MODEL COURSE 2.07

ENGINE-ROOM SIMULATOR

2002 Edition

ELECTRONIC EDITION

INTERNATIONAL MARITIME ORGANIZATION

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Ass. Prof. Per-Einar Rosenhave
Eik, 22 February 2001

A43205

CONTENTS

Foreword

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

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

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

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

W.A. O'NEIL
Secretary-General

Introduction

■ Purpose of the model courses

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

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

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

■ Use of the model course

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

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

Adjustment of the course objectives have to be made, if the student is to undertake duties which differ from the course objectives.

■ Lesson plans

The instructor should draw up lesson plans based on the detailed syllabus. He/She must pay due attention to the student's background and previous knowledge when adjusting the course content to suit the student intake and any revision of the course objectives. The detailed syllabus contains some references to textbooks or teaching material, which can be used in the course. In most model courses an example of a lesson plan is included in the instructor manual, but in this course the exercise scenarios that are supplied will serve this purpose. The scenarios can be found in the appendix.

■ Presentation

The presentation of concepts and methodologies must be repeated in various ways until the student has met each specific learning objective. The syllabus is laid out in learning objective format and each objective specifies what kind of knowledge, understanding and proficiency the student shall have acquired after the exercise.

■ Evaluation or assessment of trainee progress

The nature of this course will involve all the students and the instructors in an ongoing process of individual and group evaluation. However, formal evaluation is a very important aspect of all simulator training because it provides the means to determine whether or not the student has 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 therefore be emphasized and conducted as soon as the student is ready and always at the end of the course. More about evaluation and assessment on simulators can be found on page 20 onwards.

■ Implementation

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

- teaching facilities
- equipment
- textbooks, technical papers; and
- other reference material.

Properly qualified and trained instructors, support staff, observers and assessors are absolutely vital in order to achieve a good end result. The STCW95 Regulation I/6, (p. 27), deals with provisions regarding training and assessment. Further the regulation refers to Section A-I/6 of the Code (pp. 14–15). Selected text from Section A-I/6 is cited below:

Start of Citation

Training and assessment

1 Each Party shall ensure that all training and assessment of seafarers for certification under the Convention is:

.1 structured in accordance with written programmes, including such methods and media of delivery, procedures, and course material as are necessary to achieve the prescribed standard of competence; and

.2 conducted, monitored, evaluated and supported by persons qualified in accordance with paragraphs 4, 5 and 6.

Qualifications of instructors, supervisors and assessors

2 Each Party shall ensure that instructors, supervisors and assessors are appropriately qualified for the particular types and levels of training or assessment of competence of seafarers either on board or ashore, as required under the Convention, in accordance with the provisions of this section.

In-service training

3 Any person conducting in-service training of a seafarer, either on board or ashore, which is intended to be used in qualifying for certification under the Convention, shall:

.1 have an appreciation of the training programme and an understanding of the specific training objectives for the particular type of training being conducted

.2 be qualified in the task for which training is being conducted; and

.3 if conducting training using a simulator:

.3.1 have received appropriate guidance in instructional techniques involving the use of simulators, and

.3.2 have gained practical operational experience on the particular type of simulator being used.

4 Any person responsible for the supervision of in-service training of a seafarer intended to be used in qualifying for certification under the Convention shall have a full understanding of the training programme and the specific objectives for each type of training being conducted.

Assessment of competence

5 Any person conducting in-service assessment of competence of a seafarer, either on board or ashore, which is intended to be used in qualifying for certification under the Convention, shall:

.1 have an appropriate level of knowledge and understanding of the competence to be assessed

.2 be qualified in the task for which the assessment is being made

.3 have received appropriate guidance in assessment methods and practice

.4 have gained practical assessment experience; and

.5 if conducting assessment involving the use of simulators, have gained practical assessment experience on the particular type of simulator under the supervision and to the satisfaction of an experienced assessor.

Training and assessment within an institution

6 Each Party which recognizes a course of training, a training institution, or a qualification granted by a training institution, as part of its requirements for the issue of a certificate required under the Convention, shall ensure that the qualifications and experience of instructors and assessors are covered in the application of the quality

standard provisions of section A-I/8. Such qualification, experience and application of quality standards shall incorporate appropriate training in instructional techniques, and training and assessment methods and practice, and comply with all applicable requirements of paragraphs 4 to 6.

End of Citation.

IMO has produced a booklet[1] entitled "Guidance on the Implementation of IMO Model Courses", which may be of assistance when implementing this model course.

1 The booklet is included as an attachment to this course.

Part A

A.1 Course Framework

A.1.1 Scope

The course is essentially a practical one, consisting of a series of exercises structured around the operation of a ship's machinery installation and carried out in conjunction with an engine-room simulator.

The exercises are supervised by an instructor and will, initially, allow the student to become familiar with the instrumentation and controls used in the engine-rooms of modern merchant ships. The student shall become skilled in the scanning of instrument displays when assessing the normal operational conditions of an engineering plant.

The exercises increase in complexity as the course progresses, as the student works through and becomes familiar with the procedures used for starting up auxiliary and propulsion plants, setting the normal operation condition and keeping an engine-room watch. The final exercises deal with watchkeeping and the procedures and techniques needed for the location and trouble-shooting of faults, diagnosis and malfunctions that can occur in an operational plant.

Each exercise should be preceded by a briefing session and followed up by a group debrief, which will analyse the actions and decisions of the student.

During the series of exercises each student will assume different roles in the engineering watchkeeping team, and shall have more than one opportunity to take on the part of the engineer in charge of the watch.

A.1.2 Objective

To provide knowledge and skills to operate, supervise and monitor the safe operation and control of a ship's machinery installation in accordance with provisions of Section A-III/1, A-VIII/2 and B-VIII/2 of the STCW95 Code.

In particular, the student will gain:

- familiarization with the use of instrumentation and controls used in the engine-rooms of modern merchant ships
- awareness of the need for proper pre-planning, the use of checklists and of the timescales involved in start up procedures
- understanding and awareness of correct watchkeeping procedures
- understanding of the way in which machinery units are interdependent
- experience in identifying operational problems and trouble-shooting them
- the ability to make decisions, which promote the safety and efficiency of an operational plant.

A.1.3 Entry standards

Entry to the course is open to students with basic background and knowledge and to marine engineers who wish to improve their knowledge and understanding of the operation and control of the machinery installation of a modern merchant ship.

The student's watchkeeping experience at sea in the engine-room of a merchant ship will be enhanced and consolidated by the structured activities undertaken in this course.

A.1.4 Course diploma

On successful completion of this course, a document should be issued certifying that the holder has successfully completed a course of training on an engine-room simulator.

A.1.5 Course intake limitations

The target activity will regulate the number of students who can use the simulator at any given time. Some activities may only allow three or four students to be directly involved in a simulator exercise simultaneously. Student groups must therefore be sub-divided and activities be phased so that all students can receive the same period of training on the simulator.

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

A.1.6 Staff requirements

Both the assessor and instructor in charge should be qualified according to STCW95, Section A-I/6. At least one additional instructor is required to operate the course effectively, preferably with qualifications and experience similar to those of the instructor in charge. An observer, who can provide support as directed by the instructor in charge, is also a desirable addition to the staff. The observer's main task is to observe the student in action and gather information about his/her activities and attitudes shown for later presentation during the debrief session. The observer shall not actively intervene.

A.1.7 Teaching facilities and equipment

The simulator system should incorporate basic units found in the engine-room of a modern merchant ship:

- a slow-speed main-propulsion turbocharged diesel engine
- a steam boiler
- a waste-heat steam boiler
- a turbo generator
- auxiliary machinery and equipment needed to support the main engine and operate the engine-room and ship.

The simulator complex should be divided into "engine-room", "control room" and "instructor unit".

The "engine-room" should contain the main propulsion unit, auxiliary units with associated equipment being suitably positioned and identified with local controls and related instrumentation adjacent to them. Realistic sounds associated with an engine-room add to the realism of the exercises.

The "control room" should contain all the instrumentation and controls needed to operate the plant, including a switchboard for the electrical system.

The "instructor unit" should allow observation of the students as operational commands are given or faults introduced. It may also be used as the bridge control point.

Separate rooms for briefing and debriefing should be available. These rooms should be equipped with appropriate teaching aids.

An example of a simulator installation layout is included in the Instructor Manual on page 36.

A.1.8 Teaching aids (A)

A1 Instructor Manual and its Appendixes.

A2 Videos

V1 EFFICIENT OPERATION OF MARINE DIESEL ENGINES (Code No.693)
V2 PERSONAL SAFETY IN THE ENGINE-ROOM (Code No. 556)

Available from: Videotel Marine International Ltd.
84 Newman Street
London W1T 3EU, UK
Tel: +44 (0) 207 299 1800
Fax: +44 (0) 207 299 1818
e-mail: mail@videotel.co.uk
web site: www.videotel.co.uk

A3 PC-based aids

P1 ENGINEERING CBT

Available from: PC Maritime Ltd
1 Brunswick Road
Plymouth, PL4 0NP, UK
Tel: +44 (0) 1752 254205
Fax: +44 (0) 1752 253599
e-mail: commercial.sales@pcmaritime.co.uk
web site: www.pcmaritime.co.uk

P2 BASIC STEAM TURBINE PLANT OPERATION (CD-ROM) (Code No.817)

Available from: Videotel Marine International Ltd. (as above)

Audio-visual examples listed above may be replaced by other similar audio-visual material at the discretion of the training provider and administration.

A.1.9 IMO references (R)

R1 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, STCW95, IMO Sales number: IMO-938E, ISBN 92-801-6091-5

A.1.10 Textbooks

No specific textbooks have been used in structuring this course.

Internet website references

In an attempt to learn from previous accidents and incidents further useful material to support the preparation of lessons, teaching and assessment may be found amongst the following websites:

W1 Safety Digests of the Marine Accident Investigation Branch are available at www.maib.dtlr.gov.uk
The site has useful links to many other similar data and reports

W2 The Nautical Institute site carries an extensive section under its Marine Accident Investigation Scheme at www.nautinst.org/marineac.htm

A.1.11 Bibliography (B)

No material has been specifically identified for supplementary reading, but a large number of textbooks on marine diesel engines and marine auxiliary plants are available and provide suitable reference material.

Four such books are:

B1 Taylor D. A., *Introduction to Marine Engineering*, Revised Second Edition, Butterworth-Heinemann, 1999. ISBN 0 7506 2530 9

B2 Doug Woodyard (Editor), *Pounder's Marine Diesel Engines*, Seventh Edition, Butterworth-Heinemann, 1998. ISBN 0 7506 2583 X

B3 McGeorge H. D., *Marine Auxiliary Machinery*, Seventh Edition, Butterworth-Heinemann, 1995. ISBN 0 7506 4398 6

B4 Instruction Manual for the main propulsion plant being simulated

Part B

Course Outline

Subject Area	Hours
Course Introduction	1
Familiarization Plant arrangements Instrumentation Controls Operational procedures	6
Operation General procedures Auxiliary units and systems Diesel generator Steam boiler Steam turbo generator Steam cargo turbine Main-propulsion diesel engine	13
Main engine operation	10
Trouble-shooting	20
Maintain a safe engineering watch Duties associated with taking over and accepting a watch Routine duties undertaken during a watch Duties associated with handing over of a watch	30
TOTAL	**80**

Note: Teaching staff should note that the sequence and length of time allocated to each subject are suggestions only. These factors may be adapted by lecturers to suit individual groups of students according to their experience and ability as well as equipment and staff available for training. Remember that the STCW95 Convention **does not focus upon duration but on skills**. Knowledge, understanding and proficiency are the terms used by the Convention. A skill is more easily achieved by active participation during the exercises in combination with an inquisitive mind and hard work. A student claiming that he/she is ready for the final subject test should be allowed to do the test even though the student has not completed the subject study. If the student fails, this may prove to be a valuable personal experience. If he/she already has the required knowledge and passes the test, the student will benefit from the fact that he/she may use his/her resources within other areas.

Part C

Detailed Teaching Syllabus

The detailed teaching syllabus has been written in learning objective format. It describes what the student must do to demonstrate that the specified knowledge or skill has been achieved.

All objectives are understood to be prefixed by the words, "The expected learning outcome is that the student shall......................................"

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 when preparing and presenting course material. The material listed in the course framework has been used to structure the detailed teaching syllabus:

- Teaching aids (indicated by A),
- IMO references (indicated by R) and
- Bibliography (indicated by B).

The abbreviations used are:

- App. appendix
- Ex. exercise
- p., pp. page, pages
- Para. paragraph
- Reg. regulation
- Sect. section
- Ta. table

The following is an example of the use of references:

"R1 – p. 39, Reg. III/1" refers to page 39 of Regulation III/1 of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, STCW95.

Note: Throughout the course, safe working practices are to be clearly defined and emphasized with reference to current international requirements and regulations. It is expected that the national institution implementing the course will insert references to national requirements and regulations as necessary.

