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| IALA Guideline |

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GUIDANCE ON MARINE AIDS TO NAVIGATION (AtoN) TRAINING AND AWARENESS FOR MARINERS

Edition x.x

Date (of approval by Council)

urn:mrn:iala:pub:gnnnn

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

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# INTRODUCTION

## Background

The responsibility for safe navigation resides with the mariner, through the appropriate use of Marine Aids to Navigation (AtoN), in conjunction with official nautical documents and prudent seamanship, including voyage planning as defined in International Maritime Organization (IMO) Resolutions.

AtoN contribute towards the improvement of safety and efficiency of navigation, the safety of life at sea and the protection of the marine environment from possible adverse effects of maritime traffic.

According to the International Convention for the Safety of Life at Sea (SOLAS) V/13, Paragraph 2, “In order to obtain the greatest possible uniformity in AtoN, Contracting Governments undertake to take into account the international recommendations and guidelines when establishing such aids.” Reference is made to IALA Recommendations and Guidelines.

Mariners involved with the safe navigation of all types of vessels should have the ability to determine the vessel’s position by use of AtoN, including lighthouses, beacons, and buoys as they are required to regularly utilise AtoN to enhance the safety and efficiency of their voyages. It is however recognised that not all mariners have the same knowledge level of AtoN due to various reasons.

A higher level of knowledge of AtoN will enable better utilisation and understanding, resulting in enhanced situational awareness.

Although the 2010 Manila amendments to the annex to the International Convention on Standards for Training, Certification and Watchkeeping for Seafarers, 1978 (STCW), amongst others, states that deck officers should have the ability to determine the ship’s position by use of AtoN, STCW model courses currently do not include any AtoN training modules.

# AIMS AND OBJECTIVES

## INITIAL

Flag States, National Competent Authorities, shipping owners and organisation*s* responsible for mariners’ in-service development and awareness, and stakeholders such as training institutions are encouraged to implement this Guideline as the basis for mandatory training in a manner consistent with their domestic legal framework, and taking the applicable level of qualification (e.g. deck officers vs small vessel skippers) into consideration.

This Guideline presents guidance and information on AtoN training to be used by maritime training organisations as an integral part of the training and awareness of mariners, to enhance their understanding and to facilitate effective use of AtoN and to be kept updated for on-board / in-service training regarding AtoN developments.

This Guideline also provides examples of activities that could be used to facilitate effective communication and the exchange of information for the benefit of the mariner.

With IALA developing and making the required AtoN training material available for mariners would ensure world-wide consistency in the training of mariners on AtoN.

## LONG TERM

This Guideline is to lay the foundation for AtoN training and development of mariners:

1. To be included and promulgated via STCW and other international legislation, to ensure a formulised, standardised, and global standard to all mariners undergoing training to qualify and operate as necessary and awareness to be kept updated on AtoN developments throughout their careers.

This includes the need for AtoN to be included in cadets / apprentices’ Training Record Books.

1. For the IALA WWA to ensure uniformity of AtoN training material on all platforms
2. The possibility of new, or complex AtoN to be included in paper charts’ notes.
3. With the demise of the paper chart in its current format being considered by both the International Hydrographic Organization (IHO) and IMO, consideration should be given to include more information on AtoN on Electronic Navigational Charts (ENC) charts when an icon on an Electronic Chart Display and Information System (ECDIS) is interrogated, such as new, or complex AtoN.

# OVERVIEW OF MARINE AIDS TO NAVIGATION

## Terms (to be finalised at the end)

**Approved AtoN Training Course** - is a course of study in AtoN that has successfully completed the quality assurance process under which a training course is assessed to ensure that IALA Standards are met.

**Accredited AtoN Training Organisation** - is an organisation that the Competent Authority, or an authority designated and approved by the Competent Authority, grants recognition to a training organisation for demonstrated ability to meet predetermined criteria for established standards.

**Competent authority (AtoN)** - is an authority made responsible, in whole or in part, by the Government for the safety (including environmental safety) and efficiency of aids to navigation service provision and the protection of the environment.

**Marine Aid to Navigation (AtoN)** means a device, system, or service, external to a vessel, designed and operated to enhance safe and efficient navigation of individual vessels and vessel traffic. For the purpose of IALA, this definition includes Vessel Traffic Services (VTS), noting that guidance on VTS awareness is not addressed in this Guideline – for VTS refer to Guideline G1149 on VTS Training for Deck Officers.

**Mariner** in this document means it is a person who navigates, or assists in navigating a ship or a boat, a sailor, a seaman, or a person working on a ship or a boat or ship.

**Scintillations** are rapid fluctuations in the phase and amplitude of trans-ionospheric radio signals caused by small-scale ionospheric plasma density irregularities. In the case of Global Navigation Satellite System (GNSS) receivers, scintillations can cause cycle slips, degrade the positioning accuracy and when severe enough can even lead to complete loss of signal lock.

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## Purpose of MARINE AIDS TO NAVIGATION

The provision and operation of AtoN are recognised internationally as a navigational safety measure through SOLAS Chapter V/13 and is implemented and operated under a national legal framework adhering to international standards and recommendations.

