



# PRIMAR Conversion Task Force Project

Final Report

2023

**FREEDOM TO CHOOSE**

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## 1 Executive summary

This is a final report from the PRIMAR Conversion Task Force describing the project organisation, content and outlining the main conclusions and findings.

## 2 Project Organisation

### 2.1 Background

Following the IHO Assembly Decision (Decision A2/29, A2/30 and A2/31 refer) and endorsement of the "S-100 roadmap for the S-100 Implementation Decade (2020-2030) version 1.0 Rev1", the PRIMAR Advisory Committee (PAC) 27th meeting decided to establish a PRIMAR Data Conversion Task Force.

The project attempted to coordinate S-100 activities among PRIMAR member states and in their work on S-100/S-101 related issues where there is a great opportunity for experience sharing. IHO has also identified that conversion of S-57 datasets initially will be the main source for production of S-101 datasets.

Several member states have set in place timeframes for the production of S-101. These are still dependent on the availability of the final operational version of the standard, indicated by HSSC to be ready by mid-2024.

### 2.2 Scope

The main objectives to be addressed by the PRIMAR Data Conversion Task Force are:

- Establish an active forum for exchange of experience and knowledge building between PRIMAR and member countries for conversion to and from S-101 with required validation of datasets.
- Enable PRIMAR member states to create converted test S-101 datasets for active participation and use in the PRIMAR dual-fuel S-57/S-101 project.
- Utilize the latest results from IHO S-100 standardisation and data conversion working groups, and shared results from conversion work within PRIMAR member states and other hydrographic offices in all its activities to minimize duplication of work.
- Perform testing of commercial converters and validation software using datasets from PRIMAR member states (has variations of encoding, production system and database setups). Testing of conversions from S-57 to S-101 and from S-101 to S-57 (the quality and completeness of the conversion is dependent on its source data)
  - Monitor and benchmark conversion software tools between S-57 to S-101 and S-101 to S-57
  - Assess completeness of conversion and identify which types of information and features are difficult to convert, including the encoding and conversion of metadata (e.g. FOID management, skin of earth objects, object relationships, metadata information)
  - Identify strategies for identifying and converting remaining features or undefined data during the conversion process.
  - Evaluate the functionality for datasets conversion of cells, updates, cancel cells and re-issues.

- Prepare guiding principles and workflows which can be used by the HOs and PRIMAR to improve the completeness and quality of the conversion process and the subsequent validation of the datasets.
- Provide high level strategic guidance on dual-fuel conversion of S-57/S-101 during the IHO transition period, e.g., maintenance of product schemes or possibilities for merging of cells to larger units (file size limits in S-57), relevant guidance on the use of 3 usage bands in S-101 versus 6 usage bands in S-57 etc.
- Investigate legal, resource and capacity building issues in data conversion with pre/post processing and identify potential consequences on the PRIMAR operation in a thought scenario where PRIMAR takes on a conversion responsibility (i.e., from S-101 to S-57) by delegation of a member state.

## 2.3 Organisation and Participants

### 2.3.1 Organisation

The CTF was organised using agile project methodology. The project organisation roles and responsibility were:

Role	Organisation	Responsibility
Project owner	PRIMAR – Norwegian Hydrographic Service	<ul style="list-style-type: none"> <li>● Monitor project scope, objectives, and requirements</li> </ul>
Project manager and project team	ECC	<ul style="list-style-type: none"> <li>● Project supervision and communication with project participants and stakeholders</li> <li>● Participate in conversion activities, provide guidance and document project results</li> </ul>
HO participants	PRIMAR member nations and one invited hydrographic office	<ul style="list-style-type: none"> <li>● Identify applicable test data and participate in conversion activities</li> </ul>
System providers	Providers of software tools for conversion and validation	<ul style="list-style-type: none"> <li>● Make software tools available for conversion and validation</li> <li>● Provide feedback on identified issues</li> <li>● Updating of conversion software</li> </ul>

### 2.3.2 PRIMAR Member States Participation

The initial CTF project proposal approved by PAC27 assumed that only 4 nations wanted or were in a position to participate in the project. The other nations were invited to participate in planned joint meetings to discuss and share experiences. The feedback at the project kick-off meeting were unanimous that all nations wanted to participate actively in the conversion activities, and the project was later expanded at PAC28 to cover the inclusion of all PRIMAR member states in phases.

