3rd Tidal, Water Level and Currents Working Group Meeting

Marina Del Rey Hotel, Viña del Mar, Chile
16 - 20 April 2018

(Paragraph numbering is the same as the Agenda Item numbering and does not necessarily reflect the order in which matters were discussed. ISO three letter country codes have been used to identify individual participants)

1 Opening

On completion of the opening ceremony, at which Rear-Admiral Patricio Carrasco Hellwig, Director of the Servicio Hidrografico y Oceanografico de la Armada de Chile (SHOA), welcomed all participants to Chile and to the 3rd meeting of the IHO Tidal, Water Level and Currents Working Group (TWCWG3).

1.1 The Chair, Dr Gwenaële Jan (France) opened the meeting and welcomed all participants. She also thanked the SHOA for hosting the meeting and arranging excellent support and facilities. She highlighted the work required on the S-100 based Product Specifications (PS) and the need for all to contribute and share experience. She hoped the worked achieved at TWCWG2 would be continued.

1.2 Lieutenant Commander Carlos Zúñiga (Chile), welcomed all on behalf of the SHOA. He then provided details of logistics and the general programme. He finished by highlighting the importance of standards and information commonality.

1.3 David Wyatt (IHO), on behalf the Secretary General of the IHO and Director Abri Kampfer (Director Programme 2), thanked the SHOA for hosting the meeting and providing a high level of support and excellent facilities. He highlighted the work that had been progressed on the S-100 based PS since the last meeting (TWCWG2). He also noted the other work items, which were being progressed and encouraged all participants to remain engaged and to contribute to the collective efforts of the WG.

The Chair endorsed these sentiments and highlighted a need for continued active engagement by the TWCWG members during and between meetings to progress actions and WP items.

The Chair then invited all delegates – representing Australia (AUS), Chile (CHL), Finland (FIN), France (FRA), Germany (DEU), Italy (ITA), Japan (JPN), Korea (KOR), Netherlands (NLD), New Zealand (NZL), Norway (NOR), Perú (PER), South Africa (ZAF), Spain (ESP), United Kingdom (GBR), USA (NOAA-OCS) and invited expert contributor from CCOM/JHC UNH – to introduce themselves, Annex A.

2 Administrative Arrangements

2.1 The Secretary introduced the Agenda which was adopted, Annex B. He reported that apologies for non-attendance had been received from Brazil and Canada.

2.2 The draft timetable was introduced, it was explained that this was intended for guidance only and was not intended to be a rigid structure. Where necessary time spent on individual topics would be amended to allow an appropriate discussion. The Chair highlighted some changes which had been made to the published programme; see list of documents at Annex C.

2.3 CHL provided a short brief covering the extracurricular activities and the visit to the SHOA offices in Valparaíso.

2.4 The Chair provided an update on the report to HSSC9 (TWCWG3-2.4a and TWCWG3-2.4b) and noted the outcomes of the meeting relevant to the TWCWG (TWCWG3-2.4c). She highlighted the outstanding issues which need to be addressed. The WG was invited to investigate ways to increase interaction with the S-100WG to assist in the further development of the PS for which the TWCWG is responsible. It was felt that the request to HSSC9 to stop development of S-112 – *Dynamic Water Level Data Transfer* – and for the S-100WG to develop a more generic S-100 data transfer standard had not been fully understood and that the point needed to be raised again at HSSC10. **Action Chair**

2.5 The Action List from TWCWG2 was reviewed, it was noted that the outstanding items were covered in the agenda for the meeting and it was agreed these should be taken under their appropriate agenda item. The Secretary reiterated the need for all those leading on actions to keep the Chair, vice-Chair and IHO informed of progress and completions, so that the Action List can be kept up-dated intersessionally. A new list of Action Items would be prepared for the meeting, Annex D.

The Secretary encouraged all to contribute to the progress of agenda item actions and to regularly check the website for new items and information.

3 National Presentations

3.1 National presentations were received from Chile, Finland, Republic of Korea, New Zealand, United Kingdom and USA; all of which are available under the meeting document section, Annex C.

3.1.1 KOR provided a presentation on TideBed developed by KHOA. It highlighted the Port Oceanographic Information System for a number of ports around the coast of Korea, based on Incheon as the reference port. This was followed by information on the Korea Seamless Vertical Reference Frame. A brief on the approach for the Development of S-111 Surface Current was provided, which highlighted the work undertaken at KHOA for the prediction system and marine forecast charts. The challenges and future plans were highlighted. These presentations generated numerous questions and discussion.

3.1.2 USA provided an update brief on progress with S-412 – *Weather Overlay* – and the next developments, challenges and data encoding. The relationship with the World Meteorology Organization (WMO) World-Wide MetOcean Information and Warning Service (WWMIWS) Committee was explained, together with the use and difficulties of harmonizing with WMO publications. The harmonization with S-124 Navigational warnings was noted. Particularly the portrayal challenges, which need to be addressed, were highlighted. This presentation generated numerous questions and discussion.

3.1.3 FIN provided an update on activities in Finish Transport Agency and developments with regards to Baltic Sea Datum 2000, European Vertical Reference System (EVRS) and national height systems around the Baltic Sea, and the Finalising Surveys for the Baltic Motorways of the Sea (FAMOS) gravity observations. The relationship and work being undertaken in association with the Finish Meteorological Institute (FMI) were highlighted. This generated much discussion and numerous questions.

3.1.4 CHL provided a brief on the National Tide Gauge Network, which included details of new equipment installations and developments. It was noted that there were presently 42 stations located along the coast of Chile, it was indicated that this was being increased to 52 stations, which was considered to be the ideal number. The Tsunami warning data processing was explained and how the data comparison between different sites was conducted to measure a tsunami. It was noted that the details included in the Inventory of Tide gauges and Current meters used by Member States was not the same as the information provided in the presentation.

3.1.5 CHL provided a presentation on measuring strong currents in the Magellan Strait; the methods used, the challenges presented and the results were highlighted. Some analysis of the final data was provided and discussed.

3.1.6 NZL provided a brief on the activities of Land Information New Zealand (LINZ) and the network of permanent tide gauges for generating sea level data. It provided details of the NZL tsunami monitoring network, consisting of 18 sites, mainly focused along the east coast. Also provided was a brief background on the IOC-IHO GEBCO Seabed 2030 project, with which all were encouraged to engage; IHO provided additional information.

NZL requested any members who have experience on the analysis of tidal stream/currant data using Foreman's analysis package to contact them. NZL has not done this in the past and is starting to look into providing better tidal stream information for their region. Participants with experience using Foreman's tidal stream analysis software to contact NZL. **Action All**

3.1.7 GBR provided a background brief on the structure and activities of the UKHO and the funding modelling under which it works. It was explained the geographic area of responsibilities covered all the overseas territories as well as home waters. The work in capacity building and training was highlighted. The sources of data for the UKHO were explained, including the survey work conducted overseas, and the variety of systems used. The relationship with the UKHO Tides Section was highlighted and the activities undertaken, the products generated were noted. Also highlighted was the future direction into a data centric approach, including the Marine INformaTion (MINT) project. This generated numerous questions and wide ranging discussions.

4 Product Specification Presentations

4.1 AUS provided a comprehensive background brief on the IHO S-100 Geospatial Information Registry. The presentation commenced with the KHOA S-100 introduction video (https://www.youtube.com/watch?v=VIAP4Uo11xw).

4.2 AUS provided a comprehensive presentation on the development of the S-104 – *Water Level Information for Surface Navigation*, which included a full brief on the background development and the progress achieved. The next activities and actions were highlighted. This generated a number of questions and comments, particularly on creating HDF5 format datasets. Numerous questions on the relationship with S-129 – *Under Keel Clearance Management* – and whether the same models should be used.

AUS presented the Influence Polygons, providing three scenarios for consideration:

- A polygon with tidal station somewhere within it;
- Channel with sub-regions – linear relationship between two tidal stations;

- Co-tidal

There was much discussion on which measurements from vessels are required and to what level of uncertainty to benefit from the data. It was suggested a member of the S-129PT could attend the TWCWG meeting to assist in harmonization of the PSs development. **Action Chair**

This initiated a clarification on the differences between S-104 and S-129 and what each PS is representing.

A fourth scenario was later presented to replace the influence polygons with a gridded model of the "CD to Ellipsoid" vertical surface model instead. This was suggested due to the increasing number of Nations now developing this model relationship. Members to consider which of the scenarios would be of most benefit as a future product for ECDIS and if this would support S-129 as well, comments and input should be provided to S-104 product specification leader by 28 September 2018. **Action All**

4.3 USA provided an update brief on progress and developments of the S-111 – *Surface Currents* – which included a comprehensive background update. Observation was made that there remains a fundamental difference between S-104 and S-111, the latter being considered as a S-101 overlay with the former being Information, which potentially changes the depth data portrayed on the chart.
S-111: PS documentation developed with the S-100WG guidance. The PS is in compliance with the HDF5 file formatting as proposed at S-100WG3. The PS is in a mature form. It is now in its 13th version at TWCWG level and has been reviewed by TWCWG.

4.4 UNH provided a comprehensive presentation covering S-111 and S-124/S-126 interoperability issues. A case study was presented to demonstrate how to improve portrayal of textural information into easily ingested visual information.

UNH gave a brief on portrayal and the potential dynamic visualizations of data and what approaches are being considered for further development. This generated a number of questions and comments.

5 Product Specification Work Packages

5.1 Chair posed the question: "Will accuracy of vertical Datums be included in total uncertainty?" which resulted from the presentation on S-111 and was originally posed by the Chair of the DQWG.

The Chair suggested that the accuracy of vertical Datums should be included in an uncertainty budget if the datum value is used in calculating a vertical height/elevation.

Also suggested only the total uncertainty value will be displayed in the metadata.

This resulted in a wide ranging discussion on uncertainty of data, the relative accuracy of a solution and to which Datum should it be referred.

The Chair demonstrated:

- Time for a single point time series
- 2 time series at 2 locations into a single block

In order to answer the question "could the PS put in one object with two time series from two tide gauges?" It was suggested to keep treating separately the two time series, this could be reviewed in a future S-104 PS version as experience was gained.