Knowledge, understanding and proficiency (Learning Objectives)	IMO/STCW Reference	Textbooks, Bibliography	Teaching Aid
1 Course introduction (1 hour)			
The instructor shall:			
1.1 explain the scope and objectives of the course			
1.2 explain the relationship of this course to other courses within the subject area			
1.3 explain that use is made during the course of individual and group activities to develop skills and attitudes in preparing for future service			
1.4 explain the need to supplement what is learned with practical experience, especially for lower grade certificates			
1.5 explain what is required in order to reach each learning objective and pass each evaluation exercise			
2 Familiarization (6 hours)			
2.1 Plant arrangements		B1	A1 pp. 23–82
2.1.1 list the machinery and associated systems and equipment which form the simulated plant, such as: ● tanks ● valves ● pipe systems ● pumps ● heat exchangers ● oil treatment plant ● line filters ● electric generators ● steam generators ● main propulsion unit ● local controls ● distant controls	R1- Ta. A-III/1, p. 75 Operate main and auxiliary machinery and associated control systems R1- Ta. A-III/1, p. 76 Operate alternators, generators and control systems		
2.1.2 describe how the machinery and associated systems and equipment are arranged and linked together to form the plant, and compile a block diagram illustrating this			
2.1.3 describe the relationship between the block diagram and the plant mimic diagram			
2.2 Instrumentation			
2.2.1 describe and list the instrumentation used in the simulated plant to measure and indicate: ● pressure ● temperature ● fluid level ● volume/mass (quantity) ● flow rate ● speed of rotation ● torque/power ● voltage ● current			

Knowledge, understanding and proficiency (Learning Objectives)	IMO/STCW Reference	Textbooks, Bibliography	Teaching Aid
• CO_2 content (of exhaust gases) • pressure/volume in the engine cylinder ("indicator diagram")	R1- Ta. A-III/1, pp. 74–75 Maintain a safe engineering watch		
2.2.2 describe the alarms that are used to indicate malfunctions and faults			
2.2.3 use the recorder to obtain a cylinder P/V diagram ("indicator card") with the engine control at a specified power setting			
2.2.4 be able to calculate: • power output to shaft • cylinder mean effective pressure • power produced in cylinders • engine's mechanical efficiency • specific fuel consumption in [kg/kWhour]	R1- Ta. A-III/1, p. 75 Operate main and auxiliary machinery and associated control systems		
2.2.5 use the thermal data obtained to establish a heat balance			
2.3 Controls	R1- Ta. A-III/1, p. 76 Operate, alternators, generators and control systems		
2.3.1 state that the machinery units forming the plant can be controlled from: • a position adjacent to the units in the engine-room (local control) • a console in the control room (central control) • the bridge (bridge control)			
2.3.2 state that operation of the main propulsion unit can be monitored from the instructor room, and faults introduced as required by the training programme			
2.3.3 state that the instructor room can also be used to issue commands for main engine power output to the control centre or to control the power output (bridge control)			
2.3.4 demonstrate the use of controls from each location			
2.4 Operational procedures			
2.4.1 state that safe practices must always be used when preparing machinery units and associated systems for start up and operation			
2.4.2 discuss the safe practices to be used for: • opening and closing valves • starting and running pumps • operating water-circulation systems • admitting steam into a steam system • firing up an oil-fired boiler • filling oil tanks • operating centrifuges • keeping bilges empty • disposing of oil wastes	R1- Ta. A-III/1, pp. 74–75 Maintain a safe engineering watch		
2.4.3 state that as far as practicable a check-list should be used for all machinery units and systems when:			

Knowledge, understanding and proficiency (Learning Objectives)	IMO/STCW Reference	Textbooks, Bibliography	Teaching Aid
● preparing for use ● starting up ● entering normal operating mode 2.4.4 compile a check-list for the preparation, start up and operation of an auxiliary machinery unit or system 2.4.5 state the special requirements for connecting an electric generator into the electrical system in the terms of:	R1- Ta. A-III/1, p. 75 Operate main and auxiliary machinery and associated control systems		
● speed ● voltage ● frequency ● synchronization 2.4.6 demonstrate the use of the simulated plant, a check-list and the procedures for: ● the opening and closing of valves in a system ● the circulation of seawater ● firing up the steam boiler ● operating a fuel oil centrifuge ● pumping out bilges	R1- Ta. A-III/1, p. 76 Operate alternators, generators and control systems		
3 Operation (13 hours) 3.1 General procedures 3.1.1 observe and apply safe practices in all exercises 3.1.2 use check-lists in all exercises 3.1.3 maintain a log of procedures and normal operating conditions for each exercise 3.2 Auxiliary units and systems 3.2.1 prepare, start up, and put into the normal operating mode:	R1- Ta. A-III/1, pp. 74–75 Maintain a safe engineering watch	B1	A1 pp. 23–82
● the seawater circulating system ● the freshwater circulating system ● the compressed air system ● the fuel centrifuge 3.3 Diesel generator 3.3.1 prepare, start up, and run the diesel electric generator 3.3.2 couple, synchronize and load sheer	R1- Ta. A-III/1, p. 76 Operate pumping systems and associated control systems		
3.4 Steam boiler 3.4.1 prepare and raise steam to normal working pressure 3.4.2 put the steam boiler on line	R1- Ta. A-III/1, p. 76 Operate alternators, generators and control systems		App. – p. 50
3.5 Steam turbo generator 3.5.1 prepare, start up and run the steam turbo generator 3.5.2 connect the turbo generator to the main electrical system, applying control on:			App. – p. 55

Knowledge, understanding and proficiency (Learning Objectives)	IMO/STCW Reference	Textbooks, Bibliography	Teaching Aid
• voltage • frequency • synchronization			
3.5.3 demonstrate load sharing between diesel- and turbo generators			
3.6 Steam cargo turbine 3.6.1 prepare, start and run the steam cargo turbine 3.6.2 operate the pump to discharge cargo 3.7 Main-propulsion diesel engine 3.7.1 apply preparation procedures, including:	R1- Ta. A-III/1, p. 75 Operate main and auxiliary machinery and associated control systems		
• checking the seawater circulation through heat exchangers			App. – p. 59
• checking the freshwater circulation through engine and heat exchangers • checking the lubricating-oil circulation through engine and heat exchangers			
• confirming that the engine turning gear is disconnected			App. – p. 64
• checking the fuel oil circulation through heaters to injection pump inlets • confirming that compressed air is available for starting • confirming that the engine cylinder lubrication is functioning • turning the engine with starting air for one revolution with indicator cocks open			
3.7.2 apply preparation procedures, including: • confirming that all indicator cocks are closed • confirming fuel oil circulation • confirming of bridge order for engine movement • application of starting air for 3-4 revolutions • moving fuel control to required speed position			
3.7.3 establish normal running mode and observe operating conditions, including: • temperatures of lubricating oil and cooling water • temperatures of exhaust gas from each cylinder • temperatures of engine exhaust gas at inlet and exit from turbo charger • engine speed and power output • maintaining a check on fuel oil supply (service tank) • maintaining a check on fuel viscosity and temperature • applying changes of engine speed and power as directed by the bridge and note changes in operating conditions	R1- Ta. A-III/1, p. 75 Operate main and auxiliary machinery and associated control systems		
4 Main engine operation (10 hours) 4.1 prepare, start and run the main propulsion unit and associated systems 4.2 set the main propulsion unit controls to maximum full ahead sea power as directed from bridge control, or	R1- Ta. A-III/1, p. 75 Operate main and auxiliary machinery and associated control systems	B1, B4	A1 pp. 23–82

Knowledge, understanding and proficiency (Learning Objectives)	IMO/STCW Reference	Textbooks, Bibliography	Teaching Aid
4.3 apply manoeuvring procedures and use the controls to obtain required power outputs			
5 Trouble-shooting (20 hours)			
5.1 Locate and apply remedial action for the following malfunctions or faults:		B2, B4	A1 pp. 23–82
1. Fuel injection timing (early/late) 2. Worn piston rings in one cylinder 3. Fire in the scavenge air space 4. Fouled turbo charger (exhaust side) 5. Fouled turbo charger (air side) 6. Fouled turbo charger air filters 7. Fouled scavenge air cooler/ports 8. Blackout 9. Clogged auxiliary machinery oil filters 10. Overheated main bearing 11. Fouled heat exchanger surfaces 12. Lubricating-oil circulation pump failure 13. Flooded bilge sump 14. Bridge control failure	R1- Ta. A-III/1, p. 75 Operate main and auxiliary machinery and associated control systems		
6 Maintain a safe engineering watch (30 hours)			
6.1 Duties associated with taking over and accepting a watch		B4	A1 pp. 23–82
6.1.1 enter the machinery space 15 minutes before the change of watch			
6.1.2 inspect all operating units, noting operational conditions and any deviations from the normal mode			
6.1.3 check steam boiler water level 6.1.4 inspect bilge and under floor spaces 6.1.5 note engine telegraph instruction and check engine control position and related speed	R1- Ta. A-III/1, pp. 74–75 Maintain a safe engineering watch		
6.1.6 check quantities and levels in engine-room service tanks			
6.1.7 ensure that the relieving watch members are capable of performing their duties			
6.1.8 examine the engine-room log			
6.1.9 receive an oral report from the engineer officer in charge of the watch for the period of watchkeeping now completed			
6.1.10 enter in the engine-room log any abnormal operational conditions noted during inspection			
6.1.11 accept, if satisfied, responsibility for the machinery space operation			
6.1.12 maintain the log book			

Knowledge, understanding and proficiency (Learning Objectives)	IMO/STCW Reference	Textbooks, Bibliography	Teaching Aid
6.2 Routine duties undertaken during a watch			
6.2.1 at regular intervals: inspect all operational machinery, noting operating conditions and correcting any deviations from the normal mode	R1- Sect. A-VIII/2, Pt. 3-2 "Principles to be observed in keeping an engineering watch", pp. 150–155		
6.2.2 operate the oil centrifuges as necessary			
6.2.3 check the steam production plant periodically and adjust as necessary: ● CO_2 content of exhaust gas ● exhaust gas inlet and outlet temperatures if operating on waste heat ● the seawater temperature periodically and adjust the heat exchanger control valves in order to maintain the engine cooling water and lubricating oil within the correct operational range			
6.2.4 check that the main engine cylinder lubrication is within the correct range			
6.2.5 check the electrical system voltage and load and, if two or more generators are operating, that the load is properly balanced			
6.2.6 check the pressure in compressed air storage tanks and top up			
6.2.7 inspect bilge and under floor spaces and clear them using the bilge pump and complying with any anti-pollution regulations	Pt. 4, "Watchkeeping in port", p. 158, Pt. 4-2, pp. 159–160 Pt. 4-4, pp. 161–162		
6.2.8 state that when serving on an actual ship the watchkeeping routines and duties would also include responsibilities related to: ● steering gear ● propeller shaft casing and bearings ● domestic freshwater ● water for sanitary use			
6.2.9 maintain the machinery space log book and know the significance of the readings taken			
6.3 Duties associated with handing over of a watch			
6.3.1 prepare an oral report to the relieving engineer officer in charge of the watch			
6.3.2 not hand over the watch to the relieving officer if there is a reason to believe that the latter is not capable of carrying out the watchkeeping duties			
6.3.3 maintain the machinery space log book			

Part D: Instructor Manual

D.1 General

This manual reflects the views of the course designer on methodology and organization and what he considers relevant and important in the light of his experience as an instructor. Although the guidance given should be of value initially, the course instructor should work out his own methods and ideas, refine and develop what is successful, and discard ideas and methods, which are unsuitable.

D.1.1 Briefing and debriefing sessions

Practical exercises constitute the main training components in the course. They are carried out under supervision on the simulated engineering plant. 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 student shall be given a clear and concise description of what is required in order to pass the test. Provision has been made for this in the course structure.

The instructor should use practical examples involving real shipboard equipment and systems, referring to diagrams, layout plans and technical drawings, photographs, and 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. Then explain in detail those aspects that are felt to be important. Finally let the student summarize the exercise, using key words and phrases.

There should always be a final discussion to make sure that everyone understands the role he/she will play, as well as what is to be done and achieved by the exercise.

An overhead projector is a useful teaching aid during the briefing. Copies of the transparencies used can be distributed to the students for reference purposes during the exercise.

D.1.2 Simulator exercises

The engineering plant and systems may differ widely in their layout from ship to ship. Students with some previous experience may have different and varied knowledge and experience. Therefore it is important to use the briefing period to explain precisely which particular machinery units and systems are being simulated in the exercise as well as their function, how they interact with each other and the role to be performed by each student during the exercise.

Before the exercise the students 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.

Safety is a fundamental aspect of machinery operation. Safety should be stressed during the briefing, throughout the exercise and the following debrief session. The use of pre-planning, checklists and safe working procedures should be stressed. Before the students are allowed to start any simulation, they shall have prepared themselves by pre-planning, working out checklists and safe working procedures for the exercise in question.

Often, such as during stand-by, there is more than one engineer on duty. When simulating this situation, one may assume that the chief engineer, a first engineer and an assistant are on duty.

During such an exercise, one student should assume the role of engineer in charge, with the responsibility of ensuring that the requirements and activities of the exercise are properly carried out. The other students act as his assistants. If the exercise is a lengthy one, each student in turn may undertake the role of team leader.

D.1.3 Preparing and conducting exercises

When new exercises are developed, or the ones supplied in the course are modified, these should not be so complicated that the students will have difficulties in carrying out their tasks and duties.

An exercise should start with simple activities, in which students can use simple elements such as valves, pumps, fluid systems or tanks. Step by step they should 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 and faulty machinery operation. It is important for the students to achieve a satisfactory level of competence under normal conditions before proceeding to exercises in which faults have been introduced.

The exercises should be made to reflect realistic situations in order to provide the students with the impression of actually being in an engine-room or control centre aboard ship. For this reason, the simulator's sound system should be activated. Likewise, external activities, such as ongoing maintenance and support, accommodation systems, deck requirements and safety aspects should be included in the exercise.

D.1.4 Exercise scenarios

Simulator scenarios should be designed for the specific simulator that is available. The following four main scenarios should be developed:

- Familiarization
- Operation
- Watchkeeping
- Trouble-shooting

The familiarization scenario shall familiarize the students with the units and systems being simulated and provide some hands-on experience with the simulator.

The operational scenario shall provide experience with start up and running procedures, including the main propulsion plant and the electrical system.

The watchkeeping scenario shall be based on the STCW95 Convention Regulation A-III/1 including Section B-VIII/2 relating to watchkeeping procedures and the duties and responsibilities of the engineer in charge of the watch.

The trouble-shooting scenario shall be designed to provide experience in identifying malfunctions and applying proper remedial procedures. Most simulator designs can introduce a very large number of malfunctions. Beware not to introduce too many malfunctions at the same time. Start with only one or two, ending up with three or four simultaneous malfunctions. The number of simultaneous malfunctions in each exercise is less important. Instead the scenario constructor should focus on malfunctions that will appear as a consequence of poor ability to identify problems and situations in advance.

Further details regarding the content of the scenarios are provided in the Appendixes on page 39.

D.1.5 Monitoring of exercises

During an exercise the instructor is responsible for monitoring and taking notes for use during the debrief session. To assist him/her a second instructor or an observer, which could be an experienced student, should be available. The observer's task will vary according to the students' abilities and competence. He/she will be involved in the briefing and debriefing activities, and will also, when the students become more experienced, take part in assisting and guiding them in the use of the equipment. The observer should follow their work closely, but should avoid interrupting them and save observations for the debrief session. The use of the simulator event log may be of assistance during the whole operation.

D.1.6 Debriefing

The time spent on debriefing should occupy between 15 and 20 per cent of the total time used for simulator exercises. Various facilities may be used in debriefing, such as exercise playback, multi-channel recorder and data-logging equipment.

The debriefer should refer to the notes taken during the exercise, raise important points and lead the discussion among the students. They should be encouraged to examine their performances critically. The debriefer should not impose his own views, but ensure that the students have the right attitude and are encouraged to use safe and correct procedures at all times.

D.1.7 Evaluation or assessment of trainee progress

Introduction

Formal evaluation is an important aspect of all simulator training. It provides the means to determine the student's abilities in Engine-Room Watchkeeping and Marine Engineering during normal and emergency situations. Examples of standard assessment and evaluation procedures common to simulator and at-sea training have been developed and can be found on page 24. This is to ensure consistency amongst evaluation staff and to ensure an objective summary of a student's progress. Further, it is vital to keep evaluation of performance on a simulator as objective as possible in order to enhance uniformity and rule out subjective judgments. A team of three persons: the instructor running the simulator, an observer and an assessor, should preferably undertake the final evaluation of the student. The assessor should be chosen from outside the institution, ensuring that he/she does not have any close relations to the instructor, the observer or the student.

It is the duty of the assessor to ensure that: (R1-Section A-I/12, p. 23)

Start of citation:

1. performance criteria are identified clearly and explicitly and are valid and available to the candidates
2. assessment criteria are established clearly and are explicit to ensure reliability and uniformity of assessment and to optimize objective measurement and evaluation, so that subjective judgments are kept to a minimum
3. candidates are briefed clearly on the tasks and /or skills to be assessed and on the tasks and performance criteria by which their competency will be determined
4. assessment of performance takes into account normal operating procedures and any behavioural interaction with other candidates on the simulator or simulator staff
5. scoring or grading methods to assess performance are used with caution until they have been validated; and
6. the prime criterion is that the candidate demonstrates the ability to carry out a task safely and effectively to the satisfaction of the assessor.

