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Regional product harmonisation guidelines for S-104 and S-111

Version history

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1.2	4.2.2026	Rephrasing of Recommendation #6: no data overlap should occur across borders Further editing and removal of	Swedish Maritime Administration (SMA)
1.3	25.2.2026	Further editing and removal of "Real Time Hydrographic and Environmental Information Service"	Swedish Maritime Administration (SMA)

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Preface

This harmonisation work and document has been started and prepared under the [Baltic Sea e-Nav project](#) (Shared waters - Same standards. Baltic Sea Partnership for Future Navigation) funded by Interreg Baltic Sea Region (EU), in close cooperation with the BSHC Chart Datum, Water level and Currents Working Group ([CDWCWG](#)) and its newly established Harmonisation subgroup. Since June 2025, the working group are responsible to coordinate the harmonisation work.

The Baltic Sea e-Nav project is dedicated to modernising the digital navigation tools for maritime navigation, in the Baltic Sea Region (BSR). The first objective is to empower data producers to generate next-generation navigational products by enhancing their capabilities and upgrading systems to S-100 standards. Secondly, the project aims to harmonise these products regionally under the Baltic Sea Hydrographic Commission ([BSHC](#)), ensuring a uniform user experience.

The workflow and status of harmonisation activities in the Baltic Sea e-Nav is presented below. After the regional harmonisation guidelines for S-104 and S-111 has been refined, it needs to be endorsed by the CDWCWG and be presented at BSHC30 in September 2025. The final adoption of the document is scheduled for BSHC31 in September 2026.



Harmonisation activities

- Activity lead of harmonisation activities: Traficom
 - A2.3 Refinement of regional product harmonisation guidelines
 - A3.2 Formally adopt regional product harmonisation guidelines and establish delivery capabilities
- Standard-specific task forces (S-101, S-102, S-104 & S-111)

Workflow and status of harmonisation activities:

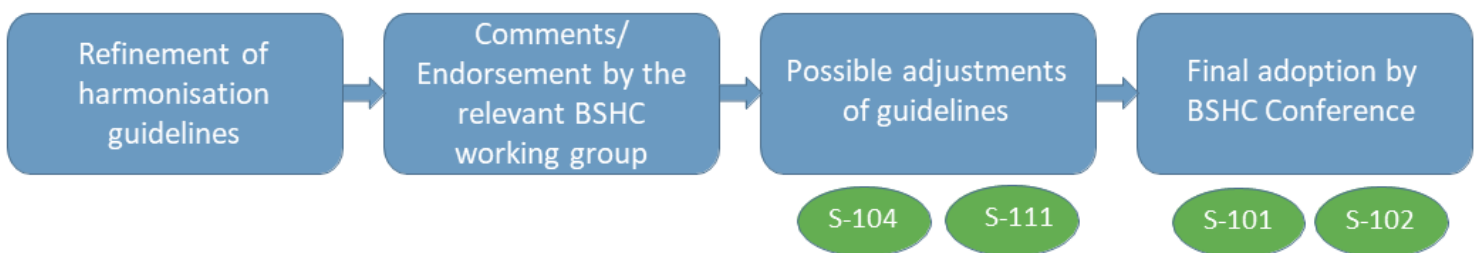


Figure 1. Harmonisation activities in the Baltic Sea e-Nav project (Status in September 2025).

Chart Datum, Water level and Currents Working Group

In 2005, the Baltic Sea Hydrographic Commission ([BSHC](#)) recognized the issue of the incompatible chart datum and established the Chart Datum Working Group (CDWG) to develop a concept of a harmonised chart datum, i.e. to implement the Baltic Sea Chart Datum 2000 ([BSCD2000](#)) as a common reference level in the Baltic Sea. BSCD2000 has been registered as Chart Datum number 44 in the IHO Geospatial Information (GI) Registry and can therefore be used as a reference datum in all future S-100 products. It applies to all national realizations of the European Vertical Reference System (EVRS).

