

Chief Engineer Officer, Small Vessel, III/2

Written Examination Syllabus

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Source: UK MCA

1. Auxiliary Equipment Part 2
2. Chief Engineer Statutory and Operational Requirements
3. Applied Marine Engineering

Auxiliary Equipment part 2

1. Pumps

- a) Variable delivery pumps, construction and theory of operation.
- b) Swash plate type pump.

2. Hydraulic systems

- a) Application of hydraulic control systems
- b) Constant pressure hydraulic system for deck machinery (crane, windlass etc)
- c) Constant pressure hydraulic system for a stabiliser system

3. Electrical Plant

- a) Function and operation of AVR (auto-voltage regulator)
- b) Star Delta motor connection
- c) Load sharing between generators
- d) Inverters
- e) A.C. motor soft starting and speed controllers

4. Refrigeration and Air Conditioning (AC) plant

- a) Principles of refrigeration
- b) Design, construction and operation of refrigeration systems (direct and indirect expansion and secondary cooling)
- c) Design, construction and operation of AC systems
- d) Refrigeration compressors (sealed unit, reciprocating, rotary)
- e) Safety features. (Oil pressure cut-outs & gas high pressure trips, electrical overload trip, safety heads.).
- f) Gases and oils
- g) Blended refrigerants

- i) Understands the terms and relevance of zoetrope, azeotrope, near-azeotrope and glide, when applied to blended refrigerants
- j) Planned maintenance of Refrigeration and AC plants
- k) Fault finding of Refrigeration and AC plants
- l) Types of refrigeration gas bottles (single valve, double valve, with/without dip-tube)
- m) Charging a refrigeration system
- n) Checking a refrigeration system for air, removing air from the system
- o) Symptoms and effects of overcharging a refrigeration system
- p) Symptoms and effects of undercharging a refrigeration system
- q) Methods of draining a refrigerant from a system

5. High Pressure Air Compressor and air system.

- a) Construction and operation of multi-stage high pressure air compressors
- b) Filtering and cleaning of high pressure breathing air
- c) Testing and certification of compressed air cylinders

6. Lifting plant

- a) Lifting appliances and winches including:
 - i) Hydraulic equipment (types of hydraulic circuit, identification of symbols, fluids)
 - ii) Regulations, testing and certification of winches and lifting equipment
 - iii) Thorough examination, regulations, testing and certification of 'loose gear,' lifting strops and wires

7. Alternative fuels

- a) Safe storage and use of alternative fuels and operation e.g. Tenders and recreational vessels including:
 - i) Petrol and LPG
 - ii) Construction and safe operation of outboard motors
 - iii) Construction, handling and maintenance of inflatable and semi-inflatable craft
 - iv) Aviation fuels for helicopter use

8. Ship Construction and Dry Docking

- a) Protective coatings
- b) Transverse and longitudinal stresses and causes

- c) Panting and pounding stresses and causes
- d) Transverse and longitudinal framing construction
- e) Vibration, cause and effect
- f) Structural fire protection and subdivision
- g) Watertight integrity and subdivision
- h) Position, height and number of watertight bulkheads
- i) Purpose, construction and regulations regarding the collision bulkhead
- j) Watertight bulkhead and deck penetrations (doors, hatches, vents, pipes, shafts electrical glands)
- k) Static and dynamic condition of vessel in the water
- l) The effect of vessel (yacht, tug, workboat, fishing vessel) design on the stability of the vessel
- m) Effect of modifications and moving weights on stability
- n) Awareness of hazardous materials used in ship construction (EU Directives/Hong Kong convention)

Chief Engineer Statutory and Operational Requirements

1. IMO

- a) The role of the International Maritime Organisation (IMO)
- b) Basic knowledge of the structure and functions of IMO
- c) Basic knowledge of the Instruments of IMO (Conventions, Codes and Guidelines, Protocols, Amendments, Resolutions)

