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**IALA GUIDELINE**

1081

PROVISION OF VIRTUAL AIDS TO NAVIGATION

**Edition 1.1**

**May 2013**



**DOCUMENT REVISION**

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

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| May 2013 | Minor amendments throughout the document | To reflect developments at IMO NAV discussion on AIS AtoN. |
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# INTRODUCTION

IALA recognises that there are various tools available for use by Aids to Navigation (AtoN) authorities to improve and enhance services to mariners. Among these are visual, radio and now, virtual AtoN.

This document offers national members and other authorities guidance on the provision of virtual AtoN.

# SCOPE

This document provides guidance on the use of virtual AtoN limitations and benefits, criteria for application, notification process, display, application and delivery methods, applicable standards and guidelines, availability and integrity, legal and liability issues.

This document is a general guide only and is not intended to specify in detail when or how to deploy virtual AtoN. Appropriate sources (see references) should be consulted for additional relevant information.

The concept of virtual AtoN has its roots in AIS but in the future other means of transmission and presentation may evolve. References to AIS in this document should not be construed as limiting virtual AtoN to that system.

# PURPOSE

The purpose of this Guideline is to inform AtoN authorities, mariners and equipment manufacturers of the value and uses of Virtual AtoN. It will assist administrations and authorities in determining the appropriate uses for and the means to establish and operate virtual AtoN. This Guideline will assist shipmasters, pilots and other mariners and private AtoN owners in realizing the benefits, limitations and the inherent risks involved when using virtual AtoN as a means to verify their position, determine a safe course to steer or to avoid dangers. This Guideline will assist marine electronics equipment manufacturers in designing and upgrading the shipborne navigational display systems. Finally, maritime training institutes may also wish to avail themselves of the information contained herein in order to develop syllabi that will prepare seafarers to take advantage of this emerging technology.

# DEFINING A VIRTUAL AID TO NAVIGATION

## DEFINITION

A virtual AtoN does not physically exist but is a digital information object (symbol and text information) promulgated by an authorized service provider that may be presented on navigational systems. This is used to mark an object other than an existing AtoN or a non object such as a reference point in the water.

## AMPLIFICATION

Virtual AtoN should only be used after approval by a national competent authority.

Virtual AtoN can be used to inform the mariner about dangers to navigation as well as safe waterways, areas in which extra caution may be necessary and areas to be avoided.

They may be used to represent a line, area, position or other form that may be displayed graphically. The AIS ASM Area Notice message might replace or supplement that need in the future.

The information, including geographic position, carried by virtual AtoN may be fixed or may be changed over time (dynamic), depending on the intended purpose. Dynamic is not intended for a mobile object but more for a changing situation such as bathymetric change related to shifting bottom.

Virtual AtoN are used primarily where there is a time critical consideration. They may also be used in places where permanent physical AtoN cannot be sited or maintained. However, they are not intended to replace physical AtoN.

There are two applications of Virtual AtoN, temporary and permanent and they should be reflected in Maritime Safety Information (MSI). If the temporary change continues for more than six months (according to IHO, if any temporary continues for more than 6 months, it should be charted accordingly) it will be treated as permanent and be shown on the relevant nautical paper chart, Electronic Navigational Chart (ENC) and other relevant nautical publications in due course. In some countries, permanent status is sub categorized into annual and seasonal period.

# APPLICATION OF VIRTUAL ATON

Virtual AtoN can provide early notification to the mariner of urgent, temporary or dynamic information. Virtual AtoN should not, in general, be considered as a replacement for other forms of MSI but can provide a valuable supplementary delivery mechanism, enabling an automated graphical display of MSI otherwise only available in textual form. In certain circumstances, refer to the chapter 5 of the IALA Recommendation O‐143 on the Provision of Virtual Aids to Navigation, Virtual AtoN can be also used as permanent marking. Specific applications are described at the Annex 1 of this Guideline.

## USER NEEDS

Users will include mariners and shore side authorities. User needs may include presentation of information on:

* new hazards, excluding drifting object (fixed or dynamic);
* temporary channels or routes;
* temporary areas to be avoided (e.g. restricted areas (i.e. military exercises) /survey / dredging/ fishing /marine events);
* changed hydrography, such as shifting banks;
* temporary replacement of ~~off station~~ gone from position physical AtoN;
* dynamic areas (e.g. reduced visibility, presence of protected species);
* Polar navigation providing there is sufficient radio communication means and charting;
* ice conditions and navigation;
* incident response (e.g. environmental, SAR);
* port specific applications (e.g. passage planning, amended pilot boarding location, etc.);
* measures for the protection of the marine environment;
* security.
  + 1. **ADVICE TO ATON AUTHORITIES AND OTHER USERS**

In using virtual AtoN the following are among the issues that need to be considered:

* carrying out a proper risk assessment to ascertain the need for virtual AtoN;
* be aware of over proliferation and use virtual AtoN where appropriate;
* take into account the vulnerability of Global Navigation Satellite System (GNSS) ~~systems~~, etc;
* verify quality assurance through ~~consider~~ monitoring ~~(quality assurances)~~, cyber security risks, etc;
* take into account the limitation of ~~display systems on ships~~ shipborne navigational equipment required to be equipped with AIS (non-graphical display, old shipborne AIS firmware, wrong symbol or no symbol at all);
* take into account that it is not mandatory for certain vessels to be equipped with AIS equipment or vessels may be fitted with equipment not capable to receive the AIS AtoN.
* promulgate the information widely to different users using MSI, AtoN Authority Web or Portal, etc ;
* mixture of other types of AtoN located in such area;
* take into account the limitation of virtual AtoN technology such as the lack of flexibility in using free text to add complementary information.
* take into account the limitation of data link load, numbers allocated, e.g. Maritime Mobile Service Identity (MMSI) numbers for AIS, that the primary function of AIS technology is to prevent collisions, etc.
  + 1. **ADVICE TO MARINERS**

In using virtual AtoN the following are among the issues that need to be considered:

* there could be some position offsets in the display of the virtual ATON due to equipment issues such as the quality of GNSS, GNSS smoothing, antenna offsets, gyro and radar error, etc;
* refer to MSI in order to validate that the correct information is broadcasted;
* be aware of the possibility of different symbols on different systems;
* be aware of limitations of virtual AtoN provision and presentation;
* the difference between virtual, synthetic and physical/real AIS AtoN;
* the need to maintain situational awareness by comparing electronic and non‐electronic means and avoidance of reliance on single sources of information;
* be aware of cluttering effect caused by too many AIS targets ~~information~~;
* many systems, including AIS, are GNSS dependent for position and timing and subject to the same vulnerabilities.

## 5.2. BENEFITS

Some of the potential benefits of virtual AtoN in enhancing safety and environment protections. Other benefits are:

* timely notification;
* ease of presentation, where displayed graphically;
* quick deployment;
* direct delivery to navigational systems; limited to relevant area;
* information readily apparent to the user;
* easily deployed / changed / amended depending on the situation (storms, marine incidents, etc;
* low cost to install and maintain;
* marking where physical or real AIS AtoN is not practical.

# TECHNICAL DEPLOYMENT OF VIRTUAL ATON

Information from the virtual AtoN services should be broadcast to shipboard receivers by more than one means. The navigation information provided for virtual AIS AtoN must be repeated in MSI broadcasts to assure that all mariners receive safety information. Virtual AIS AtoN messages should include a reference to identify the associated MSI message. Reference could be provided in the Message 21 field ‘Name of AtoN Extension’. (see Reference [20].) The ‘Name of AtoN Extension’ needs to be considered on a wider scale when developing new message definitions for virtual AtoN delivery. (See section 8.1)

The navigation information needs to be displayed on Electronic Chart Display & Information System (ECDIS), Electronic Chart System (ECS) and on radar equipment based on the latest IMO, IEC and ITU standards. These displays should indicate the information graphically as well as provide text display of detailed information ~~when available~~ in addition to the graphic.

There may be a limit to the number of virtual AtoN and / or their reporting interval (update rate) that can be in the same area due to limitations in the capacity of the communication link. There may also be a limitation on the shipboard processing capability.

To mark areas, AIS binary application specific messages (ASM) may be used, rather than multiple virtual AIS AtoN (Message 21). There is a limit to the number of virtual AIS AtoN that can be in the same area due to available timeslots in the AIS system. Multiple virtual AIS AtoN (Message 21) could increase clutter on the display. The authority needs to be aware that the number of MMSI available for use by AIS AtoN is a finite resource (1000 per designated area code) and for this reason another means of unique identification, linking virtual AtoN to relevant MSI or chart objects may need to be considered in the future.

MMSI numbers are normally assigned to a transmitting device. For virtual AIS AtoN using Message 21, the MMSI number represents the unique identity of the AtoN itself, rather than the transmitting source. The repeat indicator is used to identify whether the signal is transmitted from another station. Authority should consider broadcasting from more than one AIS base station for assuring some redundancy.

# REGULATORY ISSUES

## AUTHORITY TO DEPLOY

SOLAS Chapter V Regulation 13 (Establishment and operation of aids to navigation) states, in part, that ‘each Contracting Government undertakes to provide, as it deems practical and necessary, either individually or in co‐ operation with other Contracting Governments, such aids to navigation as the volume of traffic justifies and the degree of risk requires.’

Under SOLAS, Contracting Governments are obliged to provide aids to navigation, subject to IALA Recommendations and Guidelines and based on the navigational requirements for waters under their jurisdiction. However, SOLAS allows administrations significant discretion in determining what would be an appropriate mix of visual, radio and AIS AtoNs, now virtual aids to navigation to meet the needs of mariners. Some National Authorities have establish their own policies and level of service for the provision of AtoN services.

