ELECTRO-TECHNICAL OFFICER TRAINING PROGRAM

Part A
Framework

Scope

This program deals with the training on specific skills and competence for the acquisition of required knowledge, understanding and proficiency leading towards certification as Electro-Technical Officer (ETO) in accordance with Regulation III/6, Section A-III/6 and Table A-III/6 of the STCW '78 Convention, as amended. It has a total of **551 minimum training hours** (excluding time for assessments) covering four (4) Clusters, namely: Cluster 1. Marine Engineering Systems; Cluster 2. Electrical and Electronic Systems; Cluster 3. Automation and Control Technology; and Cluster 4. Ancillary Trainings. Each Cluster is subdivided into several Modules to ensure a structured design and delivery, which shall follow a **progressive approach** from the **Fundamental Knowledge, Operation and Functionality** to the **Maintenance and Repair** aspects in order to achieve the intended learning outcomes of this training program.

Pursuant to Regulation III/6, paragraph [2.3] and Section A-III/6, paragraph [1] of the aforesaid Convention, a total of **317 hours** out of the 545 total training hours covers “**electronic**” and “**electrical**” **workshop skills training** relevant to the duties of an ETO, which is considered equivalent to **3.23 months** of workshop skills training, computed at 4 training hours per day and 24 training days per month.

In addition, participants are required to complete the mandatory seagoing service under Regulation III/6, paragraph [2.2] based on the following options:

**Option 1:** Not less than nine (9) months of seagoing service, documented in the approved Training Record Book (TRB), as part of this training program, which shall involve practical training and experience in the tasks, duties and responsibilities of an ETO under the supervision and monitoring of qualified and certificated officers on board the ship where the seagoing service is being undertaken. The tasks that will be performed during the required seagoing service are contained under the TRB especially designed for this training program; **or**

**Option 2:** Not less than thirty three (33) months of seagoing service, in the engine department, which shall be evidenced by the following:

1. Seafarer’s Identification and Record Book; and
2. Certificate of seagoing service from the company.
Outcome

Upon successful completion of this training program, the participants are expected to have gained the knowledge, understanding and proficiency needed to perform, at the operational level, the tasks, duties and responsibilities relating to Electrical, Electronic and Control Engineering, Maintenance and Repair and Controlling the Operation of the Ship and Care for Persons on Board.

Intended Learning Outcomes per Cluster

Upon successful completion of each training module, the participants must be able to:

CLUSTER 1:

Module 1: Thermodynamics for Marine Application

1. State the principles and applications of Thermodynamics;
2. Describe and illustrate transmission of heat; and
3. Interpret systems involving Thermodynamics on board the ship.

Module 2: Auxiliary Machinery

1. List down the different engine room auxiliary machinery on board the ship;
2. Describe the principles and operation of the different engine room auxiliary machinery;
3. Explain the operation of mechanical engineering systems and auxiliary machinery; and
4. Demonstrate the maintenance and repair requirements for automation and control systems of the different engine room auxiliary machinery.

Module 3: Engine Technology

1. State the different main propulsion systems used on the ship;
2. Discuss the principles of each propulsion plant systems;
3. Demonstrate the operation of the propulsion plant systems; and
4. Illustrate maintenance and repair requirements for automation and control systems of main propulsion plants.

Module 4: Marine Refrigeration and Air Conditioning Systems

1. Describe the principles and operation of ship’s refrigeration systems;
2. Describe the principles and operation of ship’s heating, ventilation, and air conditioning (HVAC) systems;
3. Demonstrate operating procedures of refrigeration systems;
4. Demonstrate operating procedures of HVAC;
5. Perform maintenance and testing of refrigeration systems;
6. Perform maintenance and testing of HVAC systems;
7. Perform fault-finding and repair of refrigeration systems; and
8. Perform fault-finding and repair of HVAC systems.

CLUSTER 2:

Module 5: Marine Electro-Technology

1. Enumerate the different electrical materials – insulators, conductors and semiconductors;
2. Describe the properties, characteristics and factors affecting electrical materials;
3. Describe the requirements to prevent damage to electronic equipment and control systems;
4. Describe digital techniques and its applications;
5. Discuss the maintenance procedures for electronic equipment and control systems;
6. Analyze ways of detecting electronic malfunctions;
7. Interpret electronic circuit diagrams systematically;
8. Demonstrate safe & proper operation and calibration of electronic testing instruments;
9. Apply safe isolation procedures on electronic equipment and control systems; and
10. Apply fault-finding techniques and repair procedures to effectively locate and rectify faults and restore electronic control equipment to operating condition.

Module 6: Electrical Equipment, Schematics and Safety

1. Identify different electrical equipment such as hotel equipment, lightings, batteries/power supplies, transformers, motors, and motor starters and controllers used onboard;
2. Identify electrical equipment installed in flammable areas;
3. State the different symbols used in electrical circuit diagram;
4. Classify different motor types, starters and controllers;
5. Interpret electrical circuit diagrams for hotel equipment, lightings, batteries/power supplies, transformers, motors, motor starters and controllers, and bridge navigation and communication equipment;
6. Discuss the maintenance procedures for electrical equipment;
7. Demonstrate proper use of personal protective equipment (PPE) as used in electrical maintenance;
8. Demonstrate safety measures and practices to prevent electrical hazards in the workplace;
9. Demonstrate safe and proper operation and calibration of electrical testing instruments;
10. Apply safe isolation procedures on electrical equipment;
11. Practice preventive maintenance procedures for electrical equipment;
12. Apply fault-finding techniques to effectively locate and rectify faults; and
13. Apply repair procedures to restore electrical equipment to operating condition.

