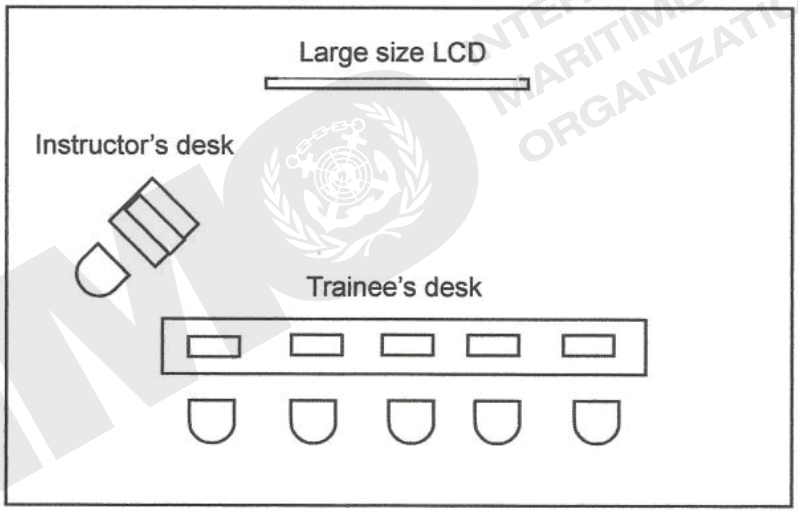


Figure 1

Concept of ERS II

ERS II is a full-scale engine-room simulator among various engine-room simulators and provides fidelity and similar functions of as actual machinery with the engine and control rooms where the trainees can perform various operations under the most realistic training environment. All operating procedures necessary for the engine-room machinery in principle can be performed in the engine-room in a same manner as an actual engine-room and the trainees can observe running parameters necessary for a safe engineering watch.

ERS II consists of the following rooms equipped with appropriate equipment based upon the learning/assessment point.

- Engine-room
- Control room
- Instructor room
- Briefing room

Engine-room comprises the following:

- Mimic panel
- Main engine local control stand
- Pump panels/Group starter panels (GSPs)
- Auxiliary boiler control stand
- Purifier control stand
- Sound system equipment
- Communication system equipment
- Illumination system equipment
- CCTV system equipment

Control room comprises the following:

- Main console
- Main switch board (MSB)
- Communication system equipment
- Sound system equipment
- Illumination system equipment
- CCTV system equipment

Instructor room comprises the following:

- Instructor console
- Simulator control equipment
- Communication system equipment
- CCTV system equipment

Briefing room comprises the following:

- Instructor desk
- Trainees' desk
- Overhead projector and screen

Figure 2 shows recommended arrangement of ERS II.

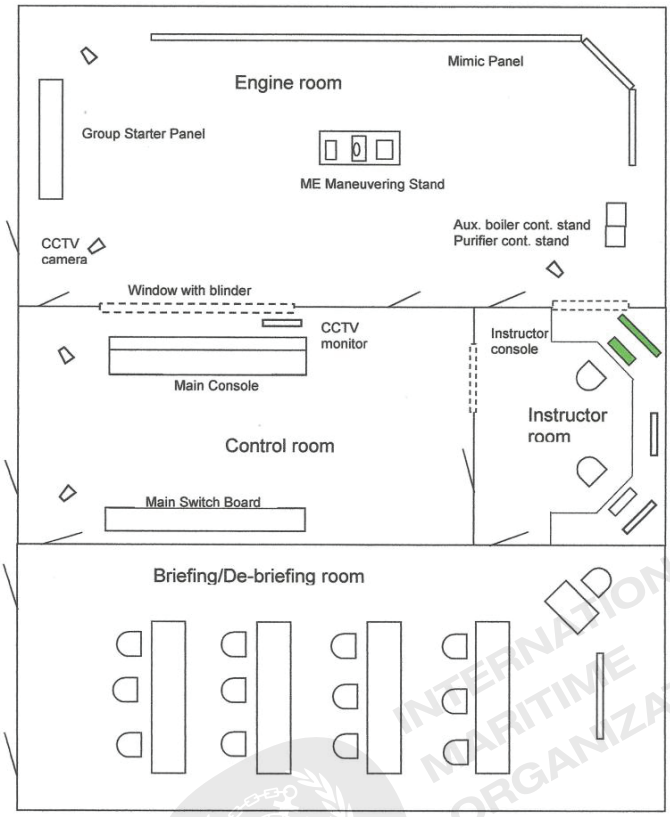


Figure 2

Outline of engine-room installations

(Mimic panel)

