



Water Level Information on S-100 ECDIS

S-100 WG8

13-16 November 2023



- The following tests “at the S-100 level” were suggested for S-102 and S-104 datasets on S-100 ECDIS:
 - identical vertical (sounding) datums
 - no holes in the S-102/S-104 coverage unless over land and no coverage on land
 - use of only regular grids
 - coincident coverage of S-102/S-104
- “all S-102/S-104 data destined for ECDIS (and this is only for data for use on an ECDIS) should meet these requirements - the OEM will filter out anything not meeting them”
 - tests have been requested for S-164 so they can develop that functionality.
- TWCWG and S-102 PT comments on these and other validation checks were submitted earlier to the S-100 validation subgroup, ~ 28 August.
- TWCWG support the concept of water level adjustment on S-100 ECDIS, but not the exclusion of all other uses of water level information on ECDIS.



- **MSC.530(06) requirements:**

*1.3 ECDIS should be capable of displaying **all nautical information necessary for safe and efficient navigation**, originated and distributed by or on the authority of a government, authorized hydrographic office or other relevant government institution, as required by SOLAS regulations V/19 and V/27.*

- **MSC.530(106) defines “ENDS” as:**

*3.3 Electronic navigational data service (ENDS) means a special-purpose database **compiled from nautical chart and nautical publication data**, standardized as to content, structure and format, issued for use with ECDIS by or on the authority of a government, authorized hydrographic office or other relevant government institution, and conforming to IHO standards; and, which is **designed to meet the requirement of marine navigation and the nautical charts and nautical publications carriage requirements** in SOLAS regulations V/19 and V/27. The navigational base layer of ENDS is the electronic navigational chart (ENC).*



- The validation checks as formulated would block the following kinds of water level information (largely because it is not in regular grid form):
 - Tide tables on ECDIS – point-based data, with the geographic coordinates being the location of the tide station.
 - Data generated by some hydrodynamic models, including forecast information, using grids whose cells are not rectangles. This can be encoded and distributed as georeferenced grids or TIN (Triangulated Irregular Network) data.
 - Hydrodynamic models whose cells are rectangles or not can also be encoded and distributed as point-based data, i.e., sampling of the model at a tide station location for model evaluation comparison to astronomical tidal predictions and/or total water level observations (which would also be point-based data).
 - Water level information distributed via AIS Application Specific Messages is unlikely to be gridded data.
- Such information is necessary for safe and efficient navigation and should be available to the mariner on ECDIS – even if it is not used for water-level adjustment functionality as described in S-98.



- Conversion of existing water level information from tide gauge stations to regular grid format requires a substantial investment of time, effort and know-how.
 - Smaller hydrographic offices in particular may not have the resources and expertise to complete this by 2026 or shortly after.
- Hydrographic Offices need to validate their water level models and be confident of the reported accuracy of the data they distribute.
 - This requires significant development even for well-resourced Hydrographic Offices.
- The matter of distribution, including technical, infrastructure, licensing, and management aspects, needs to be addressed, especially since some Hydrographic Offices plan to distribute S-104 datasets multiple times a day.
- TWCWG expect that only a few hydrographic offices will be ready to distribute S-104 datasets in the regular grid format at the time S-100 ECDIS become operational.
 - Tide tables on the other hand are relatively easy to convert to S-104 digital datasets.
- Too-strict restrictions on “what is allowed on ECDIS” mean tide and water level data will be absent from ECDIS for many ports and marine waterways.
 - This means important nautical publications (i.e., tide tables or a substitute) will be missing from the “ENDS” defined in MSC.530(106).



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USE ON ECDIS

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- What can ECDIS do with S-104 water level information other than use it for water level adjustment?
- S-100 5.1.0 portrayal apparently does not include the necessary functionality for time series plots and complex structured portrayals.
- Alternative approaches to address this for the near future:
 - 1) define interim portrayal compatible with S-100 5.1.0;
 - 2) make it available to the end user via ordinary pick reports;
 - 3) use it in other types of interoperability – that is, other than Annex C water level adjustment – specifically, interoperability as described in S-98 “Main” and S-100 Part 16.