End of citation.

During the evaluation, the student should have access to diagrams, procedures, manuals and other documentation, which normally should be found in a well-equipped control room of any ship.

Note: The main purpose of an evaluation **should not be** to check if the student is able to memorize specific procedures or potentially dangerous situations, **but to check** if the student has acquired the necessary knowledge, understanding and proficiency enabling him/her to operate a complex machinery plant. Indeed, he/she shall also demonstrate, beyond any reasonable doubt, that he/she is confident about his/her performance and treats all situations showing a sound and conscientious attitude by adhering to procedures, consulting reference literature and even a Senior Engineer Officer if in doubt about how to handle a situation. Too often accidents and loss of lives due to Human Error can be related to the fact that the person in charge did not act upon a warning signal or mistakenly trusted his/her bad memory instead of checking the procedure.

D.1.7.1 Aim

The aim of the Simulator Evaluation Guide is to provide information for students, Instructors and Assessors on evaluation criteria and procedures used in a simulated environment, including use and completion of the evaluation forms contained in the Appendixes.

DISCUSSION

The practical components of marine engineering training are conducted at sea and in a simulator. The simulator phase is completed in two stages: development and evaluation, defined as follows:

Development Stage

This stage allows the instructor to continue instructing students in a practical training environment in order to build on the classroom lessons and earlier simulator practice. Once completed, simulator staff will have a measured estimate, in quantitative and qualitative terms, of the accomplishments of a student at particular tasks for the purpose of feedback to improve learning. The development stage consists of a series of 90-minute events designed to build skills and to increase student confidence. Students should be placed under as many final test conditions as possible, so that they can perform to the required standard. Students are normally required to complete three simulator development training events as Officer of the Watch prior to evaluation. Assessment during the development stage is conducted using the Officer of the Watch form on page 73. In order to provide the student with a trend analysis of performance, development runs will be assessed as either *below*, *meeting* or *above standard*, but do not count towards the final pass/fail result (see supplemental Notes 1 and 2 below).

Evaluation Stage

Evaluation determines whether the standard has been reached for a particular performance objective and assists in determining a student's suitability to challenge the final evaluation goals (practice at sea). In accordance with accepted rules, each student is afforded three opportunities to meet the required standard as an engine watchkeeper acting as Officer of the Watch. Students are required to pass the evaluation without failure to meet the standard.

Note 1: A student may advance to the evaluation stage prior to completing all simulator development events if the assessor finds that the required skill and confidence level has been demonstrated. When this occurs, the student shall be informed that the development period has concluded and subsequent events will be evaluated. Once the evaluation stage begins, a student may not revert to the development phase without the recommendation of a Progress Review Board or a Training Review Board.

Note 2: Every student is to be afforded maximum opportunity to achieve course requirements. If a student has not demonstrated the ability to meet the required standard after three development assessments, and if time and resources permit, the candidate may then be afforded additional practice before entering the evaluation stage.

D.1.8 Assessment during development and evaluation runs

1. During the development stage of simulator training, the Officer of the Watch Form is to be used as a tool to provide feedback on the student's strong and weak points. When the student proceeds to the evaluation stage, the same form is to be used to record whether or not the standard was met, exceeded, or not achieved. All safety factors listed in the Officer of the Watch Form must be achieved in order to meet the standard.
2. Conduct of Evaluation. The student shall be assessed on all factors listed on the appropriate form. Formal evaluation of a student requires successful pass of a watch lasting for two hours. The Officer of the Watch shall be evaluated with respect to Watch Turnover, Execution of the Watch, Preparing for periodic unmanned condition, Trouble-shooting, Attitude and Safety. Assessors shall indicate the quality of the student's performance as either below, meeting or above standard. Students will receive three opportunities to meet the required standard. In the event of below standard performance, the candidate shall receive a Verbal Warning as soon as it becomes apparent that a problem exists. A Formal Caution shall be issued after two failed evaluations. After three failed evaluations the candidate shall be referred to a Training Review Board.

Note: **Definition of Basic Level of Competency:** Wherever the terms *basic* or *basic understanding and competency* are employed, the terms cover a level of proficiency required to perform duties and tasks under supervision. In addition an understanding of definitions and basic concepts relating knowledge to job requirements is expected.

D.1.8.1 Simulator observation and evaluation criteria for plant operation (PO FORM – Appendix page 69)

A. General procedures
The Officer in Charge shall:

1. **Safe practices:** Ensure that the members of the engineering watch are apparently fully capable of performing their duties effectively and observe and always apply safe work practices.
2. **Checklists:** Understand and operate the propulsion- and auxiliary plant status, while using checklists.
3. **Maintaining the log:** The state of completion of the engine-room log shall reflect the work and changes that have been carried out.

B. Auxiliary units and systems
The Officer in Charge shall:

- prepare, start up and engage normal operation mode of:
  - the seawater system
  - the freshwater system
  - the air systems
  - the lubrication oil system
  - the fuel oil system
  - the centrifuges

C. Diesel generators
The Officer in Charge shall prepare, start up and engage normal operation mode of the diesel generators including proper synchronization and load sheering.

D. Steam boiler
The Officer in Charge shall prepare, start up and engage normal operation mode of the steam boiler and its sub systems.

E. Steam turbo generators
The Officer in Charge shall prepare, start up and engage normal operation mode of the steam-driven generators including proper synchronization and load sheering.

F. Steam cargo turbines
The Officer in Charge shall prepare, start up and engage normal operation mode of the steam cargo turbines.

G. The main propulsion unit
The Officer in Charge shall prepare, start up and engage normal operation mode of the main propulsion unit. He/She shall demonstrate thorough understanding of the different operational modes, such as Bridge, Local and Emergency Control, and react properly to Emergency Run, Shut and Slow down of the main engine.

H. Attitude
The Officer of the Watch shall demonstrate:

1. confidence, including the ability to learn from past mistakes and accept constructive criticism
2. initiative, including the ability to identify problems and situations in advance and subsequently develop and implement solutions in a timely manner
3. flexibility, including the ability to react to unexpected changes; and
4. intensity (sense of urgency) including the ability to maintain control under stress and demonstrate an understanding of the degree of risk posed by various breakdowns or abnormal situations during navigation, ship handling and collision avoidance scenarios.

I. Safety

Without hesitation the Officer of the Watch shall:

1. demonstrate correct assessment of risk of equipment malfunctions or breakdown based on available information, while taking into consideration ship safety and emergency procedures and changeover from remote/automatic to local control of affected systems
2. assess, plan and take necessary action to contain the effects of damage resulting from equipment breakdown, rupture, fire, or other causes
3. immediately inform the bridge in the event of fire and of any impending action in machinery spaces that may cause reduction in the ship's speed, imminent steering failure, stoppage of the ship's propulsion system or any alteration in the generation of electric power or similar threats to safety
4. inform the Chief Engineer Officer without delay
   - 4.1. when engine damage or a malfunction occurs which may endanger the safe operation of the ship
   - 4.2. in any emergency or in doubt as to what decision or measures to take
5. explain and always take into account the possibilities of hazards and prioritize the safety of human lives, over the marine environment and over damage to cargo and vessel.

D.1.8.2 Simulator observation and evaluation criteria for trouble-shooting (ETS FORM – Appendix page 71)

A. Assess and Plan

The Officer shall:

1. demonstrate, without hesitation, the ability to respond properly to warning and alarm signals, whether they are optical, acoustic or indicated by gauges or electronic monitoring equipment
2. assess, plan and take necessary action to contain the effects of the malfunction identified while paying due attention to relevant procedures and safe working practice
3. inform the Bridge and Chief Engineer Officer when engine damage or a malfunction occurs which may endanger the safe operation of the ship.

B. Execution

The Officer shall:

1. demonstrate that he/she masters both the special engineering terminology and the terminology normally used on board a ship. He/she shall be able to demonstrate this by using proper English
2. demonstrate the ability to identify problems and situations in advance and subsequently develop and implement solutions in a timely manner

3. diagnose the malfunction(s) with an acceptable precision. The diagnosis shall be based on the information available from monitoring systems and from the engine-room personnel or other sources
4. demonstrate willingness to adjust his/her solution to the problem if new information emerges or special circumstances are hindering him/her from carrying out the initial solution
5. use the rest of the Engine-room team effectively in the diagnostic process and solution phase
6. demonstrate willingness to adjust his/her solution to the diagnosis or problem solution taking into account multiple inputs from others
7. show reasonable consort consideration during the whole process
8. be able to perform a mental analysis of the situation and the possible consequences of chosen solutions while taking into account all possible hazards.

C. Remedy Situation
The Officer shall:

1. take correct action and remedy the situation within an acceptable timeframe depending on the complexity of the situation.

D. Attitude
The Officer of the Watch shall demonstrate:

1. confidence, including the ability to learn from past mistakes and accept constructive criticism
2. willingness to always apply correct terminology in order to reduce the chance of misunderstandings from occurring
3. flexibility, including the ability to react to unexpected changes; and
4. intensity (sense of urgency) including the ability to maintain control under stress and demonstrate an understanding of the degree of risk posed by various breakdowns or abnormal situations during navigation, ship handling and collision avoidance scenarios.

E. Safety
Without hesitation the Officer of the Watch shall demonstrate:

1. willingness to consult ship procedures and reference literature in order to seek out the best solution without endangering the ship
2. proper reaction to the situation by:
   2.1. correct assessment of risk of consequential equipment malfunctions or breakdown based on available information

2.2. immediately informing the bridge, in the event of any impending action in machinery spaces that may cause reduction in the ship's speed, imminent steering failure, stoppage of the ship's propulsion system or any alteration in the generation of electric power or similar threat to safety
2.3. informing the Chief Engineer Officer without delay
   2.3.1. in any emergency
   2.3.2. if in doubt about what decision to make or measures to take
2.4. always taking into account the possibilities of hazards and prioritize the safety of human lives, over the marine environment and over damage to cargo and vessel.

D.1.8.3 Simulator observation and evaluation criteria for the officer taking over the watch (OOW FORM – Appendix page 73)

A. Watch Turnover

The Officer of the Watch turnover procedure shall include the following:

1. **Personnel.** Ensure that the members of the engineering watch are apparently fully capable of performing their duties effectively
2. **Machinery.** Understand the propulsion- and auxiliary plant status including:
   2.1. the nature of all work being performed on machinery and systems, the personnel involved and potential hazards
   2.2. the level, and where applicable, the condition of water or residues in bilges, ballast tanks, slop tanks, reserve tanks, fresh water tanks, sewage tanks and any special requirements for use or disposal of the contents thereof
   2.3. the condition and level of fuel in the reserve tanks, settling tanks, day tanks and other fuel storage facilities
   2.4. the condition and mode of operation of centrifuges
   2.5. any special requirements relating to sanitary system disposals
   2.6. condition and mode of operation of the various main and auxiliary systems, including the electrical power distribution system
   2.7. the condition of monitoring and control console equipment and which equipment that is manually operated
   2.8. the condition and mode of operation of automatic boiler controls and other equipment related to the operation of steam boilers
   2.9. the reports of engine-room ratings relating to their assigned duties
   2.10. the availability of fire-fighting appliances; and
   2.11. the state of completion of the engine-room log
3. **Communications.** Relevant communication passed and received from the bridge or other stations: e.g. bunkering, emergency stations including equipment status
4. **Operations.** The standing orders and special orders of the Chief Engineer Officer relating to the operation of the ship's systems and machinery

5. **Weather and Ephemeral Data.** Including any potentially adverse conditions resulting from bad weather, ice, or contaminated or shallow water.

B. Watch Execution
The Officer of the Watch shall:

demonstrate basic knowledge of and ability to use all engine-room equipment relevant to the type of ship being simulated

1. establish an effective working relationship with the engine-room crew
2. demonstrate effective supervision of engine-room personnel
3. demonstrate a basic understanding of engineering principles, including:
4. the ability to select and utilize available information to keep the ship safe from danger by identifying possible hazardous situations or upcoming events and take the necessary precautions by
   - 4.1. assessing the effects (ship movements) of wind, tide, and current on the ship's propulsion machinery and auxiliary machinery, including presentation of valid solutions to maintain/regain safe operation
   - 4.2. using available information from external sources and observations of equipment in the engine-room and other areas together with information obtained from alarm and monitoring systems to plan and schedule maintenance and other unforeseen, but necessary, actions required to maintain a safe and efficient operation of the ship
   - 4.3. meeting a scheduled arrival time and in this process demonstrating an appreciation of the importance of correct disposal of bilge, preparing for manoeuvring, securing adequate reserve of power and steering gear equipment, taking into account fuel consumption considerations, and the requirement to achieve a pre-planned arrival
   - 4.4. being able to make correct and timely reports to the Bridge Officer and Chief Engineer Officer and follow their instructions
   - 4.5. recording and properly documenting all events, which have occurred during the watch, such as events related to main and auxiliary machinery, bunkering, oil transfer, waste or bilge disposal
   - 4.6. being able to promptly execute all bridge orders and record any changes in direction or speed of the main propulsion units; and
   - 4.7. supervising and using internal and external communications efficiently.

C. Handling
The Officer of the Watch shall:

1. take the actions necessary to contain the effects of damage resulting from equipment breakdown, fire, flooding, or other cause
2. communicate any emergency or abnormal situation to the bridge, Chief Engineer Officer and other persons according to ship procedures
3. demonstrate a basic knowledge of the main engine manoeuvring characteristics

4. demonstrate the ability to positively supervise ratings on the engineering watch and direct them to inform of potentially hazardous conditions; and
5. demonstrate the ability to pay due attention to the ongoing maintenance and support of all machinery, their control apparatus, accommodation service systems and safety equipment.

D. Attitude
The Officer of the Watch shall demonstrate:

1. confidence, including the ability to learn from past mistakes and accept constructive criticism
2. initiative, including the ability to identify problems and situations in advance and subsequently develop and implement solutions in a timely manner
3. flexibility, including the ability to react to unexpected changes; and
4. intensity (sense of urgency) including the ability to maintain control under stress and demonstrate an understanding of the degree of risk posed by various breakdowns or abnormal situations during navigation, ship handling and collision avoidance scenarios.