5.3 The Chair provided a brief on the webinar sessions conducted in February 2017 and February 2018 with attendance from a broad spectrum of TWCWG members. It was agreed to investigate whether a further webinar session could be arranged**. Action CAN/FRA/USA** The Chair requested a page be created on the IHO website where the TWCWG can exchange data, it was noted the IHO has developed a single access page for all information on S-100 (http://s100.iho.int/S100). It was noted that S-111 had not been included in the IHO list of PS. **Action IHO**

5.4 USA provided an update brief on progress on the S-111 PS, in which the focus was particularly on progress and activities since TWCWG2. The outcomes of the discussions at the Test Strategy Meeting in Arlington, VA, USA on 19-21 September 2017 were reported. It was suggested that S-104 and S-111 should be formally represented at future Test Strategy meetings. A comprehensive progress report was provided since the review of the S-111 PS, the revisions which had been included were highlighted, it was noted that 38 pages of comments had been received. The review of data quality by the Data Quality Working Group (DQWG) highlighted a number of items, which needed to be considered. A summary of discussions and comments is at Annex I. It was felt that the outstanding work could be completed ready to submit the S-111 to HSSC10; however IHO suggested that, as S-100 Edition 4.0.0 was being considered and given the limited time available prior to HSCSC10, it may be more appropriate to undertake informal Stakeholder and Member State reviews in preparation for formal presentation of the draft Edition 1.0.0 at HSSC11 in 2019. IHO provided a short brief on IHO resolution 2/2007, as amended, to explain the adoption and change processes for published IHO Technical Standards and Specifications. Subsequently it was decided to submit and propose the S-111 Edition 1.0.0. to HSSC10. **Action Chair** It was asked whether S-411 – *Ice Information* – and S-412 – *Weather Overlay* – would follow the same process or a separate WMO approval process. It was agreed that clarification should be obtained from the WMO on the approval process they intended to follow for S-411 and S-412. **Action USA**

5.5 USA provided a comprehensive brief on the HDF5 file formats for PS data, particularly for S-104 and S-111. Potential future developments of the format and the impacts on the PS development were highlighted. Considerable discussion followed on harmonization with Climate Forecast (CF) conventions and whether it was required or desired as an option. It was agreed that USA would provide clarification. **Action USA** FIN asked for clarification on the benefits and disadvantages of harmonization with CF; it was noted that the software and equipment manufacturers had shown considerable interest in harmonization. It was considered appropriate to postpone further work towards harmonization until more information was available. A number of clarifications and questions were presented to the participants for comment and input. It was suggested that investigation should be undertaken to store data values for regular grids as one dimensional compound arrays, similar to other formats. **Action USA** A recommendation was received to consider encoding time series using the time dimension instead of separate datasets or groups; it was consider suitable for grids but an option needed to be maintained for single station inputs. It was agreed to wait for additional clarification as it was unclear what the impact on packaging of the data would be. It was agreed that all participants should review the PSs and aim to provide at least one new dataset in the S-104 and S-111 formats for review, this was also considered to be a good way to gain experience prior to formal adoption of the PS by IHO Member States. **Action All** It was agreed the data

encoders should be made available on the generic S-100 page (under S-104 and S-111) so that Member States can utilize some or all of the code to help them in providing at least one dataset in S-104 and S-111 formats.

5.6 The Chair brought up the issue of future engagement with the S-100WG and HSSC as well the way to report to HSSC. The Chair asked whether the leads for S-104 and S-111 could attend the S-100WG meetings, it was agreed to discuss this with the Chair S-100WG at HSSC10. **Action Chair** The Chair also encouraged all to review the Product Specifications and provide more datasets in the desired formats for further evaluation and testing. **Action All**

6 Programme Matters

6.1 Standard constituent list

GBR introduced the Standard Constituent List, it was highlighted that there were a number of constituents in use that did not appear on the list. It was also noted that not all had been converted to 7 decimals, work which remained ongoing. **Action GBR**

6.2 Standard for digital tide tables

USA provided an update brief on the proposed IHO resolution of the Standard for digital Tide Tables, Annex E. The input and comments received were included and re-formatted into a resolution style. It was felt that the issue of licencing of the information and controlling of reproduction could be addressed via additional programmes included in the media, however it was agreed that this was not appropriate for inclusion in the proposed resolution. It was suggested that the issue of time to be used should follow 27/1919 for consistency. It was agreed that geographical positions should follow the ISO19130 Geographic information and ISO6709 Standard for geographic point locations by coordinates formats. It was noted that it remained a national decision on what constituents were provided either through open source or via individual request. A number of other amendments were suggested to the wording in the draft; the IHO reminded the participants that resolutions are designed to provide guidance to achieve a level of consistency and harmonization on what Member States provide, it was not strict criteria to be followed. It was agreed the IHO would undertake the formatting and it was proposed the final draft version should be provided for submission to HSSC11. **Action USA/IHO**

6.3 The study of long term data sets for the determination of global sea level rise

NOR provided a presentation on Visualization of storm surges and future sea level rise. The combining of many different datasets in one tool to enable the visualization of sea level in maps and display potential impacts in graphical format were explained. This generated numerous questions and comments. It was questioned whether the TWCWG should become more involved in this topic; it was agreed that the participants should continue to be aware of activities and have closer engagement with the IOC GLOSS programme, however it was considered unwise to duplicate their work.

6.4 Compare Tidal Predictions generated as a result of analysis of a common data set by different analysis software

USA provided a brief on the work previously undertaken, indicating that little work had been conducted in recent years. It was highlighted that the past results had been analysed and compared with the comments uploaded to the TWCWG document page.

It was suggested that additional datasets could be provided by members for uploading and subsequent analysis should be undertaken with the results being made available for wider comment and input. The section in the TWCWG page was demonstrated, it was agreed that more datasets are required to allow most comprehensive and broader analysis. **Action All** NOR indicated they wished to contribute data if desired. The Chair noted that this item was part of the WG ToRs and therefore needs to be progressed. USA noted that this topic would be of considerable interest to GLOSS and should be progressed in preparation of TWCWG4, which could be in collaboration with the GLOSS Group.

6.7 Determining ellipsoidal height of MSL at the coast

6.7.1 GBR provided a short presentation on the Ellipsoidal height of the MSL at the coast and Vertical Reference Frames. It was noted the work had similarities with the work and objectives of the GLOSS programme for its Core Network of gauges. The connection between the GRS80 ellipsoid and the UK developed Vertical Offshore Reference Frame (VORF) was described, which required an accurate determination of MSL via the network of long term tide gauge stations. The methods used to determine the relationship offshore were described. This generated a number of questions and comments.

6.7.2 NOR gave a presentation on a common reference frame in Norway. The relationship between the various European datums was highlighted along with the physical challenges of the location. The Fieldwork programme was detailed and the locations of the selected stations. The data analysis process was described and the preliminary results were presented. The second Phase of the project was explained. FIN questioned whether it would be possible to maintain the same level of uncertainty along the entire coast.

6.7.3 NLD gave a presentation on geoid and stressed the fact that geoids offer some positive points considering a stable, precise and accessible vertical reference surface. 6.10.3 NLD provided a presentation on NLGEO2018, the Dutch quasi-geoid model followed by a description of NLLAT2018, the new Dutch LAT model. The presentation introduced future work on the 'Versatile Hydrodynamics' – a synergistic development of tomorrow's marine navigation products – and the anticipated follow-on work and developments. It challenged participants whether LAT as Chart Datum remains suitable, providing a number of identified shortfalls, which could/should be considered. It was suggested to develop tomorrow's marine navigation products, the geoid is the preferred vertical reference for bathymetric data.

6.74 FRA gave a presentation on vertical reference surface (SurfRef project based on BathyElli – FR, Shom project). It described the methods and techniques used in the initial project areas and first results.

6.8 Inventory of Tide gauges used by IHO Member States

The Inventory of Tide gauges used by IHO Member States was highlighted and requested for all to check, at least annually, their national details and provide amendments, corrections and updates to keep the inventory current. Participants were requested, through their appropriate representatives, to highlight the Inventory to RHC meetings so as to expand the contents beyond TWCWG members. **Action All**

6.9 Actual Tides On-line Link status

The Actual Tides and Currents on-Line links were highlighted and requests for all to check, at least annually, their national details and provide amendments, corrections and updates to keep the list current. It was recognized as a highly valuable and unique resource, which needed to be expanded beyond the member states represented in the TWCWG; all were encouraged to contact their national representations for RHC meetings to advertise the list and request additional inputs from all coastal states. **Action All** It was requested whether a different format could be used other than the current excel spreadsheet, IHO to investigate. **Action IHO**

6.10 National project presentations

National project presentations were received from France, Germany, Netherlands and USA; all of which are available under the meeting document section, Annex C.

6.10.1 NLD provided a presentation covering a Realisation of a mutually consistent set of on- and offshore vertical reference surfaces in the Netherlands. The presentation described the process used by USA and GBR to determine a separation model; however it was not considered appropriate for the NLD, for which a different method was developed. The national agencies and commercial organizations engaged in the project were highlighted.

6.10.2 NLD provided an update brief on the work of the North Sea Hydrographic Commission (NSHC) Tidal Working Group (TWG) activities and actions on LAT and CD, focusing on the recent meeting held in Oostende, Belgium, in March (https://www.iho.int/mtg_docs/rhc/NSHC/NSHC33/NSHC33-B.7-NSHC_TWG_Report.pdf). The differences between the values used by various NSHC member states were highlighted. The NSTWG had asked for comments/input from the TWCWG for the tasks set by the NSHC for the NSHC TWG to redefine the norm; the actions asked of each NSHC member state were highlighted.

6.10.3 DEU provided an update brief on the integration of oceanographic data in ECDIS being led by the Bundesamt für Seeschifffahrt und Hydrographie (BSH) (The Federal Maritime and Hydrographic Agency). It described the products, users and further applications which it is anticipated will result, all of which need to meet IHO standards. This generated a numerous questions and comments.

6.10.4 USA gave a presentation on Modernizing Geodetic Control at National Water Level Observation Network (NWLON) Stations. The presentation highlighted some of the challenges and issues which need to be addressed to improve the resultant data, some of the actions in progress were articulated. It provided details of the new installations being undertaken over the next year, also indicated future activities over the next few years.

7 IHO Resolutions and Charting Specifications

7.1 The IHO Resolutions relevant to the TWCWG were reviewed and it was agreed that no amendments were necessary at present.

7.2 The IHO Charting Specifications were reviewed and it was agreed that no amendments were necessary at present.

8 IOC/GLOSS Programme

8.1 CHL provided brief comments on the recent TOWS meeting and outcomes, including the activities.

The meeting was held between 12th and 17th February 2018, at the IOC in the UNESCO HQ; it consisted of a 3-daysTsunami Symposium followed by the TOWS meetings.