- "Portrayal" for tide table data, in the sense of displaying a symbol on the chart graphic, consists only of displaying the existing TIDHT01 symbol at the locations of the tide stations.
- The content of water level information contained in tide tables is actually in the "pick report " generated when the location of the tide station is clicked.
- "Complex pick reports" are currently the subject of NIPWG work and related papers have been submitted to this S-100WG meeting.
- Some possible solutions for S-104:
 - There is already a proposed interim solution, to pre-generate the displayed material (e.g., as HTML) and store them in a "system attribute" when the dataset is being compiled. NIPWG is expected to work on the modeling details.
 - An *interoperabilityIdentifier* is another possible method of linking information in S-104 datasets to features in other data products (e.g., tide stations to depth areas). Details TBD.
 - Very basic portrayal for non-point S-104 data (e.g., polygon with a centered TIDHT01 symbol or a complex linestyle boundary including that symbol), to indicate areas where water level information is available.
 - Cursor pick on a point within that polygon brings up an ordinary pick report or hover box reporting the local water level and trend.



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- Some possible solutions for S-104:
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CASE 1 – TEXTUAL PICK REPORT, DISCRETE POINT COV.

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Data: Tide table (point coverage) with pre-generated formatted text support files showing high and low water for all calendar weeks for an entire year.

ECDIS displays the TIDHT01 symbol at the location of the tide station.

Click on symbol - > system takes the date setting from the ECDIS and displays the high and low water times for the current calendar week.

NOAA/NOS/CO-OPS

Disclaimer: These data are based upon the latest information available as of the date of your request, and may differ from the published tide tables.

Daily Tide Predictions

StationName: Los Angeles

State: CA

Stationid: 9410660

Prediction Type: Harmonic

From: 20231022 06:31 - 20231028 22:01

Units: Metric

Time Zone: LST_LDT

Datum: MLLW

Interval Type: High/Low

Date	Day	Time	Pred	High/Low
2023/10/22	Sun	06:31 AM	1.20	H
2023/10/22	Sun	10:18 AM	1.06	L
2023/10/22	Sun	04:04 PM	1.53	H
2023/10/22	Sun	11:45 PM	0.00	L
2023/10/23	Mon	06:50 AM	1.33	H
2023/10/23	Mon	11:48 AM	0.86	L
2023/10/23	Mon	05:29 PM	1.58	H
2023/10/24	Tue	12:32 AM	-0.04	L
2023/10/24	Tue	07:14 AM	1.48	H
2023/10/24	Tue	12:46 PM	0.61	L
2023/10/24	Tue	06:34 PM	1.64	H
2023/10/25	Wed	01:11 AM	-0.04	L
2023/10/25	Wed	07:40 AM	1.65	H
2023/10/25	Wed	01:35 PM	0.36	L
2023/10/25	Wed	07:30 PM	1.66	H
2023/10/26	Thu	01:47 AM	0.01	L
2023/10/26	Thu	08:08 AM	1.81	H
2023/10/26	Thu	02:21 PM	0.12	L
2023/10/26	Thu	08:22 PM	1.64	H
2023/10/27	Fri	02:21 AM	0.10	L
2023/10/27	Fri	08:37 AM	1.94	H
2023/10/27	Fri	03:05 PM	-0.06	L
2023/10/27	Fri	09:12 PM	1.57	H
2023/10/28	Sat	02:53 AM	0.23	L
2023/10/28	Sat	09:07 AM	2.03	H
2023/10/28	Sat	03:49 PM	-0.18	L
2023/10/28	Sat	10:01 PM	1.47	H