E. Safety
Without hesitation the Officer of the Watch shall:

1. demonstrate correct assessment of risk of equipment malfunctions or breakdown based on available information, while taking into consideration ship safety and emergency procedures and changeover from remote/automatic to local control of affected systems
2. assess, plan and take necessary action to contain the effects of damage resulting from equipment breakdown, rupture, fire, or other cause
3. immediately inform the bridge, in the event of fire and of any impending action in machinery spaces that may cause reduction in the ship's speed, imminent steering failure, stoppage of the ship's propulsion system or any alteration in the generation of electric power or similar threat to safety. This notification, when possible, shall be accomplished before changes are made, in order to afford the bridge the maximum available time to take whatever action necessary
4. inform the Chief Engineer Officer and make recommendations to the Bridge Officer without delay
   - 4.1. when engine damage or a malfunction occurs which may be such as to endanger the safe operation of the ship
5. inform the Chief Engineer Officer without delay:
   - 5.1. when any malfunction occurs, which is believed to cause damage or breakdown of propulsion machinery, auxiliary machinery or monitoring and governing systems; and
   - 5.2. if in doubt about what decision to make or measures to take

6. demonstrate, when necessary, the ability to assess an emergency situation and perform necessary emergency operation of propulsion machinery and auxiliary machinery; and
7. take into account the possibilities of hazards and prioritize the safety of human lives, over the marine environment and over damage to cargo and vessel.

D.2 Guidance on specific subject areas

The guidance notes, which follow, contain advice on the treatment of the subject areas listed in the course outline. The instructor should develop a methodology based on his own experience as well as the advice and guidance provided with the simulator being used. At the same time he should bear in mind the recommendations and the requirements in Regulations III/1, III/4 and Section A-VIII/2 part 3-2, part 4-2 and 4-4 including Section B-VIII/2 part 3-2 of the STCW95 Convention.

D.2.1 Guidance notes

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

D.2.1.1 Course introduction

Objective: Familiarize the student with staff, purpose and content of the course.

Estimated duration: 1 hour

D.2.1.2 Familiarization

Objective: Familiarize the student with the layout of the plant, the instrumentation used, and the location and use of controls

Estimated duration: 6 hours

It is important for the students to become familiar with what is being simulated, as well as the simulator layout and controls. The briefing must therefore cover at least:

- the engineering plant, its systems and equipment
- the instrumentation being used and the parameters being indicated and recorded
- the controls that are used and where they are located
- the alarm system and what it indicates
- the use of safe practices and procedures at all times
- the importance of proper planning before undertaking any activity in the machinery spaces
- the use of checklists to ensure that actions and activities are carried out in a safe and correct sequence.

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

- opening and closing valves
- starting and stopping pumps
- filling tanks
- circulating seawater through heat exchangers
- circulating freshwater

and then proceed to more complicated activities, such as:

- operating centrifuges and filling service tanks
- operating the steam boiler
- emptying bilges
- operating alarms.

The student should note and record important readings and events during the exercise.

D.2.1.3 Operation

Objective: Familiarize the student with the machinery units and systems that are being simulated. Introduce situations where the student can gain experience using correct and safe procedures for preparation, starting and normal operation.

Estimated duration: 13 hours

Sufficient auxiliary units have been identified in the syllabus to cover most simulator designs, so that sufficient practice can be obtained. For example, not all designs incorporate a cargo turbine or a turbo generator. As a substitute, an exercise operating two diesel generators in parallel might be used.

The next activity is the preparation, starting and normal operation of the main propulsion unit. Some time must be spent in order to give the student necessary experience in starting and stopping units (including the main engine), changing over pumps, filters, etc. The final step of the exercise is where the next exercise on watchkeeping begins, i.e. at the point where the whole plant is operational, with the vessel making a voyage at sea.

D.2.1.4 Main engine operation

Objective: Familiarize the student with the main propulsion machinery that is being simulated. Introduce situations where the student can gain experience using correct and safe procedures for normal operation.

Estimated duration: 10 hours

Provide experience with the normal operation of the main propulsion unit. Some time must be spent in order to give the student necessary experience in starting and stopping units (including the main engine), changing over pumps, filters, etc. Manoeuvres from the Emergency manoeuvre stand and Local manoeuvre stand should be covered together with Crash and Emergency manoeuvres.

The final step of the exercise is where the next exercise on trouble-shooting begins, i.e. at the point where the whole plant is operational, with the vessel making a voyage at sea and the sea watch is set.

D.2.1.5 Trouble-shooting

Objective: Provide experience in identifying malfunctions, find possible causes and remedy the situation. All operations shall be planned and carried out in accordance with established rules and procedures to ensure safety of operations.

Note: When the student has acquired some diagnostic skills, it is advisable to let him/her demonstrate independent trouble-shooting without interference from the instructor. The latter may act merely as a counsellor.

Estimated duration: 20 hours

These exercises aim at developing skill and confidence in the handling of operational problems. A number of malfunctions have been mentioned in the syllabus.

When introducing malfunctions in the scenario, see to it that they are introduced one by one. The next malfunction should not be introduced until the student has successfully identified and remedied the situation. At a later stage more complex situations involving more than one malfunction may be introduced. The scenario constructor should focus on malfunctions that will appear as a consequence of poor ability to identify problems and situations in advance.

The instructors should not intrude too much in the exercises, but should allow the student to get on with the job and sort out the problems on his/her own. Malfunctions involving cylinder operation may require some indicator diagrams to be taken.

Give the student the opportunity during the debrief session to explain how, why and in which way the malfunction was identified, located and dealt with. Engage the other students in the discussion. Interfere where appropriate.

Each simulator design will incorporate its own catalogue of faults or malfunctions. The manufacturer's guidance should be used to construct appropriate scenarios. Some general guidance, however, can be given for the trouble-shooting items mentioned in the syllabus.

1. Fuel injection timing (early/late)

Indications: Changes in average exhaust gas temperatures for one or more cylinders indicate that something is wrong. Depending on the severity of the situation, a possible lack of power and blackening of exhaust will be the result. An indicator diagram will help to decide whether the timing is early or late and if the timing is adjusted properly.

Remedy: Correct the timing.

2. Worn piston rings in one cylinder

Indications:
- reduction in compression and maximum pressures, reduction in exhaust gas temperature
- increase in scavenge space pressure and temperature, or increase in crankcase pressure (depending upon design)
- blackening of exhaust gases.

If no action is taken and the condition becomes worse, a fire might occur in the scavenge space, or crankcase conditions might activate the smoke detection alarm.

Remedy: Replace worn rings.

3. Scavenge space fire

Indications: A scavenge space fire will produce an increase in temperature in the exhaust gas, jacket cooling water, piston cooling system and scavenge air.

Hot gases together with carbon particles blowing past the piston rings have ignited residues of cylinder or crankcase lubricating oil in the scavenge space. If the fire is severe, the turbo chargers will start to surge.

Remedy: Move the fuel control to slow speed. If the engine stops or is stopped, engage the turning gear and keep the engine moving to prevent the piston from seizing in the liner. If the fire is spreading, CO_2 or steam could be used to control the fire. But applying CO_2 or steam could affect the engine severely. Use it with caution. Lubrication to the affected cylinder should be maintained or increased.

The heat of the fire may destroy the seal rings in the stuffing box. Assuring that there is no piston ring blow by and that scavenge air spaces are clean prevents the situation.

4. Fouled turbo charger (exhaust side)

Indications: *In general*: A simple diagnosis is difficult based on changes in scavenging air pressure alone. Fouled air filters, air coolers and turbo chargers can greatly influence the scavenge air pressure. Changes in the scavenge air pressure (reduction) should thus merely be seen as a consequential effect which is closely related to changes in:

- the air cooler condition
- the turbo charger condition
- the cam timing.

Any deposit will reduce the turbo charger efficiency by increasing the flow resistance and thus have a great influence on the exhaust temperatures, which will increase. Turbo charger revolutions will drop.

Remedy: Clean the exhaust side.

5. Fouled turbo charger (air side)

Indications: See item No. 4 above. Normally, turbo charger revolutions will increase, as the airside gets more and more fouled. This is not a clear indication, since an increase in rpm can also be attributed to a fouled air filter or charging air cooler.

Remedy: Clean the airside.

6. Fouled turbo charger air filters

Indications: See items No. 4 and 5 above. Fouled air filters are normally easily detected by monitoring the pressure drop across the turbo charger air filter. Filter elements should be cleaned if the drop is 50% higher than the testbed value.

Remedy: Clean the air filters.

7. Fouled scavenge air cooler/ports

Indications: See items No. 4 and 5 above. In addition, fouling will introduce changes in the temperature difference between air outlet and water inlet, the cooling water difference and the pressure drop across the air cooler. Generally, for the above three parameters, a change of approximately 50% of the testbed value is considered to be a maximum. However, the effect of the altered temperatures should be kept under observation and compared with changes in the exhaust temperatures, while seeking to rule out other causes.

Fouling of the cooler airside will manifest itself as an increased pressure drop across the airside.

Fouling of the waterside will normally involve a reduction of the cooling water temperature difference, because the heat transmission is reduced.

Choking of the cylinder ports will raise the exhaust temperature of the effected cylinder.

Remedy: Clean the cooler or ports.

8. Blackout

Indications: Obvious! A blackout will always lead to a situation where, at least for a period of time, control over the propulsion and auxiliary machinery is reduced or lost. Under unfortunate conditions a blackout can endanger the safety of the ship, leading to grounding or collision. A non-planned blackout should therefore be regarded as an emergency situation and treated likewise. There could be multiple reasons for a blackout occurring. A clogged fuel oil filter is one, electrical malfunctions another, and fire or explosion a third. The list has almost no end.

Remedy: Start and connect stand by generators as quickly as possible and restore manoeuvring capability. In case of a fire: follow fire-fighting procedures. If the situation allows for it, restore propulsion. Then deal with the cause of the blackout.

9. Clogged auxiliary machinery oil filters

Indications: Increased delta pressure across the filter unit and possibly a reduction in flow rate. If not remedied, it will eventually halt the diesel generator.

Remedy: Change over to the cleaned filter unit and clean the affected unit.

10. Overheated main bearing

Indications: Increased bearing temperature. Increased friction will eventually lead to reduced drive speed and overheating of the bearing. Detection of oil mist in the crankcase will occur before total breakdown.

Remedy: Stop the engine if allowed. Remedy the initial cause.

11. Fouled heat exchanger surfaces

Indications: A fouled heat exchanger surface will result in reduced heat transfer. As a result, normal operating temperatures will not be reached.

This condition usually builds up over a period of time, as there is some extra heat transfer capacity built into the system. Still, it must be dealt with at the first opportunity.

Remedy: Clean the surfaces.

12. Main engine lubricating oil circulation pump failure

Indications: Sudden drop in lubrication oil pressure. Main engine shuts down.

Remedy: Start the stand by pump. Restart main engine. Locate the cause of the pump failure.

13. Bilge sumps flooded

Indications: Flooding of bilge sumps introduces several hazards. One is the spread of oil throughout the tank top area, leaving oil residues behind creating a potentially combustible atmosphere.

Another is the hazard of reduced ship stability due to the free surface effect. In addition to the bilge pump, there is always an additional pump that can be used, such as the general service pump or ballast pump.

Remedy: Empty bilge sumps. If it is necessary to pump bilge water overboard, then ship specific procedures are to be adhered to along with local and international regulations.

In an emergency situation, the main seawater pumps can be used to remove water from the bilges.

14. Bridge control failure

Indications: Could be numerous. E.g. the main engine could shut down instantly, not react to manoeuvring commands or slowly increase or decrease speed. Notifications will be given from the bridge during manoeuvre.

Remedy: Go to local control. If this does not work, establish emergency control by using the emergency control stand.

D.2.1.6 Maintain a safe engineering watch

Objective: The intention of the exercises is to provide the student with the correct and proper procedures for watchkeeping and reflect the requirements of Section A-III/1, Section A-VIII/2 part 3-2, part 4-2 and part 4-4 including B/VIII/2 part 3-2 of the STCW95 Convention.

Estimated duration: 30 hours

Use the Simulator observation and evaluation criteria for the Officer Taking Over the Watch on page 26 for guidance.

Here again, safe practices must be stressed and the importance of pre-planning and the use of checklists should be emphasized. This exercise must be made as realistic as possible in order for the students to obtain maximum benefit.

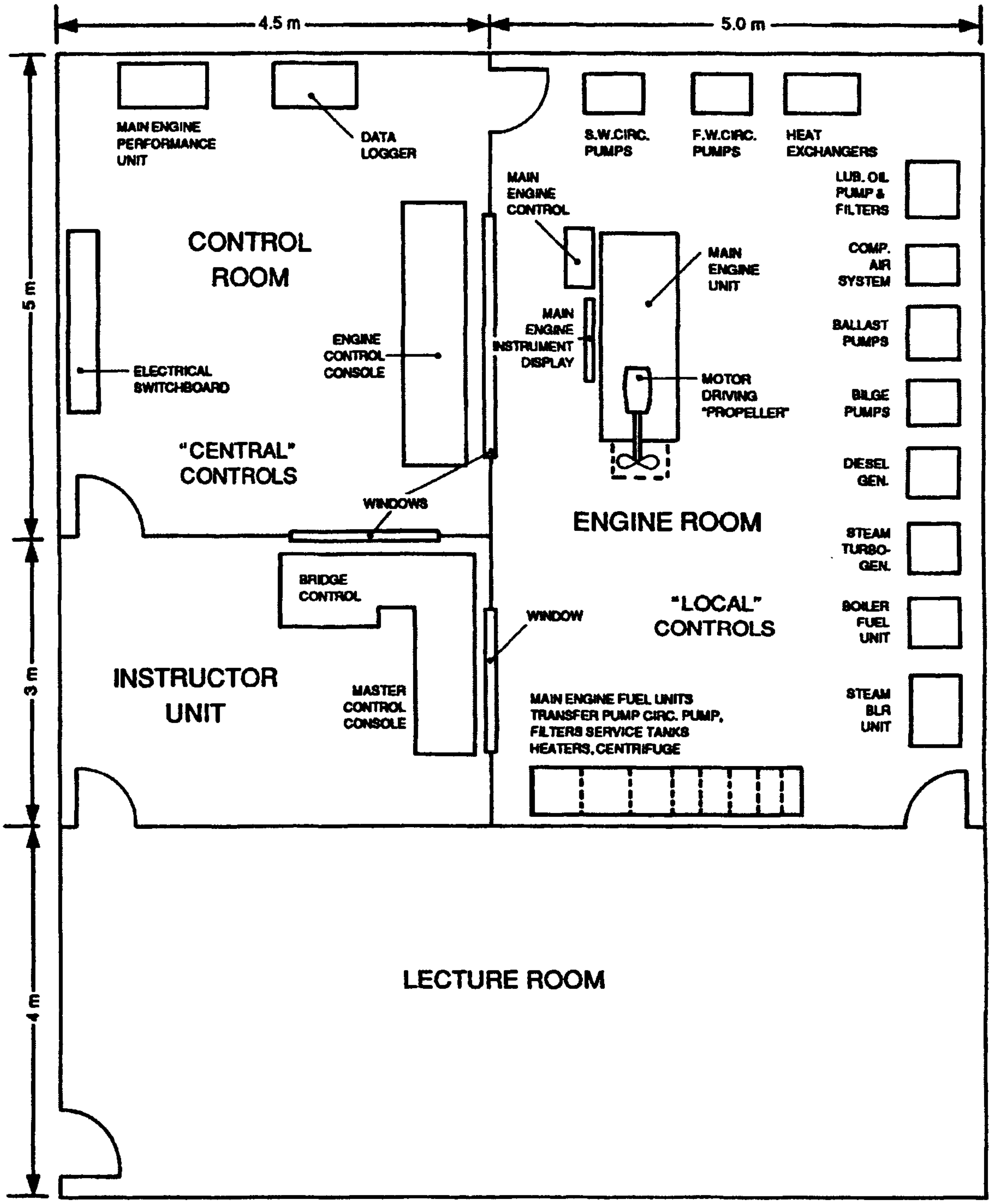

Figure D-1. Line sketch of an Engine-Room Simulator Arrangement. The units in the engine-room provide local control through "black boxes" (with instrument display at each unit). The central control has complete instrumentation display and controls. The main engine performance unit can provide indicator diagrams.