Module 7: Generators and Distribution Systems

1. Define the principles and operation of AC generators;
2. Identify the electrical power distribution system onboard (main, emergency switchboards and distribution panels);
3. Discuss the electrical power distribution system onboard (main, emergency switchboards and distribution panels);
4. Perform coupling, load sharing and changing over of generators;
5. Perform coupling and breaking connection between switchboards and distribution panels;
6. Apply safe isolation procedures on generators and switchboards;
7. Apply preventive maintenance and repair procedures of electrical equipment (switchboards, motors, generators, DC systems);
8. Perform fault analysis based on information from computerized monitoring system; and
9. Discuss Uninterruptible Power Supply (including battery) systems onboard.

Module 8: Ship’s Communication Systems and Bridge Navigation Equipment

1. Identify ship’s communication systems and bridge navigation equipment;
2. Explain the principles and operation of ship’s communication systems;
3. Describe the principles of operation of bridge navigation equipment;
4. Demonstrate the use of ship’s internal communication systems;
5. Differentiate maintenance procedures for ship’s internal from external communication systems;
6. Identify electrical and electronic systems operating in flammable areas;
7. Apply safe isolation procedures on ship’s communication systems and bridge navigation equipment;
8. Demonstrate maintenance of ship communication systems and bridge navigation equipment; and
9. Perform troubleshooting and repair of ship communication systems and bridge navigation equipment.
Module 9: Marine High Voltage

1. Identify the hazards and safety precautions required for marine high voltage;
2. Discuss the safety requirements and procedures when working with high voltage systems onboard ships;
3. Describe high voltage installations onboard ships;
4. Discuss electrical propulsion of the ships, electrical motors and control systems;
5. Use approved high-voltage type of safety tools, testing equipment and personal protective equipment;
6. Demonstrate safe operation and maintenance of high-voltage systems;
7. Create a remedial action necessary during faults in high-voltage systems;
8. Plan a switching strategy for isolating components of a high-voltage system, complete with safety documentation; and
9. Perform insulation resistance and polarization index test of high-voltage equipment.

CLUSTER 3:

Module 10: Electro-Hydraulics

1. State the fundamentals of electro-hydraulic systems;
2. Explain the operating principle of electro-hydraulic systems;
3. Describe electro-hydraulic design features in main engine auxiliary systems, steering systems, deck machinery, cargo-handling equipment, and hotel equipment onboard ships;
4. Explain the automation and control in electro-hydraulic systems;
5. Discuss preventive maintenance requirements for electro-hydraulic systems;
6. Interpret electro-hydraulic circuit schematic diagrams;
7. Apply safe isolation procedures on electro-hydraulic systems;
8. Demonstrate troubleshooting of electro-hydraulic systems; and
9. Apply maintenance and repair procedures to restore electro-hydraulic equipment to operating condition.

Module 11: Electro-Pneumatics

1. State the fundamentals of electro-pneumatic systems;
2. Explain the operating principle of electro-pneumatic systems;
3. Describe electro-pneumatic design features in starting-air systems, deck machinery, hotel equipment onboard ships;
4. Explain the automation and control in electro-pneumatic systems;
5. Discuss preventive maintenance requirements for electro-pneumatic systems;
6. Interpret electro-pneumatic circuit schematic diagrams;
7. Apply safe isolation procedures on electro-pneumatic systems;
8. Demonstrate troubleshooting of electro-hydraulic systems; and
9. Apply maintenance and repair procedures to restore electro-
   hydraulic equipment to operating condition.

Module 12: Programmable Logic Controllers with Networking

1. State the fundamentals of programmable logic controllers (PLC);
2. Explain the operating principle of PLC and networking systems
   onboard ship;
3. Understand main features of data processing, construction and use
   of computer networks on ships, bridge-based, engine-room-based
   and commercial computer use;
4. Explain programmable logic controllers as applied to automation
   and control;
5. Operate computer consoles on PLC-based data networks;
6. Discuss preventive maintenance requirements for PLC and network
   systems;
7. Apply safe isolation procedures on PLC and networking systems;
8. Demonstrate troubleshooting of PLC and networking systems; and
9. Apply maintenance and repair procedures to restore PLC and
   networking equipment to operating condition.

Module 13: Instrumentation, Automation and Alarm Systems

1. Identify different instrument and process control elements of control
   system;
2. Explain the fundamentals of process control systems;
3. Explain the function of electronic controllers in process control
   loops;
4. Apply process control measurements on process control systems
   onboard ships;
5. Demonstrate transmitter and converter function used in process
   control loops;
6. Distinguish the different kinds of final control elements and their
   applications onboard ships;
7. Operate generators and power distribution systems thru
   instrumentation and automation;
8. Analyze process control systems in marine control applications;
9. Interpret alarms and safety systems onboard ships;
10. Interpret PI&D (Piping and Instrumentation Diagram);
11. Apply safe isolation procedures on instrumentation and automation
    system;
12. Perform function configuration and performance tests of monitoring
    systems, automatic control devices, and protective devices for
    instrumentation and automation system; and
13. Apply practical knowledge for the testing, maintenance, fault finding
    and repair of instrumentation and automation system.
CLUSTER 4:

Module 14: Use of English in Written and Oral Form

1. Use English in written and oral form to:
   - perform the electro-technical officer's duties;
   - use general maritime vocabulary;
   - use marine technical terminology;
   - read manufacturer’s manuals;
   - orally interpret shipboard drawings; and
   - read other engineering publications.

Module 15: Ensure Compliance with Pollution Prevention Requirements

1. Enumerate the statutory rules and regulations for the prevention of pollution of the marine environment;
2. List down the precautions to be taken to prevent pollution of the marine environment;
3. Identify anti-pollution procedures and all associated equipment; and
4. Discuss the importance of proactive measures to protect the marine environment.

