REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS
MARITIME INDUSTRY AUTHORITY

MARINA Circular No. 2014 - 01

ANNEX II

NEW MANAGEMENT LEVEL COURSE FOR MARINE ENGINEER OFFICERS

(Chief Engineer Officer and Second Engineer Officer)

In Accordance with
2010 Manila Amendments to the
1978 STCW Convention

6th Floor Parkview Plaza, 984 Taft Avenue cor T.M. Kalaw, Ermita, Manila, Philippines
Tel. No. (632) 526-0971 Email: stcw@marina.gov.ph
Fax No. (632) 524-2895

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FOREWORD

This New Management Level Course for Marine Engineer Officers was developed to comply with the requirements under Regulation III/2 of the 2010 Manila Amendments to the 1978 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention).

The curriculum was designed based on the minimum standards of competence provided in Table A-III/2 under the said regulation and guided by the revised IMO Model Course 7.02 (Chief Engineer Officer and Second Engineer Officer), which was validated during the 44th session of the IMO's Sub-Committee on Standards of Training and Watchkeeping (STW 44) held from 29 April to 3 May 2013. Likewise, the newly revised approved education and training for Officers In Charge of an Engineering Watch on seagoing ships powered by main propulsion machinery of 750 kW propulsion power or more, otherwise known as the Bachelor of Science in Marine Engineering (BSMarE) program, which was approved and issued under the oversight and supervision of the STCW Administration through CHED Memorandum Order (CMO) No. 32, series of 2013, has been accorded due consideration since the said program now covers specific topics in the management level course for marine engineer officers.

In order to avoid duplication or repetition of subjects/topics and also to ensure congruence between the BSMarE and this Management Level Course, a course mapping was made to identify which management level subjects or topics were already covered in the aforesaid program. The management level topics that were already covered are no longer repeated in this New Management Level Course for Marine Engineer Officers.

Guided by the topics or subjects and the corresponding time allocation in the above-mentioned revised IMO Model Course 7.02, the curriculum for the New Management Level Course for Marine Engineer Officers was formulated in accordance with the 2010 Manila Amendments to the 1978 STCW Convention.

MAXIMO Q MEJIA JR, PhD
Administrator

FUNCTION 1

MARINE ENGINEERING AT THE MANAGEMENT LEVEL

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1. F1-Module 1: Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery

FUNCTION 1

PART A
COURSE FRAMEWORK

SCOPE

This Function covers the mandatory requirements for knowledge, understanding and proficiencies for *"Marine Engineering at the Management Level"* as provided for under the 2010 STCW Manila Amendments, Regulation III/2 in relation to Section A-III/2, Table A-III/2 thereof. The topics were carefully selected following a course mapping based on the revised IMO Model Course 7.02 and the revised Bachelor of Science in Marine Engineering (BSMarE) program under CHED Memorandum Order (CMO) No. 32, series of 2013, which now covers specific management level topics under this function.

LEARNING OBJECTIVES

Upon successful completion of the training under this Function, trainees shall be expected to have gained the minimum knowledge, understanding and proficiencies needed to carry out and undertake at the management level the tasks, duties and responsibilities in marine engineering on ships powered by main propulsion machinery of 3,000 kW propulsion power or more.

ENTRY STANDARD

Entrants to this course must be Marine Engineer Officers who are holders of Certificate of Competency (COC) under Regulation III/1 of the STCW '78 Convention, as amended and have not less than one (1) year of seagoing service as officer in charge of an engineering watch on seagoing ships powered by main propulsion machinery of 750 kW propulsion power or more.

COURSE INTAKE LIMITATION

- Trainees shall not exceed 24 students per class.
- Practical training using a full mission engine simulator shall follow a man-machine ratio of 4:1.

STAFF REQUIREMENTS

Every METI offering this Management Level Course shall have a Training Supervisor, a minimum of two (2) instructors and an assessor for the course; subject the approval by the Administration in accordance with MARINA Circular (MC) No. 2013-03, as amended by MC 2013-12, series of 2013. The qualification requirements shall be as follows:

STAFF REQUIREMENTS *(Continued…)*

Training Supervisor

- Holder of at least a Bachelor of Science Degree;
- Have not less than one (1) year experience in maritime education and training;
- Have an understanding of the training course and the specific objectives of the training being conducted under his supervision; and
- Holder of a Certificate of Completion of Instructor's Training Course (IMO Model Course 6.09) or 18 earned units in teacher education covering teaching methodologies, test and measurement.

Instructors

- Management Level Engineering Officer with not less than one (1) year seagoing service in that capacity on board a ship powered by main propulsion machinery of 3,000 kW propulsion power or more;
- Holder of a Certificate of Completion of Instructor's Training Course (IMO Model Course 6.09) or 18 earned units in teacher education covering teaching methodologies, test and measurement;
- Holder of a Certificate of Completion of the Management Level Course for Marine Engineer Officers;
- Holder of a COC as Management Level Marine Engineer Officer;
- Holder of a valid Professional Regulation Commission (PRC) License as Management Level Marine Engineer Officer;
- If conducting training using simulator:
  - Must be holder of a Certificate of Completion of the "Train the Simulator Trainer and Assessor" (IMO Model Course 6.10), or approved Training Course for Simulator Instructors and Assessors; and
  - Have gained practical operational experience on the particular type of simulator being used.

STAFF REQUIREMENTS *(Continued…)*

Assessors

- Management Level Engineer Officer with not less than one (1) year seagoing service in that capacity on board a ship powered by main propulsion machinery of 3,000 kW propulsion power or more;
- Holder of a Certificate of Completion of the Management Level Course for Marine Engineer Officers;
- Holder of a valid PRC License as Management Level Engineer Officer;
- Holder of a Certificate of Completion of the Training Course in Assessment, Examination and Certification of Seafarers (IMO Model Course 3.12);
- Have gained practical assessment experience as understudy for not less than three (3) times;
- If conducting assessment involving the use of simulators:
  - Must be holder of a Certificate of Completion of the Train the Simulator Trainer and Assessor (IMO Model Course 6.10), or approved Training Course for Simulator Instructors and Assessors; and
  - Has gained practical assessment experience on the particular type of simulator being used under the supervision and to the satisfaction of an experienced Assessor for a minimum of for not less than three (3) times.

Resource Person

The METI may be allowed to engage the services of other persons with established expertise on particular topics, provided that the Administration shall be duly informed at least five (5) working days prior to engagement.

<u>NOTE TO METIs:</u>

The foregoing are the qualification standards that must be met by the Instructors, Assessors and Supervisor. In addition, METIs shall exercise utmost diligence and responsibility in the selection of such Staff and ensure that they are appropriately qualified to carry out effective teaching, assessment and supervision of the course, respectively.

TRAINING FACILITIES
For the theoretical part, a classroom with multi-media over-head projector, with a computer set, and a white board with eraser will be utilized, among others. This does not however preclude METIs from utilizing additional teaching aids to facilitate learning.
TRAINING EQUIPMENT
A Full Mission Engine Room Simulator certified as Class "A" or similar category showing reference to STCW Table A-III/2, by an internationally recognized Classification Society, capable of simulating the required knowledge, understanding and proficiencies (KUPs) for marine engineering at the management level in the aforesaid Table, with briefing and debriefing room.
EXEMPTION
There is no particular exemption from any part of this Function. However, since topics about *Steam and Gas Turbines relating to marine propulsion plant machinery* were not covered by this New Management Level Course for Marine Engineer Officers, a *"limitation on Steam and Gas Turbines"* shall be indicated in the COCs of successful candidates for certification.
CERTIFICATE OF COURSE COMPLETION
Trainees, who successfully completed this Function and passed the assessment thereof, shall be issued a Certificate of Completion. The format of such certificate shall be in accordance with the format prescribed by the Administration.
SUGGESTED TEXT BOOKS AND REFERENCES
For the textbooks and reference materials, METIs should refer to the list of Teaching Aids, Videos, References, Textbooks and Bibliographies indicated in the revised IMO Model Course 7.02 validated during the 44th Session of the IMO Sub-Committee on Standards of Training and Watchkeeping. This does not however preclude METIs from utilizing other relevant and more updated books and references that may be available or prescribed by the Administration. METIs shall exercise prudence and utmost responsibility in selecting the textbooks and references for this Function to ensure that only relevant and up-to-date ones shall be used.

FUNCTION 1

PART B
COURSE OUTLINE

<u>**MAIN TOPICS**</u>	**NO. OF HOURS**
Competence	
F1 - Module 1: Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery	
1. Start up and shut down main propulsion and auxiliary machinery, including associated systems	20
2. Operating limits of propulsion plant	8
3. The efficient operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery	125
4. Functions and mechanism of automatic control for main engine	4
5. Functions and mechanism of automatic control for auxiliary machinery	9
TOTAL FOR FUNCTION 1:	**166**

General Rule on Time Allocation:

METIs must note that the number of hours allocated for the topics in this Function are the minimum and can be increased as may be necessary to cover new requirements, laws, rules and regulations, new developments, trends and practices in the maritime industry.

FUNCTION 1

PART C
COURSE SYLLABUS

F1 - Module 1

Competence: ***Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery***

1. **Start up and shut down and main auxiliary machinery, including associated system**

1.1 Main machinery and associated systems

1.1.1 Describe precautions to be observed when starting up and shutting down main machinery
1.1.2 Explain the need for authorized and documented procedures/ check list for starting up main machinery
1.1.3 Describe limitations/conditions for starting up and shutting down main machinery depending on types of main machinery
1.1.4 Describe the functions of interlocking and how they work while main machinery is being started up
1.1.5 Explain procedures for starting up and shutting down main machinery in terms of design features of main machinery including associated systems
1.1.6 Describe parameters and factors necessary to develop procedures for starting up and shutting down main machinery including associated system
1.1.7 Explain that principles of starting up and shutting down procedures of main machinery are the same for any type of main diesel engine, steam turbine and gas turbine
1.1.8 Describe precautions for conducting trial run of main machinery

1.2 Steam boilers and associated systems

1.2.1 Explain the need of developing procedures for starting up and shutting down boilers depending on types and specifications of boilers
1.2.2 Describe precautions to be observed when starting up and shutting down main and auxiliary boilers
1.2.3 Describe the standard procedures of firing up main and auxiliary boilers, and building up steam pressure including the use of bypass functions
1.2.4 Describe the standard procedures of shutting down main and auxiliary boilers
1.2.5 Describe the preparations for associated systems including control systems and drain system for starting up main and auxiliary boilers

1.3 Auxiliary prime mover and associated systems

1.3.1 Explain the general status of auxiliary prime movers and associated systems before starting up depending on types of ships

1.3.2 Describe precautions to be observed when starting up and shutting down prime movers

1.3.3 Describe the functions of interlocking and how they work while auxiliary prime movers are being started up including automatic control systems

1.3.4 Describe the standard procedures of starting up and shutting down auxiliary prime movers in terms of types and specifications of prime movers in terms of types and specifications of prime movers

1.4 Other auxiliary machinery

1.4.1 Explain the general status of auxiliary machinery and associated systems before starting up depending on types of ships

1.4.2 Explain the differences between auxiliary machinery used for ship's propulsion and others in terms of back-up systems and safety systems

1.4.3 Describe the standard procedures of starting up and shutting down auxiliary machinery used for ship's propulsion

2. Operating Limits of Propulsion Plants

2.1 Describe the parameters concerning operating limits of main diesel engine such as mean indicated pressure, maximum indicated pressure, shaft revolution, torque, scavenging air pressure, exhaust gas temperature, cooling water temperature, lubricating oil temperature, turbocharger revolution and others

2.2 Describe the parameters concerning operating limits of main steam turbine such as steam inlet pressure and temperature, torque, revolution, vibration, and others

2.3 Describe the parameters concerning operating limits of main gas turbine such as exhaust gas temperature, torque, revolution, vibration and others

2.4 Describe the parameters concerning operating limits of main/auxiliary steam boiler such as properties of boiler water, air/fuel ratio and others

2.5 Describe the parameters concerning operating limits of diesel, shaft and steam turbine generator

2.6 Describe the design standards of propulsion plants concerning operating limits of plant machinery such as sea water temperature, ambient temperature and fluid velocity

3. The efficient operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery

3.1 Diesel engines

3.1.1 Explains the use of indicator diagrams and draws diagrams to explain:
- Compression pressure, maximum pressure and faults
- Area of indicator diagram
- Calculation of indicated and effective engine power
- Calculating turbocharger efficiency
- Estimation of effective engine power without indicator diagrams
    - Fuel index
    - Turbocharger speed
- Detects faults from sample indicator diagrams
- Discusses engine condition monitoring and evaluation systems with regard to:
    - On line system with automatic sampling of engine parameters supplemented by cylinder pressure measurement
    - Engine diagnosis system and computer controlled surveillance

3.2 Engine components

3.2.1 Interpret static and dynamic loads and stresses, identifying service limitations of diesel engine components

3.2.2 Evaluate different fabrication methods of diesel engine components, including:
- Welding
- Forging
- Utilizing composite materials
- Plasma-spraying
- Laser hardening and
- Use of ceramics and other special materials.

3.2.3 Identify two and four stroke operating cycle forces, couples, and moments, relating these to design principles of:
- Crankshafts
- Bedplates
- Foundations
- Crossheads.

3.2.4 Explain out of balance gas and inertia forces, couples, and moments, and relate these to flywheels, balance weights, and first/second order balancing, and hull vibration.

3.2.5 Explain factors contributing to torsional vibration, and identify methods of minimizing or eliminating harmful effects of critical speeds.

3.2.6 Evaluate the calibration of:
- Pistons
- Cylinder liners
- Piston rings
- Bearings
- Crankshafts, to identify wear patterns, limits, and means of correction

3.2.7 Specify alignment and adjustment criteria of:
- Crankshafts
- Chain drives
- Gear drives
- Integral thrust bearings
- Crossheads.

3.2.8 Compile specified working clearances and limits of all bearings, sliding surfaces, and interference fits of a typical diesel engine, using engine builders' manuals.

3.3 Fuel Injection

3.3.1 Explain why atomization and penetration of fuel and the turbulence of air are essential to optimum combustion in a diesel engine.

3.3.2 State typical injection pressures and viscosities for different grades of fuel.

3.3.3 Describe how and why fuel pumps, camshafts, and injectors are altered for varying fuel types.

3.3.4 Describe, with the aid of simple sketches, the difference between constant and variable injection timing of fuel, showing materials, principal parts, and methods of operation and adjustments of common types of fuel pump.

3.3.5 Compare injection requirements for slow speed, medium speed, and high speed diesel engines, including pilot injection and pre-combustion chambers.

3.3.6 Identify common service faults, symptoms, and causes of combustion problems, specifying appropriate adjustments, including methods of fuel pump timing.

