

Minutes

28th Meeting of the North Sea Hydrographic Commission Tidal Working Group (NSHC TWG28)

3rd February 2026

VTC

For reference, see the NSHC TWG [website](#).

Participants (See also Annex A)

Belgium (BE)	– Johan Verstraeten (JV)
Denmark (DK)	– Kristian Villadsen Kristmar (KK)
France (FR)	– Nathalie Giloy (NG)
Germany (DE)	– Andreas Boesch (AB) (<u>Chair</u>)
Iceland (IS)	– Daníel Þórhallsson (DP)
Netherlands (NL)	– Ronald Kuilman (RK)
Norway (NO)	– Torbjørn Taskjelle (TT)
Republic of Ireland (IE)	– Sean Cullen (SC)
Sweden (SE)	– Thomas Hammarklint (TH)
United Kingdom (UK)	– Chris Jones (CJ)

Invited experts:

BSH	– Thorben Knoop (not present)
UKHO	– Tom Cropper (TC)
DFO-MPO Canada	– Phillip MacAulay (PM)
DTU	– Ole Baltazar Andersen (OA)

1 Opening

1.1 Opening address

- The Chair of NSHC TWG, Dr Andreas Boesch (AB) from DE, opened the meeting at 0900 CET and welcomed the group to the 28th meeting of the NSHC TWG.
- He noted we have representatives from all countries involved with NSHC region, and he gave a special welcome to two new representatives, as follows:-
 - From Norway, Torbjørn Taskjelle (TT) has now taken over from Aksel Voldsund
 - From Iceland, Daníel Þórhallsson (DP) has now taken over from Gudmundur Birkir Agnarsson
- AB asked for permission to record the meeting – there were no objections to this. Recordings will be deleted after the minutes have been finalized.
- AB mentioned that the ToR's have been amended in order to expand the group to invite expert contributors. He stated this was essential for group interaction and development.
- He welcomed the Expert Contributors Dr Tom Cropper (TC) (UKHO, UK), Nathalie Giloy (NG) (Shom, FR), Thorben Knoop (TK) (BSH, DE), Ole Baltazar Andersen (OA) (DTU, DK).

- He also mentioned that Dr Phil MacAulay (PM) from the Canadian Hydrographic Service (CHS) will join later as he is interested in the group's work on harmonizing vertical reference surfaces across national maritime boundaries.
- AB mentioned he had hoped to have a representative of NOOS (North West European Shelf Operational Oceanographic System, part of the EuroGOOS system) attend this meeting, but unfortunately this was not able to be arranged. (AB has been in contact with the Chair of the Water Level & Waves WG of NOOS).
- AB briefly mentioned the Draft Agenda, which has been circulated before the meeting, and that it is based on the work plan. He outlined the Programme Items and that the agenda was quite extensive (See Agenda Item 2.3).

1.2 Introduction round

- Each delegate gave a brief overview of their roles and responsibilities within their own Hydrographic Office or relevant institution, and Sean Cullen (SC), (GSI, IR), advised that his colleague, David Hardy, may join the meeting in his place during the course of the day.
- The newest members of the group from NO, IS and FR were welcomed.
- OA mentioned the development of global vertical separation models and his long working history in their development.
- Phil MacAulay (PM) joined the meeting at 1010 CET, he introduced himself to the group – he was interested in the work to join vertical datums together, which he mentioned is not a trivial task.
- List of Participants; the List of Participants was reviewed and accepted. See Annex A.

2 Administrative Arrangements

2.1 Appoint a secretary for the meeting

- CJ (UK) volunteered to act as Secretary for the meeting. This was greatly appreciated by the Chair and the group.

2.2 Meeting Logistics

- AB explained that the timings and order of the Agenda Items / Programme Matters may change depending on how things run. There is flexibility and the aim was to finish by 1630 hrs (CET).

2.3 Adoption of the Agenda

- AB briefly went through the items on the agenda - no issues or questions were raised and the draft V2 agenda was accepted as the main agenda for the meeting.
- AB asked if anyone had a presentation they wished to give. NG reported she had some slides to present, and these will be taken under the appropriate topics of the agenda.
- The agenda was adopted without further amendment. See Annex B for the final agenda.

2.4 Report on activities since TWG27 (including minutes of TWG27 and NSHC38)

- AB thanked CJ and the UKHO for hosting TWG27, which was a productive meeting.
- He displayed the minutes from TWG27.
- He focussed on the action items the TWG received from the NSHC, which have now been completed.

- Regarding the LAT surfaces from MS, there has been one new surface from DE; so there is no specific update on “LAT differences on the North Sea” report for this meeting (as the majority of MS surfaces remain the same as the previous comparison work).
- AB summarised the action item on collating the information used to calculate LAT within each MS region.
- He went on to discuss the paper on harmonisation for sounding datum in the North Sea – he referred to the discussions within the **North Sea International Charting Coordination Working Group (NSICCWG)** as well as our own discussions within TWG on this topic. This was a chart-related discussion; not all MS were content to change to ALAT at that time. There had been a lot of e-mail ‘ping-pong’, therefore the NSHC has sent this back to NSICCWG to resolve.
- NL reported they have decided to change the reference plane for the Dutch part of the North Sea from LAT to ALAT as of 1 January 2026.
- AB mentioned the excellent set of presentations that were given at TWG27, including the various updates on MS national developments etc.
- He referred to **Action AP27/02** about the questionnaire for S-104/S-111 (See Agenda Item 4).
- He summarised the decision about alternative meetings (in person / VTC alternating each year). (See Agenda Item 11).
- Regarding the [Report on S-104/S-111 implementation to NSICCWG \(https://www.bshc.pro/wp-content/uploads/TWG_report_to_NSICCWG_2025.pdf\)](https://www.bshc.pro/wp-content/uploads/TWG_report_to_NSICCWG_2025.pdf), AB briefly introduced and explained the content of this report. The test data sets will be made available on <https://iho-ohi.github.io/S100Resources>. He highlighted the crucial roles of S-102 & S-104 working together for Water Level Adjustment (WLA).
- AB moved on to briefly outline the TWG 27 report he presented at the NSHC38 meeting, and that there was only one action for TWG (which is a permanent action):

<ul style="list-style-type: none"> • 8-9 April 2025: <ul style="list-style-type: none"> – NSHC 38th meeting, VTC – TWG Presentation at NSHC38 (local, online) – Minutes (local, online) – No new actions for TWG; one permanent action 				
Action 4/2024 C.3	TWG	The Commission tasked the TWG to report to NSICCWG on the progress of S-104 and S-111 implementation coordination. Reference: Decision 6/2023 C.2	TWG Chair	Continuous

2.5 Review Terms of Reference (ToR)

- AB (Chair) displayed the ToR’s (see Annex C).
- There were no comments or issues raised.