Later, the group has been tasked to also coordinate the implementation of S-104 water level and S-111 in the Baltic Sea and the group changed name to Chart Datum, Water level and Currents Working Group ([CDWCWG](#)). The CDWCWG reports to the BSHC Conferences. The working group cooperates with relevant bodies, reviews the progress of national plans and proposes harmonisation actions. The working group also liaises with relevant IHO bodies and studies relevant IHO resolutions and specifications.

A CDWCWG Harmonisation subgroup was established in May 2025 to work on and propose harmonisation actions, such as regional product harmonisation guidelines for S-104 and S-111.

The [Roadmap](#) for the implementation of Baltic Sea Chart Datum 2000 (BSCD2000), S-104 water level and S-111 surface currents is presented below. The implementation status are summarized ([Summary 2025](#)) and available on the [CDWCWG website](#).

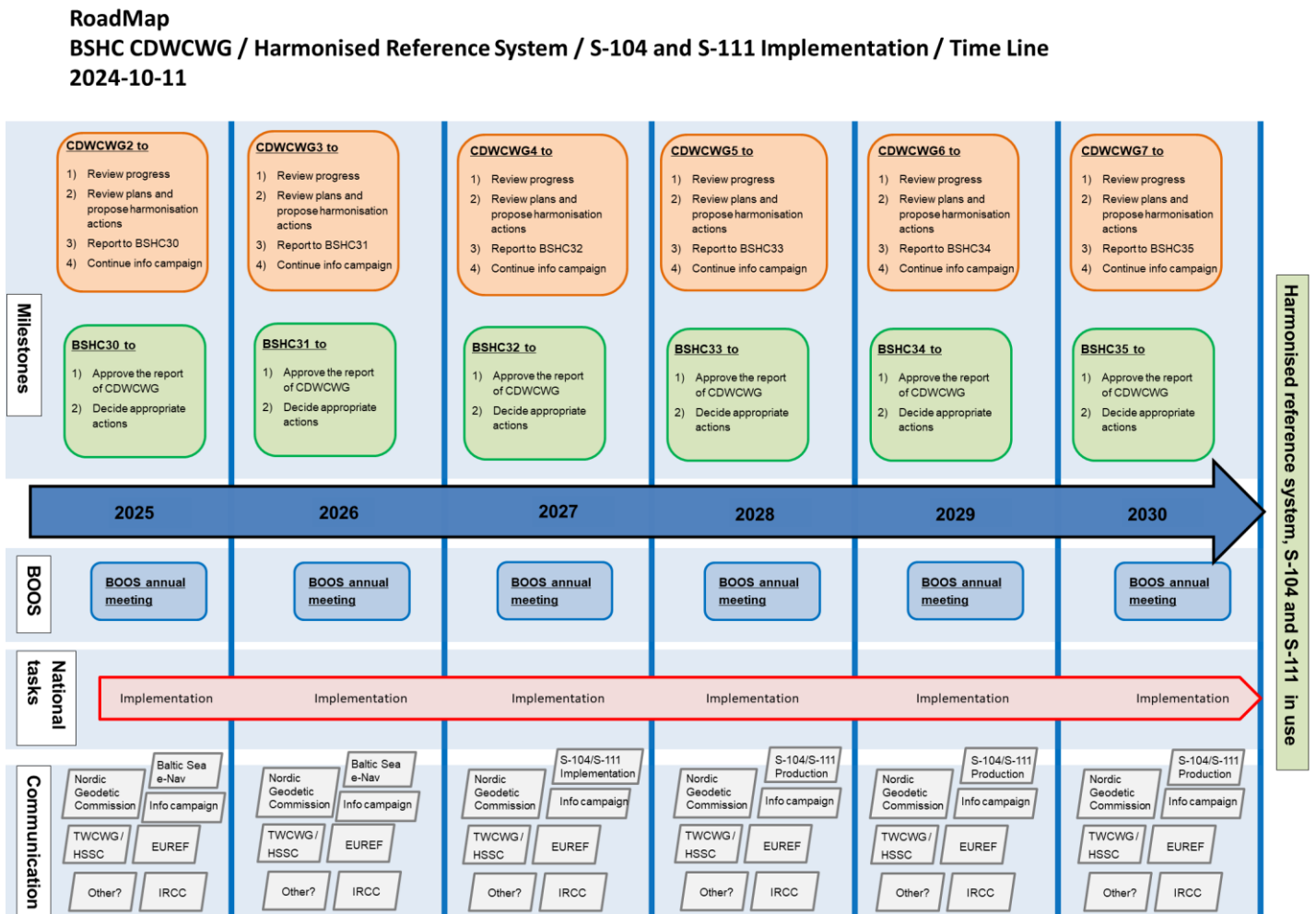


Figure 3. The Roadmap and timeline for the implementation of Baltic Sea Chart Datum 2000 (BSCD2000), S-104 water level and S-111 surface currents.

Status of implementation

Within the BSHC Chart Datum, Water level and Currents Working Group (CDWCWG), a questionnaire/survey is sent around to all Baltic Hydrographic Offices before the working group meeting (F2F meeting), which is held end of March every year. The questionnaire focuses on the implementation status of the common vertical reference level Baltic Sea Chart Datum 2000 (BSCD2000) and the two S-100 products [S-104 Water Level Information for Surface Navigation](#) and [S-111 Surface Currents](#). The intention of the questionnaire is to monitor the status of implementation and identify possible tasks to coordinate and cooperate on, such as the need for harmonisation and a coordinated roll-out plan of products in the region. The latest results are summarized ([Summary 2025](#)) and available on the [CDWCWG website](#).

The questionnaire results show a significant variation in the planned implementation of S-104 and S-111, probably due to the reason that the Hydrographic Offices are more or a less dependent on a close cooperation with the meteorological and/or oceanographic national organization (data producer) responsible for the information and data to be used to populate the S-104 and S-111 products. The cooperation is more developed in some countries and therefore the implementation is further advanced. A national S-100 board to coordinate the S-100 implementation has been established in many countries.

Some of the HO's is planning to dedicate the production of S-104 and S-111 to the national meteorological and oceanographic institute. The signing of the data files can also be dedicated to the data producer or be managed by the HO. An upcoming question is what requirements the HO's can place on data producers regarding data quality and uncertainties.