Section 10 of this document is intended to assist administrations to assess the risk associated with virtual AtoN for this purpose.

## CAPABILITY

A Contracting Government has an obligation under SOLAS to provide AtoN. This obligation is exercised by the appropriate entity (usually a national administration). This entity should also be responsible for determining who may be permitted to deploy virtual AtoN. Typically, a VTS, Harbour Master, Rescue Co‐ordination Centre (RCC) or some other entity may have the capability to deploy virtual AtoN. Further guidelines may be needed to help Government manage the request from other entities to deploy Virtual AIS AtoN.

The lines of authority between the Contracting Government and the entity deploying virtual AtoN should be clearly delineated. Roles and responsibilities at all levels should be clearly defined.

## LIABILITY

Virtual AtoN are simply another type of Aid to Navigation. Having elected to deploy a virtual AtoN, an administration should be able to establish that the virtual AtoN is being provided as promulgated and is operating correctly through direct monitoring or on relaying on another party.

It is likely that an administration’s exposure to liability from deploying a virtual AtoN will be similar to that for any other Aid to Navigation. Therefore, noting the unique nature of virtual AtoN, robust processes and procedures for approval, promulgating information about them, together with integrity monitoring and record keeping, should be established.

# DELIVERY METHODS

## TECHNICAL ASPECTS

This guideline addresses near term and long term alternatives for delivery of a virtual AtoN service.

In the near term, shore based AIS networks provide competent authorities with means to operate an information service for shore‐based VTS, traffic management schemes, ship reporting systems and other shore‐based safety‐

related services, including virtual AtoN services. This service consists of information delivery between ships and shore and vice versa.

Technical details of the AIS technology and of the layout and local configuration of shore‐based AIS are described in IALA Recommendation A‐124.

In the longer term, authorities may expect that other media for information services will become available. This would enable virtual AtoN services to be transmitted via means other than AIS, for example: sitcom / internet; WiMAX; VDES, VDE-SAT, NAVDAT, ~~LORAN; DGPS~~ ‐ IALA maritime beacon system; ~~GPRS~~ cell phone data transmission protocol.

In the near term, not all vessels can be expected to be able to effectively display virtual AtoN information. As of July 2008 SOLAS Radars are required to interface to AIS and display AIS information, as in MSC Resolution 192(79). Although ECDIS is capable of displaying AIS information, it is not required to do so. Based on current rates of navigational system upgrades, it is expected to take at least some years before the substantial percentage of the international commercial fleet will have this capability. Changes in mandatory carriage requirements may accelerate this development for SOLAS vessels. Portable Pilot Unit (PPU) Navigational Systems may facilitate implementation. Economic benefit to the shipping industry could also provide an impetus to early adoption of this technology.

The nominal report rate of virtual AIS AtoN broadcasts is specified in ITU‐R‐M.1371. However, due to the limitations in data link capacity IALA Recommendation A‐126 recommends a more flexible approach to be considered, taking data link capacity and power consumption at transmitting stations into account.

In the longer term, different report rates may be implemented on different communication media, as appropriate.

A virtual AIS AtoN should be considered lost after 15 minutes, unless updated on the shipborne navigational displays, as specified in IMO MSC.1/Circ. 1473. A lost target symbol has depicted in IEC 62288-2 should be shown on the AIS AtoN symbol. This consist of two crossed solid lines centred on the target symbol. Once acknowledged, the lost target symbol and its target symbol shall be removed from the display.

The IMO e‐Navigation concept includes the need to harmonise the presentation of both shipboard and shore side safety related information. Consideration should be given in implementing virtual AtoN to the harmonisation process within e‐Navigation for future applications.

## DISPLAY

* + 1. **GENERAL**

The virtual AtoN should clearly indicate by its name or other relevant attribute the related navigational warning, notice to mariners or other form of MSI relating to the provision of the object.

The display or representation of symbols for virtual AtoN onboard should be standardised. The display of symbols ashore should align to the onboard standard as closely as possible, to facilitate a common interpretation of the maritime situation [[23]].

* + 1. **LIMITATIONS**

In the short to medium term virtual AtoN will not be visible on the displays of many ships and, if visible, the symbols may differ from one display to another. (See section 10.2.)

* + 1. **SYMBOLS**

IMO SN/Circ. 243 Annex 2 provides guidance on the use of navigation related symbols on all shipborne navigational systems and equipment.

#### Figure 1 The symbol for an AIS AtoN

~~No~~ A distinction is made between real and virtual AtoN. These navigation related symbols are not chart symbols.

In IEC 62288-2 (Navigation Displays) ~~and IEC 62388-2 (Radars)~~ that came into force in 2012, the thin dashed line diamond with crossed lines centred at the reported position of the AtoN is specified for AIS AtoN. ~~For virtual AIS AtoN the diamond has a V inside~~. This symbol will be implemented as an overlay on

navigation equipment (ECDIS, radar etc.) compliant with these specifications. ~~Currently~~ The symbols ~~do not~~ indicate the type of AtoN~~, although display equipment may allow interrogation to obtain such information~~ as well as the attached text information where the virtual flag is active.

