

Syllabus for One Year Marine Engineering Course

(8 Months Training ashore & 4 Months Training onboard)

1) On Board Operations:

Introduction to watch keeping, Number of watches per day, day watch/sea watch, number of watch keepers, stand by duties, Familiarity with the engine room and plant. Knowing emergency exits, location of fire fighting equipment in engine room,

Stand actual watch on the running diesel generator in the live bay of the workshop/ Ship-in-campus and/or in Engine Room during Afloat period - Noting and logging temperatures, pressures, tank levels and other parameters in the engine log book.

Check list for taking over watch at sea, port/anchorage, UMS check list etc. Standing orders, night orders.

A brief introduction to Contingency Manual and a few likely scenarios where an emergency or contingency may arise.

Getting main engine, steam plant ready for departure, checks on plant while engine maneuvering, arriving port, stopping main engine. Readings to take during maneuvering, preparing noon chits. Arrival/Departure check lists. To gain understanding that operation are planned and carried out in accordance with established rules and procedures to ensure safety of operations and to avoid pollution of the marine environment. Learning to identify deviations from norms, causes of machinery malfunction and taking to ensure overall safety of ship and plant.

2) Preparing Main Engine and associated auxiliaries for Arrival /departure. Starting up / Shutting off a steam Boiler and associated steam systems: Starting Auxiliary prime movers and associated systems, Starting and putting in operation refrigeration, air conditioning & ventilating systems.

Practical knowledge - Start up and shut down main propulsion and auxiliary machinery, including associated systems. Operating limits of propulsion plant.

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

3) Engine Room Resource Management:

ERM principles based on Bridge Resource Management

Necessity of ERM - ERM in terms of maintaining the safe engineering watch

Resources considered in ERM - Resource management eg, personnel management, information management and management of installations/ equipment

Necessity to practice ERM - Allocation, assignment and prioritization of the resources, effective communication, assertiveness and leadership, obtaining and maintaining situational awareness, consideration of team experience.

4) Internal Communication:

Knowledge of various communication systems available on board, such as: Verbal, telephonic (power/sound power), signals, telegraph, hand signals;

5) Use of English Language:

To exhibit communication skill in English & proficiency in Marine Vocabulary

Writing letters with correct grammar & spellings, in English.

To demonstrate ability to comprehend clearly & use engineering publications and perform engineering functions to speak ensuring that the intended message is understood in English.

Address & type letters both of technical and non technical nature with correct grammar & spellings, in English.

6) Thermodynamics and Heat Engines:

Theoretical knowledge -Thermodynamics and heat transmission, Mechanics and hydromechanics.

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

Heat cycle, thermal efficiency and heat balance of marine diesel engine, marine steam turbine, marine gas turbine and marine steam boiler.

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7) Marine Diesel Engines:

Basic Principles, cycles, timings, engine types, configuration and features. Structure, components, gas exchange process - scavenging, supercharging, turbochargers, combustion process, fuel injection, camshaft. Power measurement, Indicator cards, fault finding. Control, safety, operation, difficulties, trouble shooting, governor, modern developments. Maintenance, Decarburization, bearing clearances, etc.

8) Auxiliary Machinery: Acquire knowledge of construction & operation of all auxiliary machinery including associated equipment. Study & understand the general layout of machinery in the engine room.

9) Air Compressors:

Air compressor and system principles - Operation, Principles, Types, Material of construction, Compression process, Inter and after coolers.

10) Purifier:

Purifier and fuel oil treatment – Operation, Principles, Types, Material of construction. Familiarize with filtration & purification methods in fuels & lubricants, their necessity, operation & care.

11) Boiler:

Marine Boiler - Steam boiler fuel atomization and combustion, Marine boiler fundamentals, Marine Boiler construction, Boiler mountings and steam distribution, Marine boiler operation.

Steam Cycle, Properties of steam, Feed water, Basic components, types of boilers - smoke & water tube, Feed water and circulation, tubes, stays, headers, super heaters, furnace, casing, supports, internal fittings, external fittings, mountings. Burners. Instrumentation, Automation, Controls. Safeties. Preparation, Flashing up, Steaming up, Pre and Post purging. Cooling down, blowing down, and blowing through gauge glass. Boiler water testing and treatment. Emergency Operation.