The following nations participated in the CTF conversion activities:

- Albania, Croatia, Estonia, Finland, France, Latvia, Lithuania, Norway, Poland, Sweden.

NTOU (Taiwan) was also invited to participate in the project because of their current work on S-100 dataset production and technical maturity arising from other discussions with PRIMAR staff.

The following nations were prevented from participating in the project for various reasons: Mozambique, Vietnam, Iran, Ukraine, Georgia, Russia. There is an ongoing discussion with Iran to coordinate a physical visit to review and exchange experiences on S-100 dataset production, validation and conversion.

### 2.3.3 System Manufacturer Participations

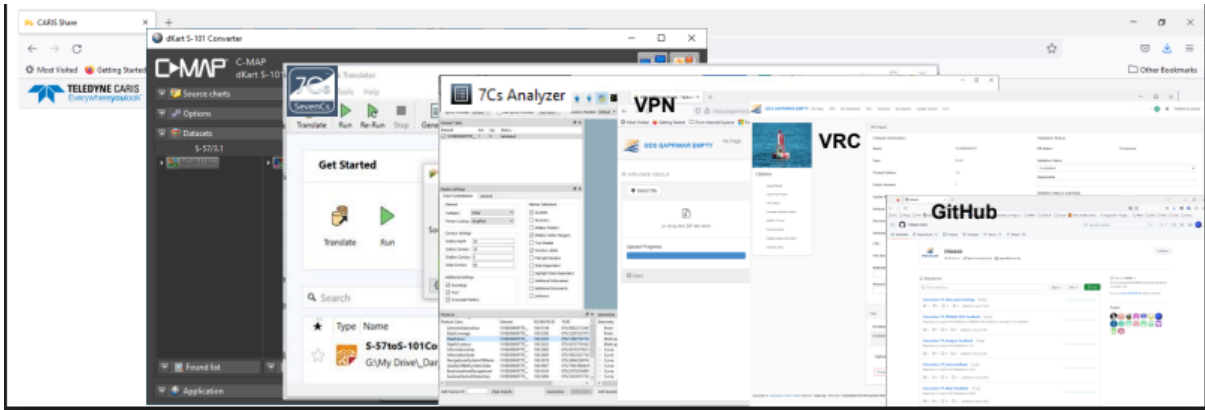
The following companies were invited to participate in the project: SevenCs, Nautical Dimensions, Lloyds Register, Teledyne, ESRI and IIC.

The following manufacturers provided the following applications for use used during the project:

<b>Provider</b>	<b>Application</b>	<b>Functionality</b>	<b>Conditions</b>
Teledyne Caris	CARIS platform	Web based conversion service S-57 to S-101	Subscription purchased for access to online conversion
SevenCs	7Cs Analyzer and Converter plugin for FME	S-57 and S-101 ENC validation, and converter module	Provided for free during project
Lloyd's Register and i4 Insight	dKart platform	Desktop converter and AWS PC converter S-57 to S-101, and S-101 to S-57	Provided for free during project
PRIMAR	VPN/VRC	Upload, validation and release "sandbox" version of S-100 functionality	Provided for free during project

Github training material was created and made available on the PRIMAR Training Portal together with existing S-100 based courses.

The manufacturers provided made several upgrades to their prototype and commercial applications and services during the project to improve the conversion and validation functionality based on the issues identified and feedback provided.



## 2.4 Progress

A kick off meeting was organised where all PRIMAR member states were invited. Information about project content, organisation and objectives were presented. It was envisaged that only a limited number of PRIMAR member states would be interested, had capacity or were in a process implementing support for S-100 or S-101. The kick-off meeting concluded that ALL PRIMAR member states wanted to participate, and the original CTP project proposal was extended to include all countries.