The ECDIS performance standard requires that overlay symbols should be readily distinguishable from chart symbols. Chart symbols for virtual AIS AtoN have been developed and chart manufacturer are free to incorporate them according to the existing S-57 Appendix B.1 – Annex A (Edition 4.1.0). ~~are under development by the IHO based on the existing chart symbology for AtoN.~~

~~It should be noted that colours for the use of virtual AtoN symbols are not clearly stated for ECDIS overlay and radar display in current specifications.~~ The basic color for the virtual AtoN symbols is the normal colour symbol of an AIS AtoN symbol. IMO does not specify exact colour but the interpretation is that it should be the same colour, for example all being green, and avoid red and yellow which are reserved for special purpose. The absence of a charted physical AtoN is communicated as a combined state of “virtual” and “off position”. This shall be indicated with yellow text “Missing” above the dotted outline diamond using colour yellow. The symbol shall have no crosshair at the position centre.

~~It should also be noted that IMO is developing new symbols for AIS AtoN scheduled to complete in 2014. The new symbols are expected to clearly distinguish virtual AIS AtoN from physical AIS AtoN and show the type of AIS AtoN.~~ A new symbology for AIS AtoN has been issued where the type of the AtoN consisting of a topmark (purpose) has been added to the basic diamond shape. The latest IEC 62288-2 is providing further details.

* + 1. **POINT AND AREA REPRESENTATION**

In addition to the use of the AtoN Report Message 21, emerging AIS Application Specific Messages (ASM) could be used to provide a representation of a point position, line, area, or other form that may be displayed graphically. ~~There is a need to develop appropriate methods of representation, clearly distinguishable from existing charted symbols~~. The presentation have been developed in the latest IEC 62288-2 but navigational displays manufacturers needs to incorporate them into their system in order to fully benefit from this new feature.

* + 1. **EXPIRY AND CANCELLATION OF VIRTUAL ATON OBJECTS**

Some virtual AtoN objects (like the AIS AtoN Message 21) rely on repeated transmission to remain valid – however current display standards are not clear on this issue, and implementation may therefore vary in the short to medium term. The timeout limit of a repeatedly transmitted virtual AtoN must be defined in future standards, in order to ensure that the same information is available to all users at all times. (The IEC 62388 radar standards defines when AIS class A and B vessel targets are lost – approximately when the nominal repetition rate has been exceeded by a factor of 6. This general rule is recommended to be implemented for the display of virtual AtoN in future display standards.)

Some virtual AtoN objects (like the emerging application specific messages) may themselves contain a definition of their own lifetime – time of issue and time of expiration. These virtual AtoN objects – and virtual AtoN objects relying on repeated transmissions with repetition, but with a long timeout – should be accompanied by a mechanism for cancellation, in case they become obsolete during their defined lifetime or contain errors. Such a cancellation mechanism also constitutes a mitigation measure to ensure that erroneous or malicious transmissions can be cancelled.

When the lifetime of a virtual AtoN object is timed out or cancelled, it should be removed from display systems. Objects relying on repeated transmissions that have exceeded the nominal reporting rate, but have not yet reached the timeout should, when queried for additional information, clearly indicate that the information may not be up to date.

# NOTIFICATION

Having elected to deploy virtual AtoN, administrations should arrange for detailed information related to such aids to be made available to all concerned.

Administrations should use all available means to ensure that mariners have the necessary information concerning the presence and purpose of virtual aids, including the intended duration of deployment. These means may include MSI broadcast via NAVTEX, INMARSAT Enhanced Group Call (EGC) or VHF/HF/MF radio. The administration should send specific notification to their hydrographic offices for inclusion in notices to mariners and should correct and update relevant paper charts, electronic charts and nautical publications.

As with other aids to navigation, mariners have an obligation to report malfunctioning virtual aids to navigation to the competent authority.

# RISKS AND LIMITATIONS

The virtual AtoN are ~~not~~ now becoming visible on the displays of many ships and, ~~if~~ but when visible, the symbols may differ from one display to another. The consequences may be confusion, lack of information for the user and the undermining confidence in ECDIS, the chart and other systems. ~~It is likely to take at least a decade to harmonise the provision of virtual AtoN as a result of the ’grand‐fathering‘ clauses in the carriage requirement program for ECDIS and the likely schedule for the adoption of Integrated Bridge System (IBS) & e‐Navigation.~~

~~Radar will only display virtual AIS AtoN as an overlay of a diamond with a V inside if they are compliant with IEC 62388. This test specification came into force in 2008.~~ At the current rate of fitting new equipment, 10‐15 years appears to be a realistic timescale for the majority of ships to benefit from the provision of display of virtual AtoN.

