S-98

Annex C

Harmonised User Experience for ECDIS and INS

Edition 1.0.0 – May 2022

IHO

International Hydrographic Organization

CONTENTS

Document History

Changes to this Specification are coordinated by the IHO S-100 Working Group. New editions will be made available via the IHO website. Maintenance of the Specification shall conform to IHO Resolution 2/2007 (as amended).

Version Number	Date	Approved By	Purpose
0.0.1	28 Aug 2020	RM	First draft. Reviewed by EM.
0.0.2	01 Nov 2021	J.Powell	Numerous revisions to take into account the S-98 Correspondence Group adjudication work.
1.0.0	May 2022	S-100WG	Submission to HSSC14 for approval.
1.0.0	May 2022	HSSC	Initial published version for evaluation and testing.

C-1   Introduction

This Annex contains guidance for the implementation of harmonised portrayal and other user interaction functionalities for S-101 Electronic Navigational Chart (ENC) and other S-100 based data products in an Electronic Chart Display and Information System (ECDIS). It describes how S-100 products are to be used and displayed simultaneously on the navigation screen. It does not address the portrayal processes or architectures, which are addressed in S-100 Part 9. It is based on the general principles described in S-100 Part 16A, and the requirements for ECDIS specified in the relevant International Maritime Organization (IMO), International Hydrographic Organization (IHO), and International Electrotechnical Commission (IEC) standards.

This Annex is the successor to the IHO S-52 Standard for chart content and display in ECDIS. It contains material from S-52 that has been updated for S-100, but does not include symbol specifications (the S-52 "presentation library") or portrayal rules because symbols and portrayal rules are now defined in the IHO GI Registry and portrayal catalogues for individual product specifications. This document focuses on the principles for portraying S-101 ENC and S-100 based data on ECDIS. The principles described herein are intended to be compatible with the corresponding requirements for ECDIS portrayal of S-57 ENCs.

This Annex does not revoke nor does it supersede S-52 in its applicability to the use of S-57 information on ECDIS. It assumes ECDIS will support both S-52/S-57 and S-101 ENCs for the foreseeable future. Such systems should continue to follow the S-52/S-57 principles for S-57 information.

ECDIS presentation and user interactions are determined by the following standards:

- IMO standards control presentation, performance, and user experience. They include standards and guidelines for display and user interaction, including alerts.
- IHO standards provide the framework for data content, primarily in S-100. S-100 also provides an abstract specification for visual interoperability; for ECDIS, details about interoperability are specified in S-98.
- IEC standards describe methods and required results for equipment and system testing.
- Data product specifications describe the content, data formats, symbols, portrayal rules, packaging, and delivery, of individual data products. For ECDIS, the basic data product is S-101 (Electronic Navigational Charts). Other products describe additional information relevant to navigation, for example, bathymetry, currents, water levels, regulated areas, services and weather.

The standards that are current at the time of writing of this Annex are listed in the References section. More detailed information about the various standards is provided in S-100 Part 16A.

Application developers should obtain an up-to-date set of applicable standards and specifications from the relevant organisations. Developers must conform to the mandatory requirements of the particular standards which apply to an application or system. In case of a conflict between this Annex and a mandatory requirement in an applicable standard, the requirement in the standard supersedes the guidance in this Annex.

The specifications in this Annex also apply to navigation displays in an Integrated Navigation System (INS) which fulfil the role of an ECDIS.

Users of this document should refer to IEC publications when dealing with implementation testing.

C-2   References

C-2.1   Normative references

A.1021(26)   *Code on Alerts and Indicators (2009)*, IMO Resolution A.1021(26), 2009.

IEC 60945   *Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results*, International Electrotechnical Commission (IEC), Fourth Edition, 2002.

IEC 61174   *Maritime navigation and radiocommunication equipment and systems – Electronic chart display and information system (ECDIS) – Operational and performance requirements,*

methods of testing and required test results, International Electrotechnical Commission (IEC), Edition 4.0, 2015.

IEC 61924-2   *Maritime navigation and radiocommunication equipment and systems – Integrated navigation systems – Part 2: Modular structure for INS – Operational and performance requirements, methods of testing and required test results*, International Electrotechnical Commission (IEC), Edition 1.0, 2012.

IEC 62288   *Maritime navigation and radiocommunication equipment and systems – Presentation of navigation-related information on shipborne navigational displays – General requirements, methods of testing and required test results*, International Electrotechnical Commission (IEC), Edition 2.0, 2014.

MSC.191(79)   *Amendments to the Performance Standards for the Presentation of Navigation-Related Information on Shipborne Navigational Displays*, IMO Resolution MSC.191(79), 2004. As amended by MSC 466(101).

MSC.232(82)   *Revised Performance Standards for Electronic Chart Display And Information Systems (ECDIS)*, IMO Resolution MSC.232(82), 2006.

MSC.252(83)   *Performance Standards for Integrated Navigation Systems (INS)*, IMO Resolution 252(83), 2007.

MSC.302(87)   *Adoption of Performance Standards for Bridge Alert Management*, IMO Resolution 302(87), 2010.

MSC.466(101)   *Amendments to the Performance Standards for the Presentation of Navigation-Related Information on Shipborne Navigational Displays*, Resolution MSC.191(79), 2019.

MSC.1593   *Interim Guidelines for the Harmonized Display of Navigation Information Received via Communication Equipment*, IMO MSC.1/Circ.1593, 2018.

MSC.1609   *Guidelines for the Standardization of User Interface Design for Navigation Equipment*, IMO MSC.1/Circ 1609, 2019.

S-97   *IHO Guidelines for Creating S-100 Product Specifications*, IHO Publication S-97 1.1.0 (June 2020).

S-98   *Data Product Interoperability in S-100 Navigation Systems*, IHO Publication S-98 (Draft).

S-100   *Universal Hydrographic Data Model*, IHO Publication S-100, Edition 5.0.0 (June 2022).

SN.243/2   *Guidelines for the Presentation of Navigational-Related Symbols, Terms and Abbreviations*, IMO SN.1/Circ.243/Rev.2, 2019.

C-2.2 Informative references

ISO 19117   *Geographic Information – Portrayal*, ISO Standard 19117 Edition 2, 2012.

S-4   *Regulations of the IHO for International (INT) Charts and Chart Specifications of the IHO*, IHO Publication S-4, Edition 4.8.0, October 2018. (Parts B and C in particular.)

S-52   *Specifications for Chart Content and Display Aspects of ECDIS*, IHO Publication S-52, Edition 6.1.1, June 2015.

S-63   *IHO Data Protection Scheme*, IHO Publication S-63, Edition 1.2.1, March 2020.

SVG-Tiny   *Scalable Vector Graphics (SVG) Tiny 1.2 Specification*, W3C Recommendation 22 December 2008, <http://www.w3.org/TR/2008/REC-SVGTiny12-20081222>.

C-3 Abbreviations and Notation

C-3.1 Abbreviations

AIS   Automatic Identification System

ARPA   Automatic Radar Plotting Aid

CRS   Coordinate Reference System

CSS   Cascading Style Sheets

EBL   Electronic Bearing Line

ECDIS   Electronic Chart Display and Information System

ECS   Electronic Chart System

ENC   Electronic Navigational Chart

GML   Geographic Markup Language

HO   Hydrographic Office

INS   Integrated Navigation System

IEC   International Electrotechnical Commission

IHO   International Hydrographic Organization

IMO   International Maritime Organization

SENC   System Electronic Navigational Chart

SVG   Scalable Vector Graphics

VRM   Variable Range Marker

XML   EXtensible Markup Language

XSLT   EXtensible Stylesheet Language Transformations

C-3.2   Notation

The following notation is used throughout the document to describe various portrayal aspects.

(Name of feature or information type)

Features and information types are referenced by their names in camel-case or space-separated names in initial capitals ("LandArea" or "Land Area").

(Name of attribute)

Attributes are referenced by their names in camel-case with initial letters in lower case, or space-separated names in all lower case ("visuallyConspicuous" or "visually conspicuous").

(Portrayal register item)

Items from the IHO portrayal registry are referenced by their registered name and item type ("line style SCLBDY51"). The portrayal registry is a component of the IHO Geospatial Information Registry (https://registry.iho.int).

C-4   System Concepts and Limitations

C-4.1   The concepts of ENC/SENC

The SENC concept extends to all S-100 products and for purposes of S-100 the SEND includes multiple products for use in navigations systems.

IMO MSC.232(82) defines Electronic Navigational Chart (ENC) and System Electronic Navigational Chart (SENC) as follows:

> *3.2 Electronic Navigational Chart (ENC) means the database, 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 conform to IHO standards. The ENC contains all the chart information necessary for safe navigation and may contain supplementary information in addition to that*

contained in the paper chart (e.g. sailing directions) which may be considered necessary for safe navigation.

3.3 System Electronic Navigational Chart (SENC) means a database, in the manufacturer's internal ECDIS format, resulting from the lossless transformation of the entire ENC contents and its updates. It is this database that is accessed by ECDIS for the display generation and other navigational functions, and is equivalent to an up-to-date paper chart. The SENC may also contain information added by the mariner and information from other sources.

C-4.2   ECDIS concept, limitations, and challenges

Electronic Chart Display and Information System (ECDIS) means a navigation information system which with adequate back-up arrangements can be accepted as complying with the up-to-date chart required by regulations V/19 and V/27 of the 1974 SOLAS Convention, as amended, by displaying selected information from a System Electronic Navigational chart (SENC) with positional information from navigation sensors to assist the mariner in voyage planning and route monitoring, and if required display additional navigation-related information in day, dusk and night mode.

The concept of ECDIS is outlined in the introduction section of the IMO Performance Standards MSC 232(82). The following list explains more of the concept in detail and provides information about certain limitations.

a) ENC is an integral part of ECDIS and therefore is defined as the base layer for the portrayal harmonisation framework. Additional layers are classified as two main types, additional information to that of the ENC or enhanced information to that of the ENC. Additional information is information that is not contained in the ENC, while enhanced information are layers that contain improved, detailed or higher resolution information than the ENC.

b) ECDIS, used together with official data, [is] accepted as complying with the up-to-date charts carriage requirements for nautical publications required by regulation V/19 of the 1974 SOLAS Convention amended in 2009. Electronic chart systems not meeting these ECDIS specifications of IHO and IMO, or ECDIS using non-official data, are known as ECS (Electronic Chart Systems).

c) Chart information may be used in conjunction with a radar overlay on ECDIS. Integration of tracked radar targets provided for collision avoidance radar (ARPA), targets tracked by AIS (Automatic Identification System) into the ECDIS display is another option, as well as other navigational information may be added to the ECDIS display. With the advent of S-100, additional types of data may also be occasionally added to the ECDIS display, especially high-density bathymetry, surface current and water levels data or predictions, maritime safety information (MSI), and under keel clearance area data.

d) Colours and symbols defined in the S-101 portrayal catalogue are conceptually based on the symbology of conventional paper charts. However, due to the special conditions of the ECDIS chart display as a computer-generated image, the ECDIS presentation of ENC data may differ from the appearance of a conventional paper chart, especially when simplified portrayal mode is used. There may be considerable differences in symbology in shape, colour and size, and in the placement of text in particular.

e) ECDIS combines chart and real-time navigational positioning information. Modern navigation systems (i.e. GNSS) may offer a more accurate positioning than was available to position some of the surveys from which the digital chart data ENC was derived. Further, other products may not be encoded to the same accuracy or precision as ENC data or ship's positioning, therefore there is a potentially greater reliance on metadata covering data quality and precision in a digital navigation context

f) The display categories specified in the IMO Performance Standards and the IHO priorities of the various types of chart information (alarms, updates, mariner's and non-HO chart data, etc.) are applied to features by the display plane and drawing order assignments in individual portrayal catalogues. The drawing order may be modified if interoperability is activated.

g) For definition of 'single operator action' and 'simple operator action', see IMO MSC.252(83).

h) In the initial period of S-100 roll-out, S-100 compatible ECDIS are likely to be "dual-fuel" in that they will have both S-57 and S-101 ENCs. It is possible that there will be situations where the navigation screen has to display both S-57 and S-101 ENCs. The user experience aspects of such situations are discussed in Clause C-18.

The versatility of ECDIS poses several challenges for ECDIS display design. These challenges are discussed below.

The diversity of information displayed on an ECDIS may include:

- physical chart information, for example, coastline, depth contours, buoys;
- traffic routeing; specified areas; cautions; etc.;
- supplementary HO information from light list, etc.;
- mariner's notes; additional local chart information; manufacturer's information;
- chartwork such as planned route; electronic bearing lines and range rings; etc.;
- own ship's position and velocity vector; ship's head and rate of turn; past track;
- fix accuracy, or position check from secondary positioning system;
- possibly, shiphandling options, based on ship's characteristics, alphanumeric navigation information (ship's latitude, longitude, heading, course, etc.);
- information from radar and other sensors;
- information from AIS;
- navigational indications and alarms generated by ECDIS;
- possibly, telemetered information from shore authorities (traffic, real-time tides etc.);
- possibly, ice information;
- reminders (for example, time to contact pilot station);
- possibly, messages from other displays.

The flexibility of portrayal may include:

- displaying/removing various types of chart and non-chart information,
- selecting standard chart display or a thinned out display, and either paper chart symbols or simplified symbols,
- using cursor interrogation for further detail,
- overlaying/removing radar video or radar target information (in order to: confirm ship's positioning; aid radar interpretation; show the entire navigation situation on one screen),
- overlaying/removing various other sensor information, or information telemetered from shore,
- changing the scale or orientation of the display,
- selecting true motion or relative motion,
- changing screen layout with windowed displays, text information in the margins, etc.,
- possibility of pull-down menus and other operator interaction devices being alongside the operational navigation display and so interacting with it,
- giving navigation and chart warnings such as "too close approach to safety contour"; "about to enter prohibited area"; "overscale display"; "more detailed (larger scale) data available"; etc.,
- possibly, a diagrammatic representation of a computer evaluation of grounding danger,
- possibly, a diagrammatic representation of the immediate vicinity of the ship to aid in close quarters manoeuvring,

C-4.2.1 Depth Related Functionality

Depth information may be adjusted by water level height. When water level adjustment is provided:

1. The system shall default to no water level adjustment.

2. The mariner may select one for the following methods of depth adjustment:
   a. Current date and time;
   b. A mariner specified date and time;

    c.   Where the ECDIS supports schedules, the depth at the predicted date and time of transit in each area along a route (*Comment: This is the feature that will reduce the mariner workload. Additionally, manually setting the time is prone to errors*).

3. When water level adjustment is applied (full details provided in Appendix C-4):

    a.   The safety contour, depth zone shades, safety depth and indication of isolated dangers shall use the adjusted depth;

    b.   The pick report shall indicate both adjusted and unadjusted depth;

    c.   The applied water level adjustment method shall be provided in the legend;

    d.   Other details of the water level adjustment shall be readily available, such as the data source, relevant times, and applicable areas;

    e.   It shall be possible to remove all water level adjustment via simple operator action;

    f.   There shall be a permanent indication "Water level adjustment".

4. ECDIS voyage recording shall include:

    a.   The state of water level adjustment (method applied);

    b.   All other information necessary to reconstruct depths as presented to the mariner.

C-4.3 Integrated Navigation System (INS) concept, limitations and challenges

The concept of an Integrated Navigation System (INS) is outlined in the IMO Performance Standards MSC 252(83). INS workstations have multifunctional displays providing at least route monitoring and collision avoidance functions, and may provide manual or automatic navigation control functions. In addition to these functions, an INS generally also provide route planning, navigation control data and status, and alert management functions. INS integrate sources, data, and displays into one navigation system. An INS may consist of multiple task stations.

Since the concept of ECDIS is included in the INS concept, the principle described in clause C-6.1.1 of having ENC as the base layer applies - but in the context of an INS it applies to components playing the role of an ECDIS. Components playing other roles will generally use ENC or similar data, but this may depend on function and task.

The considerations related to portrayal and user interaction for an INS are outlined below:

    a)   An INS may have multiple workstations, and the considerations for a workstation depend on the task it is being used for at the moment.

    b)   An INS may substitute under some carriage requirements for certain navigational equipment. The INS is required to fulfil the requirements for the systems it replaces. For example, an INS component used for the tasks of route monitoring and route planning must meet the requirements for an ECDIS, which are described IMO MSC 232(82). This means that the portrayal and user interaction considerations for an ECDIS described in C-4.2 apply to the workstation playing the role of an ECDIS.

    c)   All tasks of an INS should use the same electronic chart data and other S-100 navigational databases such as routes, maps, tide information. If ENCs are available, they should be used as a common data source for INS.

    d)   The INS should support mode and situation awareness on the part of the operator and take human factors into consideration to keep the workload within the capacity of the operator.

    e)   An INS should combine, process and evaluate data from connected sensors and sources. Data integrity should be monitored. Failure of data exchange should not affect any independent functionality.

    f)   The INS should offer default display configurations for the tasks route monitoring and collision avoidance selectable at each task station to provide the bridge team and pilot with a standardized display. This configuration should be accessible by a simple operator action.

    g)   The INS should provide operational modes for open sea, coastal, confined waters (pilotage, harbour berthing, anchorage). It is recommended that the INS provides means to generate pre-defined or operator-defined display modes that are optimally suitable to the navigation task.

h) Integrated graphical and alphanumeric display and control functions should adopt a consistent Human Machine Interface (HMI) philosophy and implementation.

i) Information should be presented consistently within and between different sub-systems. Standardized information presentation, symbols and coding should be used according to resolution MSC.191(79).

j) The alert management should distinguish between unacknowledged and acknowledged alarms or warnings. A caution should be indicated by a steady visual indication. No acknowledgement should be necessary for a caution.

IMO Performance Standards (MSC.252(83)) state that for each task it is used for, the INS should fulfil the relevant modules of the performance standards for standalone equipment for the task. An INS display being used for route monitoring will be subject to the ECDIS performance standards, and therefore the relevant INS display will have largely the same limitations and challenges described in clause C-4.2. The potential availability of other workstations in an INS allows manufacturers somewhat more flexibility in designing solutions, but this is limited by human factors constraints related to compatibility and divided attention.

Given the complexity of the issues and the necessity for compatibility, this document does not distinguish between INS and ECDIS displays for the purpose of harmonised portrayal. If the data products are shown on the same screen, the same rules apply for INS and ECDIS displays, and the treatment should be the same for INS as for ECDIS. If the data products are on different INS screens, the treatment should be compatible in the sense of the guidelines in IMO Circ.1609.

C-5 User Interface Design

C-5.1 General principles

The guidelines in IMO MSC.1609 (Guidelines for the Standardization of User Interface Design for Navigational Equipment) must be applied to the design of user interfaces for navigation systems. The general principles are described in MSC.1609 and summarised in S-100 Part 16A.

Operator control of information should be effective and simple.

- The operator interface should provide clear, simple control of the display such that there is no danger of confusion, or of failure to retrieve important chart information in a stressful situation.

- There should be enough commonality between the user interfaces of the various makes of ECDIS that a pilot, or watch officer new to the ship, can use an unfamiliar type of ECDIS. However, over-strict standardisation will hamper development of an effective interface.

The mariner should have full control over any automatically linked display changes, including the option to inhibit such changes.

The capability to flash a symbol should be used only rarely in very special cases. It should be used to draw attention rather than to simulate a real flashing object.

C-5.2 User interface elements

IMO Circulars SN.243/Rev.2 and MSC.1609 define symbols for navigation-related symbols and functions. For ECDIS and INS, this entails the following requirements and recommendations:

1) For feature and information data objects in S-100 datasets, the symbols defined in the IHO GI registry and specified in the respective data product specifications must be used, subject only to such modifications as may be specified by an approved interoperability catalogue conforming to S-98 (ECDIS Interoperability).

2) For navigation-related symbols, the symbols and icons defined in Annex 1 to SN.243/Rev.2 are strongly recommended. The terms and abbreviations in Annex 2 to SN.243/Rev.2 should be used where terms or abbreviations are needed in the user interface.

3) For navigation-related functions, use of the standard symbols and icons for navigation-related functions defined in Appendix 2 of MSC.1609 is strongly recommended. The terms and

abbreviations defined in the same Appendix should be used where terms or abbreviations are needed in the user interface.

4) For functions and symbols to use when S-98 interoperability is activated on the display, see Sections C-8.2 and C-8.3 of this Annex.

5) Where a standard symbol, icon or term is not available, manufacturers may define a new symbol, icon or term, but such symbols, icons and terms should not conflict with those defined by IMO or IHO. New abbreviations should be defined only for new symbols, icons, or terms, and should not conflict with existing abbreviations. Manufacturers are encouraged to discuss the need for new symbols, icons, terms or abbreviations with IMO and IHO.

6) Logical grouping of information should be consistent with the groups specified in Appendix 3 of MSC.1609. Note that Appendix 3 does not specify where the groups should appear on the screen or the order of information elements within groups, nor is the list exhaustive.

7) While many symbol and icon definitions in SN.243/Rev.2 and MSC.1609 do not specify colours for the standard symbols and icons, the general principles of user interface design and likely environmental and lighting conditions (e.g., use of red light on the bridge, day/night/dusk lighting, prominence vs. distraction tradeoffs) should be kept in mind when determining colours for these symbols and icons. The colour assignment table in Part 16A may be consulted to assess possible colours, but developers should note that assignment of a colour in that table does not necessarily preclude its use for navigation-related symbols or functions.

8) Access to user interface functions should be consistent with Appendix 4 of MSC.1609, keeping in mind the clarifications in the Introduction to that Appendix.

9) Management of default and user settings should be consistent with Appendix 5 of MSC.1609.

C-6 Data Layers

Since there no restriction on which data layers can be displayed other than IMO Performance Standards' requirement that the data does not degrade the displayed SENC information and should be clearly distinguishable from the SENC information, navigation systems should be prepared to display any S-100 data product that satisfies the technical requirements, i.e., is classified as S-100 compliance category 4 ("IHO S-100 and IMO harmonized display compliant" - see S-100 5.0.0 Part 17 - S100_CompliancyCategory).

C-6.1 Data products and information layers

C-6.1.1 Basic products and layers

Navigation displays such as the ECDIS main screen must be able to display the following data layers:

- S-101 ENC data as the base layer, which may be replaced by S-57 ENC data where S-101 data is not available. Raster Navigational Chart (RNC) may be displayed if neither is available;
- Target data from RADAR or AIS;
- Own ship information such as own ship symbol, heading and course information, safety contours, alerts and highlights caused by interaction or course with other data;
- Mariner-plotted information such as mariner-plotted hazards;
- S-102 Bathymetric Surface;
- S-104 Water Level information for Surface Navigation;
- S-111 Surface Currents;
- S-124 Navigational Warnings;
- S-129 Underkeel Clearance;
- S-421 Route Plan.