Advances in Tsunami Warning to Enhance Community Responses Symposium addressed the importance of better and faster characterization of earthquakes, considering the large uncertainties of seismic events during the first minutes. Having more accurate inputs of CMT, slip distribution, energy released, etc, National / Regional Tsunami Warning Centres might be able to have a more precise assessment. New sensors and detection techniques have to be developed.

TOWS WG meeting noted that the UN decade for Decade of Ocean Science for Sustainable Development for the 10-year period beginning on 1 January 2021 had been identified as a good opportunity to increase Tsunami awareness and also to achieve the main output of the Symposium. Improving tsunami detections and assessment, was identified as a good chance for scientist to provide a direct and visible contribution for communities.

In educational matters, since it was established the (WTAD) World Tsunami Awareness Day, on 5th November, many activities have been developed along coasts, tsunami drills, decision makers / communities training, including public and private institutions. Basin-wide exercises are organized by TOWS Task Team, such as PacificWave, CaribeWave; NeamWave, among others. Also it was recognized the physical, economic and social impact of the 2017 Hurricane season in the Caribbean region. A number of resultant actions and recommendations were identified and taken on by different TOWS members.

The Chair proposed that CHL was formally recognised as the contact with the IOC TOWSWG.

JPN provided a presentation on the Tsunami Warning System in Japan with information from the Japan Meteorological Agency. The presentation provided details on major seismic activities since 1868 in which there were more than 100 casualties resulting from each event. The timeline of tsunami warning system was described. It was noted there were 407 real-time tsunami monitoring stations in the network (coastal and offshore), examples of stations were shown. The earthquake data processing systems in Tokyo and Osaka were described. The types for warnings provided were detailed from advisories up to full warnings, including the necessary actions to be taken; the target timeline was indicated to be three minutes. The details of each category of event (>10m to <1m in three categories (Major Tsunami Warning, High Tsunami Warning or Advisory Tsunami Warning)) was described with expected wave size, actions to be taken and expected damage. The communication systems used for broadcasting and dissemination of the warning information were displayed. This generated numerous questions and comments.

8.2 USA provided a short report on the recent IOC GLOSS meeting in July 2017.

- GLOSS will be updating their website over the next couple of years (POC: Lesley Rickards);
- GLOSS will be working on a draft of an updated GLOSS Implementation Plan that focuses on Missions (POC: Gary Mitchum in consultation with GLOSS Data Coordination Panel and GLOSS Scientific Working Group);

- GLOSS offered to provide advice to IHO TWCWG on tidal analysis if requested and to coordinate Capacity Building efforts. (POC: (Phil Thomson, Lesley Rickards, Bill Mitchell, Peter Stone, Gael Andre, Gary Mitchum);
- SONEL will circulate a letter appealing for levelling information from host countries between GLOSS Core Network Tide Gauges and nearby GNSS; high priority is for stations that are less than 1km apart;
- To improve data access, IOC Sea Level Station Monitoring Facility (SLSMF) is planning on establishing a second GTS link from a GTS node institution (POC: Francisco Hernandez and Bart van Hoorne, and with support from WMO);
- ICG/CARIBE recommended to add the following stations on to the GLOSS Core Network:

  - George Town- Cayman Island
  - Puerto Barrios- Guatemala
  - Puerto Morelos- Mexico
  - San Andrés- Colombia
  - Barbuda – Antigua and Barbuda

- France proposed at the GLOSS GE XIII meeting that four French Stations in Pacific be added to the GLOSS Core Network:

  - Leava Futuna
  - Rangiroa
  - Makemor
  - Tubuai

GLOSS GE XV agreed in principle to these, pending formal approval from the national IOC focal points for the respective countries; and
- GLOSS Sea Level Science Award: Mark Merrifield to develop a proposal for a GLOSS Sea Level Science Award.

It was agreed that USA would continue as the focal point for GLOSS issues. There was general interest in attending a GLOSS meeting if it took place either immediately before or after the TWCWG meeting. Potential participants were asked to indicate early so that the agenda could be adjusted and harmonized. More than six participants indicated an interest to attend both meetings. It was agreed that the proposal should be investigated further. **Action Chair/vice-Chair/IHO**

9 Capacity Building (CB)

9.1 ZAF provided an update brief on progress with the development of the Technical Tidal capacity building course. Background to the development of the course was provided and the initial target coastal states. The initial course delivery regions were highlighted and the outcomes achieved were noted. It was noted that the technical knowledge of students was lacking compared to their theoretical understanding of the subject. The minimum capability of the nominated students was articulated and the challenges of organizing the course were highlighted. The next phases of development of the course were noted. This generated numerous questions and comments. Participants were requested, through their appropriate representatives, to highlight to RHC meetings the course availability and the intended target audiences. **Action All**

Some of the course contents was displayed for input and comment. Participants were requested to review the course content and provide feedback to ZAF **Action All** It was noted that the material for first module of the course, covering ocean tide, its measurement and application, was available in three languages (English, French and Spanish). It was also noted that all other modules were available in English and French, the translation work remained a task for the TWCWG.

Guidance was requested from the IHO on how the written assessment documents should be managed within the IHO Capacity Building framework. **Action IHO**

10 Any other business

10.1 The Chair gave a short presentation on historical data recovery, the objectives and the various methods of converting historical data into easily usable digital data. Presented the processes used by SHOM for recovering historical national data to identify significant events and the associated tidal data and afterwards how to use the data. This generated numerous comments and questions. The presentation given by KESTI on Construct tide observation record DB at TWLWG2 in Stavanger, Norway, in 2010 was highlighted (https://www.iho.int/mtg_docs/com_wg/IHOTC/TWLWG%202/TWLWG2_3-Korea-2.pdf). Participants were encouraged investigate what historical data was held and to consider preserving it as digital data for future use. **Action All**

10.2 ZAF provided details of a government project to revise the Land Survey Act, particularly to explain the various datums used and their origin and meanings. The participants were asked how best to explain what HW, LW and LWL were and how they should be used. The various documents generated by the government were provided with the proposed amendments. A number of comments and suggestions were provided. It was agreed the track change version of the Definition of the low-water line and high-water line documents could be circulated for further input and comment by 18 May. **Action All**

11 TWCWG Work Plan and ToRs

11.1 TWCWG ToRs and RoPs

The ToRs and RoPs for TWCWG were displayed, Annex F. No revisions were deemed necessary.

11.2 TWCWG Work Plan 2019-2020

The IHO displayed the draft work programme for 2019-2020 which had been prepared in advance of the meeting. Amendments were made to reflect discussion and progress during this meeting, Annex G. It was noted that the updated version would be included in the meeting report and that it would submitted to HSSC10 for approval. **Action Chair/IHO**

12 Election of vice-Chair

Mr Peter Stone (NOAA-OCS-USA) was unanimously elected for the period 2018-2020 as vice-Chair to fill the vacancy created by the departure of Mr Louis Maltais (CHS-Canada).

13 Venue and dates of the 4th TWCWG Meeting

The Chair asked if any MS would volunteer to host TWCWG4. KHOA offered to host the next meet, TWCWG4, in Busan, Korea, during the week 8-12 April 2019. It was agreed to accept this kind offer and the IHO was requested to liaise with KHOA to make the necessary arrangements and upload them to the website. **Action IHO/KOR** It was also agreed to liaise with the Secretariat of the IOC of UNSECO to investigate

the possibility of hold the 2019 GLOSS meeting immediately before or after the TWCWG4. **Action Chair/IHO**

14 Review of Action Items

14.1 A draft list of Action Items from the meeting were reviewed and agreed. All Action Items are marked in this report and are collected together at Annex D. It should be noted that the list of action items does not include tasks that are in the TWCWG Work Plan. An updated list of the Action Items will be maintained on the TWCWG4 web page and all those who have actions to complete should keep the IHO informed of any progress. **Action All.**

15 Draft Report to the HSSC / Draft Agenda for TWCWG4

15.1 It was agreed that the IHO would circulate a draft meeting report to all attendees by 27 April. **Action IHO.** Participants were requested to provide any comments by 11 May. **Action All.** It was intended the final meeting report would be published by 25 May. **Action IHO**

15.2 The IHO, Chair and vice-Chair would prepare the final report to HSSC10 and HSSC11 using the format required by HSSC. Representation of TWCWG at the HSSC10 and HSSC11 meetings would be discussed between the Chair and the vice-Chair. **Action IHO, Chair & vice-Chair**

15.3 A draft Agenda was presented to the meeting and is included at Annex H to this report. The draft Agenda may require further amendment following the outcome of HSSC10.

16 Closing remarks

The Chair summarized the TWCWG3 outcomes, highlighting the activities on which participants should focus during the intersessional period before the next meeting, TWCWG4.

On behalf the group, the Chair thanked the Servicio Hidrografico y Oceanografico de la Armada de Chile for hosting this meeting, providing excellent support and facilities, without which the meeting would not have achieved the progress it did, and for their warm hospitality. Chair thanked all working group members for their participation and contributions. She noted the data test sets for future water level and surface current products for e-navigation will be delivered before the end of this year. Also a number of the other identified actions are underway.

Finally the Chair wished all a safe trip back to their home countries and looked forward to seeing everybody in Busan, Korea, in 8-12 April 2019.

The meeting closed at 12:00 on 20 April 2018

The following Annexes are attached:

A. TWCWG3 – List of Participants.
B. TWCWG3 – Agenda
C. TWCWG3 – List of Documents
D. TWCWG3 – List of Actions
E. TWCWG3 – Proposed draft IHO resolution for Standard for Digital Tide Tables
F. TWCWG3 – TWCWG ToRs and RoPs
G. TWCWG3 – TWCWG draft Work Programme 2019-2020

H. TWCWG3 – TWCWG4 Draft Agenda
I. TWCWG3 – S-111 PS discussion and comments summary

LIST OF PARTICIPANTS

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Expert Contributor	Briana Sullivan	CCOM/UNH	briana@ccom.unh.edu

Tides, Water Level and Currents Working Group
Viña del Mar, Chile – 16-20 April 2018
Agenda – (TWCWG3)

1. Opening

.1 Opening address – Chair
.2 Address by host nation – Director SHOA
.3 IHO address – IHO

2. Administrative Arrangements

.1 Adoption of the Agenda and Apologies – Chair/Secretary
.2 Programme and timetable of the Sessions – Chair/Secretary
.3 Meeting administration, including H&S – Host
.4 Report on Intercessional Activities including HSSC9 – Chair
.5 Matters arising from TWCWG2/Review of Action Items – Secretary

3. National Presentations

.1 Presentations by delegates on "National Tidal and Current issues and projects"

.1 KHOA, Korea;
.2 NOAA, USA;
.3 FTA, Finland;
.4 SHOA, Chile;
.5 SHOA, Chile.

