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TP 2293 E		<i>THE EXAMINATION AND CERTIFICATION OF SEAFARERS</i>		

CHAPTER 30 - FIRST-CLASS ENGINEER, MOTOR SHIP, AND FIRST-CLASS ENGINEER, STEAMSHIP

PART I - GENERAL REQUIREMENTS OF APPLICANTS

- 30.1 (1) Every applicant for a certificate as First-Class Engineer, Motor Ship or Steamship, shall:
- (a) obtain a medical certificate prescribed in the Crewing Regulations;
 - (b) obtain a certificate of completion for each of the following courses from a school listed in TP 10655:
 - (i) Marine Emergency Duties Courses, set out in TP 4957:
 - (A) with respect to survival craft
 - (B) with respect to marine fire fighting
 - (C) for officers, and
 - (D) for senior officers
 - (ii) Propulsion Plant Simulator Course Level II, set out in TP 10935; and
 - (iii) Marine First Aid Advanced Course, set out in TP 13008; and
 - (c) pass a written examination in each of the following subjects:
 - (i) Applied Mechanics;
 - (ii) Thermodynamics;
 - (iii) Electrotechnology;
 - (iv) Naval Architecture; and
 - (v) Engineering Knowledge, General.
- (2) Every applicant for a certificate as First-Class Engineer, Steamship, shall
- (a) complete the requirements set out in subsection 30.1 (1);
 - (b) pass a written examination in Engineering Knowledge, Steam; and
 - (c) pass an oral examination.
- (3) Every applicant for a certificate as First-Class Engineer, Motor Ship, shall
- (a) complete the requirements set out in subsection 30.1 (1);
 - (b) pass a written examination in Engineering Knowledge, Motor; and
 - (c) pass an oral examination.

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- 30.2 (1) The service required by an applicant for a First-Class Engineer, Steamship, or First-Class Engineer, Motor Ship, Certificate is 18 months as follows:
- (a) a minimum of nine months sea service while holding the certificate of Second-Class Engineer, Steamship, as an engineer officer in charge of the machinery on a steamship of not less than 1500 kW propulsion power where the applicant applies for a certificate as a First-Class Engineer, Steamship;
 - (b) a minimum of nine months sea service while holding the certificate of Second-Class Engineer, Motor Ship, as an engineer officer in charge of the machinery on a motor ship of not less than 1500 kW propulsion power where the applicant applies for a certificate as a First-Class Engineer, Motor Ship;
 - (c) a minimum of nine months sea service while holding the certificate as a second class engineer, motor ship, or as a maintenance supervisor in charge of the machinery on a MODU/surface of not less than 1 500 kW propulsion power; and
 - (d) the remaining service made up of any combination of the following, subject to any time limitations set out herein:
 - (i) service as an engineer officer on a motor ship, steamship or mobile offshore unit of not less than 1500 kW propulsion power; and
 - (ii) time spent at the marine department of a school listed in TP 10655, credited at a ratio of one day for every three days of attendance to a maximum of three months.

Steam and Motor Certificates

- 30.3 (1) An applicant for a First-Class Engineer, Steamship or Motor Ship, Certificate shall have not less than 18 months sea service, as specified in section 30.2 (1) of this Schedule, while holding a Second-Class Certificate of which:
- (a) not less than nine months was in a steamship of not less than 1500 kilowatt propulsion power; and
 - (b) not less than nine months was in a motor ship of not less than 1500 kilowatt propulsion power.
- (2) Not in use.
- 30.4 Not in use.

PART II - EXAMINATIONS

30.5 (1) The following table lists the written and oral examinations for the First-Class Engineer Certificate, the qualifying service required before each may be attempted, and other requirements:

Steam Certificate

EXAMINATION	QUALIFYING SERVICE	OTHER REQUIREMENTS
Applied Mechanics	-	-
Thermodynamics	-	-
Electrotechnology	-	-
Naval Architecture	-	-
Engineering Knowledge, General	18 months	Second Class Certificate MED D, PPS Level 2
Engineering Knowledge, Steam	18 months including nine months Steam 1500 kW	Pass Engineering Knowledge, General
Oral Examination	-	Pass Engineering Knowledge, General & Steam

Motor Certificate

EXAMINATION	QUALIFYING SERVICE	OTHER REQUIREMENTS
Applied Mechanics	-	-
Thermodynamics	-	-
Electrotechnology	-	-
Naval Architecture	-	-
Engineering Knowledge, General	18 months 1500 kW	Second Class Certificate MED D, PPS Level 2
Engineering Knowledge, Motor	18 months including nine months motor 1500 kW	Pass Engineering Knowledge, General
Oral Examination	-	Pass Engineering Knowledge, General & Motor