The list specifies S-100 data products which much be supported in ECDIS.

C-6.1.2   Other data products

In addition, navigation displays such as the ECDIS main screen should allow the mariner to toggle the display of the following data products:

- S-122 Marine Protected Areas;
- S-123 Marine Radio Services;
- S-127 Marine Traffic Management;
- S-412 Weather and Wave Hazards;
- S-411 Sea Ice (when conformant to S-100 compliance category 4[1]).

C-6.1.3   Future data products (informative)

Other data products are in early stages of development, and are unlikely to need display capabilities for the next several years. These include:

- S-125 Marine Navigational Services;
- S-126 Marine Physical Environment;
- S-128 Nautical Product Catalogue;
- S-413 Weather and Wave Conditions;
- S-414 Weather and Wave Observations.

C-6.1.4   User selection of displayed data products

The user interface must provide a way for the mariner to select data layers from non-ENC S-100 data products to be added to or removed from the navigation display window.

C-6.2   Mitigation of data overload

Each additional data layer multiplies clutter and the potential for hiding critical information. General user interface principles as well as IMO guidance (MSC.232(82), MSC.1609) recommend avoiding cluttering screens with too much information. To reduce the likelihood of screen clutter when multiple data products are loaded on the screen, the ECDIS should limit the number of simultaneous layers to those necessary to perform a specific task.

Detection of and response to possible data overload should be guided by the role a particular system is playing at the moment (e.g., a display being used for planning may be able to treat potential overloading in a laxer manner than navigation displays being used for route monitoring and collision avoidance). See clause C-8.3.10 for user interface recommendations relating to possible data overload.

C-7   Portrayal Process, Catalogue Elements, and Alerting

This section provides a brief summary of the portrayal process, the main elements of Portrayal Catalogues, and the alerting model. More details about the process and definitions of Portrayal Catalogue elements and the alerting model are available in S-100 Parts 9 and 9a.

Later sections of the present document describe how the portrayal elements should be used in an ECDIS implementation.

C-7.1   Overview of the portrayal process

The system has feature data within its internal database that needs to be portrayed. The System Portrayal Engine transforms the feature data into drawing instructions according to the portrayal rules

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[1] The inclusion of S-411 as an S-100 data product is tentative. S-411 Edition 1.0 datasets are not in an S-100 data format (S-411 1.0.0, which was developed before the GML profile was added to S-100, specifies a GML format different from that in S-100 Part 10b) and the transition to an S-100 data format is undetermined at this time. Wherever S-411 is treated in this document as an S-100 product, its inclusion should be regarded as contingent on availability of "S-100 compliance category 4" S-411 Product Specification and datasets.

defined in the Portrayal Catalogue. The drawing instructions are intermediate data used by the rendering engine to produce the portrayal output. Drawing instructions include such things as references to symbol definitions, priority and filtering information. The symbol definitions contain the details of all graphical elements used for the portrayal. The drawing instructions are processed by the rendering engine to produce the final display according to the output device.

S-100 describes two different portrayal mechanisms, one based on XSLT templates and the other on a scripting architecture based on Lua. The basic portrayal process is the same for both, and is described in S-100 Part 9; variations to the process and input/output that are required for Lua Portrayal Catalogues are described in Part 9a.

When interoperability is activated and there is an interoperable product loaded to the display, either feature data or drawing instructions (depending on the implementation architecture) are further filtered and/or have their priorities adjusted as specified in the interoperability catalogue. Interoperability processing is described in S-100 Part 16 and S-98.

In the absence of interoperability, portrayal is as described in S-100 Part 9. When interoperability is activated the portrayal is modified as specified by the Interoperability Catalogue. Interoperability processing is described in S-100 Part 16 and S-98.

C-7.2   Elements of portrayal catalogues

C-7.2.1   Pixmaps

Pixmaps can be used for defining pattern fills for areas that are not sufficiently described to be symbolised, or for which no symbol exists in the IHO Geospatial Information (GI) Registry.

C-7.2.2   Colour coding scheme

The Portrayal Catalogue uses a colour scheme, which classifies colours by their usage. Each colour usage is represented by a five-letter colour token. Each colour token corresponds to a colour definition given in CIE and/or sRGB coordinates in one of a set of colours; each set is intended for a different bridge lighting condition. Each such set of colours is referred to as a "palette" and is generally identified by a descriptive name, such as "Day-Bright", "Dusk" and "Night". A particular colour token is often assigned different CIE/sRGB coordinates in different palettes (especially day/night/dusk palettes).

A "colour profile", as the term is used in S-100, is a collection of different palettes within a single XML file. An ECDIS must, at a minimum, have palettes for day, night, and dusk conditions available on the system (MSC 232(82) / A10.4.

Symbols, fill styles and line styles refer to the colour tables by using the standardized colour tokens as part of the symbol definition.

C-7.2.3   Symbols

The Portrayal Catalogue provides a set of symbols, which are generally based on the traditional paper chart symbols. The symbols for point features are generally based on the traditional paper chart symbols and, in addition a set of more compact, but more visible, 'simplified' buoy and beacon symbols are provided for use under difficult viewing conditions.

C-7.2.4   Area fills

The Portrayal Catalogue offers various ways to fill areas. They can be filled with an opaque colour; with a colour shown with some transparency; or with a pattern of symbols (fill pattern) or with a centred symbol. Fill patterns and centred symbols are introduced as a solution for the symbolization of areas in special situations. A fill pattern showing arrows does not have a certain position on the chart like the paper chart arrow symbol. It shows up as long as any part of the traffic separation lane can be seen on the screen. A centred symbol moves to the centre of the part of the area that remains in the display window. Fill patterns or centred area symbols may be used to symbolize the case when the entire display window lies within an area.

The Portrayal Catalogue provides two options for area boundaries, referred to as "plain" and "symbolised".

Centred symbols must be used with symbolized boundaries to symbolize the case when the entire display window lies within an area.

Area boundaries should not be visible on the edge of the display window when the display window is enclosed by an area. However, if the boundary is actually on the edge of the display window, it should be visible.

In the context of S-100 area fills effect surface geometry portrayal.

C-7.2.5 Line styles

The Portrayal Catalogue uses two types of line styles: simple line styles and complex line styles. Simple line styles are solid, dashed or dotted lines with varying colour and thickness (width or stroke width). Complex (or "composite") line styles are composed of repeating line patterns.

Simple line styles are generally described by continuity, width, and colour. The full specification of a simple line style may also include other elements such as dash interval, cap and join types (see S-100 clauses 9-12.4 and 9a-11.2.2.3), defaults for which may be set in the Portrayal Catalogue. Complex line styles consist of additional elements, described in S-100 9-12.4 and 9a-11.2.2.3.

Complex linestyles may be one-sided (symbols, text, etc., which are part of the line extend to only one side of the line) or two-sided (symbols, text, etc. extend on both sides of the line).

In the context of S-100 line styles effect curve geometry portrayal.

C-7.2.6 Text

S-101 and other Product Specifications utilize a cartographic feature called **TextPlacement** that is used in association with a feature to optimise placement of labels (specifically, either feature name or light characteristic description string).

There are three types of text instructions possible in portrayal catalogues:

- Text relative to a point;
- Text that will be drawn along a line; and
- Text placed relative to an area uses a local coordinate reference system. Note that this can cause the text to be drawn at multiple locations.

However, explicit cartographic placement along curves or relative to area/local CRS cannot be explicitly encoded in S-101 datasets, though it can be encoded in portrayal rules in a Portrayal Catalogue (S-100 Part 9a, clause 9a-11.2).

C-7.2.7 Style sheets

Cascading Style Sheets (CSS) files are used to provide different sets of stroke and fill style instructions to be applied to symbols. This mechanism allows changing colours and line weights used in the symbols by swapping CSS files according to the desired colour scheme.

In principle, any style attribute can be set in a CSS file, but the CSS files in IHO Portrayal Catalogues will affect only a limited set of style attributes, namely, stroke and fill colours, line cap and join styles. Note also that the style precedence rules will affect whether the style attribute in a CSS file will actually be applied to a displayed element.

C-7.2.8 Display planes

Display planes are used to split the output of the portrayal functions into mutually exclusive lists. An example of this is the separation of chart information drawn under a radar image and chart information drawn over a radar image.

C-7.2.9 Display priorities

Display priorities control the order in which the output of the portrayal functions is processed by the rendering engine. Priorities with smaller numerical values will be processed first.

The display priority must be of a value between '00' and '99' (proposed scale - see Table C-9), where '99' identifies the highest priority. The display priority applies irrespective of whether a feature is a point, curve or surface. If the display priority is equal among features, curve features have to be drawn on top of surface features whereas point features have to be drawn on top of both. If the display priority is still equal among features of the same type of geometry (curve, surface or point) the given sequence in the data structure of the SENC, or some other neutral criterion, must be used for a decision as to which feature is drawn on top. Text must be drawn last (except for own ship etc.), in priority 80-89.

Display priorities are also called "drawing priorities" in S-100 Parts 9 and 9a.

C-7.2.10 Viewing groups

The viewing group controls the content of the display. It provides an on/off switch in the Portrayal Catalogue for any drawing instruction assigned to the corresponding viewing group.

C-7.2.11 Viewing group layers

A viewing group layer defines a collection of viewing groups whose visibility can be simultaneously toggled by an application.

C-7.2.12 Display modes

A display mode defines a collection of viewing group layers which can be simultaneously toggled by an application.

C-7.2.13 Foundation mode

The foundation mode defines a collection of viewing groups that forms the foundation of the portrayal and cannot be removed from the display. The content of these viewing groups should comply with Display Base rules in IMO MSC.232(82).

C-7.2.14 Rules

A portrayal rule is a set of machine processable statements that describes the transformation of feature data into drawing instructions.

C-7.2.15 Context

The context is a set of parameters passed into portrayal processing at the top level. Context parameters are accessible only in processing rules in the same portrayal catalogue, but can be accessed by any of the rules in that portrayal catalogue. These parameters can be used to provide contextual information to the execution of transformation rules in portrayal processing. Examples are settings of depth values for the safety depth, shallow and deep contours.

C-7.2.16 Validity times

Drawing instructions can be designated as being valid only during a specified interval, which may be open-ended at either beginning or end, or a single time point (with beginning and end the same). Intervals may be specified in terms of date, time (of day), or date-time endpoints.

The start and end instants are defined by their date/time component of the smallest granularity. For example, if the end instant is specified a date without a time of day, and the interval is "right-closed", the end instant is midnight at the end of the specified day (240000 in ISO 8601 terms). This is consistent with the S-100 treatment of *dateStart* and *dateEnd* attributes (see S-100 Part 3 clause 3-8-3 (Interpretation of models of time intervals and period), but note that the open/closed nature of the interval affects the interpretation for Part 9 time intervals — if the same interval is specified as "right-open" the end time point is midnight at the beginning of the specified day (000000 in ISO 8601 terms).

C-7.3 Alerts

The Alerts Catalogue is a component of the Portrayal Catalogue; it describes each alert event along with its associated message(s) and highlighting rules.

The alerting model allows product developers to associate alerts with features (optionally satisfying specified conditions on attribute values) by encoding rules in the Portrayal Catalogue.

Alerts are associated with drawing instructions output by the portrayal, and are triggered when the vessel route (either actual track, during route monitoring, or planned, during route planning) intersects the geometry (which may be restricted or augmented) of a feature. The events are alarms, warnings, cautions, or indications as described in IMO MSC.252(83).

C-8   Visual Interoperability

Ensuring visual interoperability in the presence of simultaneously displayed layers is an important aspect of user interfaces for navigation screens. IHO Publication S-98 (Data Product Interoperability in S-100 Navigation Systems) specifies the structure of the interoperability catalogue for ECDIS and INS.

While the Interoperability Catalogue provided by IHO will provide a normative Interoperability Catalogue for ECDIS, S-98 permits extensions, substitutes and customizations provided the minimum functions provided by the IHO Catalogue are maintained and interoperability is not degraded (S-98 clauses 12.1.1–12.1.3).

C-8.1   Phased implementation of interoperability

S-98 is designed with two levels of interoperability, of increasing power and complexity.

ECDIS implementations of interoperability should be capable of applying Level 2 interoperability and should therefore comply with the "S-98 – Main" document plus S-98 Part B. Note that Level 2 interoperability functionality is a superset of Level 1 functionality, which means that compliant systems must be capable of both Level 2 or Level 1 interoperability (or turning it off altogether, for "Level 0" interoperability).

Implementers should consult S-100 Part 16 for the formal specification of the Interoperability Catalogue model and XML schema, which are common to all Interoperability Catalogues. S-98 is a restriction of the common interoperability model intended for implementations on ECDIS.

C-8.2   Symbols and icons with interoperability ON

When interoperability is turned on, symbols and icons for chart display of features in interoperating products are selected by interoperability operations or rules, and will be one of the following:

- The standard symbol defined in the portrayal catalogue for the individual product;
- The substitute symbol, if any, defined in the *substituteSymbolization* sub-element of an **S100_IC_DrawingInstruction** element of the interoperability catalogue; or
- A symbol defined in the hybrid portrayal catalogue (only for Level 3 or 4 interoperability).

C-8.3   User interface functions for interoperability

The terms and abbreviations defined in this clause are to be treated like the standard terms and abbreviations as described in SN.243/Rev.2 Annex 2. In particular, as required in that document, terms should be shown in lower case and abbreviations in upper case.

Implementation of the user interface functions for interoperability specified in this clause is required only for systems which implement S-98 interoperability.

C-8.3.1   General navigation functions

The following interoperability functions should be added to the user interface, extending Table 1 (General Navigation Functions) in IMO MSC.1609:

Explanation	Term	Abbreviation	Icon ("hot key")
[None in this edition.]			

Table C-1 - Additional general navigation functions

C-8.3.2   Control of chart display functions

The following functions should be added to the user interface, extending Table 2 (Control of Chart Display Functions) in IMO MSC.1609 (multiple entries in a cell are alternatives to be resolved in the next edition):

Explanation	Level Information	Abbreviation	Hydrographic Symbol	Icon ("hot key")
Selector for interoperability level	Level 1 visual interoperability Information layer merge Level 1	VINTOP L1 INFO LYR MRG L1	(none)	
	Level 2 visual interoperability Information layer merge Level 1	VINTOP L2 INFO LYR MRG L2	(none)	
	No visual interoperability Information layer merging off	VINTOP OFF INFO LYR MRG OFF	(none)	
Selector for predefined combination in the currently active interoperability catalogue (see notes 1, 2)	Visual interoperability ruleset Information layer merging ruleset	VINTOP RULES INFO LYR MRG RULES	(none)	 **PDC SEL**

Table C-2 - Additional functions for control of chart display

Notes:

1) This function should be disabled when interoperability is OFF or the interoperability level of the Catalogue as a whole (attribute *interoperabilityLevel* of **S100_IC_InteroperabilityCatalogue**) is 1. Level 1 Catalogues do not include predefined combinations.

2) This function should display a list of predefined combinations in the currently active Interoperability Catalogue. Names of predefined combinations can be found in the *name* attribute of **S100_PredefinedCombination** in the Interoperability Catalogue. The name should be displayed; other information (description, use condition, level) should either be displayed at the same time or accessible from the display.

C-8.3.3 Functions for control of chart functionality

The following functions should be added to the user interface, extending Table 3 (Control of Chart Functionality) in MSC.1609:

Explanation	Term	Abbreviation	Icon ("hot key")
To toggle interoperability	Visual interoperability Layer merging	VINTOP LYR MRG	 **ON / OFF**

Table C-3 - Additional functions for control of chart functionality

C-8.3.4 Database functions

The following functions should be added to the user interface, extending Table 4 (Database Functions) in MSC.1609.

Function	Term	Abbreviation	Icon ("hot key")
To review available interoperability catalogues	Rulesets for layer merging	LYR MRG INDX	INDEX

Table C-4 - Additional database functions

C-8.3.5   Function groups

Interoperability functions should be in the "Chart display settings" group in Table 6 (Groups of Functions) in MSC.1609.

The following group(s) should be added to the function groups in the user interface, extending Table 6 (Groups of Functions) in MSC.1609:

Group of Functions	Term	Abbreviation	Icon ("shortcut")
[None in this edition.]			

Table C-5 - Additional function groups

C-8.3.6   Function accessibility

The following functions should be added to the list in MSC.1609 of functions accessible by single or simple operator action (Table 2 in MSC.1609 App. 4):

Function	Equipment	Access
Disable visual interoperability without loading or unloading data products to the display	ECDIS	Single operator action
Load data products in a predefined combination and activate interoperability	ECDIS	Simple operator action (S-100 Part 16, clause 16-4.4.2.6)
Change interoperability level when interoperability is active	ECDIS	Simple operator action (S-100 Part 16, clause 16-C-5)
Change predefined combination to a different predefined combination covering the currently loaded products on the display at the current level	ECDIS	No operator action other than selecting predefined combination. Interoperability rules from the new predefined combination must be applied automatically (S-100 Part 16, clause 16-C-5.)
Load additional product to the display and apply interoperability rules when there is a predefined combination covering the new set of loaded products at the current level	ECDIS	No operator action other than loading product. Interoperability rules from the applicable predefined combination must be applied automatically (S-100 Part 16, clause 16-C-5.)

Table C-6 - Additional functions accessible by single or simple operator action

C-8.3.7   Condition-dependent enhancements to user interface

The terms, abbreviations, and icons in Table C-7 may be used to enhance (as a suffix, prefix, superposition, etc.) the terms, abbreviations and icons defined in this Annex when the appropriate condition holds (for example, the function is not available). Manufacturers who have implemented equivalent functionality using other methods (for example, greying out icons for unavailable functions) should use their existing methods instead, to keep the user interface consistent.

Explanation	Term	Abbreviation	Icon
Function not available (superimposed on pictorial icon)	[Unavailable] ([ ] brackets included)	[UNAVL] ([ ] brackets included)	(see note 1)
Function not available (for text "icon")			(see note 2)

Table C-7 - Modifying terms, abbreviations, and icons

Notes:
1) The colour of the superimposed icon should be red or grey, but may be adapted to both common understandings of colours and current viewing conditions; for example, day/dusk/night. It should also be adapted to ensure that icons for unavailable functions are not more prominent in the interface than icons for available functions. The opacity should be set to allow the underlying icon to be visible. The stroke thickness may be adapted to the interface.
2) The strikethrough stroke should be of noticeable weight, proportional to the size of the text.

C-8.3.8 Status display

Interoperability status (indicating whether visual interoperability rules are being applied to the display) and current interoperability level should be indicated by a status indicator in the user interface, located outside the chart graphic. The selector for interoperability level can serve this purpose when visible.

C-8.3.9 Settings

The default and user ECDIS settings related to interoperability are listed in Table C-8. The principles in MSC.1609 Appendix 5 also apply to interoperability settings.

Function	Setting
Interoperability toggle	Interoperability Off
Selector for interoperability level	Remain unchanged if previously set (selector disabled, because the default setting is interoperability Off)
Predefined combination	Remain unchanged if previously set
S-100 data products displayed on screen (see IMO MSC.1609 for AIS, Radar, Own Ship, and Track settings)	S-101 + any active data products in overlay mode
Selected interoperability catalogue	IHO-provided Catalogue

Table C-8 - Additional settings configured in response to "Default" selection

The defaults in Table C-8 supplement the defaults specified in MSC.232(82), MSC.252(83) and IEC 61174.

If a system does not implement an interoperability level, the corresponding user interface elements must either be omitted from the interface, or disabled as specified in C-8.3.7.

C-8.3.10 Display overload indications

Clause C-6.2 describes possible problems with data overload and the likely practical limits on the number of data products simultaneously loaded to a navigation display.

If the number of layers loaded on the display appears to be excessive, the ECDIS should provide a noticeable but unobtrusive (that is, non-blocking) visual indication of possible visual overload.

The criteria for deciding when the number of layers appears to be excessive are left to manufacturers, but a trigger level of 4 S-100 data products is suggested. (In the absence of sufficient data products and applications to experiment with, it is hard to be more definite.) Manufacturers may vary the trigger level depending on experience or particular conditions; for example, displays being used for route planning may allow one or two more products before triggering the indicator.

C-9   Display Organisation and Operation

C-9.1   Display of non-S-100 information

This clause describes the display of information that is not from official S-100-based data products, S-57, radar, or AIS.

C-9.1.1   Distinguishing between official data and additional data

IMO Performance Standards (MSC.232(82) section 1.5) states that ECDIS should enable the mariner to execute all route planning, route monitoring, and positioning at present performed on the paper chart and section 3.3 states that the SENC may contain information from other sources than ENCs. This specification requires that ECDIS distinguish between official data and such additional data from users (mariners) and manufacturers. The colour and symbol usage for mariners' and manufacturers' data in the IHO GI Registry and the Portrayal Catalogues for S-100 data products are designed to implement this while ensuring the display remains clear and uncluttered.

IMO Guidelines (SN.243/Rev.2 and MSC.1609) describe "Mariner's Navigational Features" for route planning and route monitoring chartwork, and for adding mariner's and manufacturer's information to the SENC. The descriptions are in the same format as chart features, in order to avoid the ECDIS having to deal with two differently coded types of data.

Mariners may alter the IMO categories for Mariner's Features (but not for ENC features). Note, however, that IMO MSC.232(82) section 11.4.1 requires that own ship's position and selected planned route should always appear when the display covers either, and these "features" must therefore remain in Display Base.

Viewing groups assigned to mariner's and manufacturer's features will not be provided in any Portrayal Catalogue; it is the responsibility of application developers to implement support for these features:

- Using viewing groups as specified in C-9.5.5;
- Using viewing group layers as specified in C-9.5.6.

Note that Mariner's Features should be kept independent of data from official or non-official producers in the SENC, and that mariners' information does not need to be split into datasets.

In referring to Mariner's Features it is important to distinguish between:

- "Add/Enter", "Revise" or "Delete" mariner's or manufacturer's information (this refers to the contents of the SENC); and
- "Display" or "Remove" the information (this refers to the ECDIS display).

