IALA GUIDELINE

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

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DOCUMENT REVISION

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1. INTRODUCTION

1.1. INTERNATIONAL ORGANIZATIONS

The United Nations (UN) emphasizes the need for further efforts to promote a culture of safety and security in the shipping industry and to address the shortage of adequately trained personnel. It also urges the development and strengthening of capacity-building activities and the provision of knowledge and skills through the required education and training, promoted in particular by the International Maritime Organization (IMO) in collaboration with other relevant international organizations and agencies, as appropriate.

Recalling that the IMO is a specialized agency that promotes the safety of navigation and sustainable shipping.

The International Hydrographic Organization (IHO) aims to ensure that all the world's seas, oceans and navigable waters are surveyed and charted, supporting the safety of navigation.

The International Telecommunication Union (ITU) is a specialized agency for information and communication technologies and there is a need to promote its knowledge to ensure the use of relevant information.

The aim of IALA is to foster the safe, economic and efficient movement of vessels, through harmonising and improving Marine Aids to Navigation (AtoN) worldwide and other appropriate means, for the benefit of the maritime community and the protection of the marine environment.

IALA is the only international organization that deals with marine AtoN and related matters. IALA brings together services and organizations concerned with the provision or maintenance of marine AtoN systems and allied activities.

1.2. BACKGROUND

The responsibility for safe navigation resides with the mariner, through the appropriate use of AtoN, in conjunction with official nautical documents and prudent seamanship, including voyage planning as defined in IMO resolutions.

AtoN contribute towards the improvement of safety of life at sea and the protection of the marine environment and safety and efficiency of navigation 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 visible AtoN (lighthouses, beacons, and buoys), radio- and satellite systems and Automatic Identification System (AIS) AtoN as they are required to regularly utilize AtoN to enhance the safety and efficiency of their voyages. It is however recognized 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 utilization and understanding, resulting in enhanced situational awareness.

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. Related IMO model courses currently do not include any AtoN training modules.

2. AIMS AND OBJECTIVES

2.1. INITIAL

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

This Guideline presents guidance and information on AtoN training and awareness to be take into consideration by maritime training organizations 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 informed by onboard / in-service training regarding AtoN developments.

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

IALA is developing and making the required AtoN training material available for mariners to contribute towards world-wide consistency in the training of mariners on AtoN.

2.2. LONG TERM

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

- To propose:
  - the inclusion of a formulised 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.
- For the IALA World-Wide Academy (WWA) to ensure uniformity of AtoN training material for all mariners.
- The possibility of new, or complex AtoN to be included in charts' notes.
- With the decline in use of the paper chart in its current format, a stronger focus should be given the inclusion of more information on AtoN on Electronic Navigational Charts (ENC), e.g., when an icon on an Electronic Chart Display and Information System (ECDIS) is interrogated, such as new, or complex AtoN, Electronic Chart System (ECS), portable pilot units (PPU) and radars.

3. OVERVIEW OF MARINE AIDS TO NAVIGATION

3.1. PURPOSE OF MARINE AIDS TO NAVIGATION

The provision and operation of AtoN are recognized 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 takes into account the volume of traffic, degree of risk, geographic and environmental conditions within an area, economic considerations, and user requirements.

3.2. BENEFITS OF MARINE 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:

- Determining their position
- Maintaining a safe course
- Warning of dangers and obstructions
- Situational awareness
- Avoiding particular areas, such as Areas to be Avoided (ATBA), environmentally sensitive sea areas, dumping areas, discharge pipe areas, dredged and swept areas, limit of restricted area, and particularly sensitive sea areas (PSSA).
- Precautionary situations such as:
  - Anchorage areas
  - Two-way route with one-way sections
  - Off-shore renewable energy installations (OREI) 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.

4. TRAINING ACTIVITIES

Noting that the ability to use AtoN is a requirement of STCW, AtoN training modules and future IALA standardized training material should be included in the mandatory national training programmes for mariners and be reflected in examinations and assessments.

Note: Relevant standardized AtoN training should also be included for small vessel skippers' training as per local requirements.

4.1. MARITIME TRAINING INSTITUTIONS

4.1.1. 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 (physical, virtual and synthetic AIS AtoN), radar target enhancer and radar beacon (Racon).

3 A detailed understanding of the IALA Maritime Buoyage System (MBS).

4 Satisfactory understanding of the difference between charted and the actual position of the buoy, including:

a Charted position defines the nominal (or true) position for the sinker (anchor)

b Buoys will almost never float directly over the sinker

c The actual position of buoys will almost always be different than their charted position

d Buoys could have been removed, broken away, dragged or drifting

5 Satisfactory understanding of other Marks (definition, description, visual depiction) and their usage, such as:

a Lighthouses

b Beacons (minor lights)

c Daymarks

d Leading/Range Lights

e Sector Lights

f Major floating aids

g Navigational buoys

h Supplementary information:

i Buoys can be unlit, or lit

ii Buoys may also carry a:

– Topmark

– Racon

– AIS

– Sound signal

– Radar Reflector

i Auxiliary marks

j Marking new dangers

k 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.

l Audible, or sound / fog signals

i Fog signals are mostly located at lighthouses, at the end of breakwaters within ports and harbours, and on floating aids

ii Activation of fog signals

These signals are mostly activated by fog detectors and less frequently through Mariner Radio Activated Sound Signals (MRASS).

m Synchronization of lights

n Retro reflective material used on floating and other marks to enhance their visual detection during night-time

6 Good understanding of lights in general

a Definitions

b Geographic Range

c Nominal Range

IALA has recommended the adoption of a nominal range in nautical miles (NM) 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.

d Intended usage sector lights

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.

e Light Characters

7 AIS AtoN

An AIS AtoN is a digital aid to navigation that is broadcast by an authorized service provider using the AIS Message 21 (Aids to navigation report) and is displayed on navigation equipment such as the ECDIS, radar, or an Integrated Navigation System (INS) (International Maritime Organization (IMO) *MSC.1/Circ.1473*). An AIS AtoN may also be used to mark a Route, channel, or area.