2.6 Review Work Plan and List of Actions

- AB displayed the current Work Plan as proposed by TWG27 to NHSC38.
- He highlighted the newer items (S-104/S-111 coordination, and also data archaeology).
- He explained the ‘clean-up’ of some “similar-type” action items into more representative single action items.

- Specifically, AP27/03 is now one action item created from the merger of similar-type individual actions.

3 LAT/CD/Reference Systems [WP 16/04, WP 18/01, WP 18/02, WP 22/01]

Introduction to BSCW shared workspace & AP 27/01: Information on how LAT/CD surfaces are calculated.

- Andreas showed the BSCW website and went through its structure, with the documents that have been uploaded.
- He referenced the work he had done to digitise the old documents from the previous NSHC meetings.
- There was some discussion on old Chart Datums and moving from one vertical datum to another (for example MLWS to LAT in Germany). And now “ALAT” is the suggested vertical Chart Datum
- Andreas showed the Member State entries in the “Overview of LAT-CD” [on the BSCW web portal <https://social.bscw.bund.de/>]
- There was discussion surrounding SE, which of course does not have an LAT surface (minimal astronomical tide)
- CJ stated it’s important to remember we are talking about Chart Datum, which is individually defined within each MS maritime areas and so having the BSCD information is important.
- Thomas Hammarklint (TH) stated it is important to harmonize the surfaces, and particularly important to manage the differences; this was a key feature and goal in the development of the [BSCD2000 datum](#).
- Kristian Kristmar (KK) referenced that DK also has a BSCD border with Sweden.

ACTION (AP 28/01): To provide a link to the BSCD reference website(s) and documentation within the BSCW web portal.

NL to undertake a comparison between BSCD2000 and other adjoining MS Chart Datums in the appropriate maritime regions where those vertical Chart Datums can be compared meaningfully.

Presentation: OA - Development in Danish / Greenland / Global LAT models from Satellites and Ocean Modelling

- OA gave a very informative presentation, which also included information provided by KK:
- The latest developments in satellite altimetry and the recent forward-leap in satellite technology
- The current version of the DK LAT model is DKLAT2023; they are now looking at creating DKLAT26 - but how different could this be?
- Since 2023 there has been a revolution in the technology – the [Surface Water and Ocean Topography \(SWOT\)](#) satellites increase spatial resolution from 8km to 250 metres! SAR of the sea surface is much improved with high accuracy. Critically, it also covers the coastal zones – no contamination within 7km of the coastline, as was the case with previous techniques.
- For the DK LAT model, they firstly obtained MSS height with respect to the reference Ellipsoid.
- Then, they take a LAT model run over 20 years; for this FES2022 is used (spatial resolution less than 2km, compared to FES 2014 which was around 8km resolution);
- There is one caveat, which is MSL change, so DTU25 is referenced to the epoch 2003 Jan 1st.
- In DK, this is ok, but in Greenland, this is more problematic, because of inaccurate bathymetry...therefore the ocean tidal modelling is unreliable. Some regions are good (i.e. NUUK), but 50km to the south, the modelling goes wrong (sea ice, limited bathy => metres of errors).

- They need physical sea level measurements over a minimum of 3-4 weeks in the data sparse areas.
- There are 6 permanent gauges now, plus GNSS interferometry gauges.
- The average error around Greenland is around 12cm, when compared with SWOT surfaces...but it is still much larger in the fjords.

Discussion:

- TH mentioned the datum of the hydrodynamic models used; that the bias between the model and observations will vary. At tide gauges you can correct that bias; but offshore you have no clue about the bias. TH said that in Estonia, they have started to use satellite altimetry (see [Microsoft PowerPoint - Ellmann et al Tallinn hydrography 2025](#)) (and that Estonia is the first Baltic nation to release S-104 & S-111 data). The satellite passes over every 2 weeks, which, although improved, is still not enough for detailed MSS derivation.
- OB commented that SWOT passes are improving and are every 4 days...and that this will continue to improve. OA stated that in Greenland it's simpler than the Baltic Sea, because 95% of sea surface variation there is due to tides, but in the Baltic that's more like 5%.
- PM advised that northern Canada has the same problem. It is difficult to estimate the behavioural changes. They built their surface generation to be able to swap in new data as it becomes available and to re-iterate the surfaces.
- OA referenced the Foxe Basin in Canada, and there is paper coming out about this soon. PM mentioned they are also looking at SWOT data now.

Presentation: AB - Updated German Chart Datum 2026

- AB gave an overview of the ALAT CD update work in DE
- They compare CD and LAT at the tide gauges every year
- In Region I (open sea and coast): they update their CD every 5 years
- In Region II (tidally influenced rivers): assess the frequency of LW dropping below CD and decide if CD required amending.
- He showed the differences between CD 2021 & CD 2026 – there were very small differences in general.
- He explained some of the comparison work with the DK published LAT values in their Tide Tables. AB also mentioned the fact there are a water level sensor from a German State agency in the Danish tide gauge facility at Højer. DE computed their own LAT at that location which gave good agreement with the latest LAT as published by DK.
- He detailed the work BSH have done in combining Ellipsoidal reference heights by using a combination of approaches via Quasi-Geoids.
- He showed the differences (mean & median) between DE & DK along their maritime boundary, and also the differences between DE & NL (smaller differences as the same modelling was used in both cases).
- The new surfaces are now [publicly available](#). The public download only permits access to the German official CD; the extended version with parts of DK & NL waters is available on request from Andreas at BSH.
- Information on German chart datum (North Sea and Baltic Sea) is available on the [BSH Website](#).