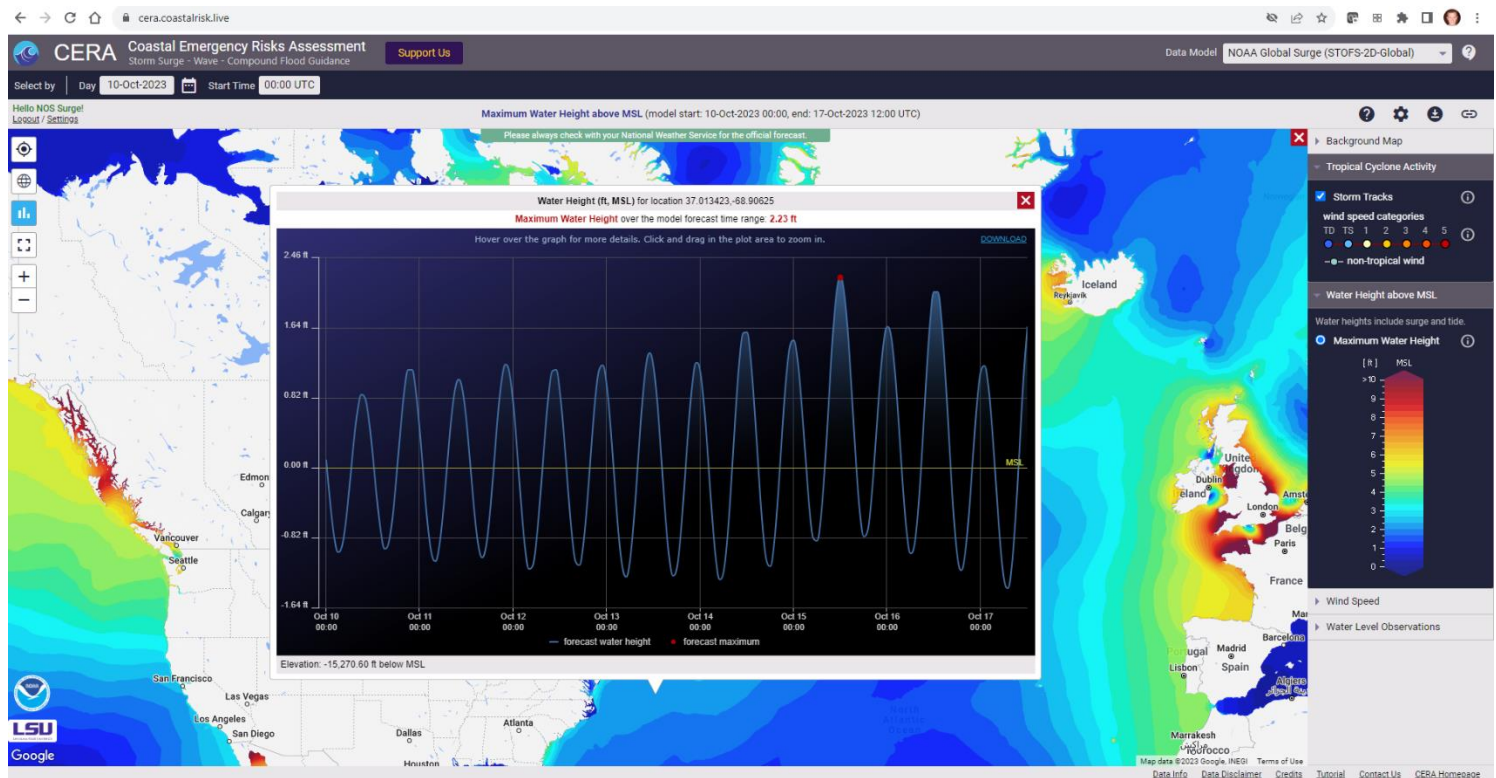
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PICK REPORT ON CONTINUOUS COVERAGE

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Data: Regular grid (DCF 2), ungeorectified data (DCF 3) or TIN data (DCF 7) from hydrodynamic forecast model.

