# S-101 Value Added Roadmap DRAFT

**February 2021**

**IHO**

International
Hydrographic
Organization

# 1    Introduction

S-101 is the new Product Specification for Electronic Navigational Chart data based on the overarching S-100 framework. Future S-101 compliant ENCs are intended to succeed, and eventually replace S-57 compliant ENCs as official chart data for ECDIS. The development of S-101 as currently undertaken by the S-101 Project Team under the IHOs S-100 Working Group reflects the experience and stakeholder feedback gained over a number of years with regard to some limitations of S-57 compliant ENCs. S-101 compliant ENCs do not constitute a radical reengineering of the S-57 concept. S-101 retains most of the features of S-57 but improves those elements of S-57 which can benefit from a more flexible framework compliant with current ISO geospatial standards, emerging spatial data infrastructure requirements and modern geoinformation technology, including e-navigation. Importantly through its use of S-100, S-101 can be extended as new requirements emerge. S-101 is intended to provide the base chart layer for the implementation of the IMO e-navigation initiative. Its full potential will be realized when other S-10x datasets can be integrated as described in the S-98 Interoperability Specification. The components of S-101 are shown in Figure 1.
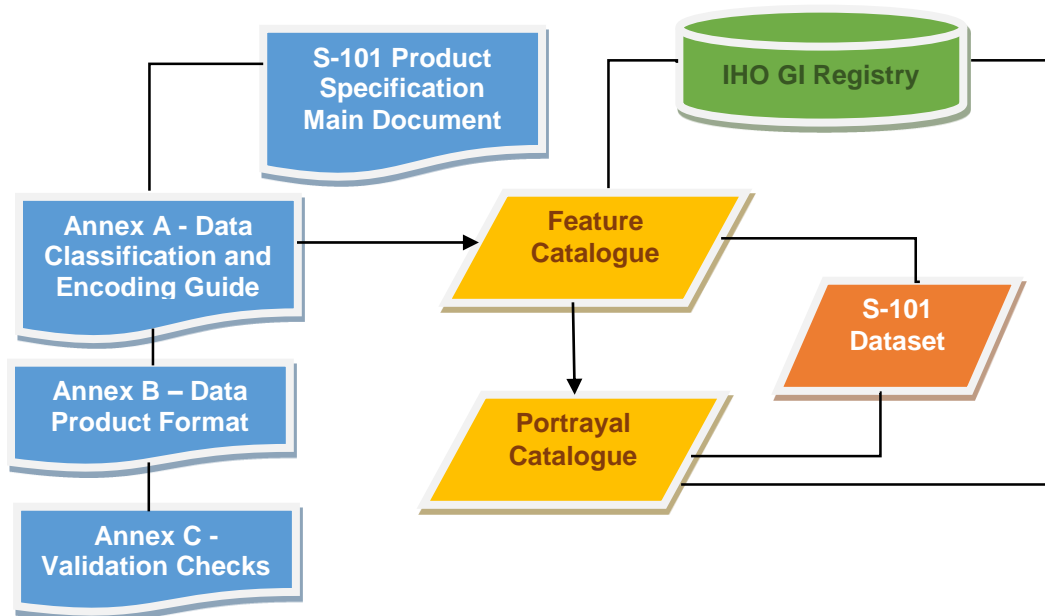


**Figure 1 – S-101 Components**

The purpose of this roadmap is to provide an estimated timescale of events (Figure 2) in the development, testing and implementation of S-101. The sequence of activities is supported by a more detailed description of the various processes and impacts which are anticipated to have an effect on the various stakeholders. The timescales involved are very much dependent on available resources and a number of dependencies. The S-101 Project Team Work Plan provides more detail on specific Project Team activities in the short term (years 1-2).