The ambition from IHO is for S-104 to focus on gridded water level data for the water level adjustment (WLA) of S-102 (high-resolution bathymetry) data, as described in the [S-98 Data Product Interoperability in S-100 Navigation Systems](#). This edition of the S-104 product specification describes one data type that can be delivered to recipients such as ECDIS or other applications, either on board a vessel or in a shore installation: A time series of water level height relative to a vertical datum and water level trend. The data represent an array of points contained in a grid. Time and datum information are contained in the metadata. The primary purpose of this data type is to enable displays of dynamic depth information on ECDIS in combination with bathymetric data (S-101 or S-102); another purpose is to update water depths for under-keel clearance management (S-129).

This requires gridded data from a hydrodynamic or oceanographic (modelled) 3D-model, tide model or predicted values from tide tables. The S-104 cells can also be populated with observed water level data represented for a larger area, such as a harbour area or fairway, located close to the tide gauge.

The implementation of point data (observations) has been excluded from S-104 version 2.0 and is proposed to be included in a new product S-105, which will be implemented in a later stage. The focus is on the finalization of S-104 and to produce a good and value-added product for the users.

For the S-111 product, point data is still included. The water velocity and direction from the surface to a given depth is to be encoded either as a time series or data represented as an array of points contained in a grid. Current direction and speed sometimes vary greatly with depth. The depth should be chosen carefully so that the S-111 product is populated with current data useful for navigation in a particular fairway. One consideration may be given to produce multiple data bands from different depths to cover the user needs of vessels with different draughts.

In the Baltic Sea, it has been agreed to present all water level and bathymetry data in relation to one common vertical reference system, i.e. Baltic Sea Chart Datum 2000 (BSCD2000). The tide gauges in the Baltic Sea has been connected to BSCD2000 ([Table](#), [Map](#)). For gridded (modelled) data close to a tide gauge, where water level observations related to BSCD2000 is available, this is done by applying a bias-correction to the gridded data. Further away from the tide gauges, a more complicated method is required, taking into account several tide gauges and satellite altimetry information.

