HCA11-05B

ANNEX

Precautions in using navigational charts in Polar waters

Submitted by Australia, Canada, Denmark, Norway, Russia and the United States

Background

1 At its eighty-sixth session, the Maritime Safety Committee adopted a carriage requirement for an Electronic Chart Display and Information System (ECDIS) for SOLAS vessels with an implementation period from 2012 to 2018. In this context, it has been found essential to provide guidance on navigation in Polar waters in the light of the status of Electronic Navigational Charts (ENC) in these waters in 2012 and ahead. Supplementary information is given on the special conditions for navigation in Polar regions in relation to navigational charts and positioning. This circular gives in the appendixes information for the Arctic region by Canada, Denmark - Greenland, Norway, Russia and the United States and for the Antarctic region by Australia.

2 The Polar regions cover large areas and is navigationally considered as remote. The distances between the settlements or special purpose stations are large, and the consequences of an accident may be greater in a polar area compared to more densely navigated waters, where search and rescue facilities are seldom far away. In addition to this, an accident could have a serious impact on the vulnerable polar environment.

3 Navigation in polar waters differs significantly from navigation in other (non-Polar) waters. In general, it is difficult for mariners who are not familiar with the conditions to navigate around in these areas. It is, to a high degree, due to the climate and the influence of the weather. Furthermore, instruments such as magnetic compasses may be unusable and gyrocompasses may be unreliable.

4 In waters with more frequent maritime traffic, markings and other navigational systems have normally been established to assist mariners. Due to the remote location of the polar regions and the historically low density of maritime traffic, the assistance offered to mariners in the form of charts within the scope of relevant standards and other facilities has not reached the same level as in other regions. Furthermore, floating markings are not an option due to ice conditions and great depths.

5 In addition, systematic and completely covering hydrographic surveys have not been carried out in many areas due to the wide extent of remote coast lines and archipelago areas. In other words, depth conditions can be unknown or depth data will be of poor quality in large areas. Surveys which gives the sources for a navigational chart can be hundred years old or more. For mariners it is essential to understand the limitations in the source material providing the basis for the production of paper charts and, consequently, the information given in the paper charts must be interpreted with caution.

6 Modern navigation is based on Global Navigational Satellite Systems (GNSS) as e.g. GPS. The continuous marking of the ship's position on an ENC in the ECDIS system is made by means of GNSS. Positions obtained from satellite navigation systems refer often to World Geodetic System 1984 (WGS-84) datum.

7 The use of ECDIS in polar waters requires the availability of ENCs which refer to WGS-84 datum and are produced with a correct positioning of topography, including coastline, and hydrography in the geographic net. At present, ENCs are limited available for polar coastal navigation, except for a very few exceptions.

8 In polar coastal waters, the inaccuracies in the present paper charts could endanger safety of navigation if the navigator relies on satellite based electronic navigation instead of the use of terrestrial navigation.

Navigation in polar waters in terms of inaccuracies in paper charts

9 At present, the paper charts available for polar waters are in many areas not compatible with GNSS navigation, as e.g. GPS, for several reasons.

10 Incorrect positioning of topography and hydrography in the geographic net. A major difficulty with the paper charts available for polar waters is the incorrect positioning of the coastline in the geographic net in the charts. Where the uncertainty is most distinct, the coastline may be positioned several nautical miles incorrect. In other parts the uncertainty may be less, but still at a substantive level when comparing with the accurate position achievable from a GNSS receiver.

11 Due to this fact a note has been inserted in some paper charts covering polar coastlines, stating e.g.: *Due to age, quality and some of the source material, it must be expected that positions obtained from satellite navigation system are more accurate than those on this chart* or *The difference between satellite-derived positions and positions on this chart cannot be determined; mariners are warned that these differences MAY BE SIGNIFICANT TO NAVIGATION and are therefore advised to use alternative sources of positional information, particularly when closing the shore or navigating in the vicinity of dangers.*

12 Conclusion: In the paper charts available for polar waters, the positioning of the information in the charts (i.e. topography, including coastline, and hydrography, etc.) is inaccurate, which means that ships cannot navigate safely by means of satellite navigation on the basis of the present paper charts.