S-101 Edition 1.0.0 was published in December 2018 and currently (January 2021) remains in a development phase which is seeking to achieve an Operational version for implementation by 2024. S-101 Edition 1.1.0 is currently being prepared; will be aligned to S-100 Edition 5.0.0; and is intended to provide a version to support more complete and robust testing. An interim version 1.0.1 of the S-101 Data Classification and Encoding Guide (and corresponding version 1.0.1 Feature Catalogue), aligned to S-100 Edition 4.0.0, is also being developed to facilitate more robust testing of the S-101 data model for changes that are not reliant on enhancements to be introduced in S-100 Edition 5.0.0. Testbed software is key to progress and more mature S-100 Testbeds including shore based ECDIS are now available.

S-101 sits within a wider landscape of Standards as shown in Figure 3; this highlights that:

- S-101 is dependent on a specific version of the S-100 standard;
- S-101 is still closely related to S-57 and this relationship needs to be well understood to support conversion and a period of dual production;
- S-101 will be reused in other Product Specifications either by extension (for example S-401 Inland ENCs) or by reusing some features and attributes.

Therefore, in addition to developing S-101 itself efforts will be required to maintain alignment between the different Product Specifications.

Section 2 provides a detailed account of the stages involved in the development and testing of S-101; its environment and the transition from S-57 ENCs into products of the new format; and its surrounding IHO, IMO and IEC standardization environment including IHO, IMO ECDIS Performance Standards and IEC 61174 including participation of navigation system providers.

Section 3 provides details of how S-101 differs from S-57 ENC; its impact on regular production of ENCs and their processing along the chain from production via dissemination and use in an ECDIS in particular.

Section 4 provides a stakeholder analysis which seeks to identify the different stakeholder groups and outline how engagement with them will be conducted.

Annex A provides a Risk Register for the S-101 Product Specification which seeks to document the identified risks and associated mitigations.

This Roadmap supports the IHO S-100 Implementation Roadmap which is maintained by the HSSC.

| | |
|---|---|
| **Develop and publish S-101 Ed 1.1.0** | Currently the S-101 Project Team is preparing S-101 Edition 1.1.0. This edition will reflect S-100 Edition 5.0.0 and is planned to be published immediately following S-100 Edition 5.0.0. This edition will include a complete Portrayal Catalogue and Validation Checks for S-101 data. Publication is currently expected by late 2022. |
| **Preliminary Implementation** | Following publication of Edition 1.1.0 software providers will need to update their tools to support S-100 Edition 5.0.0 and S-101 Edition 1.1.0. This will then support a period of active test and development which will include trials to ensure that S-101 data effectively meets the requirements of the various stakeholders. |
| **Develop and publish S-101 Ed 2.0.0** | Based on experience gained during test and development activities a further version of S-101 will be prepared. S-101 Edition 2.0.0 will be the operational version based on which operational data can be produced. |
| **Final Implementation** | S-101 Edition 2.0.0 will then be implemented and this will require the maturity of the relevant IEC test standard to support S-100 ECDIS that can be type approved. This phase will require comprehensive final testing. |