The purpose of AtoN is to contribute to safety of life at sea, the protection of the marine environment, safety and efficiency of navigation and the enhancement of trade.

The provision of AtoN will, amongst others, take into account the volume of traffic, degree of risk, geographic and environmental conditions within an area, economic considerations, and user requirements.

## Benefits of AIDS TO NAVIGATION for the MARINER

The primary objective of AtoN is to mitigate transit risks to ensure the protection of life and property at sea, the protection of the marine environment and to promote the safe, economic, and efﬁcient movement of vessels by assisting mariners with:

1. Determining their position
2. Maintaining a safe course
3. Maintaining a proper lookout
4. Warning of dangers and obstructions
5. Situational awareness

especially when used in conjunction with other aids within visual, audio, or radar range of the mariner on coastal voyages, in restricted waters, traffic separation schemes, port, harbour approaches and inland waterways, thereby improving maritime traffic efficiency and safety of navigation.

# TRAINING ACTIVITIES

AtoN training modules and standardised training material should be included in the mandatory national training programmes for mariners and be reflected in examinations and assessments.

**Note**: Relevant standardised AtoN training should also be included for small vessel skippers’ training as per local requirements.

## Maritime training institutions

* + 1. **Teaching Programme**

Theoretical training on AtoN should, where available, be based on relevant IALA model courses, and to include the following:

1. Introduction to AtoN, and their significance to safety of navigation by assisting all mariners navigating anywhere in the world, to fix their position and avoid dangers without fear of ambiguity
2. Introduction to Fixed, Floating, Mobile (MAtoN), Electronic (AIS AtoN), radar target enhancer and radar beacon (racon))
3. A detailed understanding of the type of buoys in the IALA Maritime Buoyage System (MBS)
4. Principle of a “conventional direction of buoyage”
5. Various types of buoys
6. Principle applications, rules (including and their light characteristics), usage and description of the various buoyage, their visual depiction and numbering, or lettering
7. IALA Regions A & B
8. Satisfied understanding of the difference between charted and the actual position of the buoy
9. Charted position defines the nominal (or true) position for the sinker (anchor)
10. Buoys will almost never float directly over the sinker
11. The actual position will almost always be different that their charted position
12. Synchronisation of lights
13. Retro reflective material used on floating and other marks to enhance their visual detection during night-time
14. Satisfactory understanding of other Marks (definition, description, visual depiction) and their usage, such as:
15. Lighthouses
16. Beacons (minor lights
17. Daymarks
18. Leading/Range Lights
19. Sector Lights
20. Major floating aids
21. Navigational buoys
22. Supplement information:
23. Buoys can be unlit, or lit
24. Buoys may carry a:

* Topmark
* Racon
* AIS
* Sound signal

1. Auxiliary marks
2. Marking new dangers
3. Port, Harbour and other local marks, e.g. breakwaters, quays and jetties; leisure areas, bridges, traffic signals, other river, channel, canal, lock and waterways marked within the responsibilities of competent authorities.
4. Audible, or sound / fog signals
5. Fog signals are mostly located at lighthouses, at the end of breakwaters within Ports and Harbours, and on floating aids
6. Activation of Fog Signals

Where fog signals are still operational, these signals mostly are activated by fog detectors when fog is detected within the detection range of that fog detector.

1. Good understanding of lights in general (should (a)-(e) be included, noting that small vessel skippers’ lowest category of certificate of competence should also be familiar with (d)-(e)?)
2. Definitions
3. Geographic Range
4. Nominal Range

IALA has recommended the adoption of a nominal range in miles (M) defined as the luminous range in a homogeneous atmosphere with a standard meteorological visibility of 10NM. **Note**: Visibility and background lighting have an influence on the range of light detection.

1. Intended usage sector lights
   1. Sector limits (length) should cover the area where they are useful for the mariner, this will require individual lengths of sector limits to be displayed, highlighting the danger the sector limit is warning the mariner about.
2. Light Characters and Rhythms
3. AIS AtoN

A particular type of AIS unit fitted to an AtoN (ashore/fixed, or on a buoy) which transmits one, or several of below messages:

Message 21

1. MMSI
2. Name: (of AtoN)
3. Type of AtoN
4. Position
5. Dimension
6. AtoN Status
7. Virtual Flag: Identifies the AtoN as either physical, or virtual, noting that there is no physical AtoN in place

No flag: “synthetic” – this means that it is transmitted from a different location than the actual AtoN. No information is obtained from the AtoN

1. Position from GNSS/DGNSS and buoy out of position warning (Message 21)
2. AtoN performance monitoring Message 21, or Message 6
3. AtoN condition (e.g. battery) and control – Message 6
4. Meteorological and hydrological data – Message 6 (addressed) or Message 8 (broadcast)
5. Can be used for Route; channel, or area marking
   * 1. **Nautical Charts and Maritime Safety Information Publications**

In those instances where chart work and maritime safety information (MSI) publications are not included in the mariners’ training modules, the following should be included: taking the lowest category of small vessel skippers’ certificate of competence requirements into consideration:

1. A good understanding of the contents of the:
2. List of Lights and Radio Signals (check descriptions against IALA dictionary definitions)
3. Definitions

Lights - General Terms

Alternating Light - A rhythmic light showing light of alternating colours. (as per IALA Dictionary).