~~Navigational displays compliant with IEC 62288, which came into force in 2008 will show virtual AIS AtoN as an overlay of a diamond with a V inside.~~

~~ECDIS equipment fitted prior to 2009 will not show virtual AIS AtoN until the equipment is upgraded or replaced, which is unlikely under the current ‘grand‐fathering’ arrangements. There is currently no provision for virtual AIS AtoN in S‐57, or a symbol in S‐52, but this is capable of implementation.~~ ~~However, even when virtual~~ It is still possible that when a AIS AtoN are reflected in S‐57 and S‐52, existing ECDIS will only show an orange ‘?’ upon encountering a virtual AIS AtoN object in the ENC database. The orange ‘?’ can be interrogated for further detail.

The Minimum Keyboard Display (MKD) should display AIS AtoN, including the virtual flag, but it is known that some MKDs do not meet this requirement.

## RISK MITIGATION

#### Table 1 Potential risk mitigation measures

|  |  |
| --- | --- |
| **Risk** | **Potential Mitigation** |
| Complete dependence of virtual AtoN | Not rely completely on virtual AtoN but to cross check with other data or information |
| Not all mariners will receive or be able to display virtual AtoN | MSI should be maintained as primary system, Virtual AtoN supplements MSI  Encourage integration with navigation displays, where fitted Development of e‐Navigation and S Mode |
| Information overload | Use of lines and areas versus points  Only competent authorities may approve issue Area specific display  Development of e‐Navigation  Limited use of virtual AtoN in any area |
| Lack of user awareness or understanding | Training  Clear promulgation of information  Develop educational material |
| Confusion from varying symbology | Standardisation of symbology by IMO, IHO, IALA, IEC. |
| Equipment may be set up not to show data | Instruction and training  S Mode |
| Confusion from message options for locations, area and lines | IMO / IALA to define message formats |
| Loss of signal | Published standards for availability, continuity, integrity Verification of transmission by originator  Redundancy Integrity warning  Correlation with MSI and / or chart  Shipborne Navigational displays able to manage and display the lost target symbol. |

|  |  |
| --- | --- |
| **Risk** | **Potential Mitigation** |
| GNSS vulnerability | AIS semaphore mode Satellite monitoring / RAIM DGNSS integrity message  Electronic terrestrial backup |
| Virtual AtoN vulnerability; jamming / spoofing | Verification of transmission by originator Correlation with MSI and / or charts Data link monitoring by authorities  Counter‐spoofing (cancelation methods) |
| No confirmation of receipt of message | Repeated or addressed / acknowledged transmissions  Verification of transmission by originator Multiple transmission paths (MSI) Development of e‐Navigation |
| Erroneous message transmitted | Procedures for message checking  Verification of transmission by originator |
| Dynamic prediction accuracy i.e. floating object | Estimation of zone of uncertainty Updated verification  Remove position from message after time |

## LIMITATIONS

* + 1. **GNSS VULNERABILITY**

Ships may lose their positioning capability when the GNSS service is lost due to jamming or interference, unless they have an alternative positioning system. Poor installation or failure of on board equipment can similarly interfere with or degrade GNSS reception.

~~Delivery of a virtual AtoN Service through the AIS VHF Data Link (VDL) would not necessarily be affected immediately by loss of GNSS, since the position part of the message is fixed and transmitted independent of GNSS.~~

* + 1. **SPOOFING AND JAMMING OF VIRTUAL ATON**

Depending on the media, a virtual AtoN service can be spoofed and jammed easily. Jamming can be unintentional or intentional while spoofing would typically be intentional.

Some spoofing methods can be detected through careful monitoring of the transmission channel. One possibility is to monitor MMSI numbers within the service coverage area. Duplicated or non‐existing MMSI numbers within the coverage area may indicate spoofing.

Increased spoofing detection capability can be achieved through regional co‐operation between neighbouring countries, exchanging valid MMSI numbers and co‐operating on identifying invalid MMSI numbers, for example handing over MMSI numbers from one authority to another authority when vessels cross the administrative boundaries of these authorities. Such a scheme is implemented on the administrative boundary between the Malacca and Singapore straits.

Authorities who provide virtual AtoN services should maintain a database of all valid MMSI numbers assigned to virtual AtoN. This database should be shared with such stakeholders as neighbouring countries.

Both spoofing and jamming can compromise and/or shut down a virtual AtoN service. Jamming will typically block the service in a certain geographic region. Spoofing is more sinister since the targeted receiver cannot detect the deception (i.e. the signal appears to be genuine), which could mislead the navigator.

* + 1. **AIS VDL CAPACITY AND FATDMA PLANNING**

Virtual AtoN services transmitted on an AIS VDL typically use the FATDMA protocol.

If the population of virtual AtoN in a given area is too high, this may overload the VDL FATDMA slot capacity. This should be overcome through careful FATDMA planning (IALA Recommendation A‐124 refers).