Discussion:

- PM asked about the 'striations' in the differences of old and new CD surfaces (grey lines); how are they caused? It may be related to the derivation of the harmonic constituents and how they were 'epoched'. Canada has seen similar effects in their data.
- KK asked about the differences in the some of the inland DK regions.

Presentation: NG - BathyElli version 2.2

- NG explained that FR is still working on a new version of their [BATHYELLI](#) vertical separation model, which will be completed soon.
- She showed the 12 tidal regions of France, with different CD's relative to LAT. This work has also improved the differences previously seen between LAT and CD along the UK/FR maritime border.

4. Implementation of S-104/S-111 [WP 24/01]

Presentation: AB - AP 27/02: Results from questionnaire on implementation status of S-104/S-111

S-104 questionnaire results

- AB presented the results of the S-104 questionnaire he generated in the intersessional period after TWC27.
- He reported that all the MS have now responded (as of January 2026)
- The detailed completed questionnaires can be found on BSCW workspace
- He showed the summary of responses about what actions have already been done to implement S-104 products. He also showed those actions which were planned by MS.
- The *types* of data planned by MS were displayed: Real-time observation, Astronomical prediction, Analysis Method (statistical or other methods indirect methods), Hybrid method (combination of methods), Forecast (Hydrodynamic models).
- *Extract from S-104 Ed 2.0.0 to explain the types of water level data in the last bullet point above:-*

7.1 Data sources for water levels

Water level data comes primarily from a few specific sources: observations; astronomical predictions; analyses; and forecast models. When such data are produced and quality-controlled by an approved Producing Authority (IHO Resolutions A6.3 & A6.9, S-62), they are suitable for inclusion in the water level data product.

NOTE: S-104 Edition 2.0.0 uses only data types which the water level adjustment algorithm described in S-98 can process.

Observational Data: Observational water level data comes initially from *in situ* sensors in the field (for example tide gauges deployed along a channel) and if feasible interpolated or extrapolated values where there are no observations, and are monitored by the data collecting authority. After data acquisition, the data are quality controlled and stored by the Producing Authority. Some of the observed data may be available for distribution within minutes of being collected and are described as being 'in real time'. Other data may be days or years old, and are called historical data.

NOTE: Observational Data in S-104 Edition 2.0.0 must still conform to the regular grid format.

Astronomical Predictions: Astronomical predictions are produced when a sufficiently long time series of observed water level has been obtained and the data has been harmonically analysed by the Producing Authority to produce a set of amplitude and phase constants. The harmonic values can then be used to predict the astronomical component of the water level as a time series covering any desired time interval. Astronomical predictions can also be produced by other proven methods of tidal analysis. Data available for single stations or numerous stations must be arranged by the Producing Authority into a gridded field to conform to this edition of S-104.

Analysed and Hybrid Values: Analysed water level values may be derived from sea-surface topography, data assimilation, statistical correlations or other means. A hybrid method combines two of or more approaches.

Forecast Data: Hydrodynamic models numerically solve a set of fluid dynamic equations in two or three dimensions, and rely on observational data, including water levels and winds, to supply boundary conditions. Model grids may be either regular or irregular. Such models are often run several times per day. The forecast is a simulation made for many hours into the future using predicted winds, water levels, etc. The results are saved for a limited number of times, and are stored as arrays that derive from the model's grid. These models and methods are developed, run and monitored by the Producing Authority.

- AB displayed the results on Horizontal Reference Systems implemented by MS for S-104.
- He did the same for the Vertical Reference System. It was evident there was quite some difference in the responses; but the critical point is that the S-102 and S-104 datums must match

Vertical Reference System	
9. Which vertical reference system do you use for S-104? (see Section 5.2 of product specification)	
Vertical Coordinate System EPSG code; Allowed values: • 6498 (Depth – Metres – Orientation Down) • 6499 (Height – Metres – Orientation Up)	NL: no EPSG code available SE: 1390 DE, UK, NO: 6499
Vertical Datum Reference 1 – S-100 vertical datum 2 – EPSG	NL: Approximate Lowest Astronomical Tide (ALAT) SE: 1390 DE, NO: 2 - EPSG UK, FR: 1 – S-100 vertical datum BE: EPSG 5861
Vertical Datum If verticalDatumReference = 1 this is a value from S100_VericalAndSoundingDatum If verticalDatumReference = 2 this is an EPSG code for vertical datum	NL, DE, FR: ALAT SE: Baltic Sea Chart Datum 2000 (BSCD2000) UK: 10 (approximateLowestAstronomicalTide) NO: 1301 (Norwegian Chart Datum) BE: LAT
Is this vertical reference system the same as for your S-102 products?	NL, SE, DE, UK, NO, FR, BE: Yes

- TH stated that there was a need to further develop real-time observations in S-104
- NG agreed mentioned request for real-time S-104 from some French ports, including Le Havre.
- PM also mentioned the DCF8 re-introduction to S-104 [the “S-105” type discussion ongoing within the IHO TWCWG].
- UK reported is not currently going through its RENC [IC-ENC] for distribution, but is likely to do so.
- KK asked about the S-100 vertical datum and his understanding from discussions with ISO that there appeared to be some “mixing-up” of vertical **datums** and vertical **CRS**. Each vertical datum should have an EPSG code and an S-100 enumeration otherwise some software may not allow for S-104 to properly work; leading to users circumventing to implement their own solutions.
- Temporal outputs, uncertainties and test data sets were all discussed
- JV mentioned the decision from BE to push forward with ALAT as their cartographic datum.

