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| From: ARM Committee | ARM10-13.2.1 |
| To: PAP and ENG Committee | 18 October 2019 |

LIAISON NOTE

AtoN provision in cold climates

# Introduction

China MSA provided an input paper ARM10-3.11 (Annex A) to the ARM10 Committee regarding provision of AtoN in northern Chinese waters during ice conditions. The document details the challenges facing the authority during winter, not only from ice damaging floating AtoN but also fixed marks losing function due to snow and fog.

The paper also describes suggested methods of dealing with these challenges by limiting the use of floating AtoN to critical points in a fairway, increased emphasis on fixed AtoN and the use of transponders, both Racon and AIS. The paper also suggests using virtual AtoN where use of physical AtoN is challenging.

The CMSA requested that IALA consider developing relevant guidance for provision of AtoN in ice conditions.

# Comments from the ARM Committee

* Several IALA members have many years of experience of providing AtoN in harsh ice conditions and have established methods in place.
* There are floating AtoN specifically designed for use in icy waters. Various types of ice buoys are used in e.g. North America and Scandinavia with good results. Using this kind of floating aid makes it possible for an authority to use floating AtoN with sufficient daymark and radar conspicuity capacity that can be deployed without needing to be removed or replaced during winter.
* Fixed AtoN at critical positions can be fitted with heating to reduce the risk of being obscured by ice and snow.
* Radar reflectors or racons can be added to existing fixed AtoN to enhance radar detection in icy conditions during winter.
* Virtual AIS AtoN should be used with caution, due to observed offset location of the broadcasted position on the shipborne navigational display. The ARM Committee is currently updating the guidance on the use of virtual AIS AtoN in Guideline 1081.

There is currently an IALA Guideline 1108 The challenges of providing AtoN services in polar regions, whilst guideline G1136 provides guidance on AtoN services in extremely hot and humid climates. G1136 was produced following a workshop on the subject in 2016.

# Action requested

The committee is requested to consider drafting or expanding relevant guidance on the provision of AtoN in cold climates.

# Annex A

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**Practice on AtoN Distribution During Freeze-up in the North China Sea**

1. **Summary**

This document introduces the AtoN distribution scheme and experience adopted by the various ports in the ice-covered ports in the northern China in accordance with their geographical locations. By demonstrating case, it proposes that AtoN in ice-covered waters should be distributed in locations, such as individual side of fairway, critical waypoints and large space of fairways, with the AtoN on land and radio marks as complement, which jointly contribute to the distribution of AtoN in the ice-covered water, in order to provide insightful inputs for the distribution of AtoN in the ice-covered waters, further enhance the AtoN efficiency during freeze-up and reduce AtoN losses brought by the sea ice.

* 1. **Purpose of the document**

The document is expected to provide insightful inputs for the distribution of AtoN in the ice-covered waters by drawing experience from our practice in the ice-covered area of northern China.

* 1. **Related documents**

1. **Background**

The most common ice condition in winter in North China Sea is ice-covered throughout the year, and the Bohai Sea suffers the most serious ice condition with its sea ice thickness reaching half a meter and extending for tens of nautical miles.

The navigation assistance in ice-covered ports during freeze-up faces great difficulties, for the buoys of common use fail to function effectively due to their movement, drifting away, damage and even sinking in case of their encounter with sea ice through squeeze, clash, entrainment, frozen adhesion and fiction, and for the light range and visual effect of light beacons and other marks on land decrease due to heavy snow and fog.

Therefore, a scientific and reasonable distribution plan, together with various means, can contribute to the effectiveness of AtoN during the freeze-up.

1. **Discussion**

**3.1 Suggestions on distribution of floating marks**

**3.1.1 Buoys should be installed individually rather than in pairs.**

Buoys should be installed individually rather than in pairs during freeze-up .Even in the water area where the condition is complex such as the crossroads of the fairway, if it is inevitable to install buoys on both sides of the fairway, the distribution of paired buoys on both sides will be avoided. It is better to install buoys at large staggered angle, which is convenient for ships to control the navigation in the unmarked fairway and can reduce the collision probability with AtoN, taking account of the specific situation that the buoy is covered by floating ice and cannot provide navigation assistance.