* + 1. **DISPLAY LIMITATIONS**

Although there are clear benefits that can be gained by providing safety information through virtual AtoN, it must be borne in mind that not all ~~very few~~ SOLAS class ships, or other craft, may have the ability to display the virtual AtoN. Some smaller craft may never have the ability to display virtual AtoN.

MKD – All SOLAS class vessels are required to be fitted with a Class A AIS station and many non‐SOLAS vessels voluntarily carry Class A AIS or Class B AIS stations. However, ~~currently, few~~ a growing number of vessels integrate the AIS data into a navigation display such as ECDIS or Radar. The display of virtual AtoN on an AIS MKD is limited to alpha‐numeric text and, on some units, a graphic display, although there is no standard for such display.

Radar – Only radars that meet the revised performance standard, which came into force in 2008, have a requirement to be capable of displaying a virtual AIS AtoN. However, there is currently no requirement for the AIS to be integrated or displayed on Radar.

ECDIS – ECDIS mandatory carriage requirement for certain classes of SOLAS vessels is being implemented in stages up to 2018, however the current ECDIS performance standard MSC 232(82) does not require AIS or other virtual AtoN to be able to be displayed, nor to be integrated.

Administrations should take into account the limited display capabilities for AIS, or other forms of transmission, for all classes of seaborne craft when assessing the value and risks associated with transmitting virtual AtoN.

# LEVEL OF SERVICE

## AVAILABILITY

The basic principles for categorising AtoN in accordance with their importance is described in Recommendation O‐130 (IALA Category 1, 2, or 3). Virtual AtoN Services should be categorised in the same manner.

If a transmitting site is transmitting signals for multiple virtual AtoN, the most critical one would determine the availability requirements for the service. It should be noted that virtual AtoN transmitting sites must deliver a specified minimum signal strength at the user antenna within a specified service area.

IALA Recommendation A‐126 defines the required availability for virtual AIS AtoN and sets the service area criteria in terms of required signal strength.

Similar signal strength criteria should be defined for transmissions transmitted via means other than AIS.

Availability is determined by the ability to deliver the specified reporting rate, signal strength and valid information content. Virtual AtoN criteria should be specified for each of these elements in order to clearly define when the service is no longer available (failure state).

## INTEGRITY ALERTING

Authorised service providers should have the ability to provide users with warnings within a specified time when a virtual AtoN service is not available.

The warning should be given within a time frame compatible with the criticality of the AtoN (IALA Categories 1, 2 and 3).

Warnings may be issued as MSI and, in the case of AIS, using the flags of message 21, using message 14 or by any other appropriate means.

There is a requirement for integrity monitoring. Such monitoring schemes should be independent of the system providing the basic service. Integrity monitoring can take place both onboard a vessel and ashore.

Shipborne monitoring is limited to validity checking of the received datagram and the reporting rate of the virtual AtoN.

## CONTINUITY

Continuity is the probability that, assuming a fault‐free system at the receiving end, the virtual AtoN will be received and displayed on the navigational display over the time interval applicable for a particular operation.

The continuity of a virtual AtoN service should be determined as described in Recommendation R‐121. The time interval should be chosen as 3 hours, or a suitable time frame as determined by the authority providing the service. The probability should be according to the category (IALA categories 1, 2 and 3) of each virtual AtoN. If a transmitting site is transmitting signals for multiple virtual AtoN, the most critical one would determine the continuity requirements for the service.

# DEVELOPMENT CONSIDERATIONS

For the full benefits of virtual AtoN to be realised, a number of issues must be addressed in consultation with other bodies, including:

* appropriate instruction and training of all mariners and providers as to the provision of virtual AtoN, symbology, display, and limitations;
* harmonisation of integration and ship navigation system specification to enable the display of virtual AtoN for SOLAS ships and other users;
* a strategy for implementation of virtual AtoN using non‐AIS based systems;
* the harmonisation of the use of MSI by virtual AtoN within the context of the IMO’s e‐Navigation concept;
* harmonised presentation of virtual AtoN.

# ACRONYMS

AIS Automatic Identification System

AtoN Aids to Navigation

DGPS Differential Global Positioning System

ECDIS Electronic Chart Display and Information System ECS Electronic Chart System

EGC Enhanced Group Calling

FATDMA Fixed Access Time Division Multiple Access GNSS Global Navigation Satellite System

GPRS General Packet Radio Service

GPS Global Positioning System

HF High Frequency

IALA International Association of Marine Aids to Navigation and Lighthouse Authorities IBS Integrated Bridge System

IEC International Electro‐technical Commission

IHO International Hydrographic Organization

IMO International Maritime Organization INMARSAT International Maritime Satellite Organization ITU International Telecommunication Union

ITU‐R ITU Radiocommunications Sector

ITU‐R‐M ITU‐R M series Recommendations and ITU‐R M series Reports LORAN LOng RAnge Navigation

MF Medium Frequency

MIO Marine Information Overlay

MKD Minimum Keyboard and Display

MMSI Maritime Mobile Service Identity

MSC Maritime Safety Committee (IMO)

