



Dual Fuel ECDIS under S-100

v1.0 March 2nd - 2020

Goals:

- Expand on definition of “Dual Fuel ECDIS”
- Determine basic principles of operation
- Assess implications for
 - OEMs
 - Data Producers
 - End Users
- Gauge opinions from member states, data producers, distribution chain and end user system manufacturers.

20. In order to maintain ECDIS devices already installed on SOLAS vessels which are technically not ready nor required to be upgraded to S-101 ENC compatibility, and to comply with the applicable IMO regulations pertaining to existing navigation equipment, identical coverage will be provided for S-57 ENCs and S-101 ENCs for a transition period until there is no significant number of legacy systems in the field and all ECDIS in operation have become S-101 compatible. This situation is expected near the end of the decade, but will be continuously monitored to enable a decision to be made by the responsible IMO body.

21. As a consequence, new ECDIS systems to be brought into the market at the time when S-101 ENC coverage starts (2024) will have to be capable to process both transfer standard formats: S-57 ENCs and S-101 ENCs.

22. Safety of navigation will be maintained by cartographic content of both S-57 and S-101 standards. From the user's perspective, presentation of cartographic and functional features to meet the IMO mandated content in a mixed environment of S-57 ENCs and S-101 ENCs in one ECDIS device will be seamless and presented under the identical presentation regime for charted features and navigational objects.

NCSR paper extract

Fundamentals:

SOLAS places an obligation on member states to produce and promulgate ENC data to support mandatory carriage of ECDIS. Currently that mandate is fulfilled by the production of S-57.

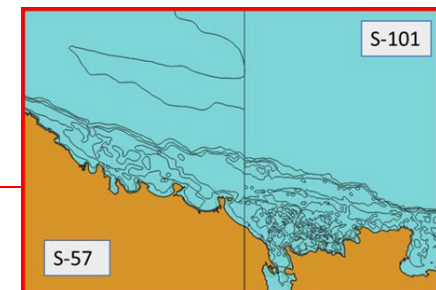
The addition of S-100 to the IMO PS will allow S-100 data to also satisfy the carriage requirement.

States will provide data which is “safe” using the relevant IHO standards (currently S-57)

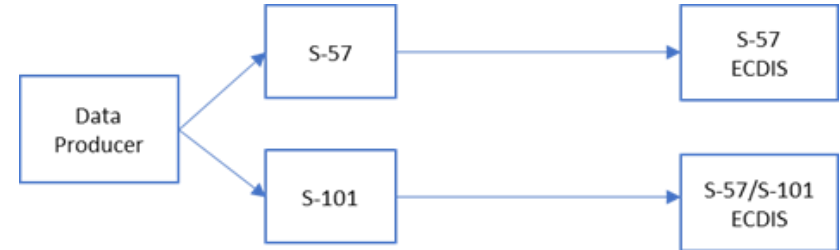
Principles:

The principles of a dual fuel ECDIS should be:

- It should allow unambiguous and defined import and use of both S-57 and S-101 data. In addition, a selection of S-100 data products should be able to be imported and used to enhance user functionality and safety.
- ECDIS behaviour should not be any less “safe” (as defined by the IMO PS) whether S-57 or S-101 data is in use. The requirements of the IMO PS should be met in all eventualities.
- User Experience should not be negatively impacted by the introduction of any S-100 data to the ECDIS.

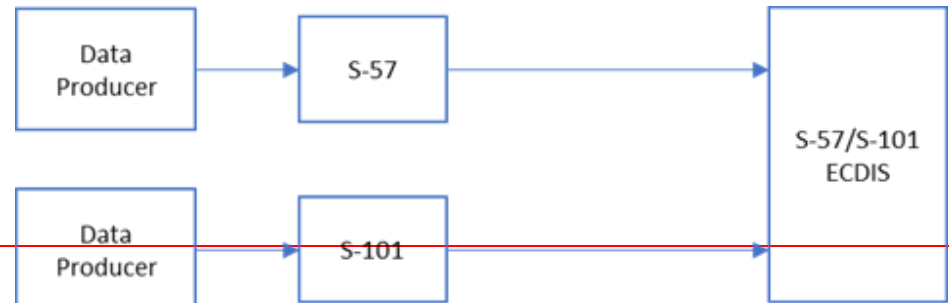


The transition period



During the transition period:

- Data producers will produce data in both S-57 and S-101 forms
 - S-57 for for legacy ECDIS which are unable to process S-101
 - S-101 for new S-100 enabled ECDIS
- The 2024 date for production of S-101 is the start of S-101 production by member states (and the supporting delivery, testing and support infrastructure)
- Because data producers will need time to migrate entire production holdings to S-101 during the transition period ECDIS will need to accept both S-57 and S-101 in that time.



