



# IALA MODEL COURSE

L2.2.3

MARINE AIDS TO NAVIGATION – TECHNICIAN  
TRAINING

LEVEL 2 - PHOTOVOLTAIC (SOLAR PANEL)  
SYSTEMS AND MAINTENANCE

**Edition 3**

**December 2018**



# DOCUMENT HISTORY

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Revisions to this IALA document are to be noted in the table prior to the issue of a revised document.

Date	Details	Approval
2010	1 <sup>st</sup> issue	
December 2014	Whole document New Edition in revised standard format	Council 59
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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 photovoltaic systems and their 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 photovoltaic systems and their 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 use, servicing and maintenance of photovoltaic 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 photovoltaic 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 photovoltaic systems 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 photovoltaic systems and their 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
Introduction to solar panel technology	1	This module describes the technology behind photovoltaic systems; the terminology used and the types of solar panels used at AtoN stations
Safety	1	This module describes how to store and handle solar panels and how to work with solar panels safely at height
Installation	2	This module describes how to wire and install solar panels on fixed and floating AtoN
Inspection, testing and maintenance	3	This module describes how to understand manufacturers' specifications and how to test, inspect, and troubleshoot problems with solar panels
Inventory management and disposal	0.5	This module describes how to manage an inventory of solar panels and how to recycle or dispose of solar panels in a proper and safe manner
Evaluation	1	Practical test
<b>Total Hours:</b>	<b>8.5</b>	Total number of days 1.5



## 5. SPECIFIC COURSE RELATED TEACHING AIDS

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- 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 solar panels and associated equipment. This would include such things as solar panels, wiring, charging equipment and testing equipment. The practical section of working with solar panels requires working in the sun and proper sun protection should be observed. As a minimum this should include:
  - Sun screen;
  - Broad brimmed hat;
  - Steel-toed shoes.

## 6. REFERENCES

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

- 1 IALA Guideline G1067-0 - Selection of Power Systems for AtoN and Associated Equipment.
- 2 IALA Guideline G1039 - Designing Solar Power Systems for AtoN.
- 3 IALA Guideline G1067-2 - Power Sources.
- 4 Other applicable guidelines and standards would be available from the Institute of Electrical and Electronics Engineers ([www.ieee.org](http://www.ieee.org)), and the International Electrotechnical Commission ([www.iec.ch](http://www.iec.ch)).
- 5 Technical documentation from solar panel manufacturers would be another useful source of information.



## PART 2 – TEACHING MODULES

### 7. MODULE 1 – INTRODUCTION TO SOLAR PANEL TECHNOLOGY

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#### 7.1. SCOPE

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This module describes the technology behind photovoltaic systems; the terminology used and the types of solar panels used at AtoN stations.

#### 7.2. LEARNING OBJECTIVE

To gain a **basic** understanding of how solar panels work and a **satisfactory** understanding of the types of solar panels most commonly used at AtoN stations.

#### 7.3. SYLLABUS

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##### 7.3.1. LESSON 1 – SOLAR PANEL TECHNOLOGY

- 1 Physical construction.
- 2 Principles of operation.
- 3 Terminology:
  - a. Service life;
  - b. Sizing.

##### 7.3.2. LESSON 2 – TYPES OF SOLAR PANELS

- 1 Monocrystalline cells.
- 2 Polycrystalline cells.
- 3 Amorphous cells.
- 4 Advantages and disadvantages of each type.
- 5 Typical applications for each type.

### 8. MODULE 2 – SAFETY

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#### 8.1. SCOPE

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This module describes how to store and handle solar panels and how to work with solar panels safely at height.

#### 8.2. LEARNING OBJECTIVE

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To gain a **good** understanding of how to work with solar panels safely, including working at height.

#### 8.3. 2.2.3 SYLLABUS

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##### 8.3.1. LESSON 1 POTENTIAL HAZARDS

- 1 Short-circuiting:
  - a. Methods of prevention;
  - b. First aid measures.
- 2 Open Circuit:
  - a. High voltage potential.
- 3 Personal protection:





- a. Sun protection;
  - b. Body protection;
  - c. High surface temperatures;
  - d. Broken glass or plastic;
  - e. Foot protection.
- 4 Safe handling and storage:
- a. Material safety data sheets;
  - b. Guidelines for transportation and storage;
  - c. Proper lifting methods.

## 9. MODULE 3 – INSTALLATION

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### 9.1. SCOPE

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This module describes how to wire and install solar panels on fixed and floating AtoN.

### 9.2. LEARNING OBJECTIVE

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To gain a **satisfactory** understanding of how to install solar panels safely at AtoN stations.

### 9.3. SYLLABUS

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#### 9.3.1. LESSON 1 INSPECTION PRIOR TO INSTALLATION

- 1 Physical condition.
- 2 Date of manufacture.

#### 9.3.2. LESSON 2 WIRING

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

#### 9.3.3. LESSON 3 INSTALLATION

- 1 Physical requirements:
  - a. Solar panel orientation;
  - b. Avoidance of shading;
  - c. Installation of bird deterrents;
  - d. Tamper-proofing;
  - e. Protection of the solar panels against site environmental conditions;
  - f. Working at heights.
- 2 Installing solar panels:
  - a. Solar panel frames, earthing and panel ventilation.
  - b. Dissimilar materials and insulation;
  - c. Solar panel terminal boxes.



## 10. MODULE 4 – INSPECTION, TESTING AND MAINTENANCE

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### 10.1. SCOPE

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This module describes how to understand manufacturers' specifications and how to test, inspect, and troubleshoot problems with solar panels.

### 10.2. LEARNING OBJECTIVE

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To gain a **satisfactory** understanding of how to inspect, test, and troubleshoot problems with solar panels in a proper and safe manner.

### 10.3. SYLLABUS

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#### 10.3.1. LESSON 1 MEASUREMENT AND TEST EQUIPMENT

- 1 Use of a calibrated multi-meter.

#### 10.3.2. LESSON 2 TESTS, INSPECTIONS AND MAINTENANCE

- 1 Voltage testing.
- 2 Short circuit testing.
- 3 Open circuit testing.
- 4 Changing orientation of the panels.
- 5 Cleaning with correct products.
- 6 Insulation resistance.
- 7 Visual inspection:
  - a. Corrosion at connections;
  - b. Condition of cables;
  - c. Integrity of solar panel support structures and enclosures;
  - d. Condition of safety installations.
- 8 Troubleshooting problems found during tests and inspections.

## 11. MODULE 5 – INVENTORY MANAGEMENT AND DISPOSAL

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### 11.1. SCOPE

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This module describes how to manage an inventory of solar panels and how to recycle or dispose of solar panels in a safe and environmentally correct manner.

### 11.2. LEARNING OBJECTIVE

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To gain a **satisfactory** understanding of how to manage an inventory of solar panels and a **good** understanding of the policies and regulations in his or her organization which govern the proper management and disposal of solar panels.



## 11.3. SYLLABUS

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### 11.3.1. LESSON 1 INVENTORY MANAGEMENT

- 1 Legal requirements and regulations governing solar panel management.
- 2 Procedures for life-cycle inventory tracking.
- 3 Solar panel labelling.
- 4 Inspection records.

### 11.3.2. LESSON 2 DISPOSAL

- 1 Legal requirements and regulations governing solar panel disposal.
- 2 Methods of disposal:
  - a. Recycling options;
  - b. Proper disposal methods.
- 2 Disposal records.