Appendixes

Table of Contents

SAMPLE EXERCISE SCENARIOS

This appendix contains four sample exercise scenarios relating to machinery units, which are used in most marine engine simulator designs.

The briefing, which shall precede every exercise, shall include clear information on the purpose of the exercise and the learning objectives to be achieved. This can be achieved by handing out the description of the aim of the Simulator Evaluation Guide on page 21, the Simulator observation and evaluation criteria on page 22 together with the appropriate Evaluation Form found in the Appendixes on page 69 outwards. If the briefing precedes an assessment session, the student shall be given a clear and concise description of what is required in order to pass the test.

Exercise 1 (Ref. page 40, and Detailed Syllabus item 3.3)

This exercise involves the preparation, start up, and running of an auxiliary diesel engine. Incorporate the use of the electrical system, or, alternatively, run the turbo generator during this exercise.

Exercise 2 (Ref. page 44, and Detailed Syllabus item 3.4)

This exercise covers the preparation and procedures for connecting a steam boiler to the main system.

Exercise 3 (Ref. page 48, and Detailed Syllabus item 3.5)

This three-part sample scenario covers:

- operating diesel generator(s)
- operating a steam system
- establishing the energy (heat) balance.

Two diesel generators are to be used, or one diesel generator and the turbo generator. The main objective is to ensure that all the students can apply the procedures for running electrical machines in parallel and perform load sharing.

Establish a heat balance for the boiler using the turbo generator or the cargo turbines. Alternatively: establish a heat balance for the diesel generators.

Exercise 4 (Ref. page 53, and Detailed Syllabus item 4)

This sample scenario covers the start up and operation of the main propulsion machinery.

Exercise 5 (Ref. page 60, and Detailed Syllabus item 5.1)

In service diagnostics

This scenario covers in service diagnostics of an engine that is not optimally tuned.

Exercise 1

Name: **Preparing, starting and operating an auxiliary diesel engine**

Function: Marine engineering at the operational level

Competence: Operate main and auxiliary machinery and associated control systems

Stage: Development

Objective: Provide experience in the preparation, start up and operation of an auxiliary diesel engine generator. Furthermore, provide experience in synchronizing, coupling it to the main switchboard and subsequent load sharing. All operations shall be planned and carried out in accordance with established rules and procedures to ensure safety of operations.

Initial condition: Dead ship. Regulators are optimally set

Briefing: Make sure that the student is able to:

- plan and carry out operations in accordance with established rules and procedures to ensure safe working practice
- explain the cooling systems and which pumps can be started without the auxiliary engines being in operation
- explain the fuel oil and lubrication oil systems
- explain the generator system and coupling of the same to the main switchboard
- explain how the voltage and frequency are regulated, and how different power units can be synchronized. Load sharing and maximum load should also be covered.
- explain why it is necessary to have an adequate supply of control air

Action: Start the simulation and let the student:

- prepare the seawater and freshwater systems required for cooling the auxiliary diesel engine
- start the compressors for supplying starting and control air
- prepare the fuel oil system and lubrication oil system used by the auxiliary diesel engine and, after applying the starting sequence, bring the engine to the normal operational mode
- apply the procedures for regulation of the voltage and frequency. Synchronize and couple the generator to the main switchboard.
- identify and record normal cooling water temperatures, exhaust gas temperatures, rpm and fuel consumption data for the diesel engine, as well as produced power, voltage, current and frequency for the electrical system.

After the briefing the student shall:

Prepare and start the seawater circulation system.	Select the appropriate sea chest, pumps and coolers. Operate relevant valves in order to obtain correct temperatures.
Prepare and start the seawater circulation system.	Check the freshwater level. Open correct freshwater coolers. Select/open necessary low temperature coolers. Start pumps for high and low temperature cooling.
Prepare the fuel oil system for use.	Check the diesel oil level. Open necessary valves.
Prepare the fuel oil system for use.	Check the diesel oil level. Open necessary valves.
Prepare the lubrication oil system and put it into operation.	Check the lubrication oil level. Open valves for filter and cooler.
Start the auxiliary diesel engine.	Start from local control.
Couple the generator to the main switchboard.	Adjust speed, voltage, frequency and synchronization and connect the generator to the main switchboard.
Start fans and control room air-conditioning.	Start engine-room fans and air-conditioning.
Prepare the compressed air system.	Drain the air system. Start necessary compressors and switch to automatic control.
Operate the system over an agreed period of time.	Observe temperatures, fuel consumption, loads, etc., while in the normal operating mode.

Debrief: After the exercise has been carried out, time must be allocated to discussion of the exercise. Any deviation from normal operation should be discussed and investigated more closely.

Duration: The instructor must allocate enough time for briefing on the systems before the students start to use the simulator. The starting procedure could be carried out in one hour, after which observations should continue for at least one hour to check that the system is stable and working correctly. Ample time should be allocated for the student to reach his/her learning objectives during the session. Ample time must be allocated for debrief after the exercise.

Exercise 1: Preparing, starting and operating an auxiliary diesel engine

Student observation form

The observations were taken _____ minutes after the start of aux. engine No. _______

Readings:

Rpm: _____

Torque: ____________________ [Nm]

Fuel mass flow: ____________ [kg/s]

Heat value: ____________________ [J/kg]

Power yield: ______________ [kW]

Shaft power: ____________________ [kW]

Heat loss in coolers and exhaust gas:

Component	Mass flow [kg/s]	Inlet temp. [K]	Outlet temp. [K]	Specific heat capacity [kJ/kg K]	*Waste* heat [kJ/s]
				Waste heat total:	

Generator:

Voltage:_____ [V] Current:_____ [kA] Power:_____ [kW] Frequency:_____ [Hz]

Air system:

The following compressors are in operation: ____________________

Air pressure in the starting air tank:_____ [bar] service tank: _____ [bar]

Exercise notes

Oil consumption:

The temperatures of the exhaust gas/lubricating oil/cooling water:

The electrical system:

The regulating system:

Safety aspects to consider and lessons learnt:

Exercise 2

Name: **Preparing and firing up a cold steam boiler**

Function: Marine engineering at the operational level

Competence: Operate main and auxiliary machinery and associated control systems

Stage: Development

Objective: Provide experience in raising steam in a cold boiler and put it into operation. Ensure that all safety procedures are understood and all operations carried out in accordance with established rules and working practices.

Initial condition: One auxiliary engine, the air compressors, both engine-room fans and the air conditioning system are in operation.

Briefing: Make sure that the student is able to:

- handle hazards, safety precautions and procedures involved when operating a steam generating plant
- explain the boiler construction and operation
- explain the steam system using the flow diagrams
- explain the heat transfer process. Relate the different temperatures to the heat transfer process.
- explain the criteria that must be fulfilled before:
  - firing up
  - admitting steam to a cold pipeline or system
- explain the term *water hammering*
- explain the regulation of all systems associated with a steam generating plant
- explain the fuel oil system including the steam atomising system
- explain the term *natural circulation* and how oxygen and carbon dioxide contents vary with changing combustion parameters

Action: Start the simulation and let the student:

- prepare the primary and secondary steam systems for firing up
- fire up the boiler manually and change to automatic regulation when appropriate
- bring the system up to normal operational mode
- submit a report of the session

After the briefing the student shall:

Prepare the boiler by obtaining the correct water level.	Replenish the water, open/close valves and start pumps.
Prepare the fuel oil combustion system.	Check the fuel oil system. Open necessary valves and start pump.
Prepare the regulators.	Set the regulators in manual position.
Prepare the burners.	Select the fuel oil. Start the forced draught fan. Purge the system.
Light the burner.	Regulate air/*fuel* oil manually. Light burner and regulate manually. Check oxygen and carbon dioxide levels. Check pressure in primary and secondary boilers.
Change over to heavy fuel oil.	Prepare the heavy fuel oil system. Open steam for heating and atomising.
Operate the system for a given period of time.	Observe changes in pressures, temperatures, *fuel* oil consumption, carbon dioxide and oxygen content.

Debrief: After the exercise has been carried out, time must be allocated for discussion of the exercise. Any deviation from normal operation should be discussed and investigated more closely. Discuss: Can a boiler of this size be fired up from a cold state to full pressure in one go? How does the pressure vary? Why do oscillations occur? How long are the periods between oscillations?

Duration: The instructor must allocate enough time for briefing on the systems before the students start to use the simulator. When normal operation mode has been reached, observations should continue for at least one hour to check that the system is stable and working correctly. Ample time should be allocated for the student to reach his/her learning objectives during the session. Ample time must be allocated for debrief after the exercise.

Exercise 2: Preparing and firing up a cold steam boiler

Student observation form

Pre-start readings: Primary boiler: Secondary boiler:

Water level: __________ __________ [mm]

Pressure: __________ __________ [bar]

Set point: __________ __________ [bar]

Fan's power drain at start: __________ Normal operation: __________ [kW]

Firing started at: __________ [hours]

Working pressure at: __________ [hours] Primary press: __________ [bar]

Energy flow during starting and operation of the primary boiler:

Time	Temperature [K]	Supplied [kJ/s]	Radiation [kJ/s]	Convection [kJ/s]	Super heater [kJ/s]

Following regulators in auto: Time

__________ __________ [hours]

__________ __________ [hours]

__________ __________ [hours]

__________ __________ [hours]

__________ __________ [hours]

Exercise notes

Calculate the relationship between the combustion air and the fuel oil consumption. Discuss why excess air is needed and how the oxygen and carbon dioxide content in the exhaust gas are linked to the air to oil ratio. Does the energy production vary with the air to oil ratio?

$$(\text{Fuel}) + (\text{Air}) \rightarrow \text{Combustion Products} + \text{Energy}$$
$$(C + H_2 + S_2) + (O_2 + N_2) \rightarrow CO_2 + CO + H_2O + O_2 + N_2 + SO_2 + \text{Energy}$$

The regulation system:

Safety aspects to consider and lessons learnt:

Exercise 3

Name: **Preparation and operation of cargo turbine(s)**

Function: Marine engineering at the operational level

Competence: Operate pumping systems and associated control systems

Stage: Development

Initial condition: The boiler is in operation with small burners

Briefing: Make sure that the student is able to:

- ensure that all safety procedures are understood and all operations carried out in accordance with established rules and working practices

Objective: Operate a steam cargo turbine and establish a heat balance.

Action: Start the simulation and let the student:

- establish required power reserves using a steam- or a diesel generator
- prepare start up and bring the cargo turbines to stand-by
- establish normal operation mode when requested
- operate the plant for a specified time period while maintaining normal operating conditions and remedy malfunctions
- establish a heat balance for the system
- submit a report of the session

After the briefing the student shall:

Establish power reserve.	Follow ship specific procedures.
Prepare the cargo turbines for operation.	Start necessary auxiliary equipment.
Start two cargo turbines and run these at 80% output.	Check pressure and water level in the boiler. Observe the exhaust gas. Regulate the turbine in accordance with load requirements.
Operate the two cargo turbines for a given period of time.	Operate and observe the system over a period of time.
Establish a boiler heat balance.	Note relevant values.

The instructor may introduce changes to the scenario in order to increase the degree of difficulty or in order to focus on specific aspects.

Note: As an alternative, the exercise could use a steam-driven turbo generator in place of the steam cargo turbines. In this case the diesel generator should be used.

Debrief: After the exercise has been carried out, time must be allocated for discussion of the exercise. Any deviation from normal operation should be discussed and investigated more closely.

- Discuss:
  - problems related to excess air and deposits
  - how excess of air affects the acid dew point
  - how oscillations in pressure and temperature vary
  - how the efficiency and state of the plant and single parts of the system (e.g. boiler, condenser and turbine) vary under differing operational conditions
  - why careful monitoring of the oxygen and carbon dioxide content of the waste gas is important

Duration: The instructor must allocate enough time for briefing on the systems before the students start to use the simulator. When normal operation mode has been reached, observations should continue for at least one hour to check that the system is stable and working correctly. The instructor may accelerate the simulation in order to reduce this time span. Ample time should be allocated for the student to reach his/her learning objectives during the session. Ample time must be allocated for debrief after the exercise.

Exercise 3: Preparation and operation of cargo turbine(s)

Student observation form

Burner(s):

Operating burner(s) no(s).: ______________ Oil type: __________

Air mass flow: ____________________ [kg/s] Temperature: ______ [°C]

Oil mass flow: ____________________ [kg/s] Temperature: ______ [°C]

Heat value: ______________________ [kJ/kg] (see simulator manual)

Heat supplied: ____________________ [kJ]

Atomising steam mass flow: ________ [kg/s] Pressure: __________ [bar]

Regulators:

Main (master) is in ______________________ with __________________________

Air regulator in _________________________ with __________________________

Oil regulator in _________________________ with __________________________

Burner management: ___________________ Burner type: _________________

Exhaust gas:

O_2 content: _______ [%] CO_2 content: ______ [%]

Temperature: ______ [°C] Oxygen regulator: _______

Specific heat capacity of air: ______ [kJ/kg K] Exhaust gas: __________ [kJ/kg K]

Enthalpy of air: ________________ [kJ/kg] Exhaust gas: __________ [kJ/kg]

Notes:

____

____

____

____

____

____

Primary boiler in normal operation

The pressure oscillates between: ________ [bar] and ___________ [bar]

Oscillation time for one period is: ________ [s]

Steam temperature before the secondary boiler: ______ [°C] after: ______ [°C]

The condition of the primary steam before the secondary boiler is: _______________

Heat transferred in the steam generator: _____________ [kJ/s]

Calculated mass flow in the primary boiler: ___________ [kg/s]

Secondary boiler in normal operation:

Secondary boiler pressure set point: _____ [bar]

The pressure oscillates between: ________ [bar] and ___________ [bar]

Oscillation time for one period is: ________ [s] Temperature: ____ [°C]

Steam dryness factor (leaving the drum) is estimated to be: ___________ [%]

Steam mass flow to:

Super heater: __________________________ [kg/s] (for cargo turbines)

Gasification: ___________________________ [kg/s]

Heating: ______________________________ [kg/s]

Turbo generator: ________________________ [kg/s]

Total production: ________________________ [kg/s]

Feed water mass: _______________________ [kg/s] Temperature: ____ [°C]

After super heater the temperature is: _____ [°C] Enthalpy: _______ [kJ/kg]

Heat supplied in secondary boiler: _____________________ [kJ/s]

Heat supplied in super heater: __________________________ [kJ/s]

Total heat supplied in secondary circuit: __________________ [kJ/s]

Condenser:

Steam mass flow: ____________________ [kg/s]

Condenser total pressure: ____________ [bar] Gas pressure: ____________________ [bar]

Steam inlet temperature: ______________ [°C] Pressure: ______________________ [bar]

Condensate temperature: ______________ [°C] Supercooled? ☐ Yes ☐ No ______ [°C]

Condensate pump(s) in operation: ________________

Specific heat capacity of seawater: ________________ [kJ/kg K]

Seawater mass flow: ____________________________ [kg/s]

Seawater temperature in: _______ [°C] out: ______ [°C]

Heat transferred to the seawater: __________________ [kJ/s]

This represents a _________ [%] heat loss Equivalent to _______ [kW]

Enthalpy: _______________ [kJ/kg K] Dryness: ________ [%] of entering steam

Power efficiency of: _____________________________ [%]

The primary boiler: ______________________________ [%]

The secondary boiler: ____________________________ [%]

The boiler plant: ________________________________ [%]

The cargo turbines: _____________________________ [%]

The complete steam system: ______________________ [%]

Notes:

Safety aspects to consider and lessons learnt:

Exercise 4

Name: **Preparation and operation of main engine**

Function: Marine engineering at the operational level

Competence: Operate main and auxiliary machinery and associated control systems

Stage: Development

Briefing: Make sure that the student is able to:

- explain the construction of the main engine freshwater cooling system, how it is regulated and normal temperature ranges in the various parts of the circuits
- explain the function of the main engine lubricating oil system, how the oil circulates, the normal operating temperatures and where the temperature sensor for the regulator can be located
- explain the function of the main engine fuel oil system and how it is controlled, discussing each of the regulation circuits for "master" and "slave" and how you can select between viscosity and temperature regulation
- explain the construction and function of the charging air system
- ensure that all safety procedures are understood and all operations carried out in accordance with established rules and working practices

Initial condition: The oil-fired boiler is in operation, two cargo turbines are working at 80% power and the two auxiliary diesel engines are in operation (or one diesel generator and one turbo generator).