**3.1.2 Instalment of buoys should be few during freeze-up.**

In view of the fact that buoys may be damaged by the collision and extrusion of the floating ice, or be covered by the floating ice during freeze-up, which result in limited observable time of navigation assistance, it is necessary to pay attention to the vessels’ navigation risks brought by AtoN when it suffers damage or in unobservable period. In addition, considering that floating ice will increase the maneuvering difficulty of vessels and the frequency of vessels’ sailing out of the fairway, as well as the frequency of non-limited draft vessels sailing in and out of the fairway, the number of buoys’ installment should be decreased during freeze-up, which only should be installed at the key points and waypoints of the fairway, so as to meet the minimum navigation needs of vessels, maximize the water area for vessels to navigate and reduce the probability of collision between vessels and buoys.

**3.1.3 Distribution plan of buoys should be in accordance with the local conditions during freeze-up.**

Buoys should be classified and installed scientifically in line with regional ice conditions. According to ice conditions and previous management experience, for those areas with most serious ice conditions, all the marks should be removed due to the fact that the ports are closed for the suspension of production; for those areas with serious ice conditions, and buoys with strong ice-resistance should be installed on one side and at critical waypoints and large space of fairway; for those areas with moderate ice conditions, the number of marks should remain unchanged and all of them should be replaced by buoys that are available during freeze-up, in order to meet the needs of the production and operation of ports.

**3.2 Suggestions on distribution of fixed marks**

Fixed marks have the advantages in accurate location and stable navigation assistance, whose navigation assistance efficiency should be ensured during freeze-up. Therefore, the design of distribution plan of AtoN in the ice-free periods should take consideration of the navigation assistance needs of fixed marks in ice-covered periods.

**3.2.1 Fixed marks in water**

It is an effective way to solve the problem of seasonal navigation that fixed marks in water and marks on land are used together to build a complete and continuous AtoN chain of fixed marks. The instalment of fixed marks in water should comprehensively consider their ice-resistance strength, and whether they posses good long-term viability during freeze-up. Lights and radar transponders installed at fixed marks in water could provide continuous navigation assistance information, together with other fixed marks, and then vessels can navigate in accordance with the information obtained to ensure their safe entry and exit.

**3.2.2 Fixed marks on land**

The man-made fairway should install one group or above leading marks to ensure the efficiency of navigation assistance of land marks for ice-covered port during the freeze-up period. The efficiency of land marks on land should be strengthened on condition that the number of marks in water is insufficient.

**3.3 Suggestions on distribution of radio marks**

Developing high-tech digital AtoN and improving the overall efficiency of navigation assistance is in line with the development trend of AtoN, and it also provides an effective way to improve the efficiency of navigation assistance in winter.

**3.3.1 Improving the application of DGNSS’s high precision location and navigation**

The role of DGNSS high precision navigation is significant on the condition that the performance of navigation assistance is poor in winter. The operation and management of RBN/DGNSS should be strengthened and stable DGNSS signal should be provided for vessels. At the same time, maritime and shipping sectors should increase the promotion of the new type of marine DGNSS and the application of sailor’ portable DGNSS to enable navigators to accurately locate and navigate in order to ensure the safe navigation of vessels.

**3.3.2 Improving the application of transponders**

The application of transponders should be improved for the fact that radar transponders and AIS transponders can provide all-weather navigation assistance information for vessels under adverse conditions such as rain, snow and fog. Radar and AIS transponders should be appropriately installed on fixed marks in water to achieve information consistency of radio navigation assistance, and they should be appropriately installed on land marks if there’s no fixed mark in water. Their instalment could offset the insufficient navigation assistance of visual AtoN during freeze-up and strengthen the navigation efficiency of land marks.

**3.3.3 Instalment of virtual AIS marks**

Virtual AIS mark, which is based on AIS system, will appear on the display screen of vessels’ AIS terminals, aiming at AtoN symbol arranged in the specified position. During freeze-up, virtual AIS marks can be installed to provide navigation assistance when it is difficult to install buoys in important positions of fairway or dangerous sea areas.

**4. References**

None

1. **Action requested of the Committee**

The Committee is requested to note the above-mentioned measures that have been taken by China thereof and develop relevant guidance on AtoN distribution during freeze-up.

**Annex**

**Practice on AtoN Distribution during Freeze-up in the North China Sea**

1. **Background**

The navigation assistance in ice-covered ports during freeze-up needs special consideration, for the light buoys of common use fail to function effectively due to their movement, drifting away, damage and even sinking in case of their encounter with sea ice through squeeze, clash, entrainment, frozen adhesion and fiction, and for the light range and visual effect of light beacons and other marks on land decrease due to heavy snow and fog.