C-9.1.2   Mariner's information on the route monitoring display

In addition to the ability to enter manual chart corrections and to carry out route planning and route monitoring chartwork, the mariner should be provided with the capability of adding at least the following symbols, lines and areas to the SENC; and should be able to revise or delete them:

- The caution "(!)" or information "[i]" symbol, used to call up a note on the text display by cursor picking;
- Simple lines and areas with or without colour fill, set up for cursor picking to give an explanatory note in the text display;
- Any of the chart symbols from the Portrayal Catalogue;
- Text notes.

Information added by the mariner should be in normal chart colours as specified in the Portrayal Catalogue.

Other information added by the mariner should be distinguished by the colour orange (colour token NINFO) except for colour fill, which should use transparent yellow (colour token ADINF).

Mariner's information should not overwrite official information.

C-9.1.3   Manufacturer's information on the route monitoring display

If the manufacturer should add non-chart information to the SENC, they should use the following symbols, lines and areas:

(i)   The circled "!" caution symbol CHINFO11, or boxed "i" information symbol CHINFO10, used to call up a note on the alphanumeric display by cursor picking;

(ii)   Simple lines, or areas without colour fill, set up for cursor picking to give an explanatory note in the alphanumeric display (colour fill should not be used);

(iii) Non-chart information entered by the manufacturer should be distinguished by the colour yellow (colour token ADINF). It should not overwrite official ENC information.

If the manufacturer should add non-official information to the SENC it should be symbolised in the same way as official chart information and distinguished from official chart information as described for the various cases below:

(i)   Limited non-official data is added to existing official data to augment the chart information: Each feature should be marked by the special identifiers.

(ii)   An area of non-official data is located in waters for which official chart data exists: It is superimposed on the official data. In some cases the non-official data may be more appropriate for the intended purpose, for example it may be more detailed.

If the mariner selects the non-official data, the boundary of this data should be identified on the ECDIS display by the line style NONHODAT and the warning "Unofficial data displayed; refer to official RNC or paper chart" should be displayed. The diagonal stroke of the line should be on the non-HO data side.

(iii) An area of non-official data is located wholly outside the area covered by official data (although it may share a boundary with the official data) but is shown on the same display as official data.

(iv)   The entire display contains nothing but non-official data: The warning "No official data available; refer to official RNC or paper chart." should be displayed. In this case, special identifiers need not be used.

The mariner should be able to remove all manufacturer's information if the need should arise.

C-9.1.4   Supplemental display items

The following information should be shown on demand on the same screen as the chart display or on an additional graphic or text display:

- Positional data and time;
- Legend;
- Feature description and associated attributes (result of "cursor query") in human readable language, including the meaning given in the Portrayal Catalogue for any symbol selected by cursor-pick; textual information from ENC, for example, dataset name, compilation date, date of issue;
- Record of updates for all data products;
- ECDIS Chart 1;
- Colour differentiation diagram;
- Black adjust symbol for contrast adjustment;
- List of categories which are removed from Standard Display;
- Edition and update numbers of S-101 and other Products in use;
- Details of navigational warnings, accessible in the following categories (this is the minimum set; manufacturers may add other categories or access methods, or substitute equivalent methods):
  - Result of "cursor query" on MSI feature(s);
  - Selection from a list of navigational warnings provided elsewhere (outside the chart graphic) on the same screen, or on an additional graphic or text display;
  - Within a user-specified distance from the vessel's current position;

      o   Within a user-specified distance from the planned route (the same distance as the previous item);

      o   In the local NAVAREA, and neighbouring area when the vessel is near a NAVAREA boundary.

C-9.1.5   Units

The units listed below should be indicated in the display legend:

Position:	Latitude and longitude in degrees, minutes and decimal minutes.
Depth:	Metres and decimetres.
Height:	Metres.
Distance:	Nautical miles and decimal miles; or metres.
Speed:	Knots and decimal knots.

C-9.1.6   Legend

A standard legend of general information relating to the area displayed, applicable to the position selected by the mariner, should be shown on a graphic or text display. This legend should contain at minimum:

1) Units for depth;
2) Units for height;
3) Scale of display; in addition overscale indication where appropriate;
4) Data quality indicator;
5) Sounding/vertical datum;
6) Horizontal datum;
7) The value of the safety depth if used;
8) The value of the safety contour selected by the mariner, as well as the value of the safety contour displayed (which may be different from that selected by the mariner);
9) Magnetic variation;
10) Date and number of last update(s) affecting the datasets currently in use;
11) Edition number and date of issue of the datasets;
12) Chart projection.

See clause C-12.10.3 for details about the listed items.

Since attempting to display all the above items for all displayed data products may lead to an unduly large legend, manufacturers may suppress information from data products other than ENCs. If this is done, the suppressed information should be available through simple operator action, such as a temporary expansion of the legend activated by clicking on a target in the legend. (Note that some of the items will be the same for all data products - in particular, units and datums should be the same for all products, or converted to present the same display result, in order to reduce the chances of user error.)

C-9.2   Priority of information

C-9.2.1   Priority layers

The IMO Performance Standard divides SENC information into three categories that determine what data is to be on the display: Display Base (always present on the display); Standard Display (the default display); and Other Information (displayed on demand). (MSC.232(82), section 3 and Appendix 2).

There are 10 basic priority layers for the drawing sequence of the data on the display, ordered from higher to lower priorities in the list below:

1) ECDIS visual alarms/indications (for example caution, overscale);
2) Official-data: Points/lines and areas + official updates;
3) Notices to Mariners, manual input and Navigational Warnings;
4) Official-caution (ENC and other cautions);
5) Official-colour-fill area data;

6) Official on demand data (for example, water levels, surface currents, underkeel clearance);
7) Radar and AIS information;
8) Mariners data: Points/lines and areas;
9) Manufacturer's data: Points/lines and areas;
10) Mariners colour-fill area data.

This list is not intended to indicate a drawing sequence, but to specify that the information content of category n+1 must not obscure the information content of category n, or any higher-priority category (n-1 etc.).

Category (7) should have a radar off switch to facilitate its removal.

C-9.2.2   Radar priority

Radar priority for a given display plane is described by the *order* attribute within the Portrayal Catalogue.

RadarOverlay Portrayal Catalogue context parameters must be updated whenever the radar image is toggled on or off.

When present, the radar image should be written over Portrayal Catalogue display planes with a negative *order* attribute; and below display planes with a positive *order* attribute.

Opaque area fills should generally be assigned to display planes with negative *order* attributes so that they do not obscure the radar image.

Symbolization of curves and points should generally be assigned to display planes with positive *order* attributes so that they are not obscured by the radar image.

In order to meet the requirements of IMO MSC.232(82) section 11.4.14 to adjust the ship's position, the ECDIS may incorporate the capability of temporarily changing the radar image priority during the adjustment. Operation of this feature should be clearly indicated.

As a fail-safe, features are automatically assigned to an above Radar display plane if the displayPlane field in the drawing instruction is empty. A warning should be recorded by the system in this case.

C-9.3   Display categories

C-9.3.1   IMO Categories

The IMO "Display Base" is that part of the Standard Display that should never be removed. It is a list of basic features which the IMO consider to be required at all times, in all geographic areas and under all circumstances. The IMO do not intend the Display Base to be sufficient for safe navigation on its own, therefore it should not be a display option to "Show Display Base" without any additions.

The IMO "Standard Display" is a list of features that the mariner may either add further features to or remove features from (except Display Base), in deciding what is to be displayed. As soon as any feature on this list is removed from the display, or any feature not on this list is added to the display, the display no longer shows the IMO "Standard Display".

The IMO category "Other Information" contains every feature in the SENC which is not classed as "Standard Display".

The mariner should be able to remove information selectively from "Standard Display", except that they cannot remove any feature of the "Display Base". The mariner should also be able to add selectively to the Standard Display any items of the "Other" category.

The portrayal generates one or more drawing instructions for each feature. Each drawing instruction has a display mode, which may correspond to an IMO category. The mariner may override the category for mariner's features, but not for chart features.

C-9.3.2   Selecting features for the route monitoring display

Section 5.5 of the IMO Performance Standard (MSC.232(82)) requires that "It should be easy to add or remove information from the ECDIS display". For example, the mariner might want to retain "caution areas" from the Standard Display (see Table C-12) but remove the other areas, including features such as protected areas (for example, "game preserve"). Another example is that they might want to add

soundings from "Other", but omit submarine cables (which cause serious clutter at certain ocean terminals).

As an aid to adding and removing information from the display, the Portrayal Catalogue also assigns every feature in the SENC to a viewing set, and these sets are arranged in groups which are related to the lettered groups of INT 1 for the paper chart, a classification which is familiar to the mariner.

The manufacturer is responsible for organising SENC features, viewing sets and viewing groups for display in such a way that the mariner has reasonable flexibility in selecting what he sees without the selection process becoming too complex. Note that it is not necessary to provide access to each feature, viewing set or even viewing group individually.

Note that combined groups which include features from different IMO categories should not be linked permanently, since doing so would, in effect, drag additional features into the Display Base or Standard Display. For example, if a combined group includes soundings (which are "Other") and lights (which are "Standard Display"), this link should not cause soundings to be shown with the Standard Display on first switching on the ECDIS.

C-9.3.3   Selecting text for the route monitoring display

In S-100 based products, the display of text is controlled as specified in clause C-10.3.2. There is no special provision for display of text unless specified within a particular Product Specification.

C-9.3.4   Linkages between ECDIS options

Because vessels vary widely in their requirements and their operational procedures, linkages between options which reduce the flexibility of the ECDIS must be avoided.

C-9.4   Drawing priorities

Display priorities control the order in which the output of the portrayal functions is processed by the rendering engine. Priorities with smaller numerical values will be processed first. In the S-100 portrayal model the display priority is known as the drawing priority.

The drawing priority should be used to ensure that features that overlap each other are drawn in the right sequence. Thus, a feature with a higher priority should be drawn after (on top of) a feature with a lower drawing priority.

The drawing priority applies irrespective of whether a feature is a point, curve or surface. The following rule applies:

(1)   The drawing of manual chart correction lines is an exception to the rule for suppressing overlapping lines. The manual chart correction lines (line styles CHCRID01 and CHCRDEL1) should coexist with the underlying line. Both these manual chart correction line styles and the underlying line should be drawn.

The following table gives an indication of how drawing priorities are allocated. Within each group priorities are adjusted to meet specific cases. *Italics* indicate S-100 data products other than ENC (only the "basic" and "other" products from clauses C-6.1.1 and C-6.1.2 are included). The Table below is indicative; definitive priorities are assigned in the Portrayal Catalogues.

Data Groupings (*italics* - data other than S-101)	Drawing Priorities (0-9 scale)	Drawing Priorities (0-27 scale – IHO GI Registry)	Drawing Priorities (proposed)
No S-101 data filled area pattern	0	0	0
Reserved	--	--	1-8
S-101 Skin of the earth filled areas *S-102 bathymetry coverages*	1	3	10–19
Superimposed areas *S-123 radio service areas* *S-412 weather (non-hazardous)*	2, 3	6, 9	20–39

Restricted area *S-122 protected areas*	5	15	50–59
Traffic areas VTS areas *S-129 go/no-go areas* *S-127 traffic areas*	6	18	60–69
land features	4, 5	12, 15	40–59
Water features *S-111 surface currents coverages* *S-104 water levels coverages* *S-411 sea ice*	3, 4, 5, 6	9, 12, 15, 18	30–69
Coastline features	5, 6, 7	15, 18, 21	50–79
Routeing lines *S-127 routeing lines*	5, 6, 7	15, 18, 21	50–79
Symbols for lines and areas	4, 5, 6	12, 15, 18	40–69
Hazards (bridge, safety contour) *S-124 navigational warnings* *S-102 safety contour* *S-412 hazards and storms*	8	24	80–89
Aids to navigation	8	24	80-89
Text *Operating times (schedules, etc.)*	8	24	80–89
Mariners VRM & EBL *S-421(?)*	9	27	90–98
Own ship	9	27	99

Table C-9 - Drawing priorities

NOTE: The <u>rule of thumb</u> for conversion between the new scale (z) and the 0-9 scale (x) and 0-27 scale (y) can be described by $z \approx 10x+5 \approx 10y/3 + 5$. The "No ENC data" and "Own ship" categories are placed to the extreme ends of the new scale and a reserved range inserted for priorities 1-8.

C-9.5 Viewing groups

The viewing group controls the content of the display. It provides an on/off switch in the Portrayal Catalogue for any drawing instruction assigned to the corresponding viewing group. A viewing group can be regarded as a filter on the list of drawing instructions.

Viewing groups are 'on' or 'off' switches for use by the Mariner to control the information appearing on the display, as required by IMO Performance Standards (MSC.232(82) App.2 section 3). An item in the viewing group table may be a chart feature; a Mariners' or other time-variable feature; a special symbol such as the "depth less than safety contour" pattern; or a non-ENC feature such as the shallow water pattern. Additional 'symbol viewing groups' have been added to allow auxiliary symbols such as contour labels, the 'low accuracy' symbol, etc., to be switched on or off without affecting the primary symbolisation of the feature.

Viewing groups can be aggregated into Viewing Group Layers and Viewing Group Layer can be aggregated into Display Modes. Both aggregations are part of the Portrayal Catalogue

Items in the viewing group tables are arranged in numbered groups (for example, group 26230 consisting of the items pipeline area and cable area) which in turn are arranged in layers (for example, layer 26000 consisting of cautionary areas). The groups are arranged by IMO Category, in the sequence of INT 1; upper-case letters following group numbers correspond to symbolisation sections in INT 1.

Viewing groups from different IMO categories must not be combined under a single display selector.

C-9.5.1   Viewing group layers

Table C-10 shows the layers and numbering scheme for viewing groups. Groups for Mariner's information are in *italics*.

The viewing groups in this table cover the "Basic" and "Other" products listed in clauses C-6.1.1 and C-6.1.2. Viewing groups for other S-100 products will be assigned later.

DISPLAY BASE	STANDARD DISPLAY	OTHER INFORMATION
00000–09999 reserved for administrative purposes		
10000 reserved *40000 reserved*	20000 reserved *50000 reserved*	30000 reserved *60000 reserved*
11000 A,B information about the chart display *41000 tools*	21000 A,B 51000 tools	31000 A,B *61000 tools*
12000 C, D, E, F land features	22000 C, D, E, F	32000 C, D, E, F
13000 H, I depths & currents	23000 H,I	33000 H,I S-102 bathymetry S-104 water levels S-111 surface currents
14000 J,K,L obstructions, pipelines	24000 J,K,L	34000 J,K,L
15000 M traffic,routes	25000 M	35000 M S-127 traffic routes
16000 N special areas	26000 N	36000 N S-122 protected areas S-129 underkeel clearance areas
17000 P,Q,R,S buoys, beacons, lights, radar	27000 P,Q,R,S *57000 reserved*	37000 P,Q,R,S *67000 reserved*
18000 T,U services & small craft facilities	28000 T,U S-127 pilotage features *58000 reserved*	38000 T,U S-123 radio services *68000 reserved*
19000–19999 reserved *49000 49999 reserved*	29000 29999 reserved *59000 59999 reserved*	39000 39999 reserved *69000 69999 reserved*
70000–70999 reserved *71000–71999 reserved*	72000–72999 reserved *73000–73999 reserved*	74000–74999 Weather and natural conditions[2] (S-412) *75000–75999 reserved*
76000–76999 reserved *77000–77999 reserved*	78000–78999 reserved Navigational Warnings (S-124) *79000–79999 reserved*	80000–80999 Navigational warnings (S-124) *81000–81999 reserved*
82000–99999 reserved for future use		

Table C-10 - Viewing group layers and numbering scheme

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[2] S-411, S-413, S-414, and perhaps parts of S-126 will be included in this layer when those specifications are more mature.

C-9.5.2 Viewing groups for display base

The groupings in Table C-11 list[3] the contents of the Display Base. All features of this category should be permanently retained on the ECDIS display (subject to the application of interoperability when interoperability is activated).

Features are S-101 features except where designated as being from other products.

Group	Contents
RESERVED	
10000-10999	Reserved for chart information
A, B	CHART FURNITURE
11000	*Information about the Chart Display*
11010	cursor [symbol CURSRA01]
11020	na (not assigned)
11030	scalebar [symbol SCALEB10], latitude scale [symbol SCALEB11]
11040	north arrow [symbol NORTHAR1]
11050	no data [solid fill with colour token NODTA, area fill NODATA03], unsurveyed (UNSARE), incompletely surveyed area
11060	Non-HO data boundary [line style NONHODAT]
C, D, E, F	TOPOGRAPHY AND INFRASTRUCTURE
12000	Land area
12010	land area
12200	Dangers above water
12210	bridge, pylon, overhead cable, conveyor, overhead pipeline, offshore platform
12400	Shoreline
12410	coastline, ice shelf, glacier, shoreline construction, tie-up wall, dolphin, gate, pile, crib, wellhead, ice boom, floating dock, hulk, pontoon, oilboom, log boom, flood barrage
12420	dock , lock , canal , river
H, I	HYDROGRAPHY
13000	Safety Contour
13010	safety contour (from portrayal rule DEPCNT03)
13020	na
13030	depth area , dredged area ,
J, K, L	SUBSEA FEATURES
14000	Dangers under water
14010	isolated underwater dangers in water deeper than the displayed safety contour (rocks, wrecks, obstructions, mooring cables from portrayal rule CableSubmarine)
M	TRACKS AND ROUTES
15000-15999	na (not assigned)

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[3] This table covers the Basic and Other products in clauses C-6.1.1 and C-6.1.2. Note that portrayal catalogues might be revised to change assignments to viewing groups.

Group	Contents
N	SPECIAL AREAS
16000 16999	na (not assigned)
P, Q, R, S	AIDS TO NAVIGATION
17000-17999	na (not assigned)
T, U	SERVICES
18000 18999	na (not assigned)
RESERVED	
19000-19999	Reserved for chart information

Table C-11 - Viewing groups and their contents for Display Base (illustrative)

C-9.5.3   Viewing groups for Standard Display

The groupings in Table C-12 illustrate the contents of the Standard Display. Features are S-101 features except where designated as being from other products.

Group	Contents
RESERVED	
20000	Reserved for chart information
A, B	INFORMATION ABOUT THE CHART DISPLAY
21000	Information about the Chart Display
21010	Unknown feature (magenta question mark) (retained as failsafe)
21020	Generic Feature
21030	Chart scale boundary, overscale data [area fill OVERSC01]
21040	na
21050	na
21060	Place-holder for geographic names (LNDRGN, SEAARE)
C, D, E, F	NATURAL & MAN MADE FEATURES, PORT FEATURES
22000	Major Coastal Features
22010	Lake, sloping ground, slope top, dyke, causeway, dam
22200	Conspicuous landmarks:
22210	Radar conspicuous feature
22220	Visually conspicuous feature
22230	na
22240	Built up area
H, I	DEPTHS, CURRENTS, etc.
23000	Depths
23010	Area of depth less than the safety contour (DIAMON01 pattern)
23020	na
23030	Swept area
J, K, L	SEABED, OBSTRUCTIONS, PIPELINES

Group	Contents
24000	Seabed dangers
24010	Mooring cables, tunnel on seabed, sandwaves
M	TRAFFIC ROUTES
25000	Routes and Tracks
25010	Leading line, clearing line, traffic lane, deep water route, traffic separation area, traffic separation line, traffic roundabout, traffic crossing, precautionary area, traffic separation scheme boundary, deep water route centre line, two way route part, inshore traffic zone
25020	Recommended track, recommended traffic lane, recommended route centreline
25030	Ferry route
25040	Radar line, limit of shore radar
25060	Radio calling-in point
N	SPECIAL AREAS
26000	Restricted and Cautionary Areas
26010	Restricted area, both Navigational and Regulatory
26020	na
26030	na
26040	Submarine transit lane, military practice area, sea plane landing area, offshore production area
26050	Fairway
26150	Caution area
26200	Information Areas, Protected Areas
26210	Fishing ground, marine farm, Fishing Facility
26220	Anchorage area, anchor berth
26230	na
26240	Dumping ground
26250	Cargo transhipment area
26260	Archipelagic sea lane
P, Q, R, S	BUOYS & BEACONS, LIGHTS, FOG SIGNALS, RADAR
27000	Buoys, Beacons, Topmarks, Lights, Fog Signals, AIS AtoNs
27010	Buoy, light float, mooring buoy
27011	Light vessel
27020	Beacon
27025	Daymark
27030	Distance mark
27040	Direction of buoyage IALA buoyage regions
27050	Topmarks for paper chart symbols
27060	Gridiron
27070	Light

Group	Contents
27080	Fog signal, retro-reflector
27200	Radar
27210	Racon
27220	na
27230	Radar reflector
27240	Physical and Virtual AIS Aids to Navigation
T, U	SERVICES & SMALL CRAFT FACILITIES
28000	Services
28010	Pilot boarding place, pilotage district
28020	Signal station traffic, signal station warning
28030	Vessel traffic service area
28040	S-127 pilotage features
	NAVIGATIONAL WARNINGS
78100	Navigational warnings types [A, B, C]
78110	Navigational warnings types [D, E, F]
RESERVED	
29000	reserved for chart information

Table C-12 - Viewing groups and their contents for Standard Display

C-9.5.4   Viewing groups for other chart information

The groupings in Table C-13 illustrate viewing group usage for other information. Features are S-101 features except where designated as being from other products.