4. Product Specification Presentations

.1 IHO GI Registry brief – AUS
.2 Water Level Information for Surface Navigation (S-104) – AUS
.3 Surface Current Product Specification (S-111) – USA/CAN
.4 S-111 and S-126/S-124 interoperability – UNH

5. Product Specifications Work Packages

.1 Progress report on current datasets – CAN
.2 Feedback on results from first encoding tests – USA/CAN
.3 Feedback from Webinar session – CAN
.4 Application of encoding tool(s) to additional datasets – CAN
.5 Encoding datasets in HDF5 S-111 format – CAN
.6 Engagement with S-100WG – FRA

6. Programme Matters

.1 Standard Constituent List – GBR
.2 Standard for digital Tide Tables – USA
.3 The study of long term data sets for the determination of global sea level rise. – GBR, NOR, USA & ESP
.1 Visualization of storm surges and future sea level rise – NOR
.4 Compare Tidal Predictions generated as a result of analysis of a common data set by different analysis software – USA
.5 Exchange of Harmonic constants/predictions, feedback on comparison of tidal constituents – GBR/USA

.6 Establishment and Maintenance of VRF for High Resolution Bathymetric Surfaces – GBR & NLD
.7 Determining ellipsoidal height of MSL at the coast – ???
  .1 A common reference frame - NOR
.8 Inventory of Tide gauges used by IHO Member States – IHO
.9 Actual Tides On-line Link status – IHO
.10 National project presentations:

  .1 Nevref project (R.Klees, C.Slobbe) – NLD
  .2 NSHC action on LAT and CD – NLD
  .3 Versatile Hydrodynamics – NLD
  .4 Surfef project – FRA
  .5 Integration of oceanographic data in ECDIS (L.Becker) – DEU

7. IHO Resolutions and Charting Specifications

.1 Review of relevant IHO Resolutions – IHO
.2 Review of relevant IHO Charting Specifications – IHO

8. IOC Programmes

.1 Update on IOC GLOSS/TOWS Programme items and events – JPN

9. Capacity Building

.1 Tides and Water Levels Workshop training material – ZAF/AUS

10. Any Other Business

.1 Development of report to S-100WG and revisions to draft report to HSSC10 – Chair
.2 Historical data recovery – Chair
.3 Consider need to create Project Teams for development of S-100 PS – Chair

11. Work Plan and ToRs

.1 TWCWG Work Plan up-dates – IHO
.2 Review TWCWG ToRs and RoPs – IHO

12. Election of vice-Chair – Chair/Secretary

13. Venue and dates of the 4th TWCWG Meeting (TWCWG4) – Chair/Secretary

14. Review of Action Items from TWCWG3 – Secretary

15. Draft Agenda for TWCWG4 – Chair/Secretary

16. Closing remarks – Chair

TWCWG3 - List of Documents

Document No	Document Title
TWCWG3 Letter 1	Letter of Invitation
TWCWG3 Annex B	TWCWG3 Registration (Word version)
TWCWG3 Annex C	Logistic Information
TWCWG3-2.1	Agenda v11.0
TWCWG3-2.2	Programme v9.0
TWCWG3-2.4a	TWCWG Report to HSSC9
TWCWG3-2.4b	TWCWG Presentation to HSSC9
TWCWG3-2.4c	Extract from HSSC9 Report
TWCWG3-2.5	TWCWG2-List of Actions - 27 June 2017
TWCWG3-4.2.3	S-111 Version 0.1.12 - Clean and Track Change versions and Comment form
TWCWG3-5.5	Part 10c HDF5 Encoding - edition 4.0.0 - Draft
TWCWG3-6.2	Digital Tide and Tidal Current Table - Draft IHO Resolution v2.0
TWCWG3-7.1	IHO Resolutions
TWCWG3-7.2	Review of relevant IHO Charting Specifications
TWCWG3-11.1	TWCWG Work Plan 2019-2020
TWCWG3-11.2	TWCWG ToR
TWCWG3-15	TWCWG4 - Draft Agenda
TWCWG3-16	Chair closing remarks
TWCWG3-Presentations	Presentations.zip
TWCWG3-National Presentations	National Presentations.zip
TWCWG3-Participants	List of Participants

LIST OF ACTIONS – Updated 5 June 2018

Agenda Item	Subject	Status/Date	Comments	Action
Continuous				
6.1	Standard Constituent List	On going	Add additional data and upload to website for further comment.	All
6.3	Study of long term data sets	On going	Circulate to TWCWG national reports on studies into sea level rise and trends	All
6.4	Compare tidal and current predictions	On-going	Provide additional datasets for analysis, with constituents used, to IHO for uploading to web page	All
6.4	Compare tidal and current predictions	On-going	Provide reports of analysis to USA/GBR/NOR and IHO for wider discussion and comments	All
6.8	Inventory of tide gauges	On going	Contact national representative attending RHC meetings to raise awareness of inventory and encourage input and updating of information	All
6.8	Inventory of tide gauges	On going	Regularly check entries and provide up-dates and amendments to IHO as necessary	All
6.9	Actual Tides On-line Link	On going	Check and provide up-dates and amendments to the information provided to ensure content is current and all links work	All
TWCWG3				
2.4	Outcomes of HSSC9	HSSC10	Clarify generic S-100 data transfer standard development from HSSC9 Decision 9/38	Chair
3.1.6	National Presentation	TWCWG4	Participants with experience using Foreman's tidal stream analysis software to contact NZL	All
4.2	S-104 Product Specification presentations	TWCWG4	Invite member of S-129PT to attend next TWCWG meeting	Chair
4.2	S-104 Product Specification presentations	28 Sep	Consider which of the scenario's would be of most benefit as a future product for ECDIS and if it would support S-129, comments to AUS	All
5.3	Feedback from Webinar sessions	30 Nov	Investigate organizing a further Webinar session	CAN/FRA/USA
5.3	Feedback from Webinar sessions	25 May	Include S-111 in the IHO list of PS on the generic S-100 page	IHO
5.4	Application of encoding tools	TWCWG4	Investigate WMO approval process for S-411 and S-412	USA

~~5.4~~	~~Application of encoding tools~~	~~HSSC10~~ Complete	~~Submit S-111 Ed 1.0.0 for consideration at HSSC10~~	~~Chair~~
5.5	HDF5 Encoding	28 Sep	Provide clarification on whether harmonization with Climate Forecast (CF) conventions was required or desired as an option	USA
5.5	HDF5 Encoding	28 Sep	Investigate to store data values for regular grids as one dimensional compound arrays	USA
5.5	HDF5 Encoding	TWCWG4	Make data encoders available on the generic S-100 page (under S-104 and S-111) for use by Member States	USA/AUS/IHO
5.5	HDF5 Encoding	30 Nov	Provide at least one dataset in S-104 and S-111 formats for review	All
5.6	Engagement with S-100WG	HSSC10	Discuss with Chair S-100WG whether leads for S-104 and S-111 could attend S-100WG meetings	Chair
5.6	Engagement with S-100WG	30 Nov	Review the Product Specifications and provide more datasets in the desired formats for further evaluation and testing	All
6.1	Standard Constituent List	TWCWG4	Continue calculations convert all constituents to 7 decimals	GBR
6.2	Standard for digital Tide Tables	31 Aug	Provide final draft version of proposed IHO resolution for submission to HSSC11	USA/IHO
6.9	Actual Tides On-line Link	TWCWG4	Investigate alternative formats to excel spreadsheet for website	IHO
8.2/13	IOC GLOSS Programme	TWCWG4	Engage with IOC Secretariat and GLOSS Programme lead to advance proposal for collocated meeting	Chair/vice-Chair/IHO
9.1	Capacity Building	TWCWG4	Provide guidance on how written assessment documents should be managed	IHO
9.1	Capacity Building	On going	Through their appropriate representatives, highlight to RHC meetings the course availability and the intended target audiences	All
9.1	Capacity Building	TWCWG4	Review the course content and provide feedback to ZAF	All
10.1	Any other business	On going	Investigate what historical data is held and to consider preserving it as digital data for future use	All
10.2	Any other business	18 May	Provide comment and input to ZAF on draft documents	All
~~11.2~~	~~Work Plan~~	~~HSSC10~~ Complete	~~Included revised version of Work Plan 2019-2020 in report to HSSC10~~	~~Chair/IHO~~

13	TWCWG4	5 Oct	Circulate an initial letter of invitation and post on the website.	KOR/IHO
~~14~~	~~Action List~~	~~TWCWG4~~ Complete	~~Keep IHO and the Chair and vice-Chair informed of progress with allocated actions~~	~~All~~
~~15~~	~~TWCWG3 Draft Report~~	~~27 Apr~~ Complete	~~Draft to be circulated for comment~~	~~IHO~~
~~15~~	~~TWCWG3 Draft Report~~	~~11 May~~ Complete	~~All to provide comments on draft report~~	~~All~~
~~15~~	~~TWCWG3 Final Report~~	~~25 May~~ Complete	~~Publish final report~~	~~IHO~~
15	Report to HSSC11	1 Mar	Draft report for review and amendment.	Chair/vice-Chair/IHO

TITLE	Reference	Last amendment (CL or IHC)	1st Edition Reference
Digital Tide and Tidal Current Tables.	XX/1919 as amended	Draft	Ver 2.0

NOTE: Items in red still need clarification and approval by the working group members.

1 It is resolved that member Hydrographic Organizations (HO) may choose to publish their tide and tidal current tables in either paper format or digitally. If digitally, they can be distributed either through the HO's web site, or representative complement or via portable media such as a DVD.

General Guidelines for Digital Tide and Tidal Current Tables

2 It is resolved that digital tide and tidal current tables should adhere to all the same requirements as existing paper tide and tidal current tables as specified in IHO Programme 2 "Hydrographic Services and Standards" Section 2.2 – Tides and Water Levels

3 It is resolved that the issuing office should provide documentation on how to install or read the electronic tables, minimum computer specifications how to obtain product support and general information on the Digital Tide and Tidal Current Tables. This information should be provided in either hardcopy written form (for example, on a separate sheet of paper or on the cover of the disk or other media), or electronically in a plain ASCII text 'readme.txt' type of file. This file should also include user license and/or condition of use information.

4 It is resolved that the issuing office should provide its formal name, mailing address; web url and point of contact information on the cover of the media. It should also provide information on the production of the tables (including both address and website), information on how to obtain annual updates, and how to obtain interim updates or errata information.

5 It is resolved that the digital tide and tidal current tables should include a statement concerning the standing of the digital tables as meeting the applicable maritime regulations, either SOLAS and/or local country carriage requirements.

