



IALA MODEL COURSE

L2.2.2

MARINE AIDS TO NAVIGATION - TECHNICIAN
TRAINING

LEVEL 2 MODULE 2 ELEMENT 2.2

PRIMARY AND SECONDARY BATTERY
MAINTENANCE

Edition 3

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FOREWORD

The International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) recognises that training in all aspects of Marine Aids to Navigation (AtoN) service delivery, from inception through installation and maintenance to replacement or removal at the end of a planned life-cycle, is critical to the consistent provision of that AtoN service.

Taking into account that under the SOLAS Convention, Chapter 5, Regulation 13, paragraph 2; Contracting Governments, mindful of their obligations published by the International Maritime Organisation, undertake to consider international recommendations and guidelines when establishing Marine Aids to Navigation. As such publications should include recommendations on the training and qualification of AtoN technicians, IALA has adopted Recommendation R0141 on Standards for Training and Certification of AtoN personnel.

IALA Committees, working closely with the IALA World Wide Academy, have developed a series of model courses for AtoN personnel having R0141 Level 2 technician functions. This model course on primary and secondary battery maintenance should be read in conjunction with the Training Overview Document IALA WWA.L2.0 which contains standard guidance for the conduct of all Level 2 model courses.

This model course is intended to provide national members and other appropriate authorities charged with the provision of AtoN services with specific guidance on the training of AtoN technicians in primary and secondary battery maintenance. Assistance in implementing this and other model courses may be obtained from the IALA World Wide Academy at the following address:

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PART 1- COURSE OVERVIEW

1. SCOPE

This course is intended to provide technicians with the theoretical and practical training necessary to have a satisfactory understanding of the maintenance of primary and secondary batteries used in Marine Aids to Navigation (AtoN).

This course is intended to be supported by further theoretical and practical training modules on aspects of power supply and maintenance records. Details of these supporting model courses can be found in the Level 2 Technician training overview document IALA WWA L2.0.

2. OBJECTIVE

Upon successful completion of this course, participants will have acquired sufficient knowledge to maintain primary and secondary batteries used in both fixed and floating AtoN.

3. COURSE OUTLINE

This practical course covers the knowledge and practical competence required for a technician to properly service and maintain primary and secondary batteries used on buoys, lighthouses and major floating aids. The complete course comprises 5 modules, each of which deals with a specific subject representing an aspect of the maintenance of primary and secondary batteries. Each module begins by stating its scope and aims, and then provides a teaching syllabus.

4. TABLE OF TEACHING MODULES

Table 1 Table of Teaching Modules

Module Title	Time in hours	Overview
Introduction to battery technology	1	This module describes battery technology, terminology, and the types of batteries used in marine aids to navigation
Safety	1	This module describes how to safely store, handle and work with batteries
Installation	3	This module describes the charging, wiring, and installation of batteries on both fixed and floating AtoN
Inspection, testing and maintenance	2.5	This module describes how to test and inspect batteries and troubleshoot problems with them
Inventory management and disposal	0.5	This module describes how to manage the battery inventory and properly recycle or dispose of them after use
Evaluation	1	Practical test
Total Hours:	9	Total number of days 1.5

5. SPECIFIC COURSE RELATED TEACHING AIDS



- 1 This course involves both classroom instruction and practical experience in a work area. . Classrooms should be equipped with blackboards, whiteboards, and overhead projectors to enable presentation of the subject matter.
- 2 An alternative to classroom instruction would be to provide the lecture material to participants via distance-learning via the Internet (i.e. 'e-learning'). In that case, participants would need access to computers and related equipment, and should be provided with a means of interacting with instructors for discussion and to answer questions.
- 3 For the hands-on portion of the course, work areas should be suitable for trainees to safely and efficiently practice with batteries and associated equipment. If this work area is indoors, it should have the proper ventilation for working safely with batteries.
- 4 Trainees should have access to the types of equipment that they will be expected to work with on the job. This would include such things as batteries; wiring; charging; testing equipment and insulated tools. At a minimum, each student should be provided with the following safety equipment:
 - Rubber gloves;
 - Splash-proof goggles or a full face shield;
 - Steel-toed shoes;
 - Rubber apron.

