



**IALA MODEL COURSE**

L1.4

AIDS TO NAVIGATION MANAGEMENT TRAINING

LEVEL 1 - GLOBAL NAVIGATION SATELLITE SYSTEMS AND e-NAVIGATION

**Edition 3.0**

**XXXXXX XXXX**



# 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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| --- | --- | --- |
| **Date** | **Page / Section Revised** | **Requirement for Revision** |
| December 2015 | Page 5/ Part B | Inclusion of new Module 3 on GNSS and amendment to lesson plans |
| December 2025 |  |  |
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**FOREWORD**

The International Organisation for Marine Aids to Navigation (IALA) recognises that training in all aspects of the management of Aids to Navigation (AtoN) service delivery 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 (IMO), undertake to consider the international recommendations and guidelines when establishing aids to navigation, including recommendations on training and qualification of AtoN managers, IALA has adopted Recommendation E-141 Edition 2 on Standards for Training and Certification of AtoN personnel.

IALA Committees, working closely with the IALA World Wide Academy (The Academy), have developed a series of model courses for AtoN personnel having R0141Level 1 management functions. This model course on Global Navigation Satellite Systems and e-navigation should be read in conjunction with IALA Recommendation R0141 – Model Course on Level 1 Manager Training, which contains standard guidance for the conduct of all Level 1 model courses.

This model course is intended to be delivered by The Academy in conjunction with a national member and other appropriate authorities charged with the provision of AtoN services in a particular region. It contains specific guidance on the training of AtoN managers on Global Navigation Satellite Systems and the principles of the e- navigation concept. Assistance in implementing this and other model courses may be obtained from the IALA World Wide Academy at the following address:

|  |  |  |
| --- | --- | --- |
| The Secretary-General |  | |
| IALA | Tel: | (+) 33 1 34 51 70 01 |
| 10 rue des Gaudines | Fax: | (+) 33 1 34 51 82 05 |
| 78100 Saint Germain-en-Laye | e-mail: | [contact@iala.int](mailto:contact@iala.int) |
| France | Internet: | [www.iala.int](http://www.iala.int) |

## PART A COURSE OVERVIEW

### SCOPE

This course is intended to provide aids to navigation managers and other interested parties with the training necessary to have a satisfactory understanding of Global Navigation Satellite Systems (GNSS) and the e-navigation concept.

### OBJECTIVE

Upon successful completion of this course, participants will have acquired sufficient knowledge to explain the development of GNSS and its impact on the e-navigation concept to members of their organisations and associated stakeholders.

### COURSE OUTLINE

This course is intended to cover the knowledge required for an aids to navigation manager to gain an understanding of GNSS and e-navigation and disseminate that knowledge more widely. The course comprises 6 teaching modules.

***Table 1 Teaching Modules***

|  |  |  |
| --- | --- | --- |
| **Module Title** | **Time in hours** | **Overview** |
| The background to e- navigation | 1.5 | This module describes the inception, adoption and development of the e-navigation concept |
| Electronic Navigation Charts and ECDIS | 1.5 | This module describes the importance of valid electronic chart data required to support e-navigation |
| Global Navigation Satellite Systems | 1 | This module describes the principles of GNSS and their potential vulnerability |
| Position Navigation and Timing | 1.5 | This module describes why an uninterrupted  determination of position, navigation and coordinated time is essential to e-navigation |
| Communications and AIS | 2 | This module describes the communications systems necessary to support e-navigation |
| Information Systems | 1 | This module describes existing and developing information systems and test beds which are designed to improve the flow of information ship to shore; ship  to ship and shore to ship |
| Competency test | 0.5 |  |
| **Total Hours:** | **9** | Two day course |

### SPECIFIC COURSE RELATED TEACHING AIDS AND NOTES

* 1. This course will be classroom based with presentations delivered using MS PowerPoint®. Although the course is limited to 24 participants, the classroom should be big enough to permit the participants to sit at desks large enough to operate a laptop computer with room for printed material to hand. Each desk should be provided with a power socket.
  2. The classroom should be equipped with overhead projectors and screens to enable presentation of the subject matter.
  3. To enable all participants to receive clear guidance from instructors and to raise questions that can be heard throughout the classroom, lapel or fixed lectern microphones should be provided together with a roving microphone for use by participants.
  4. Participants should have Wi-Fi internet access.

### PRE-COURSE READING

Participants should be encouraged to study IALA Recommendation e-NAV140 on e-Navigation Architecture - the initial shore-based perspective.