2. SOLAS – Responsibilities of the Chief Engineer for compliance

- a) Testing of steering gears
- b) Musters, fire and boat drills
- c) On-board training and instruction
- d) Testing emergency equipment
- e) International Safety Management (ISM)
- f) Code of International Ship and Port Security (ISPS) Code

3. MARPOL – Responsibilities of the Chief Engineer for compliance

- a) Details of the content of Annexe I
 - i. Regulations for the prevention of pollution by oil
 - ii. Regulations with respect to the discharge of oil overboard using oily-water separators
 - iii. Approved oily-water separators and automatic by-pass equipment
 - iv. International Oil Pollution Prevention (IOPP) Certificate
 - v. Shipboard Oil Pollution Emergency Plan (SOPEP)
 - vi. Oil Record Book (ORB)
 - vii. Entries required to be made in the ORB
- b) Basic awareness of the existence of Annexe II
- c) Basic awareness of the existence of Annexe III
- d) Details of the content of Annexe IV
 - i. Regulations for the prevention of pollution by sewage from ships
 - ii. Regulations with respect to the discharge of sewage overboard
- e) Details of the content of Annexe V
 - i) Regulations for the prevention of pollution by garbage from ships
 - ii) Regulations with respect to the discharge of garbage overboard
 - iii) Garbage Record Book (GRB)
 - iv) Entries required to be made in the GRB
- f) Awareness of the existence of Annexe VI and its content (Emissions regulations and SECAs)
 - i) Knowledge and name the special areas, PSSA and SECA /N (Nox)ECA and relative regulations with respect to the MARPOL Annexes

4. STCW

- a) Principles of watchkeeping, performing watches
- b) Standing orders
- c) Watchkeeping at sea, setting, handing over and accepting a watch
- d) Watchkeeping in port, setting, handing over and accepting a watch
- e) Watchkeeping at anchor, setting, handing over and accepting a watch
- f) Watchkeeping with UMS class vessels, watchkeeper safety check systems

5. International Convention on Load Lines (ICLL)

- a) Strength and construction
- b) Watertight and weathertight integrity
- c) Stability, free surface effect and reserve of buoyancy
- d) Protection of crew on deck

6. International Labour Organisation (ILO)

- a) Basic knowledge of the structure and functions of ILO
- b) Maritime Labour Convention (MLC), including outline knowledge of minimum hours of rest, contracts of employment and accommodation requirements.

7. Maritime Coastguard Agency (MCA)

- a) The role of an Administration, the UK Maritime Coastguard Agency (MCA)
- b) M-notice types and functions, Merchant Shipping Notices (MSN), Marine Guidance Notes (MGN) and Marine Information Notes (MIN)
- c) Knowledge of the content of the Code of Safe Working Practice for Merchant

Seamen (COSWP):

- i. Health and Safety at Work Regulations
 - ii. Safety Officials, Safety Officers, Safety Committee, Risk Assessment
 - iii. Dangers of handling hazardous substances, asbestos, fuel oil, lubricating oil etc
 - iv. Personal protective clothing and equipment
 - v. Permit to work system
 - vi. Entering enclosed or confined spaces
 - vii. Regulations associated with the testing and certification of lifting devices
 - viii. Emergency procedures and fire precautions
 - ix. Working in machinery spaces
 - x. Maintenance
 - xi. Colour coding systems (safety signs, gas cylinders, pipelines, fire extinguishers)
 - xii. Material Safety Data Sheets (MSDS) (product data sheets)
- d) Knowledge of the content of the Code of Practice for Control of Noise and Vibration in Ships
 - e) The role of the Marine Accident Investigation Branch (MAIB)
 - f) The role of a Port State Control (PSC)

- g) The role of a Flag State Control (FSC)

8. Classification Societies

- a) The role and functions of Classification Societies
- b) The role of the International Association of Classification Societies (IACS)
- c) Understand about classification of ships and class rules and Certificates of Class
- d) Timescale requirements of continuous survey of ship's machinery and hull with appropriate certification as required by Flag State and Class Society