6. REFERENCES

In addition to any specific references required by the Competent Authority, the following material is relevant to this course: the following material is relevant to this course:

- IALA Guideline G1067-0 - Selection of Power Systems for AtoN and Associated Equipment;
- IALA Guideline G1067-2 - Power Sources;
- IALA Guideline G1067-3 - Electrical Energy Storage for AtoN.

The following references are additional examples that can be useful in developing the course:

- Buchmann, Isador. Batteries in a Portable World: A Handbook on Rechargeable Batteries for Non-Engineers. Cadex Electronics, Inc., 2001;
- Crompton, T.R. Battery Reference Book. SAE International, 1996;
- Dell, R.M. and D.A.J. Rand. Understanding Batteries. Royal Society of Chemistry, 2001;
- Linden, David and Thomas B. Reddy. Handbook of Batteries. McGraw-Hill, 2001;
- Vincent, Colin and Bruno Scrosati. Modern Batteries: An Introduction to Electrochemical Power Sources. Butterworth-Heinemann, 1997;
- Other applicable guidelines and standards would be available from the Institute of Electrical and Electronics Engineers (www.ieee.org), and the International Electrotechnical Commission (www.iec.ch). Technical documentation from battery manufacturers would be another useful source of information.



PART 2 - TEACHING MODULES

1. MODULE 1 – INTRODUCTION TO BATTERY TECHNOLOGY

1.1. SCOPE

This module describes battery technology, terminology, and the types of batteries used in Marine Aids to Navigation.

1.2. LEARNING OBJECTIVE

To gain a **satisfactory** understanding of how batteries work and be familiar with the types most commonly used at Marine Aids to Navigation stations.

1.3. SYLLABUS

1.3.1. LESSON 1 – BATTERY TECHNOLOGY

- 1 Physical construction.
- 2 Principles of operation.
- 3 Terminology:
 - a. Shelf life;
 - b. Service life;
 - c. Capacity;
 - d. Cycle life;
 - e. Autonomy;
 - f. State of charge;
 - g. Depth of discharge;
 - h. Charge control;
 - i. Self-discharge.

1.3.2. LESSON 2 – BATTERY TYPES

- 1 Non-rechargeable (primary) batteries:
 - a. Air depolarized dry batteries;
 - b. Zinc carbon batteries;
 - c. Sealed alkaline batteries;
 - d. Lithium batteries.
- 2 Rechargeable (secondary) batteries:
 - a. Lead-acid batteries;
 - b. Nickel-Cadmium batteries;
 - c. Nickel-Metal Hydride batteries;
 - d. Lithium batteries.
- 3 Advantages and disadvantages of each type.
- 4 Typical applications of each type.



2. MODULE 2 – SAFETY

2.1. SCOPE

This module describes how to safely store, handle and work with batteries.

2.2. LEARNING OBJECTIVE

To gain a **good** understanding of how to work safely with batteries.

2.3. 2.2.3 SYLLABUS

2.3.1. LESSON 1 POTENTIAL HAZARDS

- 1 Electrolyte spills:
 - a. Methods of prevention;
 - b. First aid measures.
- 2 Explosions.
 - a. Methods of prevention;
 - b. First aid measures.
- 3 Short-circuiting.
 - a. Methods of prevention;
 - b. First aid measures.
- 4 Physical hazards.

2.3.2. LESSON 2 PERSONAL PROTECTION

- 1 Gloves.
- 2 Face protection.
- 3 Body protection.
- 4 Foot protection.
- 5 Eyewash stations.
- 6 Insulated tools.