The start-up of the project was delayed because none of the commercial software providers had applications available with required conversion and/or validation functionality. It enabled the HOs to complete any training on Github or S-100/S-101 available on the PRIMAR Training Portal.

Each country had identified a few sample S-57 cells which were representative for their coverage, or had special encoding issues which would be of interest during dataset conversion. It was possible for a nation to convert additional datasets if they wanted.

**The Experience of the Conversion**

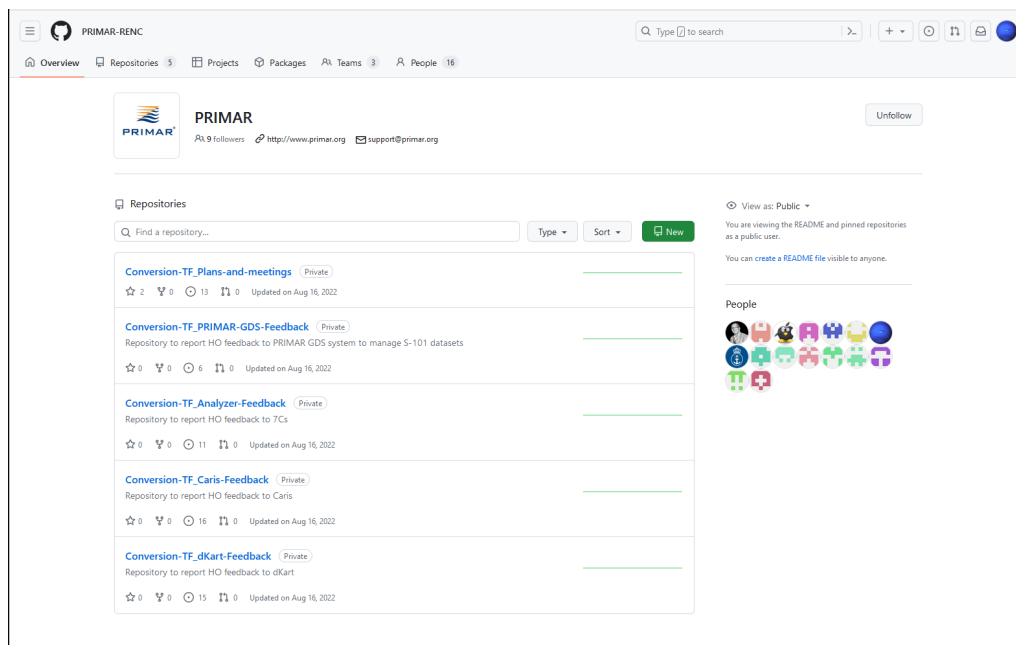
PRIMAR

- In short, a couple of words on the **experiences at HOs** on their achievements in ENC and/or production database conversion. **(HO representatives)**
  - Tools used (Caris, dKart, SevenCs, PRIMAR GDS, GitHub)
  - Conversion trials
    - file based?
    - database based?
    - both?
  - Production considerations, if any at this stage
    - ENC main production workstream – S-57?, S-101?, both?
    - Which way conversion considered?
    - Is the choice influenced by other production needs (e.g., paper chart production?, NtM production?, other?)
  - Other information would like to note for the project or Report?

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The project was divided into three consecutive phases where 3-4 countries participated in each phase. Each phase was started with a kick-off meeting with the HO's outlining how to use the tools, exchange of current experiences from the project and how to register any issues. PRIMAR staff monitored conversion progress and did also perform internal validation of sample datasets from each nation. Ad-hoc meetings were organised with nations when requested. The project manager did during the project start to organise weekly meetings to answer questions about conversion and validation, and to discuss any issues identified by a nation in their dataset. A total of 31 VTC meetings were completed during the project.

The project manager brought relevant issues identified during the project to the IHO S-57 to S-101 conversion sub WG.



The system manufacturers provided answers and solutions to issues identified by the nations on Github, and they made several upgrades to their software to resolve issues automatically. Several of the countries continued to re-test the conversion of their datasets after the software had been updated.