**Figure 2 – S-101 Development and Implementation timeline**

January 2021

S-100
Version 5.0.0

<< A version of *S-101 will
always be related to a specific
version of S-100*

*S-101 is predicated on conversion
from S-57*

S-57 ENC

S-101 ENC

S-401

*S-101 will also be extended and
reused within other Specifications*

S-98

S-100 ECDIS

IEC-61174

*To realise operational S-100 ECDIS both S-
98 and the corresponding Type Approval
standards will need to be in place*
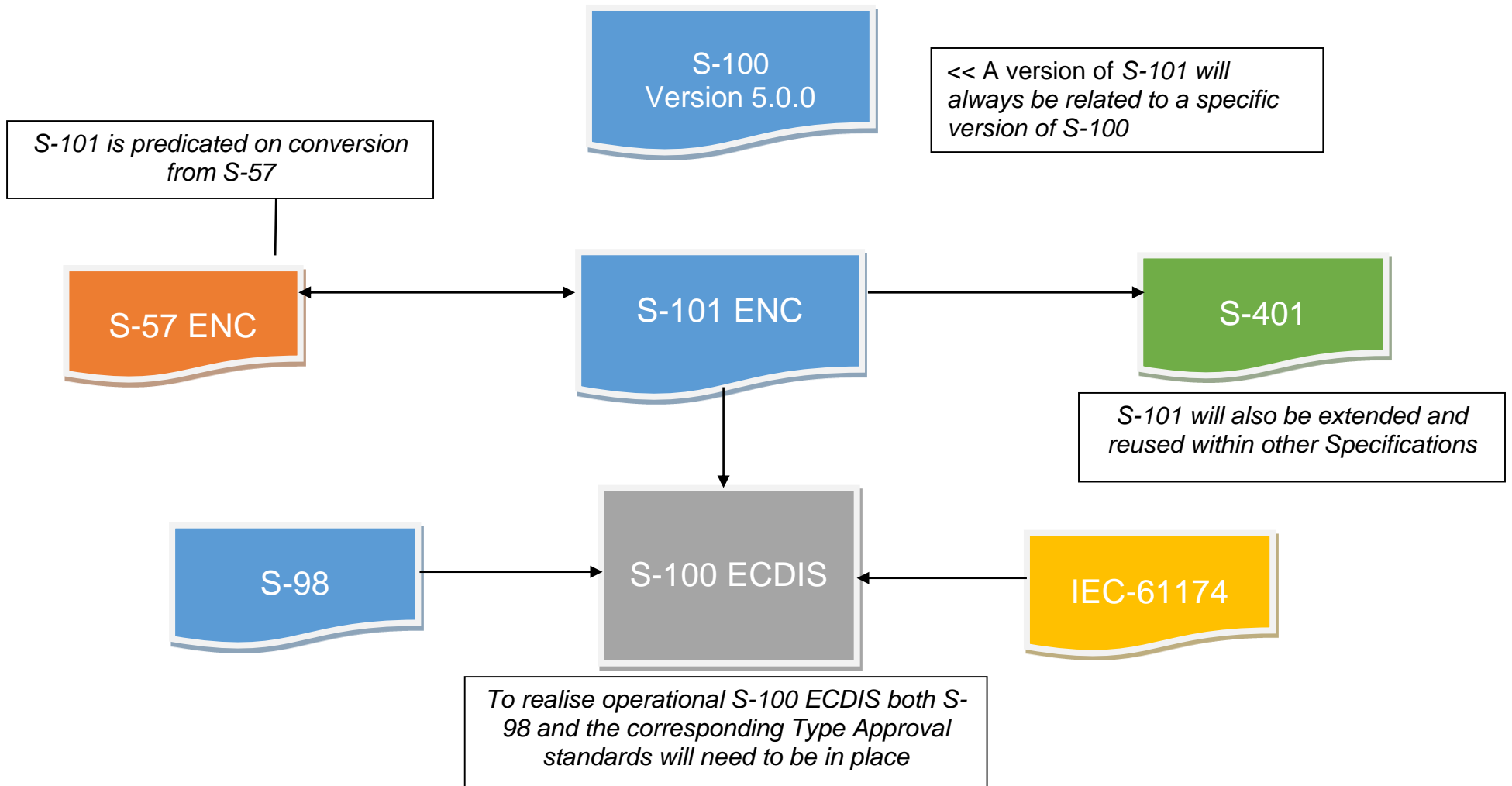
**Figure 3 - S-101 External Landscape**

## 2    S-101 Roadmap

### 2.1    Stage 1 – Initial Development and Testing COMPLETED

The initial development of S-101 involved developing the data model through the Data Classification and Encoding Guide Sub-Working Group. This allowed an initial Feature Catalogue to be developed early conversion tools were then developed using this catalogue.