Group	Contents
RESERVED	
30000	Reserved for chart information
A, B	INFORMATION ABOUT THE CHART DISPLAY
31000	Information about the Chart Display
31010	Quality of non-bathymetric data, quality of survey, quality of bathymetric data for ENC data
31011	Symbol LOWACC01, identifying low accuracy data, applied to the spatial feature of point and area wrecks, rocks and obstructions and to point land areas
31012	Quality of non-bathymetric data, quality of survey, quality of bathymetric data for non-ENC data
31020	Reserved (retained for backward compatibility in dual-fuel displays - was M_NPUB in S-52)
31021-31029	Reserved for supplementary information in products other than S-101
31030	Supplementary Information - S-101 feature InformationArea; NauticalInformation instances associated to S-101 features.
31031	Reserved for Additional Documents (referenced by fileReference attributes).
31040	DataCoverage

Group	Contents
31050	na
31060	na
31070	na
31080	Magnetic variation , local magnetic anomaly
31090	Update information features
C, D, E, F	NATURAL & MAN MADE FEATURES, PORT FEATURES
32000	Natural Features
32010	Dunes, hills, ridge, clifftop, contours and elevation
32020	na
32030	Trees, vegetation, mangrove, marsh
32040	na
32050	River or lake; also rapids, waterfall
32060	na
32070	Tideway
32080	na
32200	Shore Structures
32210	na
32220	Any of the following not classified as visually conspicuous: landmark, building, tank, silo, water tower, wall, fort
32230	na
32240	Airport, runway
32250	Railway, road, tunnel, control point
32260	na
32270	Quarry, refinery, power station, tank farm, wind farm, factory, timber yard
32280	na
32400	Port Features
32410	Harbour type, customs check point [note: "small craft facilities" is in group 38210]
32420	na
32430	na
32440	Berth number, mooring facility (such as bollard), gate (such as lock gate), dry dock, crane
32450	na
32460	na
H, I	DEPTHS, CURRENTS ETC
33000	Depths, Currents, Tide Rips, etc
33010	Soundings
33020	Depth contours other than the safety contour
33021	Label for the safety contour

Group	Contents
33022	Label for contours other than the safety contour
33030	na
33040	Water turbulence
33050	Reserved (retained for backward compatibility in dual-fuel displays)
33060	Current and tidal stream information
33100	S-102 Bathymetry features
33200	S-104 Water level features
33300	S-111 Surface currents features
J, K, L	SEABED, OBSTRUCTIONS, PIPELINES
34000	Seabed Information: Rocks, Wrecks and Obstructions; Pipes and Cables
34010	Nature of seabed
34020	Spring, sea weed
34030	Pipeline area, cable area
34040	na
34050	Rocks, wrecks, obstructions, which are not a danger to own ship's navigation (these are all Display Base if a danger to own ship)
34051	Non-dangerous rocks, wrecks and obstructions which have a valueOfSounding attribute and are not a danger to own-ship's navigation (these features are all Display Base if a danger to own-ship)
34060	na
34070	Submarine cable, submarine pipeline
M	TRAFFIC ROUTES
35000	Routes
35010	na
35100	S-127 Marine Traffic Management traffic routes & associated features
N	SPECIAL AREAS
36000	Administrative Areas, (by cursor enquiry)
36010	Continental shelf,
36020	Harbour area, free port area, customs zone
36030	na
36040	Fishery zone
36050	Contiguous zone, exclusive economic zone, national territorial area, territorial sea, territorial sea baseline, administration area
36100	S-122 Marine Protected Areas features
36200	S-129 Underkeel Clearance features
P, Q, R, S	BUOYS & BEACONS, LIGHTS, FOG SIGNALS, RADAR
37000-37999	na
T, U	SERVICES & SMALL CRAFT FACILITIES
38000	Services

Group	Contents
38010	Radar station, radio station
38020	na
38030	Coastguard station, rescue station
38200	Small Craft Facilities
38210	Small craft facility
38300	S-123 Marine Radio Services features
WEATHER AND NATURAL CONDITIONS	
74100	Weather hazards (S-412)
74110	Wave hazards (S-412)
NAVIGATIONAL WARNINGS	
80100	Navigational warnings types [X, Y, Z] (S-124)
80110	Navigational warnings types [P, Q, R] (S-124)
80200	Navigational warnings (other) (S-124)
RESERVED	
39000	Reserved for chart information

Table C-13 - Viewing groups and their contents for other information

C-9.5.5 Viewing groups for mariner's and manufacturer's information

Table C-14 illustrates the contents of viewing groups for mariner's information.

Groups	Contents
MARINERS' FEATURES	
53000	Mariners' Features
53010	Danger highlight (dnghlt)
53030	Mariners' information note (marnot catnot 1)
53040	Mariners' cautionary note (marnot catnot 2)
53050	Mariners' feature (marfea)

Table C-14 -Viewing groups and their contents for mariners' information - Standard Display

C-9.5.6 ECDIS viewing group layer implementation

For standardization of the ECDIS Human Machine Interface (HMI) and to facilitate generic training of Mariners as a minimum the following viewing group layers should be implemented to control display of charted features. An ECDIS may provide more display on/off controls than are available in this table, but OEMs should use the viewing group layer names contained in Table C-15. The viewing group names are derived from the IMO Performance Standards.

Viewing Group Layer	Name of viewing group layer in the ECDIS	Viewing groups included
1	Display Base	10000–19999
Standard Display		
2	Drying line	22010
3	Buoys, beacons, aids to navigation	21020, 22200–22240, 27000, 27010, 27011, 27020, 27025, 27040, 27050, 27070, 27080, 27200, 27210, 27230, 27240, 27030, 27060

Viewing Group Layer	Name of viewing group layer in the ECDIS	Viewing groups included
3.1	Buoys, beacons, structures	21010, 21020, 22200–22240, 27000–27050, 27080, 27200–27230, 27030, 27060, 27240
3.2	Lights	27070
4	Boundaries and limits	23030, 26050, 26220, 26240, 26250
5	Prohibited and restricted areas	26000, 26010, 26040
6	Chart scale boundaries	21030
7	Cautionary notes	26150
8	Ships' routeing systems and ferry routes	25010–25060
9	Archipelagic sea lanes	26260
10	Miscellaneous	Switches on and off features in viewing groups 20000–29999 (other than the groups listed in layers 2–9 above) and features in mariners' information viewing groups 50000–56999
Other		
11	Spot soundings	33010
12	Submarine cables and pipelines	34030, 34070
13	All isolated dangers	34050, 34051
14	Magnetic variation	31080
15	Depth contours	33020
16	Seabed	34010, 34020, 33040
17	Tidal	33050, 33060
18	Miscellaneous	Switches on and off features in viewing groups 30000–39999 (other than the groups listed in layers 11–17 above) and independent mariner selections (mariners' tools) other than those listed in Table C-16 (-Mandatory and optional display functions).

Table C-15 - Recommended set of viewing groups for ECDIS

For text groups see clause C-11.2.

C-9.6   Display modes

See IMO MSC.232(82) and clause C-9.3.1).

C-9.7   Displaying ECDIS updates

The strategy for displaying ECDIS updates is derived from the IMO Performance Standard Circ.232(82). The citations below are to sections in that Standard.

MSC.232(82) 4.5   Automatic and semi-automatic updates: These should be displayed in the same manner as ENC information, using standard colours and symbols.

MSC.232(82) 4.6   Manual updates should be distinguished as specified in clause C-14.11

MSC.232(82) 4.8   The mariner should be able to display updates for review as described in clauses C-9.7.1 and C-9.7.2.

C-9.7.1   Automatic updates

The manufacturer must provide a means of distinguishing automatic updates. The S-101 Feature Catalogue provides encoders with an **Update Information** feature that is used to represent a change to the information shown.

EXAMPLE: The ENC update contains updates to various features that adjoined the feature that was actually updated. In this case, the producer will use an **Update Information** feature to indicate the actual feature that was affected and a brief description of the changes.

C-9.7.2   Manual updates

The manual updates should be distinguishable from official information and its official updates.

C-9.8   Display functions

Display functions are described in IMO MSC.232(82), MSC.252(83), MSC.1609, and clause C-8.3 of this document. Each of these functions has a display mode assigned but should only be shown in that display mode if the Mariner has decided to select this option. Listed in Table C-16 below are the Mariner selectors that should be available in ECDIS, the name of the selector in the ECDIS GUI and a functional description in terms of S-101 information and viewing groups. The Table is not a complete set of ECDIS user functions; there are a number of other Mariner selectors that can be included in ECDIS, listed in the cited IMO documents.

This Table adds a user function for displaying information from additional products to the IMO list.

Context parameters associated with functions listed in Table C-16 are given in the IHO GI Registry. Certain functionality may be implemented by means of viewing groups. Manufacturers may use other means of conveying settings for ECDIS functions to portrayal processing, but should note that some of the context parameters are used by the official IHO S-101 Portrayal Catalogue.

Context parameters may be added or removed by updates to the Portrayal Catalogues. Context parameters which cannot be automatically associated with ECDIS display functions or user interface features must be exposed to the mariner for use.

If a context parameter is removed, the mariner should be notified during implementation of the update of the Catalogues of any associated ECDIS display functions or user interface features that functionality is degraded or deprecated.

All ECDIS-capable products (that is, S-100 compliance category 4) are expected to map the user functions/selectors to viewing groups, layers, and context parameters in their respective Portrayal Catalogues. The ECDIS user interface should combine the effects for all on-screen products, modifying the combination process as guided by the Scope column or equivalent settings.

EXAMPLE 1: Function applicable to all on-screen products: The display should switch to the same national language for all on-screen products when the National Language function is activated by the Mariner.

EXAMPLE 2: Function applicable to S-101 only: The "Accuracy" selector displays accuracy symbols from only S-101 datasets. Accuracy from other S-100 data products is not displayed. This is the default action for this user function; manufacturers may allow switching to displaying accuracy for other data products by further or separate user action.

EXAMPLE 3: Function applicable to S-101 only, because no other product qualifies: The "Full light lines" selector displays full light sector lines for lights encoded in S-101. (There is no question of it applying to any other product, because S-101 is the only product that contains the relevant light features.)

[This table will be updated after S-101 Edition 2.0.0 is published]

Clause	ECDIS Implementation	Name of Selector in ECDIS	Function Description	Remarks
C-9.5.4	Mandatory	Accuracy	Independent pattern selection of data quality (Quality of Bathymetric Data), viewing group 31010. Symbol LOWACC01, viewing group 31011	According to MSC.1609 "Accuracy" is the function "To show accuracy related symbols".
C-12.7	Mandatory	Date dependent	Date Dependent Features – to turn on and off the display of temporal features by viewing a date range.	
--	Mandatory	Full light lines	Full Light Sector Lines	See Note 1
C-12.7.2	Mandatory	Highlight date dependent	Indication of date dependent features – to turn on and off the display of symbol CHDATD01	
C-9.5.4 C-12.10.1	Mandatory	Highlight info	Additional Information - viewing group 31030	See Notes 2 & 4
C-9.5.4 C-12.10.1	Mandatory	Highlight document	Additional Information - viewing group 31030 / 31031.	See Notes 2 & 4
C-9.5.4 C-12.10.1	Mandatory	Highlight overlay info	Additional information in products other than ENC - viewing group 31020-31029	
C-9.5.3 C-10.1 C-12.6.2	Mandatory	Unknown	Unknown Features - to turn on the display of features in S-101 datasets which are not specified in the S-101 Product Specification – viewing group 21010	
C-12.11	Mandatory	Update review	Review of Updates – This function turns on colour highlighting for the S-101 **UpdateInformation** feature which have undergone modification in the process of the latest accepted correction.	
C-12.8	Mandatory	Scale min	Turn SCAMIN Off	
C-12.9.5	Mandatory	Shallow pattern	Shallow Water Pattern	
C-12.5	Mandatory	Shallow water dangers	Isolated Dangers in Shallow Water – to turn on the display of isolated danger features which are located in the unsafe waters - viewing group 24050	
C-9.5.4	Optional	Contour label	Contour Labels – to turn on the display of contour labels (incl. label of safety contour) – viewing group 33021, 33022	See Note 3

Clause	ECDIS Implementation	Name of Selector in ECDIS	Function Description	Remarks
C-14.6 (Table C-27)	Optional	Four shades	Four Colour Depth Shades	
C-12.10.2	Optional	National language	National Language, text group 31	
--	Mandatory	Paper chart / simplified symbols	Selection of Point symbol style	
--	Mandatory	Plain / Symbolized boundaries	Selection of Line symbol style	

Table C-16 - Mandatory and optional display functions

NOTES:

1) Assumes that S-101 or the equivalent is the only data product containing the relevant features. If in the future another product containing relevant features is introduced, this guidance may need to be revised to restrict the scope.

2) Other data products also have these attributes and features, but since turning that on may unduly overload the display, this selector is restricted to S-101.

3) S-102 contours are displayed only if a contour generated from S-102 data is available and S-102 is activated on the display. See clause C-12.9.11

4) "Highlight document" and "Highlight info" produce the same result because the information may be provided in either a *text* sub-attribute or an external file named by a *fileReference* attribute. Additional information for features is provided via the feature instance itself or an information association to the information type **Nautical Information**, which binds the complex attribute *information*. Distinguishing "highlight document" and "highlight info" may therefore involve a multi-level query. Manufacturers may implement such a query if desired; if implemented, viewing group 31031 must be used for "Highlight document".

C-10   General Rules for Symbols and Text

C-10.1   Symbol Specifications

All symbols are specified in the Portrayal Catalogue for the respective Product Specifications and are defined according to S-100 Part 9 appendix B.

Some feature classes do not have a symbol (for example, territorial sea). Such "no symbol" features may be picked up by cursor interrogation of the area.

Should an "unknown feature" occur in the SENC which is not adequately defined or for which no symbol exists, its presence should be indicated on the display by symbol QUESMRK1 (a magenta "?") with the IMO category "Standard Display".

Some features are symbolised differently depending on circumstances (for example the symbol for a contour depends on whether it is the safety contour).

C-10.2   Guidelines for reproduction of lines, symbols and text

C-10.2.1   Introduction (informative)

In a navigation system the viewing distance will be about 70 cm for route planning, but experience to date indicates that the viewing distance for important features during route monitoring may be several metres.

Human factors experts recommend that symbols and characters subtend 20 arc minutes at the observer's eye. (For example, a symbol viewed from 70 cm for route planning should be about 4mm in size, 1.5 times the size of a normal chart symbol. Two times chart size is a good general rule.) Symbols and characters important for route monitoring may have to be significantly bigger.

For clear representation, symbols require a minimum number of screen units (pixels), depending on their complexity. A simple chart symbol of height 4mm should extend at least 13 pixels for a screen that just meets the current minimum standards for chart display size and resolution (clause C-20.1).

The minimum resolution is defined by IEC 61174 and/or IEC 62288.

C-10.2.2   Guidelines for size and resolution

Lines, symbols and text should be large enough that they can be easily interpreted at the operational viewing distance. Also, for clear representation, symbols require a minimum number of screen units (pixels), depending on their complexity. The ensuing requirements for size in absolute and pixel terms are described in this clause.

The minimum sizes for all symbols should be as shown in the Portrayal Catalogue.

Enough "picture units" (pixels) must be used to draw small features and symbols clearly and allow viewers to distinguish similar symbols. Symbols should therefore always be drawn with at least the same number of pixels as are required to draw the symbol at the size defined in the Portrayal Catalogue for the minimum resolution and minimum chart display area.

NOTE (informative): This requirement means the minimum height in pixels of a symbol is: (symbol height in mm) divided by the "pixel size" for the minimum size chart display (see clause C-20.1).

The text on the ECDIS should be readable from 1 metre[4,5]. Pending reconciliation of the two rules of thumb cited in S-52, this Annex adopts the IEC 60945 recommendation of a minimum character height of 3.5mm for a 1-metre viewing distance.

Since viewing conditions and anticipated viewing distances may vary between installations, manufacturers should provide for configuring ECDIS software for viewing distances on different bridges. Operating conditions (for example low illumination, bright daylight, etc.) may also need to be considered.

The CHKSYM01 symbol may be used for comparison; this symbol should measure 5mm×5mm when displayed at its nominal size (that is, scaled to 100%), within the tolerance specified by the IEC testing standard (recommended tolerance: 1 physical pixel width in each of the X and Y dimensions).

Since the CHKSYM01 symbol is quite small for the purpose of on-site system configuration by ordinary users, manufacturers may use an enlarged version or an equivalent method for that purpose.

C-10.2.3   Fonts

The portrayal specifies the font for chart data. For non-chart data, sans serif, non-italic fonts should be used. The font should be plain and clearly readable. The computer 0 ('slashed zero') should not be used.

Because several appropriate commercial fonts are available, this document does not prescribe a specific font. Manufacturers should make their own arrangements for the use of a font.

C-10.2.4   Zooming

When the display scale is enlarged by zooming in, it should be possible to hold symbol size constant. The same applies to text. Symbol and text size should never be decreased when zooming out.

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[4] IEC 60945 as cited in S-52 specifies that character size in mm be not less than 3.5 x the viewing distance in metres. According to this criterion "readable from 1 metre" requires that characters be not less than 3.5 mm in size. A 3.5mm symbol or character subtends an angle of approximately 12 arc minutes at a distance of 1 metre.

[5] The rule that symbols and characters should subtend an angle of not less than 20 arc minutes at the observer's eye (mentioned in S-52) results in a minimum character height of 5.76mm for a 1 metre viewing distance.

C-10.3   Mariner's options in symbols and linestyles

At large scale, it may be difficult to identify the area or see on which side of the boundary the area lies. The S-101 Portrayal Catalogue therefore provides, as a mariner's option, symbolised area boundary linestyles for use on large scale displays. These make the areas easier to figure out than the plain linestyles recommended for small scale displays, where symbolised lines would cause clutter. Two options are provided within the portrayal catalogue, to display either symbolised or plain area boundary linestyles.

The mariner should be given the option of selecting the buoy symbols and area boundary linestyles (plain or symbolised) that best fit the situation, without linkages. For example, boundary linestyle should be selectable independent of the choice of buoy symbol, and independent of the actual display scale. See Table C-16: Selection of Point symbol style, and Selection of Line symbol style.

C-10.4   Display orientation

It should always be possible to display the chart north-up (IMO MSC.232(82) section 8.1), but other orientations are allowed.

If the display is oriented course-up, the orientation should not be altered too frequently, in order to avoid jitter from frequent rewriting of chart information.

The north arrow is always required on the display, as part of the IMO Performance Standards Display Base.

C-10.5   Common text information attributes

Several Product Specifications use similar structures for feature names and information attributes. The following guidelines should be used when this document mentions displaying the "feature name" or "information" attributes.

C-10.5.1   Feature names

Attribute "feature name" (*featureName*) is a complex attribute consisting of the mandatory sub-attribute "name" (the actual name of the feature) and sub-attributes "language" and "display name". The sub-attribute "display name" is a boolean indicating which one of multiple instances (in the same feature) of the complex attribute *featureName* should be displayed. Only one instance of *featureName* attribute of a feature can have *displayName*=TRUE. Selecting which instance of the *featureName* attribute should take into account the value of *displayName*.

C-10.5.2   Generic attribute "information"

Attribute "*information*" is a complex attribute consisting of the following sub-attributes:

- *fileLocator*: Indicator for location of text within the file named by *fileReference*;
- *fileReference*: Name of text file;
- *headline*: Heading relevant to the content in co-attribute "text" or the file named by *fileReference* (specifically, the section indicated by *fileLocator*, if used). The length of "headline" will generally be much shorter than "text".
- *language*: The language of the text or referenced file;
- *text*: A text string providing the information content.

At least one of "*fileReference*" or "*text*" must be populated (usually only one of the two).

If *headline* is populated, it can be used as needed by the manufacturer, for example as a short title in a collapsible sidebar, collapsible menu item, etc.; or as a paragraph heading for the longer content in attribute text or the content of the file named by *fileReference*.

C-10.6 Queries

ECDIS must be capable of performing spatial queries on ENC and other data during import and symbolisation. Spatial query is defined as the ability to inspect geographical position and numerical value of spatial coordinates associated with a charted feature. Spatial query could be available by means of cursor pick or as an independent function.

C-11 Text and Graphics

C-11.1 Text as part of the display

Text information should be used on the route monitoring display only when unavoidable, since it has to be written large to be readable and so causes clutter.

The complex attribute *featureName* has a Boolean sub-attribute *displayName*. When the ENC data is encoded with a *displayName* as TRUE then it is intended for that instance of *featureName* to be displayed on the ECDIS. This is intended to declutter much of the text display on an ECDIS. The other alternative *featureName*s must be able to be queried by the ECDIS Pick Report.

Soundings are treated by the Portrayal Catalogue as symbols to ensure they are legible and correctly located.

In addition the following guidance should be used for text:
1. Text is normally coloured black, to give best readability under all light conditions.
2. Text should only be displayed when the feature it applies to is displayed.
3. Text should always have sufficiently high drawing priority, to ensure it is readable, independent of the feature it applies to.
4. The manufacturer should provide the capability to select "Important Text" and "Other Text", and they may also provide further text groupings if they so wish.

The display of text must be controlled independently of the display of the feature it applies to and the Mariner must have full control over the display of text.

C-11.2 Viewing groups used for text

Viewing groups for text are listed in Table C-17 below.

Viewing Group	Description	S-101 Features and Attributes (attributes in lower case; indentation indicates attribute or sub-attribute)
00-10	reserved for future assignment by IHO.	
IMPORTANT Text		
10		

11	Vertical Clearance of Fixed Spans	Span Fixed
		    vertical clearance fixed
		        vertical clearance value

	Vertical Clearance of Open Spans	Span Opening
		    vertical clearance closed
		        vertical clearance value
		    vertical clearance open
		        vertical clearance value

Viewing Group	Description	S-101 Features and Attributes (attributes in lower case; indentation indicates attribute or sub-attribute)

	Vertical Clearance of Overhead Cable	Cable Overhead
		   vertical clearance fixed
		      vertical clearance value
		   vertical clearance safe
		      vertical clearance value

	Vertical Clearance of Overhead Pipeline	Pipeline Overhead
		   vertical clearance fixed
		      vertical clearance value

	Vertical Clearance of Conveyor	Conveyer
		   vertical clearance fixed
		      vertical clearance value

	Vertical Clearance of structures over navigable water	Building (with *in the water* = TRUE)
		   vertical clearance fixed
		      vertical clearance value

		Wind Turbine (with *in the water* = TRUE)
		   vertical clearance fixed
		      vertical clearance value

		Crane (with *in the water* = TRUE)
		   vertical clearance fixed
		      vertical clearance value

	Bearing of Navline	Navigation Line
		   orientation
		      orientation value

	Recommended Route	Recommended Route Centreline orientation value
	Deep Water Route Centreline Line	Deepwater Route Centreline orientation value
	Recommended Track	Recommended Track orientation value

	Name and Communications Channel of Radio Calling-In Point	Radio Calling In Point
		   feature name
		   communications channel

Other Text		
20		
21	Names for position reporting	
	Name or Number of Buoys	Buoy (all types) feature name
	Name or Number of Beacons	Beacon (all types) feature name
	Name or Number Daymarks	Daymark feature name
	Name or Number Light Vessel	Light Vessel feature name
	Name or Number Light Float	Light Float feature name

Viewing Group	Description	S-101 Features and Attributes (attributes in lower case; indentation indicates attribute or sub-attribute)
	Name or Number Offshore Platform	Offshore Platform feature name
22	NA (Not Allocated)	
23	Light Description String	(various features and attributes)

24	Note on chart data (INFORM) or nautical publication (TXTDSC)	information
		    language
		    text or fileReference

25	Nature of Seabed	Seabed Area
		    surface characteristics
		        nature of surface

26	Geographic Names	Anchorage Area feature name
		Bridge feature name
		Builtup Area feature name
		Building Single feature name
		Dock Area feature name
		Fairway feature name
		Landarea feature name
		Landmark feature name
		Land Region feature name
		Sea Area/Named Water Area feature name
		Tideway feature name
		Pilot Boarding Place feature name
27	Value of Magnetic Variation	Magnetic Variation value of magnetic variation
	Value of Swept Depth	Swept Area depth range minimum value
28	Height of Islet Or Land Feature	Land Area height
29	Berth Number	Berths feature name
		Anchor Berth feature name

Viewing Group	Description	S-101 Features and Attributes (attributes in lower case; indentation indicates attribute or sub-attribute)
30		NA

31[6]	National Language Text	feature name
		   language (other than English)
		   name

		information
		   language
		   text or fileReference

33	Schedules	Service Hours
		Non-standard Working Day
34	Organisations and Contacts	Contact Details
35-49	Reserved For IHO	
50-69	Mariners' Text, Including Planned Speed etc.	
70-79	Manufacturer's Text	
80-99	Future Requirements	

Table C-17 - Viewing groups for text

C-11.3   Viewing group layers used for text

To enable the Mariner to make selections regarding the text visible in the chart display the ECDIS should use the individual text groups in Table C-17 collected under distinct text group layers.