Message 21

i Repeat Indicator

ii Maritime Mobile Service Identity (MMSI)

iii Type of AtoN

iv Name of AtoN (may include an extension field)

v Position accuracy

vi Latitude and longitude

vii Dimension/reference for position

viii Type of electronic position fixing device

ix Time Stamp

x Off-position

xi AtoN Status

xii RAIM (Receiver autonomous integrity monitoring)-flag

xiii Virtual Flag: Identifies the AtoN as either physical or virtual, noting that a virtual AtoN does not physically exist

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

xiv AtoN performance monitoring Message 21, or Message 6

xv AtoN condition (e.g., battery) and control – Message 6

xvi Meteorological, oceanographic and hydrographic data – Message 6 (addressed) or Message 8 (broadcast)

8 A detailed understanding of IHO S-4 Part B, symbols and abbreviations

4.1.2. NAUTICAL CHARTS, LIST OF LIGHTS AND MARITIME SAFETY INFORMATION

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:

a List of Lights, sound signals and radio signals

b Radio aids to navigation

c Radio Services

i Navigational warnings

ii Global Maritime Distress and Safety Systems (GMDSS)

iii Vessel traffic services (VTS)

iv Regional/National/Local reporting system(s)

v Global Navigation Satellite Systems (GNSS)

vi Differential Global Navigation Satellite Systems (DGNSS)

2 A good understanding of the information contained in:

a Directions

b Tide Tables, electronic or printed

c Chart Symbols and abbreviations

d Mariners Handbook (NP100)

e Nautical instructions

f AtoN - is a summary of the mariner's essential knowledge of AtoN and communication signals. includes:

i the main rules of AtoN (description of lights and buoyage),

ii the main communication and transmission signals (tide, port, distress, storm and essential elements of the International Code of Signals)

iii other useful information for navigators (sea state code, wind speed code, etc.).

3 Members / mariners have a statutory responsibility report navigational hazards

The Maritime Safety Information Service of the GMDSS is the internationally and nationally coordinated network of broadcasts containing information, which is necessary for safe navigation, received on ships by equipment which automatically monitors the appropriate transmissions, displays information which is relevant to the ship and provides a print capability. Maritime safety information is of vital concern to all ships. It is therefore essential that common standards are applied to the collection, editing and dissemination of this information. Only by doing so will the mariner be assured of receiving the information they need, in a form which they understand, at the earliest possible time.

4 All members and mariners have a moral responsibility to report errors and corrections regarding their national MSI publications.

5 Chartwork

a A good understanding of relevant AtoN symbols, abbreviations, and associated information appearing on nautical charts.

b It is highly important that mariners know how to interpret and understand chart symbols and identify AIS AtoN.

c In certain areas in the world there may be outdated charts, the lack of charts, or the lack of large scale charts, communication systems and other navigational aids, all of which pose challenges for mariners.

d The relative lack of good charts, communication systems and other navigational aids, as well as poor weather conditions all pose challenges for mariners

6 Understanding the purpose of Notices to Mariners (NtMs)

a NtMs advise of corrections to be affected to nautical charts and publications.

b NtMs only contain information which is vitally important for safety at sea. It advises mariners of important matters affecting navigational safety, including new hydrographic information, changes in channels and AtoN, and other important information.

c Mariners are obliged to keep their products (charts, publications, etc.) up to date with NtMs until a new edition of a product is issued. NtMs only apply to additions in force. As soon as a chart / publication edition is cancelled, it is no longer possible to correct that product with a NtM.

d Mariners should always use the latest edition of a chart or publication

4.2. ON BOARD/IN-SERVICE TRAINING

1 In-service practical training:

a In-service training would be applicable to:

i Cadets / apprentices having undergone theoretical AtoN training at a training institution, and require putting it into practice

ii Mariners not having undergone theoretical AtoN training at a training institution, and require improving their knowledge and experience

b Expose cadets / apprentices and mariners referred to in 4.2(1)(a) to AtoN, through guidance and training from the Officer of the Watch (OOW) and performing watchkeeping duties

c Up to date AtoN related publications to be carried onboard and made available to all

d Encourage mariners to obtain more AtoN information through various sources such as those given at section 5 below.

e Familiarisation with information contained on charts (paper and ENCs).

f Training Record Book (TRB)

i A TRB, or similar is an effective tool to standardize cadet / apprentice / rating knowledge and ensure global onboard AtoN training standards.

ii For cadets / apprentices that are required to complete a 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.

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

g Depending on geographical area (e.g., 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 1 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.