Module 16: Leadership and Teamworking Skills

1. Describe the basic duties and responsibilities of vessel personnel;
2. Generate a work plan for the electrical and electronic maintenance aboard ship;
3. Execute a work plan for the electrical and electronic maintenance aboard ship; and
4. Supervise an emergency team.
Entry Standards

Maritime Training Institutions (MTI) shall ensure that participants to this training program must be:

1. Filipino Citizen, Atleast 18 years of age;

2. Holders of a Bachelor’s Degree in any of the following:
   - Electrical Engineering; or
   - Electronics and Communications Engineering; or
   - Industrial Technology, with major or specialization in any of the following:
     - Electrical; or
     - Electronics; or
     - Instrumentation and Control; or
   - Marine Engineering; and

3. Medically Fit.

The Bachelor’s Degree required herein shall be evidenced by the Transcript of Records indicating the Special Order Number of graduation or Board Resolution Number for graduates of autonomous or deregulated, accredited level I, II and III, and public institutions of higher learning.

Training Certificate

A participant may complete this training program in clusters. However, he shall only be issued a Certificate of Completion by the MTI concerned after successful completion of all the four (4) clusters of this training program. The certificate shall be in accordance with the format prescribed by the Administration.

Class Intake Limitation

The number of participants in this training program shall not exceed twelve (12) in a class. For laboratory and simulation class, the MTIs shall ensure that each participant shall have sufficient opportunity and exposure when using laboratory equipment and simulators for training and assessment purposes.
### Staff Requirements

1. The staff and qualification requirements for this training program shall be as follows:

<table>
<thead>
<tr>
<th>Staff Requirement</th>
<th>Qualification Standards</th>
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</thead>
</table>
| 1. **For Cluster 1 and 4** | 1.1. **Instructor:**
  1.1.1. a Management Level Marine Engineer Officer;
  1.1.2. holder of a certificate of completion of the Training Course for Instructors (IMO Model Course 6.09);
  1.1.3. have not less than three (3) months of teaching experience “related to the field of study” within the last five (5) years prior to the date of application for accreditation as Instructor of this training program;
  1.1.4. holder of a certificate of completion of the Train the Simulator Trainer and Assessor (IMO Model Course 6.10);
  1.1.5. gained practical experience on the operation of the particular type of Simulator being used through a training provided by the Manufacturer or its authorized agent;
  1.1.6. holder of a valid Certificate of Competency (COC) as Management Level Marine Engineer Officer; and
  1.1.7. have not less than 24 months of seagoing service as Management Level Marine Engineer Officer.

1.2. **Assessor:**
  1.2.1. holder of a certificate of accreditation as Instructor for Clusters 1 and 4 of the ETO training program; and
  1.2.2. certificate of completion of the training course for Assessment, Examination and Certification of Seafarers (IMO Model Course 3.12).
<table>
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<tr>
<th>Staff Requirement</th>
<th>Qualification Standards</th>
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</table>
| **2. For Clusters 2, 3, and 4** | **2.1. Instructor:**  
  2.1.1. an Electro-Technical Officer (ETO);  
  2.1.2. holder of a certificate of completion of the Training Course for Instructors (IMO Model Course 6.09);  
  2.1.3. have not less than three (3) months of teaching experience “related to the field of study” within the last five (5) years prior to the date of application for accreditation as Instructor of this training program;  
  2.1.4. holder of a certificate of completion of the Train the Simulator Trainer and Assessor (IMO Model Course 6.10);  
  2.1.5. gained practical experience on the operation of the particular type of Simulator being used through a training provided by the Manufacturer or its authorized agent;  
  2.1.6. holder of a valid COC as ETO without limitation;  
  2.1.7. have not less than 36 months of seagoing service as ETO or as Electrician, Electrical Officer, Electrical Engineer, Electronics Engineer prior to the date of application for accreditation as Instructor of this training program.  

**Note:** An ETO who is duly accredited as Instructor for this training program shall also be qualified and allowed to teach “Module 4. Marine Refrigeration and Air Conditioning Systems” under Cluster 1.  

**2.2. Assessor:**  
  2.2.1. holder of a certificate of accreditation as Instructor for Clusters 2, 3, and 4 of the ETO training program; and  
  2.2.2. certificate of completion of the training course for Assessment, Examination and Certification of Seafarers (IMO Model Course 3.12).
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<tr>
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<tr>
<td><strong>Note:</strong> To augment the staff complement for the ETO training program, MTIs may employ the services of the following professionals as <strong>full-time Instructor</strong> to handle and teach <strong>Clusters 2 and 3:</strong></td>
<td><strong>2.3. Instructor:</strong></td>
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<td>• Registered Electrical Engineer; or</td>
<td>2.3.1. holder of a Professional Regulation Commission (PRC) Certificate of Passing the Licensure Examination as such;</td>
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<tr>
<td>• Registered Electronics Engineer; or</td>
<td>2.3.2. holder of a certificate of completion of the Training Course for Instructors (IMO Model Course 6.09);</td>
</tr>
<tr>
<td>• Registered Electronics and Communications Engineer</td>
<td>2.3.3. holder of a certificate of completion of the Train the Simulator Trainer and Assessor (IMO Model Course 6.10);</td>
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<td>2.3.4. gained practical experience on the operation of the particular type of Simulator being used through a training provided by the Manufacturer or its authorized agent;</td>
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<td>2.3.5. have not less than <strong>36 months</strong> of seagoing or land-based experience or a combination of both as Electrical Engineer as specified under Section 2 [a], Article I of Republic Act No. 7920, or as Electronics Engineer or Electronics and Communications Engineer as specified under Section 5 [a], Article I of Republic Act No. 9292, of which not less than <strong>eighteen (18) months shall be teaching experience</strong> “related to the field of study” within the last five (5) years prior to the date of application for accreditation as Instructor; and</td>
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<td>2.3.6. holder of a certificate of completion of <strong>Module 9 “Marine High Voltage”</strong> under Cluster 2 of the ETO training program approved by the Administration.</td>
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<tr>
<td><strong>3. Supervisor</strong></td>
<td><strong>3.1. holder of a certificate of completion of the Training Course for Instructors (IMO Model Course 6.09); and</strong></td>
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<td><strong>3.2. have not less than three (3) months of teaching experience “related to the field of study” within the last five (5) years prior to the date of application for accreditation as Supervisor of this training program.</strong></td>
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<td><strong>Note:</strong> The MTI shall ensure that, while so accredited, the Supervisor shall have full understanding of the training program and its intended learning outcomes.</td>
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</table>
2. Additionally, the MTI offering this training program shall be responsible to ensure that a newly accredited Assessor shall:

2.1. Have gained practical assessment experience by participating as understudy in at least three (3) practical assessment activities conducted by an accredited and experienced Assessor before being assigned to perform actual assessment of participants in this training program, pursuant to Regulation I/6, paragraph .2 and Section A-I/6, paragraph 6.4 of the STCW '78 Convention, as amended; and

2.2. If conducting assessment involving the use of simulator, the assessor shall have gained practical assessment experience on that particular type of simulator under the supervision and to the satisfaction of an accredited and experienced Assessor, pursuant to Regulation I/6.2 and Section A-I/6.6.5 of the STCW '78 Convention, as amended.

3. The MTIs shall have a quality assurance mechanism or process in its Quality Standards System (QSS) to ensure that their Assessors shall have gained practical assessment experience, whether involving the use of simulator or not, before performing actual assessment of participants in this training program.

4. The implementation and compliance with the required quality assurance mechanism shall, among others, be clearly and properly documented and, shall be checked and verified during the monitoring by the Administration’s STCW Office.

### Teaching Facilities

For the theoretical part of this training program, the MTI shall provide at least one (1) lecture classroom equipped with multimedia projector, a computer set, white board and other necessary paraphernalia, as well as other facilities and fixtures needed. This does not however prevent the MTI from utilizing additional teaching facilities as it may deem necessary.

### Training Equipment

For the practical and workshop skills training, the MTI shall provide the following equipment, tools and instruments and supplies/consumables in its designated laboratory and practical workshop skills training area for the participants' utilization.
EQUIPMENT:

1 Set **Diesel Engine Simulator**
   with at least three (3) student stations and one (1) Instructor station;
   whole set capable of simulating *Engine Control* and *Power Management System*

1 Set **Refrigerant Charging and Recovery Equipment**
   must include, but not limited to, a *Manifold Gauge Set, Refrigerant Tank, Recovery Unit*, and *Recovery/Service Tank*

2 Stations **Refrigeration and Air-Conditioning System Trainer**
   each station capable of delivering training on *Operation, Maintenance, Servicing* and *Fault-finding* of a refrigeration equipment

1 Set **Fire Alarm System**
   capable of delivering training on *Operation* and *Testing* of *Annunciators, Flame Sensors, Heat Sensors*, and *Smoke Detectors*

4 Units **Regulated DC Power Supply** (Variable 0 –30 VDC)

4 Units **Audio Frequency Generator**

4 Units **Dual Trace Oscilloscope**

2 Units **Three-Phase Transformer**

2 Units **Single-Phase Transformer**

1 Unit **Lead Acid Battery**

1 Unit **Battery Charger** (for Lead Acid Batteries)

4 Units **Uninterruptible Power Supply** (500VA)

4 Sets **Electronic Training Boards**
   with electrical and electronic component modules including, but not limited to Resistors, Capacitors, Inductors, Diodes, Transistors, Silicon-Controlled Rectifiers, Triacs, and Diacs

4 Stations **Electrical Control Trainer**
   with the following electrical motors: 3-phase **AC Motor** (6-Leads Out); Single-Phase **AC Motor**; and **DC Motor** capable of delivering training on *Practical Wiring, Operation, Testing* and *Troubleshooting* of components and circuits of different motor control arrangements (Direct Online Starter, Reversible Controller, Speed Controller, Wye-to-Delta Starter, Variable Frequency Drive, Remote Control)
1 Unit **Hot Plate** (Electric - 3-phase)

1 Set **Fluorescent Lamp Fixture**

1 Set **Cargo Flood Lamp Fixture**

1 Set **Brushless AC Generator Training Equipment** capable of delivering training on *Operation and Testing* of generators

1 Set **Switchboard / Panel** (440VAC) with various Circuit Breakers, Fuses, Motor Controllers, Contactors and Protection Devices capable of delivering training on *Operation*, Maintenance and Testing of switchboards and electrical panels

1 Set **Lock-Out Tag-Out Equipment** including but not limited to Lock Modules, Tags and Warning Signs

4 Units **Hydraulic Power Pack Equipment**

4 Stations **Electro-Hydraulic Trainer**


Each station capable of delivering training on *Operation, Maintenance, Testing* and *Troubleshooting* of electro-hydraulic systems.

4 Units **Programmable Logic Controller (PLC)** minimum of 4 input ports and 4 output ports

4 Sets **Computer** for Networking and Programming the PLC

4 Units **Proportional-Integral-Derivative** (PID) **Controller**

1 Station **Instrumentation and Control Trainer** capable of delivering training on the *Operation, Testing* and *Calibration* of the four basic control variables Pressure, Temperature, Level, and Flow Rate

1 Unit **Air Compressor**

4 Stations **Electro-Pneumatic Trainer**

- including Compressed-Air Reducing Unit, Pneumatic Cylinder, Solenoid-Actuated Directional Control Valves, Flow Control Valves, Non-Return Valves, Connecting Hoses, and Electrical Control Components.