12) Marine Steam Turbines:

Marine Steam Turbine – Rankin cycle, Operation principle, Basic construction and materials of Steam Turbine, Impulse Turbine, Reaction turbine, Bleeder turbine (extraction turbine), Regenerative turbine, Reheat turbine.

Principle, Major components, number of nozzles, multi-stage turbines, types and stages, vacuum exhaust, compound turbines, high pressure with reaction stages, double flow low-pressure turbines, single cased propulsion turbines, turbines for fans and pumps.

Turbine Details: Casing, Bearing Housing, Bed Plate, Rotor, Blades, Diaphragm, Nozzles, packing gland, Journal, Thrust Bearings, preparation, Raising Vacuum, Maneuvering, Routine and Emergency operation.

13) Marine Gas Turbines:

Marine Gas Turbine – Operation principle & Basic construction.

Characteristics of gas turbine plants, gas turbines Vs other prime movers, principles, major components, temperature limits, waste heat recovery, maintenance, compressor, turbine types.

14) Pumps & Piping:

Principles, Types of pumps, Characteristics, Fundamentals, Centrifugal, Reciprocating, Rotary and Jet Pumps, Liquid-ring vacuum pumps, blowers, fans, compressors, pump operation, starting procedure for - centrifugal as well as positive displacement pumps.

Fluid flow and characteristics of major systems – Description of all fluid flow systems on board, Operation and material construction of devices/ equipment in the system. Operation and maintenance of machinery, including pumps and piping systems. Construction and characteristics of pumps and pumping systems.

Physical & chemical properties of fuels and lubricants.

Familiarize with the various pipe line layout of bilge, ballast, fuel, lubricating oil & cooling water systems.

Introduction, Piping and Tubing, Valves, different types of valves, maintenance of valves, vents, sounding pipes, fuel -oil transfer and service systems, steam, condensate and feed systems, waste heat recovery systems, sea water circulating and cooling systems, fresh water cooling systems, main lubricating systems, Bilge and ballast systems, Compressed air and Control systems, Fire main systems, Sanitary and drinking water hydrophone systems, Cargo Handling Systems.

15) Deck Machinery:

Deck Machinery - Operation, Principles, Types, Material of construction, Windlass/ mooring winch, Winch, Boat winch.

16) Shafting Installations & Propeller:

Equipment constructing shafting, Types of propeller and features, Material of construction and definitions, Cavitation. Shafting Arrangements, Shaft bearings, Stern Tube, Stern Tube Seal, Propeller Shaft, Propeller - Fixed and Controllable, Tightening/ Withdrawal of propeller, tail shaft, inspection, etc. Study shafting & propellers.

17) Fresh Water Generator:

Evaporators and distillers – Operation, Principles, Types, Material of construction. Flash evaporators, Multiple effect evaporation. Familiarize with purification methods in respect of fresh water, their necessity, operation & care.

18) Heat exchangers:

Operation, Principles, Types, Material of construction.

19) Refrigeration:

Marine refrigeration cycle, Principles of refrigeration, Refrigerating compressors and system components, Refrigerating system brines, Cold storage spaces and insulation, Air conditioning and ventilation system.

20) Main Engine & Auxiliary Machinery - Maintenance and Repair:

Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems.

Main Engine and Associated Auxiliaries, Boiler and Associated Auxiliaries, and Steam Systems, Auxiliary Prime Movers and Associated Systems (Diesel engine, Steam Turbine),

Other Auxiliaries – Purifiers and Fuel oil treatment, Air compressors, Evaporators and distillers, Refrigerator.

Practical knowledge - Organizing & managing safe and effective maintenance and repair procedures. Planning maintenance & repairs

21) Maintenance and repair such as dismantling, adjustment and reassembling of machinery and equipment:

Fastening, Centrifugal Pumps, Reciprocating Pumps, Screw and Gear Pumps, Valves, Air Compressors, Heat Exchangers, Diesel Engine, Turbocharger, Boiler, Maintenance Propulsion Shafting Procedures, Refrigeration Maintenance, Oils Fuels and Lubricating System Maintenance, Deck Machinery Maintenance.

22) Marine Engineering Practice:

Methods for carrying out safe emergency/ temporary repairs.