The most common ice condition in winter in North China Sea is ice-covered throughout the year, and the Bohai Sea suffers the most serious ice condition with its sea ice thickness reaching half a meter and extending for tens of nautical miles, as shown in Figure 1.Sea ice is destructive under the effect of wind and current, which not only makes the light buoy face the risk of damage and drift, but also brings great inconvenience to the navigation and operation of ships. In order to ensure the normal performance of navigation assistance in winter, safeguard the safety of ships, further support port construction and serve regional economic development, it is of particular significance to guarantee winter navigation assistance.

At present, international and domestic standards and concepts on distribution of AtoN are not ideal for guiding the distribution of AtoN during freeze-up in the ice-covered ports. At the same time, some issues needed to be investigated and studied in depth and systematicallyin different regions and ice conditions, such as, how to identify the number, distance, form and type of marks, how to use floating marks together with fixed marks, how to distribute AIS terminals and AIS virtual marks, and how to use radio marks and visual marks.

In view of the ice conditions of the North China Sea, this paper will propose the optimized distribution to provide high quality service with combining the practice of AtoN management for years, which means that the AtoN distribution in the freeze-up period should optimize the distribution plan to provide quality AtoN service and take full account of the necessity of navigation management, on the basis of meeting the minimum requirements of ship’s navigation safety. Taking the account of the need of navigational aids, ice conditions and various properties of AtoN, the distribution of floating, fixed and radio marks should be comprehensively considered to achieve complementary results and improve the efficiency of AtoN during freeze-up.



**Figure.1.Sketch map of sea ice area extraction in the Bohai Sea**



**Figure.2.Sketch map of sea ice area extraction in the Bohai Sea**



**Figure.3.Sketch map of sea ice area extraction in the Bohai Sea**

**2.Analysis on improving the efficiency of AtoN during freeze-up**

**2.1 Scientific distribution of marks during freeze-up**

In line with the distribution conditions of fixed marks, ice conditions and actual need, distribution form and density of floating marks should be in compliance with the following principles:

**2.1.1 Buoys should be installed individually rather than in pairs**

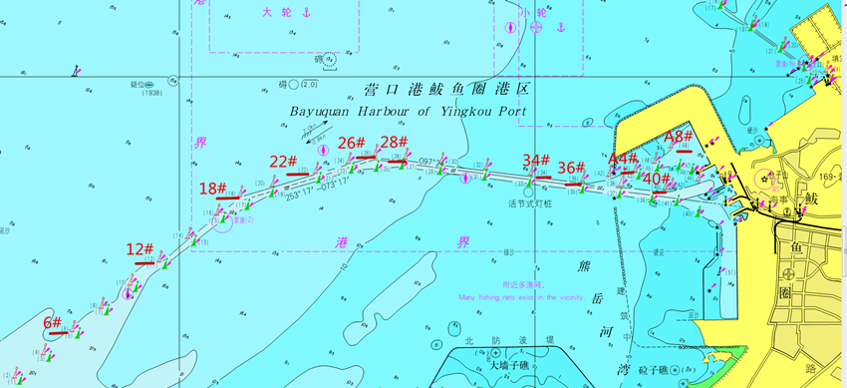
Buoys should be installed individually rather than in pairs during freeze-up.Even in the water area where the condition is complex such as the crossroads of the fairway, if it is inevitable to install buoys on both sides of the fairway, the distribution of paired buoys on both sides will be avoided. It is better to install buoys at large staggered angle, which is convenient for ships to control the navigation in the unmarked fairway and can reduce the collision probability with AtoN, taking account of the specific situation that the buoy is covered by floating ice and cannot provide navigation assistance.

**2.1.2 Instalment of buoys should be few during freeze-up.**

In view of the fact that buoys may be damaged by the collision and extrusion of the floating ice, or be covered by the floating ice during freeze-up, which result in limited observable time of navigation assistance, it is necessary to pay attention to the ship’s navigation risks brought by AtoN when it suffers damage or in unobservable period. In addition, considering that floating ice will increase the maneuvering difficulty of vessels and the frequency of ship’s sailing out of the fairway, as well as the frequency of non-limited draft vessels sailing in and out of the fairway, the number of buoys’ instalment should be decreased during freeze-up, which only should be installed at the key points and waypoints of the fairway, so as to meet the minimum navigation needs of vessels, maximize the water area for vessels to navigate and reduce the probability of collision between vessels and buoys.