## 2.5 Activities not included in the project scope

- To develop a PRIMAR conversion tool, or integrate external conversion software into existing PRIMAR conversion tool,
- Conversion of national data
  - PRIMAR staff participated in all data conversion discussions, but where it was seen to be of only a particular national conversion variance, further discussions were recommended to be continued outside this project on a bilateral basis.
- Rescheming of cells
  - No rescheming of cells were considered or conducted during the project.

This project summary report will serve as a foundation to consider the necessity for adding relevant functionality for conversion readiness assessment or validation as part of the PRIMAR's S-101 Adaptations project, phase 2, starting in 2024.



### 3 Project Objectives and Deliverables

The project proposal documents identified a range of tangible project deliverables described below with a presentation of the relevant deliverables and results:

- 1) Invite all PRIMAR member states to participate in a coordinated effort to get experience with the new S-101 ENC standard and of the process of converting and validating S-101 datasets. The project should cover both S-57 to S-101 and S-101 to S-57 conversion.
  - All PRIMAR member states were invited to participate throughout the Project timeframe.
  - Eleven PRIMAR member states (in addition to one non-PRIMAR hydrographic office – NTOU - Taiwan) defined test areas and provided data. Most of the participants contributed by testing and using the provided tools.
  - The activities increased the level of knowledge related to the conversion tasks, ability to convert using a conversion tool and in general the new IHO S-101 ENC product specification and the S-57 to S-101 conversion sub-WG.
  
- 2) Establish a forum to exchange experience and knowledge between the project team and participating member states related to conversion to and from S-101 with required validation of datasets.
  - A repository was established on Github (<https://github.com/PRIMAR-RENC>) and used throughout the project. Each software provider had its own shielded repository for the exchange of issues specific to their application.
  
- 3) Enable PRIMAR member states to create converted S-101 test datasets to use in other projects related to the new IHO ENC standard.
  - All participating HOs were able to create sample S-101 datasets.
  
- 4) Utilize the latest results from IHO S-100 standardization and data conversion working groups. Share results from conversion work within PRIMAR member states and other hydrographic offices to minimize duplication of work.
  - The PRIMAR project team have monitored and participated in IHO S-100 standardization and data conversion working groups and have provided input to both the IHO Working Group and Conversion Task Force GitHub repositories about issues identified, suggestions for resolution and registration of status.
  
- 5) Perform testing of commercial conversion and validation software using datasets from PRIMAR member states. Testing was converting datasets from S-57 to S-101, and from S-101 to S-57.
  - 55 test datasets were defined and used, based on the selection of test data guideline from the PRIMAR project team. The datasets had variations in encoding, production system and database setup. The quality and completeness of the conversion was dependent on its source data.

- 6) Investigate legal, resource and procedure impacts if a Hydrographic Office, in the future, wants PRIMAR to perform data conversion on their behalf.
- PRIMAR is operated by the Norwegian Hydrographic Service, a division of the Norwegian Mapping Authority and funded by the Norwegian Government. There are restrictions on what liability government organisations can accept.
  - PRIMAR has in its agreements with cooperating hydrographic offices and other data suppliers stated liability for the services it provides. Liability for the datasets remains with the data producer and the country with a production responsibility covering the water of jurisdiction.
  - The tested functionality shows that it is possible to out-source the conversion activity, albeit validation can be complicated without having access to additional source material. Existing prototype production tools show high efficiencies to carry out this task at HOs easily. In opposite, the one-time, initial conversion to the new IHO S-100 standard seems reasonable to consider to out-source in whole or partially, especially for HOs with a large dataset amounts or large national data databases.
  - Identified important areas to be considered by a hydrographic office when outsourcing conversion to an external company are:
    - Who has the legal responsibility and status of converted product for use in navigation.
    - How the HO involvement is facilitated in validation of converted product
    - The need to share additional chart information and chart sources with organization performing the conversion/validation.
    - If the converted datasets will be made available to all interested parties on the same terms and conditions
    - How to coordinate release of same datasets/updates as S-57 and S-101 (no significant delays)
    - How is upgrade of converted datasets to newer editions of the S-101 standard planned.
  - Experiences from the Conversion Task Force projects show that several quality related issues identified during the conversion or validation might require access to additional source material for proper resolution, and that information is only available within the producing hydrographic office. This limits what PRIMAR can achieve when it comes to conversion and validation, and it primarily focuses on checking compliance with IHO standards and guidelines and not positional accuracy, completeness etc.
  - A possible option is that PRIMAR can set up an online conversion service where hydrographic offices can upload datasets, perform conversion, and download the converted datasets with logfiles for internal quality control and validation. Functionality can be added for visualization, error resolution etc. It is however important that the source/product databases within a hydrographic office are also updated based on results from the issue resolution.