For standardization of the ECDIS user interface and to facilitate generic training of mariners, at least the following text group layers should be implemented to control the display of text:

   (1) Important text
   (2) Other text

"Important text" consists of the following :

- Communication channels for calling-in points.

- Vertical clearances for obstructions and structures over navigable water.

- Track or route orientations.

"Other text" consists of all other text.

Product Specifications should conform to these definitions in their Portrayal Catalogues.

An ECDIS may provide more textual on/off controls than are available in this table, but manufacturers should use the names of text groups or layers contained in Table C-17. Descriptive names may be combined but should be clearly indicative of the descriptive names in Table C-17.

EXAMPLE: A manufacturer provides more detailed selections. The table has text group layer "Other text". The manufacturer may subdivide this category into "names", "light description" and "all other" (Table C-18).

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[6] National text is a supplementary option for ECDIS. If used, the style for Latin characters must be similar to the English text. Other characters should conform to the requirements in C-10.2.2 and C-10.2.3 as far as possible.

Viewing Group Layer	Name of Viewing group layer in the ECDIS	Viewing groups included
1	Important text	11
2	Other Text	20-49, 0-10
2.1	Names	21, 26, 29
2.2	Light description	23
2.3	All other	0-10, 25, 27, 28, 32-49

Table C-18 - Example of subdivision of "Other Text" layer to provide more detailed selections

C-11.4   Abbreviations

The abbreviations listed below are to be used on the ECDIS display. The meanings of the abbreviations should be available to the Mariner through the ECDIS Pick Report.

C-11.4.1   Text abbreviations

The abbreviations in Table C-19 are used with text instructions and Lua format specifiers.

NOTE:. See the Lua documentation for further details.

Abbreviations		
Prefixes	**Suffixes**	
bn = beacon (INT1) by = buoy clr = overhead clearance clr cl = clearance closed clr op = clearance open sf clr = safe clearance No = number (INT1) Plt = pilot Prod = offshore production (INT1) LtV = light vessel Varn = magnetic variation ch = communication channel NMT = not more than "CLEARING BEARING" NLT = not less than "CLEARING BEARING"	kn = knots (INT1) deg = degrees	

Table C-19 - Abbreviations and format specifiers used with text instructions

EXAMPLE: The format specifier "%03.0f deg" printing an orientationValue of 60.1 produces the string "`060 deg`" (without quotes).

C-11.5   Additional information in text form

S-101 datasets encode uncategorised additional information in the complex attribute *information*, which is bound to feature types and the information type **Nautical Information** in S-101. Other data products may use the complex attribute *textContent*, which allows encoding of Internet information resources and descriptions of the sources from which the information is derived. The actual information may be encoded in the form of a text string or the name of a support file in text format that contains the information.

Additional information may be displayed in a hover box (see clause C-15.2.3). The size of the box should not be excessive in proportion to the chart window. The hover box should contain the following content, in order of precedence:

(1) The content of the *headline* sub-attribute, if not empty or blank.

(2) The content of the *text* sub-attribute, if not empty or blank.

(3) Full or partial content of the file referenced by the *fileReference* sub-attribute, if any.

If all the information available in the text and referenced file cannot be contained in the hover box, an element should be added indicating the availability of more information than is displayed, and enabling the mariner to view all the information (for example, "…(more)" suffixed to partial content).

It is not necessary to display content derived from more than one of the sub-attributes *headline*, *text*, and *fileReference*. For example, displaying the headline with a link to access the other attributes will be sufficient.

S-100 allows several different formats for support files which may be suitable for displaying information in text form. S-101 restricts this set to text, HTML, and XML. Other Product Specifications may use additional formats from those listed in S-100.

Rendering of additional text information should conform to the following rules:

- The displayed text must be formatted according to its format type (that is, as plain text, rendered according to HTML format specified in the header, styled according to CSS style rules, etc). This rule implicitly means that embedded markup (such as HTML <br> tags for line breaks) should not be displayed to the user in raw form.

- Any dynamic content (for example embedded Javascript, Flash, DHTML, etc) should be ignored[7].

- Any off-system links should be disabled[7]. The link should still be shown if it would normally be visible, but as an inactive element.

- Off-system resources should not be accessed, but if the manufacturer has provided local copies, they may be used in place of off-site resources. (Note that this prevents accessing any CSS files not available on the local system.)

- Manufacturers should not attempt to display information encoded in *information* or *textContent* attributes, or the content of text support files, that is in any format other than plain text, HTML, or XML. Specifically, PDF files should not be opened. Instead the interface should show an indication of a file type that cannot be opened on the ECDIS, for example, the file type with a "not allowed" icon superimposed (Table C-7). Clicking on this indication should provide an appropriate message to the user, for example "This file type cannot be displayed on an ECDIS, but may be readable on other systems."

The optional sub-attribute *fileLocator* is intended to indicate the location of information relevant to the current feature within a larger file, and can be used to automatically position the text viewer at the correct place in a large file. Manufacturers should not assume that the content of *filelocator* will be human-readable. The content of *fileLocator* should be interpreted according to Table C-20. If this attribute is present and the file is large enough to require scrolling of the text viewer window/panel, its use is encouraged, to save the mariner time in scrolling through possibly large amounts of text.

File Format	Interpretation of *fileLocator* content
Text	Integer value of fileLocator: The offset of the start of the section relative to the beginning of the file (the first character in the file has offset 0). This can be used to position the view at a specific place in a long text document.
	Text value of fileLocator: Section heading; clause heading or number; page number, etc. This cannot be used to position the view at the section, clause, page, etc.
HTML	HTML fragment identifier: This is the value of the *name* or *id* attribute of an HTML element in the file (as defined in the relevant HTML specification). Browsers can use this to position the viewer at a unique location in the document.

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[7] Because of potential usability and cybersecurity issues. Revised restrictions may be adopted after the IEC cybersecurity standard is complete.

File Format	Interpretation of *fileLocator* content
XML	XML fragment identifier as defined in the relevant specification; for example, the value of an *xml:id* attribute of an element in the file. As in HTML, this identifies a unique

Table C-20 - Interpretation of *fileLocator* attribute

Additional information should be displayed in the current language of the display (the language sub-attribute of information is provided). If information in the current language is not encoded in the data, the English version should be displayed.

Final determination of the presentation type (hover box, side panel, etc.), the proper size of the presentation, its styling, and the arrangement and formatting of its content rests with the manufacturer. ECDIS manufacturers should provide appropriate solutions that enable text information to be displayed without affecting the night vision of the user.

C-11.6   Graphics

S-101 datasets encode graphical information such as diagrams and photographs in the simple attribute *pictorialRepresentation*, which is bound to feature types and the information type **Nautical Information** in S-101. The *pictorialRepresentation* attribute contains the name of a support file in an allowed graphics format. Other data products may use the complex attribute *graphic*, which allows encoding descriptive information related to the picture, such as a caption, the date a photograph was taken, the aspect from which it was taken, etc. This is in addition to encoding the name of the picture file in *pictorialRepresentation*.

Pictorial information may be displayed in a hover box (see clause C-15.2.3) or side panel, or auxiliary display. If a hover box is used, its size should not be excessive in proportion to the chart window, and it should be distanced from own ship, planned track, alerts or indications by at least the track buffer distance. If these guidelines cannot be satisfied, a side panel or auxiliary display should be used. Expansion to the full size of the picture (or available display space in the picture side panel/auxiliary display, if smaller) should be allowed; whether the expanded picture is displayed over the chart window or in a side panel or elsewhere is left to manufacturer discretion. If a picture caption and aspect are available, they should also be displayed with the picture. Other information related to the picture should be accessible to the user via a "further information" link in or next to the hover box or panel.

ECDIS manufacturers should provide appropriate solutions that enable pictures to be displayed without affecting the night vision of the user.

Manufacturers should be prepared to handle pictures of resolution 800 x 800 pixels, in conformance with the guideline for picture files in S-101.

The availability of additional information in graphical format should be indicated by the same symbolisation as other supplementary information.

C-12   Miscellaneous Display Elements

This section describes additional display elements and special symbols and considerations for ENC data, including chart furniture, contours, mariners' features, IMO-required elements, and presentation of updates. Cursor pick reports and information displays in off-graphic panels are described in clause C-15.

C-12.1   Elements related to data and display scales

C-12.1.1   ENC scale

The *minimumDisplayScale* and *maximumDisplayScale* of the ENC is the range of scales at which the ENC was designed to be displayed. It may not be the same as the scale of the source data.

C-12.1.2   Overscale

Overscale is where the mariner has zoomed larger than the largest *maximumDisplayScale* of the ENC data that is shown in the mariner's viewing window.

C-12.1.2.1   Overscale Indication

The overscale indication is intended to remind the mariner that the size of chart errors is magnified when they increase the display scale.   A 1 mm error at *maximumDisplayScale* of 1/20,000 becomes a 1.3 mm error at a display scale of 1/15,000 and a 2 mm error at 1/10,000.

The overscale factor must be calculated as [denominator of the *maximumDisplayScale*] / [denominator of the mariners selected viewing scale], expressed as, for example "X1.3", or "X2" (using the figures in the example above.)

This must be indicated on the same screen as the chart display, and treated as display base. Use colour SCLBR.

This overscale indication is required by IMO Performance Standards (MSC.232(82)) whenever the display scale exceeds the maximum intended viewing scale as indicated by *maximumDisplayScale*.

NOTE   If the display is compiled from more than one ENC of the same *maximumDisplayScale*, and if the mariner deliberately chooses to zoom in so that the display scale exceeds the *maximumDisplayScale*, then only the "overscale indication" must be shown. The "overscale pattern" (area fill OVERSC01) must not be shown.

C-12.1.3   Scale boundary

This shows where the *maximumDisplayScale* of the ENC data available changes. The ECDIS should warn the mariner of upcoming ENC scale change. Only the major changes in *maximumDisplayScale* resulting from the scale jumping more than three steps in *maximumDisplayScale*s should be shown. The steps are given in S-101.

The "chart scale boundaries", where the *maximumDisplayScale* of the data changes, must be symbolised on the ECDIS display by a solid 0.32mm wide line using colour token CHGRD. Alternatively linestyle SCLBDY51 may be used. The display priority is 9; over-radar; standard display; viewing group 21030.

When scale boundaries of smaller scale **Data Coverage** areas overlap larger scale **Data Coverage** areas, that portion of the scale boundary which intersects the larger scale **Data Coverage** area should not be visible.

C-12.1.4   Overscale area at scale boundary

ECDIS displays all chart data at the same scale. In order to avoid leaving part of the display blank, the display may be rendered using data from multiple datasets. These datasets may contain **Data Coverage** areas with varying *maximumDisplayScale*s.

The area fill OVERSC01 must be used to indicate **Data Coverage** areas displayed {, X2 or more larger than} the *maximumDisplayScale*; provided that the area was displayed automatically by the ECDIS in order to avoid leaving that portion of the display blank.

NOTE: This symbol applies only to the automatic overscaling performed by the ECDIS in matching ENCs at different *maximumDisplayScale*s. It should not be applied to an overscale display deliberately requested by the mariner, which should trigger the overscale indication required by IMO Performance Standard section 6.1.1.

A different overscale situation arises when the ship approaches a scale boundary from a larger to a smaller scale ENC, typically when leaving harbour. In combining data from the large scale and the small scale ENCs to generate a display at the larger scale, the ECDIS will have "grossly enlarged" the small scale data.

In addition to drawing the scale boundaries, the "grossly overscale" part of the display should be identified with area fill OVERSC01, as illustrated in Figure C-1.

In this context, "grossly enlarged" and "grossly overscale" should be taken to mean that the display scale is enlarged/overscale by X2 or more with respect to the *maximumDisplayScale*. For example, at the left edge of Figure C-1 the display scale of 1/12,500 is X4 the *maximumDisplayScale* of 1/50,000, and so the overscale pattern is required.
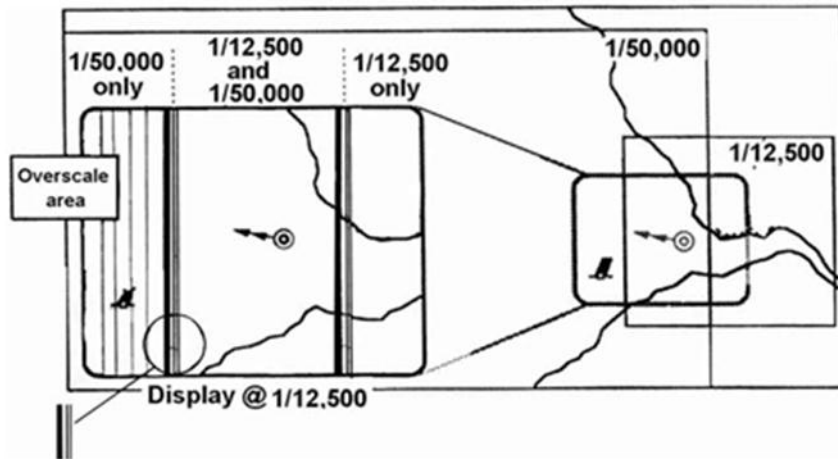
Figure C-1 - Illustration of overscale display

[The right hand side of the Figure shows the ENC layout with the screen window overlaid, and the left hand side is enlarged to show the ECDIS display on that screen.]

Note that in this situation the OVERSC01 area fill should only be shown on the area compiled from the smaller scale ENC. If the area from the larger scale ENC is also overscale, this should be indicated by the "overscale indication". The OVERSC01 area fill should not be shown on the part of the display taken from the larger scale ENC. For example if the display scale of the situation in the data coverage diagram was 1/3,500 the area of compilation scale 1/12,500 would have an overscale indication of X 3.6 but would have no OVERSC01 area fill.

C-12.1.5   Larger scale data available

As the mariner's display window moves and begins to cover an ENC that is of a larger *maximumDisplayScale*, the ECDIS must indicate that larger scale data will shortly become available, as required by IMO Performance Standards.

C-12.2   Graphical indexes

C-12.2.1   Graphical indexes of ENCs

The system **must** be capable of displaying a graphical index of ENCs by maximum display scale.

Without cursor enquiry of the chart area it will not always be clear what *maximumDisplayScale* applies to a given part of a mixed source display. Display of S-101 requires a graphical index of the *maximumDisplayScale* of the data to clarify the situation. A graphical index of available S-101 data should be shown on demand.

The system should clearly indicate the product for which the graphical index is displayed. This may be done by any suitable means, such as displaying the product (for example, "ENC Index" or other suitable terminology) in a transparent box in the corner of the display, or in a message area off the chart display area. This requirement applies even if the system is capable only of displaying a graphical index of ENCs.

Since the HO will not issue a data coverage diagram[8], the ECDIS should compile a graphical index of the HO ENC data available, classified by *maximumDisplayScale*, and make it available to the mariner.

Only datasets actually installed on the system can be included in the graphical index. Discovery metadata from Exchange Catalogue files in Exchange Sets, or compilations derived from such Exchange Catalogue files, can be used if and only if the Exchange Sets have been validated[9] to contain the claimed datasets (this will normally have been done when the Exchange Set is added to the system).

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[8] Adoption of S-128 (Catalogue of Nautical Products) may change this situation.

[9] Depending on implementation design, one-time validation upon installation, removal, or update of datasets on the system may suffice.

Listings in any general catalogue listing of datasets, for example S-128 (Catalogue of Nautical Products) information, must be used only for folio purposes.

C-12.2.2   Graphical indexes of other S-100 products

The system **may** implement a capability for displaying graphical indexes of non-ENC data products by the maximum display scale.

If graphical indexes of other products are implemented, the mariner should be able to call up a graphical index of S-100 data products by maximum display scale on demand. Scale-independent products should be included in the index, treated as having *maximumDisplayScale*=1000 (that is, the lower bound of the set of allowed display scale values for S-101 ENCs, corresponding to scale 1:1000).

The system should clearly indicate the product for which the graphical index is displayed in the same way as for ENCs.

If the system displays graphical indexes for different products simultaneously, the indexes should be distinguishable. For example, dataset extent boundaries in the graphical index may be designed so that the dataset boundaries for one product do not hide the dataset extents of another product; or the system may provide a means of emphasizing the extents for a product selected by the mariner.

As for ENCs, the graphical index should be compiled from available datasets pending the availability of coverage diagrams or the equivalent in S-128 (Catalogue of Nautical Products), and only datasets actually installed on the system should be included in the graphical index. Listings in any general catalogue, for example S-128 (Catalogue of Nautical Products) information, must be used only for folio purposes.

C-12.3   Limits of data

C-12.3.1   Limit of HO S-101 data and data from non-HO sources

The limit of HO S-101 data on the graphical index defines the limit of HO ENC coverage.

The limit of HO S-101 data relative to "no data" areas need not be demarcated on the display. The appearance of the "No data" colour (colour token NODTA) and NODATA03 area fill (see C-12.3.3) will indicate the end of HO data.

If non-HO chart data is shown on the ECDIS display, its boundary should be demarcated by the line style NONHODAT. Note that the NONHODAT line style is a "one-sided" line and the boundary of the non-HO data must be drawn according to S-101 rules to ensure that the diagonal stroke of the line is on the non-HO data side of the line. The non-HO data boundary indicated by the NONHODAT line style serves to separate ENC data from non-HO chart information.

C-12.3.2   Limits of other S-100 product data

To reduce screen clutter, "no data" areas and "non-HO data" boundaries for products other than S-101 and S-57 ENCs should be depicted only when specifically called up by the mariner for a product, and then only if the product is actually displayed on the screen. The fill patterns and boundaries should indicate the product to which they apply, for example by mentioning the product in a corner or embedded in the line as for the graphical indexes (see C-12.2.1 and C-12.2.2).

For gridded data, the no-data area limits do not need to demarcate areas within the grid extent which are covered by fill values.

Implementing the depiction of limits for data other than S-101 and S-57 ENCs is optional.

NOTE: For some types of coverage products (for example gridded data), no-data areas may be easily distinguished by the lack of portrayal. Nevertheless, consistent treatment of products is recommended for the convenience of the mariner - either this clause should be implemented for all the non-ENC S-100 products, or for none of them.

C-12.3.3   No data areas

The first action of the ECDIS display re-draw should be to fill the entire screen using colour token NODTA, then fill the entire screen using area pattern NODATA03. These will remain to identify any area not subsequently covered by chart information as a no data area. The NODATA03 area pattern and NODTA colour fill are assigned drawing priority 0 (Table C-9) and viewing group 11050 (Table C-11).

An indication "refer to the official chart" is required if the display includes waters for which no ENC at appropriate scale exists.

If a scale boundary is shown on the display, the information in an overscale area should be identified, and should not be relied on.

An indication that the mariner must refer to the official chart should be given whenever line style NONHODAT appears on the display, or whenever the display is comprised of other than ENC data.

C-12.4   Data quality indicators

A bathymetric data quality indicator will cover the entire area of depth data or bathymetry for the ENC. This indicator is generated from the S-101 meta-feature **Quality O fBathymetric Data** by a rule in the Portrayal Catalogue.

Other indicators of data quality (quality of non-bathymetric information, information about survey dates, positional uncertainty for non-bathymetric data, etc) are derived from other quality meta-features in the S-101 dataset and may be displayed by turning on the appropriate viewing groups (Table C-13) and/or by means of cursor queries ("pick reports").

Quality indicators for other S-100 products may also be displayed by turning on the appropriate viewing layers (Table C-13) and/or by means of cursor queries ("Pick Reports") on (meta-)features describing data quality. Quality indicators for products other than S-101 and S-57 ENCs should be displayed only when specifically enabled or called up by the mariner.

C-12.5   Special ECDIS chart symbols to identify unsafe depths

The ECDIS highlights four features that are important for safe navigation. These are the safety contour, depth shades, the safety depth and isolated dangers

C-12.5.1   Safety Contour

The own-ship safety contour, selected by the mariner from among the contours in the SENC, is double-coded by a thick line and a prominent change in depth shade.

If the safety contour selected by the mariner is not available in the SENC, the ECDIS should default to next deeper contour and **inform the mariner**. If, when the ship moves onto a new chart, the safety contour previously in use is no longer available, the ECDIS should again select the next deeper contour, and **inform the mariner**.

If the mariner does not select a safety contour, the value should default to 30 metres.

C-12.6   Other ECDIS symbols and their use

C-12.6.1   Mariners Caution Notes

Point cautions and notes entered by the mariner and the manufacturer are distinguished by the colours orange and yellow respectively.

C-12.6.2   Unknown feature

A magenta question mark ("?") marks the position of a feature which cannot be identified or for which there is no rule set in the Portrayal Catalogue.

C-12.6.3   Change of horizontal (geodetic) datum

The use of non-WGS 84 data does not comply with IHO S-101, and the boundary at which the local geodetic datum changes is not symbolized by the Portrayal Catalogue.