– The latest and typical diesel engine propulsion plant is represented on the panel with its constructing machinery, piping diagrams and recommended accessories such as lamps, switches, meters and indicators.

– The panel must be designed based on the following ideas for effective training of plant operation and for better understanding of construction of the plant system:

(1) The panel should be such it would be possible for trainees to:

– observe the entire range of the panel from the appropriate position of the engine-room and easy to identify what machinery comprises the propulsion plant;

– identify mutual relationship of the machinery and actual arrangement of boiler, generator and other auxiliaries on board; and

– stay in control of running conditions and status of the propulsion plant.

(2) The panel should be designed with the intent to allow trainees to easily learn piping and systems. Accessories should be of appropriate size in relationship to the learning objectives.

– The following is considered to be precautions to meet the ideas above:

(1) Sufficient clear space would be desirable to present entire system of the diesel engine propulsion plant in terms of size of illustrated machinery, presentation of piping diagrams and the idea (1) aforementioned.

(2) Piping systems representing cooling fresh water, fuel oil, lubricating oil and others should be illustrated in recognizable colour code, width, length and arrangement as much as possible.

(3) Actual relativity between the machinery should be reflected in designing their shapes and sizes.

(4) The illustrated machinery should be drawn and arranged in an impressive manner as much as possible according to actual arrangement on board.

(5) Appropriate size of pressing area and lower height of push button switches from the panel surface should be adopted in terms of the idea (2) aforementioned and to ensure reliable operations on the panel.

(6) Brightness and higher visibility and appropriate size of indication lamps should be adopted in terms of the idea (2) aforementioned.

(7) Appropriate size and number of indication meters for pressure, temperature, level and control parameters should be fitted on the panel as necessary to allow trainees to observe the running conditions.

(8) Mounting models or LCD display available for showing animation videos of steering gear and propeller is desirable.

(Main engine control stand)

Main engine control stand is a desk type control stand equipped with main engine maneuvering equipment, engine telegraph and communication system equipment.

(Pump panel/Group Starter Panel: GSP)

Pump panel/GSP is a dead front type panel equipped with starter panels of auxiliaries such as pumps, air compressors and purifiers.

(Auxiliary boiler control stand)

Auxiliary boiler control panel is a desk type control stand equipped with manual and automatic control equipment and available to remotely control the auxiliary boiler represented on the mimic panel.

(Purifier control stand)

Purifier control stand is a desk type control stand equipped with manual and automatic control equipment of FO, DO and LO purifiers and available to remotely control the purifiers represented on the mimic panel

(Sound system equipment)

A speaker of the sound system plays simulated engine-room sounds according to running conditions of the propulsion plant while simulation is performed.

(Communication system equipment)

The main engine control stand should be equipped with communication system equipment which are microphoned to communicate to the control and instructor rooms with speaker systems, speaker to sound messages from the control and instructor rooms to all persons in the engine-room.

(Illumination system equipment)

The illumination system equipment consists of room and emergency lightings which are controlled by simulated conditions of the propulsion plant.

(CCTV system equipment)

Two or three cameras of CCTV system are to be installed at suitable positions so that trainees and instructors in the briefing, control and instructor rooms can observe performances being made by other trainees in the engine-room.

Outline of control room installations

(Main console)

The main console is a desk front type console equipped with main engine remote and automatic control panel, monitoring (Data logger) system and main auxiliary machinery control panel and others

(Main Switch Board: MSB)

The main switch board is dead front type panel equipped with recommended panels.