Table 1 Examples of practical training elements

Training activity	Specific items	Evaluation elements about AtoN	Evaluation requirements
Voyage or passage plan	Develop a voyage or passage plan (IMO Resolution A.893(21) – Guidelines for Voyage Planning)	• Passage planning includes identification of relevant and significant AtoN, and any known AtoN related MSI along planned tracklines. Obtain: ◦ The necessary information of AtoN available along planned tracklines, e.g., List of Lights, Fog Signals, and Radio Signals ◦ MSI on AtoN • In referencing passage planning in company quality management systems (QMS), AtoN information should be stipulated as compulsory content. • Include the AtoN information in the voyage or passage plan	AtoN and MSI along the planned trackline should be fully considered and reflected in the formulation of the voyage or passage plan

5. WHERE TO FIND INFORMATION ON MARINE AIDS TO NAVIGATION

AtoN information can be obtained from:

1 In practice:

- a Charts, tables, sailing directions
- b List of Lights, fog signals and radio signals
- c Mariners Handbook (NP100)

2 For theoretical knowledge:

- a IALA website (https://www.iala-aism.org/)
- b IALA Recommendations and Guidelines (https://www.iala-aism.org/product-category/publications/)
- c MBS - NP735 compulsory publication to be carried on board
- d NAVGUIDE (IALA NAVGUIDE 2018 digital copy - IALA AISM (iala-aism.org)
- e Industrial partners' websites (https://www.iala-aism.org/about-iala/membership/)
- f National and public resources (websites, etc.)
- g Related webinars

6. MARINE AIDS TO NAVIGATION AWARENESS AND NEW DEVELOPMENTS

Mariners need to be kept informed of changes made to current types of AtoN, new types and kinds of AtoN, and developments to AtoN equipment.

1 Awareness for all mariners:

a 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 optimize the utilization of the AtoN publication.

b Dissemination of AtoN to the mariner

i Competent Authorities should inform local mariners of non-SOLAS vessels about new AtoN (e.g., virtual AtoN, MAtoN, etc.) via Boating- and Sailing Clubs, professional bodies/associations/societies, publications, etc.

ii 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.

iii IALA prepared short educational clips (30-60s) that provide practical cautionary/advisory notes to the mariner on AtoN and disseminated via through Competent Authorities, encouraging social media sharing and onward sharing by all members.

iv National and local legislation

v Notice to Mariners

vi National authorities' websites

7. CHALLENGES MARINERS MAY FACE WITH MARINE AIDS TO NAVIGATION

Mariners need to know how to use AtoN (limitations of AtoN, practical examples, virtual AtoN displayed, etc.), as required by STCW.

Note: When mariners find AtoN to be defective, they should report it to the relevant authority.

The training, both at training Institutions and onboard/in-service training and awareness should also address practical problems/challenges mariners may face with AtoN, such as discussed below.

7.1. LIGHTS

Lights are by far the most common form of aid to navigation from lighthouses to range lights to sector lights or bridge lights, etc. and their use remains critical. Mariners should therefore be aware of:

1 General, detection, type and position:

a Lights at high elevations are more frequently obscured by clouds than those at or near sea level.

b The mariner may find lit AtoN extinguished without warning.

c Aeronautical 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 organizations 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.

d As with aeronautical lights, aeronautical obstruction lights are not intended for marine navigation and the same reservations apply equally to them.

2 Optics:

a There are always some losses of intensity, due to:

i Unwanted reflection (applicable to rotating optics)

ii The absorption of light in glass, reflectors, and/or coloured filters

iii Inaccuracies in the manufacture of the optic

iv Obstructions by framework or supporting structure

v Biological obstructions such as flora and guano

vi Atmospheric phenomena, e.g., rain, snow, smoke, fog, etc.

vii Atmospheric transmissivity

b Incandescent light source:

i Does not radiate uniformly in all directions

ii Decreases in luminance during its service life

c 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

d Atmospheric transmissivity

i The atmosphere is not uniform over the observing distances of most visual aids

ii 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%

iii A figure of $T = 0.85$ is occasionally used in regions where the atmosphere is very clear

e The visibility of lights can be reduced when lanterns are covered with snow and / or ice.

7.2. LIGHT CHARACTERS

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:

1 Lights with very short flashes may not be identifiable at expected distances, even if the flashes are of normal length.

2 The duration of a short flash may appear to be reduced when it is observed at a distance close to its maximum range and in poor atmospheric conditions.

3 The apparent characteristic of floating aids can be totally different from the advertised/charted characteristic due to wave action, and/or depending upon the height and angle from which they are observed.

7.3. COLOURS

Under certain circumstances, the colour of an AtoN may be affected by a number of factors as discussed below.

7.3.1. LIT ATON

Atmospheric light propagation conditions and eye strain can contribute to a considerable reduction in the ability to distinguish colours. At night, it could be particularly difficult to distinguish a white light from a yellow or a blue one seen in isolation except when close up, therefore white and yellow lights should have different characters. In certain atmospheric conditions, a white light can take on a reddish hue. By day, colours are unclear 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.

In severely reduced visibility due to rain or mist yellow/amber lights can appear white when first sighted until the mariner gets sufficiently close and the colour is not affected by the meteorological conditions.

Exposure to ultraviolet (UV) light could also lead to the fading and degradation of lanterns and optics, especially those that are made of plastic, to the point of causing the risk of misidentification by the mariner.

7.3.2. SURFACE COLOURS

Mariners should be aware that as soon as a coloured surface of an AtoN is exposed to the atmosphere, the colour will begin to change to the point of causing the risk of misidentification by the mariner.