C-12.6.4   Manual chart correction

Small orange identifiers are used to distinguish hand-entered chart corrections, which are subject to human error, from corrections entered automatically by electronic means. The original chart feature should not be removed or altered.

C-12.6.5   Manual corrections to non-ENC S-100 products

Manual corrections to other S-100 products are entered in the same way as chart corrections. They are not visually distinguished from manual chart corrections. However, for portrayal purposes they are treated as part of the appropriate product data rather than the S-101 data and are displayed or removed from the display along with the appropriate viewing groups from the relevant S-100 product.

C-12.6.6   One-sided linestyle for boundaries

A one-sided linestyle is provided for use on large-scale displays to indicate the side of an area boundary on which the area lies, when only a part of the boundary can be seen on the display.

C-12.6.7   Special identifiers

Identifiers are provided for low accuracy chart data; and for ENC features which have additional information for cursor picking utilizing the S-101 attribute *information* on feature types or the information type **Nautical Information** that is associated to the feature using the information association *additionalInformation*. The latter may cause clutter, and should only be displayed temporarily.

Similarly, special identifiers may also be provided for other S-100 products and should provide cursor pick functionality for any associated information type using any information association, since other products may use information types other than **Nautical Information** and information associations other than *additionalInformation*. These identifiers should only be displayed on request by the user. The symbols for such identifiers are defined in the respective Portrayal Catalogues.

C-12.7   Date-dependent features

There are a number of features within the Marine environment, which are seasonal, such as racing buoys. These features are only to be displayed over a certain period, S-101 uses the complex attribute *periodicDateRange* with the sub attributes *dateStart* and *dateEnd* to indicate the periodic nature of the feature. Other features, such as traffic separation schemes, use the complex attribute *fixedDateRange* with the sub attributes *dateStart* and *dateEnd* to indicate their introduction or removal. In order for the Mariner to receive important changes to traffic separation schemes before the event, Hydrographic Offices are required to provide updates or new editions containing the alterations at least one month before they come into force. Any S-101 feature with one of the above complex attributes must not be displayed outside its effective dates unless requested by the Mariner.

C-12.7.1   Display of date-dependent features by mariner-selected date

To provide the Mariner with effective route planning capabilities and for the look-ahead function during route monitoring ECDIS must display date dependent chart data based on a Mariner selected date or date range (start viewing date and end viewing date).

During route planning and monitoring the Mariner must be able to select a date or date range to display all date dependent chart features. The display of date dependent information is indicated by the symbol CHDATD01.

All features for which any of the values for the complex attributes *periodicDateRange* and *fixedDateRange* are within the Mariner selected date range should be indicated using symbol CHDATD01.

EXAMPLE: A new traffic separation scheme is coming into effect on 01.01.2013, it has been encoded by the ENC producer using the attribute date start (DATSTA). The current date is 12.12.2012 and the Mariner is planning a route that will cross this area over the effective start period.

The ECDIS should be capable of providing the Mariner the ability to set the date the vessel will be in the area (02.01.2013) and the system should show the new traffic scheme.

C-12.7.2   Highlighting of date-dependent features

The mariner should have the ability to turn on and off the highlighting of date dependent features.

C-12.7.3   Indication of date adjustment

When viewing date or date range do not include the current date, the mariner must be informed by a permanent indication on the chart display that the date has been adjusted. The indication must begin

with the text "Display Not Real Time" and the selected date or date range must be readily available. The format of the date should be: dd mmm yyyy = Day, Month, Year; for example, 28 Jan 2014.

The use of one of the following formats is recommended:

- Display Not Real Time – Display is based on date dd mmm yyyy
- Display Not Real Time – Display is based on viewing date range from dd mmm yyyy to dd mmm yyyy

C-12.8 Scale-dependent features

To reduce screen clutter most features within ENC should carry the attribute *scaleMinimum* to specify the smallest display scale at which they should be drawn. At display scales smaller than *scaleMinimum* the feature must not be drawn. For example, a feature with a *scaleMinimum* value of 49999, indicating a scale of 1/49,999, should not be drawn on an ECDIS display of 1/50,000.

C-12.9 IMO presentation elements

In some cases S-101 does not provide a symbology instruction in the Portrayal Catalogue that specifies how to present a specific feature on the ECDIS screen. The reason is that such a feature cannot be clearly identified as an S-101 feature class or it appears to be illogical to include it to the Mariners' navigational feature classes.

The following presentation instructions are therefore provided in order to assist the manufacturer to set up a satisfactory and comprehensive ECDIS display.

C-12.9.1 Scale bar and latitude scale

The IMO Performance Standards require an indication of scale and range as part of the Display Base. The display scale determines which should be used:

(1) Case 1: for display scales larger than 1/90,000: always display the 1 Nautical Mile scale bar provided in the Portrayal Catalogue

(2) Case 2: for display scales at 1/90,000 or smaller: always display the 10 Nautical Miles (at latitude) scale provided in the Portrayal Catalogue.

The scale bar or latitude scale should always be drawn vertically at the left side of the chart display, just clear of the border of the display. The symbols and drawing parameters are described in Table C-21.

The placement should be 3mm in from the border of the display. Make sure the symbol is properly sized by your software to represent 1 nautical mile at the scale of the display (for Case 1) or 10 nautical miles at the scale of the display (for Case 2).

The mariner should be able to remove any labels on the scales to avoid clutter.

Scale range	Symbol	Drawing priority	Display plane	Display category	Viewing group
1:89999 and larger scale	SCALEB10	90	OverRADAR	Display Base	11030
1:90000 and smaller scale	SCALEB11				

Table C-21 - Scale bar presentation parameters

EXAMPLE 1: For *maximumDisplayScale* values larger than 1/90,000 (for example, a scale of 1/50,000) draw symbol 'SCALEB10' on the left side of the chart display, bottom justified and 3mm in from the border of the display. Make sure the symbol should be sized to represent 1 nautical mile (1852 m) at the scale of the display.

EXAMPLE 2: For display scales of 1/90,000 or smaller (for example, 1/250,000) use symbol 'SCALEB11', similarly located, and scaled to represent 10 miles at the scale of the display.

IEC define a requirement for indicating the location at which the scale is calculated under certain circumstances, as follows:

> *If the displayed area together with the used projection is such that scale is not uniform over the displayed area then the scale bar (more than 5% difference in uniformity for all directions or displayed area is over latitude 70º) or latitude scale (more than 5% difference in uniformity for latitude direction or displayed area is over latitude 70º) shall indicate the scale either at own ship location or at the centre of the displayed area. In such case a permanent indication "at own ship" or "at centre" shall be close to the scale bar or latitude scale. [IEC 61174:2015].*

C-12.9.2   North arrow

The IMO Performance Standard requires a north arrow as part of the Display Base. The north arrow should always be shown at the top left corner of the chart display, just clear of the scale bar or latitude scale. Other requirements for the north arrow are defined in IEC 61174.

Use symbol 'NORTHAR1' to indicate true north. Place it in the top left corner of the chart display, on the inner side of the scalebar. Rotate the symbol to true north if the display is other than north up, and make sure it is clear of the scalebar even if the latter extends the full height of the display.

The symbols and drawing parameters for the north arrow are described in the IHO GI Registry.

C-12.9.3   Graticule

If the ECDIS shows a graticule (listed in "other information" in IMO Performance Standards (MSC.232(82)) the lines should use the colour token CHBLK.

C-12.9.4   Display mode

The ECDIS manufacturer should provide the indication of display mode required in the display base by IMO Performance Standards (MSC.232(82)).

C-12.9.5   Shallow water pattern

When the entire water area on the ECDIS display is of less depth than the safety contour, it is not possible for the mariner to easily detect this problem. The issue is exacerbated when the ECDIS is set to night mode due to the small differences between the depth area shades in the ECDIS chart display. Therefore S-101 provides a faint lattice pattern DIAMOND1 to distinguish shallow water.

The mariner must be provided with a selection to turn the shallow water pattern on or off from within the ECDIS.

Symbol	Drawing priority	Display plane	Display category	Viewing group
DIAMOND1	35	UnderRADAR	Standard	23010

Table C-22 - Shallow water pattern presentation parameters

C-12.9.6   Black level adjustment symbol

Unless the brightness and contrast controls of the monitor are properly adjusted there is a danger that information may be lost from the chart display, particularly at night. Symbol BLKADJ is provided for checking correct adjustment and for re-adjusting as necessary. It should be available for call-up by the Mariner as required.

C-12.9.7   Detection and notification of navigational hazards

The IMO Performance Standard for ECDIS MSC.232(82), clause 11.3.5 Route planning states:

> *An indication should also be given if the mariner plans a route closer than a user-specified distance from a point feature, such as a fixed or floating aid to navigation or isolated danger.*

Clause 11.4.6 Route monitoring states:

> *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 (For example, obstruction, wreck, rock) that is shallower than the mariner's safety contour or an aid to navigation.*

The ECDIS must implement support for the Alert and Indications Catalogue which may be provided within each product's Portrayal Catalogue.

The safety contour value is set by the user; in the absence of a user setting, its default value should be 30m.

The highlight should indicate the intersection between the ship's look-ahead buffer (computed using speed, course, look-ahead time and cross-track deviation) and the spatial components associated with alert instructions output by the portrayal.

Figure C-2 depicts indication highlights for points, curves, and surfaces.
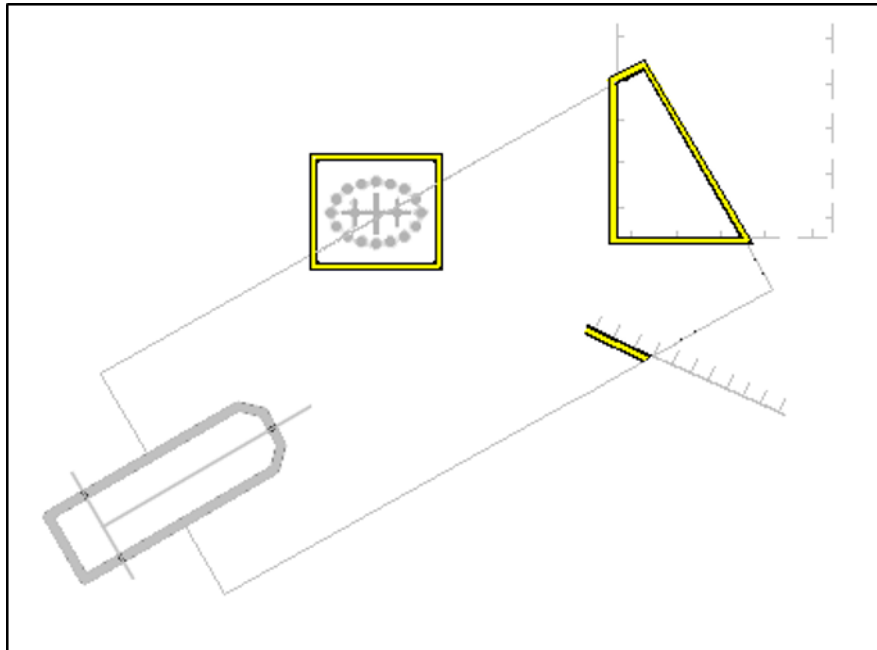
Figure C-2 - Examples of indication highlights

C-12.9.8   Detection of areas for which special conditions exist

The IMO Performance Standard for ECDIS MSC.232(82), clause 11.3.5 Route Planning states;

> *An indication should be given if the mariner plans a route closer than a user-specified distance from the boundary of a prohibited area or a geographic area for which special conditions exist.*

Clause 11.4.4 Route Monitoring states;

> *ECDIS should give an alarm or indication, as selected by the mariner, if, within a specified time set by the mariner, own ship will cross the boundary of a prohibited area or area for which special conditions exist.*

The ECDIS must implement support for the Alert and Indications Catalogue which may be provided within each product's Portrayal Catalogue.

C-12.9.9   Visualisation of the safety contour

The safety contour is defined as an edge between safe and unsafe Skin of the Earth features from S-101.

C-12.9.10 Detection of safety contour

The IMO Performance Standard for ECDIS MSC.232(82), clause 11.3.4 Route Planning states;

> *An indication is required if the Mariner plans a route across an own ship's safety contour.*

Clause 11.4.3 Route Monitoring states;

> *ECDIS should give an alarm if the ship, within a specified time set by the Mariner, is going to cross the safety contour.*

The ECDIS must implement support for the Alert and Indications Catalogue which may be provided within each product's Portrayal Catalogue.

The point, line or surface should be graphically indicated using the presentation named as "DNGHLT" in the Portrayal Catalogue, as depicted in Figure C-3.
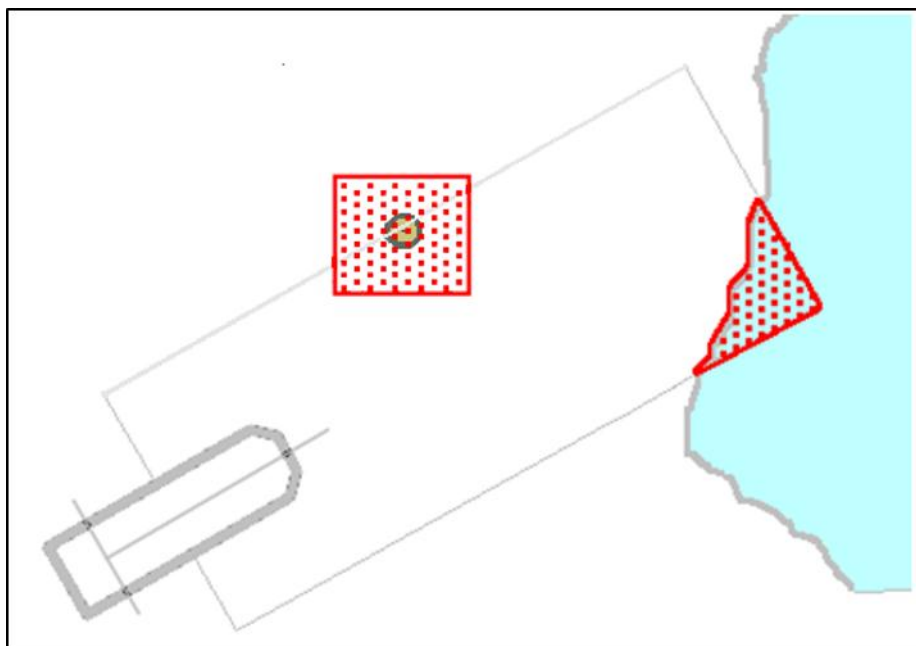
Figure C-3 - Examples of danger highlights in ECDIS

C-12.9.11   User Selected Safety Contour and Water Level Adjustment.

User selected safety contour means the creation of the safety contour from bathymetric grid data based on a value set by the user. With ENCs the user sets a value for the safety contour, but if the exact fit is not found from the available depth information in the ENC then the safety contour defaults to the next deepest which can be substantially deeper than the value requested by the user.

Bathymetric grid data allows the user the ability to define a value and for the system to delineate areas of safe and unsafe water based on that value. The areas defined can then be used for the definition of safety contour and attendant alerts/indications. When this is done contextual ENC features with depth information are also substituted from the bathymetric grid to present the user a harmonised picture.

The combination of S-101 with S-104 can also enable Water Level Adjustment (WLA), allowing the water level data contained in S-104 to complement the S-101 chart data. WLA can also be applied to S-102 data suppressing S-101 features. As with depth information, WLA processes adjust other attribute values in the ENC to present the user a harmonised picture.

Appendix C-4 defines the detailed mechanisms for user selected safety contour and water level adjustment.

C-12.9.12   Range indicator

The IMO Performance Standards require an indication of scale and range as part of the Display Base. ECDIS should implement this as an emphasized marker on the course and speed made good vector (see IEC 62288).

C-12.9.13   Detection of route-based conditions

The IMO Performance Standard requires that:

> *An alarm should be given by ECDIS when the ship reaches a specified time or distance, set by the mariner, in advance of a critical point on the planned route. [MSC.232(82) 11.4.9]*

Critical points on the planned route are defined in S-421. When the ship arrives within the mariner-specified time or distance of the point, the system shall generate an alarm. [Further details or a reference to S-421 will be added later.]

The IMO Performance Standard requires that:

An alarm should be given when the specified cross track limit for deviation from the planned route is exceeded. [MSC.232(82) 11.4.5.]

[Further details or a reference to S-421 will be added later.]

C-12.10   Data Producer specified display features

C-12.10.1 Supplementary information

Additional chart content in S-101 is encoded using the attributes *information* and *textualDescription* on feature types or the information type **Nautical Information**. This information type is associated to S-101 features using the information association *additionalInformation*. This information must be discoverable by means of a hover box or user query (Pick Report).

Schedules and contact information may also be encoded in datasets and should also use the same symbol. They are encoded using the information types **Service Hours**, **Non-Standard Working Day** and **Contact Details**, associated to features using the *additionalInformation* information association.

Other data products may also link regulations and specifications of vessel/cargo characteristics to features in their own Feature Catalogues. Such supplementary information should also be indicated using the supplementary information symbol. The names of the associations are defined in the respective Product Specifications; in general, any information association in a feature instance should be treated as a link to additional information for display purposes on ECDIS.

Display or suppression of supplementary information symbols should be under mariner control (see MSC.1609 App. 2 Table 2).

Presentation of the content of *information* is described in clause C-11.5. Presentation of *textualDescription* is described in clause C-11.6. Presentation for the content of schedules and contact information is described in clause C-15.5.

C-12.10.2 Display in languages other than English

To support dataset portrayal using languages other than English, the ECDIS should expose to the mariner any national language context parameter provided in a products Portrayal Catalogue. For other details of national language support the Data Classification and Encoding Guide (DCEG) of the relevant product should be consulted.

C-12.10.3 ECDIS Legend

The ECDIS chart legend containing the following elements should be available for display at the position selected by the Mariner. Table C-23 indicates which ENC data elements should be used.

NOTE: The legend is currently described in terms of elements of the Dataset Identification (DSID) record in dataset headers in the ISO 8211 encoding as well as dataset discovery metadata because neither the dataset header nor discovery metadata contain all the elements of the legend.

ECDIS Legend Item	Values
Units for depth	Axis Unit of Measure (AXUM) subfield in the Coordinate System Axes (CSAX) field
Units for height	AXUM subfield in the CSAX field
Note: Units for depth and height: although the S-101 ENC Product Specification does not allow any units other than metres for depths and heights, these two elements should be stated for clarity for the Mariner	
Scale of display	Selected by mariner
Data quality indicator	(a) *verticalUncertainty.uncertaintyFixed* (*SOUACC*) attribute of the **Quality Of Bathymetric Data** (M_QUAL) meta-feature. (b) *horizontalPositionUncertainty.uncertaintyfixed* (*POSACC*) attribute of the **Quality Of Non-Bathymetric Data** (M_ACCY) meta-feature if available.

ECDIS Legend Item	Values
Note: Due to the way quality is encoded in the ENC, both values (a and b) should be used	
Sounding/vertical datum	The *soundingDatum* and *verticalDatum* fields of the dataset discovery metadata in the exchange catalogue, or the *verticalDatum* attribute of the **SoundingDatum** feature and **VerticalDatum** feature when available. (*verticalDatum* attributes of individual features should not be used for the legend.)
Horizontal datum	WGS84
Value of safety depth	Selected by Mariner. Default is 30 metres
Value of safety contour	Selected by Mariner. Default is 30 metres
Note: If the Mariner has selected a contour that is not available in the ENC and the ECDIS displays a default contour, both the contour selected and the contour displayed should be quoted	
Magnetic variation	**MagneticVariation** (MAGVAR) feature, attributes: *referenceYearForMagneticVariation (RYRMGV)*, *valueofAnnualChangeInMagneticVariation (VALACM)*, and *valueOfMagneticVariation (VALMAG)* Item should be displayed as: VALMAG RYRMGV (VALACM) For example, 4°15W 1990 (8'E)
Date and number of latest update affecting chart datasets currently in use	Issue date and update number from the dataset discovery record of the last update dataset applied. (See S-100 Part 17)
Edition number and date of the ENC	Edition number and issue date from the dataset discovery record of the current base issue of the ENC dataset. (See S-100 Part 17)
Chart projection	Projection used for the ECDIS display (For example, oblique azimuthal). This should be appropriate to the scale and latitude of the data in use

Table C-23 - Legend elements

The list above is the minimum that should be available, but the complete list need not always be shown. Individual items may be picked by the mariner for display for a period; examples are magnetic variation, data quality for depths, etc.

C-12.11   Displaying manual and automatic updates and added information

C-12.11.1 Manual update

Manual updates of ENC information should be displayed using the same symbology as ENC information and should be distinguished from ENC information as described in the following sub-clauses.

C-12.11.1.1 Added feature (manual)

Point feature: Superimpose symbol CHCRID01.

Line feature: Overwrite with line style CHCRID01.

Surface feature: Overwrite area boundary with line style CHCRID01 and superimpose symbol CHCRID01 on any centred symbol.

C-12.11.1.2 Deleted feature (manual)

The feature should remain on the display and should be marked as follows:

Point feature: Superimpose symbol CHCRDEL1.

Line feature: Overwrite with line style CHCRDEL1 (do not remove the original line).

Surface feature: Overwrite area boundary with line style CHCRDEL1 and superimpose symbol CHCRDEL1 on any centred symbol.

C-12.11.1.3 Moved feature (manual)

As for deleted feature, followed by added feature.

C-12.11.1.4 Modified feature (manual)

There are three cases, which are treated as follows:

   a) If the only modification is an addition (for example, an existing buoy has a retro-reflector added with no other change):

   Superimpose symbol CHCRID01 or line style CHCRID01.

   b) If the only modification is a deletion of a part (for example, an area has a «fishing prohibited» restriction removed), then this creates both a change and a deletion and both should be symbolized:

   Point: Superimpose symbol CHCRID01 and symbol CHCRDEL1.

   Line: Overwrite with line styles CHCRID01 and CHCRDEL1.

   Area: Overwrite the boundary with line styles CHCRID01 and CHCRDEL1 and also superimpose symbols CHCRID01 and CHCRDEL1 on any centred symbol.

   c) If the modification is an addition and a deletion then it is handled as in (b) above.

A deleted feature should appear on the display only when its IMO category and viewing group are displayed.

A manually updated feature must be capable of the same performance in feature selection, response to cursor-picking, etc, as an ENC feature. In addition, it should provide updating information (identification and source of update, when and by whom entered, etc) on cursor picking.