Bearings - the limits of light sectors and areas of visibility of lights and alignments of leading lights and directional lights are given as bearings from seaward. The bearings of sectors are given in clockwise order.

Character - The distinctive combination of various aspects of a light (i.e. when lit, extinguished, coloured or white) which appear regularly or rhythmically allowing it to be identified (for example, fixed, flashing, group flashing, alternating). Lights with the same character exit, but will be separated in distance, so that they are outside each nominal light range to avoid confusion.

Fixed Light – a light which appears continuous and steady and of constant colour to an observer whose position remains unchanged in relation to it. (as per IALA Dictionary)

Oscillating Light - alternating colours at sector limit, with increasing portion of coloured light proportional relating to the white sector. See image an Annex E.

An Oscillating Boundary in a sector light is a method of giving more information of position near the sector boundary to the mariner by creating a light character with alternately flashing colours. (as per IALA Dictionary)

Period - time interval between the beginnings of two successive cycles of rhythmic light.

Phase - each successive element of a rhythmic light’s cycle (e.g. flash, eclipse).

Rhythmic Light - A light showing intermittently with a regular periodicity. (as per IALA Dictionary).

Lights - Descriptive Terms

Aeromarine Light - marine light in which the beam has been deflected at an angle of 10° - 15° above the horizon, so that the light is usable for aircraft navigation.

Aeronautical Light - often a light of great intensity and elevation, principally for aircraft navigation. Because of their intensity, these may be the first lights to be seen when approaching land.

Daytime Light - light operating 24 hours a day without change of character. The intensity may be increased by day.

Direction Light - light illuminating a very narrow sector, used to mark a direction to be followed. This sector may be flanked by sectors of greatly reduced intensity or by sectors of different colour or character. (as per SA List of Lights)

Direction Light - A light illuminating a sector of very narrow angle and intended to mark a direction to be followed. (as per IALA Dictionary)

Elevation of Light - vertical distance between the focal point of the light and Mean Sea Level.

Fog Detector Light - light able to detect fog automatically. There are various types; some are visible only over a narrow arc; some exhibit a blueish-white flash lasting approximately one second; others sweep back and forth.

Fog Light - light which is shown only when visibility is reduced.

Height of a Light - vertical distance between ground level and the top of the light structure including any finial, but excluding aerials, antennas etc.

Leading Lights - two or more lights positioned to form a leading line to be followed.

Leading Lights - Two or more lights associated to form one or more leading lines (or ranges). (as per IALA Dictionary)

Loom - diffused light resulting from atmospheric effects observed when a light is below the horizon or is hidden by an obstacle.

Luminous Intensity - luminous flux emitted by a light source in a given direction as a solid angle: luminous intensity is expressed in candelas. (as per SA List of Lights)

Luminous Intensity (of a source, in a given direction) - The quotient of the luminous flux (dF) leaving the source, propagated in an element of solid angle containing the given direction, by the element of solid angle (dO). (as per IALA Dictionary)

Main Light - the most important light in a group of two or more lights on the same support or neighbouring supports. (as per SA List of Lights)

Main Light - The major light of two or more lights situated on the same support or neighbouring supports. (as per IALA Dictionary)

Obstruction Lights - lights marking obstructions to aircraft; they are usually red.

Occasional Lights - shown only in certain circumstances; for example, shown when vessels are expected; Fishing lights. (as per SA List of Lights)

Occasional Lights - A light put into service only on demand. (as per IALA Dictionary)

Secondary Light - light placed on or near to a main light’s support and having a special navigational function, for example a passing light on a leading light structure or a single sector light.

Sector Light - A light presenting different characters (usually different colours) over various parts of the horizon of interest to marine navigation.

Unmanned Light - light which operates automatically, and which is controlled automatically over a considerable period of time, with only periodic maintenance visits. (as per SA List of Lights)

Unmanned Light - A light which is operated automatically and may be maintained in service automatically for extended periods of time, but with routine visits for maintenance purposes. (as per IALA Dictionary)

Should “Unmanned Light“ be listed?

Sound Signals - General Terms

Fog Signal - An audible signal intended to warn or guide ships in low visibility. (as per IALA Dictionary)

Fog Signal - sound signal to warn or guide ships in conditions of poor visibility. (as per SA List of Lights)

Morse Code Fog Signal - fog signal emitting one or more characters of the Morse Code.

Sound Signal - sound transmitted to convey information. (as per SA List of Lights)

Sound Signal - A sound transmitted in order to convey information. (as per IALA Dictionary)

True Range - maximum distance, measured from the place of emission to positions, at which the information carried by the signal can be understood, in existing propagation and listening conditions.

Fog Signals and Sound Producing Systems

Bell - equipment producing a characteristic sound by striking a metal bell-shape. (as per SA List of Lights)

Bell - A fog signal apparatus comprising a hollow, usually cast, metal vessel which rings when excited by percussion. (as per IALA Dictionary)

Diaphone - equipment producing a characteristic sound using a reciprocating piston with vents operated by compressed air. Output can be in the form of two tones at different sound levels, the second tone being at a lower frequency. If there is only one tone, it ends in a suddenly lowered pitch known as a “grunt”. (as per SA List of Lights)

Diaphone - A fog signal operating on the principle of periodic release of compressed air controlled by the reciprocating motion of a piston operated by compressed air. (as per IALA Dictionary)

Membrane horn - produces its sound by means of a membrane vibrated by compressed air, steam or electricity.