13 It is important to emphasize that, despite the inaccuracies of the paper charts; it is possible for ships to navigate in coastal areas if they use their radar equipment as the primary positioning instrument and rely on terrestrial navigation methods when navigating in polar waters.

14 Chart datum. The paper charts available for polar waters can be produced in other, and less known, geographical datum's then WGS 84 datum. On each paper chart a note can be inserted giving the correction to be used if positions are obtained from a satellite navigation system, such as GPS, which refers to WGS-84 datum. This could state e.g.: *Positions obtained from satellite navigation systems refer to WGS-84 datum; they should be moved 0.08' northward and 0.25 westward to agree with the chart.*

15 For some paper charts covering distant waters and areas, the source material for chart datum may be unknown.

16 It is important to notice that the correction may vary from one chart to another and the correction is only to be used if the GNSS receiver has not been pre-selected to the referred datum.

17 The use of other geodetic datums instead of the WGS-84 may have the following effect for Automatic Identification System (AIS) which relays the ship's position signal from a GNSS receiver. It can get this information in two ways: From an external or a built-in receiver. AIS with an internal receiver transmit the ship's position in WGS-84 coordinates. AIS with an external receiver can transmit the ship's position in WGS-84 or other datums. This can give rise to misunderstandings and misinterpretations when AIS is used for anti-collision purposes.

18 Conclusion: GNSS should be used only as a secondary positioning instrument, and if used as such, mariners must be aware of the necessary correction between the reference chart datum in the paper charts and the information received from GNSS.

19 The lack of survey data or its poor quality is reflected in the charts by e.g. waters where depths are given only by passages of reconnaissance lines or even as white unsurveyed areas in the chart. Attention is also drawn to the fact that source diagrams are lacking in many of the paper charts available for polar waters. The basic lack of IHO compatible survey data for chart production should make ships keep an additional safety distance when passing underwater rocks and obstructions.

20 Unfortunately, it will be many years before all areas have been surveyed or re-surveyed and all paper charts revised accordingly. Until then, mariners should remain cautious to the dangers mentioned in this paper.

Caution to be taken in terms of inaccuracies in paper charts before navigating in polar coastal waters

21 In summary, at present caution must be taken in consideration that:

- Official ENCs are most common not available for coastal navigation.
- Normally only paper charts are available for coastal navigation, but these are not compatible with GNSS navigation.
- Paper charts have incorrect positioning of coastlines in the geographic net.
- Chart datum reference must be checked if it is a datum used instead of WGS-84 datum.
- For other areas, , the source material for chart datum may be unknown and the accuracy may be affected by the age and quality.
- Hydrographic surveys may be sporadic and areas may be considered as unexplored. In some areas, depths are only given by sounding tracks from passages of a reconnaissance nature.

22 Since official ENCs only rarely can be expected to be available for coastal navigation, voyages conducted primarily by means of GNSS navigation should not be chosen as a solution at present.

23 Furthermore, it must be noted that digital raster navigational charts (RNC-charts) used in an approved ECDIS or an Electronic Chart System (ECS) should not be considered as an

acceptable method for safe navigation in polar waters. In this case,raster charts will have been produced by means of digitalisation of paper charts and will, consequently, have inherited the topographic and hydrographic inaccuracies of paper charts.

24 Even if a position obtained from a GNSS receiver is corrected to the datum of the paper chart, where available, the navigator cannot trust the inserted GNSS-position in the paper chart due to the inaccurate positioning of the coastline in the geographic net.

25 It is important to be aware that terrestrial navigation, including the use of radar navigation, gyro, log, echo sounder and visual input, is the best method for conducting safe navigation when satellite navigation becomes uncertain. Paper charts and nautical publications become primary sources when planning and conducting a safe voyage. Terrestrial navigation will be relative to the surrounding coastline when using radar and visual observation methods.

The factor of high latitudes

26 The navigators' traditional way of observing a charted sea area is by the Mercator projection with meridians perpendicular to the latitudes. In the polar areas it is different. Here are the meridians converging towards the poles which are the centre for the concentric latitude circles. The extreme converges of the meridians makes it inappropriate or impossible in these charts to determine directions. A compass line will be curved and will differ considerable from a great circle, even at short distances. Visual bearings can not, or only with large inaccuracy, represent a compass line in the chart. This means that Mercator chart becomes more and more useless at higher latitudes, as the compass lines become less usable.