(Communication system equipment)

Microphone and speaker systems

(Sound system equipment)

A speaker of the sound system plays simulated control room sounds caused by operation of the propulsion plant.

(Illumination system equipment)

The illumination system equipment consists of room and emergency lightings which are controlled by simulated conditions of the propulsion plant.

(CCTV system equipment)

Two or three cameras of CCTV system are to be installed at suitable positions so that trainees and instructors in the briefing and instructor rooms can observe performances being made by other trainees in the control room.

Outline of instructor room installations

(Instructor console)

The instructor console is a desk front type console equipped with simulator control equipment, communication system equipment, CCTV system equipment.

(Simulator control equipment)

Simulator control equipment controls various functions of the simulator consisting of the dedicated key board, monitor display and control unit.

(Communication system equipment)

Microphone and speaker systems

(CCTV system equipment)

Two monitor displays with control unit are to be installed on the instructor console so that instructors in the instructor room can observe performances being made by trainees in the engine and control rooms.

Outline of briefing room installations

(Instructor desk)

The instructor desk is a desk front console equipped with equipment consisting of monitor display and control unit available to show displays of monitoring (data logger) system of the simulator and video pictures of CCTV system on the screen.

(Trainee desk)

The trainee desk should be available for 10 to 15 trainees with enough space for writing.

(Overhead projector and screen)

The screen should be large enough for 10 to 15 trainees to clearly watch displays.

Guidance on the implementation of IMO model courses

Contents

Part 1: Preparation

1 Introduction

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

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

2 General considerations

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

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

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

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

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

3 Specific considerations

3.1 *Scope of course*

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

3.2 *Course objective*

.**1** The course objective, as stated in the course material, should be very carefully considered so that its meaning is fully understood. Does the course objective require expansion to encompass any additional task that national or local requirements will impose upon those who successfully complete the course? Conversely, are there elements included which are not validated by national industry requirements?

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

3.3 *Entry standards*

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

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

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

3.4 *Course certificate, diploma or document*

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

3.5 *Course intake limitations*

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

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

3.6 *Staff requirements*

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

.2 Such a person is often termed a "course coordinator" or "course director". Other staff, such as lecturers, instructors, laboratory technicians, workshop instructors, etc., will be needed to implement the course effectively. Staff involved in presenting the course will need to be properly briefed about the course work they will be dealing with, and a system must be set up for checking the material they may be required to prepare. To do this, it will be essential to make a thorough study of the syllabus and apportion the parts of the course work according to the abilities of the staff called upon to present the work.

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

3.7 *Teaching facilities and equipment*

.1 *Rooms and other services*

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

.2 *Equipment*

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

– blackboards and writing materials

– apparatus in laboratories for any associated demonstrations and experiments

– machinery and related equipment in workshops
– equipment and materials in other spaces (e.g. for demonstrating firefighting, personal survival, etc.)

3.8 *Teaching aids*

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

3.9 *Audiovisual aids*

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

.**1** *Overhead projectors*

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

.**2** *Slide projectors*

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

.**3** *Cine projector*

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

.**4** *Video equipment*

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

.**5** *Computer equipment*

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

.**6** *General note*

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

3.10 *IMO references*

The content of the course, and therefore its standard, reflects the requirements of all the relevant IMO international conventions and the provisions of other instruments as indicated in the model course. The relevant publications can be obtained from the Publication Service of IMO, and should be available, at least to

those involved in presenting the course, if the indicated extracts are not included in a compendium supplied with the course.

3.11 *Textbooks*

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

3.12 *Bibliography*

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

3.13 *Timetable*

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

Part 2: Notes on teaching technique

1 Preparation

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

1.2 Read and study thoroughly all the syllabus elements.

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

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

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

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

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

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

2 Delivery

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

2.2 Talk clearly and sufficiently loudly to reach everyone.

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

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

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

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

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

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

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

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

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

Part 3: Curriculum development

1 Curriculum

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

2 Course content

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

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

3 Job analysis

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

4 Course plan

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

5 Syllabus

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

6 Syllabus content

The material contained in a syllabus is not static; technology is continuously undergoing change and there must therefore be a means for reviewing course material in order to eliminate what is redundant and introduce new material reflecting current practice. As defined above, a syllabus can be thought of as a list and, traditionally, there have always been an "examination syllabus" and a "teaching syllabus"; these indicate, respectively, the subject matter contained in an examination paper, and the subject matter a teacher is to use in preparing lessons or lectures.