More recently with the publication of S-101 Edition 1.0.0 conversion tools and production software have further matured. Additionally, testbed viewers have matured towards Shore-based ECDIS and now support the integration of multiple datasets and multiple product types.
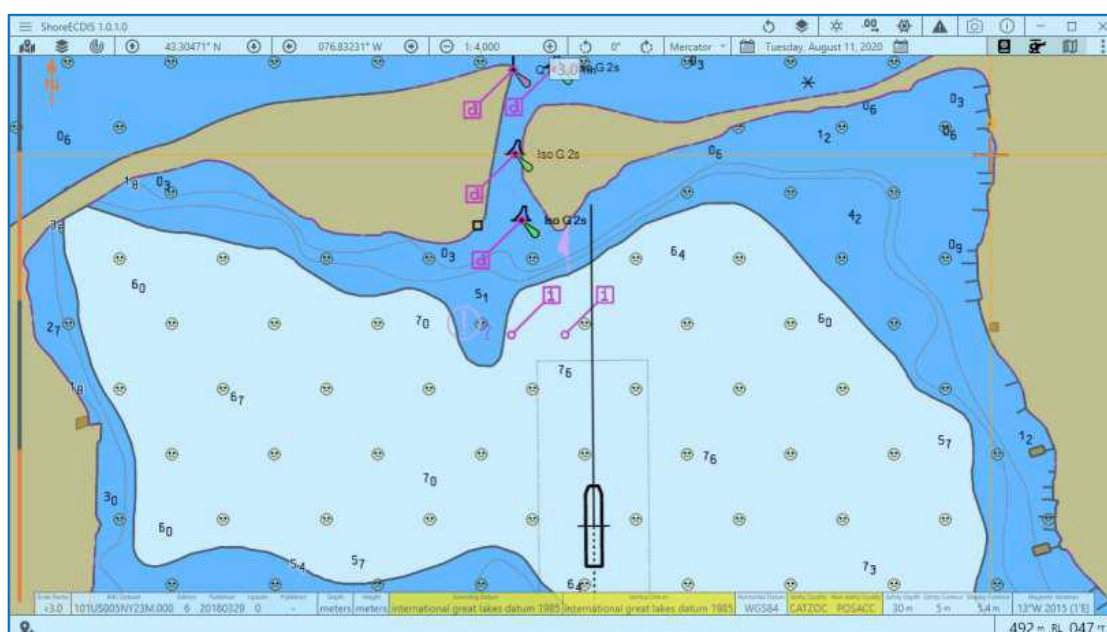
Figure 4 -NIWC Shore-based ECDIS

### 2.2    Stage 2 – Testing and development ONGOING

Currently test and development continues with S-101 Edition 1.0.0 and S-101 Edition 1.1.0 is now in active development. Work is progressing to deliver a more complete S-101 Product Specification in line with S-100 Readiness Levels; this will include a complete Portrayal Catalogue and Validation checks.

Importantly it is also intended to include an alerts and indications catalogue; where possible test data sets will also be provided to support implementation.

Work to finalise changes for Edition 1.1.0 will be progressed during 2021, the GI Registry is correspondingly being updated, and the associated catalogues generated. An interim version S-101 Data Classification and Encoding Guide and Feature Catalogue (version 1.0.1) based on S-100 Edition 4.0.0 will be published in early 2021 to test proposed improvements to the S-101 data model that are not reliant on the enhancements to be introduced in S-100 Edition 5.0.0, with the possibility of further interim versions (version 1.0.2, …) as required. Finally, the Data Quality Working Group will review the draft components prior to publication to ensure consistency.

In parallel the IHO ENCWG has now established a dedicated group to support the conversion between S-57 and S-101. This group will develop guidance to support producers as they begin conversion and production of S-101 ENCs.

In order to develop an S-100 ECDIS additional standards such as the S-98 Interoperability Specification and the IEC ECDIS Performance Standard 61174 will also need to be mature.

## 2.3  Stage 3 – Preparation of Operational Version PLANNED

The implementation of S-101 Edition 1.1.0 will support further test and development activities supported by trial data production to ensure that representative data is available to provide realistic tests. This will identify changes to S-101 to enhance the Specification based on testing.