- 7) Project progress reporting during the project timeframe.
- The PRIMAR Data Conversion Task Force project progress was presented to the PRIMAR member states in common meetings including the PSWG/PFMWG/PTEWG and PAC meetings for 2021, 2022 and 2023. PRIMAR also performed internal project progress and review at regular intervals during the project period.
  - The project scope and proposed timeframes were adjusted, and various new and additional activities were identified throughout the project based on new insight and updated priorities. The adjusted scope and timeframe were communicated to the stakeholders accordingly.

## 4 Project Conclusions and Recommendations

This section tries to summarise the main conclusions from the activities completed during the project.

### 4.1 System Manufacturers

- The project was originally delayed because none of the commercial manufacturers had applications and functionality available for conversion and validation at scheduled project start. Software was gradually made available when the manufacturers completed their first releases supporting S-101.
- GitHub was used by all project participants as a communication channel, sharing information and monitoring the issues and discussions.
- The manufacturers welcomed all issues identified during the project and they were active on Github replying to the queries provided by the project participants. A total of 88 issues and 331 comments were registered.
- The manufacturers have used the feedback provided to make improvements to their conversion/validation functionality, and several updates of their software were released during the project. It enabled the hydrographic offices to re-test conversion of their datasets. It was also a noticeable success rate in data conversion achieved during the project:
  - *At the start of the project an estimated 36.3% of S-57 were successfully converted. The number rose significantly by the end of the project, to practically 98.2% converted ENC's. There is a 96.4% success rate of passing the PRIMAR upload checks (S-100 Readiness rate for HO's test datasets) as this project now is finalized.*
- The manufacturers used the project to get a comprehensive and thorough testing of their software, in addition to establish a close collaboration with many prospective customers.
- None of the manufacturers had specific guidelines for data conversion or S-100 validation. They offer a GIS platform where users can acquire relevant modules and have access to functionality to do conversion and validation. The conversion results will be dependent upon the quality of the input dataset, but they offer functionality to edit the dataset/database based on the validation log. Best results are achieved if the manufacturer "standard" database setup has been used.
- The GIS manufacturers claim they will have functionality to convert all types of updates, but some of this functionality is in development and was not tested in the project.

### 4.2 Evaluate the functionality and accuracy for the datasets converted, based on cells, updates, cell cancellation updates and re-issues