Formats for Digital Tide and Tidal Current Tables

6 It is resolved that there shall be two allowable formats for digital tide and tidal current tables.

A. Scanned Images of Tide and Tidal Current Tables: This format consists of scanned images of the paper tide tables. This format should have the following attributes.

B. Electronically generated Tide and Tidal Current Predictions: This format consists of software and a user interface that calculates tide and tidal current predictions from stored harmonic constituents or time and range offsets.

Detailed Specifications for Digital Tide Tables – Scanned Images of Tide Tables:

7 It is resolved that Scanned Images of Tide Tables should follow the following specifications.

a. Should be a faithful reproduction of all the pages of printed tide tables.

b. The images should be formatted in a widely available, common format. Examples formats include, but not limited to, PDF, tiff, Jpeg, Gif. If PDF files are provided, then information on how to download Adobe© Reader must be provided.

c. If multiple books are published, then each book should be located within its own folder and clearly identified.

d. No modification of the scanned images is permitted by users.

Detailed Specifications for Digital Tide Tables – Electronically Generated Tide Predictions

8 It is resolved that Electronically Generated Tide Predictions should follow the following specifications:

a. Station Selection: It is recommended that station selections can either be map based or list based, and should be organized by water body.

b. Station Information: It is recommended that the following information be included with each station;
Station Name and Number (or ID) as appropriate
Body of Water Descriptor (if appropriate)
Latitude and Longitude (degrees:min:sec and tenths? or decimal equivalent using GIS convention with western and southern hemispheres as being negative latitude and longitude)
Horizontal and Vertical Datum convention
Location Map with nearby prediction stations identified
URL to station or data portal.

c. It is recommended that Earth-Moon-Sun Astronomical Calendar Information (Tabular and/or integrated with graphical data output) be included.

d. It is recommended that Sunrise/Sunset Calendar Information (Tabular and/or integrated with graphical data output)

e. It is recommended that the default reference datum is the Chart Datum used by the Country furthermore, it is recommended that the user have the ability to reference predictions to other tidal datums supported by the HO (such as LAT, HAT, MHW, MSL) and user identified datums such as a national geodetic or ellipsoidal datum or other coastal engineering or threshold datums that are pertinent.

f. It is recommended that data displays and tables can be toggled to both in Metric or English units, with default depending upon country

g. It is recommended that the time displayed is the legal local time as default, with user selected option for UTC/GMT, daylight savings time, etc. Legal time includes daylight savings time if applicable. Furthermore, when time zone information is

displayed it should follow the convention that negative time zone offsets are used for east longitude and positive offsets for west longitude.

h. It is recommended that the following tide prediction source metadata information be provided;
Harmonic Constituents or Time and Range Correction to Reference Station,
Dates of Harmonic Analyses time series used to create the set of Harmonic Constituents used in the prediction,
Dates of the observations used to create time and height corrections (for nonharmonic based predictions) to a reference Station,
Links to the list of the Harmonic Constituents used in the Prediction. Furthermore, the display of the Harmonic Constituents should adhere to the IHO National Tidal Constituent Banks Resolution 2/1977 as amended 42/2000 A6.8
The name of the Harmonic Analysis program used to generate the harmonic constituents.

i. It is recommended that the HO provide and display tidal sea level amplitude prediction with a minimum of 4 decimals precision (for metric system) if possible.

j. It is recommended that users have the ability to obtain output in common formats such as PDF, TXT, XML, CSV, S-112 single point formats

k. It is recommended that additional information be provide special warning explaining areas of anomalous tidal conditions, special datums, or tidal based hazards to navigations (dual high or low waters, tidal bores, river flow dependencies and river datums, frequent non-tidal conditions, etc..)

l. It is recommended, when applicable, that estimates of uncertainty in the predicted times and heights of high and low waters be provided to users.

Detailed Specifications for Graphical Display of Electronic Tide Predictions

9 It is resolved that the predictions have the ability to obtain graphical and tabular output for desired time period (either historical and into the future) and should contain the following attributes with the objective not to prescribe a specific graphical view but rather to identify common elements that transcend all types of graphs:

a It is recommend that the predictions can be displayed as discrete points or a continuous curve using a curve fit routine to times and heights of high and low waters or to the time series values.

b It is recommended that all axes should be clearly labelled

c It is recommended that time series data should have a minimum, 1- hour increments

d It is recommended that times and heights of predicted high and low tides should be provided

e It is recommended that the default datum should be the same as chart datum for the location of the prediction

f It is recommended that the tidal height units default should be the same as the HO's printed tables

g It is recommended that the display should include station information (as defined above)

h It is recommended that the display include the name and/or the insignia of the source authority organization

i It is recommended that the display should have the option to view the tide prediction numerical values used to create the graphic.

j It is recommended that the display of the graphical data should be able to be adjusted to suit daytime, twilight, and night time viewing

Detailed Specifications for Digital Tidal Current Tables

10 It is resolved that Digital Tidal Current Tables can be in the same two formats as Digital Tide Tables and the same requirements that apply to digital tide tables pertain to tidal current tables.

11 It is resolved that electronically generated Tidal Current Predictions do have additional specifications as identified:

a It is recommended that the depth of prediction be included in the metadata and include a the descriptor that the depth is either from the surface down or from the bottom up

b It is recommended, if applicable, flood and ebb current direction (referenced to True North) be presented.

c It is recommended that for graphical display of tidal currents the default speed units should be knots

d It is recommended that for graphical display of tidal currents the default direction units should be degrees (referenced to true north).

Below are examples of Digital Tide Tables. I do not know if they can be included in the IHO Resolution.