Each station capable of delivering training on *Operation, Maintenance, Testing* and *Troubleshooting* of electro-pneumatic systems.
1 Set **High-Voltage (HV) Switchboard**
capable of delivering training on *Operation, Maintenance and Testing* of high-voltage equipment

1 Unit **HV Power Circuit Breaker** (Vacuum or SF6)

1 Set **Portable Grounding Equipment**
HV Grounding Cables/Clusters and Hot Stick Hooks/Connectors

*Note:* MTIs may use *better equipment* provided that it serves the same purpose of meeting the intended learning outcomes of this training program.

**TOOLS AND INSTRUMENTS:**

4 Units **Analog Multimeter**

4 Units **Digital Multimeter**

4 Units **Clampmeter**

2 Units **Insulation Resistance Tester**
for Low Voltage Equipment Testing, Test Voltage up to 1,000VDC

1 Unit **Tachometer**

1 Unit **Hydrometer**

1 Set **Pressure Calibration Instrument**

1 Set **Temperature Calibration Instrument**

4 Pieces **Pressure Sensor/Detector**

4 Pieces **Temperature Sensor/Detector**

4 Pieces **Flow Rate Sensor/Detector**

4 Pieces **Level Sensor/Detector**

4 Pieces **Proximity Sensor/Detector**

4 Pieces **Pressure Transmitters/Transducers**

4 Pieces **Temperature Transmitters/Transducers**

1 Set **Refrigeration and Air Conditioning Tools**
including, but not limited to, Ratchet, Mechanical Wrench Set, and Leak Detector
1 Unit  **High Voltage Insulation Resistance Tester**  
for High Voltage Equipment Testing, Test Voltage selection of up to at least 10,000VDC

1 Set  **Hot Stick with High Voltage Detector**

2 Pairs  **HV Coveralls**

2 Pairs  **HV Rubber Gloves**

2 Pairs  **HV Leather Gloves**

2 Pairs  **HV Boots/Shoes**

2 Pieces  **HV Helmet**

2 Units  **HV Faceshield with Chin Protection**

1 Piece  **HV Insulating Mat**

### SUPPLIES AND CONSUMABLES:

12 Sets  **Electrical and Electronic Components**  
shall be made available depending on the practical exercises presented and indicated in the Instructor’s Guide.

**Note:** Compliance with the above requirements does not, however, prevent the MTI from utilizing additional training equipment, tools and instruments and supplies/consumables as it may deem necessary to meet the intended learning outcomes of this training program.

### Teaching Aids (A)

The MTI shall provide the following teaching aids to facilitate learning in this training program:

**A1.** Manufacturer’s Operations Manual, Service Manual, and Technical Diagrams for the following shipboard machinery and equipment:

- Refrigeration System
- Air-Conditioning System
- Alternator/Generator
- Power Management Systems
- Main Engine Instrumentation and Automation System
- Steering Systems
- Crane Systems
- Mooring Winches
- Starting Air Systems
- Steam Boilers
- Automatic Telephone Systems
- Emergency Sound Powered Telephone Systems
- Talkback – Intercom Systems
- Public Address Systems
- Radars
- Global Navigation Satellite Systems
- Speed / Distance Log Device
- Echo Sounder Systems
- Marine Autopilots
- Long Range Identification and Tracking System
- Voyage Data Recorders
- VHF/MF and HF Radio Equipment
- Digital Selective Calling Equipment

A2. Training Videos or Computer-Based Training Modules of the following:
- Alternators/Generators
- Auxiliary Engine
- Digital Governor Systems
- Steam Boilers
- Pumps
- Compressed Air Systems
- Sea Water Cooling Systems
- Fresh Water Cooling Systems
- Separators (Purifiers/Clarifiers)
- Stern Tube
- Oily Water Separators
- Machinery Alarms and Protection Devices
- Electric Propulsion and High Voltage Practice
- Remote Control Systems
- Ship’s Electrical Systems – Safety and Maintenance
- Electrical Distribution Systems
- Generators and Main Circuit Breakers
- Motors and Starters
- Ancilliary Electrical Services
- Electrical Survey Requirements
- Ignition Risks from Static Electricity and Stray Currents

**Note:** MTIs may use additional teaching aids as it may deem necessary to meet the intended learning outcomes of this training program.

### References (R)

The MTI shall provide the following references to facilitate learning in this training program:


R5. IMO Resolution A.702 (17) Radio Maintenance Guidelines for the Global Maritime Distress and Safety System (GMDSS) Related to Sea Areas A3 and A4

**Note:** MTIs may use additional references as it may deem necessary to meet the intended learning outcomes of this training program.

### Textbooks (T)

MTIs offering this training program are required to identify and provide at least two (2) titles of textbooks per module used in designing their own training program from the list below. They shall ensure that such textbooks are relevant and of latest edition to ensure that the intended learning outcomes of this training program shall be met.

T1 Adnanes A.K. Maritime Electrical Installation and Diesel Electric Propulsion Tutorial, Report/textbook, ABB Marine AS, Oslo, Norway
T2  Axelson Jan, The Microcontroller Idea Bok: Circuits, Programs & Applications featuring, Lakeview Research, USA

T3  Barnes M., Practical Variable Speed Drives and Power Electronics, Elsevier

T4  Berger H., Automating with STEP 7 in LAD and FBD: Simatic S7-300/400, SIEMENS

T5  Berger H., Programmable Controllers in STEP 7 Basic with SIMATIC S7-1200, SIEMENS

T6  Bird J., Electrical Circuit Theory and Technology, Elsevier


T8  Bolton W., Programmable Logic Controllers, NEWNES

T9  Bose B. K., Power Electronics and Motor Drives - Advances and Trends, Elsevier,