**2.1.3 Distribution plan of buoys should be in accordance with the local conditions during freeze-up**

Buoys should be classified and installed scientifically in line with regional ice conditions. According to ice conditions and previous management experience, for those areas with most serious ice conditions, all the marks should be removed due to the fact that the ports are closed for the suspension of production; for those areas with serious ice conditions, for example, Yingkou Port, Jinzhou Portand Huludao Port, all the light buoys should be removed, and buoys with strong ice-resistance should be installed on one side and at critical waypoints and large space of fairway; for those areas with moderate ice conditions, such as part of the waters of Qinhuangdao Port, Tangshan Port, Tianjin Port, Huanghua Port, Zhuanghe Port, Laizhou Port and Weifang Port, the number of marks should remain unchanged and all of them should be replaced by buoys that are available during freeze-up, in order to meet the needs of the production and operation of ports.



**Figure 2 Distribution sketch map of AtoN in Bayuquan harbour basin,Yingkou**

Take Bayuquan Port area of Yingkou Port as an example, as shown in figure 2, it can satisfy perennial navigation for the fact that the ice is flowing and thin in this area in winter. However, in terms of the actual ice conditions, the ice age generally lasts from late November to early and middle March of the next year, with an average annual ice age of about 90 days; and the thickness of ice is generally 20cm and the maximum is 40cm; and it is dominated by a large area of flowing ice, which can cover several square kilometers. In view of the fact that the main fairway is distributed with one group of leading marks, the first harbour basin with one group of leading marks and a turning light beacon, A harbour basin with one group of leading marks and a turning light beacon, at the same time, taking account of the light range of modulator that are used today reaching around 3.5 nautical miles, the one-side layout should be adopted at an interval of about 3 nautical miles for the normal performance of AtoN. In addition, the 250000-ton fairway is composed of three sections, which form four important waypoints on the left of fairway, together with branch fairway of the first harbour basin and A harbour basin. 18#、26#、36#、40# buoys that are available during freeze-up should be installed at these four waypoints to achieve the basic navigation assistance efficiency of fairway.

**2.2 Practice on distribution of fixed marks**

Fixed marks have the advantages in accurate location and stable navigation assistance, whose navigation assistance efficiency should be ensured during freeze-up. Therefore, the design of distribution plan of AtoN in the ice-free periods should take consideration of the navigation assistance needs of fixed marks in ice-covered periods.

**2.2.1 Fixed marks in water**

It is an effective way to solve the problem of seasonal navigation that fixed marks in water and marks on land are used together to build a complete and continuous AtoN chain of fixed marks. The instalment of fixed marks in water should comprehensively consider their ice-resistance strength, and whether they posses good long-term viability during freeze-up. Lights and radar transponders installed at fixed marks in water could provide continuous navigation assistance information, together with other fixed marks, and then vessels can navigate in accordance with the information obtained to ensure their safe entry and exit.

**2.2.2 Fixed marks on land**

The man-made fairway should install one group or above leading marks to ensure the efficiency of navigation assistance of land marks for ice-covered port during the freeze-up period. The efficiency of land marks on land should be strengthened on condition that the number of marks in water is insufficient.

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**Figure3 Practice on distribution of fixed marks**