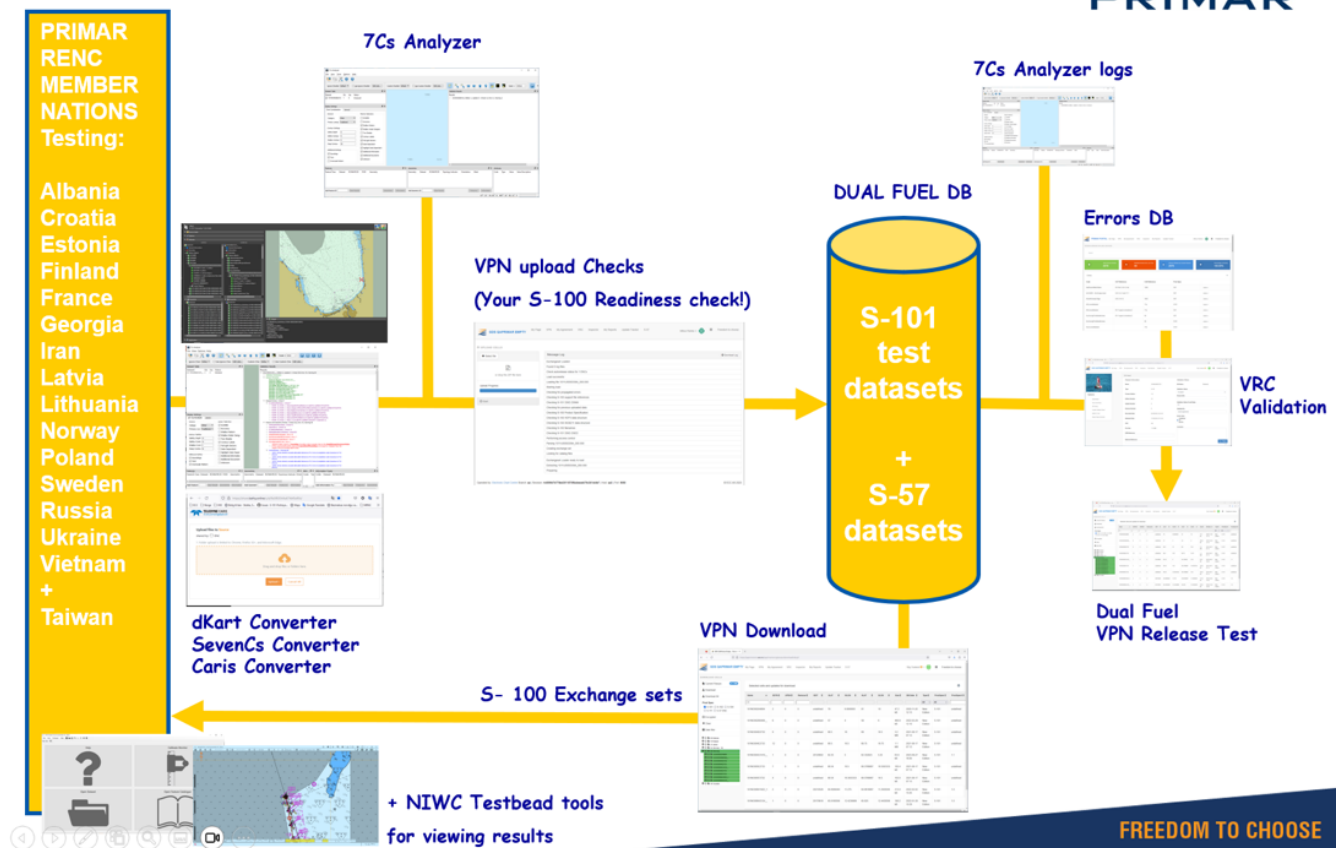
- Conversion from S-57 to S-101 was completed for 55 test datasets, with or without update files and support files. The datasets were "frozen" at that point to better understand the conversion tool improvements and the version developments between IHO standard developments during the project timeline.
- Limited conversion was completed from S-101 to S-57 due to lack of completely encoded S-101 test datasets, with or without update files and support files.
- S-57 cell update files alone were neither defined nor converted during the project.

- S-101 cell update files alone were neither defined nor converted during the project.
- S-57 dataset re-issues were not part of the defined test datasets. The software manufacturers claim that all test datasets with updates are treated by the conversion software as re-issues.
- Cell cancelling update files were not converted from S-57 to S-101. But it was possible to produce a S-101 cancel cell update file in a production software prototype. The cancel cell update was loaded successfully into the PRIMAR GDS test system.
- Some metadata files were generated along the converted test datasets by the converters.
- The new S-100 compliant exchange sets, including the CATALOG.XML file prototypes, were generated by the PRIMAR GDS test system when the uploaded and tested test datasets were downloaded back from the system.