2.3.3. LESSON 3 SAFE HANDLING AND STORAGE

- 1 Material safety data sheets.
- 2 Guidelines for transportation and storage.
- 3 Proper lifting methods.
- 4 Static electricity discharge.
- 5 Explosive gas detection.
- 6 Periodic refresh charge.
- 7 Storage of mixed battery types.
- 8 Ventilation:
 - a. Work areas;



- b. Storage areas.
- c. On site:
 - i. Battery rooms;
 - ii. Battery compartments.

3. MODULE 3 – INSTALLATION

3.1. SCOPE

This module describes the charging, wiring, and installation of batteries on both fixed and floating AtoN.

3.2. LEARNING OBJECTIVE

To gain a **satisfactory** understanding of how to install batteries properly and safely at Marine Aids to Navigation stations.

3.3. SYLLABUS

3.3.1. LESSON 1 INSPECTION PRIOR TO INSTALLATION

- 1 Physical condition.
- 2 Date of manufacture.
- 3 State of charge.
- 4 Electrolyte levels.

3.3.2. LESSON 2 CHARGING

- 1 Charging intervals.
- 2 Methods of charging and control.

3.3.3. LESSON 3 WIRING

- 1 Series and parallel.
- 2 Cable types.
- 3 Connections.

3.3.4. LESSON 4 INSPECTION PRIOR TO INSTALLATION

- 1 Physical requirements:
 - a. Battery orientation;
 - b. Protection of the battery against site environmental conditions;
 - c. Containment troughs.
- 2 Installing batteries:
 - a. Battery platforms;
 - b. Battery racks;
 - c. Battery boxes;
 - d. Battery compartments in vessels;
 - e. Battery rooms ashore.



4. MODULE 4 – INSPECTION, TESTING AND MAINTENANCE

4.1. SCOPE

This module describes how to test and inspect batteries and troubleshoot problems with them.

4.2. LEARNING OBJECTIVE

To gain a **satisfactory** understanding of how to inspect, test, and troubleshoot problems with batteries safely.

4.3. SYLLABUS

4.3.1. LESSON 1 MEASUREMENT AND TEST EQUIPMENT

- 1 Multi-meter (calibrated).
- 2 Load tester.
- 3 Torque wrench.
- 4 Capacity testing system.
- 5 Hydrometer:
 - a. For use with acid electrolytes;
 - b. For use with alkali electrolytes.
- 6 Basic rectifier charger.

4.3.2. LESSON 2 TESTS, INSPECTIONS AND MAINTENANCE

- 1 DC voltage testing.
- 2 AC voltage ripple measurement.
- 3 Bench testing.
- 4 Capacity testing.
- 5 Specific gravity.
- 6 Electrolyte levels.
- 7 Cell temperatures.
- 8 Insulation resistance.
- 9 Visual inspection:
 - a. Corrosion at connections;
 - b. Tightness of connections;
 - c. Condition of vent tubes;
 - d. Condition of cables ;
 - e. Integrity of battery support structures and enclosures;
 - f. Condition of safety equipment.
- 10 Troubleshooting problems found during tests and inspections.



5. MODULE 5 – INVENTORY MANAGEMENT AND DISPOSAL

5.1. SCOPE

This module describes how to manage the battery inventory and recycle or dispose of them after use.

5.2. LEARNING OBJECTIVE

To gain a **good** understanding of the policies and regulations in his or her organization which govern the proper management and disposal of batteries.

5.3. SYLLABUS

5.3.1. LESSON 1 INVENTORY MANAGEMENT

- 1 Legal requirements and regulations governing battery management.
- 2 Procedures for life-cycle inventory tracking.
- 3 Battery labelling.
- 4 Shelf-life monitoring.
- 5 Charging records.
- 6 Inspection records.

5.3.2. LESSON 2 DISPOSAL

- 1 Legal requirements and regulations governing battery disposal.
- 2 Environmental hazards:
 - a. Corrosive electrolytes;
 - b. Heavy metals;
 - c. Explosive potential.
- 3 Methods of disposal:
 - a. Recycling options;
 - b. Proper disposal methods.
- 4 Disposal records.