



IALA MODEL COURSE

L2.3.1-3

AIDS TO NAVIGATION - TECHNICIAN TRAINING

LEVEL 2 MODULE 3 ELEMENTS 3.1 – 3.3

LIGHTS AND MARINE LANTERNS

Edition 2.0

December 2016



DOCUMENT REVISION

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

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May 2013		Edition 1.
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FOREWORD

The International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) recognises that training in all aspects of 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 the international recommendations and guidelines when establishing aids to navigation, including recommendations on training and qualification of AtoN technicians, IALA has adopted Recommendation E-141 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 E-141 Level 2 technician functions. This model course on lights and marine lanterns 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 lights and marine lanterns. 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 of marine signal lanterns, their colour and factors affecting their range.

This course should only be conducted after participants have completed successfully Level 2 Module 1 Element 1.3 which includes an introduction to marine lanterns, light characters and ranges. This course is intended to be supported by further practical training modules on lamp changers; self-contained lanterns; classical lenses; rotating beacons; mercury rotating optics and range, sector and leading lights. 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 understand the use of marine lanterns within their organizations and factors affecting their operational efficiency.

3. COURSE OUTLINE

This principally theoretical course is intended to cover the knowledge required for a technician to understand the components of marine signal lanterns and their use both ashore and afloat. The complete course comprises 5 classroom modules, each of which deals with a specific subject concerning marine signal lanterns. Teaching Module 5 is optional for those organisations who wish their technicians to have a more detailed understanding of the physics of light. Each module begins by stating its scope and aims, and then provides a teaching syllabus.

4. TEACHING MODULES

Table 1 Table of Teaching Modules

Module Title	Time in hours	Overview
Introduction to light and range	3.0	This module describes the behaviour of light in the atmosphere and factors affecting its range
Light sources	2.0	This module describes the development of light sources and their associated reflectors and lenses
Signal colours	3.0	This module describes the colours used in visual Aids to Navigation
Lenses, prisms and mirror	2	This module describes the use of lenses, prisms and mirrors to focus a beam of light
The physics of reflection and refraction of light (Optional)	(4)	This optional practical module describes the physics of the theory of light in greater detail
Evaluation	1	Written test
Total Hours	11 or 15	Two (or three) day course

5. SPECIFIC COURSE RELATED TEACHING AIDS

- 1 This course is classroom based. Classrooms should be equipped with blackboards, whiteboards, and overhead projectors to enable presentation of the subject matter.
- 2 A light range test facility or facilities to black-out the classroom.
- 3 An appropriate light source, together with prisms and mirrors.
- 4 Complete lenses or sections of lens similar to those used in the AtoN service.
- 5 Light meter.
- 6 Laser pointer and smoke generator to demonstrate a light beam path.
- 7 Selection of light sources in use by the organisation.

6. ACRONYMS

To assist in the use of this model course, the following acronyms have been used:

AtoN	Aid(s) to Navigation
CIE	Commission Internationale de l'Eclairage (International Commission on Illumination)
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
L	Level (technician training - WWA)
LED	Light Emitting Diode
SOLAS	International Convention for the Safety of Life at Sea, 1974 (as amended)
T	(Atmospheric) Transmissivity
WWA	World-Wide Academy

7. DEFINITIONS

The definition of terms used in this Model Course can be found in the International Dictionary of Marine Aids to Navigation (IALA Dictionary) at <http://www.iala-aism.org/wiki/dictionary>.

8. REFERENCES

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

- 1 IALA NAVGUIDE.
- 2 IALA Recommendation E-108 for the surface colours used as visual signals on Aids to Navigation.
- 3 IALA Recommendation E-200-2 on Marine Signal Lights – Calculation, Definition and Determination of Luminous Range.
- 4 IALA Recommendation E-200-3 on Marine Signal Lights – Measurement.
- 5 IALA Guideline 1043 on Light Sources used in Visual Aids to Navigation.
- 6 IALA Guideline 1048 on LED Technologies and their use in Signal Lights.
- 7 Manufacturers' handbooks on marine signal lanterns used by the organisation.

PART 2 – TEACHING MODULES

1. MODULE 1 – INTRODUCTION TO LIGHT AND RANGE

1.1. SCOPE

This module describes the behaviour of light in the atmosphere and factors affecting its range.

1.2. LEARNING OBJECTIVE

To gain a **basic** understanding of how light behaves in the atmosphere and the factors affecting the range at which a light source can be seen by an observer.