3.3.7 Summarize Occupational Health & Safety aspects of handling and testing fuel injection systems.

3.3.8 Explain, using relevant diagrams and stating normal operating parameters
- Fuel valve cooling arrangement
- Uni-fuel and dual-fuel systems (for high/medium viscosity fuel types)

3.3.9 Discuss the atmospheric pollution aspects of diesel engine combustion, and give methods which reduce this pollution (especially SOx and NOx reduction).(0.25)

3.4 Scavenging and Supercharging

3.4.1 Evaluate the need for scavenging diesel engines
3.4.2 Compare methods of scavenging diesel engines
3.4.3 Specify methods of providing pressurized air for combustion in diesel engines
3.4.4 Assess pressure charging methods for diesel engines
3.4.5 Assess pressure charging methods for diesel engines
3.4.6 Examine the working principles of turbochargers
3.4.7 Assess lubrication and cooling requirements of turbochargers
3.4.8 Analyze typical faults and identify appropriate actions to be undertaken with defective or damaged turbochargers

3.5 Starting and Reversing

3.5.1 Describe starting procedures of diesel engines for power generation, propulsion, and emergency use.
3.5.2 Explain starting and maneuvering requirements/sequences for direct coupled reversible and geared propulsion diesel engines, for fixed and controllable pitch propeller application
3.5.3 Describe, with labeled diagrams to indicate major components, typical maneuvering and reversing systems for propulsion diesel engines
3.5.4 Compare different methods of reversing direct coupled propulsion diesel engines
3.5.5 Identify common faults and identify appropriate actions to be undertaken with typical diesel engine starting and maneuvering systems
3.5.6 Compare the different methods of utilizing diesel engines for ship propulsion, including:
- Direct coupled, reversible slow and medium speed engines
- Clutched and geared reversible and unidirectional medium speed engines with a fixed pitch propeller
- Clutched and geared reversible and unidirectional medium speed engines with a controllable pitch propeller, and
- Diesel electric drive.

3.6 Cooling systems

3.6.1 Analyze the problems that may arise in cooling water spaces of diesel engines.
3.6.2 Evaluate common methods of diesel engine cooling water treatment.

3.6.3 State the importance of maintaining diesel engine thermal efficiency and evaluate thermal loads on engine components.
3.6.4 Justify cooling media selection and state the advantages and disadvantages of various diesel cooling methods.
3.6.5 Evaluate the tests used in the control of diesel engine cooling water treatment.
3.6.6 Enumerate the normal operating limits for diesel engine cooling water treatment.
3.6.7 Interpret the implications of out of limit readings from water treatment tests and state the corrective procedures which should be undertaken.
3.6.8 Itemize the sources and types of contamination of diesel engine cooling water and explain the effects of these contaminations on the reserves of treatment chemicals.
3.6.9 Compare the procedures which may be used to counter contamination of diesel engine cooling water.
3.6.10 Explain, using relevant diagrams and stating normal operating parameters, typical methods of cooling:
- Medium and slow speed diesel engine pistons
- Exhaust valves
- Cylinders
- Turbochargers
- Cylinder heads

3.7 Diesel Engine Control and Safety

3.7.1 With respect to waste heat units:
- Explain the design and operational factors that contribute to fires in waste heat units
- Discuss the generation of soot and hydrogen fires
- Explain the possible consequences of such fires
- Identify routine cleaning and inspection criteria
- Identify symptoms of a fire
- Give appropriate actions to be undertaken upon fire detection in order to contain/extinguish the fire, and
- Identify the risks of isolating a waste heat unit.

3.7.2 With respect to scavenge fires:
- Explain the factors that contribute to a fire in the scavenge chamber of a diesel engine
- Explain the possible consequences of such fires
- Specify detection, protection, and extinguishing devices
- Identify routine cleaning and inspection criteria
- Identify symptoms of a fire, and
- Give appropriate actions to be undertaken upon fire detection in order to contain/extinguish the fire.

3.7.3 With respect to starting air lines:
- Identify principles of explosive mixtures
- Describe how an airline explosion can occur
- Explain the possible consequences of such an explosion
- Identify routine evaluation criteria of starting air systems for minimizing/avoiding an explosion, and
- State how the risk of explosion may be minimized / avoided by protection devices.

3.7.4 With respect to diesel engine crankcases and gearboxes:
- Explain the factors and sequence of occurrences that contribute to generation of explosive oil mist
- Discuss the generation of primary and secondary explosions in these spaces
- Explain the possible consequences of such explosions
- Specify detection and protection devices
- State how the risk may be minimized in service
- State indications of hot spots and possible explosive atmospheres, and
- Give the correct procedure to be undertaken upon indication of a potentially explosive atmosphere, in both diesel and dual fuel engines.

3.7.5 Evaluate the causes and consequences of diesel engine over speed, and give procedures which must be undertaken in the event of such an occurrence.

3.7.6 Explain, using diagrams, the operating principles of:
- Oil mist detectors, giving testing procedures
- Explosion relief doors
- Crankcase breathers
- Crankcase extraction fans.

3.8 Diesel Engine Emergency operation

3.8.1 Explain emergency procedures for maneuvering for diesel engines.

3.8.2 Explain emergency procedures which may be undertaken with defective clutches.

3.9 Multi-engine Propulsion Arrangement

3.9.1 Explain the need for changing the output speed of prime movers.

3.9.2 Define gearing concepts, and explain the advantages and disadvantages of:
- Utilizing gearing to change prime mover output speed
- In volute gearing
- Spur and helical gears

3.9.3 Assess the need for disengaging prime movers from drive lines
3.9.4 Identify common types of clutches and couplings used with prime movers
3.9.5 Outline maintenance procedures associated with clutches.

3.10 Air compressors and compressed air systems

3.10.1 Examine the functions and operation of all components including fittings and safety devices of air compressors and compressed air systems
3.10.2 Evaluate the effects of common operational faults of single and multi-stage air compressors, including: leaking valves, leaking piston rings, blocked filters, blocked coolers
3.10.3 Explain the reasons and the effects of high levels of oil or water in compressed air
3.10.4 Explain the effects of operating air compressors with synthetic lubricating oils compared to operating with mineral lubricating oils
3.10.5 Describe a procedure for inspecting and maintaining air receivers and their fittings.

3.11 Hydraulic power system

3.11.1 Analyze functions and operation of all components including fittings and safety
3.11.2 Devices of hydraulic power systems
3.11.3 Interpret symptoms, effects, and remedial actions for common faults in hydraulic power systems.

3.12 Types of auxiliary boilers

3.12.1 Examine typical boiler types illustrating cross sections, attachments and locations of all fittings, mountings, scantlings and methods of achieving water circulation and gas flow
3.12.2 Distinguish the material requirements for boiler components
3.12.3 Explain the construction of typical types of boilers
3.12.4 Explain functions and operation of all boiler components including fittings and safety devices
3.12.5 Illustrate a typical boiler fuel system and its components
3.12.6 Examine the operation and maintenance procedures of boiler fuel systems
3.12.7 Analyze the combustion process, its monitoring system, and requirements for proper combustion
3.12.8 Evaluate common types of burners and distinguish how atomization and subsequent combustion is achieved
3.12.9 Identify the protection devices, alarms, and shutdowns used in combustion control and fuel systems, and analyze their importance and methods of operation.

3.13 Auxiliary steam system

3.13.1 Illustrate a typical auxiliary steam system, showing the location and purpose of all components
3.13.2 Develop a heat energy balance for an auxiliary steam system
3.13.3 Distinguish the material requirements for auxiliary steam system components
3.13.4 Examine the construction and operation of typical auxiliary steam system components
3.13.5 Explain the reasons for operating the auxiliary steam plant and its systems at nominated temperatures and pressures, and the effects of departing from these parameters
3.13.6 Analyze the symptoms of faults in steam traps, hot wells, de-aerators and condensers
3.13.7 Analyze the requirements for contamination prevention between systems.

3.14 Safety valves

3.14.1 Analyze the requirements for steam safety valves.
3.14.2 Analyze the design formula used for steam safety valves.
3.14.3 Differentiate between common types of boiler safety valves in use and explain how they are classified in terms of valve lift.
3.14.4 Distinguish the materials of construction of safety valves.
3.14.5 Analyze operational problems that can occur with safety valves.
3.14.6 Examine how a safety valve is inspected and overhauled, giving common defects and areas of importance when inspecting.
3.14.7 Formulate a procedure for setting safety valves, and examine the precautions necessary when testing safety valves on boilers and waste heat unit.

3.15 Boiler water levels

3.15.1 Discuss requirements for boiler water level indicators
3.15.2 Differentiate between common types of local boiler water level indicator in use, explaining their different methods of construction and operation
3.15.3 Evaluate testing, maintenance and defect rectification procedures for local boiler water level indicators
3.15.4 Differentiate between common types of remote boiler water level indicator in use, explaining their different methods of construction and operation
3.15.5 Evaluate testing, maintenance and defect rectification procedures for remote boiler water level indicators.

3.16 Use of “Sea water in Boilers”

3.16.1 Explain the reasons and the effects of using sea water in Boilers.

3.17 Use of Fresh Water in Boilers

3.17.1 Analyze the different types of impurities present in boiler, feed and make up water.
3.17.2 Explain how salts are precipitated from boiler and feed water, and the consequences of this precipitation.
3.17.3 Explain how metal is corroded in the boiler and feed system.

3.18 Auxiliary Steam turbines

3.18.1 Analyze the types, uses, and methods of construction of auxiliary steam turbines in use at sea
3.18.2 Examine the typical operating conditions, including temperatures and pressures, of auxiliary steam turbines
3.18.3 Identify the materials used in auxiliary steam turbines and ancillary equipment
3.18.4 Examine typical operational problems associated with auxiliary steam turbine plants, the symptoms, effects, and possible remedies of these faults
3.18.5 Explain the processes of warming through and shutting down auxiliary steam turbine plants
3.18.6 Outline the maintenance associated with optimum performance of an auxiliary steam turbine plant.

3.19 Boiler defects

3.19.1 Identify the possible defects which may occur in a boiler, gas and water side, giving their location, nature, and effects
3.19.2 Outline procedures commonly employed to rectify defects in boilers, and explain the limitations of such repairs
3.19.3 Enumerate procedures for leak detection in boilers and other steam system components, and explain the remedial actions which may be undertaken

3.20 Boiler survey and repairs

3.20.1 Examine the need for surveying auxiliary boilers and other components of auxiliary systems
3.20.2 Outline survey requirements for auxiliary boilers and other components of auxiliary systems
3.20.3 Outline the procedures for shutting down, isolating and opening up an auxiliary boiler for inspection or during an emergency.

3.21 Evaporators

3.21.1 Compare operation, performance, problems and applications of common fresh water generation plants used at sea

3.21.2 Evaluate the need for treatment of evaporator water, and assess methods of fresh water generation plant water treatment.

3.22 Thermal fluid heating system

3.22.1 Examine typical thermal fluid heating systems and explain the advantages and disadvantages of these systems

3.22.2 Explain the locations and functions of all components, fittings, and safety devices used in thermal fluid systems

3.22.3 Analyze the properties of thermal fluids used, effects of contamination, and methods of testing the fluid

3.22.4 Compare thermal fluid plants with conventional steam plants.

4. Functions and Mechanism of Automatic Control for Main Engine

4.1 Diesel Engines

4.1.1 Describe system components and configuration for main engine automatic control

4.1.2 Describe the meaning of the following functions used for main engine automatic control including operations/control mechanism

- Automatic changeover from air running to fuel running
- Start failure
- Start impossible
- Wrong way
- Speed run-up program by revolution, load and /or combination control, including bypass program for critical speed
- Crash/Emergency astern program
- Speed control under rough/calm sea condition
- Variable injection timing
- Variable exhaust valve timing
- Safety (automatic shutdown, automatic slowdown) system

4.4.3 Describe the function and mechanism, of the lector governing system for revolution control

5. Functions and Mechanism of Automatic Control for Auxiliary Machinery

5.1 Generator and Distribution system

5.1.1 Describe system components and configuration for main engine automatic control

5.1.2 Describe the following functions used for generator and distribution system automatic control, including operation/control mechanisms

- Full automatic control for generator distribution system, including automatic starting and stopping prime mover
- Automatic synchronizing
- Automatic load sharing
- Optimum load sharing
- Large motor start blocking
- Preference trip
- Protective/Safety functions built in Automatic/Main Circuit Breaker (ACB and VCB)
- Automatic voltage (AVR) and frequency control

5.2 Steam boiler

5.2.1 Describe system components and configuration for main engine automatic control

5.2.2 Describe the following functions used for steam boiler automatic control including operation/control mechanisms

- Automatic Combustion Control (ACC), including steam pressure control, fuel oil flow control and air flow control
- Automatic feed water control
- Automatic steam temperature control
- Protective/Safety functions for steam boiler

FUNCTION 2

ELECTRICAL, ELECTRONIC AND CONTROL ENGINEERING AT THE MANAGEMENT LEVEL

FUNCTION CONTENTS

Function 2 (F2): Electrical, Electronic and Control Engineering at the Management Level

Part A: Course Framework

1. Scope
2. Learning Objectives
3. Entry Standards
4. Course Intake Limitation
5. Staff Requirements
6. Training Facilities
7. Training Equipment
8. Certificate of Course Completion
9. Suggested Textbooks and References

Part B: Course Outline

1. Competence
2. Topics
3. Time Allocation for Each Topic
4. Total Hours for Function 2

Part C: Course Syllabus

1. F2-Module 1: Manage operation of electrical and electronic control of equipment

6. F2-Module 2: Manage troubleshooting restoration of electrical and electronic control equipment to operating

FUNCTION 2

PART A
COURSE FRAMEWORK

SCOPE
This Function covers the mandatory requirements for knowledge, understanding and proficiencies for *“Electrical, Electronic and Control Engineering at the Management Level”* as provided for under the 2010 STCW Manila Amendments, Regulation III/2 in relation to Section A-III/2, Table A-III/2 thereof. The topics were carefully selected following a course mapping based on the revised IMO Model Course 7.02 and the revised BSMarE program under CMO No. 32, series of 2013, which now covers specific management level topics under this function.
LEARNING OBJECTIVES
Upon successful completion of the training under this Function, trainees shall be expected to have gained the minimum knowledge, understanding and proficiencies needed to carry out and undertake at the management level the tasks, duties and responsibilities for electrical, electronic and control engineering of ships powered by main propulsion machinery of 3,000 kW propulsion power or more.
ENTRY STANDARD
Entrants to this course must be Marine Engineer Officers who are holders of COC under Regulation III/1 of the STCW ’78 Convention, as amended and have not less than one (1) year of seagoing service as officer in charge of an engineering watch on seagoing on seagoing ships powered by main propulsion machinery of 750 kW propulsion power or more.
COURSE INTAKE LIMITATION
• Trainees shall not exceed 24 students per class. • Practical training using a full mission engine simulators shall follow a man-machine ration of 4:1
STAFF REQUIREMENTS
Every METI offering this Management Level Course shall have a Training Supervisor, a minimum of two (2) instructors and an assessor for the course; subject the approval by the Administration in accordance with MARINA Circular (MC) No. 2013-03, as amended by MC 2013-12, series of 2013. The qualification requirements shall be as follows:

STAFF REQUIREMENTS *(Continued…)*
Training Supervisor ▪ Holder of at least a Bachelor of Science Degree; ▪ Have not less than one (1) year experience in maritime education and training; ▪ Have an understanding of the training course and the specific objectives of the training being conducted under his supervision; and ▪ Holder of a Certificate of Completion of Instructor's Training Course (IMO Model Course 6.09) or 18 earned units in teacher education covering teaching methodologies, test and measurement. **Instructors** ▪ Management Level Engineering Officer with not less than one (1) year seagoing service in that capacity on board a ship powered by main propulsion machinery of 3,000 kW propulsion power or more; ▪ Holder of a Certificate of Completion of Instructor's Training Course (IMO Model Course 6.09) or 18 earned units in teacher education covering teaching methodologies, test and measurement; ▪ Holder of a Certificate of Completion of the Management Level Course for Marine Engineer Officers; ▪ Holder of a COC as Management Level Marine Engineer Officer; ▪ Holder of a valid Professional Regulation Commission (PRC) License as Management Level Marine Engineer Officer; ▪ If conducting training using simulator: – Must be holder of a Certificate of Completion of the "Train the Simulator Trainer and Assessor" (IMO Model Course 6.10), or approved Training Course for Simulator Instructors and Assessors; and – Have gained practical operational experience on the particular type of simulator being used

STAFF REQUIREMENTS *(Continued…)*

Assessors

- Management Level Engineer Officer with not less than one (1) year seagoing service in that capacity on board a ship powered by main propulsion machinery of 3,000 kW propulsion power or more;
- Holder of a Certificate of Completion of the Management Level Course for Marine Engineer Officers;
- Holder of a valid PRC License as Management Level Engineer Officer;
- Holder of a Certificate of Completion of the Training Course in Assessment, Examination and Certification of Seafarers (IMO Model Course 3.12);
- Have gained practical assessment experience as understudy for not less than three (3) times;
- If conducting assessment involving the use of simulators:
  - Must be holder of a Certificate of Completion of the Train the Simulator Trainer and Assessor (IMO Model Course 6.10), or approved Training Course for Simulator Instructors and Assessors; and
  - Has gained practical assessment experience on the particular type of simulator being used under the supervision and to the satisfaction of an experienced Assessor for a minimum of for not less than three (3) times.

Resource Person

The METI may be allowed to engage the services of other persons with established expertise on particular topics, provided that the Administration shall be duly informed at least five (5) working days prior to engagement.

<u>NOTE TO METIs:</u>

The foregoing are the qualification standards that must be met by the Instructors, Assessors and Supervisor. In addition, METIs shall exercise utmost diligence and responsibility in the selection of such Staff and ensure that they are appropriately qualified to carry out effective teaching, assessment and supervision of the course, respectively.

TRAINING FACILITIES
For the theoretical part, a classroom with multi-media over-head projector, with a computer set, and a white board with eraser will be utilized, among others. This does not however preclude METIs from utilizing additional teaching aids to facilitate learning.
TRAINING EQUIPMENT
Electrical laboratory equipment and training materials for analyzing and testing.
CERTIFICATE OF COURSE COMPLETION
Trainees, who successfully completed this Function and passed the assessment thereof, shall be issued a Certificate of Completion. The format of such certificate shall be in accordance with the format prescribed by the Administration.
SUGGESTED TEXT BOOKS AND REFERENCES
For the textbooks and reference materials, METIs should refer to the list of Teaching Aids, Videos, References, Textbooks and Bibliographies indicated in the revised IMO Model Course 7.02 validated during the 44th Session of the IMO Sub-Committee on Standards of Training and Watchkeeping. This does not however preclude METIs from utilizing other relevant and more updated books and references that may be available or prescribed by the Administration. METIs shall exercise prudence and utmost responsibility in selecting the textbooks and references for this Function to ensure that only relevant and up-to-date ones shall be used.

FUNCTION 2

PART B
COURSE OUTLINE

MAIN TOPICS	NO. OF HOURS
Competence	
F2 - Module 1: Manage operation of electrical and electronic control equipment (Theoretical knowledge)	
1. Marine electrotechnology, electronics, power electronics, automatic control engineering and safety Devices	30
2. Design features and system configuration of automatic control equipment and safety devices	26
3. Design features of high-voltage installations	22
F2 - Module 2: Manage trouble shooting restoration of electrical and electronic control equipment to operating condition (Practical Knowledge)	
1. Trouble shooting of electrical and electronic control equipment	66
2. Function test of electrical, electronic control equipment and safety devices	12
3. Trouble shooting of monitoring systems	12
4. Software version control	20
TOTAL FOR FUNCTION 2:	**188**

General Rule on Time Allocation:

METIs must note that the number of hours allocated for the topics in this Function are the minimum and can be increased as may be necessary to cover new requirements, laws, rules and regulations, new developments, trends and practices in the maritime industry.

FUNCTION 2

PART C
COURSE SYLLABUS

F2 - Module 1

Competence: Manage Operation of Electrical and Electronic Control Equipment (Theoretical Knowledge)

1. **Marine Electrotechnology, Electronics, Power Electronics, Automatic Control Engineering and Safety Devices**

1. Electronics, Power Electronics

1.1.1 Discusses the operation of semiconductor devices

- Uni-junction transistor
- The Bipolar transistor, operation and characteristics, bias circuits, AC and DC current gain, data sheets.
- Field Effect Transistors, operation. Thyristors, SCRs, GTOs, DIACs and TRIACs operation and characteristics.
- Insulated gate bipolar transistor (IGBT)
- Snubber circuits, commutation, data sheets.
- Device applications in electronic control, surveillance and recording systems, power supplies, rectification, smoothing circuits, stabilization, switching, amplification, pulse shaping, clipping and clamping.

1.1.2 Explains Integrated Circuits

- Ideal operational amplifier, characteristics, types, mounting methods and markings, advantages of ICs.
- Practical operational amplifier, circuit configurations,
- CMRR, instrumentation amplifier, 4-20mA circuit.
- Voltage regulators, multi-vibrators.
- IC applications and common circuits. Data sheets

1.1.3 Explains electronic fault diagnosis on board ship

- Interpretation and use of electronic systems and subsystem circuit diagrams, operation and maintenance manuals.
- Electronic test equipment, method of DMM display.
- Use of CRO as a testing and display instrument.
- Analysis of measurement and test result on components and circuits.
- Methods of fault detection

2. Design Features and Systems Configurations of Automatic Control Equipment and Safety Devices for the following:

2.1 General Requirements

2.1.1 Explains that electrical designed for land use of often not suitable for use in ships

2.1.2 Explains that as far as possible, all materials should be non-flammable; explains where flame retardant materials maybe used

2.1.3 Explains the meaning of the term flame retardant

2.1.4 States the angles of heels and trim at which machinery should be capable of operating

2.1.5 Explains the effect of temperature changes on:

- Electromagnetic devices
- Generator voltage

2.1.6 Discusses common maximum temperatures of air and sea water used for design purposes

2.1.7 Explains that the axis of a rotating machine should not be places athwart ships unless so designed.

2.1.8 Discusses the need to periodically check the security of all electrical connections

2.1.9 Discusses requirements regarding the provision of electrical power and lightning for normal operation and for an emergency

2.2 Main Engine

2.2.1 Control Theory

- Changing set points.
- Basic control system design.
- First order and second order systems.
- Transfer Functions.
- Control system stability.
- Natural frequency and control systems.
- Time lag and time constant.
- System response

2.2.2 Tuning

- System response
- Control loop tuning

2.2.3 Signal Transmission Systems

- Digital communication bus and fiber optic signal transmission systems

2.2.4 Final Control Elements

- Control valve trim
- Selecting control valves and their actuators
- Valve sizing

2.2.5 Electronic PID Controllers

- Single loop digital controllers
- Manual and automatic tuning of electronic controllers

2.2.6 Monitoring & Control Systems

- Boiler water level control.
- Advanced boiler combustion control.
- Diesel engine cooling control
- Main engine control for FP and CP propellers.

2.2.7 General requirements of automatic control equipment and safety devices

- Monitoring system
- Safety system
- System independence
- Local control
- Failure mode and effect analysis
- Power supply

2.2.8 Remote control – Diesel propulsion

- Control - electronic, electro-pneumatic, electro-hydraulic or pneumatic
- Malfunctions – alarm, engine slow down, engine stop

2.2.9 UMS Systems

- Concept of Unattended Machinery Spaces (UMS)
- Requirements of UMS. Bridge control
- Testing Regime for UMS

2.3 Generator and distribution system

2.3.1 Instrumentation and Safety in Generator and Distribution system

2.3.2 Auxiliary Diesel Generator Alarm and Shut Down

2.3.3 Automatic Starting of Propulsion Auxiliaries

2.4 Steam Boiler

2.4.1 Following failures will have alarms and display - feed water high salinity, high water level, boiler pressure high and low, superheated outlet temperature high, fuel pump low outlet pressure, heavy fuel temperature high and low (or high and low viscosity), uptake high gas temperature, control system power failure, atomization steam / air pressure low

2.4.2 Following failures will have alarms, display and automatic shutdown of boiler - low water level, supply air pressure failure, ignition or flame failure.

3. Design Features of High-Voltage Installations

3.1 Design Features of High-Voltage Installations

3.1.1 Generation and distribution of high voltage on ships

3.1.2 Electric propulsion system

3.1.3 Synchro-convertors and cyclo-convertors

3.1.4 Functional, operational and safety requirements for a marine high- voltage system

3.1.5 Assigning qualified personnel to carry out maintenance and repair of high-voltage switchgear of various types

3.1.6 High voltage system advantages

3.1.7 Advantages of an insulated system

3.1.8 High voltage circuit breakers

3.1.9 High voltage cable

3.1.10 High voltage fuses

3.1.11 Remedial action necessary during faults in a high-voltage system

3.1.12 Switching strategy for isolating components of a high- voltage system

3.1.13 Selection of suitable apparatus for isolation and testing of high-voltage equipment

3.1.14 Switching and isolation procedure on a marine high-voltage system, complete with safety documentation

3.1.15 Performance of insulation resistance and polarization index on high-voltage equipment

3.2 Safe Operation and Maintenance of High Voltage Systems

3.2.1 Knows how to use HV personal protection equipment (PPE): insulated gloves, goggles, insulating bars, insulating footwear, mates earthing cables, HV testers

3.2.2 Knows terms of certification of personal equipment

3.2.3 Explains HV safety procedures:

- Permission and co-ordination of HV works
- Information, warnings and protection against unauthorized influence on safety
- Assistance during HV work
- Checking for voltage presence before any work starts

F2 - Module 2

Competence: Manage Trouble Shooting Restoration of Electrical and Electronic Control Equipment to Operating Condition (Practical Knowledge)

1. Trouble Shooting of Electrical and Electronic Equipment

1.1 Electrical Safety

1.1.1 Safety procedures to be adopted when working on electrical installations.
1.1.2 The effects of electric current on the human body.

1.2 Test Equipment

1.2.1 Practical use of Meggers, multi-meters and CRO.
1.2.2 Care and precautions for carrying out open, short and insulation measurement test

1.3 Interpretation of Circuit Symbols

1.3.1 Circuit components, functional description.
1.3.2 Construction of simple electrical circuits using relays, timers, contactors and other components.

1.4 Logical six step troubleshooting procedure

1.4.1 Symptom identification
1.4.2 Symptom analysis
1.4.3 Listing of probable faulty function
1.4.4 Localizing of faulty function
1.4.5 Localizing trouble to circuit
1.4.6 Failure analysis

1.5 Generation

1.5.1 Alternators, excitation methods, AVR and auto-synchronizing equipment.
1.5.2 Manual load sharing and modern load sharing equipment

1.6 Prime Mover Electrical Controls

1.6.1 Description, identification and operation of control components of the prime mover for the alternator.

1.7 Main Circuit Breaker

1.7.1 Operating and Servicing

1.8 Protection of Generators

1.8.1 Instrumentation and control associated with the electrical protection of the generating plant
1.8.2 Routine Maintenance

1.9 Electrical Distribution Systems

1.9.1 General layout, problems encountered using neutral configuration
1.9.2 Fault tracing in distribution circuits

1.10 Motors

1.10.1 Review of motor features and starting arrangements. Trouble shooting
1.10.2 Speed control of a.c. motors using solid state devices. Soft starters

1.11 Electrical Survey Requirements

1.11.1 Conducting tests to the requirements of survey

1.12 Caliber & Adjust Transmitters & Controllers

1.12.1 Differential pressure transmitter calibration.
1.12.2 Electronic temperature transmitter calibration.
1.12.3 The operation of a PID controller.
1.12.4 Tuning a PID controller.
1.12.5 Governors and controllable pitch propeller control.
1.12.6 Tests, faults, and solutions.

1.13 Control System Fault Finding

1.13.1 Fault finding methods.
1.13.2 Governor faults.
1.13.3 Evaluation and rectification of common control systems.
1.13.4 Testing alarm and monitoring systems.
1.13.5 Electric power supply for control systems.

2. Function Test of Electrical, Electronic Control Equipment and Safety Devices

2.1 Function test of Electrical, Electronic Control Equipment and Safety Devices But Not Limited To

2.1.1 Function test Over Current Relay (OCR)
2.1.2 Function test Relays and magnetic contactors
2.1.3 Function test Timers
2.1.4 Function test Fuses
2.1.5 Function test MCCB
2.1.6 Function test ACB
2.1.7 Function test Diodes
2.1.8 Function test Silicon Controlled Rectifier (SCR)
2.1.9 Function test Temperature, Pressure and Level transmitters:
2.1.10 Function test Over speed Protection Devices
2.1.11 Function test Flame Scanners
2.1.12 Function test Fire Detecting System

3. Trouble Shooting of Monitoring Systems

1.1 Test and Calibrations of Sensors and Transducers of Monitoring Systems But Not Limited To

1.1.1 Testing and calibration of pressure sensor and transducer

1.1.2 Testing and calibration of temperature sensor and transducer

1.1.3 Testing and calibration of flow sensor and transducer

1.1.4 Testing and calibration of level sensor and transducer

1.1.5 Testing and calibration of tachometer sensor and transducer

1.1.6 Testing and calibration of viscometer sensor and transducer

4. Software Version Control

4.1 Programmable logic controllers (PLC)

4.1.1 Basics of PLC operation

4.1.2 Comparison between hard-wired and programmable control operation

4.1.3 Advantages of PLCs

4.1.4 Binary number conversion

4.1.5 Digital logic gates and its practical application

4.1.6 Inputs and output modules and configuration of PLCs

4.1.7 Understanding of ladder logic and PLCs programming

4.1.8 Human Machine Interface (HMI) and alteration of parameters in the program

4.1.9 Basic software version and control of access.

4.1.10 Maintenance of Electronic Control Equipment and PLC Controlled processes

4.1.11 Checking the program validity and faultfinding and restoration of process with the help of PLCs

4.2 Microcontrollers

4.2.1 Introduction to microcontroller

4.2.2 Basics of microcontroller

4.2.3 Analog to digital convertor

4.2.4 Digital interfaces

4.2.5 Serial peripheral interface

4.2.6 Communication with PC

4.2.7 Code integration

4.3 Digital Techniques

4.3.1 Basic Logic gates and derived Logic gates. Boolean algebra.

4.3.2 Principles and operation of digital integrated circuits (TTL and CMOS), adders, flip flops, registers, counters, multiplexers, encoders and decoders.

