



IALA MODEL COURSE

L2.2.1

MARINE AIDS TO NAVIGATION - TECHNICIAN
TRAINING

LEVEL 2 MODULE 2 ELEMENT 2.1

DC POWER SYSTEMS

Edition 3

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CONTENTS

PART 1 - COURSE OVERVIEW	6
1. Scope	6
2. Objective.....	6
3. Course outline	6
4. Table of Teaching Modules	6
5. Specific Course Related Teaching Aids	7
PART 2 - TEACHING MODULES.....	8
1. Module 1 – Overview of DC power systems	8
1.1. Scope.....	8
1.2. Learning Objective	8
1.3. Syllabus	8
1.3.1. Lesson 1 – Primary Power Sources	8
1.3.2. Lesson 2 – System components.....	8
2. Module 2 – Solar Generation.....	8
2.1. Scope.....	8
2.2. Learning Objective	8
2.3. Syllabus	9
2.3.1. Lesson 1 PV Cells - general.....	9
2.3.2. Lesson 2 PV Cells - operation.....	9
3. Module 3 – Wind Generation	9
3.1. Scope.....	9
3.2. Learning Objective	9
3.3. Syllabus	9
3.3.1. Lesson 1 Wind Generators - general.....	9
4. Module 4 – Battery Charging.....	9
4.1. Scope.....	9
4.2. Learning Objective	9
4.3. Syllabus	10
4.3.1. Lesson 1 Power Sources and Charger principles.....	10
4.3.2. Lesson 2 Charger Types	10
4.3.3. Lesson 3 Solar Charge Optimisation	10
5. Module 5 – Battery Storage	10
5.1. Scope.....	10
5.2. Learning Objective	10
5.3. Syllabus	10
5.3.1. Lesson 1 Types of Batteries	10
5.3.2. Lesson 2 Health and Safety.....	10
5.3.3. Lesson 3 – Selection.....	11



CONTENTS

5.3.4.	Lesson 4 – Inspection and Maintenance.....	11
6.	Module 6 – Isolation and Protection.....	11
6.1.	Scope.....	11
6.2.	Learning Objective	11
6.3.	Syllabus	11
6.3.1.	Lesson 1 Low Voltage Isolation.....	11
6.3.2.	Lesson 2 Low Voltage Change over to another system	11
7.	Module 7 – DC Distribution	11
7.1.	Scope.....	11
7.2.	Learning Objective	12
7.3.	Syllabus	12
7.3.1.	Lesson 1 Loads and distribution	12
7.3.2.	Lesson 2 Standards	12
8.	Module 8 – Site Visit	12
8.1.	Scope.....	12
8.2.	Learning Objective	12
8.3.	Syllabus	12
9.	REFERENCES	12

List of Tables

<i>Table 1</i>	<i>Table of Teaching Modules.....</i>	<i>6</i>
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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.

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 DC Power Systems 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 DC Power Systems. 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 use, servicing and maintenance of DC power systems 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 service and maintain DC power systems used on 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 DC power systems used on buoys, lighthouses and major floating aids. The complete course comprises 9 modules, each of which deals with a specific subject representing an aspect of DC power systems servicing and maintenance. 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
Overview of DC power systems	2	This module describes the main components in a typical DC power system
Solar Generation	1	This module describes photo-voltaic generation systems
Wind generation	1	This module describes the generation of DC power by wind generators
Battery charging	1	This module describes power sources, charging regimes and charging technology
Battery storage	2	This module describes battery types, selection capacities and health and safety factors
Isolation and protection	1	This module describes low voltage cut out and change over systems
DC distribution	2	This model describes DC distribution systems, cable sizing, installation standards and electro-magnetic interference
Site visit	4	Practical visit to a complex DC system
Evaluation	1	Written test
Total Hours:	15	Total number of days 2.5



5. SPECIFIC COURSE RELATED TEACHING AIDS

This course is classroom based with a site visit. Classrooms should be equipped with blackboards, whiteboards, and overhead projectors to enable presentation of the subject matter.

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.

Participants should have access to the types of equipment that they will be expected to work with on the job. These would include such things as multi-meters, block diagrams, circuit drawings and samples of equipment in use.



PART 2 - TEACHING MODULES

1. MODULE 1 – OVERVIEW OF DC POWER SYSTEMS

1.1. SCOPE

This module describes the main components in a typical DC power system.

1.2. LEARNING OBJECTIVE

To gain a satisfactory understanding of the types of primary power sources and their components most commonly used at AtoN stations.

1.3. SYLLABUS

1.3.1. LESSON 1 – PRIMARY POWER SOURCES

- 1 Photovoltaic cells & arrays.
- 2 Wind generation.
- 3 Mains supply.
- 4 Local generator supply.
- 5 Other potential sources of supply.

1.3.2. LESSON 2 – SYSTEM COMPONENTS

- 1 Solar regulation.
- 2 Wind generation regulators.
- 3 Mains chargers.
- 4 Battery storage.
- 5 Low voltage isolation and protection.
- 6 Low voltage change over.
- 7 High voltage isolation and protection.
- 8 Charging regimes.
- 9 Loads.
- 10 Distribution systems.

2. MODULE 2 – SOLAR GENERATION

2.1. SCOPE

This module describes photovoltaic (PV) generation systems

2.2. LEARNING OBJECTIVE

To gain a satisfactory understanding of the configuration of a PV array, its regulation and maintenance and to gain a basic understanding of the solar modelling techniques for capacity planning



2.3. SYLLABUS

2.3.1. LESSON 1 PV CELLS - GENERAL

- 1 PV cells – various types available and in use.
- 2 PV load/voltage curves.
- 3 HV generation.
- 4 LV generation.
- 5 Regulation:
 - a. Integral;
 - b. Remote.