This is due to the degradation of pigments and dyes in sunlight, the breakdown of the glossy surface film and the production of light-coloured particles due to the breakdown of the coloured surface. Bright colours (particularly fluorescent colours) break down most rapidly, while darker colours last the longest.

Marine growth, bird fouling, salt deposits and bird lime are well-known dirt covering issues on buoys, but salt deposits from sea water, sand, and/or other solid airborne particles can also have impacts on the visual performance of buoys and other structures close to the water

Mechanical abrasion occurs often on painted buoys when vessels pass too close to the AtoN and make scratches and dents in the surface.

7.4. VISIBILITY AND RANGE

It should be noted that:

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 Background lighting 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:

- a Observing distance (range)
- b Curvature of the earth
- c Atmospheric refraction
- d Atmospheric transmissivity (meteorological visibility)
- e Height of the AtoN above sea level
- f Observer's visual perception
- g Observer's height of eye
- h Observing conditions (day or night)
- i Conspicuity of the mark (shape, size, colour, reflectance, and the properties of any retro-reflecting material)
- j Contrast (type of background)
- k Intensity and character

7.5. INFLUENCES ON EFFECTIVE INTENSITY

Mariners should note that the following has an influence on the effective intensity of lights:

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

7.6. VERTICAL AND HORIZONAL DIVERGENCE OF LIGHTS

Mariners should be aware that:

1 The vertical divergence of lights on:

a Buoys - mariners may not always detect the light due to the floating aid rolling and pitching caused by swells, waves and fast-moving current

Large vessels can effectively lose sight of a light as they approach it and the watch officer's viewpoint being high above the light

b Fixed installations - mariners may not always detect the light being too close thereto

2 In terms of the horizontal divergence of lights on leading/transit lights, these are usually designed to be seen at a specific angle, and should mariners be outside of the respective angle, the light will not be detected.

7.7. ILLUMINATION OF FIXED STRUCTURES AND INDIRECT LIGHTING

1 Illumination of fixed structures means 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.

2 Indirect lighting is used for several reasons including 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 Figure 8 and Figure 9 for examples of how indirect lighting is used in Norwegian waters.

7.8. 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 familiar with the IALA Guideline *G1041 Sector Lights*. The Guideline provides useful information on aspects that mariners should be aware of when using sector lights, such as:

a Angle of Uncertainty

b 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

2 Mariners should also be aware of the following:

a A sector light's coloured sectors may have different intensities as the output is influenced by:

i the colour of the filter

ii obstructions in front of the light, etc.;

an example of filters fitted inside a lighthouse lantern appears in Figure 3.

b sector light's coloured sectors may have different ranges as the danger areas in question may be at different distances from the light.

c The limits or boundaries of a sector are not always precisely cut off due to the characteristics of the light source, fading of colours or changing rhythms between adjacent sectors

d A difference between paper charts and ENCs are the portrayal of sector lights:

i An ENC uses the nominal range of the light.

ii iPaper 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 Figure 4.

e 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.

7.8.1. SECTORS

Mariners should be aware that:

1 In most cases, sector limits should be treated with care as the mariner typically sees a mixture of the two sector characters and this causes an uncertainty where the mariner is unable to distinguish between the two sectors.

2 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.

3 Alternating and oscillating lights should be charted to show parallel different coloured arcs (or circles for all-round lights), normally with no gap between colours (see Figure 1).

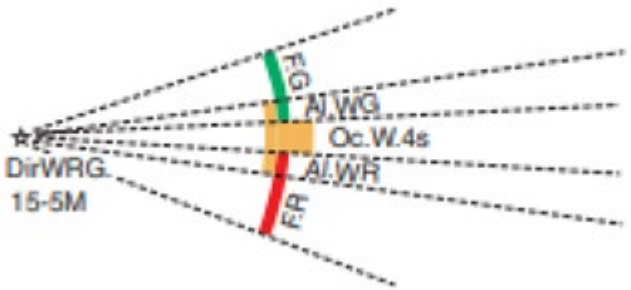

Figure 1 5-Sector image (Int. 1 of IHO publication)

The exception is if a light alternates between blue and green. In this case a small gap should be left to assist perception that there are two separate colours (see Figure 2).

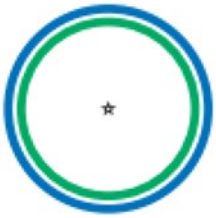

Figure 2 Blue and green alternating light image (Int. 1 of IHO publication)

7.9. BUOYS

1 Floating AtoN (buoys) are probably the most prevalent navigation mark world-wide, therefore mariners should be aware that:

Because the position of a buoy changes, mariners 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 vessel should always, when possible, navigate by bearings of fixed objects or angles between them, and not by buoys.

2 Factors affecting an actual buoy position:

a Traditional moorings: Due to the length of the moorings, buoys are not always in the charted positions due to the swinging action resulting in the circular movement of the buoy about the position of the sinker.

b Accuracy of position fixing

c Offset from position fixing system and sinker drop point

d Difference between buoy release position and sinker landing on the seabed

e Sinker weight/shape, tidal flow and depth of water

f Slope and nature of the seabed

g Extreme weather/tsunamis

h Dragged by vessel / debris catching buoy or mooring

i Ice (and icing) conditions. Buoys can be under ice and when the ice field is moving, buoys can suddenly disappear under ice and also “pop up” back. Sometimes buoys can be under the ice a long time, for example in Northern Sea of Bothnia. Buoys can also have a large angle of heel due to ice, therefore the lights may not be seen correctly due to having small vertical divergences.

j The shape and colour of AtoN can vary in different countries, colour can be faded, and buoys may have different style of shapes, etc.

k Rolling and pitching of buoys caused by swells, waves and fast moving current, may result in poor radar echoes. Refer to Figure 5 which illustrates the effect.