### CERTIFICATION

Participants who attend this model course can be presented with an AtoN Level 1 Manager certificate which states that they have completed successfully sub-elements 2a.3.9; 2b.2; 4b.4-5 and 4d.3 of Complementary Modules 2 and 4 which form part of the syllabus for Level 1 AtoN Managers set out in IALA Recommendation E- 141/1 on Standards for training and Certification of AtoN Personnel. An example is at Annex A. It should be noted that such a certificate should **not** be considered a Certificate of Competence, as no formal test of competency will be conducted.

### ACRONYMS

AIS Automatic Identification System

ASM Application Specific Message

AtoN Aid(s) to Navigation

DGNSS Differential Global Navigation Satellite System

ECDIS Electronic Chart Display and Information System ENC Electronic Navigation Chart

FSA Formal Safety Assessment(s)

GBAS Ground-Based Augmentation System

G Guideline (IALA)

GLA General Lighthouse Authority(ies)

GNSS Global Navigation Satellite System

HEAP Human Element Analysing Process

IALA International Association of Marine Aids to Navigation and Lighthouse Authorities

IHO International Hydrographic Organization

IMO International Maritime Organization

PNT Position, Navigation and Timing

Q&A Question and Answer

RAIM Receiver Autonomous Integrity Monitoring

RCO Risk Control Option(s)

Rec Recommendation(s) (IALA)

SBAS Satellite-Based Augmentation System

SOLAS International Convention for the Safety of Life at Sea (SOLAS), 1974 (as amended)

S-100 Geospatial Information Registry (IHO)

VDES VHF Data Exchange System

VHF Very High Frequency (30 MHz to 300 MHz)

WWRNP World-Wide Radionavigation Plan

WWRNWS World-Wide Radionavigation Warning Service

### DEFINITIONS

The definition of terms used in this Guideline can be found in the International Dictionary of Marine Aids to Navigation (IALA Dictionary) at <https://www.iala.int/wiki/dictionary/index.php/Main_Page>

### REFERENCES

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

* The IALA NAVGUIDE
* IALA Information Paper on e-Navigation Architecture
* IALA Maritime Radio Communications Plan
* IALA World-Wide Radionavigation Plan
* IALA Recommendation e-NAV140 on e-Navigation Architecture - the initial shore-based perspective
* IALA Recommendation e-NAV 144 on Harmonized implementation of Application Specific Messages
* IALA Recommendation R-115 on the Provision of Radio Navigation Services (DGNSS)
* IALA Recommendation R-121 on the Performance and Monitoring of a DGNSS
* IALA Recommendation R-129 on GNSS Vulnerability and Mitigation Measures
* IALA Recommendation R-135 on the Future of DGNSS
* IALA Guideline 1072 on AtoN Information Exchange & Presentation
* IALA Guideline 1085 on the Standard Format for Electronic Exchange of AtoN Product Information
* IALA Guideline1086 on the Global Sharing of Maritime Data
* IALA Guideline 1087 on Procedures for the Management of the IALA Domains under the IHO GI Registry
* IALA Guideline 1088 on an Introduction to Preparing S-100 Product Specifications

IALA Guideline 1096 on Anticipated User e-Navigation Requirements from Berth to Berth, for AtoN Authorities

## PART 2 - TEACHING MODULES

## MODULE 1 THE BACKGROUND TO e-NAVIGATION

### SCOPE

This module describes the inception, adoption and development of the e-navigation concept.

### LEARNING OBJECTIVES

To gain a satisfactory (Level 2) understanding of the definition and principles of the e-navigation concept and its development.

### DETAILED TEACHING SYLLABUS FOR MODULE 1 - THE BACKGROUND TO e-NAVIGATION

#### Table 2 Detailed Teaching Syllabus - Module 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Module** | **Element** | **Sub-element** | **Subject** | **Level of Competence** | **Recommended training aids and exercises** | **References**  **Rec = Recommendation**  **G = Guideline** | **Lecture No.** |
| **1** |  |  | **BACKGROUND TO e-NAVIGATION** |  | | | |
|  | **1.1** | **The Definition of e-Navigation** |
|  |  | 1.1.1 | The need for e-navigation | 2 |  |  | 1 |
|  |  | 1.1.2 | IMO definition and scope of e-navigation |  | NAVGUIDE Chapter 4 |
|  |  | 1.1.3 | Key components of e-navigation ashore and afloat |  | **R0140** |
|  |  | 1.1.4 | Introduction to the concept of a Common Maritime Data  Structure |  |  |
|  |  | 1.1.5 | Introduction to proposed e-navigation architecture |  |  |
|  | **1.2** |  | **The Development of e-Navigation** |  | | | |
|  |  | 1.2.1 | Role of IMO in the development of e-navigation | 2 |  |  | 2 |
|  |  |  | Role of IALA and the e-Navigation Committee |  |  |  |
|  |  |  | Strategy Implementation Plan and its status |  |  |  |
|  |  |  | Update on phased implementation programme |  |  |  |
|  |  |  | The user-driven approach to the design of e-navigation elements | 1 |  | G1096 |  |
|  |  |  | Human Element Analysing Process (HEAP) |  |  |  |
|  |  |  | Risk Control Options (RCO) and Formal Safety Assessments (FSA) |  |  |  |

## MODULE 2 ELECTRONIC NAVIGATIONAL CHARTS AND ECDIS

### SCOPE

This module describes the importance of valid electronic chart data required to support e-navigation.