No questions on resolution in the products or national publication plans were raised in the questionnaire. The resolution in the freely available data from the BAL-MFC regional model (NEMO) from Copernicus is one nautical mile (1.85 km). The resolution of S-102 is often much larger, typically 0.5 m to 32 m, depending on the intended use. Therefore, one S-104 cell usually will cover many S-102 cells and be representing a significant larger area than S-102.

The planned resolution of S-102 indicates considerable variation in the Baltic countries. Some countries also plan to publish S-102 in multiple different resolutions, i.e. data will also be available for different scale bands, which can also be applicable for S-104 and S-111 data. In some areas, as in harbour areas and narrow straits, a more high-resolution oceanographic model might be needed, which is able to resolve complicated oceanographic conditions. The quality and uncertainties of the gridded water level and surface currents data needs to be quantified somehow. Also, rules which scale band that will be primarily visible in the ECDIS needs to be agreed. Water level adjusted S-102 data will override non-adjusted S-102 data and S-101 ENC in ECDIS.

The file sizes of the distributed data in HDF5-format (binary format, similar to NetCDF, which is a popular format used for scientific data) needs to be considered by the data producers. A geographical or temporal division of the file might be needed if the size is too large. Today, a maximum 100 Mb (or one million values) per file is used as a pointer for S-104 and S-111 products. One problem that can occur with large files is problems for the RENC's (PRIMAR) to upload the files to their systems for further distribution to the users.

PRIMAR will validate and put a signature (and create an xml-file for each HDF5-file) on the test data sent to them within the Baltic Sea e-Nav project (a process called wrapping). Later this process will be performed by the national data producer or the Hydrographic Office.

Harmonisation in general is seen as important, especially where S-104 and S-111 products from different countries align. Two different oceanographic models on each side of the maritime border can differ a lot and this needs to be handled and corrected somehow.

S-104 and S-111 Harmonisation meetings

The harmonisation effort of S-104 and S-111 has been carried out by means of several face-to-face meetings (in conjunction with general Baltic Sea e-Nav project meetings in 2024 and 2025) and several subsequent VTC meetings. In addition to these meetings, harmonisation topics and questions has been raised in the annual CDWCWG meetings. At the CDWCWG2-meeting in Tallinn, 25-26 March 2025, a decision was taken to form a Harmonisation subgroup to deal with the regional harmonisation of S-104 and S-111, in close cooperation with the Baltic Sea e-Nav project.

Harmonisation drafts will be shared with all subgroup members and Baltic Sea e-Nav project partners followed by commenting periods. These guidelines will be endorsed by the CDWCWG and be presented at BSHC30 in September 2025. The BSHC makes the final adoption of the document, which is scheduled for BSHC31 in September 2026.

S-104 and S-111 harmonisation guidelines

This document describes the guidelines how S-104 (water level information for surface navigation) and S-111 (surface currents) should be produced in the Baltic Sea area. These guidelines are additional to the main guidelines in product specifications. If these guidelines conflict with the product specifications, the product specifications should be obeyed. In this document, a recommendation indicates an optional requirement to be followed, but is not mandatory. The product specifications can be downloaded from the [IHO's registry](#).

1. Vertical reference system

Baltic Sea Chart Datum 2000 ([BSCD2000](#), IHO code number 44) must be used as the vertical reference system for S-104 in the Baltic Sea, to be consistent with underlying S-101 and S-102, which uses the same vertical reference system. This has also been agreed by the BSHC Member States. Tide gauges providing water level observations are often levelled against BSCD2000 and gridded water level data coming from a hydrodynamic model etc. must be bias-corrected against BSCD2000, using for example water level observations and satellite altimetry information. This can be a challenge, especially if there are no water level observations available in the vicinity ([Synergy of oceanographic and geodetic data using machine learning](#)). For continuity reasons, a widely accepted and available bias correction method, should be used to systematically compare data coming from different models.