MSI Maritime Safety Information

NAV Sub‐Committee on Safety of Navigation (IMO) NAVTEX Navigational Telex

RAIM Receiver Autonomous Integrity Monitoring RCC Rescue Co‐ordination Centre

SAR Search and Rescue

SN/Circ. Safety of Navigation Circular (IMO)

SOLAS United Nations Convention on Safety of Life at Sea

t.b.d. to be decided

Virtual AtoN Virtual Aid to Navigation VDL VHF Data Link

VHF Very High Frequency

VTS Vessel Traffic Services

VTSO Vessel Traffic Services Operator

WiMAX Worldwide Interoperability for Microwave Access

# REFERENCES

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3. MSC 232(82) Performance Standards for ECDIS
4. MSC.192(79) Performance standards for radar equipment
5. MSC.191(79) Performance Standards for the Presentation of Navigation‐Related Information on Shipborne Navigational displays
6. MSC 86/23/7 New symbols for AIS‐AtoN ‐ Submitted by Japan
7. IMO SN/Circ. 243 – Amendments to Guidelines for the Presentation of Navigation‐Related Symbols, Terms and Abbreviations
8. IMO SN/Circ. 266 Maintenance of ECDIS Software
9. IMO SN/Circ. 289 Guidance of the Use of AIS Application Specific Messages
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11. IMO MSC.1/Circ. 1473 Policy on use of AIS Aids to Navigation
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15. IHO S‐57 Transfer Standard for Digital Hydrographic Data
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18. IHO S‐101 ENC Product Specification (ENC Product Specification based on S‐100 (not to be adopted before 2012 at the earliest))
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26. IEC 61193‐2 Class A shipborne equipment of the universal automatic identification system (AIS) ‐ Operational and performance requirements, methods of test and required test results AIS Class A
27. IEC 62288 Presentation of navigation‐related information on shipborne navigational displays
28. IEC 62320‐2 AIS AtoN stations ‐ Minimum operational and performance requirements ‐methods of test and required test results
29. IEC 62388 Maritime navigation and radio‐communication equipment and systems – Shipborne radar ‐ Performance requirements, methods of testing and required test results

New section:

***ANNEX A APPLICATION OF VIRTUAL AIDS TO NAVIGATION***

### Note

The use of virtual AtoN is only suitable for vessels that have appropriate display equipment.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Application Mode** | **Function** | **Description** | **Type of Virtual AtoN AIS** | **Consideration** |
| *Permanent Marking of Obstacles* | Marking of Shoals and Reefs | Virtual AtoN can be effectively utilized where it is difficult to place or to maintain a physical AtoN due to sea state, winds or other environmental conditions. A clear marking of the shoals and/or reefs will improve safety of navigation | Isolated Danger Marks & Cardinal Marks | * Integrity monitoring * ECDIS and radar reliability |
| *Permanent Marking (navigation support)* | Marking of Fairway Limits | Virtual AtoN can be effectively utilized where a physical AtoN placement is difficult due to the water depth, seabed, etc. | Lateral Marks | * Too much information for mariners |
|  |  | A clear marking of the fairway  limits serve for ordinary flow of marine traffic and improved safety of navigation. |  |
|  | Marking of Fairways | Virtual AtoN can be effectively utilized where a physical AtoN placement is difficult due to the water depth, seabed, etc. | Lateral Marks, & Safe Water Marks | * Too much information for mariners |
|  |  | A clear marking of fairway will  improve safety of navigation. |  |
|  |  | Virtual AtoN can be effectively utilized in approaches to a harbour entrance where a ship changes its course and where it is difficult to install a physical AtoN. | Safe Water Marks | * Too much information for mariners |
|  |  | A clear marking of the point on  approach will serve for an orderly flow of ships at an entrance and improve safety and efficiency of shipping. |  |
|  | Marking of Fairways & Marking of the Limits of Safe Waters | Virtual AtoN can be effectively utilized where navigation becomes difficult due to a thick fog, heavy rain, etc. (This application can also be adapted as a temporary marking during limited visibility.) | Lateral Marks & Safe Water Marks | * Should be temporary |
|  |  | Marking of a recommendable  fairway during times of limited visibility will serve to improve safety of navigation and efficiency of shipping. |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Application Mode** | **Function** | **Description** | **Type of Virtual AtoN AIS** | **Consideration** |
| *Permanent Marking* | Special area (e.g. anchorage area, area to be avoided) | Virtual AtoN can be effectively utilized where pre‐caution or special caution required.  A clear marking of special area will improve safety of navigation. | Special Marks | * Too much information for mariners |
| Temporary Marking | Marking of a Navigational Restricted Areas | Virtual AtoN can be effectively utilized when navigation restriction is required due to e.g., marine accidents or when marking of wreck or offshore operations.  A temporary navigation restriction can prevent subsequent incidents from developing. | Cardinal Marks, Emergency Wreck Marks, Isolated Danger Mark & Special Marks | * Need to be monitored / updated * Timely deployment required |
|  | Designation of Temporarily Recommendable Fairways | Virtual AtoN can be effectively utilized for indication of fairways when a scale disaster hits the area. | Lateral Marks & Safe Water Marks | * Need to be monitored / up dated * Timely deployment required |
|  |  | A clear marking of temporarily  recommendable fairways will be expected to serve for the relief ships dispatched to the site and to support safe and effective relief activities. |  |
|  | Marking of Aids to Navigation that are malfunctioning or off position | Virtual AtoN AIS can be effectively utilized when a physical AtoN has lost ability to perform regular functions due to a natural disaster.  When a physical AtoN has lost its ability to perform regular functions due to natural disasters, recovery actions are required at the earliest opportunity. Virtual AtoN can respond to the circumstance, even if the actions by personnel cannot be achieved due to meteorological and/or hydrographical conditions, and keep the influence of the disaster on ships navigating at a minimum level. | Cardinal Marks, Lateral Marks, Isolated Danger Marks, Safe Water Marks & Other Position Marks | * Timely deployment required |
| Temporary | Pilot boarding | Virtual AtoN will be useful to | Special Marks | * Timely deployment required |
| Marking | station | mark a pilot station where |  |
|  |  | position depends on sea |  |
|  |  | condition. |  |