S-111 questionnaire results

- AB went through the summarised results of the S-111 aspects of the questionnaire.
- PM asked if anyone is creating S-111 “3-D”? Generally there were no immediate plans for MS to do this.
- JV plans to use hydrodynamic models to produce S-111; 3-D *modelling* is used...but how to implement that in a truly 3-D S-111?
- TC mentioned the possible pitfalls of data-load for the same point ‘on the ground’ but at different depths in the water column. Also, how best to portray this too?
- PM stated CHS were motivated to be able to more accurately compare model results to HADCP data at specific depths.
- RK mentioned that they have used 3-D modelling

Presentation: AB - S-104 development status in Germany

- AB showed a presentation prepared by Thorben Knoop (BSH), who was unable to attend the meeting.
- He stated that their S-104 test data has been delivered as a 5-day forecast.
- Currently, a product with astronomical predictions is developed that uses a similar technique of combining data from a 2D numerical model and from tide gauge locations
- They use a 2-D numerical model: simulated water levels with astronomical analysis and prediction from the model, then additional information from tide gauges, meaning that the forecast at the gauges is improved and aligned with official predictions at the gauges.

- It is a numerical circulation model, HBM, with ~900 m grid spacing. They conduct a harmonic analysis at each grid point over the years 2016–2020, with special care taken at drying grid points.
- They combine that with the official predictions at the tide-gauge sites (derived through the BSH technique of “harmonic representation of inequalities”).
- The test area is the Weser river mouth
- See <https://linchart60.bsh.de/chartserver/S-100/index.html> for the BSH S-1xx test datasets.

Discussion

- KK asked about the BSH HBM model – was this is an operational forecast model? AB confirmed it was. KK then asked about model downtime...for updating etc. How does that affect the output service? AB explained that the model is a highly dependent model used for national storm surge warning services etc, and so it’s continued operation is very well controlled.
- TH asked about the spatial resolution of the model in difference areas. AB stated there are nested models within the HBM main model. TH complemented BSH on the way in which they have ensured the same water level output across different products (i.e. official national tide tables are the same within the model).
- RK asked about if it was possible to send the data every 5 days to vessels. AB explained the forecast model is updated 4 times a day. He was unsure about the exact delivery method.
- PM asked about the temporal resolution output used for S-104 and S-111 files; AB confirmed it’s 15 minute time stamp.
- TC mentioned that bias correction is very important. He also mentioned the issues about filenames and updating mechanisms (the subject of upcoming discussions within TWCWG for S-104 particularly, where he explained about the incoming paper to remove the dateTime from the filename, and just increment the iteration number by one each time). He also advised that if the forecast was unavailable, then the ‘next best option’ could be an astronomic prediction and so on. He also updated on the UK’s temporal and spatial resolution, and also commented on the plan for regularly spaced grid points interpolated from irregularly-gridded native models.

Presentation: RK - Netherlands: Developments in S-104/S-111 production

- RK gave a presentation on the NL latest developments on S-104 & S-111 implementation.
- He gave a summary of activities in 2025
- He referenced their SATIS API & S-100 viewer (created by Richard Flapper)
- They are using DCF2 for S-104 and he explained the step-by-step approach taken to create this.
- He mentioned the file sizes were much larger than the 10MB limit advised in S-104 (&S-111). CJ explained that recent discussions within TWCWG will be looking to change this to a “maximum number of points” instead of hard file size limits, and that Richard Flapper had been involved in those discussions (by correspondence).
- He similarly explained the steps taken in their creation of S-111.
- RK then went on to describe the CSMART test bed for 2026. This involves an S-100 simulator trial with the world’s largest cruise company, Carnival Corporation, using their “Carnival Corporation Simulation Centre”. They intend to simulate the real-world navigation scenarios using S-100 datasets. The test period is 9-13 March 2026.
- He finished with showing some test datasets within the confirmed waters of the Port of Rotterdam.

Discussion

- JV asked about the definition of ‘confined waters’. RK said they haven’t really defined that – they are just all large harbours with complex waterways and narrow channels.

Presentation: NG - R&D and production of S-104 & S-111

- NG showed the timeline of Shom planned development for S-104 & S-111.
- Their 'perfect deadline' for both S-104 & S-111 astronomical predictions for 4 ports is March 2027.
- The port of Le Havre is actively engaged with the developments.
- The test data sets are available at <https://diffusion.shom.fr/expertises-formation/jeux-de-donnees-test-s-100.html>
- She mentioned the issue of spatial overlap of differently scaled datasets covering the same areas, and that the Product Specifications do not allow for this.
- CJ mentioned that again this would be under discussion within TWCWG following Shom raising a Change Proposal GitHub issue on the topic.

Presentation: TH - Regional product harmonisation guidelines for S-104 and S-111 (Baltic Sea e-Nav project)

- TH advised this was a 3 year project – it finishes in October 2026.
- He briefly introduced the BSHC, and the CDWCWG (CD, WL and Surface Currents WG), who are monitoring the implementation of S-104 & S-111 for the Baltic Sea region.
- All water level gauges in the Baltic Sea are now referenced to the BSCD2000 reference level.
- TH again mentioned Estonia (who have now produced S-104 & S-111 for their region).
- He showed the extensive and detailed roadmap for the development of S-104 & S-111 through the project as a whole, including the numerous links between the IHO bodies, including other national and international stakeholders.
- He showed examples of the S-104 & S-111 test data sets, including various animations of the S-104 (and S-111) during periods of extreme water levels (both low and high levels).
- TH went through the recommendations from the regional product harmonisation guidelines for S-104 & S-111. See https://www.bshc.pro/wp-content/uploads/CDWCWG_C.3_Regional-product-harmonisation-guidelines-for-S104-S111.pdf

Discussion:

- PM asked about the term 'positioning' shown on the future proposed timeline of 2026 – 20xx. TH explained it was the future thinking relating to the positioning of vessels that will be operating within the S-10x 'stack'; vertical and horizontal positioning.
- He also asked about overlaps and how the Baltic Sea regions are dealing with S-102 & S-101 overlaps?
Ensemble modelling was mentioned, where multiple solutions are provided and you choose the best to handle the varying water levels.
- PM asked about the phrase "sufficient resolution" – what does this mean – TH stated it should be at the harbour scale (i.e. a representative cell from, say, a hydrodynamic model *outside* the harbour is not good enough to reflect the conditions inside the harbour itself).
- NG asked about overlaps in S-111 (the same producer shouldn't provide overlapping data). Again there was discussion that this topic was being raised within TWCWG. She also mentioned about different producers providing overlapping datasets.