C-12.11.2 Identifying automatic chart corrections on demand

The ECDIS manufacturer should provide a means of identifying chart corrections to the SENC on demand by the Mariner.

On Mariner demand automatic chart corrections of ENC information should be highlighted as described in the following sub-clauses.

C-12.11.2.1 Added Feature (automatic)

Point object: Superimpose symbol CHRVID01.

Line object: Overwrite with line style CHRVID02.

Area object: Overwrite area boundary with line style CHRVID02 and superimpose symbol CHRVID01 on any centred symbol.

C-12.11.2.2 Deleted Feature (automatic)

Point object: Superimpose symbol CHRVDEL1.

Line object: Overwrite with line style CHRVDEL2 (do not remove the original line).

Area object: Overwrite area boundary with line style CHRVDEL2 and superimpose symbol CHRVDEL1 on any centred symbol.

C-12.11.2.3 Moved Feature (automatic)

As for deleted feature, followed by added feature.

C-12.11.2.4 Modified Feature (automatic)

Point: Superimpose symbol CHRVID01 and symbol CHRVDEL1.

Line: Overwrite with line styles CHRVID02 and CHRVDEL2.

Area: Overwrite the boundary with line styles CHRVID02 and CHRVDEL2 and also superimpose symbols CHRVID01 and CHRVDEL1 on any centred symbol.

C-12.11.2.5 Non-HO (Non-ENC) Chart Information

Limited non-HO data added to existing HO ENC data to augment the chart information must be distinguished from the HO ENC information as follows:

Point object:	Superimpose symbol CHCRID01.
Line object:	Overwrite with line style CHCRID01.
Area object:	Overwrite area boundary with line style CHCRID01 and superimpose symbol CHCRID01 on any centred symbol.

C-12.11.2.6 Information about automatic updates

S-101 defines an **Update Information** feature to describe automatic updates and corrections. A single instance of **Update Information** may spatially cover multiple spatially dispersed ENC features. **Update Information** may also be associated with one or more features using the *updatedInformation* association to indicate features affected by the update. An **Update Information** feature can be either a point, curve or surface, and contains a description what has been updated. The presentation parameters are described in Table C-24.

Primitive	Symbol/Style	Drawing priority	Display plane	Display category	Viewing group
Point	[TBD]				
Curve	Solid 0.32mm wide line, colour token CHGRD	[TBD]	[TBD]	Other	31090
Area	Solid 0.32mm wide line, colour token CHGRD				

Table C-24 - Presentation parameters for Update Information feature

C-12.11.3 Updating non-official chart information

Limited non-official data added to existing official ENC data to augment the chart information should be distinguished from the official information as follows:

Point feature:	Superimpose symbol CHCRID01.
Line feature:	Overwrite with line style CHCRID01.
Area feature:	Overwrite area boundary with line style CHCRID01 and superimpose symbol CHCRID01 on any centred symbol.

Non-official data should be distinguished from manually updated chart information, which uses the same identifiers, by cursor picking.

Non-official chart information may be updated by any systematic procedure. A record of updates should be maintained.

The mariner should be able to remove all non-official chart information if the need should arise.

C-12.11.4 Other non-official data

Non-official data must be distinguished from manually updated chart information, which uses the same identifiers, by cursor picking.

See clause C-9.1.3 for information on how to symbolize other cases of non-HO data appearing on the ECDIS display.

Non-official chart information may be updated by any systematic procedure. A record of updates must be maintained.

The Mariner must be able to remove all non-HO chart information if the need should arise.

C-12.12 Contours from datasets other than S-101

Whether algorithms for determining contours from bathymetry, water levels, etc, should be implemented on the ECDIS is undetermined at this time. It is possible that the relevant data products will include

contours in (or with) datasets delivered to ECDIS. If contours are appropriate but unavailable in the dataset, manufacturers may devise their own methods for creating contours, but should not substitute the results for contours determined from S-101 ENCs.

Contours computed from other datasets may be displayed as "Other information" in the IMO categorisation, but should be clearly distinguishable from the contours derived from S-101 ENC data. The default method for distinguishing such contours is to use a linestyle with one or both of the following characteristics:

- A line colour that is clearly distinguishable from the colours used for safety, shallow, and deep contours, coastlines, tracks and routes.
- A complex linestyle with embedded or offset symbology identifying the data product (in terms understandable by mariners) or otherwise sufficient to distinguish the contour from safety, shallow, and deep contours, coastlines, tracks and routes.

A distinguishable colour is recommended even if the other characteristic is also used.

The effect on display clutter should be taken into account if display on the navigation window during route monitoring and collision avoidance is anticipated.

C-13   Coverages and Time Series

Coverage and time series features are encoded in the HDF5 format (see S-100 Part 10c). S-100 provides for the following types of coverage and time series data:

- Gridded data with different types of spatial grid coverages;
- Triangulated irregular network (TIN) data;
- Data at a set of discrete fixed points;
- Data at a set of moving platforms;
- Time series data at a set of fixed points.

Gridded data will specify either continuous or discrete[10] interpolation between grid points. Data for discrete fixed points, moving platform and time series at fixed points is intrinsically discrete.

A single data product may contain features of more than one spatial type. For example, the S-102 data model includes a coverage feature of gridded spatial type for depths and a point set feature for overriding values in the gridded features at particular points.

C-13.1   Discrete coverages

Cursor queries within the extent of a grid should produce a Pick Report displaying the attributes and values at the grid data points. The neighbourhood for cursor query should correspond to the visual effects of the portrayal, for example:

- A box of dimensions one-half the grid spacing along each axis.
- The same value and geometry (box, circle, etc.) as for point features in the ENC.

Thinning for display at a smaller scale should also be taken into account, and the result should include data from.

In the absence of a prescription in the Product Specification for how the neighbourhood is to be determined, manufacturers may use any suitable method of their own devising.

C-13.2   Continuous coverages

Continuous coverage data can be depicted using a sun-illuminated or static (flat) representation of the dataset. A sun-illuminated depiction requires the entry of a sun azimuth and corresponding altitude angle

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[10] "Discrete interpolation" means no interpolation between data points.

(or elevation angle). Examples are provided in Table C-25. Figure C-4 shows the difference between a sun-illuminated and static (flat) surface.

Attribute	Value	
	Sun-illuminated	Flat surface
Sun Azimuth	315°	0°
Sun Altitude Angle	45°	0°

Table C-25 - Typical sun azimuth and elevation values for sun-illuminated portrayal (S-102)
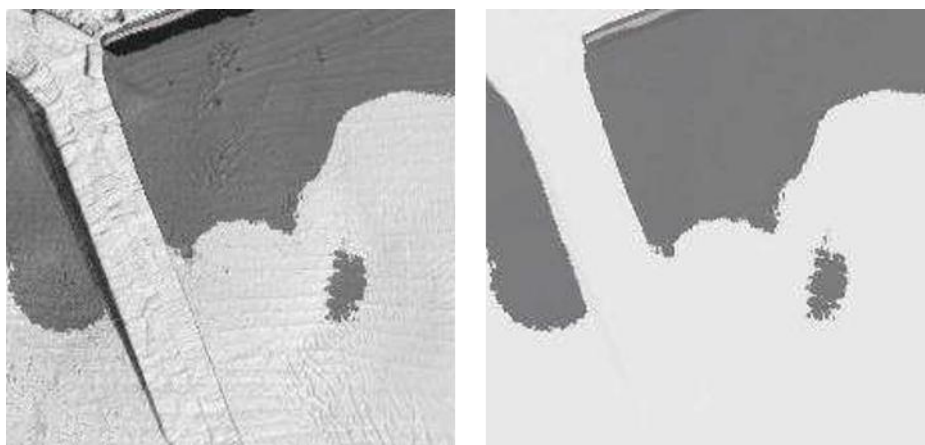
Figure C-4 - Illustration of sun-illuminated shading (L) and flat shading (R) (S-102)

ECDIS in route monitoring mode should allow sun-illuminated shading only on a side panel or a display separate from the main navigation screen.

Cursor queries within the extent of a continuous coverage feature should produce a Pick Report displaying the attributes and values at the location of the cursor query. The interpolation method specified in the Product Specification should be applied.

In the absence of a prescription in the Product Specification for the values to be returned for a cursor query, manufacturers may determine the values using any suitable method of their own devising, consistent with the requirements of this clause.

Data from any point overrides within a given neighbourhood of the query location must also be returned. The neighbourhood should be as defined in the Product Specification or, if the Product Specification does not define it, the same method as for discrete coverages.

NOTE: Other illumination models may be specified by a given product. Illumination applied when the dusk or night colour palettes are active may adversely affect the usability of the displayed data.

C-13.3 Contours from continuous coverages

The addition of S-102 datasets enhances the Mariner's ability to render and display, using colours, higher resolution depth zoning directly from the gridded data in S-102.

At time of ingest a display system should delineate navigational depth zones by comparing the depth layer of the S-102 dataset to the Mariner defined vessel draft or default safety contour.

C-13.4 Transparency

The symbol transparency must be adjusted according to the background chart/image used.

C-13.5 Thinning

When gridded data is portrayed using discrete symbols at each data point, the effects of scaling the display must be considered. A high-resolution display (that is, zooming in) of regularly gridded data

display produces a lower density of data in the visual field. Recommendations in the Product Specification as to whether spatial interpolation may be used to estimate data values at locations between grid points or point coverage locations must be followed.

Displaying at a low resolution (that is, zooming out) increases the density of symbols in the visual field. However, by applying a thinning algorithm, the number of symbols may be reduced.

This Specification requires only that a thinning algorithm be applied to reduce symbol density when the display is scaled. Manufacturers may use the algorithms described below or other algorithms of their own devising.

C-13.5.1   Thinning algorithms (informative)

C-13.5.1.1   Regularly gridded data

Let the grid cell's diagonal for the unthinned grid at the current display scale be given by D mm. Note that D is dependent on the dataset and the characteristics of the viewing monitor. If every n^{th} cell is displayed, the displayed spacing is nD. Next, suppose the maximum dimension of the largest scaled symbol in the displayed field is $Lsmax$ mm. Then the ratio R of the maximum symbol dimension to the displayed grid spacing is constrained to be less than a prescribed maximum value, $Rmax$. A typical value for $Rmax$ can be taken to be 0.5. (Given that on a navigation display there may be point features from other products within the extent of the grid, $Rmax=0.5$ may be too high for practical use; the optimal value of $Rmax$ is left to manufacturer determination, and may be different for different products, depending on the shape of the symbol.) Then the following inequality must be satisfied for the thinned grid:

$$R \ = \ \frac{L_{smax}}{nD} \ < \ R_{max}$$

If the above inequality cannot be met with increment n equal to 1, then a new value for n is computed by the following formula:

$$n \ = 1 + \ \text{fix}\left(\frac{L_{smax}}{DR_{max}}\right)$$

Where *fix()* is a function that returns the truncated integer value of its argument. For plotting, arrows at every n^{th} column and every n^{th} row are drawn, making sure that the row and column with the maximum-size symbol is drawn. The value of n must be calculated by the system. It also requires identifying a "seed point," a grid point with the maximum-size symbol from which counting starts. Designating this seed point as (x_0, y_0), the grid points where symbols are drawn are given by:

$$\left. \begin{array}{l} x_k = x_0 \pm (n \times k) \\ y_k = y_0 \pm (n \times k) \end{array} \right\} \quad \text{for } k = 0, 1, 2, 3 \ ...$$

This algorithm assumes the grid spacing can be represented by its cell diagonal. It can be adapted to allow for symbols that are aligned parallel to grid axes or for rectangular cells.

The Figures below illustrate the use of this algorithm. Figure 5 depicts a grid coverage feature symbolised by arrows of dimensions varying according to the value of an attribute at the grid point. Figure C-6 depicts the same data thinned with $Rmax$ = 0.5 (outline-only arrows are suppressed). Figure C-7 depicts the thinning of the same data with $Rmax$ = 0.33. The nominal[11] dimensions and parameters for the three cases are:

Grid spacing at the display scale (D): 36mm (grid diagonal).

Scaling of symbols by data attribute values at grid points produced symbols of four sizes (arrow length):

- L0 = 30.4mm = *Lsmax*
- L1 = 17.7mm
- L2 = 16.2mm
- L3 = 12.7mm

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[11] Values are for hypothetical data and display, and the figures have been reduced for reproduction in this document.
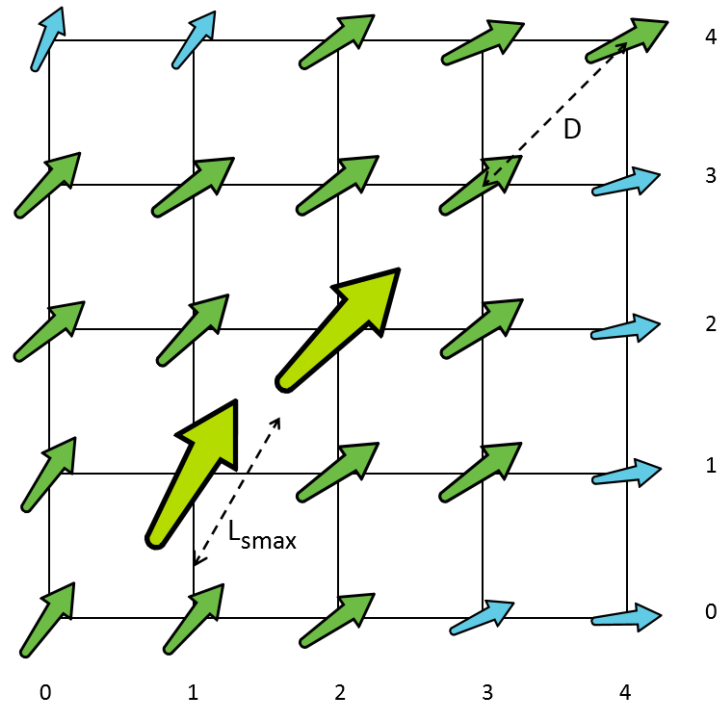
Figure 5 - Grid without thinning

For *Rmax* = 0.5, with *n* = 1, the value of *R* is greater than *Rmax*:

$$R = \frac{L_{smax}}{1 \times D} = \frac{30.4}{36} = 0.844 > 0.5$$

Applying the formula for computing *n*:

$$n = 1 + \text{fix}\left(\frac{30.4}{36 \times 0.5}\right) = 2$$

Counting in row-major order from the grid origin *(0,0)*, the first symbol of size *Lsmax* is located at *(1,1)*. Denoting this point as the seed point *(x0, y0)*, the only grid points where symbols are displayed are:

$$\left.\begin{array}{l} x_k = x_0 \pm (2 \times k) \\ y_k = y_0 \pm (2 \times k) \end{array}\right\} \quad \text{for } k = 0, 1, 2, 3 \ \dots$$

The results are depicted in Figure C-6.
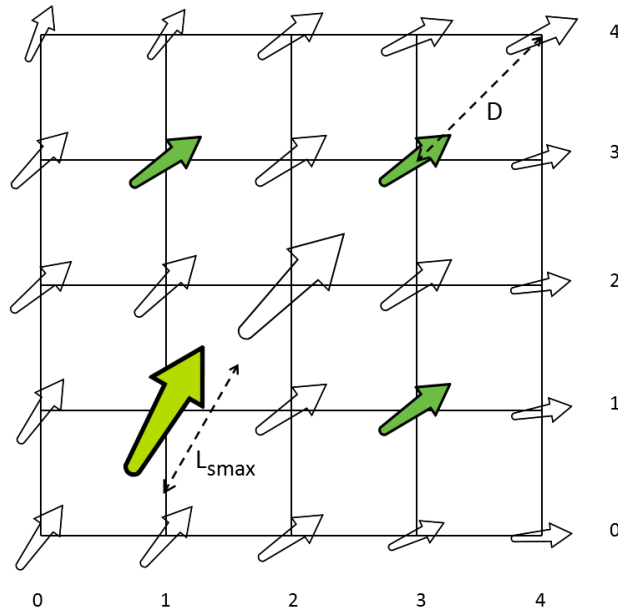
Figure C-6 - Grid thinned with *Rmax* = 0.5

For *Rmax* = 0.33, the formula for *n* yields:

$$n = 1 + \text{fix}\left(\frac{30.4}{36 \times 0.33}\right) = 3$$

and

$$\left.\begin{array}{l} x_k = x_0 \pm (3 \times k) \\ y_k = y_0 \pm (3 \times k) \end{array}\right\} \quad \text{for } k = 0, 1, 2, 3 \ldots$$

The results are shown in Figure C-7.
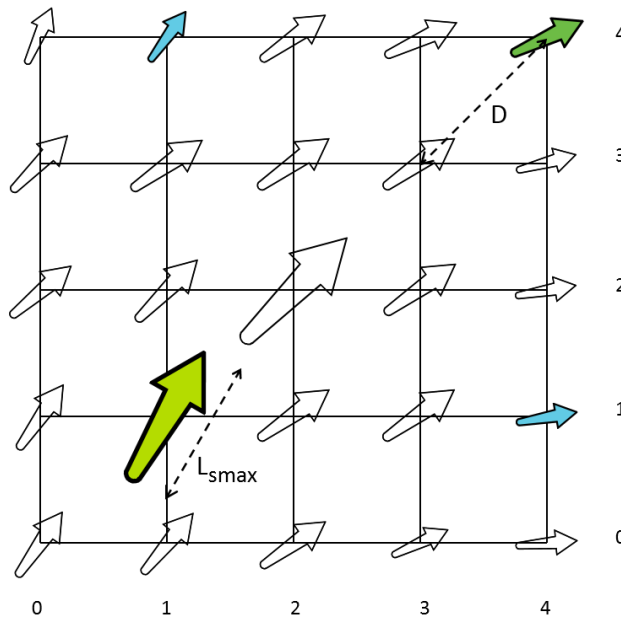
Figure C-7 - Grid thinned with *Rmax* = 0.33

The algorithm may hide significant characteristics of the data; for example, counting displayable rows and columns starting with the first instance of a maximised symbol may suppress significant information in nearby grid points and produce the wrong overall impression. In Figure C-6, row 2 would be suppressed even if all the data points in that row are of the same size as the symbol at (1,1) — this would suppress more data points with scaled-up symbols, which may represent data of more significance to the Mariner.

Grid diagonal as a measure of cell spacing is more suitable for grids where cell dimensions along both axes are approximately equal in display units (that is, in millimetres at the display scale); if there are significant differences, the D and $Rmax$ parameters will need to be different for the two axes.

Execution of this algorithm would be faster if the grid coordinates of the seed point *(x0, y0)* are known in advance, either encoded by the producer as instance metadata, or calculated when the dataset is ingested into the system. S-100 does not yet provide a standard way of encoding this information.

Manufaturers may extend or adapt this algorithm in various ways, for example:

- Adapt *Rmax* to the shape and proportions of the symbol (that is, its perceived effect on the display).
- For grids with cells whose dimensions in display units are very different along different axes, use different *D* and *Rmax* parameters for the two axes, giving different values of *n* for different axes.
- Pre-compute and cache the scale values where *n* changes, so that suppression or revelation of symbols can be determined by the scale of the display.
- Adapt the determination of the seed point to show as many significant values as possible.

In order to avoid confusing the mariner, reasonable consideration should be given to generally maintaining the regular appearance of the grid coverage, though some irregularity is probably unavoidable with greater thinning.

C-13.5.1.2   Irregularly gridded data

Thinning of irregularly-spaced symbols is more difficult. For each on-screen point the distance to all other on-screen points would have to be calculated, so that the closest point can be determined. The size and maximum dimension of the symbols at the point and its nearest point would be compared for overlap. If overlap occurred, one of the symbols would be eliminated. This procedure would be carried out for all on-screen points, keeping track of which points and their symbols had been eliminated.

An alternate solution would be to reduce the reference height of the symbol at its nomimal size or increase the reference values at which symbols are scaled. Caution may be needed with this approach to avoid giving the user the wrong impression about magnitudes of data values as the display is zoomed.

Another method, based on the assumption that non-regularly spaced data values are ordered in a nearly random manner, would be to reduce the number of symbols by plotting only every n^{th} vector. This method would require that the value of *n* be entered by the user.

C-13.6   Temporal variation

The metadata variables related to time are *dateTimeOfFirstRecord*, *dateTimeOfLastRecord*, *timeRecordInterval*, *numberOfTimes, timeIntervalIndex, timePoint, startDateTime,* and *endDateTime* (see S-100 Part 10c). The time selected for display (that is, past/present/future) will typically not correspond exactly to the timestamp (metadata variable *timePoint*) of the input data. For a correct display, the ECDIS will have to select the correct data.

For data with only a single timed record (where the timestamp of the earliest value equals that of the latest value) such as real-time data, the data values are displayed only if the display time is later than the timestamp and the absolute time difference between the display time and the data timestamp is less than a discrimination interval (for example 5 minutes). For a single record, the variable *timeRecordInterval* can be used to set the discrimination interval.

For data with multiple times, if the selected display time is later than the first timestamp and earlier than the last timestamp, or the selected display time is in the interval [*startDateTime, endDateTime]*, then the closest but immediately preceding values in the data are displayed. However, if the selected display time is earlier than the first timestamp, or outside the interval [*startDateTime*, *endDateTime*] then the data is not displayed. If the selected time is later than the last timestamp or after *endDateTime*, then data values

at that time are displayed only if the absolute time difference between the display time and the data timestamp is less than a discrimination interval (for example the value of the variable *timeRecordInterval*).

Some data change rapidly, so more-or-less continual revision or updating of such data is essential. For real-time observations, new values are periodically collected (for example, on the order of once every 5 minutes).

For a forecast, the entire field may be created one or more times per day.

New issues of real-time observations or forecasts may not be considered as new editions, but as new datasets. New datasets may be distinguished by a unique datetime in the file name.

New editions may be encountered in predicted time series data.

Other data, such as tidal atlas or harmonic constant data are updated much less often, typically on an annual basis.

The system should check for the availability of new data at a frequency that matches the update frequency.

C-13.7   Conflicting displays

Some Product Specifications may require that conflicting symbols be removed from the display. For example, S-111 states "When an S-111 dataset is displayed, symbols from the S-101 ECDIS nautical charting suite, in the area where the new data is displayed, must not be displayed. Such symbols include those for tidal stream tables (plus their points and boundary areas), flood and ebb tide stream arrows and their values and boundary areas, and other symbols for rip currents, eddies, breakers, and non-tidal currents."