Motor Qualification to a Steam Certificate

EXAMINATION	QUALIFYING SERVICE	OTHER REQUIREMENTS
Engineering Knowledge, Motor	Nine months 1500 kW motor	First-Class Steam Certificate
Oral Examination	-	Pass Engineering Knowledge, Motor

Steam Qualification to a Motor Certificate

EXAMINATION	QUALIFYING SERVICE	OTHER REQUIREMENTS
Engineering Knowledge, Steam	Nine months 1500 kW steam	First-Class Motor Certificate
Oral Examination	-	Pass Engineering Knowledge, Steam.

- (2) There are nine questions in each written paper, not more than six of which are to be answered within a maximum time of three and a half hours.
- (3) If more than the required number of questions on any paper are attempted, all the answers shall be marked and only the six questions awarded the lowest marks shall be taken to determine the overall result.
- (4) The knowledge, to be shown by an applicant for a First-Class Certificate shall be sufficient to enable the applicant to take overall charge of all engine room personnel, the safe operation and maintenance of the boilers and machinery of ships with a propulsion power of 3000 kilowatts or more, and the supervision of a ship undergoing survey and repair in dry-dock.

PART III - VALIDITY OF CERTIFICATE

30.6 The certificate of Marine Engineer, First-Class, is valid as chief engineer without restriction.

PART IV - SYLLABUSES OF EXAMINATIONS

30.7 Applied Mechanics

ITEM	COLUMN
1.	Statics Laws of equilibrium; moments and couples; polygon of forces; Rapson's slide.
2.	Friction Law of dry friction; friction angle; friction clutches; friction on inclined plane; friction on threads; work done against friction.
3.	Kinematics Linear and angular motion with constant acceleration; gravitational acceleration; velocity-time graphs; cams.
4.	Relative Velocity and Acceleration Effect of a current on the velocity and course of a ship; relative velocity between bodies moving in different planes.
5.	Dynamics Newton's law of motion; the force equation; Atwood machines; acceleration of connected bodies; effect of simple air resistance on motion under the effect of gravity; the torque equation; conservation of momentum; kinetic energy of translation and of rotation; flywheels; energy; conservation of energy; impulsive forces; centrifugal force; Porter governor with sleeve friction; simple harmonic motion; simple pendulum; simple vibrations; dynamic balancing of masses rotating in one plane; basic dynamics of the engine mechanism; use of piston velocity and acceleration formulae; derivation of piston displacement formulae.
6.	Machines Velocity ratio; mechanical advantage; efficiency.
7.	Stress and Strain Direct stress and strain and modulus of elasticity; shear stress and strain and modulus of rigidity; stresses on oblique planes; strength of simple connections such as cottered or screwed joints; resilience due to direct stress, suddenly-applied loads.
8.	Compound Bars Effects of direct loading and temperature changes.
9.	Beams Shear force and bending moments diagram for cantilevers and simply-supported beams; stresses in beams of simple section; use of simple deflection formulae.
10.	Torsion Torsion equations for solid and hollow round shafts; torsion of shaft fitted with liner; horsepower transmitted; close-coiled helical spring.
11.	Struts Eccentric loading of short columns; use of strut formulae.
12.	Thin Shells Stresses in thin shells; design of riveted joints; use of boiler shell design formulae.
13.	Hydrostatics Flotation in two liquids of different specific gravities; total force and centre of pressure on immersed surfaces such as tanks and bulkheads.
14.	Hydraulics Bernoulli's equation applied to simple flow problems; venturi meter; flow through orifices under constant head; force exerted by a jet on a flat surface perpendicular to the jet; blade-angle diagrams for a centrifugal pump; simple flow problems relating to automated control circuits.