4.3.3 Memories, RAM, ROM, PROM, EPROM,UVPROM

4.3.4 Microprocessors, principles of operation, input/output functions, application in marine control systems, programs, alteration of values

4.3.5 Single integrated circuit containing a processor core, memory, and programmable input/output peripherals.

4.3.6 Program memory in the form of NOR flash or OTP ROM is also often included on chip and RAM.

4.3.7 Microcontrollers- designed for embedded applications and real time response to events

4.3.8 Typical input and output devices- switches, relays, solenoids, LEDs, radio frequency devices, and sensors for data such as temperature, humidity, light level etc.

4.3.9 Description and use of General Purpose Input / Output pins (GPIO).

4.3.10 Analog-to-digital converter (ADC)

4.3.11 Digital-to-analog converter (DAC)

FUNCTION 3

MAINTENANCE AND REPAIR AT THE MANAGEMENT LEVEL

FUNCTION CONTENTS

Function 3 (F3): Maitenance and Repair at the Manegemnt Level

Part A: Course Framework

1. Scope
2. Learning Objectives
3. Entry Standards
4. Course Intake Limitation
5. Staff Requirements
6. Training Facilities
7. Training Equipment
8. Certificate of Course Completion
9. Suggested Textbooks and References

Part B: Course Outline

1. Competence
2. Topics
3. Time Allocation for Each Topic
4. Total Hours for Function 2

Part C: Course Syllabus

1. F3 - Module 1: Manage Safe and Effective Maintenance and Repair Procedures
2. F3 - Module 2: Detect and Identify the Cause of Machinery Malfunctions and Correct Faults
3. F3 - Module 3: Ensure Safe Working Practices

FUNCTION 3

PART A
COURSE FRAMEWORK

SCOPE
This Function covers the mandatory requirements for knowledge, understanding and proficiencies for *“Maintenance and Repair at the Management Level”* as provided for under the 2010 STCW Manila Amendments, Regulation III/2 in relation to Section A-III/2, Table A-III/2 thereof. The topics were carefully selected following a course mapping based on the revised IMO Model Course 7.02 and the revised BSMarE program under CMO No. 32, series of 2013, which now covers specific management level topics under this function.
LEARNING OBJECTIVES
Upon successful completion of the training under this Function, trainees shall be expected to have gained the minimum knowledge, understanding and proficiencies needed to carry out and undertake at the management level the tasks, duties and responsibilities for maintenance and repair on seagoing ships powered by main propulsion machinery of 3,000 kW propulsion power or more.
ENTRY STANDARD
Entrants to this course must be Marine Engineer Officers who are holders of COC under Regulation III/1 of the STCW ’78 Convention, as amended and have not less than one (1) year of seagoing service as officer in charge of an engineering watch on seagoing ships powered by main propulsion machinery of 750 kW propulsion power or more.
COURSE INTAKE LIMITATION
• Trainees shall not exceed 24 students per class • Practical training using a full mission engine simulators shall follow a man-machine ration of 4:1
STAFF REQUIREMENTS
Every METI offering this Management Level Course shall have a Training Supervisor, a minimum of two (2) instructors and an assessor for the course; subject the approval by the Administration in accordance with MARINA Circular (MC) No. 2013-03, as amended by MC 2013-12, series of 2013. The qualification requirements shall be as follows:

STAFF REQUIREMENTS *(Continued…)*

Training Supervisor

- Holder of at least a Bachelor of Science Degree;
- Have not less than one (1) year experience in maritime education and training;
- Have an understanding of the training course and the specific objectives of the training being conducted under his supervision; and
- Holder of a Certificate of Completion of Instructor's Training Course (IMO Model Course 6.09) or 18 earned units in teacher education covering teaching methodologies, test and measurement.

Instructors

- Management Level Engineering Officer with not less than one (1) year seagoing service in that capacity on board a ship powered by main propulsion machinery of 3,000 kW propulsion power or more;
- Holder of a Certificate of Completion of Instructor's Training Course (IMO Model Course 6.09) or 18 earned units in teacher education covering teaching methodologies, test and measurement;
- Holder of a Certificate of Completion of the Management Level Course for Marine Engineer Officers;
- Holder of a COC as Management Level Marine Engineer Officer;
- Holder of a valid Professional Regulation Commission (PRC) License as Management Level Marine Engineer Officer;
- If conducting training using simulator:
  - Must be holder of a Certificate of Completion of the "Train the Simulator Trainer and Assessor" (IMO Model Course 6.10), or approved Training Course for Simulator Instructors and Assessors; and
  - Have gained practical operational experience on the particular type of simulator being used

STAFF REQUIREMENTS *(Continued…)*

Assessors

- Management Level Engineer Officer with not less than one (1) year seagoing service in that capacity on board a ship powered by main propulsion machinery of 3,000 kW propulsion power or more;
- Holder of a Certificate of Completion of the Management Level Course for Marine Engineer Officers;
- Holder of a valid PRC License as Management Level Engineer Officer;
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Resource Person

The METI may be allowed to engage the services of other persons with established expertise on particular topics, provided that the Administration shall be duly informed at least five (5) working days prior to engagement.

NOTE TO METIs:

The foregoing are the qualification standards that must be met by the Instructors, Assessors and Supervisor. In addition, METIs shall exercise utmost diligence and responsibility in the selection of such Staff and ensure that they are appropriately qualified to carry out effective teaching, assessment and supervision of the course, respectively.

TRAINING FACILITIES
For the theoretical part, a classroom with multi-media over-head projector, with a computer set, and a white board with eraser will be utilized, among others. This does not however preclude METIs from utilizing additional teaching aids to facilitate learning.
TRAINING EQUIPMENT
A Full Mission Engine Simulator certified as Class “A” or similar category showing reference to STCW Table A-III/2, by an internationally recognized Classification Society, capable of simulating a total shipboard engine operations; or Practical laboratory equipment for maintenance and repair.
CERTIFICATE OF COURSE COMPLETION
Trainees, who successfully completed this Function and passed the assessment thereof, shall be issued a Certificate of Completion. The format of such certificate shall be in accordance with the format prescribed by the Administration.
SUGGESTED TEXT BOOKS AND REFERENCES
For the textbooks and reference materials, METIs should refer to the list of Teaching Aids, Videos, References, Textbooks and Bibliographies indicated in the revised IMO Model Course 7.02 validated during the 44th Session of the IMO Sub-Committee on Standards of Training and Watchkeeping. This does not however preclude METIs from utilizing other relevant and more updated books and references that may be available or prescribed by the Administration. METIs shall exercise prudence and utmost responsibility in selecting the textbooks and references for this Function to ensure that only relevant and up-to-date ones shall be used.

FUNCTION 3

PART B
COURSE OUTLINE

MAIN TOPICS	NO. OF HOURS
Competence	
F3 - Module 1: Manage Safe and Effective Maintenance and Repair Procedures	
1. Marine engineering practice	5
2. Manage Safe and Effective Maintenance and Repair Procedures	10
3. Planning Maintenance, Including Statutory and Class Verifications	5
4. Planning Repairs	5
F3 - Module 2: Detect and Identify the Cause of Machinery Malfunctions and Correct Faults (Practical Knowledge)	
1. Detection of Machinery Malfunctions, Location of Faults and Action to Prevent Damage	5
2. Inspection and Adjustment of Equipment	5
3. Non-Destructive Examination	10
F3 - Module 3: Ensure Safe Working Practices (Practical Knowledge)	
1. Safe Working Practices	21
TOTAL FOR FUNCTION 3:	**66**

General Rule on Time Allocation:

METIs must note that the number of hours allocated for the topics in this Function are the minimum and can be increased as may be necessary to cover new requirements, laws, rules and regulations, new developments, trends and practices in the maritime industry.

FUNCTION 3

PART C
COURSE SYLLABUS

F3 - Module 1

Competence: Manage Safe and Effective Maintenance and Repair Procedures

1. **Marine Engineering Practice (Theoretical Knowledge)**
   - **1.1 Discuss the preparation and use of planned maintenance systems (PMS) as per ISM Code**
     - 1.1.1 Objective of PMS
     - 1.1.2 Equipment covered under PMS
     - 1.1.3 Critical Equipment
     - 1.1.4 Preparation of vessel specific PMS
     - 1.1.5 Maintenance schedule and job procedures
     - 1.1.6 Updating of maintenance schedule
     - 1.1.7 Spare parts inventory
     - 1.1.8 Recording of defects

2 **Manage Safe and Effective Maintenance and Repair Procedures Relevant to 1**

2.1 Manage safe and effective maintenance and repair procedures relevant to 1

2.1.1 Discusses the preparation and practice of Dry-docking, In-Water survey and lay up

- Dry-dock repair file
- Preparation of dry-dock repair specification
- Dry-docking and in-water survey
- Initial and final dry-dock inspection
- Supporting the vessel in dry-dock
- Preparations for dry-docking and undocking
- Survey work and maintenance during dry-dock
- Typical arrangement for the supply of electrical power, fresh water and sanitation facilities while the vessel is in dry-dock
- Special arrangements during dry-dock for the prevention of fires and explosions
- The management of oil and water tanks during dry-docks. Testing of tanks by hydrostatic and pneumatic means
- Describe the preparations, inspections, records, planning, maintenance and events which occur with dry docking and in-water hull surveys
- Lay ups. Plan aspects of dry-docking, in water hull cleaning, and vessel layup/reactivation.

3 **Manage Safe and Effective Maintenance and Repair Procedures Practical Knowledge**

3.1 Planning maintenance, including statutory and class verifications relevant to 1

3.1.1 Discusses procedures for planned maintenance that requires dismantling and inspection/calibrations

- Dismantled in sequential order as per manufacturer's instruction manual
- Cleaned prior to inspection
- Inspected and/or calibrated as appropriate
- Items are assessed to determine whether can be reused or need to be replace/repaired/reconditioned
- Above information recorded in maintenance record of equipment/machines
- Entry completed in spare parts inventory

4 Planning Repairs (Practical Knowledge)

4.1 Planning repairs relevant to 1

4.1.1 Conducts planned maintenance that involves assembly and testing

- Individual parts are tested as per manufacturer's instruction manual
- Parts are assembled in sequential order as per manufacturer's instruction manual
- Pre-start checks are carried out in accordance with manufacturer's instruction manual
- Equipment / machinery is run up and relevant performance criteria are compared and recorded
- Updating of maintenance schedule records

F3 - Module 2

Competence: Detect and Identify the Cause of Machinery Malfunctions and Correct Faults

1. **Detection of Machinery Malfunctions, Location of Faults and Action to Prevent Damage**

1.1 Unplanned Maintenance

1.1.1 Discusses the initial action taken when fault is first identified, considering vessel's safety
1.1.2 Notifies the bridge potential problems in good time
1.1.3 Re-assesses priorities and scheduled work in light of identified fault
1.1.4 Errors are acknowledged, reported, recorded and corrective action taken.

2. **Inspection and Adjustment of Equipment**

2.1 Inspection and adjustment of equipment relevant to 1.1

2.1.1 Discusses daily, weekly, monthly and routine inspection as per manufacturer's instruction manual
2.1.2 Identifies inspection of equipment as per class and statutory requirements
2.1.3 Completes adjustment of equipment as per manufacturer's instruction manual
2.1.4 Identifies the special tools for adjustment of equipment

3. **Non-destructive Examination**

3.1 Different types of non-destructive examination

3.1.1 Discusses the practice and limitations of Visual Inspection
- Unaided visual inspection
- Use of optical aids
- Application of visual inspection on board ship

3.1.2 Discusses the use of dye penetrant testing
- Use of cleaner, penetrant and developer
- Inspection and evaluation

3.1.3 Discusses the use of Magnetic Particle Testing
- Principles of magnetic particle testing
- Magnetizing using electromagnetic
- Use of premixed aerosol cans of wet fluorescent iron oxide visible in ultraviolet rays
- Use of cracked detection of tail end shat taper

3.1.4 Discusses the use of Radiography
- Use of radiography in testing welds

3.1.5 Discusses the use of portable hardness measurement
- Measurement of hardness by portable instrument
- Used on board to check harness of turbocharger compressor impeller

3.1.6 Discusses the use of Thermography
- Use of thermographic camera using infrared imaging
- Used on board for measurement of temperature variations

F3 - Module 3

Competence: Ensure Safe Working Practices

1. **Safe Working Practices**

1.1 Explains risk assessment practices and their use on board ship

1.1.1 Elements of risk assessment
1.1.2 Identify hazards
1.1.3 Identify risk control
1.1.4 Estimate risks
1.1.5 Determine tolerability of risks
1.1.6 Prepare risk control and action plan

1.2 Discusses the role of safety officials on board

1.2.1 Safety officer
1.2.2 Safety committee
1.2.3 Safety inspections'
1.2.4 Investigation of accidents and dangerous occurrences

1.3 Discusses the use of personal protective equipment

1.3.1 Types of personal protective equipment

1.4 Explains the requirements to ensure that work equipment is safe

1.4.1 Maintenance
1.4.2 Inspection
1.4.3 Training
1.4.4 Electrical Equipment

1.5 Discusses the use of safety induction procedures

1.5.1 Emergency procedures and fire precautions
1.5.2 Accidents and medical emergencies
1.5.3 Health and hygiene
1.5.4 Good housekeeping
1.5.5 Environment responsibilities
1.5.6 Occupational health and safety

1.6 Explains the precautions required to minimize the risk of fire

1.6.1 Smoking
1.6.2 Electrical fittings
1.6.3 Spontaneous combustion
1.6.4 Precautions in machinery spaces

1.7 Explains typical shipboard emergency procedures

1.7.1 Actions in the event of fire
1.7.2 Muster and drills

1.8 Discusses the requirements to ensure the safe movement of personnel

1.8.1 Lightning
1.8.2 Guarding of openings
1.8.3 Watertight doors

1.9 Discusses safe work practices when

1.9.1 Working aloft
1.9.2 Portable ladders
1.9.3 Lagging of steam and exhaust pipes
1.9.4 Unmanned machinery spaces
1.9.5 Refrigeration machinery