Nautophone - is a horn in which the membrane is activated electrically.

Reed - is a horn in which the membrane is replaced by a steel reed vibrated by compressed air.

Siren - a deep sounding fog warning in which the sound is produced by the passage of air across slits or holes in a rotating disc. It can emit a wailing sound. (as per SA List of Lights)

Siren - a sound signal emitter using the periodic escape of compressed air through a rotary shutter. (as per IALA Dictionary)

Whistle - equipment producing a shrill sound by releasing compressed air or steam across an opening. (as per SA List of Lights)

Whistle - fog signal apparatus comprising a resonator having an orifice of suitable shape such that when a jet of air is passed through the orifice the turbulence produces a sound. (as per IALA Dictionary)

Make reference to G1041 to refer to images

1. Reading the Table of Lights
2. Information relating to Lights
3. Information relating to Audible Signals
4. Regional Information
5. Table of Light Characters
6. Luminous Range Diagram
7. Geographical range Diagram
8. Radio Aids to Navigation
9. Terms
10. Radio Services
11. Navigational Warnings
12. Port Control Communications
13. Radio Reporting Points
14. Meteorological Services
15. Coast Radio Stations
16. Standard Times
17. Global Maritime Distress and Safety Systems (GMDSS)
18. Maritime Search and Rescue (SAR)
19. Vessel Traffic Services (VTS)
20. Differential Global Positioning System (DGPS)
21. Regional/National/Local Reporting System(s)
22. Global Positioning Satellite Navigation Systems (GNDSS)
23. AIS AtoN

Not sure if:

1. If those highlighted in yellow appears in countries’ List of Lights and Radio Signals?
2. any other information/systems that are listed in countries’ List of Lights and Radio Signals that should be mentioned?
3. A good understanding of the information contained in:
4. Sailing Directions
5. Tide Tables
6. Distance Tables
7. Chart Catalogues
8. Chart Symbols & Abbreviations
9. Mariners Handbook
10. Chartwork

A good understanding of:

1. Purpose of nautical charts
2. Different chart scales and distances
3. The basic information appearing on charts
4. Relevant AtoN symbols, and associated information appearing on nautical charts
5. Geographical positions use Latitude and Longitude in standard formats
6. Charts are legal documents
7. The scale of the chart depends on the detail that it needs to show
8. Always use the largest chart available
9. Check the source data diagram to judge the reliability of the chart
10. Check the geodetic datum that positions are referred to – if not WGS 84, then beware

## On board / In-service training

1. In-service practical training
2. In-service training would be applicable to:
3. Cadets / apprentices having undergone theoretical AtoN training at a training institution, and require putting it into practice
4. Mariners not having undergone theoretical AtoN training at a training institution, and require improving their knowledge and experience
5. Expose cadets / apprentices and mariners referred to in 4.1(ii) to AtoN, through guidance and training from the Officer of the Watch (OOW) and performing watchkeeping duties
6. Up to date AtoN related publications to be carried on-board and made available to all
7. Encourage mariners to obtain more AtoN information to utilise the opportunities given at point 5.
8. Get *au fait* with information contained on charts (paper and ENCs).
9. Training Record Book (TRB)
10. The TRB is the only tool to standardise cadet / apprentice knowledge and ensure global on-board AtoN training standards.
11. As al cadets / apprentices are required to complete their TRB, having AtoN featuring therein would be an ideal solution to keep track of the progress made to get acquainted with AtoN and to gain practical experience in this regard. There is currently no section, or requirement for AtoN in the TRB.

Consideration should be given by those responsible (mandated) for the content of the TRB to include AtoN.

# WHERE TO FIND INFORMATION ON AIDS TO NAVIGATION?

AtoN information can be obtained from:

1. IALA website (<https://www.iala-aism.org/>)
2. IALA Recommendations and Guidelines (<https://www.iala-aism.org/product-category/publications/>)
3. MBS - NP735 compulsory publication to be carried on board
4. NAVGUIDE
5. Industrial partners’ websites (<https://www.iala-aism.org/about-iala/membership/>)
6. Related webinars
7. Other??

# AIDS TO NAVIGATION AWARENESS AND NEW DEVELOPMENTS

Mariners need to be kept informed when new types of AtoN being introduced, or amendments made to current types of AtoN

1. Awareness for all mariners
2. If AtoN publications are carried, possibly only include reference(s) to the publication on the ECDIS display when interrogating AtoN icon(s), to ensure mariners optimise the utilisation of the AtoN publication.
3. Dissemination of AtoN globally to the mariner
4. Competent Authorities should inform mariners of non-SOLAS vessels about new AtoN (e.g. virtual AtoN, MAtoN, etc.) via Boating Clubs, professional bodies/associations/societies, publications, etc.
5. For SOLAS vessels, relevant AtoN information should be disseminated through the IMO’s official distribution channels and industry leading authorities such as The Nautical Institute and industrial partner publications, etc.
6. IALA prepared short educational clips (30-60s) that provide practical caution/advisory notes to the mariner on AtoN and disseminated via through Competent Authorities, encouraging social media sharing and onward sharing by all members.
7. Depending on geographical area (Africa vs Northern Europe) of practical experience gained, limited or no exposure will be gained in many AtoN variants (virtual AtoN, complex Sector light arrangements, etc. The table below shows an example of an element of how to ensure that mariners are exposed to the relevant AtoN that are to be used during a voyage.