### LEARNING OBJECTIVES

To gain a basic understanding of Electronic Navigational Charts and their use in Electronic Chart Display and Information Systems.

### DETAILED SYLLABUS FOR TEACHING MODULE 2 – ELECTRONIC NAVIGATIONAL CHARTS AND ECDIS

#### Table 3 Detailed Teaching Syllabus - Module 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Module** | **Element** | **Sub-element** | **Subject** | **Level of Competence** | **Recommended training aids and exercises** | **References**  **Rec = Recommendation**  **G = Guideline** | **Lecture No.** |
| **2** |  |  | **ELECTRONIC NAVIGATIONAL CHARTS AND ECDIS** |  | | | |
|  | **2.1** | **Electronic Navigational Charts** |
|  |  | 2.1.1 | The definition and properties of ENCs | 1 |  | G1085 | 3 |
|  |  | 2.1.2. | Status of accurate hydrographic data world wide |  | G1086 |
|  |  | 2.1.3 | Availability of ENCs and the role of RENCs |  | G1087 |
|  |  | 2.1.4 | Problems with datum alignment |  | G1088 |
|  | **2.2** |  | **ECDIS** |  | | | |
|  |  | 2.2.1 | General specifications of an ECDIS | 2 |  |  | 4 |
|  |  | 2.2.2 | IMO carriage requirements |  |  |
|  |  | 2.2.3 | Harmonisation of navigation systems on board a vessel |  |  |

## MODULE 3 GLOBAL NAVIGATION SATELLITE SYSTEMS

### SCOPE

This module describes the principles of GNSS and their potential vulnerability.

### LEARNING OBJECTIVES

To gain a **satisfactory** understanding of global navigation satellite based systems, their vulnerabilities and plans to mitigate against such vulnerabilities.

### DETAILED TEACHING SYLLABUS FOR MODULE 3 – GLOBAL NAVIGATION SATELLITE SYSTEMS

#### Table 4 Detailed Teaching Syllabus - Module 3

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Module** | **Element** | **Sub-element** | **Subject** | **Level of Competence** | **Recommended training aids and exercises** | **References**  **Rec = Recommendation**  **G = Guideline** | **Lecture No.** |
| **3** |  |  | **Global Navigation Satellite Systems** |  | | | |
|  | **3.1** | **Review of Determining Continuous Position at Sea** |
|  |  | 3.1.1 | Global Navigation Satellite Systems & their current status | 2 |  | NAVGUIDE  IALA WWRNP Rec R0135 | 5 |
|  |  | 3.1.2 | Systems that meet IMO accuracy standards |  | IMO Resolution A.1046(27) |
|  |  | 3.1.3 | Ground Based Augmentation Systems (GBAS) |  | R0115; R0121 |
|  |  | 3.1.4 | Satellite Based Augmentation Systems (SBAS) |  |  |
|  | **3.2** |  | **GNSS Vulnerability** |  | | | |
|  |  | 3.2.1 | Natural sources of vulnerability | 2 |  | R0129 / G1180 | 6 |
|  |  | 3.2.2 | Human sources of vulnerability |  |  |
|  |  | 3.2.3 | Mitigation measures |  |  |

## MODULE 4 POSITION, NAVIGATION AND TIMING

### SCOPE

This module describes why an uninterrupted determination of position, navigation and co-ordinated time is essential to e-navigation.

### LEARNING OBJECTIVES

To gain a **satisfactory** understanding of how continuous timing and position at sea can be obtained.