Practical knowledge

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

Detection of faults of machinery by visual inspection, NDT methods (Non-destructive examination) and by other advanced systems such as vibration monitoring (condition monitoring). Inspection and adjustment of equipment Modern approach to machinery reliability methods and their execution.

Principles and practice of reliability and trends in breakdown. Typical failures and fault diagnosis.

Reliability of machinery, its principle and practice.

23) Electrical & Electronic

a) Basic electrical engineering:

(i) Electrical Theory – Ohm's Law, Kirchhoff's Law, Electrical circuits, Impedance and inductance.

Review of basic electrical knowledge, Introduction-Ship's electrical system-Circuit calculations-Electrical safety-Electric shock-Insulation resistance-circuit testing-insulation testing-continuity Testing-Introduction-Ship's electrical system-Circuit calculations-Electrical safety-Electric shock-Insulation resistance-circuit testing-insulation testing-continuity Testing.

(ii) Fundamentals of Alternating Current – Alternating current, Electro-magnetic induction, Work energy and power.

(iii) Generators – A.C. & D.C. generators.

Introduction to marine power generation equipment, AC / DC machines, AVR, characteristics of electrical machines used on board, induction, synchronous motors, transformers, circuit breakers. Navigational, signalling equipment, cables.

(iv) Power Distribution Systems– Distribution, Insulation, Transformer, Types.Distribution & switchboard arrangement; switchgears and starters. Operation, maintenance & repair of above equipment; Insulated and earthed neutral systems-significance of earth faults-distribution circuit breakers-Shore supply connection-Circuit protection.

Method of voltage control, paralleling procedure and load sharing between generators. Manual Synchronizing-Auto Synchronizing-Prime Mover Characteristic-parallel operation-Excitation Control-Load sharing-Speed droop and power generation.

(v) Electrical Motors – A.C. & D.C. Motor.

Introduction-Motor construction-Enclosures and ratings, Electrical Motor Starting Methodologies - Induction Motor operation-Control Equipment-Direct On-line Starting-Reduced voltage starting-Speed control-Motor operation-Single phase motors-Maintenance. Design features and system configurations of operational control equipment for electrical motors

b) Basic electronics:

Electron Theory

c) Basic Electronic Circuit Elements:

Semi conductor, Thyristor, Integrated Circuit (IC) and Large scale Integrated Circuit (LSI).

Working and Characteristics of Diode, Triode, Thyristor-TRAIIC-, Amplifier, Transistor, Rectifier-Half wave & Full Wave.

d) Electronic Control Equipment:

Control mechanism of PLC (Programmable Logic Controller), Integrated Automation Control and Monitoring System (IACMS), Computer programmable Controller, Relay Circuit unit, Digital Sequential Control devices.

Study of fuses-Relays-Overload relay-reverse power Relay-Air Circuit Breakers-MCCB-MCB-ELCB-Under Voltage Protection-Preference tripping-Over Current protection-Motor Protection-Single Phasing.

Voltage stabilization-Filter choke-Impedance-Rectification-Grid Bias Voltage-and their significance-Characteristic curves of PN Junc Diode-Forward and Reverse bias modes.

24) Electrical, Electronic Maintenance & Repair:

Principles of Maintenance, Generator, Switchboard, Electrical Motors, Starters.

Do's and don't while working on Electrical panel/Circuits-Safety precautions before entering into battery room-Safe working practices while working on any Electrical Circuits/machineries/panels.

D.C Electrical Systems and Equipment – Battery system, Remote automatic control equipment.

DC power supply control-Corrective n preventive actions in case of fire in the Main switchboard-Star-delta circuit for Main Seawater pump-Auto transformer starter-ACB.

Distribution System – Transformer, Distribution, Cables.

Open Circuit Fault-Short Circuit Fault-Earth Fault-Significance of Earth Fault-Fault finding in generator-Trouble shooting of AC motors.

Use of Engine Simulator for Electrical Fault Finding.

Construction and operation of electrical testing and measuring equipment – Construction, Operation & Principles of insulation tester, Continuity tester, Multi tester, Multimeter, Megger, Clampmeter, Wattmeter, Frequency meter, Synchronoscope, Continuity test, Insulation test.