7.10. AUDIBLE OR SOUND/HAZARD WARNING (FOG) SIGNALS

Although audible signals are still in operation in many countries, it has been IALA policy since 1985 that audible signals, also referred to as sound signals, should only be used as hazard warnings.

Mariners 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 all other navigational means available to verify position.

Sound is propagated in air irregularly and often in unexpected ways and could give the impression of having come from a direction other than the true direction of the emitter.

Hazard warning signals can be heard at greatly varying distances, and volume is no guarantee of distance from the source.

In certain conditions, when a hazard warning signal has several tones, only one of them may be audible.

It can happen that there are zones around a hazard warning signal in which the signal cannot be heard.

A vessel may find itself in fog, although no fog exists at the station and therefore the hazard warning signal is not operating.

Certain types of signals do not activate as soon as fog forms.

It can happen that hazard warning signals are not heard because of the noise of the ship.

Where applicable, hazard warning signals may be 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. In other cases, the signal can be activated by the mariner, as in the case of a Mariner Radio Activated Sound Signal (MRASS). This is typically done by keying the microphone of a radio switched to the charted frequency of the fog signal activating device (MRASS).

7.11. AIS AT SEA

It is recommended that mariners, as an extension of their training on the IALA Maritime Buoyage System, are introduced to AIS AtoN as defined by this policy, and portrayal on navigation related displays as defined by relevant documents, including the concept of a Virtual AIS AtoN, should be visible only on electronic displays. *MSC.1/Circ.1473* Annex, page 5.

1 Users must be aware that not all vessels are required to carry AIS

2 A single AIS AtoN should not be used as the primary means of fixing the vessel's position.

3 As the IMO requirement for AIS carriage is the Minimum Keyboard Display (MKD) and there is no mandate for a connection to other shipborne equipment, not all vessels with AIS have this equipment (ECDIS, ECS, radar) properly configured to visually display all of the information from an AIS AtoN with appropriate symbology.

4 Virtual AIS AtoN

- a Dependent on uninterrupted Position Navigation and Timing (PNT) systems
- b Dependent on uninterrupted AIS units
- c Super-refraction may affect the range
- d Vulnerable to jamming and spoofing
- e ECDIS and radar may not be properly configured to display AIS AtoN
- f Position errors may occur from improper placement and configuration of radio antennas

7.12. RACONS (RADAR TRANSPONDERS)

Despite the advantages of Racons, mariners should note that:

1 Older 3GHz radars still trigger Racons, but 3GHz NT radars might not trigger Racons at previous ranges

2 Racons may:

- a Not be continuously visible in large swells
- b Be obscured by sea clutter
- c Cause nulls from reflection off sea

3 Racon bearing may not be accurate

4 Side lobes may occur when a vessel is close to a Racon (suppressed by modern Racons)

7.13. GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) VULNERABILITY

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.

Mariners should be aware that GNSS (GPS, GLONASS, BDS , Galileo, NAVIC , QZSS and augmentation systems) are vulnerable to interference (intentional and unintentional) and other errors and to act accordingly to mitigate the potential risk. 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 synchronization.

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.

7.14. CHARTS

1 Navigational charts:

- a Electronic Navigational Charts (ENCs) are the future. The demise of the paper chart in its current format is being considered by both the IHO and IMO and paper charts, or its use thereof is still very much dependent on local legal carriage requirements. IMO must also still approve the demise of the paper chart and any new derivative.
- b e-Navigation is the future, and the IHO's S-100 family of Services and Standards support this. S-101, the new ENC standard should be operationalized by 2026 and then there will be a period until 2029

(transitional period) whereby producer nations of ENCs will need to produce “dual fuel” ENCs (S-57 and S-101) after which the IHO will do away with the S-57 standard for ENCs.

7.15. MISCELLANEOUS

Not all AtoN are monitored, or monitoring is not always done 24/7/365, therefore Mariners should report all defective AtoN to the responsible authority, such as:

a Lights
   i Unlit
   ii Not operational
   iii Intermittent
   iv Unreliable
   v Improper characteristics
   vi Not synchronized / out of synchronization

b Fixed installations
   i Damaged daymarkers
   ii Destroyed structures

c Buoys:
   i Damaged daymarkers, topmarks and/or bodies
   ii Damaged numbering
   iii Off station / Out of Position
   iv Missing
   v Drifting
   vi Not portraying the charted colour

d Racons / Audible or Sound Signals / AIS AtoN and/or other electronic- or radio AtoN
   i Not operational
   ii Exhibiting incorrect signals
   iii Unreliable

When sailing at night in areas of high volume of traffic, mariners need to be extra cautious 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. This is due to the large number of vessels’ navigational lights, background lights, and the light range, brightness, rhythm similarities of the preferred channel marks and the branch channel marks.

There could be an increased risk of identification confusion when arriving for the first time at an unfamiliar port / harbour and appropriate voyage planning is therefore important.

When trying to identify AtoN, especially when there are numerous AtoN in the area, the mariner should be aware that not all details of the AtoN are displayed on every scale of the chart.