| Training activity | Specific items | Evaluation elements about AtoN | Evaluation requirements |
| --- | --- | --- | --- |
| **Voyage or passage plan** | Develop a voyage or passage plan | * Obtain the necessary AtoN * Passage planning include identify the relevant AtoN mentioning of significant AtoN along planned tracks.   In referencing passage planning in company QMS, AtoN information to be stipulated, possibly as compulsory content.   * Include the AtoN information in the voyage or passage plan | ??????? |
| **Others?** |  |  |  |

1. Examples of practical training elements

# CHALLENGES MARINERS’ MAY FACE WITH AIDS TO NAVIGATION

The training, both at Training Institutions and on-board / In-service training and awareness should also address practical problems/challenges mariners may face with AtoN, such as:

## Lights

1. **General, Detection, Type and Position**
2. Lights at high elevations are more frequently obscured by clouds than are those at or near sea level.
3. Light buoys may be removed without warning for repair or replacement and may be replaced by temporary marker buoys.
4. The positions and operating of buoys are to be treated with caution.
5. Aero lights are often very powerful and as a result of their positioning on high ground, may be visible at much larger distances than ordinary navigational lights. However, they are positioned only approximately on charts, and they may at times be switched off without warning. In addition, these lights, being administered by organisations other than those dealing with marine lights, may have their colours or character altered before it is possible to notify navigators through weekly Notices to Mariners.
6. As with aero lights, aero obstruction lights are not intended for marine navigation and the same reservations apply equally to them.
7. **Optics**
8. There are always some losses: due to:
9. Unwanted reflection (applicable to rotating optics)
10. The absorption of light in glass, reflectors, and/or coloured filters
11. Inaccuracies in the manufacture of the optic
12. Obstructions by framework or supporting structure
13. Incandescent light sources
14. Does not radiate uniformly in all directions
15. Decreases in luminance during its service life
16. Effective intensity is always less than the peak intensity as the human eye does not have time to completely respond to a short flash in the same way as to a fixed light
17. Atmospheric transmissivity
18. The atmosphere is not uniform over the observing distances of most visual aids
19. As a norm, atmospheric transmissivity is usually taken as **T = 0.74** over one nautical mile. This means that 74% of the original intensity remains when a light beam has passed a distance of 1 nautical mile through the atmosphere, and consequently that the absorption loss is 26%
20. A figure of **T = 0.85** is occasionally used in regions where the atmosphere is very clear

## Light Characters

1. The apparent characters of lights having phases of varying luminous intensities can alter, depending upon the distance from which they are viewed, because certain phases are not distinguishable.
2. Lights with very short flashes may not be visible at expected distances, even if the flashes are of normal length.
3. The length of a short flash seems to be reduced when it is observed at a distance close to its maximum range and in poor atmospheric conditions.
4. The apparent characters of floating aids should be treated with care, as they can be totally different from the actual characters, de- pending upon the height and angle from which they are observed.

## Colours

Colour differences should be treated with caution. Atmospheric light propagation conditions and eye strain can contribute to a considerable reduction in the ability to distinguish colours. At night, it is particularly difficult to distinguish a white light from a yellow or a blue one seen in isolation except when close up. In certain atmospheric conditions, a white light can take on a reddish hue. By day, colours are un- clear when looking toward the sun, and a bright red tends to appear orange.

It should be noted that incandescent lights with coloured filters, the green colour may appear to be white in poor viewing conditions.

## Visibility, Range

1. The distance between a light and an observer cannot be estimated using the apparent brightness of the light.
2. Fog, mist, dust, smoke and rain are amongst factors which considerably reduce the range at which a light is visible.
3. A brightly lit area behind a light can have a big influence on a light’s visibility.
4. In cold weather, and especially when there are sudden temperature changes, ice, rime or condensation may form on light glasses considerably reducing visibility and turning certain colours to white.
5. Visibility of a Mark affected by:
6. Observing distance (range)
7. Curvature of the earth
8. Atmospheric refraction
9. Atmospheric transmissivity (meteorological visibility)
10. Height of the aid above sea level
11. Observer’s visual perception
12. Observer’s height of eye
13. Observing conditions (day or night)
14. Conspicuity of the mark (shape, size, colour, reflectance, and the properties of any retro-reflecting material)
15. Contrast (type of background)
16. Intensity and character

## Influences on effective intensity

1. Flashing/rotating
2. Atmospheric Transmissivity (metrological visibility)
3. Colour filters - typical losses are 75% (red and green) and 60% (amber)
4. Glazing - light loss occurs with filter, glass and acrylic glazing material as the light is reflected, transmitted or absorbed
5. Night / daytime
6. Background lighting

## Vertical and horizontal divergence of lights

1. The inadequate vertical divergence of lights on:
2. Buoys, mariners may not always detect the light due to the ﬂoating aid rolling and pitching caused by swells, waves and fastmoving current.
3. Large vessels can effectively lose sight of a buoy light as they approach it and the watch officer’s viewpoint being high above the buoy light
4. Fixed installations, mariners may not always detect the light being too close thereto
5. The horizontal divergence of lights on:
6. Leading /Transit lights. The latter are usually designed to be seen in a specific angle, and should mariners be outside of the respective angle, the light will not be detected
7. Due to the rolling and pitching of buoys caused by swells, waves and fastmoving current, it may result in poor radar echoes, hence radars would not pick it up. Refer to Annex C which illustrates the effect of maximum current on a buoy and its light.