25) High voltage Practice- Power supply network-Review of motor Operation-Controlled Rectification and Inversion-Converter types.

High-Voltage Installations- High voltage Protection-High Voltage safety-High voltage equipment testing. Lighting, Cables, Batteries.

26) Detection of electric malfunction and measures to prevent damage:

Essential requirements for Fault Protection, Fault Location.

Practical knowledge -Troubleshooting of electrical and electronic control equipment

Troubleshooting of monitoring systems

27) Function, performance test and configuration:

Monitoring Systems, Automatic Control Devices (Process control & system control), Protective Devices.

Design features and system configurations of automatic control equipment and safety devices for main engine, generator and distribution system and steam boiler.

Function test of electrical, electronic control equipment and safety devices.

28) Electrical and simple electronic diagrams:

Electric and Electronic symbols and Interpretations of Flow diagrams and Circuits.

29) Flowchart for Automatic and Control System – Depiction and understanding of flowcharts, Symbols utilization and processes involved.

Routine testing Flow chart, Manual and automatic starting flow chart, Automatic changeover of supply on main's failure.

30) Automation & Control Systems

a) Basic control engineering:

Fundamentals of Automatic Control, Various Automatic Control, ON-OFF Control, Sequential Control, Proportional-Integral-Derivative (PID) Control.

Process Control Theory-Open loop, close loop-Sensing elements and transducers-Monitors-Automatic control system- pneumatic controllers-electronic controllers-PLC-final control systems.

On/OFF and Continuous control system-Interdependence of PID control action-characteristics -Temperature vs time, temperature vs valve relationship-proportional band and gain-Direct acting signal-Reverse acting signal-On/off -P,P+I,P+D,P+I+D Characteristic.

b) Measurement of Process Value – Temperature (Mechanical, Electrical), Pressure, Level (Direct methods and Inferential methods), Flow, General measurement and process.

Process Control systems on ships, Boiler water level control, L.O. Temp control, Jacket cooling water, Feed water circulation, Auto combustion control of a boiler, etc

c) Transmission of Signals – Transmitters, Controlling elements (Pneumatic, Electrical, Receivers).

Steam Pressure Control of the Exhaust Gas Boiler control System - Dearator level control-Feed Water Circulation-Piston Cooling Water Temperature - Centralized cooling System-

d) Manipulator Elements– Principles, Operation, Application, Pneumatic, Electrical Servomotor, Hydraulic Servomotor.

e) Functions and mechanism of automatic control for main engine and auxiliary machinery including generator distribution systems, steam boilers, refrigeration system and pumping and piping systems.

31) Safe Working Practice:

Practical knowledge

Describe & demonstrate safe working practices in carrying out all relevant ship board tasks. Procedures for handling heavy machinery parts & overhaul of engines. Precautions to be taken while entering enclosed spaces. Safety measures to be taken to ensure a safe working environment and for using hand tools, machine tools and measuring instruments.

Safety measures to be taken for repair and maintenance including the safe isolation of shipboard machinery and equipment required before personnel are permitted to work on such machinery or equipment.

32) Ship Construction:

Ship construction Terminology, Hull construction, structure, description and construction of structural members, Fore and Aft peak, Double bottom, Load Line and draught marks ship dimensions and form, Bow and stern, Fittings, Rudders and propellers.

Understanding of fundamental principles of ship construction and the theories and factors affecting trim and stability and measures necessary to preserve trim and stability

33) Naval Architecture:

Definition of principal terms used in Naval Architecture. Draft, buoyancy, Geometry of ships, Hydrostatic calculations, Stability of ships, Trim, Stress Calculations .

Ship stability - Displacement, Buoyancy, Fresh water allowance, Statical stability, Initial stability, Angle of loll, Curves of statical stability, Movement of centre of gravity, List and Its Correction, Effect of slack tanks, Trim, Stress tables, Actions to be taken in the event of partial loss of Loss of intact buoyancy. Knowledge of the effect on trim and stability of a ship in the event of damage to, and consequent flooding of, a compartment and countermeasures to be taken

Buoyancy, Reserve buoyancy, Metacentre, Inclining experiment, water tight integrity. Stresses on ship, Resistance, Admiralty & Fuel Co-efficients.