1. Recommendation: Baltic Sea Chart Datum 2000 (BSCD2000) should be used as vertical reference system for water level information in S-104.

For S-111 surface currents, the two attributes Surface Current Speed and Surface Current Direction is to be encoded either as time series (points) or data represented as an array of points contained in a grid. The current values are obtained through in situ observations or remote measurement or by analytic methods or gridded data from a hydrodynamic model. The surface current represents the water velocity and direction at a given depth relative to either a named vertical datum or an average of the sea surface down to a given depth (the latter is most widely used).

2. Recommendation: For S-111, the current values should be presented at a given depth relative the sea surface.

2. Horizontal reference system

3. Recommendation: Same horizontal reference system should be used for S-104 and S-102.

3. Resolution

The HOs face different challenges on the data production of S-104 and S-111. The gridded/forecasted data from the BALMFC NEMO model, which is available freely from Copernicus Marine Service has a resolution of one nautical mile, meanwhile the harmonisation of resolution is not considered crucial. Thus, each HO is advised to produce S-104 and S-111 data according to their capabilities and the resolution will be determined by the producing Hydrographic Office/National Authority to support safe and efficient navigation.

The S-104 product specification states that requirements pertaining to maximum and minimum resolution of S-104 grids in relation to the underlying S-101 or S-102 datasets must be met (as of the preparation of this document, these requirements are not yet defined). Also, the spatial resolution, or the spatial dimension of the earth covered by the size of a grid matrix cell (nominal ground sample distance), varies according to the model adopted by the producer. The harmonisation of resolution is not considered crucial. Thus, each HO is advised to produce S-104 and S-111 data according to their capabilities.

The question of how to choose an appropriate resolution for S-104 and S-111 for certain areas has been brought up for discussion. In some areas, like harbours and other narrow areas will require a high-resolution model to be able to resolve the oceanographic conditions and reach model results with sufficient quality, i.e. in good resemblance with the observations. Possible data restrictions may limit the resolution and/or extent of S-102 products and the availability of high-resolution bathymetry information (finer than 300 m, which is freely available from EMODNET), may limit the possibility to run such a model and get realistic results.

Balancing is needed to find the best solution between the user needs and keeping the number of products and their sizes reasonable. The data quality on the other hand impose limitations that can be tackled either by interpolating or reducing the resolution. As the primary purpose of a S-104 product is to provide water level adjustment to the S-102 high-resolution bathymetric information, it is expected to provide added value compared to the un-adjusted S-102 information or S-101 ENC. The user experience and expectations should be carefully considered when designing and producing S-104 and S-111 products to ensure usability and trust.

4. Recommendation: It is recommended to provide a S-104 water level and S-111 surface currents products based on sufficient resolution and reliable quality required to resolve the oceanographic conditions in the area.

4. Projection

The use of projected or geographical coordinate systems has its advantages and disadvantages. When using a geographic coordinate system in high latitudes the distortion of scale may become significant already within a single product - when compared to UTM projected. This is especially true on products having a larger north-south dimension, like those from the approaches to major ports in southern Finland. On the other hand, S-101 ENCs use geographical coordinate system, and thus it may appear logical to use un-projected data also for S-102, S-104 and S-111 products. The use of projection is left for each HO to decide. No harmonisation recommendation is needed regarding the use of projection for S-104 water level and S-111 surface currents.

5. Display scale ranges

Display scale ranges are essential for user-friendly experience of S-100 products in ECDIS and will be needed especially if overlapping products of different scales exist. Currently, display scale is only metadata in S-104 water level and S-111 surface currents.

6. Product scheming

When it comes to product schemes, countries have different plans and this is left for each HO to decide as no need or means for harmonisation of product schemes/boundaries were identified. The producing Hydrographic Office/National Authority will determine the coverage area for S-104 and S-111 datasets. The S-104 datasets should cover the spatial coverage of underlying S-102 datasets; see [S-98 Interoperability Specification](#) for further information.