## Illumination of fixed structures and indirect lighting

1. Illumination of fixed structures means, that the supporting structure of a navigational light or a navigational obstacle is illuminated or floodlighted with a fixed light of non‐glaring properties.

The purpose of this illumination is to enable the mariner to positively identify the object and to allow estimation of distance and relative position to the object.

1. Indirect lighting

Indirect lighting could be used for several reasons to make the relevant mark more conspicuous.

**Note:** In the past there were accidents in Norway involving High Speed Craft (HSC). When the mariner misses one or two flashes at critical turning points, the risk for grounding is significant. Therefore, fixed in-direct yellow lightning was developed, assisting the mariner in detecting the object between flashes. It is also easier to judge correct distance for passing these objects. All objects are “equal” in physical dimensions and the mariner can train him/herself in estimating the distances.

Refer to Annex D how indirect lighting is used in Norwegian waters.

## Sector Lights

1. For those mariners that operate in areas where multiple sector lights are used, e.g. in Norwegian/Scandinavian waters, it is important to become *au fait* with the IALA Guideline 1041. The Guideline provides useful information on aspects that mariners should be aware of when using sector lights, such as:
2. Angle of Uncertainty
3. There is no reference of the vessel’s lateral position within the channel until a sector boundary is reached. This may cause a problem in channels subject to a strong cross current
4. Mariners should also be aware of the following:
5. A sector light’s coloured sectors may have different intensities as the output is influenced by:

* the colour of the filter
* obstructions in front of the light
* glazing grating
* lens grating, etc.

An example of filters fitted inside a lighthouse lantern appears at Annex A.

1. A sector light’s coloured sectors may have different ranges as the danger areas in question may be at different distances from the light.
2. A difference between paper charts and ENCs are the portrayal of sector lights:
3. An ENC uses the nominal range of the light.
4. Paper charts display the intended usage range. This means that in one direction a sector line is drawn, e.g., 5NM to warn the mariner of a danger within 5NM from the light, and in a different direction for the same sector light, a sector line is drawn e.g., 3NM to warn the mariner of a danger within 3NM from the light. This is portrayed with the image of the Storey Lysøy sector light at Annex B.
5. For sector lights fitted with incandescent lamps, the effect of transmission loss in colour filters causes the white sector to have significantly greater intensity than the red/green sectors.

## Sectors

1. In most cases, sector limits should be treated with care.
2. With the exception of Precision Port Entrance (PEL) sector lights, sector limits and sector widths are in most cases not precise and should not be used for positioning.
3. Except for Precision Sector Lights, they are in general not well-defined, with lit and unlit sectors merging gradually into each other. Colour changes between sectors are also gradual, sometimes occurring over several degrees (the angle of uncertainty).
4. When a light is masked by sloping ground, the bearing on which it disappears or appears varies with the distance and height of the observer’s eye.

## Buoys

1. Factors affecting an actual buoy position
2. Accuracy of position fixing
3. Offset from position fixing system and sinker drop point
4. Difference between buoy release position and sinker landing on seabed
5. Sinker weight/shape, tidal flow and depth of water
6. Slope and nature of seabed
7. Traditional moorings: Due to the way buoys are anchored, buoys are not always in the charted positions due to the swinging action
8. Dragging of sinker
9. Extreme weather/tsunamis
10. Dragged by vessel catching buoy or mooring
11. Because the position of a buoy changes, vessels should not use them to obtain Lines of Positions, noting that no reliance can be placed on floating aids always maintaining their exact positions. Buoys should, therefore, be regarded with caution and not as an infallible navigation mark, especially when in exposed positions. A ship should always, when possible, navigate by bearings of fixed objects or angles between them, and not by buoys.

## Audible, or Sound / Fog Signals

1. Note: it has been IALA policy since 1985 that audible signals, also referred to as sound signals, should only be used as a hazard warnings)
2. Navigators should be cautious in using sound signals even if the type and rhythm of the signal have been fully identified. In all cases it is of prime importance to use other navigational means available, especially the echo-sounder, to verify position.
3. Sound is propagated in air irregularly and often in unexpected ways.
4. Fog signals can be heard at greatly varying distances, and loudness is no guarantee of distance from the source.
5. Sound signals can give the impression of having come from a direction other than the true direction of the emitter.
6. In certain conditions, when a fog signal has several tones, only one of them may be audible.
7. It can happen that there are zones around a fog signal in which the signal cannot be heard.
8. A vessel may find itself in fog, although no fog exists at the station and therefore the fog signal is not operating.
9. Certain types of signal cannot be switched on as soon as fog forms.
10. It can happen that fog signals are not heard because of the noise of the ship. Lookouts should be posted . and all maintenance work on deck must be halted when restricted visibility is encountered. Consideration should be given to reducing main engine RPM to a minimum at which immediate manoeuvring is possible, to reduce on-board noise to a minimum.
11. Where applicable, fog signals are activated automatically by fog detectors when the visibility of the sample volume of the atmosphere in the close proximity of the detector falls below the set parameters.