AP 26/01: Provide links to S-104 and S-111 test datasets

- AB shared the S-100 test data GitHub resource for test data sets; see <https://iho-ohi.github.io/S100Resources>
- He reminded MS to place test data sets on that resource.

Discussion: how to further coordinate the implementation of S-104 Water Level and S-111 Surface Currents in the North Sea?

- TH: asked if NSHC TWG thinks it would be a good idea to have “harmonisation guidelines” for the North Sea region (similar to those he showed for the Baltic Sea)?
- RK agreed it would be a good idea.
- KK also agreed, stating that DK have already been involved in the Baltic Sea approach, and so he sees the value in having these guidelines ‘written down.
- AB called for someone to lead on this for the NSHC region; TH advised he could commence / coordinate this task, as he is already going to do this with DK in the Skagerrak, so could extend this outward to the NSHC region.

ACTION (AT 28/02): TH to draft the guiding principles for harmonisation of S-104 & S-111 for the NSHC region, based on his experiences with the same work in the Baltic Sea region.

TWG Report to North Sea International Charting Co-ordination Working Group (NSICCWG) on the progress of the implementation of S-104 and S-111

- AB advised he will provide the report.
- KK asked about the “LAT vs ALAT discussion”, plus S-100 harmonisation; the question was whether the proposal attempted to create a datum ensemble as per [ISO 19111](#), so that the LAT surfaces should be equivalent with each other, and certainly within 30cm. AB clarified that the requested report was explicitly for S-104/S-111 coordination.

5. Data Rescue and Data Archaeology [WP 24/02]

- AB introduced the topic, briefly mentioning the large volume of analogue tidal data found at BSH last year (reported at TWCW27).
- NG gave a presentation on data archaeology at Shom, a project lasting between 2023-2027. It covers data in the Gironde Estuary. They are also working on the reconstruction of Le Havre & Cherbourg Tide Gauge series. They developed a database and interface to access the forms to enable data entry.
- A question was asked if the Nuño software was being used at Shom; NG reported that external operators are involved in the task and are using other tools.
- CJ reported some ongoing work with academic researchers who are interested in looking at the historic series of published ADMIRALTY Tide Tables (so historic predictions, not observations). They are looking at how tidal characteristics (e.g., range) has changed in estuaries over the last 100-200 years. They have mostly been using long tide gauge records. However, recently they considered they could look at historic tidal predictions. They are interested in the key changes in the published information; the evolution of the *types* of information published in the books. For example, the old books were “HW only”, then LW’s started to be published later, then “HW full and change”, then “time and height differences” at ‘Secondary Ports”, then harmonic constants etc.

6. Cooperation with other working groups

- A presentation with an introduction to NOOS activities (Water level, waves etc.) was planned, but could not be realized
- AB reported there have been no updates for this meeting.

7. Topics contributed by the participants: Presentations & Updates on national activities

Discussion Points from Germany: How to produce digital tide tables for use under SOLAS? Accessible tidal information, new Co-Tidal Charts. (see e-mail 15 Jan 2026)

Discussion - How to produce digital tide tables for use under SOLAS? / Accessible Tide Table information:

- AB reported that BSH still has printed tide tables, and showed an example of this.
- He reported that HW & LW predictions for German ports are available as free downloads.
- BSH considers that S-104 cannot fully replace tide tables
- CJ advised on the IHO Resolutions M-3 (IHO Programme 2: “Hydrographic Services and Standards”), section 2.4.7 Tides Tables and Resolution (Reference) 28/1919 as amended. Also the large amount of detail at 2.2 – Tides and Water Levels – Reference 01/2019, which gives extensive information about the advised types of information is tide tables, including digital equivalents. See <https://iho.int/uploads/user/pubs/misc/M3-E-2025.pdf>.
- CJ also mentioned the IMO Circular Reference MSC-MEPC.2/Circ.2, regarding SOLAS – see <https://wwwcdn.imo.org/localresources/en/publications/Documents/carriageonboard.pdf>
- TT advised that the Norwegian Hydrographic Service no longer produce paper Tide Tables.
- KK advised that DK produce printable PDF tide tables which they can output to their websites etc.
- PM was interested in the ‘customer feedback’ from other HO’s experiences (i.e. where they had engaged with customers to find out opinions and feedback before withdrawing tide tables etc.)
- NG reported that Shom has stopped production of tide tables a few years ago; data can be purchased on their “online shop” for a year, data for 10 days are freely available on [Horaires de marées gratuits du SHOM](https://www.shom.no/mar%C3%A9er-gratis).
- RK advised that NL still have printed tide tables and the digital equivalent is the [NLTides \(HP33D\)](https://www.nltides.nl/) product.
- TT provided an example for Norway: <https://kartverket.no/en/at-sea/se-havniva/result?id=623395&location=Moskenes>. Scroll down to find a heading called “Tide table” with links to PDFs for 2026 and 2027 that has a short introduction, the tables themselves, and information about reference levels.
- JV: BE have printed and pdf-equivalent digital tide tables. There’s a “professional version” and a “beach tourist edition”. It’s only a couple of years ago we added the “beach tourist edition” with just the coastal tide tables. They are very popular and are distributed for free through local tourist information offices.
- CJ reported that UK still published paper tide tables and has numerous online resources: [EasyTide](https://www.easytide.com/), [Tidal API](https://www.tidalapi.com/), [Tida Prediction Service](https://www.tidaprediction.com/), [TotalTide](https://www.totaltide.com/)
- KK stated that the DK tide tables are published on a “per tide gauge” basis. Both in a printable pdf <https://ocean.dmi.dk/tides/2026/Hanstholm.pdf>. And in a machine readable txt file <https://ocean.dmi.dk/tides/2026/Hanstholm.t.txt>. Both are accessible through the met office website and are often also published at the relevant harbours website as well.