7. Areas of responsibility

5. Recommendation: The data producers or Hydrographic Offices are responsible for the production and distribution of S-104 water level and S-111 surface currents within their area of responsibility for the production of ENCs.

8. Harmonisation of products and data meeting at borders of areas of responsibility

It is considered important to harmonise S-104 water level and S-111 surface currents close to the borders of areas of responsibility. Matters to be discussed include data coverage and differences in data. The product specifications state that there should be no data overlap across national borders.

6. Recommendation: Neighbouring countries should agree on harmonisation of data coverage and reduce differences of S-104 water level and S-111 surface currents products meeting at borders of areas of responsibility. No data overlap should occur across borders.

9. Production technique

No harmonisation is needed. Requirements for the production technique are left for HOs to decide as long as the present S-104 water level or S-111 surface currents product specifications are used.

10. Data updating

The S-104 and S-111 product specifications specifies the updates mechanism. For updating of data coming from an operational hydrodynamic model, certain procedures may be required.

7. Recommendation: It is recommended that every time a model run is finalized (typical every six hours, covering at least five days of data), the S-104 water level and S-111 surface currents products will be updated and delivered to the RENC to be made available for the end-users. If a model run is very delayed or incorrect, a cancellation of the products should be considered.

11. Encoding

Hierarchical Data Format version 5 (HDF5) is the format used for the S-104 and S-111 products, such as encoding time series of water level heights and surface currents and trends (and optionally, uncertainty) at an array of points in a grid. HDF5 is object oriented, promotes compatible data exchange due to its common neutral encoding format and suitable for many types of data and forms the basis of the Network Common Data Form (NetCDF), a frequently used format for scientific data.

12. S-104 in relation to S-101 and S-102

The documents [S-98 Data Product Interoperability in S-100 Navigation Systems](#) and [S-158:98 Cross Product Validation](#) describes the interoperability between different S-100 products in ECDIS. S-104 and S-111 are mainly not a 'stand-alone' products and will primarily not be used as single layers in ECDIS. It is not considered as an Electronic Navigational Data Service (ENDS) in that case. Due to interoperability reasons, the S-104 and S-111 will only be of interest where S-101 and/or S-102 are available.

13. Uncertainty & quality

One of the preconditions of a S-102 bathymetric surface is that the horizontal and vertical uncertainty in the S-102 dataset must be the same or “better” than the horizontal and vertical uncertainty of the S-101 base layer. Horizontal uncertainty of the S-104 and S-111 data sets is not applicable. Oceanographic validation of the data used in the S-104 and S-111 products should to be performed continuously to verify the uncertainty and quality of the data.

8. Recommendation: It is recommended to continuously monitor and validate the quality of the S-104 water level and S-111 surface currents products to ensure usability and trust.

The assimilation of observations to the gridded model data are essential to get reliable results that can be used in the S-104 water level and S-111 surface currents products. The uncertainty and quality of S-104 and S-111 can therefore be critical in areas where no observations are available.

Both uncertainty and quality of water level and surface currents bands are optional in S-104 and S-111, respectively. Due to the optional nature of these bands and the likely differing capabilities between data producers in populating these bands (e.g. differences in source information type and/or availability), harmonisation of these bands does not appear feasible. However, Hydrographic Offices and data producers should consider including, as a minimum, an uncertainty value of the S-104 and S-111 products, to provide mariners with valuable information, enabling them to understand the usability of the data for safe navigation.

The uncertainty parameters in the metadata are 'verticalUncertainty', 'horizontalPositionUncertainty', for S-104 'waterLevelHeightUncertainty' and for S-111 'speedUncertainty' and 'directionUncertainty'. The default value, denoting a missing value, is -1.0.

9. Recommendation: Set uncertainty values in the metadata of the S-104 water level and S-111 surface currents products, to provide mariners with valuable information, enabling them to determine which data is more reliable or up to date for safe navigation.