ECDIS displays the water levels from the model as a coverage fill. User can click where there is coverage from the model to get either a graphic time series plot or text-based pick report (water level height, trend, etc.) from the model. Note that cursor pick by user is not at the location of a tide station.



Screen capture by NOAA.

Picture is for illustrative purposes, colors etc. to be harmonized with ECDIS.



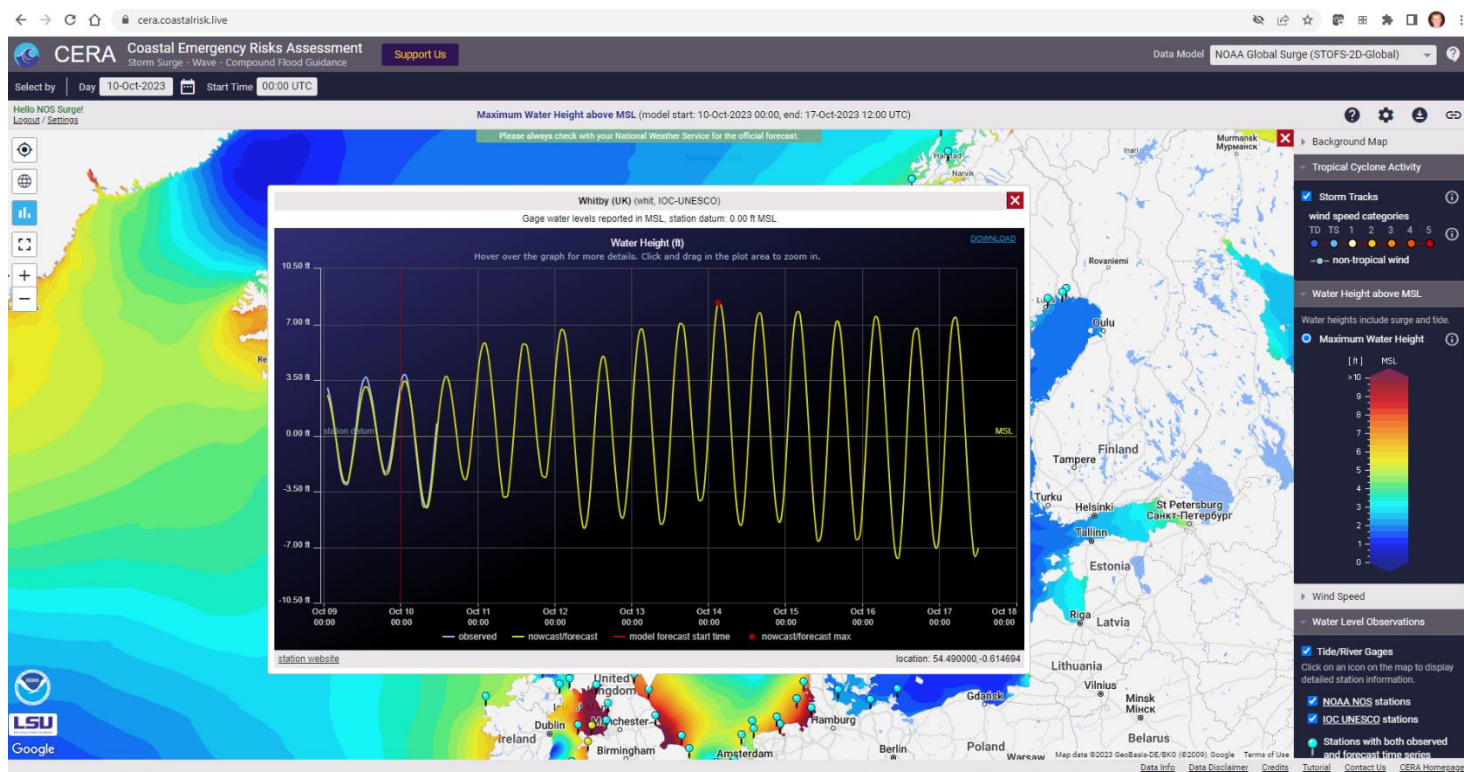
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PICK REPORT ON CONTINUOUS COVERAGE WATER LEVEL STATION

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Data: Regular grid (DCF 2), ungeorectified data (DCF 3) or TIN data (DCF 7) from hydrodynamic forecast model; time series at fixed stations (DCF 1 or 8) from hydrodynamic forecast model, astronomical tidal predictions, and/or observations.