These changes will then be used to prepare S-101 Edition 2.0.0 which will be the operational version. This version will extend S-101 to include.
- Complete Validation Tests
- Complete Test Datasets (S-164)
- Exchange Catalogue
- Data Protection (S-100 Part 15)
- Interoperability Catalogue (S-98)

In addition, the Operational version will be dependent on the availability of an updated IEC 61174 Test Standard for ECDIS. Close coordination with the IEC Technical Committee 80 will be required during this period as this development proceeds; and tested within testbed activities.

In order to achieve the requirement for ENC update status reporting currently included in IEC 61174 a published version of S-128 *Catalogue of Nautical Products* aligned with the Operational edition of S-101 Edition 2.0.0 will also be required.

It is currently planned to develop S-101 Edition 2.0.0 during 2023 with a view to publication during 2024. This will require focussed effort including coordinated engagement with relevant stakeholders to ensure that the operational version meets the needs of all stakeholders.

## 2.4  Stage 4 – Implementation PLANNED

The implementation of S-101 is ongoing but upon publication of the Operational Version a period of final implementation can be envisaged, this will require.
- Implementation of the Operational version by the providers of production and navigation software.
- Finalisation of the IEC test standard.
- A period of type approval where new systems are tested against the new test standard.
- ENC producers will commence production of S-101 Edition 2.0.0 data.
- Appropriate training and familiarisation for users and other stakeholders (port state control) will be available.
- All parts of the distribution chain will then establish operational services.

This period will require careful coordination and communication to ensure a managed transition. Particular focus will need to be made on ensuring that S-101 supports both independent operation and use within a dual fuel ECDIS.

At the completion of the implementation phase the S-101 Project Team will disband and the ongoing maintenance of the S-101 ENC Product Specification will transfer to the ENC Working Group.

## 3     S-101 ENC – New Content

S-101 ENCs will eventually become the basic electronic navigation chart for use as official data in ECDIS as well as a Technical Service within the new e-navigation environment. Since it provides enhanced options of its elements, its maintenance and compatibility it has the potential to improve the content and functionality of all applications making use of such data sets.  The S-101 Project Team have hosted two S-101 Stakeholder Workshops attended by a variety of interested parties covering the whole domain of electronic navigation. Many of the new concepts which are being introduced have either evolved through, or been improved by, the discussions held during the workshops. The following items are as included in the S-101 Edition 1.0.0, but may be subject to change and or refinement during the testing phase. For a more detailed account of the following please refer to the latest draft of S-101.

**It is important to recognize that the provisional content described in this section will undergo rigorous testing both from a technical perspective and also taking into consideration the implication for all the various stakeholders.**

**To support the migration and dual running of S-57 ENC/S-101 ENC a Conversion Sub Group has been formed o develop more detailed guidance for encoders and to optimise the relevant standards to make conversion and dual production as efficient as possible.**

**The following spreadsheet has been developed to detail changes between S-57 ENC and S-101 1.0.0.**

**Removed and Remodelled Items Spreadsheet Oct 2020**

### 3.1     Features and Attributes

The main differences between the S-57 ENC Object and Attribute catalogues and the S-101 Feature catalogue are as follows:
- A Feature Catalogue is now unique to the individual Product Specification. Currently the S-57 catalogue is designed as one fits all.
- S-100 based Feature Catalogues are the equivalent to an application schema. Therefore all features are pre-bound to their attributes within the catalogue.
- The S-101 Feature Catalogue will contain other constraints such as feature types, geometric primitives and mandatory status of attributes.

**Impact on data production systems –** This will make it easier to develop S-100 based production systems which can produce and maintain different products. Machine readable Feature Catalogues which are updateable will provide manufacturers with the opportunity to create "plug and play" systems.

**Impact on data producers –** This is an important change in practical terms as it will make encoding easier, reduce training needs and reduce errors. The "Data Classification and Encoding Guide" (DCEG), comparable to the existing "Use of object catalogue" for S-57 ENCs, will standardise the use of features for S-101 compliant encoding.

**Impact on validating S-57 converted data –** None, where there is not a direct mapping to S-101, validation tools will still find any errors**.**

The majority of features and attributes in S-101 have been inherited from the S-57 ENC object and attribute catalogues and remain unchanged; however the following are some examples demonstrating either improved functionality and/or improved end user experience.