30.8 Thermodynamics

ITEM	COLUMN
1.	Elements Expansion of solids and liquids, including coefficient of apparent cubical expansion; first and second laws of thermodynamics and their application to steady flow conditions; formulae for work done associated with the formula $PV^n = C$.
2.	Heat Transfer Conduction (use of log mean temperature difference); radiation; Stefan-Boltzmann law.
3.	Properties of Steam Enthalpy; internal energy; volume; use of steam tables and entropy charts.
4.	Mixtures Heat and temperature problems involving two or more substances; throttling and separating calorimeters.
5.	Gases Boyle's law; Charles' law; characteristic equation; relations between P, V and T when $PV^n = C$; determination of n from graph connecting P and V; proof of the formula $C_p - C_v = R$; calculations for expansions and compressions in air compressors, internal combustion engines, rotary compressors, vane and blade types, air pumps and air storage; simple applications of Dalton's law of partial pressures.
6.	Gas Cycles Use of entropy charts; constant volume cycle; diesel cycle; open and closed cycles for gas turbines; indicated and brake thermal efficiencies; mechanical efficiency; overall efficiency; Morse test.
7.	Expansion of Steam Throttling; hypothetical PV diagrams; work done; m.e.p., diagram factor, including effect of clearance; compounding; mean referred pressure; total power; combined diagrams.
8.	Steam Cycle Use of entropy charts; basic Rankine cycle; heat drop in reciprocating engines and turbines; effect on thermal efficiency of such modifications as superheating, exhaust turbine and regenerative feed heating; equivalent of evaporation; efficiencies.
9.	Density and Scale Basic calculations on the effect of condenser leakage and impure feed on the density and scale in boilers; basic calculations on evaporator performance.

30.9 Electrotechnology

ITEM	COLUMN
1.	The Electric Circuit Superposition and Thevenin's theorems in network problems; circuits involving non-linear elements.
2.	Electromagnetism Electromagnetic induction, magnetic circuit, mutual inductance; energy stored in an electric field; treatment of voltage and current charges in an electric circuit involving inductance and resistance; time constants, B/H and B/Ampere turns-per-metre curves and their effect on simple magnetic circuits involving an air gap; qualitative treatment of hysteresis.
3.	Electrostatics Types of capacitors; simple-series and parallel circuits involving capacitors; electric force and electric flux density, relative permittivity, charging and discharging currents of a capacitor connected in series with a resistor across a DC supply; energy stored in a capacitor; generation of static electricity.
4.	Electronics Characteristics of junction transistors; effect of voltage feedback on amplifier gain, input-output impedances; equivalent circuits; rectification; simple treatment of thyristors and zener diodes.
5.	Alternating Current Theory for three-phase systems; current and voltage relationships; current, voltage, power and power factor applied to RLC circuits; the impedance triangle; power-factor improvement; resonance; star and delta systems.
6.	DC Machines Armature reaction; speed control; efficiency; application to a Ward Leonard system; suitability of DC motors for various types of work; motor starters; automatic types, relay and solid state; calculations on starters.
7.	AC Machines The principles, constructional details and protection of salient pole, cylindrical and brushless alternators; EMF equation and automatic voltage regulation for alternators; production of rotating magnetic fields; relation between frequency, number of poles and speed of a machine; principles, construction details and protection of induction motors; slip, rotor EMF and frequency; torque/speed curves; wound, slip-ring, cage and double-wound types; starting methods; principles and construction details of single-phase transformers; EMF equation and efficiency; auto and current transformers; magnetic amplifiers, static and rotating; motor starters.
8.	Propulsion Types using DC and AC machines; electric drives, starting methods; speed control; advantages and disadvantages of electrical propulsion; effects of stalling propulsion motors in ice; static and rotating control using pulse modulation and magnetic amplifiers.

30.10 Naval Architecture

ITEM	COLUMN
1.	General Wetted surface formulae; Simpson's rules applied to second moments of areas, centroids and centres of pressure; shearing force and bending moment of loaded ship in still water.
2.	Transverse Stability Moment of statical stability; GZ curves; cross curves of stability; hydrostatic curves commonly supplied to ship; effect of free liquid surface and subdivision of tanks; dangers due to water accumulation during firefighting; practical requirements to ensure stability at sea; theory of free surface stabilization.
3.	Longitudinal Stability Longitudinal BM and GM and statical stability; centre of flotation and its calculation; moment to change trim by one centimetre; stability during grounding, ice breaking and dry-docking.
4.	Draught, Trim and Heel Changes due to adding or removing fuel ballast or cargo; changes due to alteration in density of water; changes due to bilging of compartments, using the lost-buoyancy and added-mass methods; forces on rudder and stress in rudder stock; heel when turning, including effect of centrifugal force and force on rudder.
5.	Resistance and Propulsion Derivation of admiralty and fuel coefficient; law of corresponding speeds; Froude's law of comparison; simple problems on the prediction of full-scale resistance from model experiments; problems on propellers involving the use of wake factor, e_p , d_p , QPC, thrust and power; qualitative treatment of cavitation.
6.	Ship Construction Forces on ship under various conditions, including the effect of panting and pounding; construction of all parts of steel ships; use of high-tensile steel and aluminium; structural fire-protection arrangements; dry-docking; design features of ships for general and specialized trades; design features for operating in ice.
7.	Ship Tonnage Measurement and Classification Meaning of classed and unclassed ships; common terms used in measurement of modern steel ships; common terms used in tonnage measurements (e.g., gross tonnage, net tonnage, propelling power allowance).
8.	Loadline Common terms, markings and main criteria used in assignment of freeboards; maintenance of conditions of assignment.
9.	Damage Control Counter ballasting, temporary patching, structural reinforcing, temporary and semi-permanent shoring.