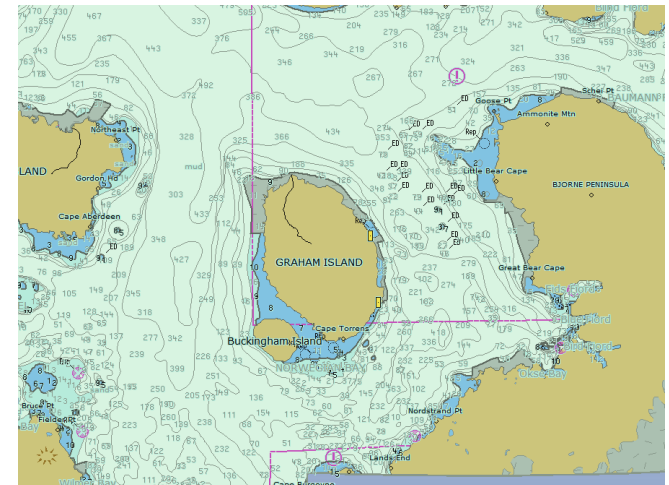
What does an ECDIS actually do?

From IMO:

- Chart Loading and Unloading – S-52/S-64
- Update, manual and automated – S-57, S-52, S-64
- “Display” – S-52 (mainly)
- Feature Interrogation (S-52)
- Alerts and Indications, Areas where special conditions exist and Safety Contour Generation. (S-52, now)
- Route Planning and Monitoring (supported by S-64)
- "Other" functions - those stipulated by the IMO PS. (S-52, S-64)

How to define Dual Fuel ECDIS?

Look at each category and define DF-ECDIS behaviour which meets the principles



Who's producing what? And Where?



During the transition period:

- Producers must ensure coverage in BOTH S-57 and S-101
- Should it be coincident? Probably, but not necessarily.
- Could produce different S-101 coverage as long as all areas and scales can be used by both legacy and DF-ECDIS. Hybrid scheming could progressively used for migration without ambiguity
- Suggests that S-101 should be a superset at a particular scale?
- The ECDIS should not have to load both S-57 and S-101 in the same area at the same scale

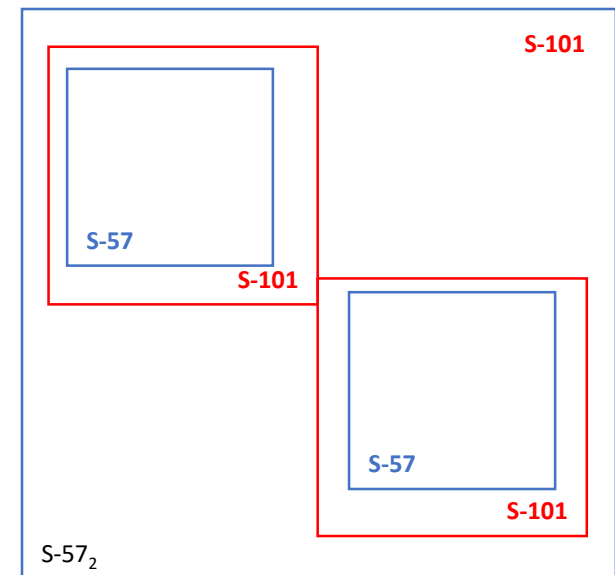
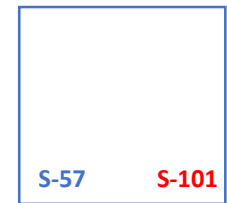
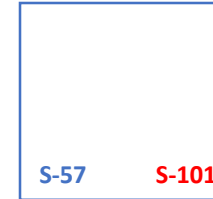
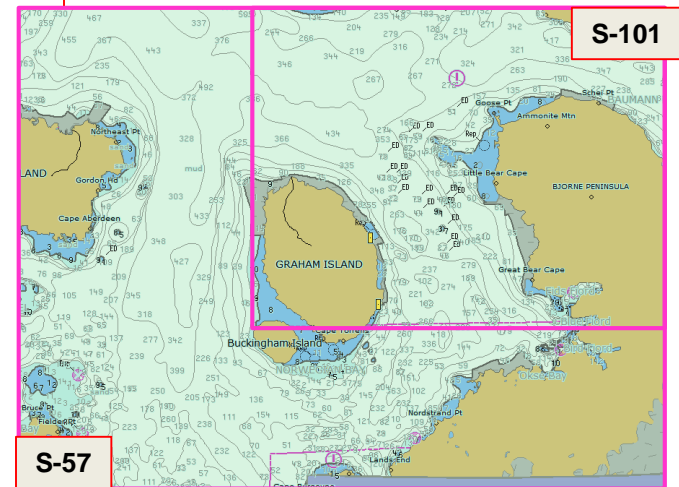