The visibility in polar areas can be considerably and visual bearings of many nautical miles can be experienced. Though using such a bearing in a nautical chart can give diverging results. Another disadvantage with the Mercator chart is the north – south going variation in scaling which gives errors in measuring distances and distortion of land areas.

27 For electronic navigation it has been revealed, that an ECDIS can be unable to display a Mercator chart north of the 84th latitude. Here it will be necessary to be able for the ECDIS to use other projection standards as the polar stereographic projection. However, other projections than Mercator has not yet been included in the current standards.

Magnetic variations

28 Magnetic variation at high latitudes can be considerably and can reach up to 180° as the magnetic poles has a dynamic position away from the geographic poles. The local paper charts should be consulted for information hereto, reminding that the accuracy of isogons information can be lesser than similar in charts from other areas.

Magnet compasses

As both the magnetic poles are in the polar regions, the horizontal intensity of the earths magnetic field is insignificant and its force is minor or absent to magnetic compasses which can be useless in some areas. The phenomenon *polar light* coursed by magnetic storms can also influence on magnetic compasses.

Recommendations on charts, ECDIS and voyage planning

29 Before planning a voyage to polar waters, the following IMO guidelines and resolutions should be consulted further in addition to the ordinary use of paper charts and nautical information:

- SN.1/Circ.207/Rev.1 on Differences between RCDS and ECDIS
- SN/Circ.213 on Guidance on chart datums and the accuracy of positions on charts
- SN.1/Circ.255 on Additional guidance on chart datums and the accuracy of positions on charts
- SN.1/Circ.276 on Transitioning from paper chart to ECDIS navigation
- Res. A.893(21) on Guidelines for voyage planning
- Res. A.999(25) on Guidelines on voyage planning for passenger ships operating in remote areas
- Res. A.1024(26) Guidelines for Ships Operating in Polar Waters

These guidelines and resolutions and other IMO guidance material can be downloaded from the IMO website, www.imo.org.

APPENDIX 1

Australia - Antarctica

APPENDIX 2

Canada

APPENDIX 3

Greenland - Denmark

Hydrographic survey. IHO Special Publication No. 55 Third Edition (2004) on status of hydrographic surveying and nautical charting worldwide, latest update of 8 May 2009, states the following for Greenland: "*The coastline of Greenland is very complex and the total sea area of the EEZ is ca. 2,000,000 square kilometres. Due to permanent ice cover, the limit for navigable waters has been set to 75 degrees northern latitude. The east coast is sparsely populated and only surveyed near populated areas. A prioritised programme is in force to resurvey navigable routes to and between populated areas on the west coast of Greenland, to modern standards*".

Present status and future developments of nautical charts for Greenland waters

Guidance to mariners on navigation in Greenland is generally given by publishing official nautical charts, nautical publications and Notices to Mariners.

The nautical charts available for Greenland waters include paper charts, port plans and, in very few cases, electronic navigation charts (ENC). Today, Greenland waters are covered by 94 paper charts of various scales, while only 10 ENCs have been produced by mid 2011. ENC coverage is, consequently, a long-term process, which has only just begun.

In 2006, the Danish Hydrographic Office launched a project with the purpose of producing improved paper charts in terms of the geometric precision of the paper charts (i.e. topography, including coastline, and hydrography, etc.). In addition to this improvement, the paper charts will also be transformed into WGS-84 datum. In the improved paper charts, the coastline will be provided with a degree of precision that makes the use of satellite navigation sound and secure.

It is expected that ENCs corresponding to the improved paper charts will be produced and published as an ongoing process ahead. Among the ENCs published, ENCs in usage band overview (corresponding to scale 1:3 500 000 for sea passage) are published in 2010. Navigational and hydrographic information is much simplified or completely left out in areas close to land. Consequently, it is only possible to use these ENCs in usage band overview for navigation in open waters.

Conclusion: At present ENCs are not available for Greenland coastal navigation, except for a few exceptions. It is expected that the ENC coverage will be continuously improved, but complete ENC coverage in coastal areas will not be in place in 2012. In coastal areas, ships will therefore as a general rule have to use paper charts for navigation.

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APPENDIX 4

Norway

APPENDIX 5

Russia

APPENDIX 6

The United States