7 Training outcomes

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

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

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

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

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

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

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

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

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

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

8 Assessment

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

Annex A1 – Preparation checklist

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

Annex A1 – Preparation checklist *(continued)*

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

Annex A2 – Example of a model course syllabus in a subject area

Subject area: Ship construction

Prerequisite: Have a broad understanding of shipyard practice

General aims: Have knowledge of materials used in shipbuilding, specification of shipbuilding steel and process of approval

Textbooks: No specific textbook has been used to construct the syllabus, but the instructor would be assisted in preparation of lecture notes by referring to suitable books on ship construction, such as *Ship Construction* by Eyres (T12) and *Merchant Ship Construction* by Taylor (T58)

Course outline				
Knowledge, understanding and proficiency			**Total hours for each topic**	**Total hours for each subject area of Required performance**
Competence :				
3.1	Control trim, stability and stress			
3.1.1	Fundamental principles of ship construction, trim and stability			
	.1	Shipbuilding materials	3	
	.2	Welding	3	
	.3	Bulkheads	4	
	.4	Watertight and weathertight doors	3	
	.5	Corrosion and its prevention	4	
	.6	Surveys and dry-docking	2	
	.7	Stability	83	102

Part C3: Detailed Teaching Syllabus

Introduction

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

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

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

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

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

will provide valuable information to instructors.

Explanation of information contained in the syllabus tables

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

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

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

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

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

3.1.1.1 *Shipbuilding materials*

3.1.1.2 *Welding*

3.1.1.3 *Bulkheads*

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

teaching process. For example, under the topic 3.1.1.1, to meet the Required performance, the trainee should be able to:

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

and so on.

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

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

FUNCTION 3: CONTROLLING THE OPERATION OF THE SHIP AND CARE FOR PERSONS ON BOARD AT THE MANAGEMENT LEVEL		
COMPETENCE 3.1	**Control trim, stability and stress**	**IMO reference**
Competence :		
3.1.1 FUNDAMENTAL PRINCIPLES OF SHIP CONSTRUCTION, TRIM AND STABILITY		
Textbooks: T11, T12, T35, T58, T69		
Teaching aids: A1, A4, V5, V6, V7		
Required performance:		
1.1 Shipbuilding materials (3 hours)		
– states that steels are alloys of iron, with properties dependent upon the type and amounts of alloying materials used		R1
– states that the specifications of shipbuilding steels are laid down by classification societies		
– states that shipbuilding steel is tested and graded by classification surveyors, who stamp it with approved marks		
– explains that mild steel, graded A – E, is used for most parts of the ship		
– states why higher tensile steel may be used in areas of high stress, such as the sheer strake		
– explains that the use of higher tensile steel in place of mild steel results in saving of weight for the same strength		
– explains what is meant by: – tensile strength – ductility – hardness – toughness		
– defines strain as extension divided by original length		
– sketches a stress-strain curve for mild steel		
– explains – yield point – ultimate tensile stress – modulus of elasticity		
– explains that toughness is related to the tendency to brittle fracture		
– explains that stress fracture may be initiated by a small crack or notch in a plate		
– states that cold conditions increase the chances of brittle fracture		
– states why mild steel is unsuitable for the very low temperatures involved in the containment of liquefied gases		
– lists examples where castings or forgings are used in ship construction		
– explains the advantages of the use of aluminium alloys in the construction of superstructures		
– states that aluminium alloys are tested and graded by classification society surveyors		
– explains how strength is preserved in aluminium superstructures in the event of fire		
– describes the special precautions against corrosion that are needed where aluminium alloy is connected to steelwork		

Annex A3 – Example of a lesson plan for annex A2

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

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

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