### 3.1.1   Complex Attributes

These are described first because they have a significant influence on the restructuring of some of the features that will change in S-101. Complex attributes are a significant improvement to enhance S-101 applicability. It provides the ability to either replace multiple attributes or break down attributes into new sub-attributes.

For example, S-57 uses structured text for certain attributes which consist of character strings constrained to set formats. In S-101 each element of the formatted string will be a sub-attribute. One of the more complicated formats is that of tidal stream information. The following diagram demonstrates a more logical and efficient structure.
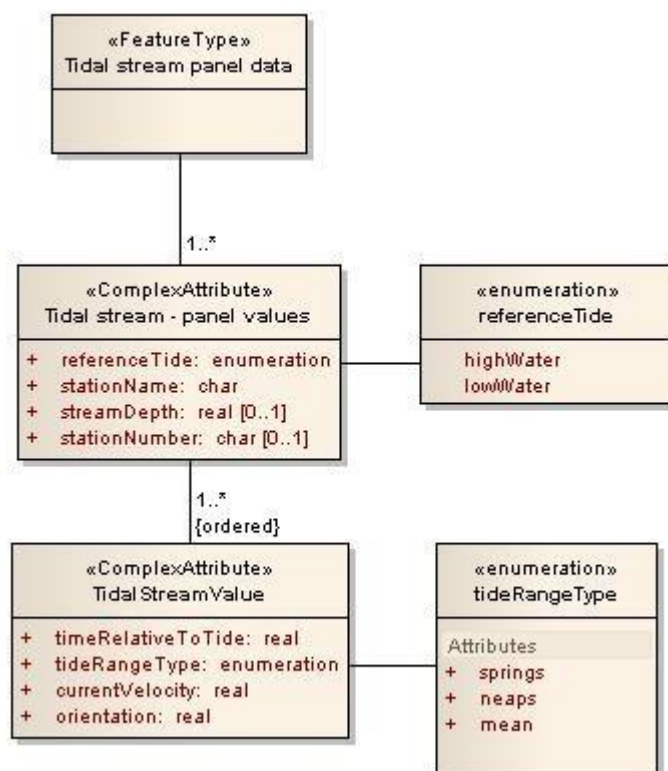


**Impact on data production systems –** Changes to software will be required to implement the new structure.

**Impact on data producers –** Minimal, the actual information remains the same; it will just be entered in a different way. It should also reduce the likelihood of formatting errors. Fundamentally most if not all current production systems, whether data base or file based, do not hold data being prepared in the S-57 format. It is at the export stage when it is converted to ISO/IEC 8211 encoded data. Therefore a production system could be configured to export either the S-57 or S-101 version of ISO/IEC 8211 data.

**Impact on validating S-57 converted data –** None, there is a direct mapping to S-101.

## 3.2    Lights Features

There will be a separate feature type for the five main categories of lights – All Round, Sector, Fog Detector, Directional and Air Obstruction. This will actually simplify both the encoding and portrayal of lights. For example a light with 2 or more sectors is currently encoded as one light feature per light sector. In S-101 the single sector light feature will have each individual sector encoded as a complex attribute.

**Impact on data production systems –** Changes to software will be required to implement the new structure.

**Impact on data producers –** Minimal, in fact it will reduce the complexity of encoding of all lights and in particular sector lights.

**Impact on validating S-57 converted data –** None, there is a direct mapping to S-101.

## 3.3    Update Feature

Currently one of the biggest problems users have is ascertaining what changes have been made after an update has been applied to the data. The ECDIS just does not have enough information to properly depict or highlight what are commonly important changes.

A new feature has been included to enable a user to clearly see what changes have been applied to a data set either by way of a notice to mariner or any other future mechanism which may emerge, including any features which may have been deleted. If necessary the text of the change can be included with all source references and dates. One of the major benefits will be that it can be included in passage planning to detect changes which may affect a chosen route. In particular temporal changes such as changes to Traffic Separation Schemes can be detected.