Clutter created by numerous radar targets and / or weather may obscure AtoN on radar and ECDIS displays.

When trying to identify AtoN at night, or during periods of poor visibility, the mariner should be aware that:

a Background lighting from shore lights, other vessels, and other marine infrastructure like offshore windfarms, may make AtoN hard to identify visually.

b Not all AtoN are fitted with AIS or Racons.

c Identification of AIS AtoN may be difficult on ECDIS as discussed in point 7.15(5), and especially on MKD in areas where there are numerous AIS signals from vessels, structures and AtoN.

Operating in sub-zero temperatures

a For ships operating in an area with sub-zero temperatures, and during periods where ice accretion is likely to occur, means to prevent the accumulation of ice on antennas are required for safety of navigation.

b In sub-zero temperature areas AtoN functionality may be adversely affected, e.g., due to battery failures, etc.

c Mariners should also be aware that sub-zero temperatures would also have an effect on both fixed and floating AtoN due to the accumulation of ice thereon.

8. DEFINTIONS

The definitions of terms used in this Guideline can be found in the International Dictionary of Marine Aids to Navigation (IALA dictionary) and were checked as correct at the time of going to print. Where conflict arises, the IALA Dictionary should be considered as the authoritative source of definitions used in IALA documents.

Specifically for this document the following terms are relevant:

Bearing (angle) – is 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 of a light – is 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).

Elevation of light – is the vertical distance from the focal point of the light and mean sea level (when the tide is not appreciable on the near shore) or (elsewhere) MHW (Mean High Water) or other appropriate high water reference level.

Fog Signal - Sound signal to warn ships in conditions of poor visibility.

Hazard warning signal – is an audible signal intended to warn ships in low visibility conditions.

Leading Lights - Two or more lights positioned to form a leading / range / transit line to be followed.

Marine Aid to Navigation 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 the Organization (IALA) this definition includes vessel traffic services

Mariner – is any person who is employed, or engaged, or works in any capacity on board a vessel.

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

Oscillating light – is a light having alternating colours at one or more sector limit(s), with increasing portion of coloured light proportional relating to the white sector.

Seafarer - means any person who is employed or engaged or works in any capacity on board a ship.

Siren - a deep sounding warning in which the sound is produced by the passage of air across slits or holes in a rotating disc, in which the membrane is activated electrically

Sound signal - a devise which transmits sound, intended to provide information to mariners during periods of restricted visibility.

9. ABBREVIATIONS

AIS	Automatic Identification System
ATBA	Area(s) to be Avoided
AtoN	Marine Aid(s) to Navigation
BDS	BeiDou Navigation Satellite System
DGNSS	Differential Global Navigation Satellite Systems
ECDIS	Electronic Chart Display and Information System
ECS	Electronic Chart System
ENC	Electronic Navigational Charts
GLONASS	Russian Global Navigation Satellite System
GMDSS	Global Maritime Distress and Safety Systems
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
HSC	High Speed Craft
ID	Identification
IHO	International Hydrographic Organization
IMO	International Maritime Organization
INS	Integrated Navigation System
ITU	International Telecommunication Union
MAtoN	Mobile Marine Aid(s) to Navigation
MBS	IALA Maritime Buoyage System
MMSI	Maritime Mobile Service Identity
MRASS	Mariner Radio Activated Sound Signal
MSI	Maritime Safety Information
NAVIC	Navigation Indian Constellation
NM	Nautical mile
NT	New Technology
NtM	Notice to Mariners
OOW	Officer of the Watch
OREI	Off-shore renewable energy installation(s)
PNT	Position Navigation and Timing
PPU	Portable Pilot Unit
PSSA	Particularly Sensitive Sea Area(s)
QMS	Quality Management Systems
QZSS	Quasi-Zenith Satellite System
RAIM	Receiver Autonomous Integrity Monitoring
SOLAS	International Convention for the Safety of Life at Sea
STCW	International Convention on Standards for Training, Certification and Watchkeeping for Seafarers
TRB	Training Record Book
UN	United Nations
UV	Ultraviolet

VTS	Vessel Traffic Services
WWA	IALA World-Wide Academy

10. REFERENCES

[1] IMO. 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] IALA. Recommendation R1021 Marine AtoN Awareness for Mariners.

[4] IALA. Recommendation R0129 (R-129) GNSS Vulnerability and Mitigation Measures.

[5] IALA. Guideline G1149 VTS Training for Deck Officers.

[6] IALA. Recommendation R1001 Maritime Buoyage System (MBS).

[7] IALA Dictionary.

[8] IALA. NAVGUIDE.

[9] IALA. L1 AtoN Manager training course material.

[10] IALA. Guideline G1061 Light Applications Illumination of Structures.

[11] IALA. Guideline G1041 Sector Lights.

[12] Oceans and the law of the sea; A/RES/75/239; 5 January 2021.