14. Geographic identifier

Name of the region is set in the metadata as 'geographicIdentifier'. For example, either an empty null value or the sub-area name can be entered, if applicable. This is up to the Hydrographic Office or the data producer to decide. For information, the BSHC has agreed on [names for sub-areas in the Baltic Sea](#).

15. Technical validation and signing of data

Technical validation of the data files will be performed by the data producer or the Hydrographic Office. For technical validation of S-104 and S-111 products, use the validation schemes for S-158:104 and S-158:111, respectively. The process to validate and put a signature to the S-104 and S-111 products is called wrapping.

S-104 Product Specification, section 10.2.2.10 Digital Certification Block: Information here is used to certify the validity or integrity of the data. This Edition does not provide for inclusion of certificates or digital signatures within the HDF5 file. When necessary, certificates and digital signatures must be provided for the HDF5 file as a whole, using the mechanisms described in S-100 Parts 15 and 17.

10. Recommendation: The data producer or the Hydrographic Office should perform a technical validation according to S-158 of the produced S-104 and S-111 data files (HDF5-format), put a signature, i.e. create and attach a signature file (xml-format) for each data file and deliver the wrapped data set to the RENC.

16. Numerous small no-data areas

Numerous small no-data areas should be avoided within especially S-104 and S-111 data coverage because of S-102 interoperability reasons. Otherwise this will cause issues with the product usability and performance.

11. Recommendation: The Hydrographic Offices and data producers aim to have continuous S-104 water level and S-111 surface current products, especially in areas where S-102 bathymetric surface are available. Therefore, the Hydrographic Offices and data producers are recommended on defining parameters (e.g. coverage and resolution adjustments or by interpolating) to assure continuous surface, ensuring usability for mariners.

17. Data provider

S-104 and S-111 data will be produced and delivered to the RENC by data providers granted by the IHO, which may be either a Hydrographic Office or a dedicated national data producer (authority). These will most likely be the main users of this document.

Summary of the harmonisation recommendations for S-104 and S-111

- 1. Recommendation: Baltic Sea Chart Datum 2000 (BSCD2000) should be used as vertical reference system for water level information in S-104.*
- 2. Recommendation: For S-111, the current values should be presented at a given depth relative the sea surface.*
- 3. Recommendation: Same horizontal reference system should be used for S-104 and S-102.*
- 4. Recommendation: It is recommended to provide a S-104 water level and S-111 surface currents products based on sufficient resolution and reliable quality required to resolve the oceanographic conditions in the area.*
- 5. Recommendation: The data producers or Hydrographic Offices are responsible for the production and delivery of S-104 water level and S-111 surface currents within their area of responsibility for the production of ENCs.*
- 6. Recommendation: Neighbouring countries should agree on harmonisation of data coverage and reduce differences of S-104 water level and S-111 surface currents products meeting at borders of areas of responsibility. No data overlap should occur across borders.*
- 7. Recommendation: It is recommended that every time a model run is finalized (typical every six hours, covering at least five days of data), the S-104 water level and S-111 surface currents products will be updated and delivered to the RENC to be made available for the end-users. If a model run is very delayed or incorrect, a cancellation of the products should be considered.*
- 8. Recommendation: It is recommended to continuously monitor and validate the quality of the S-104 water level and S-111 surface currents products to ensure usability and trust.*
- 9. Recommendation: Set uncertainty values in the metadata of the S-104 water level and S-111 surface currents products, to provide mariners with valuable information, enabling them to determine which data is more reliable or up to date for safe navigation.*
- 10. Recommendation: The data producer or the Hydrographic Office should perform a technical validation according to S-158 of the produced S-104 and S-111 data files (HDF5-format), put a signature, i.e. create and attach a signature file (xml-format) for each data file and deliver the wrapped data set to the RENC.*
- 11. Recommendation: The Hydrographic Offices and data producers aim to have continuous S-104 water level and S-111 surface current products, especially in areas where S-102 bathymetric surface are available. Therefore, the Hydrographic Offices and data producers are recommended on defining parameters (e.g. coverage and resolution adjustments or by interpolating) to assure continuous surface, ensuring usability for mariners.*