## AIS at Sea

1. Users must be aware that non-SOLAS vessels may not carry AIS
2. AIS should not be used as the primary means of anti-collision
3. Not all SOLAS ships AIS’ are set up correctly
4. Port- and Flag State Control inspections and local general safety surveys can be used to target non-conformances
5. Virtual AIS
6. Not all vessels carry AIS
7. Dependant on uninterrupted Position Navigation and Timing (PNT) systems
8. Dependant on uninterrupted AIS units
9. Super-refraction may affect the range
10. Vulnerable to jamming and spoofing
11. Some ECDIS only display ship messages (check if still correct)

## Racons

1. 3GHz New Technology (NT) radars (ships >3,000GT might not respond
2. Not continues reception in large swells
3. Obscured by sea clutter
4. Nulls from reflection off sea
5. Bearing not precise
6. Side lobes when close (suppressed by modern racons)
7. Older 3GHz radars still triggers Racons, but 3GHz NT radars do not trigger Racons at previous ranges

## Global navigation satellite system (GNSS) Vulnerability

Mariners should be aware of the potential risk that GNSS (GPS, GLONASS, BDS**[[1]](#footnote-2)**, Galileo, IRNSS**[[2]](#footnote-3)**, QZSS**[[3]](#footnote-4)** and augmentation systems) are vulnerable to interference (intentional and unintentional) and other errors and to act accordingly. Failure of electronic equipment on board a vessel is also not uncommon, due to power supply failure or to a fault, temporary or permanent, in the receiver or antenna.

Where natural events, such as space weather, affect GNSS signal reception, it is likely that the effects will be observed over large areas and during any phase of navigation. Man-made interference is most likely to arise within coastal waters since the sources of man-made interference are likely to be land-based and will be restricted to line-of-sight. However, the possibility of deliberate shipborne or airborne jamming cannot be ruled out.

The effect on marine navigation of interruptions to GNSS could be significant. The consequences could be the system is still usable but degraded, or a complete loss of use of the system.

The user may note that the signal has been lost for a period and has then returned, but has no way of knowing the cause, be it external or onboard interference, accidental or intentional. Consequences to navigation applications may range from complete loss of signal, false position information or intermittent loss to degradation of accuracy. Consequences to timing applications may include failure due to loss of synchronisation.

The consequences of spoofing are far more serious than those of jamming. If the false signals are indistinguishable from the real ones and give a position close enough to be believable, then the user may not be aware of the deception and could be led into danger.

Mariners should be warned on overreliance on GNSS only. In order not to be prone to GNSS interference, it is accepted as good practice that all available sources of positioning information should normally be used and the need to maintain skills in the use of conventional AtoN.

## CHARTS

1. Paper Charts

Paper charts have limitations for modern navigation.

1. Electronic Navigational Charts (ENCs)
2. It should be noted that the ENCs are the future and the demise of the paper chart in its current format is being considered by both the IHO and IMO, paper charts, or its use thereof is still very much dependent on local legislative carriage requirements. IMO must also still approve the demise of the paper chart and any new derivative thereof.
3. e-Navigation is the future, and the S-100 family of Services and Standards support this. S-101, the new ENC standard should be operationalised by 2024 and then there will be a period until 2030 (transitional period) whereby producer nations of ENCs will need to produce “dual fuel” ENCs (S-57 and S-101) after which hopefully the IMO will then do away with the S-57 standard for ENCs.
4. IALA supports the new Universal Data Exchange Format of S-100 family of Services and Standards and has been providing inputs towards its development.
5. Limitations of ENCs in an ECDIS

It should be noted that there are limitations hence the development of the S-100 family of Services and Standards.

1. Inflexible maintenance regime
2. Cannot support contemporary requirements, such as gritted bathymetry, time-varying information, etc.
3. Data transfer mechanisms are limited. Data model embedded in capsulation (ISO 8211)
4. S-57 never extended beyond ENCs