34) Fire:

Introduction to Fire, what 'FIRE' stands for, the Fire Triangle etc. Portable FFA.

Practical demonstration of organising fire drills.

Precautions against fire or explosion. Explosive mixtures. Danger of oil leakage's. Sources of ignition. Safety devices.

Types and classes of fire. The Fire Triangle, methods of fire fighting such as starvation, smothering etc.

Various fixed fighting systems. Their operation and maintenance.

Ship board fire fighting - Organisation, Muster list, duties, Mock drills and practice. Fighting oil fires.

Basic seamanship; knowledge of life saving appliances & equipment on board ship.

Knowledge of alarms & signals on board ship.

35) Safety Equipments:

Alarm monitoring systems, Heat detectors, Fire detectors, Oil mist Detector, Dead Man Alarm, Monitoring of CO₂-Oxygen analyzer-Explosimeter-vibration monitoring.

36) Safety & Emergency Procedures:

Safety and emergency procedures for operation of propulsion plant machinery including control systems:

Main Engine Auto-slow Down and Shut Down,

Main Boiler Auto shut Down, Power Failure,

Emergency Procedures for Other Equipment/ Installations – Emergency steering,

Back out operations and restoration. Propulsion plant operation.

37) Workshop Management & Skills:

a) Design Characteristics and limitations/ selection of materials used in construction and repair of ships and equipment

Basic Metallurgy, Metals and Processes, Technology of materials.

Properties and Uses, Non-Metallic Materials.

Review properties of materials, their limitations, heat treatment of carbon steels. Testing of components used in manufacture. Need for lifting gear, various types, their operation & care, inspections & surveys. Lifting gear-chains, tackles, chain blocks, overhead engine room crane-their testing & surveys.

b) Properties and parameters considered in the fabrication and repair of systems and components:

Materials under Load, Vibration, Self-Secured Joints, Permanent Joints, Bonding Plastics, Adhesives and Bonding, Pipework.

(i) Basic work shop practice: Fabrication, fitting, welding - (gas, arc), cutting, brazing. Operation of lathe, drilling machine. Introduction to methods of emergency repairs such as use of jubilee clips, use of plugs, adhesives, putty, doubler plates, 'C' clamps etc.

Safety practices to be adopted, use of PPE, reading and understanding standing orders, good house keeping, proper handling of equipment

The use of appropriate specialized tools and measuring instruments - Review and learn use of various tools and instruments. Their use, such as the vernier calipers, inside/outside micrometer, inside/outside calipers, depth gauge etc.

(ii) Workshop Management – Discipline, safety management, preventive maintenance, cleanliness, familiarization with safety equipment and aspects relating to shipboard practices.

Advanced skills in fitting and fabrication. Use of jigs. Joint cutting, use of chisel. Overhauling various types of valves, valve grinding, pipe line repair,

Overhaul of fuel injectors, air start valves, tappet clearance adjustment, assembling, dismantling pumps. Assist senior engineers during afloat training in decarburization, inspection, surveys, and other machinery overhauls.

(iii) Basic introduction to Preventive Maintenance program. Familiarization with AMOS/Ship manager or any other integrated PMS program. Basic understanding of the spares/stores requisition process, inventory control. Software version control.

(iv) Learn about specialized tools such as trammel gauge, peak pressure gauge, indicator instrument, crank web deflection gauge, bridge gauge, piston crown template etc.

(v) Use of various types of sealants and packings - rubber, oil, steam, general purpose, 'O' rings, copper gaskets, washers. When, where and how to use .

(vi) Study of pipes, pipe fitting, bending & fabrication. Introduction to gas welding, basic principles of welding, various electrodes and consumables, gas cutting, maintenance and safety.

(vii) Interpretation of machinery drawings and handbooks marine engineering drawing and design.

Types of Drawing, Linework, Pictorial Projection, Development, Dimensioning, Geometrical Tolerancing, Limits and Fits, Engineering Drawing Practice.

Familiarise with notations used and interpret drawings of ships structure, equipment, electrical and mechanical systems.

The interpretation of piping, hydraulic and pneumatic diagrams - Carry out assignments in drawing machinery parts and pipe system layouts from actual machinery in workshop and blue prints supplied to ships.