APPENDIX 1 EXAMPLES OF MARINE AIDS TO NAVIGATION AND ASSOCIATED ISSUES

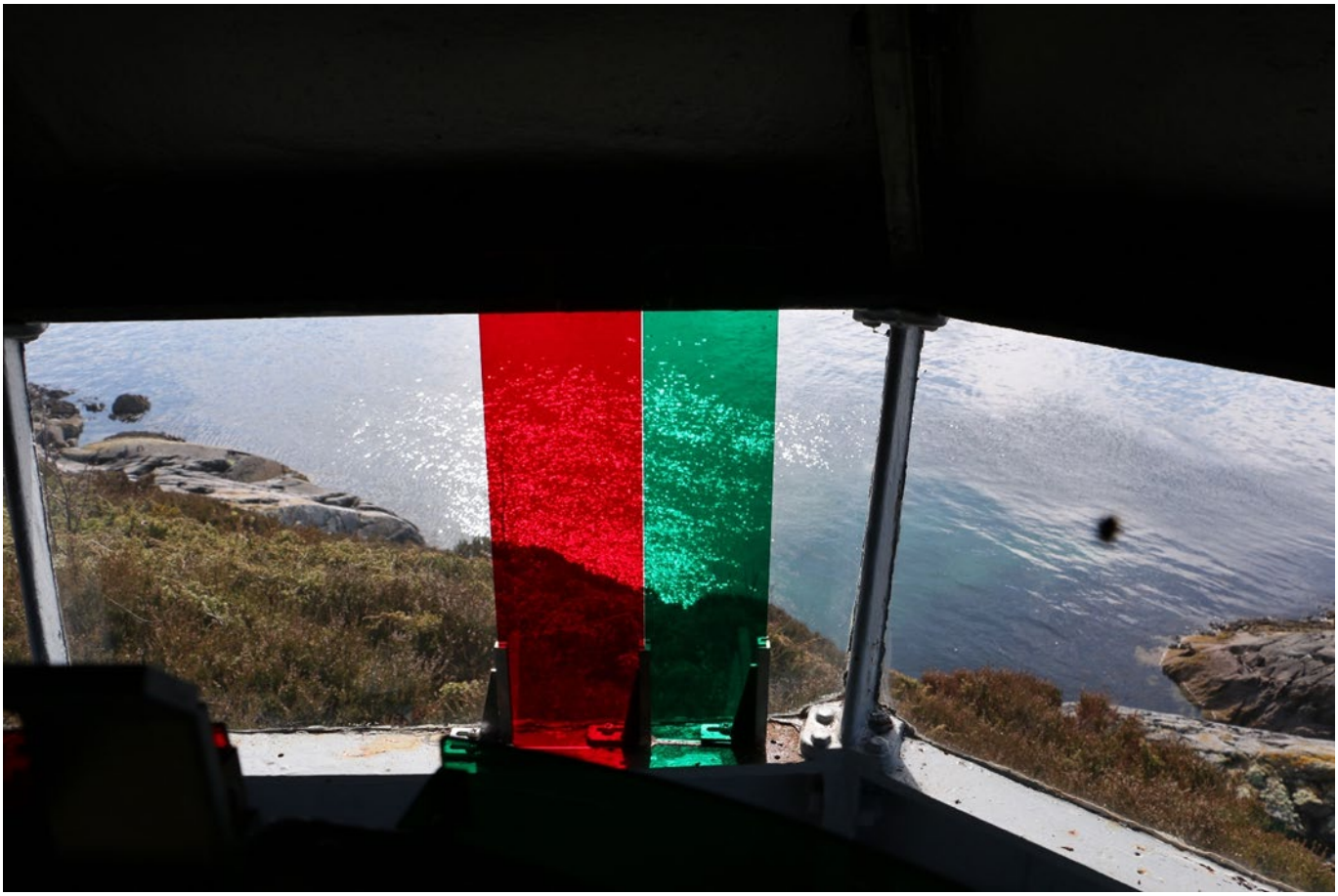

Photo courtesy of Norwegian coastal administration

Figure 3 Sector filters fitted inside a lighthouse lantern

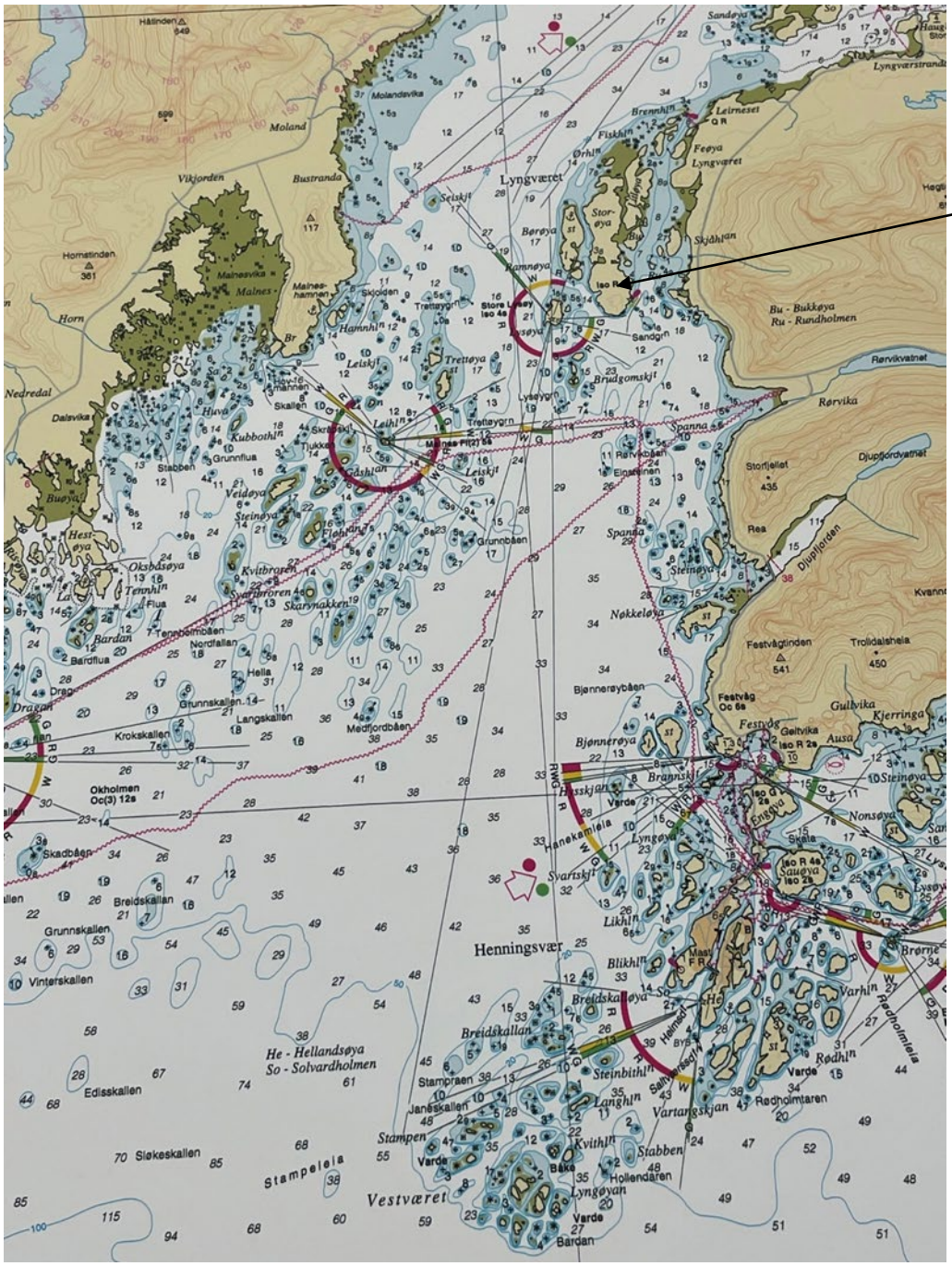

Image courtesy of Norwegian Coastal Administration

Figure 4 Sector lights being used in Norwegian waters

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

Photo courtesy of Norwegian Coastal Administration

Figure 5 Buoy semi-submerged in strong current

Photo courtesy of Finnish Transport Infrastructure Agency

Figure 6 Buoy (and light) covered in ice

Photo courtesy of Finnish Transport Infrastructure Agency

Figure 7 Leading light (and dayboard) covered in ice