### DETAILED TEACHING SYLLABUS FOR MODULE 4 – POSITION, NAVIGATION AND TIMING

#### Table 5 Detailed Teaching Syllabus - Module 4

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Module** | **Element** | **Sub-element** | **Subject** | **Level of Competence** | **Recommended training aids and exercises** | **References**  **Rec = Recommendation**  **G = Guideline** | **Lecture No.** |
| **4** |  |  | **Position, Navigation and Timing** |  | | | |
|  | **4.1** | **Considerations for Resilient PNT** |
|  |  | 4.1.1 | Systems dependent on PNT | 2 |  | GLA Jamming video - effects | 7 |
|  |  | 4.1.2 | Augmentation systems and Integrity aspects (SBAS; GBAS and  RAIM) |  |  |
|  |  | 4.1.3 | Review of all terrestrial based systems |  |  |
|  |  | 4.1.4 | Considerations for bringing together different data sources to  achieve resilient PNT |  | GLA Jamming video – potential solutions |
|  | **4.2** |  | **Resilient PNT Discussion** |  | | | |
|  |  | 4.2.1 | Tutor lead discussion and Q&A session on topic | 2 | GNSS and PNT  Q& A session | G1053, IMO Resolution  A.1046 IALA WWRNP | 8 |

## MODULE 5 COMMUNICATIONS AND AIS

### SCOPE

This module describes the communications systems necessary to support e-navigation.

### LEARNING OBJECTIVES

To gain a **satisfactory** understanding of the function of communications systems, including the Automatic Identification System on which e-navigation is dependent.

### DETAILED TEACHING SYLLABUS FOR MODULE 4 – POSITION, NAVIGATION AND TIMING

#### Table 6 Detailed Teaching Syllabus - Module 5

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Module** | **Element** | **Sub-element** | **Subject** | **Level of Competence** | **Recommended training aids and exercises** | **References**  **Rec = Recommendation**  **G = Guideline** | **Lecture No.** |
| 5 |  |  | COMMUNICATIONS AND AIS |  | | | |
|  | 5.1 | IALA Maritime Radio Communications Plan |
|  |  | 5.1.1 | Review of communications required to support e-navigation | 2 |  |  | 9 |
|  |  | 5.1.2. | Bandwidth availability |  |  |
|  |  | 5.1.3 | Advantages and disadvantages of communication via satellite |  |  |
|  |  | 5.1.4 | Modernisation of the use of VHF channels |  |  |
|  |  | 5.1.5 | Examples: VDES; ASM channels |  |  |
|  |  | 5.1.6 | Overview of GMDSS |  |  |
|  | 5.2 |  | Automatic Identification System |  | | | |
|  |  | 5.2.1 | Review of AIS | 2 |  | R0123; R0126 | 10 |
|  |  | 5.2.2 | Limitations of AIS |  | R0124 and its suffixes |
|  |  | 5.2.3 | The role of AIS in e-navigation |  | G1028; 1029 |
|  |  | 5.2.4 | Base stations and chaining |  | G1050; 1059; 1062 |
|  |  | 5.2.5 | AIS messages specific to e-navigation |  | G1082;1084; 1095; 1096 |
|  |  | 5.2.6 | Satellite AIS |  |  |

## MODULE 6 INFORMATION SYSTEMS

### SCOPE

This module describes existing and developing information systems which are designed to improve the flow of information ship to shore; ship to ship and shore to ship.

### LEARNING OBJECTIVES

To gain a **satisfactory** understanding of how both existing information systems and those under development will improve the flow of maritime and safety information between stakeholders and a **basic** understanding of geospatial information registries and test beds.

### DETAILED TEACHING SYLLABUS FOR MODULE 6 – INFORMATION SYSTEMS

#### Table 6 Detailed Teaching Syllabus - Module 6

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Module** | **Element** | **Sub-element** | **Subject** | **Level of Competence** | **Recommended training aids and exercises** | **References**  **Rec = Recommendation**  **G = Guideline** | **Lecture No.** |
| **6** |  |  | **INFORMATION SYSTEMS** |  | | | |
|  | **6.1** | **Information Architecture** |
|  |  | 6.1.1 | Existing information systems ship to ship; ship to shore; shore to ship  and shore to shore | 2 |  |  | 11 |
|  |  | 6.1.2. | Limitations of existing information systems |  |  |
|  |  | 6.1.3 | Information systems under development |  |  |
|  |  | 6.1.4 | Maritime Service Portfolios |  |  |
|  |  | 6.1.5 | The role of Vessel Traffic Services in e-navigation |  |  |
|  |  | 6.1.6 | Considerations for the management of information |  | G1086 |
|  | **6.2** |  | **Data Modelling** |  | | | |
|  |  | 6.2.1 | Concept of a universal Marine Information Registry | 1 |  |  | 12 |
|  |  | 6.2.2 | S-100 Framework and the IHO Geospatial Information Registry |  |  |
|  |  | 6.2.3 | Development of product specifications |  |  |
|  |  | 6.2.4 | AtoN information |  |  |
|  | **6.3** |  | **Test Beds** |  |  |  |  |
|  |  | 6.3.1 | Concept of test beds |  |  |  | 13 |
|  |  | 6.3.2 | Review of existing and planned test bed data |  |  |  |
|  |  | 6.3.3 | Guideline on the reporting of test bed results |  |  |  |  |