T10  Cadick J., Electrical Safety in Marine Environment. Cadick Corporation, Technical Bulletin 010,


T14  Computer Data, including: Data Set, Electronical Data Interchange, Random Access, Computer Data Processing, Text File, Binary Code, by Hephaestus Books

T15  Ellis Norman., Electrical Interference Handbook, Second edition, Publisher: NEWNES


T18  Fossen T., Marine Control Systems, Marine Cybernetics, Trondheim 2002
T30 Hellerman H., Digital Computer System Principles
T34 IACS Guidelines and Recommendations No. 35, Inspection and Maintenance of Electrical Equipment Installed in Hazardous Areas
T36 IEC 60079-series, Explosive Atmospheres


T39 International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code), London IMO

T40 International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), London IMO

T41 Jackson L., Instrumentation and Control Systems, Thomas Reed Publications Ltd. 1992


T43 Joel, R., Basic Engineering Thermodynamics in SI Units. 4th Ed. Harlow, Longman, 1996


T46 Khanna Vinod Kumar., The Insulated Gate Bipolar Transistor: IGBT Theory and Design, A John Wiley & Sons, Inc. Publication;


T51 Kothari D. P., Nagrath I. J., Electric Machines, Mac-Graw-Hill, New Delhi, 2006


T54 Kwaśniewski J., Programmable Logic Controllers, Published by WIMiR AGH, Kraków, 2002

T55 Lipo T. A., Jezernik K., AC Motor Speed Control, University of Wisconsin, Madison WI, U.S.A, University of Maribor, Maribor, Slovenia, 2002


T58 Mackay S., Wright E., Reynders D., Practical Industrial Data Networks: Design, Installation and Troubleshooting, Elsevier 2004


T60 Manual for Use by the Maritime Mobile and Maritime Mobile-Satellite Services, ITU Geneva 2011


T62 Mc George H.D., Marine Electrical Equipment and Practice, Butterworth-Heinemann, Oxford 2004


T68 Mohan N., First Course on Power Electronics and Drives, NMPERE Minneapolis 2003


T73  Pearce Durrance J. G., Sound-powered Telephone Talkers’ Training Manual NAVEDTRA 14232, Published by Naval Education and Training Professional Development and Technology Centre NAVSUP 1994

T74  Peek F. W., Dielectric Phenomena in High Voltage Engineering, Watchmaker Publishing 2006

T75  Perez T., Ship Motion Control, Springer Verlag, London 2005


T78  Rashid M.H., Power Electronics, Circuits, Devices & Applications

T79  Reed's Volume 6: Basic Electrotechnology for Engineers; E. G. R. Kraal, Publisher: London: Thomas Reed Publications, [1985]


T82  Reynders D., Mackay S., Wright E., Practical Industrial Data Communications: Best Practice Techniques, Elsevier 2005

T83  Reynders D., Wright E., Practical TCP/IP and Ethernet Networking, Elsevier 2003

T84  Roberts P. (Capt), Watchkeeping Safety and Cargo Management in Port. London, The Nautical Institute, 1995

T85  Roy G. J., Notes on Instrumentation and Control, London Stanford Maritime Ltd. 1985


T90  Smith R. G., Application of Automatic Machinery and Alarm Equipment in Ships, Institute of Marine Engineers;

T91  Strauss C., Practical Electrical Network Automation and Communication Systems, Elsevier 2003


T98  Various Technical Documentation of Ship Electrical Devices and Systems


## Part B
### Curriculum Outline

### SUMMARY

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<td>Module 10 – Electro-Hydraulics</td>
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## CLUSTER 1: MARINE ENGINEERING SYSTEMS

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<td>b. Different types of Steam</td>
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<td>c. Heat content of Steam</td>
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<td>d. Steam Table</td>
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<td>e. Mollier Diagram</td>
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<td>f. Evaporation and Condensation</td>
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<td>g. Heat Transport Medium</td>
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<td>e. Steam Trap</td>
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<td>f. Tube Heat Exchangers</td>
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<td>g. Plate Heat Exchangers</td>
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<td>3. Heat Transfer</td>
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<td>a. Main Laws of the thermodynamics</td>
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<td>b. Heat transport by Liquid</td>
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<td>c. Heat transport by Convection</td>
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<td>d. Heat transport by Radiation</td>
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<td>e. Heat transfer Overall Conductance Coefficient</td>
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ELECTRO-TECHNICAL OFFICER (ETO) TRAINING PROGRAM

STCW Circular No. ____ , Annex I  
Page 26 of 42
Module 2: **Auxiliary Machineries**

1. Steam Boilers
   a. Classification
   b. Boiler attachments
   c. Working Principles
2. Pumps
   a. Classification of Pumps
   b. Working Principle of Pumps
3. Compressed Air Systems
   a. Starting Air Systems
   b. Control Air Systems
   c. Service Air Systems
   d. Emergency Air Systems
4. Sea Water Cooling Systems
5. Fresh Water Cooling Systems
6. Separators (Purifiers/Clarifiers)
   a. Classification of Separators
   b. Working Principle of Separators
7. Stern Tube
   a. Propeller Shaft
   b. Sealing Arrangement
   c. Bearing and Glands
8. Oily Water Separators
   a. Working Principle of Oily Water Separators

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<td>1. Refrigeration Systems</td>
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<td>2. Heating Systems</td>
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<td>3. Ventilating Systems</td>
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## CLUSTER 2: ELECTRICAL AND ELECTRONIC SYSTEMS