ECDIS displays the water levels from the model as a coverage fill. User can click a location of a water level station to get either a graphic time series plot or pick report (water level height, trend, etc.) from the model, observation, and/or astronomical tidal prediction. All water level data will be on chart datum.



Screen capture by NOAA.

Picture is for illustrative purposes, colors etc. to be harmonized with ECDIS.



- S100 5.1 exchange catalogue metadata does not indicate whether a dataset is suitable for the water level adjustment algorithms described in S-98.
 - Applications have to open the dataset and check the embedded metadata to detect whether a dataset is compatible with the WLA algorithm.
 - Application opens datasets and checks embedded metadata - datum, DCF=2, extent, etc.
- Metadata can be used to indicate to the application whether the dataset is WLA-compatible.
 - Compatibility information can be determined when a water level dataset series (e.g., sequence of forecasts) is defined. It can then be encoded for every dataset in the series.
 - Add compatibility information to external (discovery) metadata in exchange catalogue.
 - Add the same compatibility information to internal (embedded) metadata in the HDF5 dataset to facilitate more flexible access by applications.
- Similar information can be added to S-128 (Catalogue of Nautical Products).
 - Amendments to S-128 will be discussed with NIPWG.



S100_DatasetDiscoveryMetadata	
+ fileName: URI	
+ description: CharacterString [0..1]	
+ datasetID: URN [0..1]	
+ compressionFlag: Boolean	
+ dataProtection: Boolean	
+ protectionScheme: S100_ProtectionScheme [0..1]	
+ digitalSignatureReference: S100_SE_DigitalSignatureReferen	
+ digitalSignatureValue: S100_SE_DigitalSignature [1..*]	
+ copyright: Boolean	
+ classification: MD_SecurityConstraints [0..1]	
+ purpose: S100_Purpose [0..1]	
+ notForNavigation: Boolean	
+ specificUsage: MD_Usage [0..1]	
+ editionNumber: Integer [0..1]	
+ updateNumber: Integer [0..1]	
+ updateApplicationDate: Date [0..1]	
+ referenceID: URN [0..1]	
+ issueDate: Date	
+ issueTime: Time [0..1]	
+ boundingBox: EX_GeographicBoundingBox [0..1]	
+ temporalExtent: S100_TemporalExtent [0..1]	
+ productSpecification: S100_ProductSpecification	
+ producingAgency: CI_Responsibility	
+ producerCode: CharacterString [0..1]	
+ encodingFormat: S100_EncodingFormat	
+ dataCoverage: S100_DataCoverage [0..*]	
+ comment: CharacterString [0..1]	
+ defaultLocale: PT_Locale [0..1]	
+ otherLocale: PT_Locale [0..*]	
+ metadataPointOfContact: CI_Responsibility [0..1]	
+ metadataDateStamp: Date [0..1]	
+ replacedData: Boolean [0..1]	
+ dataReplacement: CharacterString [0..*]	
+ navigationPurpose: S100_NavigationPurpose [0..3]	

Attribute	specificUsage	The use for which the dataset is intended	0..1	MD_USAGE>specificUsage (character string)
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Add this constraint as a Remark:

Datasets compatible with S-98 Ed. 1.1.0 water level adjustment algorithms must encode "WLA" (without quotes) as the (entire) content of this attribute, without preceding or following whitespace.