## Miscellaneous

1. Not all AtoN are monitored, or monitoring are not always done 24/7/365, therefore Mariners should report all defective AtoN to the responsible authority, such as:
2. Lights not operational
3. Missing, or broken daymarkers
4. Buoys:
5. Missing, or broken daymarkers, and/or topmarks
6. Missing, or broken numbering
7. Being out of position
8. Drifting
9. When sailing at night in areas of high volume of traffic, mariners need to be extra cautious, especially at the intersection of a main channel and the branch channel, especially at the intersection or near the intersection of two or more branch channels, due to the large number of vessels’ navigational lights and background lights, and the light quality rhythm of the preferred channel marks and the lateral marks may not be very different. There is an increased risk of identification confusion when arriving for the first time at an unfamiliar port / harbour and appropriate voyage planning is therefore important.
10. In some areas where there are many AtoN, there may be deviation and confusion in the consistency between the AtoN and the mark on the chart. For example, in some countries, the buoy numbers may not appear on the chart, but only on the buoys, or vice versa. if there are ten buoys in sight, and the mariners want to see the buoy No. 3, but the mark on the chart may be mistaken for buoy No. 4, or No. 5 – China to advise in more detail.
11. It may be difficult to identify AtoN with the background lights of the port or harbour, or adjacent waters, or the construction site on the sea.
12. Lighthouses in the form of navigation services is relatively single; different countries have different degrees of utilisation of lighthouses; seafarers have different degrees of identification of lighthouses, which will confuse the similar lighthouses. China to advise in more detail.
13. At night or poor visibility, mariners cannot see the AtoN clearly. It needs to use AIS to upgrade the digital intelligent cursor, and further improve the navigation efficiency at night. China to advise in more detail.

(Obtain information (also from the Nautical Institute/WWA/large shipping entities, etc.) more exactly what mariners’ challenges wrt AtoN are? Liaison with Kevin)

# ACRONYMS & DEFINITIONS (Complete at the end)

## Acronyms

AIS Automatic Identification System

AtoN Aid(s) to Navigation

BDS BeiDou Navigation Satellite System

CME Corona; Mass Ejections

DGNSS Differential Global Navigation Satellite System

ECDIS Electronic Chart Display and Information System

ENC Electronic Navigational Chart

GLONASS Russian Global Navigation Satellite System

GNSS Global navigation satellite system

GPS Global Positioning System

HSC High Speed Craft

IALA International Association of Marine Aids to Navigation and Lighthouse Authorities

IMO International Maritime Organization

IMO International Maritime Organization

IRNSS Indian Regional Navigation Satellite System

MAtoN Mobile Aids to Navigation

MSI Maritime Safety Information

NM Nautical Mile

NT New Technology

PEL Port Entrance

QMS Quality Management System

QZSS Quasi-Zenith Satellite System

RPM Revolutions per minute

SOLAS International Convention for the Safety of Life at Sea (SOLAS)

STCW International Convention on Standards for Training, Certification and Watchkeeping for Seafarers, 1978

STCW International Convention on Standards of Training, Certification and Watchkeeping for Seafarers

TRB Training Record Book

VHF Very High Frequency

## Definitions

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

# REFERENCES

1. SOLAS 1974- International Convention for the Safety of Life at Sea Chapter V, Regulation 13 - Establishment and operation of aids to navigation.
2. STCW 1978 - International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978, as amended
3. R1021 - Marine-AtoN-Awareness-for-Mariners-Ed1.0-December-2020
4. R0129 (R-129) - GNSS-Vulnerability-and-Mitigation-Measures – Edition 3.1-December-2012
5. G1149 Ed.1 Guideline G1149 on VTS Training for Deck Officers
6. IALA Maritime Buoyage System (MBS) and and other Marine Aids to Navigation publication
7. IALA Dictionary
8. IALA NAVGUIDE
9. IALA L1 AtoN Manager training course material
10. IALA G1061-Light-Applications-Illumination-of-Structures\_Dec2008
11. ARM Task 1 5 4: AtoN Awareness for Mariners Gap Analysis
12. South African List of Lights and Radio Signals
13. Sector filters fitted inside a lighthouse lantern



1. Sector lights being used in NORWEGIAN waters



Store Lysøy sector light

The Store Lysøy sector light has two different ranges, i.e.:

1. At long range the one side of the southwards white sector sets mariners clear of the Grunnbåen beacon pole.
2. At long range the other side of the southwards white sector sets mariners clear of Stampen Cairn, just south of Stampraen Shoal
3. Buoy semi-submerged in strong current



1. INDIRECT LIGHTING IN NORWEGIAN WATERS



1. Night-time view: Indirect lighting used on a beacon in Norwegian waters

This image shows a lantern with a fixed light on the illuminated structure. Only the white part is illuminated, not the steel structure.

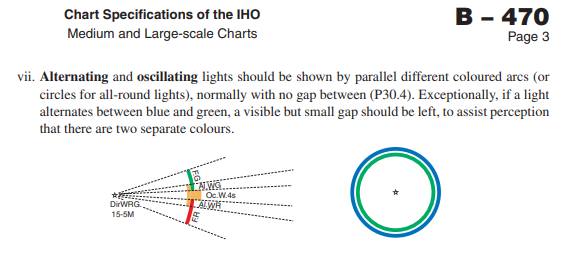


1. Day-time view: Indirect lighting used on beacons in Norwegian waters

In this instance the indirect lighting is used for close-quarter navigation and better judgement of the given turning points. This makes it easier to judge distance to a fixed light, with a better chance to avoid missing a flash (at turning points).

1. ADDITIONAL PICTURES/ IMAGES?

Heading?



1. BeiDou Navigation Satellite System [↑](#footnote-ref-2)
2. Indian Regional Navigation Satellite System (IRNSS) [↑](#footnote-ref-3)
3. Quasi-Zenith Satellite System [↑](#footnote-ref-4)