Objective: Provide understanding and experience of preparing the main propulsion diesel engine for a sea passage and operation in normal mode.

Action: Start the simulation and let the student:

- state normal operating data for the main engine and associated systems
- explain how control of these operating data can be maintained
- use measurements, observations, diagrams and established rules and procedures to explain safe operation, mode of operation and control of:
  - the high- and low-temperature cooling water circuits
  - the starting air system
  - the main engine lubrication and cooling systems and temperature regulation systems

  - the fuel oil system, centrifuges and regulation of viscosity and temperature
  - emergency shut down systems
  - emergency manoeuvre systems
- observe safe procedures when shutting down the cargo turbines
- prepare main engine and auxiliary systems for operation
- start main engine and establish normal operation mode
- run the engine at 50% and 90% of maximum load

After the briefing the student shall:

Stop the cargo turbines.	Close the valves.
Inspect the cooling water system.	Check the water level.
Inspect the starting air system.	Check pressure, temperature and humidity. Open valves.
Prepare the lubrication oil system for operation.	Replenish oil, open valves to filter and cooler, start pumps and check the regulator. Simulate lubrication of the cylinders.
Prepare the fuel oil system.	Check temperatures, level in mixing tank and viscosity. Select diesel or heavy oil. Select temperature or viscosity regulation.
Start the main engine.	Increase the load gradually to 90%.
Prepare the exhaust boiler and when ready, change over and stop the oil fired boiler.	Start the circulation pump. Operate valves to change gas flow.
Run the engine at 90%.	Check and monitor the operating conditions and the level in the sludge tanks and bilge wells.

Debrief: After the exercise has been carried out, time must be allocated for discussion of the exercise. Any deviation from normal operation should be discussed and investigated more closely.

- Discuss:
  - the fuel oil system and the lubrication oil system
  - advantages and disadvantages of temperature and viscosity regulation
  - how does the regulation circuit for the fuel supply work?
  - how is the lubricating oil distributed in the system and what are the normal bearing temperatures and bearing pressures?

- exhaust gas temperatures and air temperatures, the temperatures in the cylinder jacket, cylinder cover and valves
- the difference between a constant pressure turbocharged diesel engine and an impulse turbocharged diesel engine. Use graphs and diagrams for different types of engines and compare

Duration: The instructor must allocate enough time for briefing on the systems before the student starts to use the simulator. When normal operation mode has been reached, observations should continue for at least one hour to check that the system is stable and working correctly. The instructor may accelerate the simulation in order to reduce this time span. Ample time should be allocated for the student to reach his/her learning objectives during the session. Ample time must be allocated for debrief after the exercise.

Exercise 4: Preparation and operation of main engine

Student observation form

The ship is loaded: ________ [%]

Seawater:

Temperature: _______ [°C] Suction: _________

Pump(s) No: ______________________ in operation Power *drawn*: _________ [kW]

Cooler(s) No: ______________________ in operation Recirculation: _________ [%]

Freshwater:

Cooler(s) No: ____ in operation

Low temperature regulator set point: ______ [°C]

Pump(s) No: ______________________ in operation Power *drawn*: _________ [kW]

High temperature regulator set point: ______ [°C]

Pump(s) No: ______________________ in operation Power *drawn*: _________ [kW]

Lubricating oil:

Cooler(s) No: ____ in operation

Lubricating oil regulator set point: _________ [°C] Sensor location: _____________

Fuel oil:

Level in mixing tank: ______ [%] Temperature: ______ [°C] Viscosity: ______ [cSt]

Viscosity regulator criteria __________________________________ Set point: ______ [°C]

ENGINE-ROOM SIMULATOR

50% load after ______________ minutes and 90% after ______________ minutes

Observation	Pre start	50%	90%
Seawater			
Mass flow			
Temperature before cooler			
Temperature after cooler			
Main engine cooling water			
Mass flow			
Temperature before main engine			
Temperature after main engine			
Freshwater in low-temperature circuit			
Mass flow in oil cooler No.			
Temperature before oil cooler No.			
Temperature before oil cooler No.			
Temperature after			
Mass flow in air coolers			
Temperature before air cooler			
Temperature after air cooler			
Bearing temperatures			
Maximum temperature in main bearing			
Maximum temperature in crankshaft bearing			
Maximum temperature in cross head bearing			
Temperature in thrust bearing			

Observation	Pre start	50%	90%
Lubricating oil			
Total mass flow after filter			
Mass flow through oil coolers			
Temperature before the coolers			
Temperature after regulating valve			
Mass flow to cross head bearing			
Mass flow to crankshaft bearing			
Mass flow to piston cooling			
Temperature before piston			
Temperature after piston			
Mass flow to cam shaft			
Mass flow to cylinder liner			
Fuel before fuel pump			
Pressure			
Temperature			
Viscosity			
Consumption			
Engine power			
Calculated fuel/power ratio			
Rpm			
The ship's speed			

Observation	Pre start	50%	90%
Air/exhaust gas			
Air inlet temperature			
Temperature before air cooler			
Temperature after air cooler			
Temperature in air receiver			
Pressure in air receiver			
Temperature from cylinder			
Temperature in exhaust gas receiver			
Pressure in exhaust gas receiver			
Temperature after turbine			
Total quantity of exhaust gas			
Cylinder No.			
Temperature in cylinder liner			
Temperature in exhaust valve			
Temperature in cylinder cover			

Exercise 5

Name: Main engine in service diagnostics

Function: Marine engineering at the operational level

Competence: Operate main and auxiliary machinery and associated control systems

Stage: Development

Briefing: Make sure that the student:

- has ample basic understanding and knowledge of operation and trouble-shooting
- understands why in service diagnostics are of great value

Initial condition: The tanker, MV Simula, is fully loaded and engaged in an ordinary sea passage from the Persian Gulf bound for Esso Slagen in Norway. The Chief Engineer Officer suspects that the engine is not performing optimally and requests a main engine status report from the student.

All systems are up running normally with some malfunctions activated.

Objective: Provide understanding and experience of collecting and analysing available data in order to perform a technical analysis of the plant status.

Action: Start the simulation and let the student:

- collect data he/she finds relevant or use the data and diagrams included on page 61 of the Appendixes
- prepare a full report to the Chief Engineer Officer covering all relevant aspects regarding the plant status.

Debrief: After the exercise has been carried out, time must be allocated for discussion of the students' reports and the reported status and malfunctions.

Duration: Maximum four hours

Data and readings for MV Simula

MV Simula
Dead weight: 183.87 [kton], Cargo: Crude oil 176.00 [kton]

Engine make: MAN B&W 5L90MC
Cyl. Bore: 900 mm, Stroke: 2900 mm, Number of Cylinders: 5, Number of Air Coolers: 2, Number of Turbo Chargers: 2, Continuous rating: 17.4 MW, Corresponding engine speed: 74 rpm, Mean Indicated Pressure: 13 bar, Scavenge air pressure: 2.1 bar, Turbine speed: 8000 rpm, Specific FO Consumption: 168 g/kWh.

Prev.	New	Denom.	Name
			Dead weight
			Cargo
18.83		[m]	Draft
18.03	18.00	[MW]	Main Engine shaft power (to propeller)
14.01	14	[cSt]	FO viscosity inlet main engine
58.51	58.40	[ton/h]	Exhaust boiler water circulation flow
81.16	80.77	[ton/h]	Main Engine cylinder 1 oil flow
42.11	41.59	[ton/h]	Main Engine cylinder 1 water flow
81.16	81.01	[ton/h]	Main Engine cylinder 2 oil flow
42.11	41.59	[ton/h]	Main Engine cylinder 2 water flow
81.16	80.66	[ton/h]	Main Engine cylinder 3 oil flow
42.11	41.59	[ton/h]	Main Engine cylinder 3 water flow
81.16	80.77	[ton/h]	Main Engine cylinder 4 oil flow
42.11	41.59	[ton/h]	Main Engine cylinder 4 water flow
81.16	80.64	[ton/h]	Main Engine cylinder 5 oil flow
42.11	41.59	[ton/h]	Main Engine cylinder 5 water flow
74.01	73.98	[rpm]	Main Engine speed
7354.11	7483	[rpm]	Main Engine turbo charger 1 speed
7361.40	7461.04	[rpm]	Main Engine turbo charger 2 speed
45.8	50.45	[ºC]	Aft bunker tank FO temperature
48.75	48.00	[ºC]	Camshaft LO temperature inlet main engine
35.18	35.47	[ºC]	DO service tank temperature
237.23	207.28	[ºC]	Exhaust temperature after boiler (inlet stack)
57.32	64.71	[ºC]	FO supply pump 1 casing temperature

MV Simula
Dead weight: 183.87 [kton], Cargo: Crude oil 176.00 [kton]

Engine make: MAN B&W 5L90MC
Cyl. Bore: 900 mm, Stroke: 2900 mm, Number of Cylinders: 5, Number of Air Coolers: 2, Number of Turbo Chargers: 2, Continuous rating: 17.4 MW, Corresponding engine speed: 74 rpm, Mean Indicated Pressure: 13 bar, Scavenge air pressure: 2.1 bar, Turbine speed: 8000 rpm, Specific FO Consumption: 168 g/kWh.

Prev.	New	Denom.	Name
70.31	63.41	[°C]	FO supply pump 2 casing temperature
105.59	106.63	[°C]	FO temperature inlet main engine
55	50.43	[°C]	Fore bunker tank FO temperature
65.20	66.2	[°C]	HFO service tank temperature
72.98	71.09	[°C]	HTFW temperature inlet main engine
80.16	80.04	[°C]	HTFW temperature outlet main engine
34.10	34.2	[°C]	LTFW temperature outlet
48.12	48.94	[°C]	Main Engine air cooler 1 air outlet temperature
48.15	52.50	[°C]	Main Engine air cooler 2 air outlet temperature
48.01	50.64	[°C]	Main Engine air receiver temperature
48.69	49.84	[°C]	Main Engine cylinder 1 air inlet temperature
199.36	208.03	[°C]	Main Engine cylinder 1 cover temperature (mean)
55.31	54.94	[°C]	Main Engine cylinder 1 crank bearing temperature
57.36	58	[°C]	Main Engine cylinder 1 crosshead bearing temperature
322.84	342.28	[°C]	Main Engine cylinder 1 exhaust outlet temperature
–1.11	–7.40	[°C]	Main Engine cylinder 1 exhaust outlet temperature deviation
174.84	185.54	[°C]	Main Engine cylinder 1 liner temperature (mean)
47.28	47.52	[°C]	Main Engine cylinder 1 oil outlet temperature (piston)
80.15	80.68	[°C]	Main Engine cylinder 1 water outlet temperature (liner)
48.14	51.41	[°C]	Main Engine cylinder 2 air inlet temperature
199.78	245.31	[°C]	Main Engine cylinder 2 cover temperature (mean)
55.34	55.30	[°C]	Main Engine cylinder 2 crank bearing temperature
57.38	59.61	[°C]	Main Engine cylinder 2 crosshead bearing temperature
324.53	393.29	[°C]	Main Engine cylinder 2 exhaust outlet temperature

MV Simula
Dead weight: 183.87 [kton], Cargo: Crude oil 176.00 [kton]

Engine make: MAN B&W 5L90MC
Cyl. Bore: 900 mm, Stroke: 2900 mm, Number of Cylinders: 5, Number of Air Coolers: 2, Number of Turbo Chargers: 2, Continuous rating: 17.4 MW, Corresponding engine speed: 74 rpm, Mean Indicated Pressure: 13 bar, Scavenge air pressure: 2.1 bar, Turbine speed: 8000 rpm, Specific FO Consumption: 168 g/kWh.

Prev.	New	Denom.	Name
0.61	43.59	[ºC]	Main Engine cylinder 2 exhaust outlet temperature deviation
174.80	186.61	[ºC]	Main Engine cylinder 2 liner temperature (mean)
47.30	47.70	[ºC]	Main Engine cylinder 2 oil outlet temperature (piston)
80.55	80.24	[ºC]	Main Engine cylinder 2 water outlet temperature (liner)
47.25	50.75	[ºC]	Main Engine cylinder 3 air inlet temperature
200.09	206.81	[ºC]	Main Engine cylinder 3 cover temperature (mean)
55	55.14	[ºC]	Main Engine cylinder 3 crank bearing temperature
57.38	57.98	[ºC]	Main Engine cylinder 3 crosshead bearing temperature
325.18	351.5	[ºC]	Main Engine cylinder 3 exhaust outlet temperature
1.25	1.81	[ºC]	Main Engine cylinder 3 exhaust outlet temperature deviation
175.35	192.6	[ºC]	Main Engine cylinder 3 liner temperature (mean)
47.30	47.54	[ºC]	Main Engine cylinder 3 oil outlet temperature (piston)
80.15	79.71	[ºC]	Main Engine cylinder 3 water outlet temperature (liner)
48.04	51.42	[ºC]	Main Engine cylinder 4 air inlet temperature
199.91	202.21	[ºC]	Main Engine cylinder 4 cover temperature (mean)
55.34	56.00	[ºC]	Main Engine cylinder 4 crank bearing temperature
57.38	57.79	[ºC]	Main Engine cylinder 4 crosshead bearing temperature
324.58	333.07	[ºC]	Main Engine cylinder 4 exhaust outlet temperature
.66	–16.63	[ºC]	Main Engine cylinder 4 exhaust outlet temperature deviation
176.33	178.45	[ºC]	Main Engine cylinder 4 liner temperature (mean)
47.33	47.36	[ºC]	Main Engine cylinder 4 oil outlet temperature (piston)
79.99	79.67	[ºC]	Main Engine cylinder 4 water outlet temperature (liner)
48.31	50.32	[ºC]	Main Engine cylinder 5 air inlet temperature

MV Simula
Dead weight: 183.87 [kton], Cargo: Crude oil 176.00 [kton]

Engine make: MAN B&W 5L90MC
Cyl. Bore: 900 mm, Stroke: 2900 mm, Number of Cylinders: 5, Number of Air Coolers: 2, Number of Turbo Chargers: 2, Continuous rating: 17.4 MW, Corresponding engine speed: 74 rpm, Mean Indicated Pressure: 13 bar, Scavenge air pressure: 2.1 bar, Turbine speed: 8000 rpm, Specific FO Consumption: 168 g/kWh.