**Impact on data production systems –** Changes to software will be required to implement the new feature.

**Impact on data producers –** It is likely, but no yet confirmed, that this new feature will replace the S-57 SORIND and SORDAT attributes, however it will enable update information held in production systems to be more easily tracked. Introducing this feature will probably incur more work for encoders, but the benefit to the end user will significantly outweigh this. Over time as production systems integrate more processes the burden may actually be reduced.

**Impact on validating S-57 converted data –** As this is a new feature it will only be available in full specification S-101 data. However there may be a possibility during the transition period to include this in the S-57 data being converted.

**Impact on users –** Significant, currently the methodology for highlighting changes is at best questionable in that it is very difficult to pin point the exact change because it is mostly based on geometry. A system should now be capable of allowing queries to find any updates.

## 3.4    Cartographic Text Feature

This new feature and its attributes provides the means to control the positioning of text in order to reduce text clutter; one the most common issues raised by users. Initially this feature is thought to be only appropriate for point and possibly line features; the use and limitations of this new feature will become clearer during testing.

**Impact on data production systems –** Changes to software will be required to implement the new feature. Consideration should be given to utilizing information stored in multi-product databases.

**Impact on data producers –** Unless, as suggested above, existing information is re-used then encoding this feature will require extra effort which cannot be automated. However the impact on the end user will be considerable and achieving less cluttered displays should be a high priority.

**Impact on validating S-57 converted data –** These features can only encoded in the full specification S-101 and therefore cannot be converted.

**Impact on users –** Significant, in conjunction with the use of SCAMIN it will significantly improve the user display.

## 3.5    Data Loading and Unloading

A new methodology based on producer defined display scales (minimum and maximum) has been introduced. This will simplify the process for ECDIS, giving clear and concise rules on how and when data is loaded and unloaded. The concept of navigation purpose has been restricted for use in presenting ENCs in a visual catalogue. A direct relationship between S-101 dataset compilation scales and ECDIS data display scales has also been introduced in order to facilitate improved dataset loading and unloading, which also considerably improves the application of the scale minimum (SCAMIN) attribute.

**Impact on data production systems –** Minimal, only requires the addition of two new fields.

**Impact on producers –** Minimal, and it may be possible to introduce an algorithm to automate the encoding of the maximum and minimum scales. This will become clearer during the test phase.

**Impact on validating S-57 converted data –** Investigation is being undertaken to determine if the maximum and minimum scale values can be automatically generated. It may also be possible to introduce a mechanism to populate the fields during the conversion process.

**Impact on users –** Significant, currently there isn't a standardized formula for loading data which has led to inconsistent and sometimes unhelpful loading strategies being utilized.

## 3.6    Data Classification and Encoding Guide (DCEG)

The DCEG is the S-101 equivalent of S-57 Appendix A Chapters 1 and 2 "Object and Attribute Catalogues" and Appendix B.1 Annex A "Use of the Object Catalogue" combined, and will mean that encoders have all the necessary information in one place. The DCEG will undoubtedly evolve throughout the testing phases as the new features and constructs are put into practice.

## 4    Impact on other Stakeholders

The successful development and implementation of S-101 is dependent on the Project Team considering the needs of all stakeholders appropriately. This section will outline the identified stakeholder types and detail specific plans to engage with them. As this Roadmap evolves more detailed stakeholder engagement plans will be developed.

**Stakeholder Matrix**

| Stakeholder Group | Stakeholder Name |
|---|---|
| Production | Production Software Providers |
| | Hydrographic Offices |
| Distribution | RENC |
| | Service Providers |
| Use | Navigation System Providers |
| | Shipping Companies |
| | Mariners |
| Regulatory | Type Approval Bodies |
| | IHO |
| | IMO |
| | Flag States |

### 4.1    Production Software Providers

All of the current production software providers are engaged in IHO Working Group activities. Some are actively developing their products to support S-101. Others are more cautiously awaiting maturity of the standards. A dedicated engagement plan is not deemed required for this group.