Ability to make simple sketches relating to machinery components with supplementary notes and specifications.

38) Marine Pollution Awareness:

Importance of proactive measures.

Anti-pollution procedures and associated equipment fitted on board.

Oily water separator/ similar equipment Construction and operation – Prevention of pollution, Requirements, Principles, Their operation, maintenance, record keeping.

The precautions to be taken to prevent pollution of the marine environment – Prevention of pollution, MARPOL 73/78 technical annexes.

Regulation 26 - Annex 1 MARPOL 73/78, Anti-Pollution Equipment, Control of oil from machinery space, Oil record book (Part I – Machinery space operation), Precautions which should be taken to prevent accidental pollution by oil. Sewage.

IOPP Certificate and Surveys – Annex I – Oil, Annex II – Noxious liquid substances in bulk, Annex III – Harmful substances carried by sea in Packaged forms, Annex IV – Sewage, Annex V – Garbage, Annex VI – Air pollution.

Convention of prevention of Marine pollution by dumping of waste and other matter (London Dumping Convention (LDC)).

International Convention relating to Intervention on the High Seas in case of Oil Pollution Casualties, 1969.

International Convention on civil liability for Oil Pollution damage 1969.

Bunkering procedure, bunker plan, bunker check list, etc. SOPEP equipment. Fighting, containing oil spill.

The various emissions arising from ships, their effect on environment - sea and air. Green house emission, other emissions from ships such as SO_x and NO_x, Introduction to invasive species including ballast water, other impacts such as noise, anti-fouling paint, recycling of ships. Pollution prevention measures, Personal involvement such as behaviour, responsibility.

39) National Regulations:

Role of Govt in control of ships, DG Shipping, MMD, Flag State, Port State Control, Inspections of ships, Examinations.

Special needs of the shipping industry, various demands of the career - technical, practical, physical, emotional, psychological, desirable personal traits.

40) International Regulations:

Introduction to MARPOL, Annexes I to VI, why introduced, how the environment is affected.

Regulations governing discharge criteria, procedures for discharge, documentation, record keeping, inspection and penalty for violation.

Working knowledge of SOLAS, MARPOL, STCW etc.

Introduction to ISM, SMS documentation, manuals, ISO 9001, ISO 14001, DPA, forms, check lists

Introduction to ISPS, Security levels, Security Officer, documentation, security patrolling.

Various Classification Societies, IRS, LRS, ABS etc; CSM, ESP, Surveys, Certificates. Oil majors and Vetting Inspection.

Basic working knowledge of the relevant IMO conventions concerning safety of life at sea and protection of the marine environment

Introduction to Maritime Law, Law of sea-on high seas, Safety

International Convention on Load Lines, 1966

SOLAS, 1974 as amended

SOLAS—Sub division and stability

SOLAS—Fire protection, detection and extinction

SOLAS—LSA and arrangements (LSA Code)

SOLAS—Radio telegraphy and R/T

SOLAS—Radio communications (amended Chap. 1V)

SOLAS—Carriage of grain

SOLAS—Carriage of dangerous goods

STCW, 1995

ITU Radio regulations

STP ships Agreement, 1971

SPACE STP, 1973

PAL, 1974 and Tonnage 1969

41) Leadership & Team working/ Managerial Skills:

Introduction to human factors, communication, Inter-personal relationships.

Understanding Team work, importance of team spirit, nurturing a conducive work ethos leadership qualities, development of a positive attitude, organizational behaviour, functional responsibilities, role clarity, expectations,

Introduction to situation and risk assessment. Risk analysis, critical equipment, and critical maintenance.

Identifying activities that may be hazards to occupational health and safety and damage to property, carrying out risk assessment, documenting same in the SMS manuals.

Effective Resource Management and Decision Making. Use of probability, consequence/ severity matrix to evaluating impact on safety, loss/ damage to property, establishing acceptance criteria. Establishing control procedure to mitigate risk posed by hazard.

Task and Workload Management. Evaluation of outcome. Regular review of outcome, procedures, task identification to assess effectiveness of program.

42) Marine Industry:

Knowledge of Marine insurance, claims, legal matters in ship operation, etc.; conference systems; freight rates & fares fixation machinery and government control; Carriage of Goods by Sea Act.