Discussion - Co-Tidal Charts

- AB introduced the topic of ‘new co-tidal charts’
- CJ gave his understanding of the background of co-tidal charts in North Sea region, including the co-produced charts in the southern North Sea. He mentioned that UK had withdrawn from sale all such charts (UKHO once published 3 such charts in the region; 5057 between Dungeness (UK) and Hoek van Holland (NL). Also 5059 (southern North Sea), plus 5058 (UK Waters and also North Sea). The development of the UK Vertical Offshore Reference Frame (VORF) signalled the end of the usefulness of the co-tidal chart in the sense of using it for reduction of soundings of offshore surveys. Also, now, where offshore predictions are required, S-104-type models can be used for that.

- RK advised that during a former meeting (NSHC TWG20 in NL), action **WP15/02 – update co-tidal chart 5059**, the minutes recorded the decision to cease production.

Presentation: JV

- JV gave a brief presentation on the Notices to Mariners (NM) they had released about adopting ALAT. They will await to see how it is received (original NM on the left, translation on the right).

<p>LAT 2 ALAT</p> <ul style="list-style-type: none"> • Published in NTM on 29 January 2026. • Effective from 1st February 2026 <p><small>ALGEMENE BERICHTEN</small></p> <p><small>2026-03/079 WILDSING REFERENTIEVLAK VAN LAT NAAR ALAT</small></p> <p><small>Vanaf 1 februari 2026 wordt de naam van het referentievlak gewijzigd van Lowest Astronomical Tide (LAT) naar Approximate Lowest Astronomical Tide (ALAT) in alle nautische publicaties van de Vlaamse Hydrografie. Het referentievlak zelf blijft ongewijzigd.</small></p> <p><small>De wijzigingen zullen geleidelijk aan doorgevoerd worden in nieuwe edities van producten van de Vlaamse Hydrografie.</small></p> <p><small>Verander LAT in ALAT in alle huidige publicaties.</small></p> <p><small>from: Vlaamse Hydrografie</small></p>	<p>GENERAL NOTICES</p> <p>2026-03/079 CHANGE REFERENCE PLANE FROM LAT TO ALAT</p> <p>From 1 February 2026, the name of the reference plane will be changed from Lowest Astronomical Tide (LAT) to Approximate Lowest Astronomical Tide (ALAT) in all nautical publications of the Flemish Hydrography. The reference plane itself will remain unchanged.</p> <p>The main reason is the uniformity of the reference plane in the North Sea.</p> <p>The changes will be implemented gradually in new editions of Flemish Hydrography products.</p> <p>Change LAT into ALAT in all current publications.</p> <p>Source: Vlaamse Hydrografie</p>
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- JV gave an update on the work undertaken by UGENT on updating their national LAT surface, where the Dutch RWS / Deltares hydrodynamic models (DCSM) have been used the North Sea region.
- The final project is under evaluation.
- He also mentioned that UGENT are involved in their S-104 & S-111 product development; commenced on 1st December 2025. He gave some specific detail on the S-111 and the work to interpret the notion of “surface” current, referencing the older BE current atlases in 1992 which related to the top 10m, and by 2017 they referred to the top 20m / full water column.
- Lastly, he updated the group on a data archaeology effort capturing the reference levels used in long time series of tidal observations, and ‘tracking’ the changes in the fundamental reference level “TAW”, used since 1980, through the years it has been revised / re-calculated (1996, 2003 and 2018 [and maybe more!]).

8. Any other business

8.1 Update the List of Members

- AB showed the current list of members – some amendments were made.
- A discussion occurred on how best to handle the Expert Contributors list; KK suggested that each expert contributor (also from previous meetings) could be asked if they are happy to continue to be on the list.
- The list of members with contact details will be publicly available on the TWG website.

8.2. Review the provisional TWG website.

- AB showed the current website - <https://wwwdev.bshc.pro/working-groups/twg/>.
- He expressed his thanks to TH from SE in his work to continuously update this resource.

9. Review the Work Plan and List of Actions and unresolved issues of this meeting

- AB gave some summary discussion on this aspect – see the revised Work Plan for full details (Annex D).
- Five action items were marked “done/closed” at TWG27 and will be removed from the list.
- AP 27/02 (survey / questionnaire of S-104 & S-111) - now completed for TWC28; do we want to do this again for TWC29? Yes – this was agreed.

ACTION (AP 28/03): AB to coordinate the next survey to send to MS by 31 October 2026.

10. TWG Report to the 38th NSHC Conference and list of matters to be reported

- AB explained about the next NSHC conference being a little earlier (17-18 March) because of IHO Assembly. He reported that he will create the NSHC TWG28 report and that Thomas Dehling (DE National Hydrographer) will present it at the conference.

11. Place & Date of the next meeting

- AB displayed the schedule of NSHC Conference meetings along with the NSHC TWG meetings ‘in between’

Suggestion:
Hamburg, Germany
2-3 February 2027

Conference	NSHC Chair	VTC/Physical Conference	NSHC Vice-Chair
36 (2023)	Sweden	VTC	United Kingdom
37 (2024)	Sweden	Physical in SE	United Kingdom
38 (2025)	United Kingdom	VTC	Germany
39 (2026)	United Kingdom	Physical in UK	Germany
40 (2027)	Germany	VTC	Denmark
41 (2028)	Germany	Physical in DE	Denmark
42 (2029)	Denmark	VTC	France
43 (2030)	Denmark	Physical in DK	France
44 (2031)	France	VTC	Norway
45 (2032)	France	Physical in FR	Norway
46 (2033)	Norway	VTC	Netherlands
47 (2034)	Norway	Physical in NO	Netherlands
48 (2035)	Netherlands	VTC	Ireland
49 (2036)	Netherlands	Physical in NL	Ireland
50 (2037)	Ireland	VTC	Belgium
51 (2038)	Ireland	Physical in IE	Belgium
52 (2039)	Belgium	VTC	Iceland
53 (2040)	Belgium	Physical in BE	Iceland
54 (2041)	Iceland	VTC	Sweden
55 (2042)	Iceland	Physical in IS	Sweden
56 (2043)	Sweden	VTC	United Kingdom
57 (2044)	Sweden	Physical in SE	United Kingdom

Outlook:
 2028: VTC
 2029: Denmark

The TWG meets alternately compared to the main NSHC, i.e. when NSHC meet in person, NSHC TWG will meet via VTC, and vice-versa.