Chart Loading and update

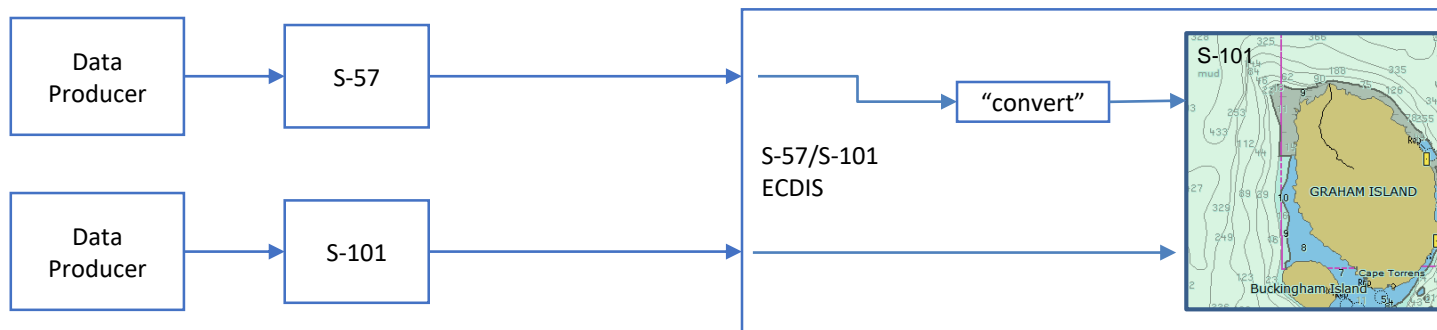
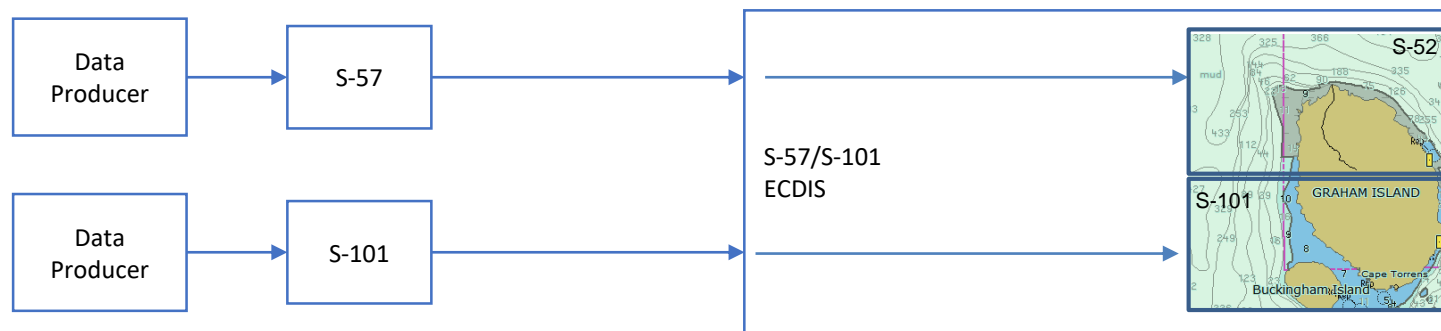
S-101 and S-57 have some common elements:

- Aggregations of feature data according to a defined dictionary (S-57 App B1 and S-101 Feature Catalogue)
- Similar definitions
 - Coverage
 - M_???? Features
 - Display scale / Compilation scale
- ENC will still be discrete datasets of S-101 features for given location(s)
- DF-ECDIS suggests a “side by side” approach to loading/update:
 - The ECDIS loads only S-57 or S-101 for any given area depending on availability, partitioning the SENC into discrete, mutually exclusive areas
 - Updates apply to data already in SENC.
 - S-57/S-101 can overlap but not at same scale (or usage band). Coverage must be unambiguous
 - Authoritative remains largest scale (CSCL or display scale)



Display Options?

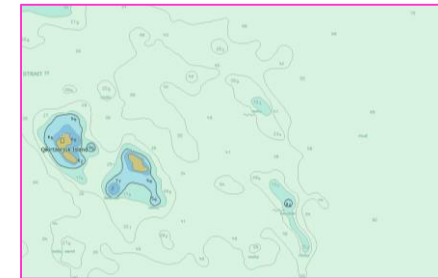
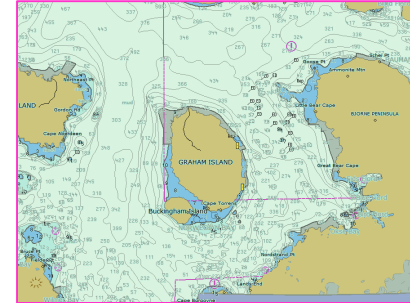
Should the ECDIS display “side by side” or convert the S-57 data to S-101 portrayal? Conversion would require a mandated process and mapping of features. Data producers would need to understand the effects of such conversion and implicitly agree with them. The user would be unaware of the boundaries. Side by Side requires OEMs to engineer parallel operation alongside existing functionality. S-64 is impacted either way.



Display and interrogation

Proposal:

- S-52 and S-101 portrayal have many common elements. They are not identical though. Differences may arise from:
 - New/Dropped features
 - New/Dropped attribute bindings
 - Skin of the Earth Changes
 - Other?
- Should it be apparent to the user where the boundary is?
- In order to ensure S-57 remains “safe”, it seems appropriate to propose:
 - Display S-57 using the S-52 methodology entirely
 - Use S-101 portrayal and interrogation for S-101 data
 - Introduce whatever may be required to show borders between the two.
 - Depends on the SENC being partitioned
- Harmonise loading strategy – use S-101 loading strategy? Both S-52 and S-101 determine a loading strategy based on user settings – zoom setting, and chart CSCL / DataCoverage display scale
- Alternative approach is to display S-57 using S-101 portrayal. To do that safely would need to guarantee safe display of all S-57 data using S-101 portrayal dealing with all layers, features, bindings, alerts, attribution changes etc...



5.6 For any operator identified geographical position (e.g. by cursor picking) ECDIS should display on demand the information about the chart objects associated with such a position.

- S-52 interrogation is implemented by “pick reports” implemented by manufacturer
- Last revision of S-52 provided stronger guidance for formatting of feature interrogation based on user feedback and industry input
- S-100 (will) specify how product specifications will expose their features and details to the ECDIS for interrogation by users. This mechanism is still partly to be determined.
- Guidance for manufacturers should reflect the detail in the current S-52 as an abstract specification and enable a harmonised portrayal where ENC types may be mixed.

5.6 For any operator identified geographical position (e.g. by cursor picking) ECDIS should display on demand the information about the chart objects associated with such a position.

Alarms and Indications

- Need to consider the mappings of Alarms/Indications, Detection and Notification of Navigational Hazards and Crossing the Safety Contour
- Current standards map IMO mandated behaviour to sets of features and attributes.