Prev.	New	Denom.	Name
198.92	199.91	[°C]	Main Engine cylinder 5 cover temperature (mean)
55.48	55.43	[°C]	Main Engine cylinder 5 crank bearing temperature
57.36	57.75	[°C]	Main Engine cylinder 5 crosshead bearing temperature
322.51	328.35	[°C]	Main Engine cylinder 5 exhaust outlet temperature
–1.41	–21.37	[°C]	Main Engine cylinder 5 exhaust outlet temperature deviation
172.98	178.94	[°C]	Main Engine cylinder 5 liner temperature (mean)
47.29	47.38	[°C]	Main Engine cylinder 5 oil outlet temperature (piston)
80.06	79.78	[°C]	Main Engine cylinder 5 water outlet temperature (liner)
49.5	49.51	[°C]	Main Engine main bearing 1 temperature
49.2	49.08	[°C]	Main Engine main bearing 2 temperature
49.4	48.96	[°C]	Main Engine main bearing 3 temperature
52.04	49.86	[°C]	Main Engine main bearing 4 temperature
49.34	50.02	[°C]	Main Engine main bearing 5 temperature
49.59	50.53	[°C]	Main Engine main bearing 6 temperature
61.37	63.28	[°C]	Main Engine thrust bearing temperature (axial y)
177.15	179.4	[°C]	Main Engine turbo charger 1 air outlet temperature
241.48	262.46	[°C]	Main Engine turbo charger 1 exhaust outlet temperature
176.63	186.04	[°C]	Main Engine turbo charger 2 air outlet temperature
250.41	262.43	[°C]	Main Engine turbo charger 2 exhaust outlet temperature
44.91	45.00	[°C]	Main LO temperature inlet main engine
44.96	45	[°C]	Main LO temperature inlet main engine
45.2	50.79	[°C]	Port bunker tank FO temperature
27	23	[°C]	Seawater temperature
66.27	65.79	[°C]	Settling tank 1 temperature

MV Simula
Dead weight: 183.87 [kton], Cargo: Crude oil 176.00 [kton]

Engine make: MAN B&W 5L90MC
Cyl. Bore: 900 mm, Stroke: 2900 mm, Number of Cylinders: 5, Number of Air Coolers: 2, Number of Turbo Chargers: 2, Continuous rating: 17.4 MW, Corresponding engine speed: 74 rpm, Mean Indicated Pressure: 13 bar, Scavenge air pressure: 2.1 bar, Turbine speed: 8000 rpm, Specific FO Consumption: 168 g/kWh.

Prev.	New	Denom.	Name
60.78	65.57	[ºC]	Settling tank 2 temperature
50	50.50	[ºC]	Starboard bunker tank FO temperature
241.7	256.24	[ºC]	Steam temperature outlet exhaust Boiler
43.89	28.77	[ºC]	Thermal oil return line temperature
133.06	87.22	[ºC]	Thermal oil supply line temperature
110.26	225.88	[mmWC]	Exhaust boiler pressure drop
186.36	202.8	[mmWC]	Main Engine air cooler 1 air flow press drop
188.42	293.79	[mmWC]	Main Engine air cooler 2 air flow press drop
124.25	135.3	[mmWC]	Main Engine turbo charger 1 air filter difference press
125.62	122.43	[mmWC]	Main Engine turbo charger 2 air filter difference press
18.00	18.00	[m]	Aft bunker tank FO level
0.31	0.61	[m]	Camshaft LO tank level
5.00	4.5	[m]	DO service tank level
10.11	8.23	[m]	Fore bunker tank FO level
5.00	4.5	[m]	HFO service tank level
0.70	0.22	[m]	Main Engine cylinder LO tank level
1.50	1.35	[m]	Main LO service tank level
16.56	4.03	[m]	Port bunker tank FO level
5	5.5	[m]	Settling tank 1 level
0.2	0.5	[m]	Settling tank 1 water level
6	6	[m]	Settling tank 2 level
0.6	0.1	[m]	Settling tank 2 water level
2.4	0.21	[m]	Spill oil tank level
16.01	4.55	[m]	Starboard bunker tank FO level
1.50	1.52	[kg/h]	Main Engine cylinder 1 liner lubrication flow

MV Simula

Dead weight: 183.87 [kton], Cargo: Crude oil 176.00 [kton]

Engine make: MAN B&W 5L90MC

Cyl. Bore: 900 mm, Stroke: 2900 mm, Number of Cylinders: 5, Number of Air Coolers: 2, Number of Turbo Chargers: 2, Continuous rating: 17.4 MW, Corresponding engine speed: 74 rpm, Mean Indicated Pressure: 13 bar, Scavenge air pressure: 2.1 bar, Turbine speed: 8000 rpm, Specific FO Consumption: 168 g/kWh.

Prev.	**New**	**Denom.**	**Name**
1.50	1.52	[kg/h]	Main Engine cylinder 2 liner lubrication flow
1.50	1.52	[kg/h]	Main Engine cylinder 3 liner lubrication flow
1.50	1.52	[kg/h]	Main Engine cylinder 4 liner lubrication flow
1.50	1.52	[kg/h]	Main Engine cylinder 5 liner lubrication flow
0.24	0.31	[bar]	Camshaft LO filter difference press
3.2	3.33	[bar]	Camshaft LO press inlet main engine
0.34	0.34	[bar]	FO filter difference pressure
7.41	7.5	[bar]	FO pressure at main engine
4.02	4.03	[bar]	FO supply pump pressure
1.89	1.85	[bar]	HTFW press inlet main engine
3.25	3.20	[bar]	LTFW pump discharge pressure
0.30	0.26	[bar]	Main LO filter difference press
2.19	2.18	[bar]	Main LO press inlet main engine bearings
2.19	2.17	[bar]	Main LO press inlet main engine bearings
15	30	[bar]	Start air receiver 1 pressure
30	28	[bar]	Start air receiver 2 pressure
0.47	0.55	[%]	Main LO contamination index

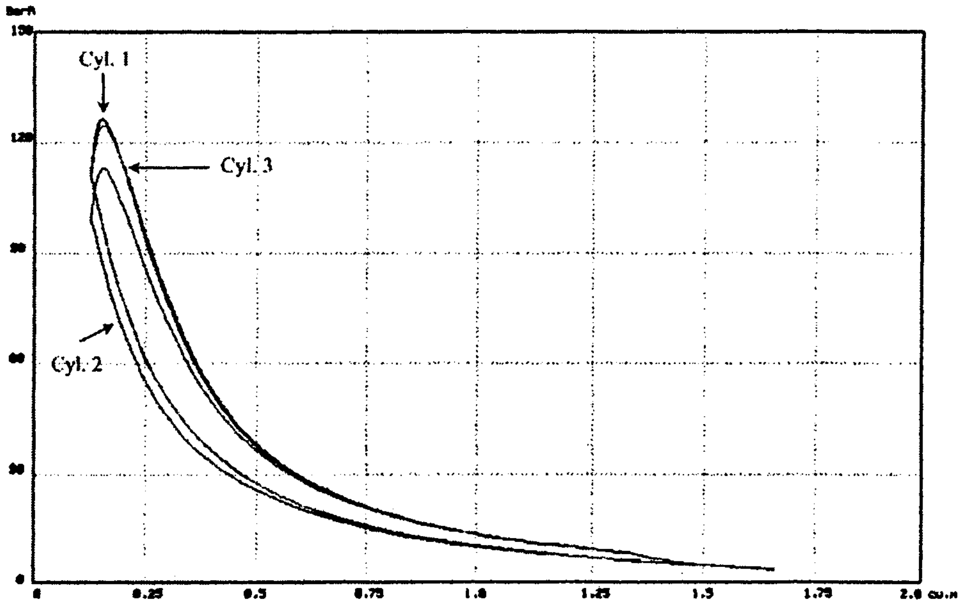

Figure D-2. Cylinder Indication Pressure/Volume Diagram for Cyl. 1, 2 and 3. The following data is given: Drive speed 74 rpm. **Cyl 1:** General; INDEX 97%, Mean Indicated Pressure (MIP) 18.6 bar, Indicated Power (kW) 4118.0 kW, Combustion; Time of Injection (TIGN) 2.2°, Maximum Pressure (PMAX) 126.5, Time of Maximum Combustion Pressure (TMAX) 14°, Compression Pressure (PCOMP) 110.4 bar Injection; Injector Opening Pressure (PINJO) 420 bar, Maximum Pressure (PINJM) 736.3 bar, Injector Opening Time (TINJO) –1.0°, Length of Injector Opening Time (LINJ) 17.5°. **Cyl 2:** General; INDEX 96.2%, MIP 16.4 bar, IkW 3652.0 kW, Combustion; TIGN 2.3°, PMAX 113.0, TMAX 14°, PCOMP 98.8 bar Injection; PINJO 420 bar, PINJM 735.3 bar, TINJO –1.0°, LINJ 17.3°. **Cyl 3:** General; INDEX 96%, MIP 17.8 bar, IkW 3963.0 kW, Combustion; TIGN 2.4°, PMAX 126.6, TMAX 14.8°, PCOMP 110.1 bar Injection; PINJO 420 bar, PINJM 735.0 bar, TINJO –1.0°, LINJ 17.3°.

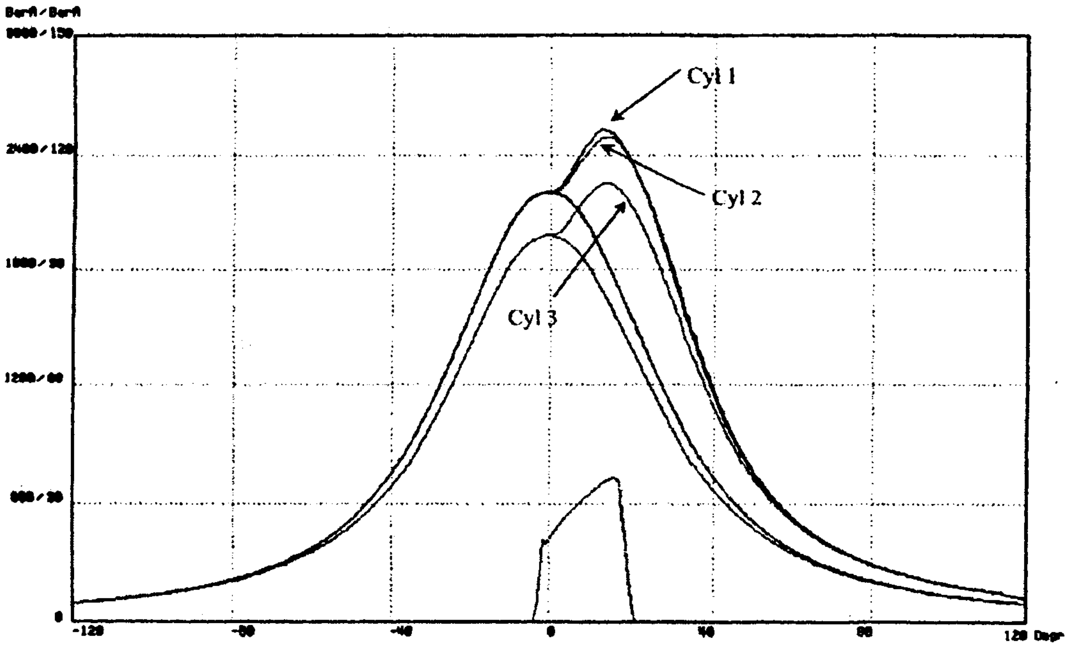

Figure D-3. Cylinder Indication Pressure/Angle Diagram for Cyl. 1, 2 and 3. Refer to Figure D-2 for more data.

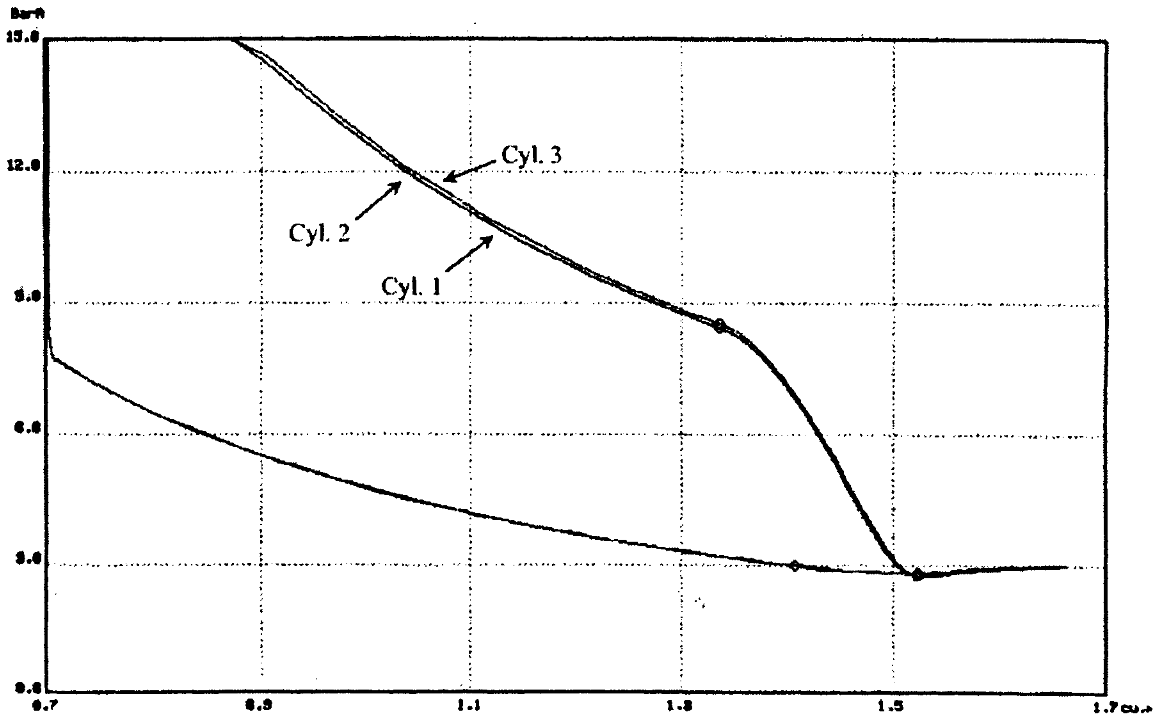

Figure D-4. Weak Spring Diagram for Cyl. 1, 2 and 3. Refer to Figure D-2 for more data. **Cyl 1:** SCAV.P 2.09 bar, EXH.P 1.71 bar. **Cyl 2:** SCAV.P 2.09 bar, EXH.P 1.70 bar. **Cyl 3:** SCAV.P 2.09 bar, EXH.P 1.70 bar.