1.10 Identifies the risks and the safety precautions and procedures for entering enclosed or confined spaces

1.10.1 Identifying hazards
- Oxygen deficiencies
- Toxicity of oil and other substances
- Flammability
- Other hazards

1.10.2 Breathing apparatus and resuscitation equipment
1.10.3 Preparing the space for entry
1.10.4 Testing atmosphere of the space
1.10.5 Procedures and arrangement before entry
1.10.6 Procedures and arrangements during entry
1.10.7 Procedures on completion

1.11 Discusses the use of permit to work systems

1.11.1 Work in unmanned machinery spaces
1.11.2 Entry in enclosed or confined spaces
1.11.3 Hot Work
1.11.4 Working aloft
1.11.5 Electrical system for other than electrical officer

1.12 Identifies safe practices for manual handling

1.12.1 Musculo-skeletal injuries due to an unsatisfactorily working method
1.12.2 Appropriate steps to reduce risk injury

1.13 Discusses the safe use of common shipboard equipment

1.13.1 Use of tools and equipment
1.13.2 Abrasive wheels
1.13.3 High pressure hydraulic and pneumatic equipment
1.13.4 Ropes

1.14 Explain procedures for the safe use of lifting plant

1.14.1 Safe working load (SWL)
1.14.2 Register of lifting appliances, markings and certificates
1.14.3 Regular maintenance
1.14.4 Examination, inspection and testing
1.14.5 Safety measures

1.15 Discusses procedures for the maintenance of machinery
1.15.1 Precautions before maintenance
1.15.2 Warning notices not to start machines
1.15.3 Securing heavy parts during maintenance

1.16 Discusses procedures for undertaking hot work on board ship
1.16.1 Pre-use equipment test
1.16.2 Precautions against fire and explosion
1.16.3 Precautions during use of electric arc welding
1.16.4 Compressed gas cylinders
1.16.5 Gas welding and cutting

1.17 Explains the preparation and use of paint systems onboard ship
1.17.1 Preparation and precautions

1.18 Discusses procedures for working safely with hazardous substances
1.18.1 Carcinogens and mutagens
1.18.2 Asbestos dust
1.18.3 Use of chemical; agents
1.18.4 Safety data sheet

1.19 Discusses procedures for minimizing adverse effects of noise and vibrations
1.19.1 Assessing exposure to noise
1.19.2 Types of vibration and their effects
1.19.3 Prevention and control of exposure to noise and vibrations

FUNCTION 4

CONTROLLING THE OPERATION OF THE SHIP AND CARE FOR PERSONS ON BOARD AT THE MANAGEMENT LEVEL

FUNCTION CONTENTS

Function 4 (F4): Maitenance and Repair at the Manegement Level

Part A: Course Framework

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1. F4 - Module 1: Control, trim and stability
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3. F4 - Module 3: Develop emergency and damage control plans and handle emergencies
4. F4 - Module 4: Use of leadership and managerial skills

FUNCTION 4

PART A
COURSE FRAMEWORK

SCOPE
This Function covers the mandatory requirements for knowledge, understanding and proficiencies for *"Controlling the Operation of the Ship and Care of Persons On Board at the Management Level"* as provided for under the 2010 STCW Manila Amendments, Regulation III/2 in relation to Section A-III/2, Table A-III/2 thereof. The topics were carefully selected following a course mapping based on the revised IMO Model Course 7.02 and the revised BSME program under CMO No. 32, series of 2013, which now covers specific management level topics under this function.
LEARNING OBJECTIVES
Upon successful completion of the training under this Function, trainees shall be expected to have gained the minimum knowledge, understanding and proficiencies needed to carry out and undertake at the management level the tasks, duties and responsibilities in controlling the operation of the ship and care of persons on board ships powered by main propulsion machinery of 3,000 kW propulsion power or more.
ENTRY STANDARD
Entrants to this course must be Marine Engineer Officers who are holders of COC under Regulation III/1 of the STCW '78 Convention, as amended and have not less than one (1) year of seagoing service as officer in charge of an engineering watch on seagoing ships powered by main propulsion machinery of 750 kW propulsion power or more.
COURSE INTAKE LIMITATION
• Trainees shall not exceed 24 students per class. • Practical training using a full mission engine simulator shall follow a man-machine ration of 4:1.
STAFF REQUIREMENTS
Every METI offering this Management Level Course shall have a Training Supervisor, a minimum of two (2) instructors and an assessor for the course; subject the approval by the Administration in accordance with MARINA Circular (MC) No. 2013-03, as amended by MC 2013-12, series of 2013. The qualification requirements shall be as follows:

STAFF REQUIREMENTS *(Continued…)*

Training Supervisor

- Holder of at least a Bachelor of Science Degree;
- Have not less than one (1) year experience in maritime education and training;
- Have an understanding of the training course and the specific objectives of the training being conducted under his supervision; and
- Holder of a Certificate of Completion of Instructor's Training Course (IMO Model Course 6.09) or 18 earned units in teacher education covering teaching methodologies, test and measurement.

Instructors

- Management Level Engineering Officer with not less than one (1) year seagoing service in that capacity on board a ship powered by main propulsion machinery of 3,000 kW propulsion power or more;
- Holder of a Certificate of Completion of Instructor's Training Course (IMO Model Course 6.09) or 18 earned units in teacher education covering teaching methodologies, test and measurement;
- Holder of a Certificate of Completion of the Management Level Course for Marine Engineer Officers;
- Holder of a COC as Management Level Marine Engineer Officer;
- Holder of a valid Professional Regulation Commission (PRC) License as Management Level Marine Engineer Officer;
- If conducting training using simulator:
  - Must be holder of a Certificate of Completion of the "Train the Simulator Trainer and Assessor" (IMO Model Course 6.10), or approved Training Course for Simulator Instructors and Assessors; and
  - Have gained practical operational experience on the particular type of simulator being used

STAFF REQUIREMENTS *(Continued…)*
Assessors ▪ Management Level Engineer Officer with not less than one (1) year seagoing service in that capacity on board a ship powered by main propulsion machinery of 3,000 kW propulsion power or more; ▪ Holder of a Certificate of Completion of the Management Level Course for Marine Engineer Officers; ▪ Holder of a valid PRC License as Management Level Engineer Officer; ▪ Holder of a Certificate of Completion of the Training Course in Assessment, Examination and Certification of Seafarers (IMO Model Course 3.12); ▪ Have gained practical assessment experience as understudy for not less than three (3) times; ▪ If conducting assessment involving the use of simulators: – Must be holder of a Certificate of Completion of the Train the Simulator Trainer and Assessor (IMO Model Course 6.10), or approved Training Course for Simulator Instructors and Assessors; and – Has gained practical assessment experience on the particular type of simulator being used under the supervision and to the satisfaction of an experienced Assessor for a minimum of for not less than three (3) times. **Resource Person** The METI may be allowed to engage the services of other persons with established expertise on particular topics, provided that the Administration shall be duly informed at least five (5) working days prior to engagement. ***NOTE TO METIs:*** *The foregoing are the qualification standards that must be met by the Instructors, Assessors and Supervisor. In addition, METIs shall exercise utmost diligence and responsibility in the selection of such Staff and ensure that they are appropriately qualified to carry out effective teaching, assessment and supervision of the course, respectively.*

TRAINING FACILITIES
For the theoretical part, a classroom with multi-media over-head projector, with a computer set, and a white board with eraser will be utilized, among others. This does not however preclude METIs from utilizing additional teaching aids to facilitate learning.
TRAINING EQUIPMENT
A Full Mission Engine Room Simulator certified as Class "A" or similar category showing reference to STCW Table A-III/2, by an internationally recognized Classification Society, capable of simulating the required knowledge, understanding and proficiencies (KUPs) for controlling the operation of the ship and care of persons on board at the management level in the aforesaid Table, with briefing and debriefing room.
CERTIFICATE OF COURSE COMPLETION
Trainees, who successfully completed this Function and passed the assessment thereof, shall be issued a Certificate of Completion. The format of such certificate shall be in accordance with the format prescribed by the Administration.
SUGGESTED TEXT BOOKS AND REFERENCES
For the textbooks and reference materials, METIs should refer to the list of Teaching Aids, Videos, References, Textbooks and Bibliographies indicated in the revised IMO Model Course 7.02 validated during the 44th Session of the IMO Sub-Committee on Standards of Training and Watchkeeping. This does not however preclude METIs from utilizing other relevant and more updated books and references that may be available or prescribed by the Administration. METIs shall exercise prudence and utmost responsibility in selecting the textbooks and references for this Function to ensure that only relevant and up-to-date ones shall be used.

FUNCTION 4

PART B
COURSE OUTLINE

MAIN TOPICS	NO. OF HOURS
Competence	
F4 - Module 1: Control Trim, Stability and Stress	
1. Fundamental principles of ship construction, trim and stability	63
2. Effect on trim and stability in the event of damage and flooding	11
3. Knowledge of IMO recommendations concerning ship stability	2
F4 - Module 2: Maintain safety and security of the ship's crew and passengers and the operational condition of life-saving, fire-fighting and other safety systems	
1. Knowledge of life-saving appliance regulations	2
2. Actions to be taken to protect and safeguard all persons on board in emergencies	4
3. Actions to limit damage and salve the ship following a fire, explosion, collision or grounding	4
F4 - Module 3: Develop emergency and damage control plans and handle emergency	
1. Preparation of contingency plans for response to emergencies	9
2. Ship construction including damage control	4
F4 - Module 4: Use of leadership and managerial skills	
1. Shipboard personnel management and training	16
2. Related international maritime conventions, recommendations and national legislation	4
3. Application of task and workload management	8
4. Effective resource management	10
5. Decision-making techniques	7
6. Development, implementation and oversight of standard operating procedures	1
TOTAL FOR FUNCTION 4:	**145**

General Rule on Time Allocation:

METIs must note that the number of hours allocated for the topics in this Function are the minimum and can be increased as may be necessary to cover new requirements, laws, rules and regulations, new developments, trends and practices in the maritime industry.

FUNCTION 4

PART C
COURSE SYLLABUS

F4 - Module 1

Competence: Control Trim, Stability and Stress

1. **Fundamental Principles of Ship Construction, Trim and**

1.1 Ship Stresses

1.1.1 stresses in ship structures: longitudinal bending, still water bending, load diagram, shear force diagram, bending moment diagram, hogging, sagging, wave bending, and transverse bending.
1.1.2 Docking, grounding.
1.1.3 Pounding, panting.

1.2 Watertight Integrity and Weather tight doors

1.2.1 Explains the general design and construction features of SOLAS compliant vessels in terms of watertight integrity

- explains the possible effects of sustaining damage when in a less favorable condition
- states that the number of openings in watertight bulkheads of passenger ships should be reduced to the minimum compatible with the design and working of the ship
- categorizes watertight doors as:
  class 1 - hinged doors
  class 2 - hand-opened sliding doors
  class 3 - sliding doors which are power-operated as well as hand-operated
- states that all types of watertight doors should be capable of being closed with the ship listed to 15° either way
- describes with sketches the arrangement of a power-operated sliding watertight door
- describes with sketches a hinged watertight door, showing the means of securing it
- states that hinged watertight doors are only permitted above a deck at least 2.0 meters above the deepest subdivision load line

Cargo Vessels

- distinguishes between ships of Type ‘A‘ and Type ‘B‘ for the purposes of computation of freeboard
- describes the extent of damage which a Type ‘A‘ ship of over 150 meters length should withstand
- explains that a Type ‘A‘ ship of over 150 meters length is described as a _one- compartment ship
- describes the requirements for survivability of Type ‘B‘ ships with reduced freeboard assigned
- summarizes the equilibrium conditions regarded as satisfactory after flooding

All Ships

- states that openings in watertight bulkheads must be fitted with watertight doors
- explains that weather tight doors in superstructure openings are similar to hinged watertight doors
- states that drills for the operating of watertight doors, side scuttles, valves and other closing mechanisms must be held weekly
- states the requirements for watertight openings to be closed at sea
- discusses procedures for ensuring that all watertight openings are closed
- states that all watertight doors in main transverse bulkheads, in use at sea, must be operated daily
- states that watertight doors and their mechanisms and indicators, all valves the closing of which is necessary to make a compartment watertight and all valves for damage-control cross-connections must be inspected at sea at least once per week
- states that records of drills and inspections are to be entered in the log, with a record of any defects found

1.3 Ship Dynamics

Explains

1.3.1 Rolling – period of roll and isochronous rolling
1.3.2 Pitching
1.3.3 Heaving
1.3.4 Bilge keels.
1.3.5 Fin Stabilizers.
1.3.6 Passive and active anti-roll tanks.
1.3.7 Vibration.

1.4 Corrosion and its Prevention

1.4.1 explains what is meant by corrosion
1.4.2 explains what is meant by erosion of metals and gives examples of where this is likely to occur
1.4.3 describes the formation of a corrosion cell and defines anode, cathode and electrolyte
1.4.4 states that corrosion takes place at the anode while the cathode remains unaffected
1.4.5 describes the galvanic series of metals in seawater
1.4.6 given the galvanic series, states which of two metals will form the anode in a corrosion cell
1.4.7 explains the differences in surface condition or in stress concentration can give rise to corrosion cells between two areas of the same metal

1.4.8 states that corrosion can be controlled by:
- applying a protective coating to isolate the steel from the air or from seawater electrolyte
- using cathodic protection to prevent steel from forming the anode of a corrosion cell

1.4.9 explains that cathodic protection can only be used to protect the underwater hull or ballasted tanks
1.4.10 states that both of the methods mentioned above are normally used together
1.4.11 explains what mill scale is and states that it is cathodic to mild steel
1.4.12 describes the treatment of steel in a shipyard and the use of holding primers (shop primers)
1.4.13 explains that the required preparation of steelwork depends upon the type of paint to be applied
1.4.14 states that many modem paints, such as epoxy and polyurethane, need to be applied to a very clean shot-blasted surface
1.4.15 states that paints consist mainly of a vehicle, a pigment and a solvent, and explains the purpose of each
1.4.16 explains the suitability of the following paint types for various applications as:
- drying oils
- oleo-resins
- alkyd resins
- polymerizing chemicals
- bitumen

1.4.17 describes the action of anti-fouling paint
1.4.18 describes the use of self-polishing anti-fouling paint
1.4.19 explains the ban on harmful types of antifouling paint
1.4.20 describes typical paint schemes for
- underwater areas
- boot topping
- topsides
- weather decks
- superstructures
- tank interiors

1.4.21 states the safety precautions to take when using paints
1.4.22 describes the system of cathodic protection using sacrificial anodes
1.4.23 lists the metals and alloys which may be used as anodes
1.4.24 explains why anodes of magnesium and of magnesium alloy are not permitted in cargo/ballast tanks and in adjacent tanks in tankers
1.4.25 states that good electrical contact between the anode and the hull or tank is essential
1.4.26 explains why the anodes are insulated from the hull
1.4.27 describes the impressed-current system of hull protection
1.4.28

1.4.29 explains that the system is adjusted for optimum protection, often automatically, by use of a reference cell

1.4.30 states that electrical connection with the hull via slip rings and brushes on the rudder stock and propeller shaft ensures protection of the rudder and propeller

1.4.31 explains that, as the underwater paintwork deteriorates, higher currents are required for protection

1.4.32 states that too high a current can result in damage to paintwork and a chalky deposit on areas of bare metal, which has to be removed before repainting can be carried out

1.4.33 states that a protective shield of epoxy resin is applied for about 1 meter around the anodes to withstand the alkaline conditions there

1.5 Survey and Dry-docking

1.5.1 states the frequency of classification society surveys

1.5.2 states that intervals between dry-dockings may be extended up to 2.5 years where a ship has high-resistance paint and an approved automatic impressed- current cathodic protection system

1.5.3 states that continuous hull survey, in which all compartments are examined over a 5-year period, may replace the special surveys

1.5.4 explains all types of survey a ship is subjected to, including but limiting to: Initial Survey, Renewal Survey, Periodical Survey, Intermediate Survey, Annual Survey, Inspection of the outside of the ships bottom, Additional Survey.