USA - NOAA Example

Scanned Tide Table

80

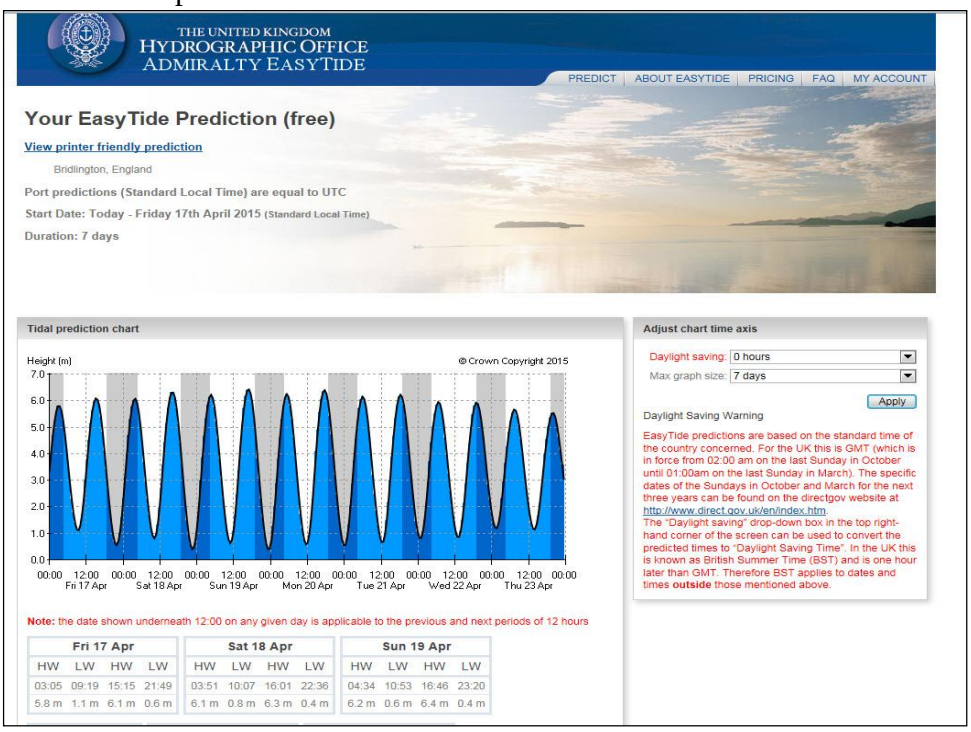
Albany, New York, 2015

Times and Heights of High and Low Waters

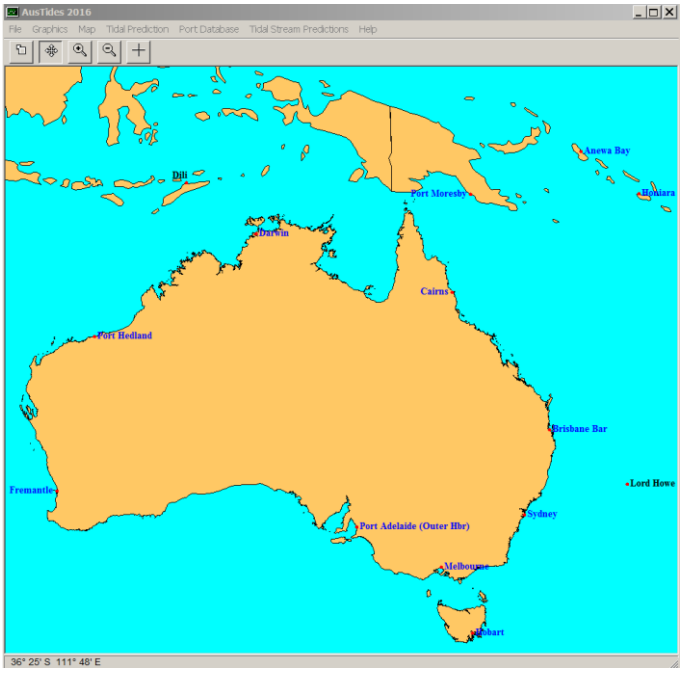
January								February								March							
	Time	Height		Time	Height			Time	Height		Time	Height				Time	Height		Time	Height			
	h m	ft	cm	h m	ft	cm		h m	ft	cm	h m	ft	cm			h m	ft	cm	h m	ft	cm		
1 Th	0048	5.1	155	16 F	0026	4.2	128	1 Su	0214	5.2	158	16 M	0144	4.8	146	1 Su	0102	5.4	165	16 M	0023	5.1	155
	0741	−0.3	−9		0705	0.4	12		0859	−0.1	−3		0836	0.3	9		0743	0.5	15		0715	0.9	27
	1317	5.5	168		1241	5.0	152		1435	5.4	165		1353	5.6	171		1324	5.5	168		1230	5.7	174
	2026	−0.4	−12		2006	0.4	12		2145	−0.3	−9		2127	0.1	3		2029	0.1	3		2006	0.7	21
2 F	0142	5.1	155	17 Sa	0121	4.3	131	2 M	0302	5.2	158	17 Tu	0234	5.0	152	2 M	0153	5.5	168	17 Tu	0120	5.4	165
	0833	−0.3	−9		0803	0.3	9		0946	−0.1	−3		0933	0.1	3		0834	0.4	12		0817	0.6	18
	1407	5.5	168		1331	5.2	158		1519	5.4	165		1445	5.7	174		1413	5.6	171		1333	5.9	180
	2120	−0.4	−12		2101	0.2	6		2230	−0.3	−9		2217	−0.1	−3		2117	0.1	3		2059	0.5	15
3 Sa	0233	5.1	155	18 Su	0211	4.4	134	3 Tu	0348	5.2	158	18 W	0322	5.3	162	3 Tu	0241	5.6	171	18 W	0212	5.7	174
	0922	−0.3	−9		0858	0.1	3		1029	0.0	0		1027	−0.2	−6		0922	0.4	12		0915	0.3	9
	1454	5.6	171		1417	5.4	165		1600	5.4	165		1535	5.9	180		1457	5.6	171		1428	6.0	183
	2210	−0.5	−15		2153	0.0	0	○	2313	−0.2	−6	●	2306	−0.2	−6		2201	0.1	3		2150	0.3	9
4 Su	0321	5.1	155	19 M	0257	4.6	140	4 W	0431	5.1	155	19 Th	0409	5.4	165	4 W	0325	5.7	174	19 Th	0300	6.0	183
	1009	−0.2	−6		0952	−0.1	−3		1112	0.1	3		1119	−0.3	−9		1006	0.4	12		1009	0.1	3
	1538	5.5	168		1503	5.6	171		1640	5.3	162		1626	5.9	180		1538	5.6	171		1519	6.2	189
○	2256	−0.4	−12		2243	−0.2	−6		2352	−0.1	−3		2353	−0.3	−9		2241	0.1	3		2239	0.1	3
5 M	0408	5.0	152	20 Tu	0343	4.8	146	5 Th	0513	5.1	155	20 F	0458	5.6	171	5 Th	0406	5.7	174	20 F	0347	6.2	189
	1054	−0.1	−3		1044	−0.2	−6		1152	0.2	6		1211	−0.4	−12		1049	0.4	12		1102	−0.1	−3
	1621	5.4	165		1549	5.7	174		1718	5.2	158		1719	5.9	180		1617	5.5	168		1610	6.2	189
	2341	−0.3	−9	●	2331	−0.4	−12									○	2319	0.3	9		2326	0.1	3
6 Tu	0454	4.9	149	21 W	0430	4.9	149	6 F	0029	0.0	0	21 Sa	0040	−0.3	−9	6 F	0444	5.6	171	21 Sa	0435	6.3	192
	1136	0.1	3		1136	−0.4	−12		0553	5.0	152		0549	5.6	171		1130	0.4	12		1154	−0.1	−3
	1702	5.3	162		1639	5.7	174		1231	0.3	9		1303	−0.3	−9		1654	5.4	165		1702	6.1	186
									1754	5.1	155		1815	5.8	177		2354	0.4	12				
7 W	0022	−0.2	−6	22 Th	0018	−0.5	−15	7 Sa	0104	0.2	6	22 Su	0128	−0.2	−6	7 Sa	0520	5.6	171	22 Su	0013	0.2	6
	0540	4.8	146		0520	5.0	152		0632	5.0	152		0642	5.6	171		1209	0.5	15		0523	6.3	192
	1216	0.2	6		1227	−0.4	−12		1310	0.5	15		1356	−0.2	−6		1728	5.3	162		1245	0.0	0
	1742	5.1	155		1733	5.7	174		1826	5.0	152		1913	5.6	171						1756	6.0	183
8 Th	0103	0.0	0	23 F	0106	−0.5	−15	8 Su	0137	0.3	9	23 M	0216	−0.1	−3	8 Su	0027	0.5	15	23 M	0100	0.3	9
	0625	4.7	143		0612	5.1	155		0706	5.0	152		0739	5.6	171		0550	5.6	171		0615	6.2	189
	1255	0.4	12		1320	−0.4	−12		1350	0.6	18		1452	−0.1	−3		1249	0.6	18		1337	0.1	3
	1822	5.0	152		1830	5.6	171		1851	4.9	149		2012	5.5	168		1757	5.2	158		1853	5.8	177
9 F	0141	0.1	3	24 Sa	0154	−0.5	−15	9 M	0208	0.4	12	24 Tu	0307	0.1	3	9 M	0058	0.6	18	24 Tu	0148	0.5	15
	0710	4.6	140		0708	5.2	158		0730	5.0	152		0837	5.6	171		0607	5.7	174		0710	6.1	186
	1334	0.5	15		1414	−0.4	−12		1434	0.7	21		1549	0.1	3		1330	0.7	21		1431	0.3	9
	1901	4.9	149		1931	5.5	168		1924	4.8	146		2111	5.4	165		1821	5.2	158		1951	5.7	174
10 Sa	0219	0.2	6	25 Su	0244	−0.4	−12	10 Tu	0240	0.5	15	25 W	0400	0.2	6	10 Tu	0129	0.7	21	25 W	0238	0.7	21
	0755	4.6	140		0806	5.2	158		0752	5.1	155		0935	5.5	168		0627	5.8	177		0807	5.9	180
	1416	0.6	18		1511	−0.3	−9		1526	0.8	24		1647	0.2	6		1414	0.8	24		1526	0.5	15
	1940	4.8	146		2032	5.4	165		2009	4.6	140	◐	2210	5.3	162		1855	5.1	155		2049	5.6	171
11 Su	0256	0.3	9	26 M	0336	−0.3	−9	11 W	0320	0.5	15	26 Th	0455	0.4	12	11 W	0202	0.8	24	26 Th	0331	0.9	27
	0839	4.6	140		0904	5.3	162		0832	5.2	158		1034	5.4	165		0704	5.8	177		0906	5.8	177
	1503	0.7	21		1610	−0.2	−6		1627	0.9	27		1746	0.3	9		1504	1.0	30		1622	0.6	18
	2021	4.6	140	◐	2132	5.2	158	◑	2109	4.5	137		2309	5.2	158		1942	5.0	152		2147	5.5	168
12 M	0334	0.4	12	27 Tu	0429	−0.3	−9	12 Th	0413	0.7	21	27 F	0552	0.5	15	12 Th	0245	0.9	27	27 F	0426	1.0	30
	0922	4.7	143		1002	5.3	162		0923	0.9	27		1133	5.4	165		0751	1.1	34		1005	0.6	171
	1559	0.8	24		1710	−0.1	−3		1733	0.9	27		1843	0.3	9		1602	1.1	34		1718	0.7	21
	2115	4.4	134		2231	5.1	155		2234	4.4	134						2041	4.9	149	◐	2245	5.5	168
13 Tu	0416	0.4	12	28 W	0524	−0.2	−6	13 F	0520	0.7	21	28 Sa	0007	5.9	162	13 F	0341	1.0	30	28 Sa	0522	1.1	34
	1006	4.7	143		1101	5.3	162		1028	5.2	158		0648	0.5	15		0844	1.1	34		1104	0.8	171
	1701	0.8	24		1810	−0.1	−3		1837	0.8	24		1231	5.4	165		1705	1.1	34		1814	0.8	24
◑	2220	4.3	131		2330	5.0	152		2348	4.4	134		1938	0.2	6	◑	2201	4.9	149		2342	5.6	171
14 W	0507	0.5	15	29 Th	0620	−0.1	−3	14 Sa	0631	0.7	21					14 Sa	0453	1.1	34	29 Su	0619	1.2	37
	1055	4.8	146		1159	5.3	162		1149	5.2	158						0947	1.1	34		1202	0.6	171
	1806	0.8	24		1908	−0.1	−3		1938	0.6	18						1808	1.1	34		1907	0.7	21
	2325	4.2	128														2318	4.9	149				
15 Th	0605	0.5	15					15 Su	0050	4.5	137					15 Su	0607	1.1	34	30 M	0037	5.7	174
	1148	4.9	149						0736	0.5	15						1110	1.1	34		0714	1.1	34
	1908	0.7	21						1256	5.4	165						1909	0.9	27		1256	5.6	171
									2034	0.4	12										1957	0.6	18
																				31 Tu	0128	5.9	180
																					0806	1.0	30
																					1346	5.7	174
																					2043	0.6	18
31 Sa	0123	5.1	155																				
	0808	−0.1	−3																				
	1347	5.4	165																				
	2057	−0.3	−9																				

Time meridian 75° W. 0000 is midnight. 1200 is noon. Times are not adjusted for Daylight Saving Time.
Heights are referred to mean low water during lowest river stages which is the chart datum of soundings.