30.11 Engineering Knowledge, General

ITEM	COLUMN
1.	General Applicants may be required to illustrate their answers by means of freehand sketches.
2.	Material Treatment The general effects of various heat treatments on the physical properties of materials commonly used in the construction of marine engines and boilers, and the physical tests to which these materials are normally subjected.
3.	Heat and combustion Physical and chemical properties of steam, fuel, lubricants and other liquids, gases and vapours used in machinery on board ship.
4.	Instrumentation Use, constructional details and operational principles involved in the action of the pressure gauge, thermometer, pyrometer, barometer, salinometer, hydrometer and other meters commonly used in remote monitoring of systems by engineers on board ship.
5.	Corrosion Causes, effects and usual remedies for encrustation and corrosion; feed-water blow densities and electrolysis.
6.	Marine Engines Constructional details and operational principles of marine engines; methods of determining their propulsion power output; principles of working and methods of calibration of dynamometers and torsion meters.
7.	Machinery Management The methods of dealing with wear and tear of machinery and boilers; alignment of machinery parts; correction of defects due to flaws in material or accident; temporary or permanent repairs in the event of derangement or total breakdown.
8.	Pump Systems Constructional details and principles of action of pumps fitted in ships; general requirements concerning feed, fuel, bilge and ballast pumping systems.
9.	Steering Gears The constructional arrangement, operational details and working of steering engines and gears, refrigerating machinery, hydraulic and other auxiliary machinery, and such steam and internal combustion engines as are used for emergency and auxiliary machinery on board ship.
10.	Power Balance Application of the indicator; calculation of mean pressure and kilowatt propulsion power; variation of pressure in the cylinder as shown by indicator diagrams; the recognition of irregularities in the running of engines from indicator diagrams; the rectification of these irregularities; illustration, by means of sketches, of the change produced in the diagram due to an alteration in the setting or working of the valves or any other factors.

11.	<p>Fire Prevention</p> <p>Precautions against fire or explosions due to oil or gas; flash point; explosive properties of gas or vapour given off by fuel or lubricating oils when mixed with a quantity of air; the danger of leakage from oil tanks, pipes, gas producers and vaporizers, particularly in bilges and other unventilated spaces; the action of wire-gauze diaphragms and the places where such devices should be fitted.</p>
12.	<p>Hazards of Coal</p> <p>Spontaneous combustion of coal; explosive properties of gas given off by coal.</p>
13.	<p>Fire Detection</p> <p>Maintenance on board of fixed methods of dealing with fire; chemical and physical action, maintenance of mechanical and chemical fire extinguishers and other firefighting appliances, respirators and safety lamps; detection meters.</p>
14.	<p>Toxic Materials</p> <p>Toxic and other dangerous properties of substances used in marine practices; maintenance of plant and equipment associated with the carriage of dangerous goods.</p>
15.	<p>Management</p> <p>Administrative duties of a chief engineer; organization of his/her staff for emergency duties and the use of safety equipment, organization of repairs and surveys; training of staff for both normal and emergency duties, including first aid relative to machinery space injuries, functions and use of lifesaving appliances and the supervision of staff in the absence of ideal safe working conditions.</p>
16.	<p>Fundamentals of Automation Instrumentation</p> <p>Periodically unattended machinery space, techniques and work practices, bridge control and monitoring systems.</p>