#### 4.3 Prepare guiding principles and workflows which can be used by the HOs and PRIMAR to improve the completeness and quality of the conversion process and the subsequent validation of the datasets

- During the project initiation phase, the “PRIMAR Conversion Task Force Guideline” document was created. It was kept updated throughout the project. The Guideline is a basic workflow to be followed to convert the datasets through various converters, and to upload, validate, and release the S-101 or Dual Fuel datasets in the PRIMAR services.
- PRIMAR provided feedback from the project to relevant IHO Working Groups which they used to improve the IHO standards and guidance documents. During the project execution it became more and more evident that the IHO’s “Conversion Guidance” document was seen as a sufficient guidance document to be used by a hydrographic office for the main conversion. In addition, HOs can build their own national guidance policies on top, adapted to their priorities, production system and production flowline.
- The project also noted that working groups within IHO, RHC and EU, other similar project initiatives and test labs are providing input or updating their respective guidance documents. It was also identified that national policies vary a lot related to requirements for the national chart databases. This also applies because the IHO S-100 standard and S-101 product specification are not yet in a finalized state/version, and the hydrographic offices are at different stages in their S-100 implementation plan.

# ENC Conversion Testing/Testbed

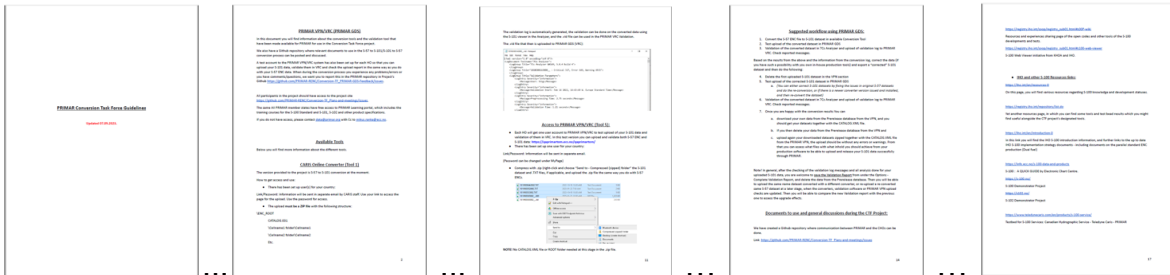


## 4.4 Other conclusions

- Benchmarking of conversion software and conversion results
  - It was agreed that the project will not benchmark or rate the conversion software from the different manufacturers, acknowledging they were all prototype versions of their software. It was concluded that the conversion success would be determined by using the PRIMAR GDS testing environment's upload and validation functionality as an HO's overall S-100 Readiness check.
  - The HO's were also able to collect experiences with the functionality and operation of the provided software.
- Provide counselling to any conversion problem and how to most effectively resolve them in the production and maintenance of ENC datasets.
  - The project team concluded that the most effective conversion is done by using the IHO Conversion Guidance and other Product Specification Documents and address all the findings or outstanding issues directly with IHO WGs developing those. The project did not address the Dual Fuel ENC dataset maintenance issues, as these guidelines are still in development at IHO WGs.



- Proposed strategic guidance to PRIMAR and its member states to support a Dual Fuel delivery during the IHO S-100 implementation decade.
  - The PRIMAR Conversion Task Force Guidelines document proposes various conversion software workflows. This includes PRIMAR proposed Dual Fuel upload and validation of the datasets through the PRIMAR GDS testing environment. The testing environment was improved and kept up to date through the entire project timeline and became the HO's S-100 conversion and Dual Fuel production Readiness checker.



- Presentation to PRIMAR member states representatives to discuss proposed recommendations and next steps (i.e. as part of a PAC/TEWG/IHO meetings)
  - Presentations on progress and findings were provided and held throughout the project timeline.
  - The project team concluded that there is no need for a dedicated continuation of the conversion testing. The recommendation is to integrate continuing actions, related to conversion into the PRIMAR's S-101 Adaptations project, phase 2, starting in 2024

## 5 Acceptance Criteria

The project is deemed finished and accepted, as the project activities have been carried out and the outcomes have been achieved as described.