9. Planned Maintenance Systems (PMS)

- a) Establishing a planned maintenance system (PMS):
 - i) Integrated maintenance and survey systems
 - ii) Unplanned (unscheduled) maintenance
 - iii) Planned (scheduled) maintenance
 - iv) Calendar based system
 - v) Hours based system
 - vi) Monitored / condition / performance based system
 - vii) Trend analysis
- b) Monitoring by human senses
- c) Monitoring by automatic control systems
- d) Recording data, log books, data loggers
- e) Continuous class surveys
- f) Approved maintenance systems
- g) Power card analysis (including computer based systems for modern engines)
- h) Periodic calibration (bearings, liner wear etc)
- i) Testing of fuel and lubricating oil
- j) Vibration analysis
- k) Developing an established PMS from experience and condition monitoring to enhance operation (e.g. extending/reducing running hours between maintenance overhauls) without overriding manufacturer's recommendations and company policy.
- l) Spare gear (Classification society requirements/recommendation)

10. Surveys

- a) Timescale requirements of continuous survey of ship's machinery and hull with appropriate certification as required by Flag State and Class Society
- b) Statutory surveys
- c) Different types of surveyors (Flag State, Port State, Classification Society, Charter and Cargo Insurance etc)
- d) Harmonised System of Survey and Certification (HSSC)
- e) In-water surveys (IWS)
- f) Methods of hull and component testing, destructive and non-destructive

11. Dry Docking

- a) Frequency of dry-docking
- b) Types of dry-dock (wet dock; graving dock; floating dock; Synchro-lift; slipway; cradle lift)
- c) Preparation for dry-dock; docking plan; plug plan; work list; survey requirements;
- d) services required when in dry-dock
- e) Shore power and fire protection when in dry-dock
- f) Entering dry-dock procedure; tank transfers; upright condition; trim by the stern;
- g) bilges pumped; tanks sounded; stability condition
- h) Preliminary inspection of underwater hull and fittings
- i) Pre-flooding of dry-dock procedure and safety checks
- j) Floating-off and leaving dry-dock procedure and safety checks
- k) Jurisdiction of safety executive (when afloat and when in dock / ashore)

12. Voyage Planning

- a) Crew manning and certification; number of passengers; fuel consumption and reserves; lubricants consumption; water consumption; chemicals; refrigerant gases; expendable items;

maintenance and survey requirements; machinery checks and alarm system tests; parts and tools; minimum spares inventory; cleaning materials and consumables; supplies and any other requirements

- b) Consultation with ship's master on planned route, deviations from planned route and alternative ports, in case of emergency
- c) Fuel consumption:
 - i) Specific fuel consumption (SFC) and units (g/kW.h or kg/kW.h)
 - ii) Simple fuel consumption calculations, involving tables or data and previous voyage experience
 - iii) Simple daily fuel consumption calculation
 - iv) Use the formula: Daily fuel con. (tonnes) = SFC (kg/kW hr) x Power (kW) x [24 / 1000]
 - v) Simple estimated voyage fuel consumption calculation
 - vi) Addition of fuel reserves to basic fuel consumption calculations and reasons for the reserves (diversion for emergency rescue, change of planned route, breakdown, weather etc)
 - vii) Definition of maximum continuous rating (MCR)
 - viii) Operation at the optimum (most economical) speed
 - ix) Determining fuel consumptions at MCR and optimum speed from vessels specific fuel consumption (SFC) / power graphical curve

13. Emergency

- a) Contingency plans dealing with flooding, to maintain intact buoyancy; watertight compartments, watertight doors, collision bulkheads, emergency bilge suction, etc.
- b) Ship's fire equipment plans and fire fighting teams; construction, use and identification of various types of fire fighting equipment; contingency planning for fighting fires, including instruction of personnel in the use of various types of equipment, by organising and supervising 'fire drills' for firefighting teams in emergency situations.