30.12 Engineering Knowledge, Steam

ITEM	COLUMN
1.	<p>Steam Engines</p> <p>The methods of constructing marine steam engines and boilers, the processes to which the several parts are submitted, or which are incidental to their manufacture, and the methods employed in fitting the machinery on board ship.</p>
2.	<p>Auxiliary Machinery</p> <p>The various types of propelling and auxiliary machinery now in use, the functions of each important part, and the attention required by the different parts of the machinery on board ship.</p>
3.	<p>Setting Valves</p> <p>The methods of testing and altering the setting of the steam admission and exhaust valves, and the effect produced in the working of the engine by definite alterations in the settings of the valves.</p>
4.	<p>Water Treatment</p> <p>The constructional details and working of evaporators, feed-water heaters and feed-water filters.</p>
5.	<p>Marine Boilers</p> <p>Various modern designs; the prevention of movement of boilers when vessels are pitching or rolling; the determination by calculation of suitable working pressure for boilers of given dimensions.</p>

6.	Boiler Mountings Use and management of boiler fittings and mountings, with special reference to water gauges and safety valves; precautions necessary when raising steam and operating stop valves, with particular reference to the danger arising from water-hammer action.
7.	Combustion Control Constructional details, operation and maintenance of installations generally employed for assisting draught, superheating steam and burning coal or oil fuel.
8.	Fundamentals of Automated Boiler Control Monitoring and recording devices, pneumatic and industrial electronics and the use of Boolean algebra in control circuits.

30.13 Engineering Knowledge, Motor

ITEM	COLUMN
1.	Marine Engines Principles underlying the working of internal combustion engines; the differences between various types of engines; constructional details of internal combustion engines in general use.
2.	Oil Fuel and Lubrication Nature and properties of the fuel and lubricating oils generally used in internal combustion engines; the supply of air and fuels to cylinders of engines of different types; the constructional details of apparatus for carburetting or atomizing the fuel; the means of cooling the cylinders and pistons; constructional details and working of air compressors.
3.	Construction of Engines Methods of constructing marine internal-combustion engines; the processes to which the several parts are submitted or which are incidental to their manufacture, and the methods employed in fitting the machinery on board ship.
4.	Starting and Reversing Arrangements and the various operations connected therewith.
5.	Machinery Management The attention required for the operation and maintenance of the various parts of machinery; the use and management of valves, pipes, connections and safety devices employed.
6.	Corrective Maintenance Enumeration and description of defects arising from working of machinery; the remedy for such defects.
7.	Construction of Auxiliaries Constructional details and management of auxiliary steam boilers, their fittings and mountings, with special reference to water gauges and safety valves; construction details and management of auxiliary machinery; draught, combustion equipment, oil fuel equipment.
8.	Fundamentals of Automated Controls Monitoring and recording devices, pneumatic and industrial electronics, and the use of Boolean algebra in control circuits.

30.14 Oral Examination

ITEM	COLUMN
1.	<p>General</p> <p>The oral examination will be based upon:</p> <ul style="list-style-type: none"> (a) the practical-knowledge subjects of the examination, and will include questions on the management of engines and boilers at sea, the duties of the supervising engineer, the work to be done on engines, boilers and auxiliary machinery in port, and the periodic examination of the working parts; (b) the casualties that may occur to machinery and boilers at sea and how these casualties may be prevented and remedied; and (c) the subjects that relate to the general aspects of regulations, international requirements and ship's business.
2.	<p>Regulations and Ship's Business</p> <p>Every applicant shall possess:</p> <ul style="list-style-type: none"> (a) a knowledge of national and international maritime law embodied in agreements and conventions as they affect the specific obligations and responsibilities of the engineering department, particularly those concerning safety and the protection of the marine environment; (b) knowledge of the methods and aids to prevent pollution of the environment by ships; regulations to be observed to prevent pollution of the marine environment; effects of marine pollution on the environment; (c) general knowledge of marine insurance and its interrelationship with charter parties, bills of lading and the <i>Marine Liability Act</i>, including: <ul style="list-style-type: none"> • knowledge of general, particular average and York/Antwerp rules; • knowledge of charter parties and bills of lading with respect to international marine laws; • statutory and contractual requirements as to sea worthiness; and • deviation and its effect on various contracts; functions and jurisdiction of IMO, ILO and the SOLAS Convention, including articles, regulations and resolutions; and (d) knowledge of the general organization of ship management, including: <ul style="list-style-type: none"> • crew welfare and training, Occupation Health and Safety Regulations; • crew representation and rights under the CSA; • accounting; • vessel traffic management; • pollution of the environment, responsibilities and abilities; • the use of consular offices; • tonnage certificates; • charter parties and bills of lading; the marine insurance contract and its relationship to the ship, and responsibility to owners and underwriters.