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1. Measurement and Calibration of Electrical Test Equipment, Analog/Digital
2. DC Circuits: Voltage Rise/Drop and Resistors
3. Ohms Law and Voltage Dividers
4. Bridge Circuits and Kirchhoff’s Laws
5. Inductance and Capacitance
6. Semiconductors
7. Transistors
   a. Circuit Arrangements
   b. Amplifiers
8. Public Address Systems (PA System)
   a. Operation and Function
   b. Circuit Diagrams
9. Operational Amplifiers
   a. Operation of Electronic Circuit
   b. Voltage Multiplying Connection
   c. Regulated Power Supply
   d. Differential Amplifier
   e. Power/Voltage Amplifier
   f. Oscillators
   g. Multi-vibrators
   h. Integrated Circuits
10. Digital Techniques
    a. Number Systems
    b. Logic Circuits
    c. Microprocessors
11. Alarm Handling Systems
    a. Addressing
    b. Testing
12. Troubleshooting and Repair Techniques

Sub-total Training Hours | 90 |
### Subject Area

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Module 6: **Electrical Equipment, Schematics and Safety**

1. Electrical Safety  
   a. Personal obligations and Responsibilities  
   b. PPE  
   c. Test Instruments and Hand Tools  
   d. Electrical Hazards  
   e. Effect of Electric Current to Human Body  
   f. Other Job-related Hazards  
   g. Do’s and Don’ts  

2. Electrical Equipment and Schematics  
   a. Circuit Testing  
      - Electrical parameters  
      - Single Phase and Three Phase Power supply  
      - Series and Parallel circuit  
      - Three-Phase Connections and Formula  
   b. Electrical Measuring Instruments  
      - Multi-Tester Operation  
      - Clamp Meter Operation  
      - Megger Tester Operation  
      - Safety Requirements  
   c. Types of Electrical Schematics/Symbols  
      - Block Diagrams  
      - Schematic Diagrams  
      - Wiring Diagrams  
      - Circuit Diagrams  
      - Applications  
   d. Ship Lighting Systems  
      - General Lighting Systems  
      - Navigation/Signal Light Systems  
      - Hazardous Areas Lighting Systems  
      - Safety Requirements
### Subject Area

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<td>e. Battery/Power Supplies</td>
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<td>- Types of Marine Batteries and their characteristics</td>
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<td>- Purpose and Function of Uninterrupted Power supplies (UPS)</td>
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<td>- Charging, Maintenance and Inspection of Batteries</td>
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<td>f. Transformers</td>
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<td>g. Electric Motors</td>
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<td>- Single phase AC motors</td>
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<td>- Three phase AC motors</td>
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<td>- DC motors</td>
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<td>- Safety Requirements</td>
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<td>h. Motor Drives/Controllers</td>
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<td>- Full Voltage Starters</td>
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<td>- Reduced Voltage Starters</td>
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<td>- Speed Controllers</td>
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<td>- DC Motor Controllers</td>
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<td>i. Safety Systems of Hotel Equipment</td>
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## Subject Area

### Module 7: Generators and Distribution Systems

1. **Self-Excited Brushless Three Phase AC Generators**
   - Main Components
   - Operating Principle
   - Circuit Connections
   - Paralleling, Load Sharing and Load Transfer
   - Maintenance and Safety Requirements

2. **Main Switchboards**
   - Main Components
   - Operating Principle
   - Circuit Connections
   - Maintenance and Safety Requirements

3. **Emergency Switchboards and Shore Connections**
   - Main Components
   - Operating Principle
   - Circuit Connection
   - Maintenance and Safety Requirements

4. **Distribution Panels**
   - 440V and 220V, 3-Phase Systems
     - Essential and Non-Essential Loads
     - Preferential and Emergency Trip System
     - Maintenance and Safety Requirements
   - ESB Distribution Panels
     - Loads and Safety Requirements

5. **Batteries**
   - Classifications of Batteries
   - Operating Principles
   - Circuit Connection
   - Maintenance and Safety Requirements

6. **Fault-finding and Troubleshooting**

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Module 8: **Ship’s Communication Systems and Bridge Navigation Equipment**

1. Description & Operation of the following:
   a. Internal Communication
      - Automatic Telephone Systems
      - Emergency Sound Powered Telephone Systems
      - Talkback – Intercom Systems
      - Public Address Systems
   b. External Communication
      - Global Maritime Distress and Safety System (GMDSS)
      - VHF/MF and HF radio
      - INMARSAT Systems
      - NAVTEX System
      - Emergency Position Indicating Radio Beacon (EPIRB)
      - Search and Rescue Radar Transponder (SART)
      - Antenna Systems
      - Communication in Maritime Mobile Service
   c. Bridge Navigation Equipment
      - Automatic Identification System
      - GPS
      - Radars
      - Global Navigation Satellite Systems
      - Inertial Navigation Systems
      - Ship Compass Equipment
      - Speed Logs
      - Echo Sounder Systems
      - Marine Autopilots
      - Voyage Data Recorders
      - Wind Trackers
      - Navigation Lights
      - Search Lights
      - Sound Signal Systems
      - Ship Horns
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<td>c. Bridge Navigation Equipment</td>
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<td>d. Electrical and electronic systems operating in flammable areas</td>
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<td>3. Detection of machinery malfunction, location of faults and action to prevent damage</td>
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# Module 9: Marine High Voltage

1. High-Voltage Technology
   a. High-Voltage Fundamentals
   b. Maintenance and Safety Requirements
2. High Voltage Shipboard Safety
   a. High-Voltage Hazards
   b. Safety Precautions and Procedures
3. High Voltage Equipment Onboard the Ships
   a. HV Generators and Distribution Systems
   b. HV Transformers
   c. HV Power Breakers and Fuses
   d. HV Contactors
   e. HV Motors
   f. Electrical Propulsion of the Ships – Electric Motors and Control Systems
   g. Maintenance and Safety Requirements
      - Locking-out and Tagging-out
4. Maintenance and Testing in High Voltage Installations
   a. Disconnection, Isolation and Earthing (DIE) Procedure
   b. Switchgear and Switchboard Isolation
      - HV Power Breaker Racking-in/Racking out Procedures
   c. HV Insulation Resistance Testing