Applied Marine Engineering

1. Materials technology

- a) Iron and steel:
 - i) Types of iron and steel (cast iron, wrought iron, mild steel, cast steel, alloyed steels)
 - ii) Definition of an alloy and alloying elements
 - iii) Effects of alloying elements in steels
 - iv) Stainless steels (Ferritic, Martensitic, Austenitic; Grade 304 and Marine Grade 316)
- b) Aluminium including Marine Grades

- c) Non-ferrous metals and alloys (zinc, copper, brasses, bronzes)
- d) Fibre reinforced plastics (FRP: Fibre glass and Carbon Fibres)

2. Heat treatment:

- a) Heat treatment of steels (Basic understanding of normalising; annealing; stress relieving; hardening; and tempering).
- b) Work hardening and annealing of aluminium

3. Knowledge of Testing Materials

- a) Properties of materials (brittleness; ductility; elasticity; hardness; malleability; plasticity; toughness)
- b) Stress and strain
- c) Forms of stress (tensile; compressive; shear)
- d) Load, deformation, relationship between load and deformation
- e) Destructive and non-destructive testing for defects/records:
 - i) Surface defects and NDT methods (visual inspection, dye penetrant test, magnetic fluid test)
 - ii) Under-surface defects and NDT methods (ringing, radiography, ultrasonic)
- f) Understand the terms: elastic limit; yield point; ultimate tensile strength (UTS);
- g) Working stress and factor of safety
- h) Modes of materials failure: (creep, fatigue, shear, torsion, tension, brinelling and fretting)

4. Knowledge of Joining Materials:

- a) Basic welding and brazing methods (oxy-acetylene, mig / mag / tig)
- b) Basic welding defects
- c) Joining and bonding of steel with aluminium (insulated bolted joints, explosive welding)

5. Corrosion

- a) Principles of metallic corrosion (oxidation, electro-chemical series, galvanic)
- b) Corrosion protection (sacrificial anodes, impressed current, protective coatings, surface preparation)

6. FRP (GRP)

- a) De-lamination, root whitening and osmosis in GRP
- b) Repairs including by bonding.

7. Instrumentation

- a) Temperature
 - i) Liquid in glass thermometers
 - ii) Bi-metallic strip thermometers
 - iii) Pyrometers
 - iv) PT 100
- b) Pressure
 - i) Bourdon tube gauge
 - ii) U-tube manometer
 - iii) Strain gauge
- c) Level
 - i) Mechanical means (float / potentiometer)
 - ii) Electronic means (capacitance)
- d) Flow
 - i) U-tube manometer with venturi
 - ii) Turbine impeller
 - iii) Electronic means

8. Control Engineering

- a) Basic terminology associated with control systems:
- b) Desired value (DV); measured value (MV); error (error = DV - MV); feedback; negative feedback; positive feedback; sensors; comparator; actuators
- c) Open loop and closed loop systems
- d) Terminology applied to a main engine cooling system, such as main engine LO or main engine jacket water (HTCW)
- e) Data measuring and power transmission media and transducers (mechanical, hydraulic, pneumatic, electrical, fibre optic, discrete, analogue, digital) and converters
- f) Types of actuator (bellows, diaphragm and piston operated devices, hydraulic, pneumatic and electrically operated devices)
- g) Types of positioner associated with actuators for feedback including Potentiometer and LVDT (Linear Variable Differential Transducer)
- h) Basic theory of PID controllers (proportional, integral, derivative)

- i) One term, two term and three term controllers (P, P+I, P+I+D)
- j) Graphical representation of a control system disturbance, proportional (P) control, proportional and integral (PI) control, proportional, integral and derivative (PID) control
- k) Digital control (bang-bang or proportional)
- l) Types of control system, methods of control and applications (terminology, open/closed loop, two-step, modulating)
- m) Examples of process control systems (single element, cascade, split range)
- n) Main engine speed/load control
- o) CPP propeller pitch / speed control with constant speed engine
- p) CPP propeller pitch/speed control with variable speed engine

9. Engineering drawing

- a) Interpret engineering and system drawings
- b) Use engineering system drawings to identify possible locations for faults
- c) Ability to produce a freehand sketch