1.3. SYLLABUS

1.3.1. LESSON 1 – THE NATURE OF LIGHT IN THE ATMOSPHERE

- 1 The visible electromagnetic spectrum.
- 2 Wavelength.
- 3 Power and the Inverse Square Law.
- 4 Absorption and Attenuation.
- 5 Atmospheric transmissivity (T).
- 6 Atmospheric refraction.

1.3.2. LESSON 2 – THE RANGE OF A LIGHT

- 1 Geographical range.
- 2 Optical range.
- 3 Visual range.
- 4 Luminous range.
- 5 Nominal range.

1.3.3. LESSON 3 – UNITS OF MEASUREMENT

- 1 Luminous flux – lumens.
- 2 Luminous intensity – candela.
- 3 Luminance (brilliance) – candelas/ square metre.
- 4 Illuminance – lux.
- 5 Threshold of illuminance.

2. MODULE 2 – LIGHT SOURCES

2.1. SCOPE

This module describes the development of light sources and their associated reflectors and lenses.

2.2. LEARNING OBJECTIVE

To gain a **satisfactory** understanding of the types of light sources used in visual Aids to Navigation.

2.3. SYLLABUS

2.3.1. LESSON 1 – THE DEVELOPMENT OF LIGHT SOURCES

- 1 Historical background from fires to oil lamps.
- 2 Gas lights.
- 3 Electric lights.

2.3.2. LESSON 2 - MODERN LIGHT SOURCES

- 1 Incandescent lamps.
- 2 Tungsten halogen lamps.
- 3 Discharge lamps (Fluorescent and Xenon).
- 4 Sodium vapour lamps.
- 5 Metal halide lamps.
- 6 Light Emitting Diode lamps.

3. MODULE 3 – SIGNAL COLOURS

3.1. SCOPE

This module describes the colours used in visual Aids to Navigation.

3.2. LEARNING OBJECTIVE

To gain a **basic** understanding of the design and use of lenses and prisms used in modern marine signal lanterns.

3.3. SYLLABUS

3.3.1. LESSON 1 – IALA RECOMMENDED COLOURS

- 1 International Commission on Illumination (CIE) Standards.
- 2 Sensitivity of the human eye to colours.
- 3 Recommended colours used by IALA.

3.3.2. LESSON 2 - COLORIMETRIC MEASUREMENT OF LIGHT

- 1 Measurement of the colour of light.
- 2 Colorimeters and Spectroradiometers.
- 3 Stepping monochromators and Imaging photometers.

3.3.3. LESSON 3 – USE OF INTENSITY / RANGE TABLES

- 1 Intensity table for white light at night.
- 2 Intensity table for coloured light at night.
- 3 Intensity table for day-time use.
- 4 Intensity loss through protective glass.
- 5 Flash duration impact on range.

4. MODULE 4 – LENSES, PRISMS & MIRRORS

4.1. SCOPE

This module describes the use of lenses and prisms to focus a beam of light.

4.2. LEARNING OBJECTIVE

To gain a **basic** understanding of the design and use of lenses and prisms used in modern marine signal lanterns.

4.3. SYLLABUS

4.3.1. LESSON 1 – BENDING LIGHT RAYS

- 1 The concept of a ray of light.
- 2 Reflection and refraction.
- 3 Flat and concave mirrors.
- 4 Prisms.
- 5 Focussing light rays.
- 6 The position of a light source.
- 7 Divergence.

4.3.2. LESSON 2 - DEVELOPMENT OF LENSES

- 1 The function of a lens.
- 2 Historical development of lenses.
- 3 Fresnel lenses.
- 4 Modern glass and acrylic lenses used in marine lanterns.

5. MODULE 5 – THE PHYSICS OF REFLECTION AND REFRACTION OF LIGHT (OPTIONAL)

5.1. SCOPE

This optional **practical** module describes the physics of the theory of light in greater detail.

5.2. LEARNING OBJECTIVE

To gain a **satisfactory** understanding of how modern lenses achieve a focussed beam of light using a light source, mirrors, prisms and lenses.

5.3. SYLLABUS

5.3.1. LESSON 1 – PHYSICS OF LIGHT

- 1 Track light rays using flat mirrors.
- 2 Track light rays using prisms.
- 3 Focus light rays using a combination of lenses and reflector elements.

5.3.2. LESSON 2 - PRACTICAL MARINE LANTERN TASK

- 1 Selection of light source.
- 2 Achievement of a focussed beam using mirrors or prisms.
- 3 Measurement of brilliance and illuminance.

4 Effect of colour filters and protective glass.

5.3.3. LESSON 3 – COLORIMETRIC MEASUREMENT OF LIGHT

1 Practical use of colorimeters used by the organisation.

2 Test records.