1.5.5 Explains the harmonized system of ship survey and certification

1.5.6 Explains Condition Assessment Scheme (CAS) for oil tankers and Condition Assessment Programme (CAP)

1.5.7 lists the items inspected at annual survey as:

- protection of openings: hatches, ventilators, cargo doors, side scuttles, overside discharges and any other openings through which water might enter
- guardrails
- water-clearing arrangements, freeing ports, scuppers
- means of access to crews quarters and working areas

1.5.8 states that the inspections listed above are also required for the annual inspection under the International Convention on Load Lines

1.5.9 lists the items to examine in dry-dock as:

- shell plating
- cathodic protection fittings
- rudder
- stem frame
- propeller

- anchors and chain cable

1.5.10 describes the examinations to be made of the items listed above
1.5.11 describes the cleaning, preparation and painting of the hull in dry-dock
1.5.12 calculates paint quantities, given the formula for wetted surface area as:

$$S = 2.58 \sqrt{\Delta L}$$

where S = surface area in m2
Δ = displacement in tones
L = length of ship in meters

1.6 Stability

1.6.1 Approximate Calculation of Areas and Volumes

- states the trapezoidal rule for the area under a curve in terms of the number of ordinates, the interval and the ordinate values
- uses the trapezoidal rule to find the area under a curve defined by given ordinates
- states Simpson's first rule as

$$A = h (y1 + 4y2 + y3) / 3$$

where: A = area under curve
h = interval length
y1, y2, y3 are ordinates

- writes down the repeated first rule for any odd number of ordinates
- uses Simpson's first rule to find the area under a curve defined by an odd number of ordinates
- states that the area is exact for a linear, quadratic or cubic curve but an approximation otherwise
- states, Simpson's second rule as

$$A = 3h (y1 + 3y2 + 3y3 + y4) / 8$$

where: A = area
h = interval length
y1, y2, y3, y4 are ordinates

- writes down the repeated second rule for 7, 10, 13, etc, ordinates
- uses Simpson's second rule to find the area under a curve defined by a suitable number of given ordinates
- states that the area is exact for linear, quadratic or cubic curves
- states that the first rule has smaller errors that the second and should be used in preference where possible

- states that errors can be reduced by using a smaller interval

- states the 5, 8, -1 rule as A = h(5y1 + 8y2 - y3) / 12

where: A = area between first and second ordinates
h = interval length
y1, y2, y3, are ordinates

- uses Simpson's rules to find the area under a curve defined by any number of ordinates
- explains that the volume of a body may be calculated by using Simpson's rules with cross-sectional areas as ordinates
- calculates the volume of a ship to a stated draught by applying Simpson's rules to given cross-sectional areas or waterplane areas
- uses Simpson's first, second and 5/8-1 Rules to approximate areas and volumes of ship structure and GZ curves with any number of ordinates and intermediate ordinates
- uses Simpson's 1st and 2nd Rules for 1st moments and centroids.
- apply Simpson's Rules to find centroids.
- uses Simpson's Rules to find common areas such as, waterplanes, sections and bulkheads.
- calculate Vertical Centre of Buoyancy, VCB; Longitudinal Centre of Buoyancy, LCB of ship shapes.
- applies Simpson's 1st and 2nd Rules for 2nd moments of area.
- Calculates transverse moment of inertia, IT; Longitudinal moment of inertia, IL of ship shapes.
- explains why the density of the water in the dock should be taken at the same time as the draughts are read
- describes the statical and dynamic effects on stability of the movement of liquids with a free surface
- calculates the virtual reduction in GM for liquids with a free surface in spaces with rectangular and triangular waterplanes
- deduces from the above objective that halving the breadth of a tank reduces the free surface effect to one eight of its original value
- deduces that the subdividing a tank at the centre reduces its free surface effect to one quarter of that of the
- undivided tank
- states that the quantity 'inertia x density of liquid' is called the 'free surface moment' of the tank, in tone-meters
- states that information for calculating free surface effect is included in tank capacity tables
- states that the information may be given in one of the following ways:

- inertia in $metre^4$

- free surface moments for a stated density of liquid in the tank
- as a loss of GM, in tabulated form for a range of draughts (displacements) for a stated density of liquid in the tank
- corrects free surface moments when a tank contains a liquid of different density from that slated in the capacity table
- given a ship's displacement and the contents of its tanks, uses the information from ship's stability information as to calculate the loss of GM due to slack tanks
- given a ship's departure conditions and the daily consumption of fuel, water and stores, calculates the GM allowing for free surfaces on arrival at destination

Stability at Moderate and Large Angles of Heel

- states that the formula $GZ = GM \sin \theta$ does not hold for angles in excess of about 10º
- states that the initial KM is calculated from

  $KM = KB + BM$

- uses a metacentric diagram to obtain values of KM, KB and BM for given draughts
- states that the transverse $BM = I / V$

  Where: I = second moment of area of the waterplane about the centre line;
  V = underwater volume of the ship

- states that for a rectangular waterplane $I = LB^3 / 12$

  where: L is the length of the waterplane;
  B is the breadth of the waterplane
- shows that, for a box-shaped vessel,

  $KM = (B^2 / 12d) + (d / 2)$
  where: d = draught

- states that, for moderate and large angles of heel, values of GZ found by calculating the position of the centre of buoyancy are provided by the shipbuilder for a range of displacements and angles of heel for an assumed position of the centre of gravity
- uses cross-curves of stability and KN curves to construct a curve of statical stability for a given displacement and value of KG, making correction for any free surface moments

- explains how to use the initial metacentric height as an aid to drawing the curve
- identifies from the curve the approximate angle at which the deck edge immerses
- describes the effect of increased freeboard on the curve of statical stability for a ship with the same initial GM
- states that the righting lever, GZ, may be found from the wall-sided formula up to the angle at which the deck edge is immersed
- given the wall-sided formula:

  GZ = (GM + BM / 2 tan2□) sin □

  and other relevant data, calculates the value of GZ for a stated angle of heel

- shows that, for small angles of heel, the term

  BM / 2 tan2□ is negligible, leading to the usual expression for GZ at small angles of heel

- uses the wall-sided formula for calculating the angle of loll of an initially unstable ship
- compares the result in the above objective with that obtained by connecting a curve of statical stability
- states that cross-curves and KN curves are drawn for the ship with its centre of gravity on the centre line
- demonstrates how to adjust the curve of statical stability for a ship with a list
- describes the effect when heeled to the listed side on:
  - the maximum righting moment
  - the angle of vanishing stability
  - the range of stability
- states that cross-curves and KN curves are drawn for the ship at the designed trim when upright
- states that righting levers may differ from those shown if the ship has a large trim when upright
- Simplified Stability Data
  - states that stability information may be supplied in a simplified form, consisting of:
  - a diagram or table of maximum deadweight moment
  - a diagram or table of minimum permissible GM
  - a diagram or table of maximum permissible KG all related to the displacement or draught in salt water
- states that a deadweight moment is mass in tones X vertical height of the mass above the keel
- states that free surface moments are to be added to the deadweight moments when using the diagram of maximum deadweight moment

- states that if, for a stated displacement or draught, the total deadweight moment or KG is less than permissible value, the ship will have adequate stability
- reads the maximum permissible deadweight moment from a curve of deadweight moment for a given displacement
- given the masses loaded, their heights above the keel and the free surface moments of slack tanks, calculates the deadweight moment and uses the result with the diagram of deadweight moment to determine if the stability is adequate
- uses the diagram of deadweight moment to calculate the maximum mass that can be loaded in a given position to ensure adequate stability during a voyage, making allowance for the fuel, water and stores consumed and for any resulting free surface
- states that curves of maximum KG or minimum GM to ensure adequate stability in the event of partial loss of intact buoyancy are provided in passenger ships

Trim and List

- defines longitudinal centre of gravity (LCG) and longitudinal centre of buoyancy (LCB)
- states that a ship trims about the centre of flotation until LCG and LCB are in the same vertical line
- states that the distance of the LOB from amidships or from the after perpendicular is given in a ship‘s hydrostatic data for the ship on an even keel
- explains that the LCG must be at the same distance from amidships as LCB when the ship floats on an even keel
- shows on a diagram of a ship constrained to an even keel the couple that is formed by the weight and buoyancy forces when LCG is not the same distance from amidships as LCB
- states that the trimming moment = displacement x the horizontal distance between LCB (tabulated) and LCG
- (actual) = Δ x GG1
- where GG1 is the horizontal distance between the position of LCG for the even- keel condition and the actual LCG
- states that trim = (Δ x GG1) / MCT 1cm
- states that if the actual LCG is abaft the tabulated position of LCB, then the trim will be by the stern, and vice versa
- given the initial displacement, initial position of LCG, masses loaded or discharged and their LCGs, calculates the final position of LCG
- using a ship‘s hydrostatic data and a given disposition of cargo, fuel, water and stores, determines the trim, the mean draught and the draughts at each end
- calculates the mass to move between given positions to produce a required trim or draught at one end

- calculates where to load a given mass to produce a required trim or draught at one end
- calculates how to divide a loaded or discharged mass between two positions to produce a required trim or draught at one end
- calculates where to load a mass so as to keep the after draught constant
- states that calculated draughts refer to draughts at the perpendiculars
- given the distance of draught marks from the perpendiculars and the length between perpendiculars, corrects the draughts indicated by the marks
- given draughts forward, aft and amidships, states whether or not the ship is hogged or sagged and the amount
- corrects the draught amidships for hog or sag
- given the forward and after draughts, the length between perpendiculars and hydrostatic data, calculates the correction for trim to apply to the displacement corresponding to the draught amidships
- states that a second correction for trim, using Nemoto‘s formula, may be applied to the displacement
- given Nemoto‘s formula, calculates the second correction to displacement
- calculates the maximum list during loading or discharging a heavy lift, using a ship‘s derrick, given the relevant stability information and the dimensions of the derrick
- calculates the minimum GM required to restrict the list to a stated maximum when loading or discharging a heavy lift
- calculates the quantities of fuel oil or ballast to move between given locations to simultaneously correct a list and achieve a desired trim
- explains how to distinguish between list and loll and describes how to return the ship to the upright in each case
- by making use of curves of statical stability, including those for ships with zero or negative initial GM, determines the equilibrium angle of heel resulting from a transverse moment of mass

Dynamical Stability

- defines dynamical stability at any angle of heel as the work done in inclining the ship to that angle
- states that the dynamical stability at any angle is given by the product of displacement and the area under the curve of statical stability up to that angle
- given a curve of statical stability, uses Simpson‘s rules to find the area in meter-radians up to a stated angle
- states that dynamical stability is usually expressed in tone-meters

- explains that the dynamical stability at a given angle of heel represents the potential energy of the ship
- states that the potential energy is used partly in overcoming resistance to rolling and partly in producing rotational energy as the ship returns to the upright
- states that the rotational energy when the ship is upright causes it to continue rolling
- states that, in the absence of other disturbing forces, the ship will roll to an angle where the sum of the energy used in overcoming resistance to rolling and the dynamical stability are equal to the rotational energy when upright
- states that a beam wind exerts a force equal to the wind pressure multiplied by the projected lateral area of the portion of the ship and deck cargo above the waterline
- explains that a heeling moment is formed, equal to the force of the wind multiplied by the vertical separation between the centers of the lateral areas of the portions of the ship above and below the waterline
- states that the heeling lever equals the heeling moment divided by the ship‘s displacement
- states that a steady wind will cause a ship to heel to an angle at which the righting lever is equal to the heeling over
- states that a ship under the action of a steady wind would roll about the resulting angle of heel
- on a curve of righting levers, indicates the angle of equilibrium under the action of a steady wind and the areas which represent the dynamical stability at angles of roll to each side of the equilibrium position
- by reference to dynamical stability, describes the effect of an increase in wind pressure when a vessel is at its maximum angle of roll to windward
- summarizes the recommendation on severe wind and rolling criterion for the intact stability of passenger and cargo ships
- by reference to a curve of righting levers and dynamical stability, describes the effect of a listing moment on the rolling of the ship about the equilibrium position

Approximate GM by Means of Rolling Period Tests

- states that, for ships up to 70m in length, the GM can be verified in still water by causing the ship to roll and noting the rolling period
- defines the rolling period as the time taken for one complete oscillation from the extreme end of a roll to one side, right across to the extreme on the other side and back to the original position
- states that for small angles of roll in still water, the initial metacentric height, GMo is given by:

GMo= [fB / Tr]2
where: f = rolling factor
B = breadth of the ship
Tr = rolling period in seconds

- states that the formula may be given as:
  GMo= F / Tr2
  where the F-value is provided by the Administration

- summarizes the procedures for determining a ship's stability by means of the rolling period test
- given values of F and T and the equation GMo = F / T2, calculates GMo
- states the limitations of the method
- states the limitations of the method states that when construction is completed, a ship undergoes an inclining test to determine the displacement and position of the centre of gravity, KG and LCG, in the light ship condition
- states that the displacement and KM are calculated from the observed draughts and the ship's lines plans, making allowance for density of water and trim
- states that the position of the centre of buoyancy is calculated to enable the LCG for the light ship to be determined
- describes how an inclining test is carded out
- given the mass and the distance through which it was moved, the displacement, length of the plumb line and the deflection, calculates the KG
- states that the values obtained in a test are corrected for masses to be removed and added to obtain the KG and LCG for the light ship
- states that, at periodical intervals not exceeding five years, a light ship survey must be carried out on all passenger ships to verify any changes in light ship displacement and longitudinal centre of gravity
- states that the ship must be re-inclined whenever, in comparison with the approved stability information, a deviation from the light ship displacement exceeding 2% or a deviation of the longitudinal centre of gravity exceeding 1% of L is found or anticipated