ALARMS AND INDICATORS

| Section | Requirements | Information |
|---------|---------------------|--|
| 11.4.3 | Alarm | Crossing safety contour |
| 11.4.4 | Alarm or Indication | Area with special conditions |
| 11.4.5 | Alarm | Deviation from route |
| 11.4.8 | Alarm | Positioning system failure |
| 11.4.9 | Alarm | Approach to critical point |
| 11.4.10 | Alarm | Different geodetic datum |
| 13.2 | Alarm or Indication | Malfunction of ECDIS |
| 5.8.3 | Indication | Default safety contour |
| 6.1.1 | Indication | Information overscale |
| 6.1.2 | Indication | Larger scale ENC available |
| 7.3 | Indication | Different reference system |
| 8.5 | Indication | No ENC available |
| 10.5 | Indication | Customized display |
| 11.3.4 | Indication | Route planning across safety contour |
| 11.3.5 | Indication | Route planning across specified area |
| 11.4.6 | Indication | Crossing a danger in route monitoring mode |
| 13.1 | Indication | System test failure |

In this Performance Standard the definitions of Indicators and Alarms provided in the IMO resolution A.830(19) "Code on Alarms and Indicators, 1995" apply.

Alarm: An alarm or alarm system which announces by audible means, or audible and visual means, a condition requiring attention.

Indicator: Visual indication giving information about the condition of a system or equipment.

Traffic separation zone
 Inshore traffic zone
 Restricted area
 Caution area
 Offshore production area
 Areas to be avoided
 User defined areas to be avoided
 Military practise area
 Seaplane landing area
 Submarine transit lane
 Anchorage area
 Marine farm/aquaculture
 PSSA (Particularly Sensitive Sea Area)

Figure 1: IMO Areas for which special conditions exist.

| IMO Special condition | S-57 Object | Attribute | Geometry |
|--|-------------|-----------------------------|-------------------|
| Traffic separation zone | TSEZNE | | AREA |
| Inshore traffic zone | ISTZNE | | AREA |
| Restricted area | RESARE | RESTRN I=14 and CATREA I=28 | AREA |
| Caution area | CTNARE | | AREA, POINT |
| Offshore production area | OSPARE | | AREA |
| Areas to be avoided | RESARE | RESTRN = 14 | AREA |
| Military practice area | MIPARE | | AREA, POINT |
| Seaplane landing area | SPLARE | | AREA, POINT |
| Submarine transit lane | SUBTLN | | AREA |
| Anchorage area | ACHARE | | AREA, POINT |
| Marine farm/aquaculture | MARCUL | | AREA, LINE, POINT |
| PSSA (Particularly Sensitive Sea Area) | RESARE | CATREA = 28 | AREA |

Figure 2: S-57 mapping

Detection and Notification of Navigational Hazards



- Direct equivalents under S-101 DCEG/FC
 - BCNCAR, BCNISD, BCNLAT, BCNSAW, BCNSPP, BOYCAR, BOYINB, BOYISD, BOYLAT, BOYSAW, BOYSPP, CBLOHD, DAYMAR, PIPOHD, CONVYR, MORFAC, FSHFAC, ICEARE, LITFLT, LITVES, LOGPON, OFSPLF, OILBAR, PILPNT
- Bridge and Pylons are covered by the S-101 bridge and its aggregation (which would add Bridge, Span Fixed/Span Opening and Pylon/Bridge Support)
- There are (e.g. PILPNT) possible changes to the geometry primitives supported which should be considered.
- Virtual AtoN have their own dedicated feature class in S-101

- Dependency on S-52's conditional symbology procedures
- Equivalent formulation in S-101 terms would need to be established for "DEPARE03, UNSAFE=true"
- The only difficult areas here are the features where their inclusion as navigational hazards is the result in part of a conditional symbology procedure under S-52 (the calculation of DEPTH_VALUE)
- Requires some analysis of the S-101 PC and an appropriate definition of the features/attributes which precipitate this behavior
- In particular DEPARE03 (is dependent on group 1 features and so needs careful consideration to establish whether the behaviour is consistent in S-101 (they're different)