2.3.2. LESSON 2 PV CELLS - OPERATION

- 1 Care and maintenance.
- 2 Inspection and testing.
- 3 Expected life.
- 4 Solar modelling for correct selection.

3. MODULE 3 – WIND GENERATION

3.1. SCOPE

This module describes the generation of DC power by wind generators.

3.2. LEARNING OBJECTIVE

To gain a basic understanding the principles of wind generation; the types of generators available and in use and of their inspection and maintenance requirements.

3.3. SYLLABUS

3.3.1. LESSON 1 WIND GENERATORS - GENERAL

- 1 Types available:
 - a. Axial;
 - b. Radial.
- 2 Location selection.
- 3 Maintenance and inspection.

4. MODULE 4 – BATTERY CHARGING

4.1. SCOPE

This module describes power sources, charging regimes and charging technology.

4.2. LEARNING OBJECTIVE

To gain a satisfactory understanding of the types of battery chargers in service and those available and how to fault-find and replace a faulty charger.



4.3. SYLLABUS

4.3.1. LESSON 1 POWER SOURCES AND CHARGER PRINCIPLES

- 1 Primary power sources:
 - a. Solar PV;
 - b. Wind generation;
 - c. Local diesel alternator;
 - d. Mains AC supply.
- 2 Basic rectifier charger.

4.3.2. LESSON 2 CHARGER TYPES

- 1 Intelligent chargers with profiled charge rates.
- 2 Float charging.
- 3 Special charging – HF pulsing.
- 4 Charge regulation – Pulse Width Modulation.

4.3.3. LESSON 3 SOLAR CHARGE OPTIMISATION

- 1 Review of solar PV load/voltage graphs.
- 2 Maximum Power Point Tracking.

5. MODULE 5 – BATTERY STORAGE

5.1. SCOPE

This module describes battery types, selection capacities and health and safety factors.

5.2. LEARNING OBJECTIVE

To gain a satisfactory understanding of the types of batteries available; those in service, their application and how to maintain them and a good understanding of the health and safety issues.

5.3. SYLLABUS

5.3.1. LESSON 1 TYPES OF BATTERIES

- 1 Primary cells.
- 2 Secondary cells:
 - a. Flooded lead acid;
 - b. Gel Lead acid;
 - c. Nickel Metal Hydride;
 - d. Nickel Cadmium;
 - e. Other Modern batteries;
 - f. Characteristics of each type.

5.3.2. LESSON 2 HEALTH AND SAFETY

- 1 Ventilation.
- 2 Energy storage.



- 3 Manual handling.
- 4 High voltage hazards.

5.3.3. LESSON 3 – SELECTION

- 1 Sizing.
- 2 Peak output & maximum capacity.
- 3 Capacity and type selection.
- 4 Matching to charger.
- 5 Autonomy requirements following power generator failure.

5.3.4. LESSON 4 – INSPECTION AND MAINTENANCE

- 1 Maintenance and inspection.
- 2 Expected battery life.
- 3 Capacity testing and verification.
- 4 Battery conditioning.

6. MODULE 6 – ISOLATION AND PROTECTION

6.1. SCOPE

This module describes low voltage cut out and change over systems.

6.2. LEARNING OBJECTIVE

To gain a satisfactory understanding of the purpose of low voltage isolation and low voltage change over.

6.3. SYLLABUS

6.3.1. LESSON 1 LOW VOLTAGE ISOLATION

- 1 Why LV isolation is required.
- 2 Where LV isolation may not be installed.
- 3 Maintenance of LV cut out systems.

6.3.2. LESSON 2 LOW VOLTAGE CHANGE OVER TO ANOTHER SYSTEM

- 1 Change over switching to an alternative power source.
- 2 Systems available.
- 3 Systems in service.
- 4 Maintenance of LV change over switch systems.

7. MODULE 7 – DC DISTRIBUTION

7.1. SCOPE

This model describes DC distribution systems, cable sizing, installation standards and electro-magnetic interference



7.2. LEARNING OBJECTIVE

To gain a satisfactory understanding of the components in a DC supply system and the capability to inspect and maintain such a system.

7.3. SYLLABUS

7.3.1. LESSON 1 LOADS AND DISTRIBUTION

- 1 Load definition.
- 2 Peak power and acceptable voltage drop.
- 3 Cable sizing.
- 4 Electrical protective devices.
- 5 Lightning protection.
- 6 Mechanical protection.

7.3.2. LESSON 2 STANDARDS

- 1 Local electrical standards.
- 2 Installation standards.
- 3 Electro-magnetic compatibility.

8. MODULE 8 – SITE VISIT

8.1. SCOPE

A practical visit to an AtoN station with complex DC system.

8.2. LEARNING OBJECTIVE

To consolidate a satisfactory understanding of theoretical knowledge gained in the class room modules.

8.3. SYLLABUS

View the equipment in use before inspection, test and fault-finding procedures conducted under strict supervision.

9. REFERENCES

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

- 1 IALA Guideline G1039 - Designing Solar Power Systems for AtoN.
- 2 IALA Guideline G1067- 0 - Selection of Power Systems for AtoN and Associated Equipment.
- 3 IALA Guideline G1067- 1 - Total Electrical Loads of AtoN.
- 4 IALA Guideline G1067-2 - Power Sources.
- 5 IALA Guideline G1067-3 - Electrical Energy Storage for AtoN.
- 6 Technical documentation from equipment manufacturers.