The Intact Stability Code

- describes the general precautions to be taken against capsizing
- states the recommended criteria for passenger and cargo ships of all types
- given the initial metacentric height and the GZ curve, determines whether the ship meets the recommended criteria

- states that stability information should comprise:
  - stability characteristics of typical loading conditions
  - information to enable the assessment of the stability of the ship in all loading conditions differing from the standard ones
  - information on the proper use of anti-rolling devices, if fitted
  - information to enable the GMo to be determined by means of a rolling test corrections to be made to GMo for free surface liquids
  - for ships carrying timber deck cargoes information setting out changes in deck cargo from that shown in the loading conditions, when the permeability of the deck cargo is significantly different from 25%
  - for ships carrying timber deck cargoes, indications of the maximum permissible amount of deck cargo
- states that criteria are laid down for ships carrying timber deck cargoes
- discusses the use of the weather criterion and how to assess whether a vessel complies with this
- states the additional criteria recommended for passenger ships
- states that the information includes a curve or table giving, as a function of the draught, the required initial GM which ensures compliance with the recommendations on intact stability

Rolling of Ships

- describes the effect on GM of rolling
- explains how increase of draught and of displacement influence rolling
- describes how the distribution of mass within the ship affects the rolling period
- explains what synchronization is and the circumstances in which it is most likely to occur
- describes the actions to take if synchronization is experienced
- describes how bilge keels, anti-rolling tanks and stabilizer fins reduce the amplitude of rolling
- states that a ship generally heels when turning
- states that, while turning, the ship is subject to an acceleration towards the centre of the turn
- states that the force producing the acceleration acts at the underwater centre of lateral resistance, which is situated at about half-draught above the keel
- states that the force in the above objective is called the centripetal force, given by F = Mv2 / r

where: M = mass of the ship in tones
v = speed in meters per second
r = radius of turn in meters
F = centripetal force in kilonewtons

- states that the ship will heel until the resulting righting moment equals the heeling couple, i.e.

$$M \times g \times GM \sin \square = \frac{Mv^2}{r} \left(KG - \frac{d}{2} \right) \cos \theta$$

where: g = acceleration due to gravity
θ = angle of heel

- given the relevant data, calculates the angle of heel from

$$\tan \theta = \frac{v2 \times \left(KG - \frac{d}{2} \right)}{g \times GM \times r}$$

Dry-Docking and Grounding

- states that for dry-docking a ship should:
  - have adequate initial metacentric height
  - be upright
  - have a small or moderate trim, normally by the stern
- states that part of the weight is taken by the blocks as soon as the ship touches, reducing the buoyancy force by the same amount
- states that the upthrust at the stern causes a virtual loss of metacentric height
- explains why the GM must remain positive until the critical instant at which the ship takes the blocks overall
- derives the formula for the upthrust at the stern

$$P = \frac{(MCT \times t)}{L}$$

where: P = upthrust at the stern in tones
t = change of trim in cm
L = distance of the centre of flotation from aft

- explains that a ship with a large trim will develop a large upthrust, which may damage the stern frame, trip the blocks or lead to an unstable condition before taking the blocks overall
- by taking moments about the centre of buoyancy, shows that, for a small angle of heel, θ,

- righting moment= Δ x GM sin θ – P x KM sin θ
- where GM is the initial metacentric height when afloat
- shows that the righting lever is that for the ship with its metacentric height reduced by (P x KM)/ Δ
- by using the equation in the above objective and KM + KG + GM, shows that righting moment = (Δ – P) x GM sin θ – P x KG sin θ
- shows that the righting lever is that for a ship of displacement (Δ – P) and with metacentric height reduced by (P x KG)/ Δ – P
- explains that the righting moment remains positive providing Δ x GM is greater than P x KM or equivalently, (Δ – P) x GM is greater than P x KG
- calculates the minimum GM to ensure that the ship remains stable at the point of taking the blocks overall
- calculates the maximum trim to ensure that the ship
- remains stable on taking the blocks overall for a given GM
- calculates the virtual loss of GM and the draughts of the ship after the after level has fallen by a stated amount
- calculates the draughts on taking the blocks overall
- explains that the stability of a ship aground at one point on the centre line is reduced in the same way as in dry-docking
- states that when grounding occurs at an off-centre point, the upthrust causes heel as well as trim and reduction of GM
- explains that the increase in upthrust as the tide falls increases the heeling moment and reduces the stability

Shear Force, Bending Moments and Torsional Stress

- explains what is meant by shearing stress
- states that the shear force at a given point of a simply supported beam is equal to the algebraic sum of the forces to one side of that point
- explains that, for a beam in equilibrium, the sum of forces to one side of a point is equal to the sum of the forces on the other side with the sign reversed
- explains what is meant by a bending moment
- states that the bending moment at a given point of a beam is the algebraic sum of the moment of force acting to one side of that point
- states that the bending moment measured to opposite sides of a point are numerically equal but opposite in sense
- draws a diagram of shear force and bending moment for simply supported beams
- states that the bending moment at any given point is equal to the area under the shear-force curve to that point
- uses the above objective to show that the bending-moment curve has a turning point where the shear force has zero value

- explains that shear forces and bending moments arise from differences between weight and buoyancy per unit length of the ship
- states that the differences between buoyancy and weight is called the load
- draws a load curve from a given buoyancy curve and weight curve
- states that the shear force at any given point is equal to the area under the load curve between the origin and that point
- draws a diagram of shear force and bending moment for a given distribution of weight for a box-shaped vessel
- explains how wave profile affects the shear-force curve and bending-moment curve
- states that each ship above a specified length is required to carry a loading manual, in which are set out acceptable loading patterns to keep shear forces and bending moments within acceptable
- states that the classification society may also require a ship to carry an approved means of calculating shear forces and bending moment at stipulated stations
- demonstrates the use of a loading instrument
- states that the loading manual and instrument, where provided, should be used to ensure that shear forces and bending moments do not exceed the permissible limits in still water during cargo and ballast handling
- explains what is meant by a torsional stress
- describes how torsional stresses in the hull are set up
- states that wave-induced torsional stresses are allowed for in the design of the ship
- states that cargo-induced torsional stresses are a problem mainly in container ships
- states that classification societies specify maximum
- permissible torsional moments at a number of specified cargo bays
- given details of loading, calculates cumulative torsional moments for stated positions
- describes the likelihood of overstressing the hull structure when loading certain bulk cargoes

1.7 Resistance and Fuel Consumption

1.7.1 Explains and completes calculations involving: -

- Frictional resistance.
- REYNOLDS‘ number.
- Residuary resistance.
- Froude number.
- Speed length ratio.
- Effective power.
- Admiralty coefficient.
- Fuel coefficient and fuel consumption.

1.8 Rudders

1.8.1 Explains and completes calculations on:

- Force on a rudder
- Torque on a rudder stock

2. Effect on Trim and Stability in the Event of Damage and Flooding

2.1 Effect of flooding on Transverse Stability and Trim

2.1.1 Passenger Vessels

- explains what is meant by 'floodable length'
- defines:
  - Margin line
  - Bulkhead deck
  - Permeability of a space
- explains what is meant by 'permissible length of compartments' in passenger ships
- describes briefly the significance of the Criterion of Service Numeral
- explains the significance of the factor of subdivision
- states the assumed extent of damage used in assessing the stability of passenger ships in damaged condition
- summarizes, with reference to the factor of subdivision, the extent of damage which a passenger ship should withstand
- describes the provisions for dealing with asymmetrical flooding
- states the requirements for the final condition of the ship after assumed damage and, where applicable, equalization of flooding
  - states that the vessel is supplied with data necessary to maintain sufficient intact stability to withstand the critical damage
  - explains the minimum residual stability requirements in the damaged condition with the required number of compartments flooded
  - discusses the use of the damaged stability information required to be provided to a passenger vessel

2.1.2 Cargo Ships

- distinguishes between ships of Type A and Type B for the purpose of computation of freeboard
- describes the extent of damage that a Type A ship of over 150 m in length should be able to withstand
- explains that a Type A ship of over 150m in length is described as a one compartment ship
- describes the requirements for the survivability of Type B ships with reduced assigned freeboard

- summarizes the equilibrium conditions regarded as satisfactory after flooding
- states that damage to compartments may cause a ship to sink as a result of :
  - insufficient reserve buoyancy leading to progressive flooding
  - progressive flooding due to excessive list or trim
  - capsizing due to a loss of stability
  - Structural failure

2.1.3 Calculation of Vessel Condition After Flooding

- states that, in the absence of hull damage, the stability is calculated in the usual way using the added mass and making allowance for free surface liquid
- states that free surface moments for any rectangular compartment that is flooded by salt water can be approximated by

  moment = length x (breadth)3 x 1. 025 / 12

- states that virtual loss of GM = $\dfrac{\text{moment}}{\text{flooded displacement}}$
- states that when a compartment is holed the ship will sink deeper in the water until the intact volume displaces water equivalent to the mass of the ship and its contents
- explains that the loss of buoyancy of a holed compartment is equal to the mass of water which enters the compartment up to the original waterline
- states that the volume of lost buoyancy for a loaded compartment is equal to the volume of the compartment x the permeability of the compartment
- calculates the permeability of cargo, given its density and its stowage factor
- states that if the lost buoyancy is greater than the reserve buoyancy the ship will sink
- states that the centre of buoyancy moves to the centre of immersed volume of the intact portion of the ship
- states that when a compartment is holed the ship‘s displacement and its centre of gravity are unchanged
- explains that a heeling arm is produced, equal to the transverse separation of G and the new position of B for the upright ship
- states that the area of intact waterplane is reduced by the area of the flooded spaces at the level of the flooded waterline multiplied by the permeability of the space
- states that if the flooded space is entirely below the waterline there is no reduction in intact waterplane

- calculates the increase in mean draught of a ship, given the TPC and the dimensions of the flooded space, using

  increase in draught = $\dfrac{\text{volume of lost buoyancy}}{\text{area of intact waterplane}}$

- states that the height of the centre of buoyancy above the keel increases by about half the increase in draught due to flooding
- states that a reduction in waterplane area leads to a reduction in the second moment of area (I)
- uses the formula BM = I / V to explain why the BM of a ship is generally less when bilged that when intact
- states that change in GM is the net result of changes in KB and BM
- explains why the GM usually decreases where:
  - there is a large loss of intact waterplane
  - there is intact buoyancy below the flooded space
  - the flooded surface has a high permeability
  - explains why the bilging of empty double-bottom tanks or of deep tanks that are wholly below the waterline leads to an increase in GM
- calculates the reduction in BM resulting from lost area of the waterplane, given the following corrections:
- second moment of lost area about its centroid / displaced volume;

  this is $\dfrac{lb^3}{12\text{ V}}$ for a rectangular surface

where: L is length of the lost area
b is breadth of the lost area
V is displaced volume = $\dfrac{\text{displacement}}{\text{density of water}}$

original waterplane area / intact waterplane area X lost area X distance from centerline)^2 / displace volume

this is original $\dfrac{\text{waterplane area}}{\text{intact waterplane area x l.b.d}^2 / \text{V}}$

for a rectangular surface, where d is the distance of the centre of the area from the centerline

- deduces that the second correction applies only in the case of asymmetrical flooding

- calculates the shift (F) of the centre of flotation (CE) from the centerline, using

$$F = \frac{a \times d}{A - a}$$

where: a is the lost area of waterplane
A is the original waterplane area
D is the distance of the centre of lost area of waterplane from the centerline

- shows that the heeling arm is given by

  heeling arm = lost buoyancy (tones) / displacement X transverse distance from new CF

- constructs a GZ curve for the estimated GM and superimposes the heeling- arm curve to determine the approximate angle of heel
- uses wall sided formula to determine GZ value
- uses wall sided formula to calculate angle of heel
- states that, for small angles of heel, θ,

$$\tan \varnothing = \frac{\text{heeling arm}}{\text{GM}}$$

- explains how lost area of waterplane affects the position of the centre of flotation

Effect of Flooding on Trim

- calculates the movement of the centre of flotation (CF), given:

  Movement of CF = moment of lost area about original CF / intact waterplane area

- explains how the reduction in intact waterplane reduces the MCT 1cm

- calculates the reduction of BML, given the following corrections:

  second moment of lost area about its centroids/ displaced volume;

  this is $\frac{bL^3}{12V}$ for a rectangular surface

  Where: L is length of lost area
  B is breadth of lost area
  V is displaced volume = $\frac{\text{displacement}}{\text{density of water}}$

  Original waterplane area / intact waterplane area X lost area X (distance from CF)^2 / displaced volume

  This is original aterplane area / intact waterplane X bld^2 / v

- for a rectangular surface, where d is the distance of the centre of area from the original centre of flotation
- calculates the reduction of MCT 1 cm, given,

  reduction of mct 1 cm = (displacement X reduction of GM) / 100 X ship's length
- states that the trimming moment is calculated from: trimming moment = lost buoyancy X distance from new CF where the lost buoyancy is measures in tones
- given the dimension of a bilged space and the ship's hydrostatic data, calculates the draughts in the damaged condition
- describes measures which may be taken to improve the stability or trim of a damaged ship

2.2 Theories Affecting Trim and Stability

2.2.1 describes the static and dynamic effects on stability of liquids with a free surface
2.2.2 identifies free surface moments and shows its application to dead-weight moment curves
2.2.3 interprets changes in stability which take place during a voyage
2.2.4 describes effect on stability of ice formation on superstructure
2.2.5 describes the effect of water absorption by deck cargo and retention of water on deck
2.2.6 describes stability requirements for dry docking
2.2.7 demonstrates understanding of angle of loll
2.2.8 states precautions to be observed in correction of angle of loll
2.2.9 explains the dangers to a vessel at an angle of loll
2.2.10 describes effects of wind and waves on ships stability
2.2.11 lists the main factors which affect the rolling period of a vessel

2.2.12 explains the terms synchronous and parametric rolling and pitching and describes the dangers associated with it
2.2.13 describes the actions that can be taken to stop synchronous and parametric effects

3. Knowledge of IMO Recommendations Concerning Ship Stability

3.1 Responsibilities under the International Conventions and Codes

1.1.1 states minimum stability requirements required by Load Line Rules 1966
1.1.2 states the minimum stability requirements and recommendations of the Intact Stability Code
1.1.3 explains the use of the weather criterion
1.1.4 demonstrates the use of IMO Grain Regulations
1.1.5 describes the requirements for passenger ship stability after damage

F4 - Module 2

Competence: Maintain Safety and Security of the vessel, Crew and Passengers and the Operational Condition of life-saving, fire-fighting and other Safety systems