UKHO Example



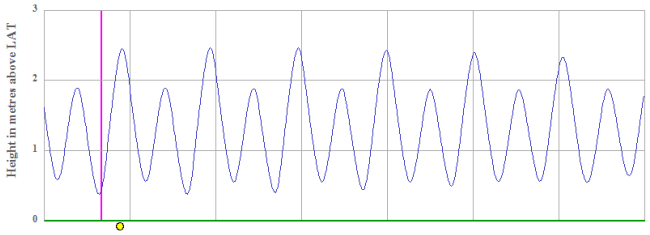
Australian Example



BRISBANE BAR

Local Standard Time Zone: -10:00 U.T. | **27° 22' S 153° 10' E** | **Year 2016**

PREDICTION DATUM below MSL: 1.31 (m) | **Port 59980**



16:00 0.4m

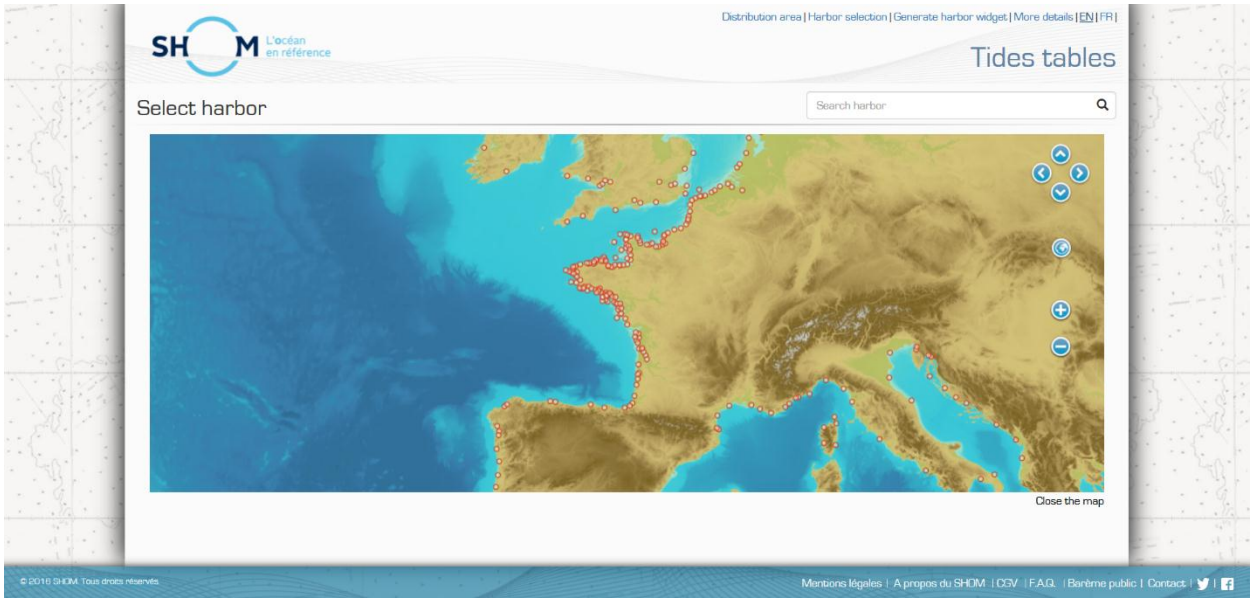
Jun 20 Mo		21 Tu		22 We		23 Th		24 Fr		25 Sa		26 Su	
Time	m	Time	m	Time	m	Time	m	Time	m	Time	m	Time	m
0343	0.6	0423	0.6	0503	0.5	0543	0.5	0624	0.5	0024	2.4	0109	2.3
0911	1.9	0951	1.9	1032	1.9	1115	1.9	1200	1.9	0707	0.5	0755	0.5
1520	0.4	1557	0.4	1635	0.4	1713	0.4	1755	0.5	1250	1.9	1347	1.9
2150	2.4	2227	2.5	2304	2.5	2343	2.4			1843	0.6	1939	0.6

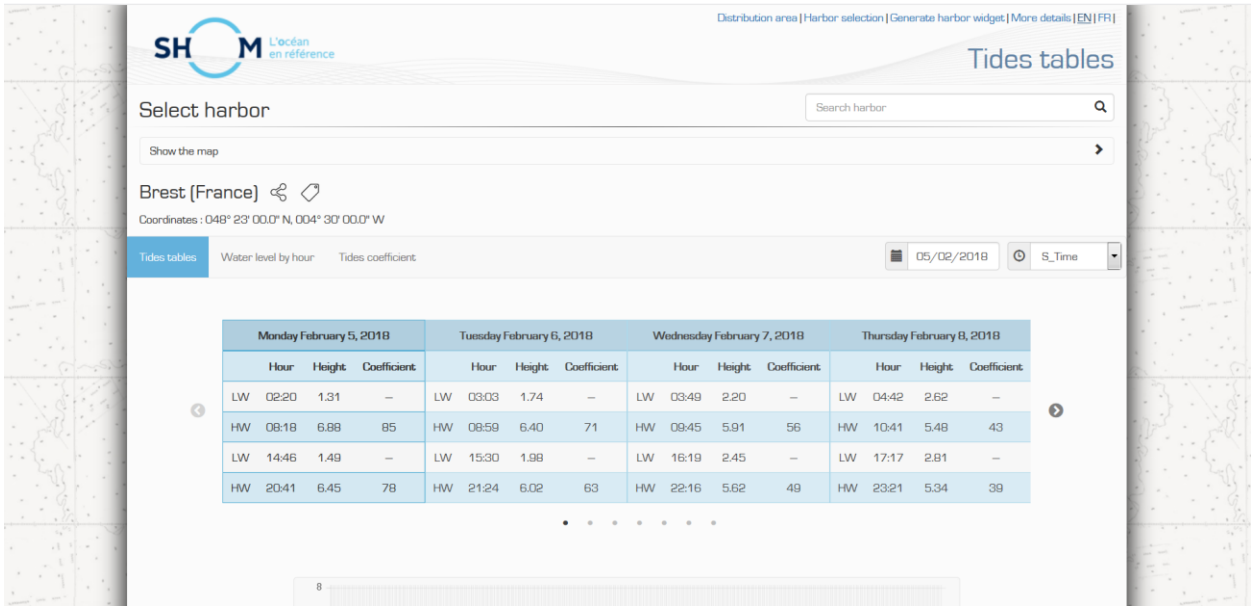
Moon phases supplied by Sydney Observatory

No account is taken of Daylight Saving Time

These predictions are identical to those published in ANTT and can thus be used as an official navigational publication.
Prediction Datum is LAT, which may not be Chart Datum. Correction to Chart Datum can be found at:
Level / To Chart Datum Corrections and Zero of Predictions Window.

Example from SHOM (France)





Monday February 5, 2018				Tuesday February 6, 2018				Wednesday February 7, 2018				Thursday February 8, 2018			
	Hour	Height	Coefficient		Hour	Height	Coefficient		Hour	Height	Coefficient		Hour	Height	Coefficient
LW	02:20	1.31	–	LW	03:03	1.74	–	LW	03:49	2.20	–	LW	04:42	2.62	–
HW	08:18	6.88	85	HW	08:59	6.40	71	HW	09:45	5.91	56	HW	10:41	5.48	43
LW	14:46	1.49	–	LW	15:30	1.98	–	LW	16:19	2.45	–	LW	17:17	2.81	–
HW	20:41	6.45	78	HW	21:24	6.02	63	HW	22:16	5.62	49	HW	23:21	5.34	39


8
6
4
2
0
hauteur d'eau (m)
4m
05:05 - 3.95m
11:40 - 3.96m
17:35 - 3.98m
23:55 - 3.96m
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
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21:00
22:00
23:00
23:55
Standard time
You can display the water level to a given hour [Water level option] or the hours according to a treshold [Treshold option].
Click on the chart to put a line [keep the mouse pressed to move the line] or enter a value in the following field
Water level
Treshold
None
4
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Tides, Water Level and Currents Working Group (TWCWG)

Terms of Reference and Rules of Procedure

References: *6th HSSC Meeting (Viña del Mar, Chile, November 2014)*
7th HSSC Meeting (Busan, Republic of Korea, November 2015)

1. Objective

a) To provide technical advice and coordination on matters related to tides, water levels, currents, relevant oceanographic data and vertical datum, including integrated water level/current data models.

b) To support the development and maintenance of related specifications in liaison with the relevant IHO bodies and non-IHO entities;

c) To develop and maintain the IHO publications for which the WG is responsible.

2. Authority

This WG is a subsidiary of the Hydrographic Services and Standards Committee (HSSC). Its work is subject to HSSC approval.

3. Composition and Chairmanship

a) The WG shall comprise representatives of IHO Member States (MS), Expert Contributors (EC), observers from accredited NGIO, and a representative of the IHO Secretariat. A membership list shall be maintained and posted on the IHO website.

b) EC membership is open to entities and organizations that can provide a relevant and constructive contribution to the work of the WG.

c) The Chair and Vice-Chair shall be a representative of a MS. The election of the Chair and Vice-Chair shall be decided at the first meeting after each ordinary session of the Assembly and shall be determined by vote of the MS present and voting.

d) If a secretary is required it should normally be drawn from a member of the WG.

e) If the Chair is unable to carry out the duties of the office, the Vice-Chair shall act as the Chair with the same powers and duties.

f) ECs shall seek approval of membership from the Chair.

g) EC membership may be withdrawn in the event that a majority of the MS represented in the WG agrees that an EC's continued participation is irrelevant or unconstructive to the work of the WG.

h) All members shall inform the Chair in advance of their intention to attend meetings of the WG.

i) In the event that a large number of EC members seek to attend a meeting, the Chair may restrict attendance by inviting ECs to act through one or more collective representatives.

4. Procedures

a) The WG should:

(i) monitor and develop the use of tidal, water level, current information and relevant oceanographic data including integrated water level/current data models;

(ii) advise on the use of vertical datums;

(iii) advise on tidal, water level and current observation, analysis and prediction;

(iv) advise on matters concerning exchange, distribution and use of tidal, water level, current information and relevant oceanographic data related data/information;

(v) study principles and contribute to the development of improved methods for conveying tidal, water level, current information and relevant oceanographic data to mariners and other users;

(vi) keep under review the relevant IHO publications and resolutions in order to advise HSSC on their updating;

(vii) draft or revise guidance document(s), resolutions and specifications as appropriate and as instructed by HSSC; and

(viii) consider new related topics as instructed by HSSC and advise HSSC accordingly.

b) The WG should work by correspondence, teleconferences, group meetings, workshops or symposia. The WG should meet about once a year. When meetings are scheduled, and in order to allow any WG submissions and reports to be submitted to HSSC on time, WG meetings should not normally occur later than nine weeks before a meeting of the HSSC.

c) Decisions should generally be made by consensus. If votes are required on issues or to endorse proposals presented to the WG, only MS may cast a vote. Votes at meetings shall be on the basis of one vote per MS represented at the meeting. Votes by correspondence shall be on the basis of one vote per MS represented in the WG.

d) The date and venue of group meetings shall normally be announced by the Chair at least six months in advance.

e) The draft record of meetings shall be distributed by the Chair (or the secretary) within six weeks of the end of meetings and participants' comments should be returned within three weeks of the date of despatch. Final minutes of meetings should be posted on the IHO website within three months after a meeting.

f) Sub-working groups and project teams may be created by the WG or proposed to HSSC to undertake detailed work on specific topics. The terms of reference and rules of procedure of the sub-working groups and project teams are determined or proposed by the WG as appropriate.

g) The WG should liaise with other IHO bodies, international organizations and industry to ensure the relevance of its work.

h) The WG should prepare annually a report on its activities and a rolling two-year work plan, including expected time frame.

TWCWG WORK PLAN 2019-20

Objective

a) To monitor developments related to tidal and water level observation, analysis and prediction and other related information including vertical and horizontal datums;

b) To develop and maintain the relevant IHO standards, specifications and publications for which it is responsible in liaison with the relevant IHO bodies and non-IHO entities;

c) To develop standards for the delivery and presentation of navigationally relevant current information; and

d) To provide technical advice and coordination on matters related to tides, water levels, currents and vertical datum.