Datasets not compatible with S-98 water level adjustment algorithms must either omit the *specificUsage* attribute altogether or ensure that its value is different from the string "WLA" (with or without quotes, and with or without preceding or following whitespace, to preclude potential human error).

```

<XC:specificUsage>
  <mri:MD_Usage>
    <mri:specificUsage>
      <gco:CharacterString>WLA</gco:CharacterString>
    </mri:specificUsage>
  </mri:MD_Usage>
</XC:specificUsage>

```

(other possibilities: *description* or *comment* instead of *specificUsage*?)



S100_ComplianceCategory

Item	Name	Description	Code	Remarks
Enumeration	S100_ComplianceCategory		-	-
Value	category1	IHO S-100 object model compliant	1	
Value	category2	IHO S-100 compliant with non-standard encoding	2	
Value	category3	IHO S-100 compliant with standard encoding	3	
Value	category4	IHO S-100 and IMO harmonized display compliant	4	

Value	Category5	IHO-S-100 and IMO harmonized display compliant and designed for S-98 water level adjustment algorithms.	5	See S-98 Annex C for water level adjustment algorithms. Product Specifications must describe appropriate requirements for encoding exchange catalogue discovery metadata.
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S100_DatasetDiscoveryMetadata
+ fileName: URI
+ description: CharacterString [0..1]
+ datasetID: URN [0..1]
+ compressionFlag: Boolean
+ dataProtection: Boolean
+ protectionScheme: S100_ProtectionScheme [0..1]
+ digitalSignatureReference: S100_SE_DigitalSignatureReference [0..1]
+ digitalSignatureValue: S100_SE_DigitalSignature [1..*]
+ copyright: Boolean
+ classification: MD_SecurityConstraints [0..1]
+ purpose: S100_Purpose [0..1]
+ notForNavigation: Boolean
+ specificUsage: MD_Usage [0..1]
+ editionNumber: Integer [0..1]
+ updateNumber: Integer [0..1]
+ updateApplicationDate: Date [0..1]
+ referenceID: URN [0..1]
+ issueDate: Date
+ issueTime: Time [0..1]
+ boundingBox: EX_GeographicBoundingBox [0..1]
+ temporalExtent: S100_TemporalExtent [0..1]
+ productSpecification: S100_ProductSpecification
+ producingAgency: CI_Responsibility
+ producerCode: CharacterString [0..1]
+ encodingFormat: S100_EncodingFormat
+ dataCoverage: S100_DataCoverage [0..*]
+ comment: CharacterString [0..1]
+ defaultLocale: PT_Locale [0..1]
+ otherLocale: PT_Locale [0..*]
+ metadataPointOfContact: CI_Responsibility [0..1]
+ metadataDateStamp: Date [0..1]
+ replacedData: Boolean [0..1]
+ dataReplacement: CharacterString [0..*]
+ navigationPurpose: S100_NavigationPurpose [0..3]

S100_ProductSpecification
+ name: CharacterString [0..1]
+ version: CharacterString [0..1]
+ date: Date [0..1]
+ productIdentifier: CharacterString
+ number: Integer
+ complianceCategory: S100_ComplianceCategory [0..1]



- Clause 4a-5.5.5 (new)
 - describe code 5
 - “As for category 4 and containing only features that meet the requirements for water level adjustment functionality on ECDIS.”

4a-5.5 S-100 compliancy categories

When implementing S-100 support, different systems may have different requirements to S-100 based products and their adherence to the S-100 framework. ECDIS may require a very high degree of compliance; while a reporting system may require a lower degree of compliance by, for example, not needing an S-100 based exchange method. To facilitate a means of communicating the intent of a Product Specification and resulting products an S-100 compliance category can be declared. Four categories are defined.

4a-5.5.1 Category 1 - IHO S-100 object model compliant

The Product Specification contains an object model which is available as a Feature Catalogue from the IHO S-100 GI Registry and is compliant with the S-100 spatial model (S-100 Parts 7 and 8).