### 5.1 Expected value of PRIMAR Conversion Task Force

- Enable PRIMAR and the HOs to investigate and get operational experience with data conversion possibilities, validation and associated software as an input for defining the production and maintenance of converted ENC datasets.
  - The conversion and some production possibilities were investigated, and operational experience built. Due to the lack of the maintenance documentation at the IHO level, it was premature to investigate the production maintenance topics. This would be further investigated and implemented through other PRIMAR S-100 implementation projects, like the S-101 Adaptations 2024 project.
- Opportunity to build more comprehensive knowledge and experience with S-101 by combining new PRIMAR S-101 training opportunities with operational S-101 experience in task force activities.
  - This was achieved with the PRIMAR Training Portal Training Courses combination with the PRIMAR ECC staff individual consultancy.
- Provide operational, procedural, technical and legal guidance to PRIMAR member states and PRIMAR operation on data conversion production strategies.
  - The PRIMAR Conversion Task Force Guidelines document was produced and maintained throughout the project. This document can be reviewed and further developed, used and maintained by the PRIMAR TEWG activities as needed.
- Enable HOs to convert some national S-57 to S-101 and participate in testing and trials of new PRIMAR S-101 Dual Fuel ENC service (PRIMAR Dual Fuel S-57/S-101 project)
  - All PRIMAR member states received equal possibilities to achieve this goal within their respective HOs. HOs should now be in much better position to participate in the PRIMAR's S-101 Adaptations project.
- Enable HO to convert S-101 to S-57 and test validation with existing S-57 ENC and test inclusion in PRIMAR Dual Fuel ENC service (PRIMAR Dual Fuel S-57/S-101 project)
  - This was investigated but limited as only one of the converter tools included the option for the “backward” / “future production” conversion - S-101 to S-57.
- Identify possible adjustments needed on existing S-57 data in order to convert data to S-101, and from S-101 to S-57.
  - Project concluded that the project's emphasis will be put on the IHO “standard” conversion and the IHO Conversion Guidance document. Any internal HOs national variations would be identified but left to the respective interested participants to investigate further individually. The outcomes of the internal decisions could be



checked back with the project participants, OEMs and the PRIMARs Dual Fuel testing environment.

It is expected that recommendations and conversion guidelines will be of value to the PRIMAR member states participating in the EU Interreg Baltic Sea E-Navigation project.

PRIMAR has, as a consequence of this project, established and maintained a close relationship with many OEMs providing conversion and validation software. The HOs have used their selected test data and the project team has in addition used further datasets to test their software. The identified issues, feedback and recommendations have been used by the manufacturers and new versions of their software have been made available for further testing throughout the project.

*At the start of the project an estimated 36.3% of S-57 were successfully converted. The number rose significantly by the end of the project, to practically 98.2% converted ENC's. There is a 96.4% success rate of passing the PRIMAR upload checks (S-100 Readiness rate for HOs test datasets) as this project now is finalized.*

Comments from hydrographic offices participating in the project:

*"Thank you for the opportunity to participate in the Conversion Task Force. It has enhanced our understanding for the possibilities and challenges, we have uncovered some issues that we hope will be handled by the standardisation work. We are hoping that we can have S-101 as the main production stream, but that depends if the tools support that". – NTOU (Taiwan)*

*"Thank you for allowing 7Cs to participate in this important project. I would like to thank all the participants for the feedback on the tools in the GitHub. There were some challenges but it has been a very valuable project for us so that we can strengthen our software". - SevenCs*

*"Finally SMA want to thank PRIMAR/ECC for the work with the project so far. The project give the HO's the opportunity to test the conversion and validation with different tools in a way that the most HO's not can do on their own.". - Sweden*

*"This project gave us a kick-start to start work on the S-101, which we needed." - Norway*

*"I really liked that we could use different software for converting our Cells. ... Thanks the GitHub channel we could ask questions straight to developers, who helped us a lot. The distribution between different service providers was well resolved on GitHub. ... Another good opportunity was to try testing converted S-101 files in 7Cs Analyzer and uploading them to Primar VPN. ... Communication with the developers and Primar were fast and useful." - Estonia*