Tasks

A	Maintain the list of standard tidal constituents (IHO Task 2.8.4)
B	Compare the tidal predictions generated as a result of analysis of a common data set using different analysis software
C	Develop, maintain and extend a Product Specification for digital tide and tidal current tables (IHO Task 2.3.4)
D	Develop, maintain and extend a Product Specification for dynamic surface currents in ECDIS (S-111) (IHO Task 2.3.4)
E	Develop, maintain and extend a Product specification for dynamic water level in ECDIS (S-104) (IHO Task 2.3.4)
F	Liaise with S-100WG on water level and current matters relevant to ECDIS applications (IHO Task 2.3.5)
G	Liaise with industry experts on the development of product specifications for water level and currents
H	Prepare and maintain an inventory of water level gauges and current meters used by Member States and publish it on the IHO/TWCWG web site (IHO Task 2.8.5)
I	Review and maintain the Actual Tides and Currents On-Line links as published on the IHO TWCWG website
J	Maintain and extend the relevant IHO standards, specifications and publications as required (IHO Tasks 2.8.4 and 2.1.8)
K	Conduct the at least annual meetings of TWCWG and its sub-group(s) and project team(s) (IHO Tasks 2.1.2.7)
L	Develop and maintain material for course on Tides, Water Levels and Currents

Work item	Title	Priority H-high M-medium L-low	Next milestone	Start Date	End Date	Status P-planned O-ongoing C-completed S-Superseded	Contact Person(s)	Related Pubs / Standard	Remarks
A.1	Maintain the list of standard tidal constituents	M		-	Permanent	O	Chris Jones*		Review current list of published tidal constituents
B.1	Compare the tidal predictions generated as a result of analysis of a common data set using different analysis software.	M		-	Permanent	O	Hilde Sande Borck * All		Select Common data set Analyse using different software Predict common set of tides Compare results
C.1	Develop, maintain and extend the standard for digital tide and tidal current tables	H	Prepare final draft Standard	2009	~~2016~~ ~~2017~~ ~~2018~~ 2019	O	Peter Stone* Chris Jones Zarina Jayaswal		
D.1	Develop and maintain a product specification for dynamic application of surface currents in ECDIS (S-111)	H		2013	~~2017~~ ~~2018~~ 2019	O	Kurt Hess		Establish joint project teams as required. Liaise with S-100WG (see F.1) Liaise with industry experts (see G.1)
E.1	Develop and maintain a product specification for dynamic application of water levels in ECDIS	H	Develop draft Product Specifications (S-104) for water level information for surface navigation in S-100.	2009	~~2017~~ ~~2018~~ ~~2019~~ 2020	O	Zarina Jayaswal* Glen Rowe Jimin Ko		Establish joint project teams as required. Liaise with S-100WG (see F.1) Liaise with industry experts (see G.1)
F.1	Liaise with S-100WG on water level and current matters relevant to ECDIS applications	H		-	Permanent	O	Gwenaële Jan Kurt Hess Zarina Jayaswal		Establish joint project teams as required.
G.1	Liaise with industry experts on the development of product specifications for water levels and currents	H		-	Permanent	O	All		

Work item	Title	Priority H-high M-medium L-low	Next milestone	Start Date	End Date	Status P-planned O-ongoing C-completed S-Superseded	Contact Person(s)	Related Pubs / Standard	Remarks
H.1	Maintain an inventory of water level gauges and current meters used by Member States and publish it on the IHO/TWCWG web site.	H		-	Permanent	O	David Wyatt* All		Initial inventory from TWCWG members available on IHO web site.
I.1	Review and maintain the Actual Tides and Currents On-Line links as published on the IHO/TWCWG website	L		-	Permanent	O	David Wyatt* All		
J.1	Maintain and extend the relevant IHO standards, specifications and publications	M		-	Permanent	O	Gwenaële Jan	IHO Resolutions in M-3 S-60 User's Handbook on Datum Transformations involving WGS 84	See IHO CL10/2017 dated 1/02/2017
L.1	Develop and maintain material for CB course on Tides and Tide gauges	H	Complete translate of course material into Spanish and Portuguese by 2018 in liaison with Regional CB Coordinator requirements	-	Permanent	O	Ruth Farre* Peter Stone Zarina Jayaswal Gwenaële Jan Cesar Borba José Ramón Torres García		Adapt currently available course material to create a course suitable for delivery in support of CBSC requests

Meetings (Task K)

Date	Location	Activity
25-28 Mar 2014	Wollongong, Australia	TWLWG-6

3-5 Jun 2014	Québec City, Canada	SCWG-2
21-24 April 2015	Silver Spring, Maryland, USA	TWLWG-7
13-15 May 2015	Tokyo, Japan	SCWG-3
25-29 April 2016	Niterói, Brazil	TWCWG-1
8-12 May 2017	Victoria, Canada	TWCWG-2
16-20 April 2018	Viña del Mar, Chile	TWCWG-3
8-12 April	Busan, Republic of Korea	TWCWG-4

Chair: Gwenaële Jan (France) Email: gwenaele.jan@shom.fr
Vice Chair: Peter Stone (USA) Email: peter.stone@noaa.gov
Secretary: David Wyatt Email: adso@iho.int

Tides, Water Level and Currents Working Group
Busan, Republic of Korea – 8-12 April 2019
Draft Agenda – (TWCWG4)

1. Opening

.1 Opening address – Chair
.2 Address by host nation – KHOA
.3 IHO comments – IHO

2. Administrative Arrangements

.1 Adoption of the Agenda and Apologies – Chair/Secretary
.2 Programme and timetable of the Sessions – Chair/Secretary
.3 Meeting administration, including H&S – Host
.4 Report on Intercessional Activities including HSSC10 – Chair
.5 Matters arising from TWCWG3/Review of Action Items – Secretary

3. Product Specification Presentations

.1 Water Level Information for Surface Navigation (S-104) – AUS
.2 Surface Current Product Specification (S-111) – USA/CAN

4. Product Specifications Work Packages

.1 Progress report on current datasets – CAN
.2 Feedback on results from encoding tests – USA
.3 Application of encoding tool(s) to additional datasets – CAN
.4 Encoding datasets in HDF5 S-111 format – CAN
.5 Engagement with S-100WG – FRA

5. Programme Matters

.1 Standard Constituent List – GBR
.2 Standard for digital Tide Tables – USA
.3 The study of long term data sets for the determination of global sea level rise. – GBR, NOR, USA & ESP
.4 Compare Tidal Predictions generated as a result of analysis of a common data set by different analysis software – USA
.5 Feedback on long term sea level variation – NOR
.6 Exchange of Harmonic constants/predictions, feedback on comparison of tidal constituents – GBR/USA
.7 Establishment and Maintenance of VRF for High Resolution Bathymetric Surfaces – GBR & NLD
.8 Determining ellipsoidal height of MSL at the coast – NLD
.9 Inventory of Tide gauges used by IHO Member States – IHO
.10 Actual Tides On-line Link status – IHO

6. IHO Resolutions and Charting Specifications

.1 Review of relevant IHO Resolutions – IHO
.2 Review of relevant IHO Charting Specifications – IHO

7. IOC Programmes

.1 Update on IOC GLOSS Programme items and events – USA
.2 Update on IOC TOWS Programme items and events – JPN

8. Capacity Building

.1 Tides and Water Levels Workshop training material – ZAF/AUS

9. Any Other Business

.1 Development of report to S-100WG and HSSC11 – Chair
.2 Historical data recovery – Chair
.3 Consider need to create Project Teams for development of S-100 PS – Chair

10. Work Plan and ToRs

.1 TWCWG Work Plan up-dates – IHO
.2 Review TWCWG ToRs and RoPs – IHO

11. Venue and dates of the 5th TWCWG Meeting (TWCWG5) – Chair/Secretary

12. Review of Action Items from TWCWG4 – Secretary

13. Draft Agenda for TWCWG5 – Chair/Secretary

14. Closing remarks – Chair

Report from Kurt Hess about TWCWG3. April 22, 2018

The following are some points I, as Project Team leader, raised and a summary of the responses received form the TWCWG3 attendees.

A. Discussion of questions pertaining to the S-111 document and to the HDF5 format.

1. As to adding the Climate and Forecast (CF) variables, the attendees did not support the idea unless they knew more about the variables. PT leader sent the attendees the link to the webpage sent by Raphael Malyankar, and leader attempted to assess how much extra work was required. It seems that the new Group_F has many of the variables, so leader recommend not adding CF variables beyond those in the new Group at this time; attendees agreed

2. As to the use of a TIN model, surface currents do not require spatial interpolation, so the node-to-cell information is unnecessary and TIN data can be specified simply as an ungeorectified grid. However, for water level data, node-to-cell data may be required, and it is not clear where this information should reside. Possibly in Group_IDX.

3. The use of ungeorectified gridded data may require the addition of 'thinning' rules for this format. Such rules may be more difficult to specify than those for regularly-gridded data.

4. As to the question of where the Producer Code is listed in the product, it is not in the metadata but will be in the newly agreed upon (by S-100WG) format for the file name.

5. As to the file naming convention, S-100 agreed to the following for the first 6 characters: 'SxxxCC', where xxx are the three digits in the Product Specification and CC is the two-character producer code. Any additional characters are to be specified by TWCWG. At this meeting, there was no consensus of what those characters should be.

6. As to the including the uncertainty in the vertical datum as a component of total uncertainty, the attendees agreed that it would be included in the total uncertainty whenever the datum uncertainty, if it existed, could be determined.

7. PT leader suggested that the specified (in S-111) precision in the transmitted values for current speed and direction be only recommended as a minimum, not required, so as to increase a producer's flexibility. This would require changes in the portrayal rules. There was no objection.

8. The suggestion of a 'Conformance' data quality measure was mentioned by a reviewer of the PS. It was agreed the PT leader would gather further information on the meaning of this measure and report back.

B. A discussion of questions and recommendations on the revised part 10c HDF format.

1. In general, the TWCWG attendees wished for either no or minimal changes in HDF file organization since they were still experimenting with it.

2. As to the recommendation to combine the data into an XYZT format, there was strong disagreement by two MS. However, in the leader's opinion, not all attendees fully understood the concepts involved.

3. PT leader suggested that the S-104 team contact Raphael Malyankar to determine where the data for areas of influence should reside.

4. As for scale offset encoding for both data values and coordinates, for more compact storage, there was a general agreement to implement if this could reduce file size.

5. As for allow storage of coordinates as integers instead of floating point values, AUS said that converting back to lat/lon may sacrifice accuracy/precision, and that GIS software manufacturers don't understand transformations very well, and adding another transformation adds confusion.

6. As for storing data values for regular grids as 1-D compound array, like other formats, FRA would like to test to see the consequences before it could provide a clearer answer. Uniformity is a noble goal, but TWCWG would like to get more opinions.