New proposed section:

Use of V-AIS AtoN in confined waterway

Scope.

Navigation in narrow channel where there is less room to manoeuver a vessel, such as in pilotage waters, requires the most accurate navigational marks for safety of navigation. Mariners have started incorporating the use of virtual AtoNs on radar, when such AIS interface is available, as a means to supplement their existing navigational means.

Mariners see the value in the way virtual AIS AtoN highlight and allow for the rapid positive identification of some natural or artificial navigational features. This is especially beneficial during weather, ice, and situations with traffic radar cluttering. Racons continue to be an essential element and should be the primary choice as they are isolated from any GNSS induced ~~errors but resources may limit their deployment~~.

There have been reports of virtual AIS symbols appearing offset from where they were expected to appear on the radar. This is usually represented by a mismatch between a definite radar echo, such as a fixed AtoN pillar, and the cross lines centered on the virtual AIS AtoN symbol. An important factor to consider with AIS interfaced on a radar, is the AIS positional process. The virtual AIS AtoN position displayed on the radar PPI is based on the calculation that is made between the virtual AIS AtoN broadcasted position and the ship’s actual GNSS position through the process of Latitude/Longitude being converted to bearing/distance. Any error with the GNSS position, for example an error caused by time lag, will directly impact where the virtual AIS AtoN symbol will appear on the radar. This may mislead mariners into thinking that the virtual AIS AtoN broadcasted position is faulty which is most likely not the case.

Once the AIS AtoN provider has validated that the virtual AIS AtoN broadcast is adequate and contains no errors, some assumptions can be made regarding the possible causes of shipborne-related errors. The ITU standard allows for accuracy in the magnitude of 20cm. This is an important process in order to help the user build confidence in the ~~new~~ service.

The potential sources of errors can be classified in three categories:

1. Limitations of the GNSS interfacing with the radar system:

* Time delayed error (smoothing update too long, processing, etc.).
* Quality of the equipment and/or wrong settings (geographic datum, lack of upgrade in the firmware, non-supported model, etc.).

1. Limitations of the shipborne navigational system:

* Equipment truncating or rounding the precise coordinate being broadcasted.
* Small scale in use causes distance and bearing errors that degrade the accuracy of the comparative radar target.
* Gyrocompass errors lead to bearing errors for the comparative radar target.
* Physical position of the vessel in relation to the radar target. ~~There is some distortion in bearing when targets are ahead or behind the vessel and distortion in distance when targets are abeam.~~

1. Antenna offset:

* GNSS antenna and/or radar antenna location on the ship are not related precisely to the Consistent Common Reference Point (CCRP) of the ship, usually the conning position.

Authorities are encouraged to warn their users about these potential position offset situations. Some of the solutions and guidance proposed to manage these issues are listed below:

* Users may validate if the displayed virtual AIS position in the information box of the radar is identical to the advertised one in the MSI or official publication. Validating the location and the associated information of the AIS AtoN symbol on other display system such as ECDIS, ECS, PPU, etc. can also provide meaningful information.
* Users may use the Target Tracking (TT) tool of the radar and place it directly on the AIS AtoN to validate that the TT coordinates displayed match those advertised for the virtual AIS AtoN. The use of largest possible radar scale is recommended in order to get the best TT accuracy.
* Some authorities have started providing synthetic and/or virtual AIS AtoN schematic reference point patterns associated with well-defined navigational marks to assist mariners in assessing the magnitude of the position offset. Some radar tools, such as the EBL and VRM, can be used to validate that the displayed information is identical to that provided on the schematic reference point diagram.