4a-5.5.2 Category 2 - IHO S-100 compliant with non-standard encoding

The Product Specification adheres to the minimum requirements of S-100 Part 11. The Product Specification specifies which of the S-100 Part 10 encoding methods is used; or it specifies another encoding, including how it maps to the S-100 GFM. Metadata is according to S-100 Part 4, a profile of Part 4 or an extension according to Part 4 rules.

4a-5.5.3 Category 3 - IHO S-100 compliant with standard encoding

As Level 2 with the following restrictions:

- The Product Specification uses only an encoding method defined in S-100 Part 10.

4a-5.5.4 Category 4 - IHO S-100 and IMO harmonized display compliant

As Level 3 with the following restrictions:

- Metadata is according to S-100 Part 4 or a profile of Part 4 metadata;
- The Product Specification includes a Portrayal Catalogue available from the IHO S-100 GI Registry;
- The Product Specification includes defined methods for the S-100 defined cyber security scheme (at a minimum including digital signature and, if applicable, the method of encryption);
- Test material is embedded into the Product Specification or test material is available in a separate package. The test cases and related material is at a minimum comparable to IHO Publication S-64 for S-52/S-57/S62/S-63);
- The Product Specification uses a CRS from the EPSG Geodetic Parameter Registry. EPSG CRSs which do not comply with the requirements of S-100 Part 6 or the selected encoding method defined in S-100 Part 10 should not be used;
- If appropriate, the Product Specification includes an Alerts and Indications Catalogue available from the IHO S-100 GI Registry; and
- If appropriate, the Product Specification is compliant with the Interoperability Catalogue available from the IHO S-100 GI Registry.



- It is important not to over-restrict the types of water level information accepted on ECDIS, which should accept the S-104 types:

dataCodingFormat	Type of Data
1	Time series data at one or more fixed stations
2	Regularly-gridded data at one or more times
3	Ungeorectified gridded data or point set data at one or more times
7	TIN data
8	Stationwise time series at one or more fixed stations

- S-128 (Catalogue of Nautical Products) may need to be extended to support designations for different types of water level information.



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RECOMMENDATIONS

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- 1) S-100 level validation should be such that S-100 ECDIS accepts S-104 data formats in addition to regular grids complying with the proposed requirements for water level adjustment.
- 2) S-104 Edition 2.0 should define portrayal and pick report formats compatible with S-100 Edition 5.1.0 or the interim solution for complex pick reports described above and in NIPWG papers.
- 3) The following checks should be in S-98 as compatibility checks for WLA purposes instead of S-100-level validation checks:
 - 1) Any checks pertaining to compatibility between S-101, S-102, and S-104 for the purposes of water level adjustment, including the proposed validation checks described in the Background section above.
 - 2) A check corresponding to whichever option (new compliancy category or specificUsage content) is selected for detection of WLA-compatible information.
- 4) Appropriate amendments should be made in one or both of S-100 and S-98 pertaining to the new compliancy category code or the restriction on specific usage.
- 5) The S-100 Validation Checks subgroup should be tasked with developing a set of checks for S-101/S-102/S-104 compatibility for WLA purposes, in conjunction with the S-102 Project Team, the S-104 Project Team (TWCWG), and the S-164/S-98 subgroup.
 - 1) The scope of these checks (“WLA compatibility checks”). should be limited to inter-product compatibility for the purposes of WLA.
 - 2) “Ordinary” S-100-level checks for compliance to S-100 (format consistency with Part 10c, etc.) should be a separate set of checks (“validation checks”).



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ACTIONS REQUESTED

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- Endorse the use on ECDIS of S-104 data types in addition to regular grid data.
- Advise on preferred interim solutions for pick reports.
- Update S-100 according to the recommendations in this paper.
- Task the S-100 validation checks subgroup and the S-98 subgroup according to the recommendations in this paper, including the preparation of appropriate updates to S-98.