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1. Electro-Hydraulic System Structure
   a. Fundamentals of Hydraulics
   b. Electrical Control Basics
2. Hydraulic Power Packs
3. Hydraulic Actuators
4. Hydraulic Control Section
   a. Directional Control Valves
   b. Pressure Control Valves
   c. Flow Control Valves
   d. Non-Return Valves
   e. Hydraulic Accumulators
5. Electrical Control of Hydraulic Systems
   a. Electrical/Electronic Input Elements
   b. Control Relays and Contactors
   c. Electrical Timers and Counters
   d. Electronic Controllers
   a. Steering Systems
   b. Crane Systems
   c. Mooring Winches
   d. CPP and Reduction gear system
   e. Other Electro-Hydraulic Marine Applications
7. Electro-Hydraulic Systems Maintenance and Repairs
8. Fault-finding and troubleshooting

**Sub-total Training Hours**: 22
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<td>2. Compressed-Air Generating Plants</td>
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<td>c. Non-Return Valves</td>
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<td>a. Electrical/Electronic Input Elements</td>
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<td>6. Electro-Pneumatic Systems Onboard Ships</td>
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<td>c. Other Electro-Pneumatic Marine Applications</td>
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<td>7. Electro-Pneumatic System Maintenance and Repairs</td>
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<td>8. Fault-finding and Troubleshooting</td>
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Sub-total Training Hours 22
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<td>c. Control Signals and Interface</td>
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<td>d. PLC-based Control System Structure</td>
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<td>a. Engine Room-Based Computers</td>
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<td>c. Bridge-Based Computers</td>
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<td>5. PLC-based Control Systems Onboard Ships:</td>
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<td>a. Deck Equipment</td>
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<td>c. Engine Equipment</td>
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<td>6. Maintenance and Repair</td>
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### Module 13: Instrumentation, Automation and Alarm Systems

1. **Introduction to Control Systems**
   a. Control Loop Types
   b. Instrumentation Principles
   c. Automation Fundamentals
   d. Process Control Basics

2. **Marine Instrumentation and Control Systems**
   a. Control Variables
      - Pressure
      - Temperature
      - Flow Rate
      - Level
      - Viscosity
      - Salinity
      - Speed
      - Vibration
   b. Control Transmitters and Converters
   c. Calibration and Testing

3. **Marine Automation Systems**
   a. Final Control Elements
   b. Controllers
      - Proportional-Integral-Derivative Controllers
      - Proportional Control Action
      - Proportional-Integral Control Action
      - Proportional-Derivative Control Action
      - Proportional-Integral-Derivative Control Action
   c. Tuning PID Controllers

4. **Practical Marine Control Systems**
   a. Hydraulic Power Pack
   b. Controllable Pitch Propeller
   c. Air Compressors
   d. Auxiliary Boilers
   e. Steering Gear

5. **Alarms and Monitoring Systems**
6. **Maintenance and Repair**
7. **Fault-finding and Troubleshooting**

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### CLUSTER 4: ANCILLARY TRAININGS

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<td>a. Performing Officer Duties</td>
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<td>- Writing of Change /Turn Over of Duties Reports</td>
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<td>- Writing of Incident Reports</td>
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<td>b. Reading Equipment Operations and Service Manuals</td>
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<td>c. Using Shipboard Drawings</td>
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<td>d. Using Other Shipboard Engineering Publications</td>
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<td>1. Prevention of Pollution of the Marine Environment</td>
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<td>a. Precautions to Prevent Pollution of Marine Environment</td>
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<td>- MARPOL 73/78 Technical Annexes: Annex I to VI of MARPOL 73/78 in detail</td>
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<td>- Conventions and legislations adopted by various countries</td>
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<td>b. Anti-Pollution Procedures and Associated Equipment</td>
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<td>c. Proactive Measures to Protect the Marine Environment</td>
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<td>1. Shipboard Personnel Management &amp; Training</td>
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<tr>
<td>a. Organization of crew, authority structure, responsibilities</td>
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<td>b. Cultural awareness, inherent traits, attitudes, behavior, cross-cultural communication</td>
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<td>c. Shipboard situation, informal social structures on board</td>
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<td>d. Human error, situation awareness, automation awareness, complacency, boredom</td>
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<td>e. Leadership and teamworking</td>
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<td>f. Training, structured shipboard training programs</td>
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<td>g. Knowledge of personal abilities and behavioral characteristics</td>
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<td>2. Task and Workload Management</td>
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<td>a. Planning and coordination</td>
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<td>c. Human limitations</td>
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<td>d. Personal abilities</td>
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<td>e. Time and resource constraints</td>
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<td>f. Prioritization</td>
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<td>g. Workloads, rest and fatigue</td>
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<td>h. Management (leadership) styles</td>
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<td>i. Challenges and responses</td>
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<td>a. Effective communication on board and ashore</td>
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<td>b. Allocation, assignment and prioritization of resources</td>
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<td>c. Decision making reflecting team experience</td>
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<td>d. Assertiveness and leadership, including motivation</td>
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<td>e. Obtaining and maintaining situational awareness</td>
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<td>f. Appraisal of work performance</td>
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<td>g. Short and long term strategies</td>
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### Training Hours

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<td>4. Apply Decision-making Techniques</td>
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<td>a. Situation and risk assessment</td>
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<td>b. Identify and consider generated options</td>
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<td>c. Selecting course of action</td>
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<td>d. Evaluation of outcome effectiveness</td>
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<td>e. Decision making and problem solving techniques</td>
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<td>f. Authority and assertiveness</td>
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<td>g. Judgment</td>
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