**2.3 Practice on distribution of radio marks**

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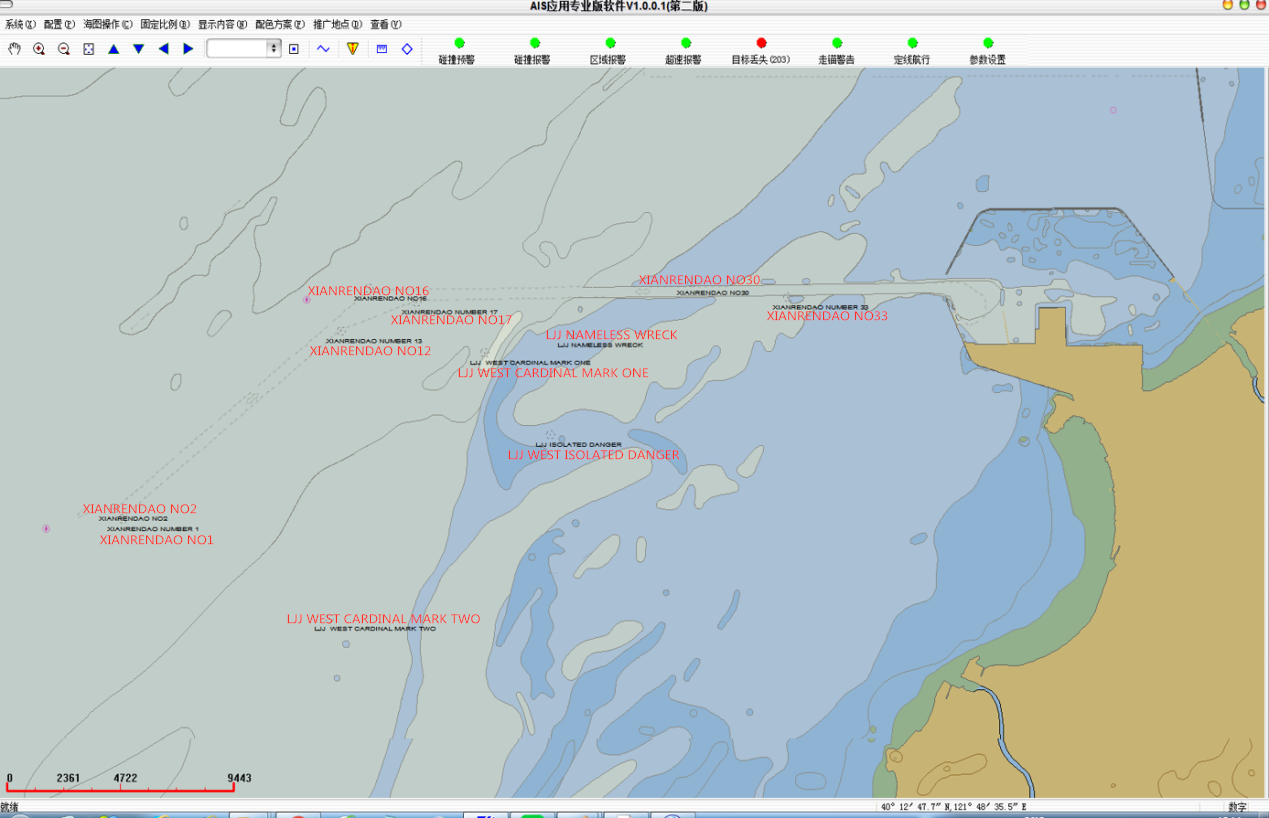
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The role of DGNSS high precision navigation is significant on the condition that the performance of navigation assistance is poor in winter. The operation and management of RBN/DGNSS should be strengthened and stable DGNSS signal should be provided for vessels. At the same time, maritime and shipping sectors should increase the promotion of the new type of marine DGNSS and the application of sailor’ portable DGNSS to enable navigators to accurately locate and navigate in order to ensure the safe navigation of vessels.

**2.3.2 Improving the application of transponders**

The application of transponders should be improved for the fact that radar transponders and AIS transponders can provide all-weather navigation assistance information for vessels under adverse conditions such as rain, snow and fog. Radar and AIS transponders should be appropriately installed on fixed marks in water to achieve information consistency of radio navigation assistance, and they should be appropriately installed on land marks if there’s no fixed mark in water. Their instalment could offset the insufficient navigation assistance of visual AtoN during freeze-up and strengthen the navigation efficiency of land marks.

**2.3.3 Installment of virtual AIS marks**



**Figure4 .Distribution sketch map of virtual AIS marks in Bayuquan harbour basin**

Virtual AIS mark, which is based on AIS system, will appear on the display screen of vessels’ AIS terminals, aiming at AtoN symbol arranged in the specified position. During freeze-up, virtual AIS marks can be installed to provide navigation assistance when it is difficult to install buoys in important positions of fairway or dangerous sea areas. As shown in figure 3, two virtual marks were installed near Lijia Reef, Yingkou in 2007, which effectively marked the dangerous areas. In 2010, virtual AIS marks were installed at all sunken vessels of ice-covered ports in the North China sea, as well as at the entrance to the fairway, waypoints and crossroads of main fairway of Bayuquan harbour basin, Yingkou Port, Tianjin Port, Qinhuangdao Port, Huanghua Port, Jingtang Port, in order to send important position information of fairway to vessels on the condition that the efficiency of marks in water cannot been guaranteed, and offer navigators various navigation assistance.