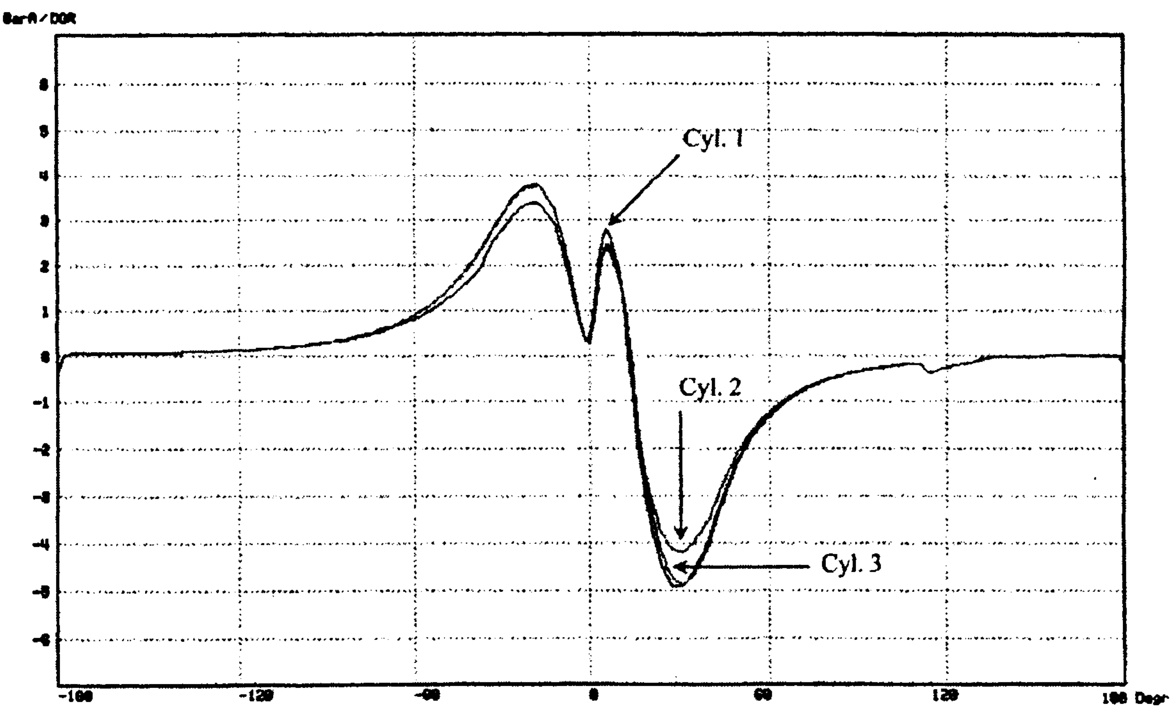

Figure D-5. Cylinder Indication Delta-Pressure/Angle Diagram for Cyl. 1, 2 and 3. Refer to Figure D-2 for more data.

PLANT OPERATION EVALUATION (PO) FORM

Student:	Date:	Watch:
Instructor:	Observer:	Assessor:
Transit From:	To:	Scenario:

PHASE: DEVELOPMENT ☐ EVALUATION ☐ NUMBER: ______

Tick off with an **X** to indicate items below standard.

ITEM		COMMENT
A. GENERAL PROCEDURES		
■ Safe practices	☐	
■ Checklists	☐	
■ Maintains the Log	☐	
B. AUXILIARY UNITS		
■ Seawater	☐	
■ Freshwater	☐	
■ Air systems	☐	
■ Lube. oil systems	☐	
■ F.O. systems	☐	
■ Centrifuges	☐	
C. DIESEL GENERATOR		
■ Preparation	☐	
■ Synchronization/Load sheering	☐	
D. STEAM BOILER		
■ Preparation	☐	
■ Connecting	☐	
E. TURBO GENERATOR		
■ Preparation	☐	
■ Synchronization/Load sheering	☐	
F. STEAM CARGO TURBINE		
■ Preparation	☐	
■ Operation	☐	
G. MAIN PROPULSION MACHINERY		
■ Preparation	☐	
■ Normal running mode	☐	
H. ATTITUDE		
■ Confidence	☐	
■ Initiative	☐	
■ Flexibility	☐	
■ Intensity	☐	
I. SAFETY (CRITICAL)		
■ Structured approach	☐	
■ Safety procedures	☐	
■ Attitude towards Safety	☐	

GENERAL IMPRESSION (INDICATE STRENGTHS AND WEAKNESSES)

FINAL DISPOSITION:

BELOW STANDARD ☐ STANDARD ☐ ABOVE STANDARD ☐

ASSESSOR: ______________________ OBSERVER: ______________________

INSTRUCTOR: ______________________ STUDENT: ______________________

First Failure:	VERBAL WARNING	☐
Second Failure:	FORMAL CAUTION	☐
Third Failure:	TRAINING REVIEW BOARD	☐

VERBAL WARNING: (issued after first failure)

You are hereby verbally warned that your performance in Engine-Room Watchkeeping has, thus far, been unsatisfactory and you must improve to meet the standard.

ASSESSOR: ______________________ STUDENT: ______________________

INSTRUCTOR: ______________________ DATE: ______________________

ENGINE TROUBLE-SHOOTING EVALUATION (ETS) FORM

Student:	Date:	Watch:
Instructor:	Observer:	Assessor:
Transit From:	To:	Scenario:

PHASE: DEVELOPMENT ☐ **EVALUATION ☐** **NUMBER: ______**

Tick off with an **X** to indicate items below standard.

ITEM	FAULT NUMBER													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
A. ASSESS and PLAN														
1. Understand warning signals	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Solution	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Brief Bridge/ Ch. Eng.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B. EXECUTION														
1. Fault prediction precision	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Adjust Solution	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Use of Eng. Room Team	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Multiple Input From Others	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Consort Consideration	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Mental Analysis	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
C. REMEDY SITUATION														
1. Within acceptable timeframe	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Correct Action Taken	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
D. ATTITUDE														
1. Confidence	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Terminology	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Flexibility	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Initiative	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
E. SAFETY (CRITICAL)														
1. Following std. procedures	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Proper reaction to situation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
FINAL RATING														

FAULT COMMENT
1
2
3
4
5
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11
12
13
14

GENERAL IMPRESSION (INDICATE STRENGTHS AND WEAKNESSES)

FINAL DISPOSITION:

BELOW STANDARD ☐ STANDARD ☐ ABOVE STANDARD ☐

ASSESSOR: ____________________ OBSERVER: ____________________

INSTRUCTOR: ____________________ STUDENT: ____________________

First Failure:	VERBAL WARNING	☐
Second Failure:	FORMAL CAUTION	☐
Third Failure:	TRAINING REVIEW BOARD	☐

VERBAL WARNING: (issued after first failure)

You are hereby verbally warned that your performance in Engine-Room Watchkeeping has, thus far, been unsatisfactory and you must improve to meet the standard.

ASSESSOR: ____________________ STUDENT: ____________________

INSTRUCTOR: ____________________ DATE: ____________________

ENGINE OFFICER OF THE WATCH EVALUATION (OOW) FORM

Student:	Date:	Watch:
Instructor:	Observer:	Assessor:
Transit From:	To:	Scenario:

PHASE: DEVELOPMENT ☐ EVALUATION ☐ NUMBER: _______

Tick off with an **X** to indicate items below standard.

ITEM		COMMENT
A. WATCH TURNOVER		
■ Personnel	☐	
■ Machinery	☐	
■ Communications	☐	
■ Operations	☐	
■ Weather	☐	
B. EXECUTION		
■ Knowledge / Use of Eng. Equip	☐	
■ OOW / Eng. Crew liaison	☐	
■ Supervision of Machinery	☐	
■ Assessment / Planning ahead	☐	
■ Information flow to Ch Eng/Bridge	☐	
■ Scheduled timing of events	☐	
■ Execution of Bridge orders	☐	
■ Internal/External Communication	☐	
■ Completion of Logbooks	☐	
C. HANDLING		
■ Machinery and equipment	☐	
■ Communications	☐	
■ Knowledge of eng. characteristics	☐	
■ Supervision of eng. staff	☐	
■ Maintenance and support	☐	
D. ATTITUDE		
■ Confidence	☐	
■ Initiative	☐	
■ Flexibility	☐	
■ Intensity	☐	
E. SAFETY (CRITICAL)		
■ Breakdown Assessment	☐	
■ Contain/Minimize Damage Effects	☐	
■ Notifying/Recomm. to Bridge	☐	
■ Reacting to Emergencies	☐	
■ Prioritizing safety	☐	
■ Informing if in doubt	☐	

GENERAL IMPRESSION (INDICATE STRENGTHS AND WEAKNESSES)

FINAL DISPOSITION:

BELOW STANDARD ☐ STANDARD ☐ ABOVE STANDARD ☐

ASSESSOR: ______________________ OBSERVER: ______________________

INSTRUCTOR: ______________________ STUDENT: ______________________

First Failure:	VERBAL WARNING	☐
Second Failure:	FORMAL CAUTION	☐
Third Failure:	TRAINING REVIEW BOARD	☐

VERBAL WARNING: (issued after first failure)

You are hereby verbally warned that your performance in Engine-Room Watchkeeping has, thus far, been unsatisfactory and you must improve to meet the standard.

ASSESSOR: ______________________ STUDENT: ______________________

INSTRUCTOR: ______________________ DATE: ______________________

Suggestions for subsequent simulator exercises

Automation:

This exercise should include the following topics:

- Level control
- Setting of optimal parameters of regulators in general
- Adjustment of P, PI and PID regulators
- Cascade regulation
- Boiler water level regulation
- Boiler combustion multi-regulation

Normal operation:

This exercise should be performed with three students acting as The Chief Engineer, First Engineer and Second Engineer. Rotate the position of Chief Engineer among them. Include the following topics:

- Arrival at port of discharge
- Discharge of cargo and watchkeeping in port
- Preparing the main propulsion plant for departure
- Departure from berth
- Quitting the pilot
- Setting of sea watch
- Preparing for an unmanned period
- Normal operation at sea, unmanned period
- Keeping of Engine log, Oil log and Manoeuvre log including preparation of required reports

Steam plant in service diagnostics:

This exercise should include the following topics:

- Condenser air leakage
- Fouled condenser heat exchange areas
- Condenser seawater leakage
- Worn turbo generator lubrication oil pump
- Fouled main boiler heat exchange areas
- Fouled waste heat boiler heat exchange areas
- Worn feed water pump
- Worn fuel oil pump for the auxiliary boiler
- Auxiliary boiler combustion control failure

Electrical power system:

This exercise should include the following topics:

- Adjusting the generator magnetizing current
- Control and adjust relevant alarm settings and regulating systems
- Correct different earth faults

GUIDANCE ON THE IMPLEMENTATION OF MODEL COURSES

Contents

Part 1 – Preparation

1 Introduction

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

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

2 General considerations

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

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

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

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

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

3 Specific considerations

3.1 **Scope of course**

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

3.2 **Course objective**

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

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

3.3 Entry standards

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

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

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

3.4 Course certificate, diploma or document

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

3.5 Course intake limitations

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

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

3.6 Staff requirements

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

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

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

3.7 Teaching facilities and equipment

Rooms and other services

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

Equipment

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

.1 blackboards and writing materials

.2 apparatus in laboratories for any associated demonstrations and experiments

.3 machinery and related equipment in workshops

.4 equipment and materials in other spaces (e.g. for demonstrating fire fighting, personal survival, etc.).

3.8 Teaching aids

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

3.9 Audio-visual aids

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

.1 Overhead projectors

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

.2 Slide projectors

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

.3 Cine projector

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

.4 Video equipment

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

.5 Computer equipment

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

.6 General note

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

3.10 IMO references

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

3.11 Textbooks

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

3.12 Bibliography

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

3.13 Timetable

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

Part 2 – Notes on Teaching Technique

1 Preparation

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

1.2 Read and study thoroughly all the syllabus elements.

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

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

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

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

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

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

2 Delivery

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

2.2 Talk clearly and sufficiently loudly to reach everyone.

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

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

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

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

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

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

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

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

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

Part 3 – Curriculum Development

1 Curriculum

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

2 Course content

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

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

3 Job analysis

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

4 Course plan

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

5 Syllabus

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

6 Syllabus content

The material contained in a syllabus is not static; technology is continuously undergoing change and there must therefore be a means for reviewing course material in order to eliminate what is redundant and introduce new material reflecting current practice. As defined above, a syllabus can be though of as a list and, traditionally, there have always been an "examination syllabus" and a "teaching syllabus"; these indicate, respectively, the subject matter contained in an examination paper, and the subject matter a teacher is to use in preparing lessons or lectures.

7 Training outcomes

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

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

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

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

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

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

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

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

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

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

8 Assessment

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

Annex A1 – Preparation checklist

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

Annex A1 – Preparation checklist *(continued)*

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

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

Subject area: Ship construction

Prerequisite: Have a broad understanding of shipyard practice

General aims: Have knowledge of materials used in shipbuilding, specification of shipbuilding steel and process of approval

Textbooks: No specific textbook has been used to construct the syllabus, but the instructor would be assisted in preparation of lecture notes by referring to suitable books on ship construction, such as *Ship Construction* by Eyres (T12) and *Merchant Ship Construction* by Taylor (T58)

COURSE OUTLINE

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

Part C3: Detailed Teaching Syllabus

Introduction

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

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

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

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

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

will provide valuable information to instructors.

Explanation of information contained in the syllabus tables

The information on each table is systematically 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. For example, the Function 3, Controlling the Operation of the Ship and Care for Persons on board at the Management Level, comprises a number of COMPETENCES. Each competence is uniquely and consistently numbered in 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 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 amounts of alloying materials used
- state that the specifications of shipbuilding steels are laid down by classification societies
- state that shipbuilding steel is tested and graded by classification society surveyors who stamp it with approval marks

and so on.

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

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

3.1.1 FUNDAMENTAL PRINCIPLES OF SHIP CONSTRUCTION, TRIM AND STABILITY

Textbooks: T11, T12, T35, T58, T69

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

Required performance:

1.1 Shipbuilding materials (3 hours) — R1

- states that steels are alloys of iron, with properties dependent upon the type and amounts of alloying materials used
- states that the specifications of shipbuilding steels are laid down by classification societies
- states that shipbuilding steel is tested and graded by classification society surveyors, who stamp it with approval marks
- explains that mild steel, graded A to 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 a 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