### 4.2    ENC producers

Hydrographic offices are a critical stakeholder for S-101 given that S-101 datasets will be produced in addition to S-57 ENC and paper charts for a potentially protracted period. The activity of the ENC Conversion Sub Group is one way in which the S-101PT will monitor progress here.

### 4.3    RENCs

Both active RENCs are preparing for S-101 services. A dedicated engagement plan is not deemed required for this group. Close engagement should continue and RENCs should be involved in trials and pilot activities to de-risk the S-101 supply chain.

### 4.4    Service Providers

A small number of service providers are engaged in IHO Working Groups but engagement with all Service Providers is needed. A dedicated engagement plan is needed for this stakeholder group.

## 4.5     Navigation System Providers

Some navigation system providers are involved in IHO working groups, but a large proportion are not. The industry group CIRM would be a logical route to engage with this stakeholder group. A dedicated engagement plan should be developed for this group in liaison with CIRM.

## 4.6     Shipping Companies

Shipping companies will ultimately need to upgrade their navigation systems at some point to support S-100. We have experience from the mandatory carriage requirement for ECDIS how the industry contains a spectrum ranging from early adopters to those who will only upgrade when they have to. Therefore, it is important to understand this stakeholder group and a dedicated engagement plan is required.

## 4.7     Mariners

This is a key stakeholder group, and it is of critical importance that S-101 not only meets user needs but that it enhances the user experience compared with S-57 ENCs. A dedicated engagement plan is required for this group.

## 4.8     Type Approval Bodies

There is limited representation of type approval bodies within IHO working groups. A key focus for these stakeholders will be the S-164 test datasets and the relationship between IHO standards for S-101 and relevant performance standards. It is important to engage with these stakeholders, but a dedicated engagement plan may not be required.

## 4.9     IHO

The S-101 Project Team reports to the S-100 Working Group which as a subsidiary organ of the Hydrographic Services and Standards Committee (HSSC). The S-100 Implementation Plan provides an overarching framework and the S-101PT will use this Roadmap to ensure that S-101 aspects are adequately described. No dedicated engagement plan is required for thse stakeholders.

## 4.10   IMO

Engagement with IMO is led by the IHO Secretariat but all IHO members should be encouraged to engage their relevant representatives to support the associated discussions.

## 4.11   Flag States

For the purposes of S-101 it is expected that the views of Flag State authorities will be represented by within IMO.

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## Annex A – S-101 Risk Register

| Risk / Hazard | Inherent Risk | Risk Controls | Residual Risk | Comment |
|---|---|---|---|---|
| Lack of resources to progress standards development (S-101PT) | C3 | Encourage IHO Member States and expert contributors to attend. | C2 | Escalate resource gaps to HSSC, potential use of special projects fund in some cases. Maintain and communicate a clear work plan. |
| S-100 and other standards on which S-101 is dependent are insufficiently mature | D3 | Liaise closely with S-100WG and other groups. | D3 | Escalate risk to HSSC. |
| Lack of resources to conduct comprehensive test and development | C4 | Proactively support testbed activities. Form pilot projects and propose trials. | C2 | Escalate risk to HSSC. |
| S-101 2.0.0 has errors or inconsistencies which affect implementation | B3 | DQWG supported by Sweden is conducting a formal review of the revision of S-101 based on ISO 9001 principles. | B2 | Initial review will be applied to S-101 1.1.0 but is expected to become part of a defined process. |
| S-101 2.0.0 is not supported by the stakeholder community | D4 | Develop and execute stakeholder engagement plans. | C3 | For example, OEMs do not develop dual fuel systems or service providers do not develop services. |
| S-101 2.0.0 does not meet user needs | D4 | Develop and execute a stakeholder engagement plan to validate S-101 2.0.0 prior to publication. | C3 | Users do not find S-101 an improvement over S-57 ENC. |

**Likelihood = 1 Very Low 2 Low 3 Medium 4 High 5 Very High**
**Impact = A Minor B Moderate C Major D Severe E Critical**

| 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|

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