- Therefore, the suggestion is:
- 2027 (TWG29): Hamburg, Germany: 2-3 February 2027 – all agreed with this proposal.
- 2028 (TWG30): VTC
- 2029 (TWG31): Denmark
- No comments or concerns were raised.

12. Closing Remarks

- AB thanked all participants for their attendance and contribution over a long day. He expressed great thanks for the level of discussions and that this has allowed for a great deal of engagement between MS. Some good progress was made, new actions identified, and a clear way forward on continued S-104 & S-111 coordination between MS of the North Sea region identified.
- All MS attendees reciprocated these sentiments.

AB closed the meeting at 1629 CET on 3 February 2026.

ANNEX A

List of Participants

**28th Meeting of the
North Sea Hydrographic Commission Tidal Working Group
(NSHC TWG28)**

3 February 2026
VTC

Country & Organisation	Name
Belgium MDK	Johan Verstraeten
Denmark DGA	Kristian Villadsen Kristmar
France Shom	Nathalie Giloy
Germany BSH	Andreas Boesch (Chair)
Netherlands MINDEF	Ronald Kuilman
Norway NHS	Torbjørn Taskjelle
Sweden SMA	Thomas Hammarklint
United Kingdom UKHO	Chris Jones
Ireland Geological Survey Ireland	Sean Cullen
Iceland Icelandic Coast Guard	Daníel Þórhallsson

Expert contributors:

Organisation	Name
BSH	Thorben Knoop (not present)
DFO-MPO Canada	Phillip MacAulay
UKHO	Tom Cropper
DTU	Ole Baltazar Andersen

ANNEX B

Agenda

NSHC TWG28

**3 February 2026
VTC**

All times in Central European Time (CET, UTC+1)

Tuesday, 3 February 2026

<p>09:00 CET (08:00 UTC)</p>	<p>Tidal Working Group meeting commence</p> <p>1. Opening 1.1 Opening address 1.2 Introduction round</p> <p>2. Administrative arrangements 2.1 Appoint a secretary for the meeting 2.2 Meeting logistics 2.3 Adoption of the Agenda 2.4 Report on activities since TWG27 (including minutes of TWG27 and NSHC38) 2.5 Review Terms of Reference 2.6 Review Work Plan and List of Actions</p>	<p>Chair All</p> <p>All Chair All Chair</p> <p>All All</p>
	<p>3. LAT/CD/Reference systems <i>[WP 16/04, WP 18/01, WP 18/02, WP 22/01]</i></p> <p>Introduction to BSCW shared workspace & AP 27/01: Information on how LAT/CD surfaces are calculated https://social.bscw.bund.de/sec/bscw.cgi/49544985</p> <p>Development in Danish/Greenland/Global LAT models from satellites and ocean modelling</p> <p>Updated German chart datum 2026</p> <p>BathyElli version 2.2</p>	<p>Chair</p> <p>DK</p> <p>DE</p> <p>FR</p>
	<p>Break</p>	
	<p>4. Implementation of S-104/S-111 <i>[WP 24/01]</i></p> <p>AP 27/02: Results from questionnaire on implementation status of S-104/S-111</p> <p>Update S-104 & S-111</p> <p>R&D and production of S-104 & S-111</p>	<p>Chair</p> <p>NL</p> <p>FR</p>

12:30 - 13:30	Group photo Lunch	
13:30	<p>4. Implementation of S-104/S-111 (continued)</p> <p>S-104 development status in Germany</p> <p>Regional product harmonisation guidelines for S-104 and S-111 (Baltic Sea e-Nav project)</p> <p>AP 26/01: Provide links to S-104 and S-111 test datasets</p> <p>Discussion: how to further coordinate the implementation of S-104 Water level and S-111 Surface Currents in the North Sea?</p> <p>TWG Report to North Sea International Charting Co-ordination Working Group (NSICCWG) on the progress of the implementation of S-104 and S-111</p> <p>5. Data rescue and data archaeology [WP 24/02]</p> <p>Data Archaeology projects</p> <p>6. Cooperation with other working groups -/-</p>	<p>DE</p> <p>SE</p> <p>Chair, All</p> <p>Chair, All</p> <p>Chair</p> <p>FR</p>
	Break	
	<p>7. Topics contributed by the participants: presentations & updates on national activities</p> <p>Discussion points from Germany: How to produce digital tide tables for use under SOLAS?, Accessible tidal information, new Co-Tidal-Charts (<i>see email 15 Jan 2026</i>)</p> <p>Belgium: National presentation</p> <p>8. Any other business</p> <p>8.1 Update the List of Members</p> <p>8.2 Review the provisional TWG Website</p> <p>9. Review the Work Plan and List of Actions and unresolved issues of this meeting</p> <p>10. TWG Report to the 39th NSHC Conference and list of matters to be reported</p> <p>11. Place and date of the next meeting 2027: Hamburg, Germany (2-3 February 2027)</p> <p>12. Closing remarks</p>	<p>DE</p> <p>BE</p> <p>All</p> <p>All, SE</p> <p>Chair</p> <p>Chair</p> <p>All</p> <p>Chair</p>
~16:30	End of meeting	

ANNEX C**NSHC Tidal Working Group
Terms of Reference**

**Approved by NSHC38, 8-9 April 2025
As proposed by TWG27, 4-5 February 2025**

1. Objective

To provide technical advice and promote co-ordination on tidal issues especially within the North Sea Hydrographic Commission (NSHC).

2. Authority

The Tidal Working Group (TWG) is a subsidiary of the NSHC and its work plan is subject to NSHC approval. Subject to approval by NSHC the TWG is especially involved with the regional interpretation and implementation of tidal issues as identified by Tides, Water Level and Currents Working Group (TWCWG).