1. Knowledge of Life-Saving Appliance Regulations (SOLAS)

1.1 Life-Saving Appliance Regulations (SOLAS)

1.1.1 Life-Saving Appliance Regulations (SOLAS)

- demonstrate a thorough knowledge of the regulations concerning life-saving appliances and arrangements (SOLAS), including the LSA Code

1.2 Organization of Fire and Abandon Ship Drills

1.2.1 Organization of Fire and Abandon Ship Drills

- prepares schedules for the conduct of fire and abandon ship drills so that all required drills and equipment are covered within required timeframes
- discusses ways in which crew can be motivated to participate fully in drills
- prepares plans for effective drills
- organizes effective drills including the briefing, conduct and debriefing of the drill
- discusses the process for ensuring that required changes are made to the safety management system and on board procedures as a result of the lessons learnt from drills

1.3 Maintenance of Operational Condition of Life-Saving, Fire-fighting and Other Safety Systems

1.3.1 Maintenance of Life-saving, Fire-fighting and Other Safety Systems

- discusses the use and upkeep of the SOLAS training manual in terms of the safety equipment provided and the required maintenance of this equipment
- prepares procedures and checklists for the inspection of lifesaving, fire fighting and other safety systems on board
- ensures that regular inspections of lifesaving, fire fighting and other safety systems on board are undertaken and that any deficiencies are identified and rectified
- prepare procedures and schedules for the maintenance of lifesaving, fire fighting and other safety systems on board
- prepares schedules for the required survey of lifesaving, fire fighting and other safety systems on board
- - prepares for and supports the survey of lifesaving, fire fighting and other safety systems on board

- prepares procedures and checklists for the inspection of watertight doors, side scuttles, cross flooding arrangements, valves and other closing mechanisms
- prepares maintenance plans and procedures for watertight doors, side scuttles, cross flooding arrangements, valves and other closing mechanisms

2. Actions to be taken to protect and safeguard all persons on board in emergencies

2.1 Actions to Protect and Safeguard all Persons on Board in Emergencies

2.1.1 states that some crew members will be assigned specific duties for mustering and control of passengers
- lists those duties as:
  - warning the passengers
  - ensuring that all passenger spaces are evacuated
  - guiding passengers to muster stations
  - maintaining discipline in passageways, stairs and doorways
  - checking that passengers are suitably clothed and that life jackets are correctly donned
  - taking a roll-call of passengers
  - instructing passengers on procedure for boarding survival craft or jumping into the sea
  - directing passengers to embarkation stations
  - instructing passengers during drills
  - ensuring that a supply of blankets is taken to the survival craft

3. Actions to Limit Damage and Salve the Ship following a Fire, Explosion, Collision or Grounding

3.1 Means of limiting damage and salving the ship following a fire or explosion

3.1.1 describes the use and limitations of standard procedures and prepared contingency plans in emergency situations
3.1.2 describes methods of fighting fires (see IMO Model Course 2.03, Advanced Training in Fire Fighting)
3.1.3 states that cooling of compartment boundaries where fire has occurred should be continued until ambient temperature is approached
3.1.4 explains the dangers of accumulated water from fire fighting and describes how to deal with it

3.1.5 states that watch for re-ignition should be maintained until the area is cold
3.1.6 describes the precautions to take before entry to a compartment where a fire has been extinguished
3.1.7 describes the inspection for damage
3.1.8 describes measures which may be taken to plug holes, shore-up damaged or stressed structure, blank broken piping, make safe damaged electrical cables and limit ingress of water through a damaged deck or superstructure
3.1.9 outlines the measures to be taken when the inert-gas main and gas lines to a mast riser are fractured
3.1.10 states that continuous watch should be kept on the damaged area and temporary repairs
3.1.11 states that course and speed should be adjusted to minimize stresses and the shipping of water

3.2 Procedure for Abandoning Ship

3.2.1 states that a ship should only be abandoned when imminent danger of sinking, breaking up, fire or explosion exists or other circumstances make remaining on board impossible
3.2.2 describes the launching of boats and liferafts when the ship is listing heavily
3.2.3 describes the launching of boats and liferafts in heavy weather conditions
3.2.4 describes the use of oil to calm the sea surface and explains why fuel oil is not suitable

F4 - Module 3

Competence: Develop emergency and damage control plans and handle emergency situations

1. Preparation of Contingency Plans for Response to Emergencies

1.1 Contingency Plans for Response to Emergencies

1.1.1 draws up a muster list and emergency instructions for a given crew and type of ship

1.1.2 assigns duties for the operation of remote controls such as:
- main engine stop
- ventilation stops
- lubricating and fuel oil transfer pump stops
- dump valves
- CO2 discharge
- watertight doors
- and for the operation of essential services such as:
  - emergency generator and switchboard
  - emergency fire and bilge pumps

1.1.3 describes options for the division of the crew, e.g., into a command team, an emergency team, a back-up emergency team and an engine-room emergency team

1.1.4 explains the composition of the emergency teams in the above objective

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

1.1.6 designates muster positions for the command team, both at sea and in port

1.1.7 designates muster positions for the emergency teams

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

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

1.1.10 prepares contingency plans to deal with:
- fire and/or explosion in specific areas, such as galley, accommodation, container stows on or under deck, engine-room or cargo space, including co-ordination with shore facilities in port, taking account of the ship‘s fire-control plan
- rescue of victims from an enclosed space
- water ingress into the ship
- serious shift of cargo
- piracy attack
- being towed by another ship or tug

- heavy-weather damage, with particular reference to hatches, ventilators and the security of deck cargo
- rescue of survivors from another ship or from the sea
- leakages and spills of dangerous cargo stranding
- abandoning ship
- explains how drills and practices should be organized

1.1.11 describes the role of a shipboard safety committee in contingency planning

Actions to be Taken when Emergencies Arise in Port

1.1.12 describes actions to take in the event of fire on own ship, with particular reference to co-operation and communication with shore facilities
1.1.13 describes action which should be taken when fire occurs on a nearby ship or an adjacent port facility
1.1.14 describes the circumstances in which a ship should put to sea for reasons of safety

2. Ship Construction, including Damage Control

2.1 Flooding of Compartments

2.1.1 defines:
- margin line
- permeability of a space

2.1.2 explains what is meant by 'floodable length'
2.1.3 explains what is meant by 'permissible length of compartments' in passenger ships
2.1.4 describes briefly the significance of the factor of subdivision
2.1.5 states the assumed extent of damage used in assessing the stability of passenger ships in damaged condition
2.1.6 summarizes, with reference to the factor of subdivision, the extent of damage which a passenger ship should withstand
2.1.7 describes the provisions for dealing with asymmetrical flooding
2.1.8 states the final conditions of the ship after assumed damage and, where applicable, equalization of flooding
2.1.9 states that the master is supplied with data necessary to maintain sufficient intact stability to withstand the critical damage
2.1.10 explains the possible effects of sustaining damage when in a less favorable condition
2.1.11 distinguishes between ships of Type 'A' and Type 'B' for the purposes of computation of freeboard
2.1.12 describes the extent of damage which a Type 'A' ship of over 150 meters length should withstand
2.1.13 explains that a Type 'A' ship of over 150 meters length is described as a 'one-compartment ship

2.1.14 describes the requirements for survivability of Type ‗B' ships with reduced freeboard assigned

2.1.15 summarizes the equilibrium conditions regarded as satisfactory after flooding

2.1.16 states that damage to compartments may cause a ship to sink as a result of:

- insufficient reserve buoyancy, leading to progressive flooding
- progressive flooding due to excessive list or trim
- capsizing due to loss of stability structural failure

F4 - Module 4

Competence: Use of Leadership and Managerial Skill

1. Shipboard Personnel Management and Training

1.1 Shipboard Personnel Management

1.1.1 Principles of Controlling Subordinates and Maintaining Good Relationships

- Identifies sources of authority and power
- discusses theories on how effective authority and power may be enhanced or diminished by management level officers on ships
- reviews theories in cultural awareness and cross cultural communication
- discusses strategies that management level officers could adopt to enhance their effectiveness in managing crews of different cultures
- reviews theories in human error, situational awareness, automation awareness, complacency and boredom
- discusses strategies that management level officers can adopt to optimize situational awareness and to minimize human error and complacency of individuals and teams
- reviews theories in leadership and teamwork
- discusses strategies that management level officers can adopt to enhance leadership and teamwork
- discusses theories of personnel motivation and relates these to shipboard situations encountered by management level officers
- explains that an individual's motivation and well being may be effected by both real and perceived influences on board ship and at home
- discusses strategies that management levels officers could adopt to optimize the motivation of individuals and teams
- discusses theories on coaching individuals and teams to improve performance
- discusses approaches to managing and improving the performance of oneself, individuals and teams
- prepares for and conducts a simulated formal performance review
- identifies the impact of repeated harassment including bullying on individuals
- recognizes indications that crew members may be physically or mentally unwell or badly demotivated
- describes strategies that can be adopted when a crew member is believed to be physically or mentally unwell or badly demotivated

- describes strategies that management level officers can take to ensure that crew remain physically well and are encouraged to remain physically active

1.1.2 Crew Employment

- explains the need for management level officers to be fully familiar with the requirements of national law relating to crew employment and of all crew agreements in place on the ship
- discusses the process for signing on and discharging crew under national law
- discusses the need to ensure that new crew are appropriately certificated, competent and familiarized with the safety management system, security plan, working procedures and equipment of the ship
- explains that procedures for conducting investigations and applying consequences in disciplinary situations are governed by national law, codes of conduct, employment agreements and company procedures
- explains the process for investigating and applying consequences in disciplinary situations under relevant national law and procedures
- explains the formal process for addressing continuing levels of unacceptable performance by a crew member under national law
- explains the process for investigating and responding to incidents of harassment or bullying of crew members under national law
- explains requirements for handling crew wages, advances and allotments when this is done by management level officers on board ship

1.2 Training

1.2.1 Training Methods

- reviews training methods that could be adopted on board ship
- discusses the effectiveness of training methods that can be adopted for training
  - in attitude
  - in skills
  - in knowledge
- describes the preparation needed before the start of a training session
- discusses methods for ensuring that crew are motivated to participate fully in training
- demonstrates how to conduct a training session for a given topic

- lists the areas in which training is required by regulation including the requirements of SOLAS

- identifies other topics where training might be desirable
- delivers a training session to other members of the class
- discusses the resources that may be available on board ship that can be used for training

2. Related International Maritime Conventions and Recommendations, and National Legislation

2.1 Related International Maritime Conventions and National Legislations

2.1.1 The ISM Code

- explains the principles underlying the ISM Code
- describes the content and application of the ISM Code

2.1.2 STCW Convention

- explains the principles underlying the STCW Convention
- describes the content and application of the STCW Convention
- explains how to implement the regulations for ensuring fitness for duty
- states that seafarers new to a particular type of vessel require ship specific shipboard familiarization
- describes what shipboard familiarization may involve for watchkeeping officers
- describes what tasks or duties elementary basic safety familiarization involves for a watchkeeping officer
- describes how to organize shipboard training and how to maintain records
- states that penalties are prescribed for breaches of STCW 95 requirements and that these are determined by the flag state
- states that national legislation is required to implement the provisions of an international convention
- states that for STCW 1978, as amended, national legislation is subject to scrutiny and checking by IMO appointed persons
- states national legislation may differ from one flag to another

2.1.3 Maritime Labor Convention (MLC)

- demonstrates a working knowledge of the Maritime Labor Convention provisions relating to the management of personnel on board ship, with particular reference to
    - engagement of crew
    - employment conditions
    - crew entitlements and repatriation

- medical requirements

3. Application of Task and Workload Management

3.1 Task and Workload Management

3.1.1 reviews theories on applying task and workload management from IMO Model Course 1.39, Leadership and Teamwork

3.1.2 explains that the scope of activity and conflict between activities managed by management level officers is broader than for operational level officers and requires greater task and workload management ability

3.1.3 plans the task and workload allocation for significant shipboard activities so that the following are considered:
- human limitations
- personal abilities
- time and resource constraints
- Prioritization
- workload, rest and fatigue

3.1.4 discusses strategies to monitor the effectiveness of task and workload management during an activity and to adjust the plan as necessary

3.1.5 discusses strategies to ensure that all personnel understand the activity to be undertaken and their tasks in this

3.1.6 discusses whether the encouragement of a challenge and response environment is appropriate to the task and workload management of particular shipboard tasks

3.1.7 discusses the importance of debriefs and reflection after activities have been conducted to identify opportunities for improving task and workload management

4. Effective Resource Management

4.1 Application of effective resource management at the management level

4.1.1 reviews theories on effective communication

4.1.2 demonstrates effective communication in simulated or real situations involving communications on board ship and between ship and shore

4.1.3 discusses how management level officers can encourage other personnel to use effective communications

4.1.4 reviews theories on effective resource allocation, assignment and prioritization

4.1.5 demonstrates the effective allocation, assignment and prioritization of resources when managing simulated or real shipboard activities

4.1.6 reviews theories on decision making that considers team experience

4.1.7 demonstrates the ability to involve team member effectively in decision making when managing simulated or real shipboard activities

4.1.8 reviews theories on assertiveness and leadership
4.1.9 discusses appropriate leadership styles and levels of assertiveness for management level officers in a range of shipboard activities
4.1.10 demonstrates the ability to apply appropriate leadership styles and levels of assertiveness when managing simulated or real shipboard activities
4.1.11 reviews theories on obtaining and maintaining situational awareness
4.1.12 demonstrates the ability to obtain and maintain situational awareness when managing complex simulated or real shipboard activities
4.1.13 reviews theories on the use of short and long term strategies
4.1.14 demonstrates the ability to apply short and long term strategies when managing simulated or real shipboard activities

5. Decision Making Techniques

5.1 Situation and risk assessment
5.1.1 reviews theories of situation and risk assessment
5.1.2 discusses formal and informal approaches to risk assessment
5.1.3 identifies typical risks that management level officers may have to assess
5.1.4 demonstrates the ability to effectively assess risk in the planning and conduct of simulated or real shipboard activities

5.2 Identify and generate options
5.1.1 review theories on identifying and generating options
5.1.2 demonstrate the ability to identify and generate options when making decisions as a management level officer in simulated or real shipboard activity

5.3 Selecting Course of Action
5.3.1 reviews theories on selecting the course of action in making decisions
5.3.2 demonstrate the ability to select appropriate courses of action when making decisions as a management level officer in simulated or real shipboard activity

5.4 Evaluation of outcome effectiveness
5.4.1 explains how to carry out the evaluation of outcome effectiveness and the importance of doing it

6. Development, Implementation and Oversight of Standard Operating Procedures

6.1 discusses approaches to developing standard operating procedures (SOP‘s)

6.2 explains the methods to implement the SOP’s

6.3 explains why it may be desirable for there to be oversight and approval of many SOPs

(End of the Course)