Photo courtesy of Norwegian Coastal Administration

Figure 8 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.

Photo courtesy of Norwegian Coastal Administration

Figure 9 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).

The following figures 10 to 13 provide images of new technology applications and what mariners could encounter en route:

Photo courtesy of Sealite

Figure 10 Advantage of solid shape as opposed to "see through"

Photo courtesy of Sealite

Figure 11 Comparison of old vs new Marine Aids to Navigation

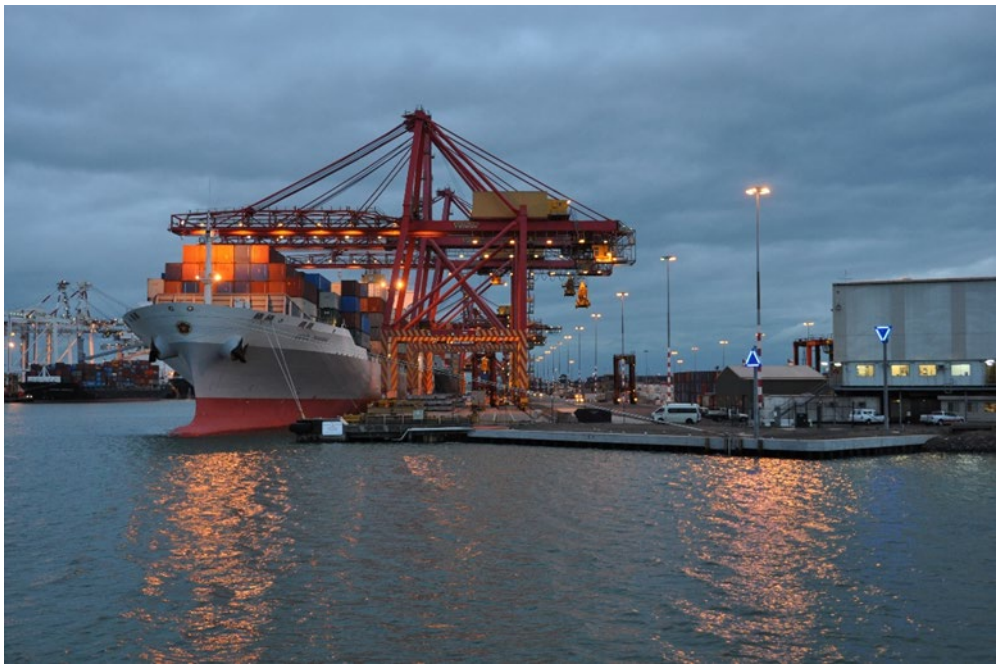

Photo courtesy of Sealite

Figure 12 Overcoming background lighting with the use of colour and shape

Photo courtesy of Sealite

Figure 13 Indication of how shape, size and colour can change over distance