3. Procedures

a. The TWG should:

1. work according to the agreed NSHC work plan
2. monitor and report the progress of the work plan
3. propose new work plan items for consideration by the NSHC.
4. invite meteorological, oceanographic and geodetic experts to the working group as contributors as appropriate.

To support the identification of new work plan items deemed relevant for the NSHC, the TWG should:

5. liaise with relevant Hydrographic Services and Standards Committee (HSSC) working groups, such as TWCWG.
6. Exchange views and experiences concerning tidal issues like unifying vertical datum, analysis, modelling and related issues like sea level rise and surge.
7. Coordinate the implementation of S-104 Water Level and S-111 Surface Currents and report on the progress to NSICCWG.

b. The TWG will conduct its business mainly by correspondence. Meetings and workshops should be scheduled as deemed necessary for the accomplishment of the work plan.

4. Composition and Chair

1. The TWG shall comprise representatives of the NSHC Member State and expert contributors if applicable.
2. Decisions should generally be made by consensus, if a majority is required each Member State has one vote.
3. External contributors can contribute to the work plan but are not entitled to vote.
4. The Chair will be nominated by the TWG and approved by the NSHC Conference.
5. The Chair should monitor and report on the work plan to the NSHC.

ANNEX D

**NSHC Tidal Working Group
Work Plan and List of Actions**

**To be approved by NSHC39
As proposed by TWG28, 3 February 2026**

Work Plan

Item Number (TWG/Item)	Objective (Why/Priority)	Task Description (What/How)	HO Involved	Status
WP 16/04	Enable GNSS-based tidal reduction and the connection with the vertical datum on land	Follow developments on geoid, MSL and LAT computations for the North Sea area	All	Permanent
WP 18/01	Improve North Sea wide realization of reference surfaces	Explain and reduce differences in reference surfaces at the international boundaries	All	Permanent
WP 18/02	Improve methodologies for ERS	Exchange between HO's on operational methodologies for ellipsoidal referenced surveying for GNSS based surveys	All	Permanent
WP 22/01	Ensure common European LAT surface adoption	Follow the developments of European initiatives on new LAT surfaces	All	Permanent
WP 24/01	Regional cooperation and coordination of the implementation of S-104 Water Level and S-111 Surface Currents	Coordinate the implementation of S-104 Water Level and S-111 Surface Currents and report on the progress to NSICCWG. Make available S-104 and/or S-111 test datasets which could be compared at national boundaries in the North Sea region, investigate and collaborate on resolving any differences.	All	Permanent
WP 24/02	Data Rescue and Data Archaeology	Exchange between HO's on details and methods used in the rescue of national / international archive tidal & water level datasets, for the purposes of climate change studies, tsunami research and any such activity requiring access to these important assets	All	Permanent

List of Actions

Item Number (TWG/Item)	Objective (Why/Priority)	Task Description (What/How)	HO Involved	Status	Corresponding Work Plan Item
AP 18/01	Explain differences in realizations of LAT	Exchange on bilateral basis between involved HO's to investigate further the origin of observed differences at the boundaries between national reference surfaces	All	Permanent	WP 18/01
AP 22/02	Investigate the differences in national LAT reference surfaces at all borders	Each member state should supply all LAT updates to NL who will update the LAT differences matrix accordingly	NL, All	closed, merged into new 27/03	WP 18/01
AP 22/03	Investigate the differences in national LAT reference surfaces at all borders	Make error estimates in LAT surfaces	All	closed, merged into new 27/03	WP 18/01
AP 22/05	Ensure common European LAT surface adoption	Follow the developments of European initiatives e.g. EMODnet on new LAT	All	Permanent	WP 22/01
AP 23/02	Investigate all LAT differences at the borders and overlapping parts of surfaces using the redefined Norm	Investigate the differences at all MS borders (and overlapping parts of surfaces) between national LAT reference surfaces	All	closed, merged into new 27/03	WP 22/01
AP 24/01	UK and FR to supply 'CD to Ellipsoid' separation values along their common boundary to NL to investigate if this improves the result in any way	Charted depths in this region are reduced to 'CD', which is approximately LAT. Therefore it is important to ensure the correct surfaces are being compared with each other, then used in the 1% norm calculation (or other suitable method as decided by TWG)	FR, UK, NL	done	WP 18/01
AP 25/01	Investigate LAT differences at overlapping parts of surfaces	Each member state should supply LAT surfaces for an as large as possible area of the North Sea to NL who will compare the surfaces	All	closed, merged into new 27/03	WP 18/01
AP 26/01	Provide links to S-104 and S-111 test datasets	Link to existing IHO website, which already coordinates this: https://iho-ohi.github.io/S100Resources	All	Permanent	WP 24/01

AP 27/01	Exchange information on LAT / CD calculation and implementation	Collect information on how LAT /CD surfaces are calculated by the HO's and make it available to the group	Chair	Permanent	WP 18/01
AP 27/02	Coordinate implementation of S-104/S-111	Conduct questionnaire on implementation status of S-104/S-111	Chair	TWG28 <u>done</u>	WP 24/01
AP 27/03	Investigate LAT differences at the borders and overlapping parts of surfaces	Investigate the differences of national LAT/CD surfaces at all MS borders using the norm "50% max TVU (S-44 Order 1a)" and at the overlapping parts of the surfaces.	NL, All	Permanent	WP 18/01
<u>AP 28/01</u>	<u>Investigate CD differences at the border between North Sea and the Baltic Sea</u>	<u>Include BSCD in the comparison of CD surfaces</u>	<u>SE, NL</u>	<u>TWG29</u>	<u>WP 18/01</u>
<u>AP 28/02</u>	<u>Coordinate implementation of S-104/S-111</u>	<u>Create a draft of harmonisation guidelines for S-104 and S-111</u>	<u>SE, All</u>	<u>TWG29</u>	<u>WP 24/01</u>
<u>AP 28/03</u>	<u>Coordinate implementation of S-104/S-111</u>	<u>Conduct new questionnaire on implementation status of S-104/S-111</u>	<u>Chair</u>	<u>TWG29</u>	<u>WP 24/01</u>