| S-57 Objects | Condition (if any) | Geometric primitive |
|--------------|---|---------------------|
| BCNCAR | | POINT |
| BCNISD | | POINT |
| BCNLAT | | POINT |
| BCNSAW | | POINT |
| BCNSPP | | POINT |
| BOYCAR | | POINT |
| BOYINB | | POINT |
| BOYISD | | POINT |
| BOYLAT | | POINT |
| BOYSAW | | POINT |
| BOYSPP | | POINT |
| BRIDGE | | POINT, LINE, AREA |
| CBLOHD | | LINE |
| DAYMAR | | POINT |
| PIPOHD | | LINE |
| CONVYR | | LINE, AREA |
| MORFAC | | POINT, LINE, AREA |
| NEWOBJ | CLSNAME = Virtual AtoN, * | POINT |
| FSHFAC | | POINT, LINE, AREA |
| ICEARE | | AREA |
| LITFLT | | POINT |
| LITVES | | POINT |
| LOGPON | | POINT, AREA |
| OFSPLF | | POINT, AREA |
| OILBAR | | LINE |
| PILPNT | | POINT |
| PYLONS | | POINT, AREA |
| OBSTRN | **DEPTH_VALUE <= safety contour value | POINT, LINE, AREA |
| UWTROC | DEPTH_VALUE <= safety contour value | POINT |
| WRECKS | DEPTH_VALUE <= safety contour value | POINT, AREA |
| SOUNDG | EXPSOU=2 and VE3D subfield<= safety contour value | POINT |

*Denotes that all New Objects with the object class name pre-fix 'Virtual AtoN' must be indicated.
 ** DEPTH_VALUE is not an S-57 attribute, it is derived from CSP OBSTRNnn and WRECKSnn. The safety contour value is set by the user.

11.4.6 An indication should be given to the mariner if, continuing on its present course and speed, over a specified time or distance set by the mariner, own ship will pass closer than a user-specified distance from a danger (e.g. obstruction, wreck, rock) that is shallower than the mariner's safety contour or an aid to navigation.

- The same option for S-52 exists as with display, More problematic due to the complex nature of how these are approached in the S-52 mappings and CSP outputs
- Which is safer?
- IMO/IEC standards also dictate the “largest scale available in the SENC” rule. This should be achievable when multiple overlapping scales of S-57/S-101 mix (authoritative is the largest scale in SENC)
- The aim within S-100 is to allow product specifications to define alarm/indications catalogues to modify this behaviour, potentially suppressing alarms from the S-101 in favour of (more specific) feature combinations within S-10x overlays
- S-98/Interoperability is an open question?
 - Should the mechanisms of S-98 allow suppression of alarms from an authoritative (i.e. largest scale) ENC.
 - Does this imply that S-10x products should ONLY overlay S-101? Suppression couldn't work on top of S-57 unless 1-1 equivalents for ALL feature combinations are defined and mandated
- Side by side operation minimises these risks, but is at the OEMs expense of including multiple “engines” within the DF-ECDIS

Initial questions to ask...



- Whether coverage of S-57 and S-101 should be coincident by producers.
- If other S-100 product specifications can overlay (and possibly interact with) S-57 ENC or whether they should be spatially contained within S-101 as a prerequisite.
- Whether the ECDIS is required to ingest BOTH S-57 and S-101 in any one area or whether it is navigationally sufficient to only ingest and translate a single ENC layer for any area (giving preference to S-101), i.e. should the SENC be “partitioned” into areas which are only S-57 or S-101
- To what extent are the more complex alert/indication triggers 1-1 compatible with the existing S-57 ones and what changes may be required to meet the IMO mandate for navigational safety
- How the “largest scale” equivalent concept is arrived at within all S-100 products.
- Whether alerts/indications stemming from the ENC base layer are suppressed by other S-100 products or whether such additional products can only “add to” the minimum level defined by IMO
- Whether additional validation tests are required to ensure S-57 and S-101 charts of the same area are “equivalent” in IMO PS terms (of safety) and the nature of ENC co-production required to support the transition period.

The S-100WG5 is asked to...



- Note the contents of the paper submitted
- Embark on the production of a “Current Working View” (CWV) of how a Dual Fuel ECDIS will work during the transition period which represents the combined views of data producers, technical experts, industry stakeholders and ECDIS manufacturers
- Communicate and use the CWV to focus efforts on preparation for S-100 rollout to the ENC community