In S-100 Edition 5.0.0 and earlier, implementing such requirements requires either customized processing (customized to the data product) or activation of interoperability (and that the Interoperability Catalogue contains an interoperability rule implementing the requirement).

C-14   Colours

C-14.1   General

In Portrayal Catalogues, colours are specified in one or both of CIE (Commission Internationale de l'Eclairage) or sRGB colour space coordinates[12]. CIE colour specifications use xy chromaticity coordinates and luminance L. The sRGB colour space (IEC 61966-2-1) defines colours in terms of the chromaticities of red, green, and blue primary colours.

The ECDIS colour scheme is based on specification of colour tokens and color conversion tolerances.

Note that these colour specifications apply to both the operational chart display (for route planning and route monitoring), and also to any text on the same screen as the chart display.

C-14.2   Selection of colours (informative)

Since chart and navigation lines and symbols must show clearly against the background shades, the colour palettes were constructed by first selecting the background area shades and then selecting colours for lines and symbols that contrast with their background. In selecting foreground colours for point and line features, lines and symbols, the aim has been to highlight important information by giving it greater contrast with the background.

In order to accommodate the very large change in bridge lighting between bright sun and dark night, the colours switch from a light background with dark foreground details, which has been found to give the best contrast under bright sun, to a dark background with light foreground details by night. The night

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[12] CSS files use hex RGB to specify colours. Colour profile files in portrayal catalogues use CIE and decimal RGB.

display has to be dim enough that it can be viewed without impairing the Mariner's night vision. The Dusk table is also a black-background table, for optional use by day as well as at twilight.

The design of both colours and symbols has concentrated on ensuring that important chart and navigation features remain clearly visible under the extremes of bright sun and dark night viewing.

C-14.3   The colour palettes

There are three colour palettes, all of which should be made available to the Mariner. They are specified as part of the colour profile file(s) in the Portrayal Catalogues. They are as follows:

DAY	The "Day" palette uses a white background as a result of a comparative test outdoors in bright sunlight which showed that a display background of maximum luminance gives the best contrast achievable under near-washout conditions. This conclusion has been confirmed by subsequent sea experience.
DUSK	The "Dusk" colour palette is based on using a black background; this palette may also be used by day as a Mariner's option.
NIGHT	The "Night" colour palette is intended for nighttime use. At night the light emitted by the display must be strictly limited to avoid impairing night vision. In case the luminance needs to be further reduced, the "Night" colour palette may be augmented by a luminance-reducing neutral density filter which should have 8 times attenuation, designated (logarithmically) "0.9 ND". (This is a manufacturer's option.)

C-14.4   Transparency

C-14.4.1   Use of transparency (informative)

Transparent area colour fill is used for the following purposes:
  (i)   So that the background colours, lines and symbols show through an area shade (for example, depth shades and contours should show through a traffic separation zone);
  (ii) To reduce the prominence of a large symbol (for example, too prominent a centred anchorage area symbol would cause clutter on the display);

When interoperability processing is activated, interoperability rules should take precedence over the purposes above in case of conflict; but if transparency for the above purposes can be used without overriding an interoperability rule, it should be used.

C-14.5   Colour assignment for navigation systems

C-14.5.1   Introduction to colours (informative)

Since chart and navigation lines and symbols must show clearly against the background shades, the colour tables were constructed by first selecting the background area shades and then selecting colours for lines and symbols that contrast with their background. In selecting foreground colours for point and line features, lines and symbols, the aim has been to highlight important information by giving it greater contrast with the background.

In order to accommodate the very large change in bridge lighting between bright sun and dark night, the colours switch from a light background with dark foreground details, which has been found to give the best contrast under bright sun, to a dark background with light foreground details by night. The night display has to be dim enough that it can be viewed without impairing the mariner's night vision. The Dusk table is also a black-background table, for optional use by day as well as at twilight.

The design of both colours and symbols has concentrated on ensuring that important chart and navigation features remain clearly visible under the extremes of bright sun and dark night viewing.

C-14.5.2   Colour assignments

The general colour assignment for navigation systems is provided below.

Colour	Usage
black/white	(black by day / white by night) is used for critical navigation features which need highlighting by contrast against their background to give them adequate prominence. Examples are the own-ship symbol, dangerous soundings equal to or less than the safety depth, buoys, conspicuous objects on land etc. It is also used for text, which is less clear in any other colour.
white/black	(white by day / black by night) as a background area shade is used for deep, safe, water.
magenta	is used to highlight critically important features such as isolated dangers, traffic routes, anchorages; and for restricted areas, submarine cables, gas pipelines etc. It is also used for aids to navigation and services such as daymarks, racons, and pilot stations.
grey	is used for many features which are black on the paper chart. It is used with thick lines for critical physical objects such as bridges and overhead cables, and with thin lines for important but less critical physical features such as non-dangerous soundings, sandwaves, overfalls, water pipelines and fish farms. It is similarly used for chart features such as fairways, harbour areas, tidal information and for information about the chart such as quality of chart data, overscale areas, etc.
grey	as a background area shade is used with a prominent pattern for no-data areas.
blue	as a background area shade is used to distinguish depth zones.
blue	as foreground colour for AIS and VTS information; also reserved for future requirements.
green	is used for the radar image and synthetics, and for buoy and lights colours.
blue-green	is used for transferred ARPA.
yellow-green	('moss-green') as a background area shade is used for the intertidal area between high and low waterlines.
yellow	is used as the manufacturer's colour; for the Mariner's transparent colour fill; and for buoy and lights colours.
red	is used for the important planned route, for the Mariner's danger highlight, and for buoy and lights colours.
orange	is the Mariner's colour, for notes, chartwork, chart corrections. The scale bar, north arrow, and Mariner's navigation objects such as EBLs and VRMs are also orange.
brown	as a background area shade is used for the land, and dark brown is used for features on land and in the intertidal area that do not have any strong significance for navigation.

Table C-26 - General colour assignments

C-14.6   Colour tokens, profiles and palettes

Colour tokens and colour profiles should be registered in the Portrayal Register in the IHO GI Registry prior to use in Portrayal Catalogues. The same colour tokens may be used by different data products. Product Specifications should use the same colour tokens as S-101 for feature types and sub-types that are conceptually similar to S-101 feature types.

The colours in this section are specifically designed for chart display.

Table C-27 lists colour tokens used in ECDIS displays and describes their roles and significance. This table is not a comprehensive list of colour tokens; see the colour profile files in the Portrayal Catalogues of individual products for the full list of colour tokens used by each product.

NOTE: This table is useful information for implementations and should be available to implementors for completeness. It should also be kept updated with information pertaining to other Product Specifications.

It is provided as part of this edition because there is at present no apparent provision for publishing it as a "living document". Future editions may replace it by a reference to a "living document" in the IHO GI Registry or on the IHO Web site.

Token	Colour, day/night	Usage	Significance
Colours for chart features			
CHBLK	black/grey	general	This selection of colours is used in general to design symbols and chart line features as well as fill styles. They are not used in cases where other colours are available for a special usage.
CHGRD	grey dominant	general	
CHGRF	grey, faint	general	
CHRED	red	general	
CHGRN	green	general	
CHYLW	yellow	general	
CHMGD	magenta, dominant	general	
CHMGF	magenta, faint	general	
CHBRN	brown	general	
CHWHT	white	general	
OUTLW	black	symbol outline on sea area background	These colours are used to outline symbols depending on which background they are normally shown (water/land).
OUTLL	pale/dark brown	symbol outline on land area background	
LITRD	red	red lights	Light symbols have their own colours to give the opportunity to influence their colour luminance individually. Yellow (LITYW) is used for white, yellow, orange and amber lights because it might be difficult to distinguish these colours from each other on a badly calibrated monitor. It also follows the tradition to show up white lights with a yellow flare or coloured arc.
LITGN	green	green lights	
LITYW	yellow	white/yellow/orange/amber lights	
ISDNG	magenta	isolated danger	Since the isolated danger symbol forms one of the most important items on the ECDIS screen, it is given a separate colour.
DNGHL	red	danger highlight	This colour is used for symbology that highlights Mariner selected dangers. The Mariner decides during route planning which features are highlighted by this colour.
TRFCD	magenta, dominant	traffic control features	

Token	Colour, day/night	Usage	Significance
TRFCF	magenta, faint	traffic control features	Traffic separation schemes are complex chart features. The navigator is confronted with important elements of the schemes and with less important elements as well. TRFCD is used to distinguish important traffic routeing features.
LANDA	brown	Land areas	This colour is used for land areas in general.
LANDF	brown	Landforms, land features	Landforms and land features are given a contrasting brown.
CSTLN	black/grey	Coastline, shoreline constructions	The coastline is a very important feature of the chart. If a radar image is combined with the chart picture it is required that coastline elements clearly show up on top of the green radar picture (see also RADHI/RADLO). To have full control over this combination under all conditions (day/night) a separate colour is reserved for coastline features.
SNDG1	grey	deep soundings > safety depth	This colour is used for soundings that are deeper than the selected safety depth ("safe" soundings).
SNDG2	black/white	shallow soundings <= safety depth	
DEPSC	grey	safety contour	This colour is reserved for the selected safety contour.
DEPCN	grey	depth contours	All depth contours other than the safety contour should use this colour.
DEPDW	white/black	deeper than selected deep contour	These are depth shades. The depth zones are:
DEPMD	pale/dark blue	safety contour to selected deep contour	• DEPDW: areas deeper than the Mariner-selected deep contour; • DEPMD: areas between deep contour and the Mariner-selected safety contour;
DEPMS	light/medium blue	shallow contour to selected safety contour	• DEPMS: areas between safety contour and the Mariner-selected shallow water contour;
DEPVS	medium/light blue	zero meter contour to shallow contour	• DEPVS: areas between shallow water contour and the low water line (zero meter contour);
DEPIT	yellow-green	high water line to zero meter contour	• DEPIT: areas between zero meter contour and coastline (intertidal).
			For route monitoring it may be desirable to distinguish only two water shades, plus DEPIT: deeper than own ship's safety contour and shallower than safety contour. In that case DEPDW and DEPVS should be used. At night it may be difficult to distinguish between DEPMD and DEPDW.
Radar image overlay colours			
RADHI	green	high intensity echo or single intensity echo	The radar image overlay can be generated by using either one intensity colour or a range of intensities. The colour for high echo intensity (RADHI) should be used where only one intensity is used. If you prefer to show more than one echo
RADLO	green	low intensity echo & target trail	

Token	Colour, day/night	Usage	Significance
			intensity or fading target trails, the corresponding colour intensities should be interpolated between the colour for high echo intensity (RADHI) and the colour for low echo intensity (RADLO). Optionally, the manufacturer may vary the radar green overlay by making it transparent.
ARPAT	green, dashed	ARPA, target symbols & information	Used for ARPA targets and information tagged on them.
Mariners' and navigation information colours			
SCLBR	orange	scalebar	Used to generate the scalebar.
CHCOR	orange	chart corrections	Hand entered chart corrections are marked by the colour.
NINFO	orange	Navigators Notes	Mariners' notes of any form (Symbols, Text) are generated using the colour.
ADINF	yellow	Mariners' transparent area fill and manufacturers' points and lines	
Ships symbol and planned route			
SHIPS	black/white	own ship, Course & Speed Made Good vector	
PSTRK	black/white	Past Track	
SYTRK	grey	Secondary Track	
PLRTE	red	planned route & notations	
APLRT	orange	alternate planned route	
Other colours			
RESBL	blue	AIS features and symbols	
RESGR	grey	reserved for line features & screened areas	
BKAJ1	black	black level test symbol background	
BKAJ2	grey	black level test symbol foreground	
TRNSP	100% transparent	transparent	This means a 100% "transparent" colour. This is not a "real" colour since it is invisible. Every pixel on the screen, which has the colour value 0 shows up as 100% transparent. In case the pixel was already painted with another (visible, for example black) colour this colour is not overwritten by the transparent colour. In

Token	Colour, day/night	Usage	Significance
			case the pixel was cleared before or not yet painted the "background" colour shows up (contrast to NODTA).
NODTA	grey	Areas without chart data	This colour shows up on every pixel on the screen, which is neither covered by chart features nor covered by other elements of the ECDIS display (for example radar overlay, user interface). Thus, it can also be called the "empty background colour" (contrast to TRNSP).
CURSR	orange	Cursor	In most graphic systems the cursor is treated as an item that can be handled completely independent from the graphic of the chart area. Therefore the cursor is given its own colour and it is kept separately from the other sections of the colour scheme. The cursor colour is also used by variable range marker (VRM), electronic bearing line (EBL), parallel indexing lines and other tools to perform absolute and relative measurements in the chart.
			[To be added - significant colour tokens for other "important" data products, taken from the Product Specifications, if they are defined there.]

Table C-27 - Significance of colour tokens for ECDIS displays

The active colour palette detemines the colour coordinates assigned to colour tokens in any particular display. Colour palettes for day, night, and dusk viewing conditions are required for S-101 and any other S-100 product intended for viewing on the navigation display.

C-15 Cursor Pick Reports and Displays in Interface Panels

ECDIS must be capable of performing spatial queries on ENC and other data during import and symbolisation. Spatial query is understood as possibility to inspect graphical position and numerical value of spatial coordinates associated with a charted feature. Spatial query could be available as by means of cursor pick or as an independent function.

It should be possible to step forward or backward in spatial chains.

C-15.1 Cursor pick rules

The rules below must be applied to all ECDIS cursor Pick Reports.
  (1) Full feature and attribute names should be displayed.
  (2) Spot selected on chart pane should be marked by symbols from IEC 62288.
  (3) Listed value names should be displayed.
  (4) There should not be any padding of attribute values, for example, a height of 10 metres should not be padded to 10.000000 metres as this could potentially confuse or mislead the Mariner.
  (5) Units of measure should be included after all attribute values which are weights or measures.
  (6) Cursor enquiry should extend to include both information associations and feature associations, including aggregations and compositions, which may link to information types or features that carry additional information such as a *featureName*.
  (7) Dates should be given in the form "Day Month Year" DD-MMM-YYYY.

  Month abbreviations should be: JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC.
  (8) The Pick Report should only return information about the visible features on the ECDIS display. If the viewing group is turned on all features even no symbol features without visible presentation within that viewing group are available via the cursor Pick Report.
  (9) Cursor enquiry should extend to the uncertainty of the spatial object, including attributes *qualityOfHorizontalMeasurement*, *verticalUncertainty*, and *horizontalPositionUncertainty* from an associated **Spatial Quality** information type.
  (10) The Pick Report should indicate the data product from which the information is extracted. Descriptive data product names or abbreviations as should be preferred if possible (for example, "ENC" or "Electronic Navigational Chart", not "S-101"). The Dataset Identification in the Product Specification and dataset discovery metadata in the Exchange Catalogue should contain this information.

Data from different products and viewing groups should be organized to facilitate navigation through complex reports in a manner logically consistent with the layering of products and groups on the screen.

C-15.2 Pick Report descriptions

A plain language explanation of each symbol is included in the Portrayal Catalogue. This gives the Mariner quick and understandable information which is not always obvious from the feature class and attribute information. The manufacturer should always provide explanations to the Mariner in response to a cursor pick on the symbol.

Attribute values provided in addition to the above explanation should be connected to their meaning, and the definitions should also be available. The definitions should be included in the XML Feature Catalogues for the data products.

C-15.2.1 User defined cursor pick parameters

The Mariner should be able to configure the content displayed in the Pick Report.

C-15.2.2   Sorting order of results

The Pick Report must be organized to facilitate navigation through complex reports in a manner logically consistent with the layering presented on the screen.

The order of features must correspond to the drawing order. Features must be prioritized using the top-most drawing instruction associated with the feature. Only active drawing instructions which intersect the pick area should be evaluated during sorting.

Results must be sorted by display plane, then within each display plane by drawing priority. When the drawing priority is equal the geometric primitive must be used to order the information, points followed by lines and finally areas.

C-15.2.3   Hover-over function

OEMs may wish to include hover-over functions for Mariners to access important charted feature details without having to select a Pick Report. If this function is implemented within an ECDIS, the Mariner should be able to configure the system to turn hover-over functionality on and off.

The hover-over function should only be used when indicated by a drawing instruction.

C-15.2.4   Unknown attributes

When the ECDIS encounters an unknown attribute not present in the product's Feature Catalogue its value should be available via the ECDIS cursor pick.

C-15.3   Cursor queries on coverage data

Cursor queries on continuous gridded coverage data should report the coverage feature's data values corresponding to the spatial location indicated by the cursor query. The data values reported should be those at the nearest data point for discrete coverages, or interpolated values for continuous coverages.

For discrete coverages, the data point from which the result is reported should be highlighted. Highlighting grid data points is not required for continuous coverages.

Depictions of results may be customized by the product specification or manufacturer, provided important information in other parts of the display is not obscured. For example, time series information may be depicted using a graph.

See clauses C-13.1 and C-13.2 for more information on methods and rules for cursor queries on coverage features.

C-15.4   Tidal stream data panels

When a **Tidal Stream Panel Data** feature is encoded within ENC, the data from the attributes should be formatted for display in the ECDIS cursor Pick Report. Table C-28 shows the template that should be used for displaying the values. (The "Hours" values should be the actual values in the *timeRelativeToTide* attribute.)

Tidal Station: (*station name*)			
Tidal Station Identifier: (*station number*)		Data From: (*data product, from dataset metadata*)	
	Hours	Direction of stream (degrees)	Rates at spring tide (knots)
Before	-6		
	-5		
	-4		
	-3		
	-2		
	-1		
(*reference tide*)	0		
After	+1		

	+2		
	+3		
	+4		
	+5		
	+6		

Table C-28 - Template for tidal stream values

Table C-29 below relates an exemplary S-101 **Tidal Stream Panel Data** feature and its attributes to its display. S-101 has modelled the tidal stream panel data as a series of complex attributes. Complex attributes are in italics and encoded values are in blue text.

<table>
<tr><th colspan="4">Tide Stream Panel Data (feature)</th><th>Example of ECDIS depiction</th></tr>
<tr><td colspan="2">Station name</td><td colspan="2">PLYMOUTH (DEVONPORT)</td><td rowspan="38">
Tidal Station: PLYMOUTH (DEVONPORT)

	Hours	Direction of stream (degrees)	Rates at spring tides (knots)
Before	-6	113	0.1
	-5	332	0.6
	-4	331	1.1
	-3	342	1.0
	-2	347	0.7
	-1	333	0.5
high water	0	317	0.3
After	+1	178	0.3
	+2	146	0.6
	+3	140	1.0
	+4	143	1.1
	+5	143	0.8
	+6	138	0.3

Tidal Station Identifier: 0014 — Data from: ENC
</td></tr>
<tr><td colspan="2">Station number</td><td colspan="2">0014</td></tr>
<tr><td colspan="4">Tide stream panel values</td></tr>
<tr><td colspan="2">Reference tide</td><td colspan="2">high water</td></tr>
<tr><td colspan="2">Reference tide type</td><td colspan="2">springs</td></tr>
<tr><td rowspan="3">Tide stream value</td><td>Orientation</td><td>Orientation Value</td><td>113</td></tr>
<tr><td colspan="2">Time relative to tide</td><td>-6</td></tr>
<tr><td colspan="2">speed maximum</td><td>0.1</td></tr>
<tr><td rowspan="3">Tide stream value</td><td>Orientation</td><td>Orientation Value</td><td>332</td></tr>
<tr><td colspan="2">Time relative to tide</td><td>-5</td></tr>
<tr><td colspan="2">speed maximum</td><td>0.6</td></tr>
<tr><td rowspan="3">Tide stream value</td><td>Orientation</td><td>Orientation Value</td><td>331</td></tr>
<tr><td colspan="2">Time relative to tide</td><td>-4</td></tr>
<tr><td colspan="2">speed maximum</td><td>1.1</td></tr>
<tr><td rowspan="3">Tide stream value</td><td>Orientation</td><td>Orientation Value</td><td>342</td></tr>
<tr><td colspan="2">Time relative to tide</td><td>-3</td></tr>
<tr><td colspan="2">speed maximum</td><td>1.0</td></tr>
<tr><td rowspan="3">Tide stream value</td><td>Orientation</td><td>Orientation Value</td><td>347</td></tr>
<tr><td colspan="2">Time relative to tide</td><td>-2</td></tr>
<tr><td colspan="2">speed maximum</td><td>0.7</td></tr>
<tr><td rowspan="3">Tide stream value</td><td>Orientation</td><td>Orientation Value</td><td>333</td></tr>
<tr><td colspan="2">Time relative to tide</td><td>-1</td></tr>
<tr><td colspan="2">speed maximum</td><td>0.5</td></tr>
<tr><td rowspan="3">Tide stream value</td><td>Orientation</td><td>Orientation Value</td><td>317</td></tr>
<tr><td colspan="2">Time relative to tide</td><td>0</td></tr>
<tr><td colspan="2">speed maximum</td><td>0.3</td></tr>
<tr><td rowspan="3">Tide stream value</td><td>Orientation</td><td>Orientation Value</td><td>178</td></tr>
<tr><td colspan="2">Time relative to tide</td><td>1</td></tr>
<tr><td colspan="2">speed maximum</td><td>0.3</td></tr>
<tr><td rowspan="3">Tide stream value</td><td>Orientation</td><td>Orientation Value</td><td>146</td></tr>
<tr><td colspan="2">Time relative to tide</td><td>2</td></tr>
<tr><td colspan="2">speed maximum</td><td>0.6</td></tr>
<tr><td rowspan="3">Tide stream value</td><td>Orientation</td><td>Orientation Value</td><td>140</td></tr>
<tr><td colspan="2">Time relative to tide</td><td>3</td></tr>
<tr><td colspan="2">speed maximum</td><td>1.0</td></tr>
</table>

Tide stream value	*Orientation*	Orientation Value	143
	Time relative to tide		4
	speed maximum		1.1
Tide stream value	*Orientation*	Orientation Value	143
	Time relative to tide		5
	speed maximum		0.8
Tide stream value	*Orientation*	Orientation Value	138
	Time relative to tide		6
	speed maximum		0.3

Table C-29 - Example of tidal stream panel data and its ECDIS display

C-15.5 Schedules, contact Information, and vessel characteristics

[Templates to be developed.]

C-15.6 Special Pick Report formats

Some Product Specifications may require or suggest specific layout and contents for Pick Reports (examples are shown in Figure C-8). Since there is at present no generic format for defining such custom Pick Reports, manufacturers will need to develop their own solutions.
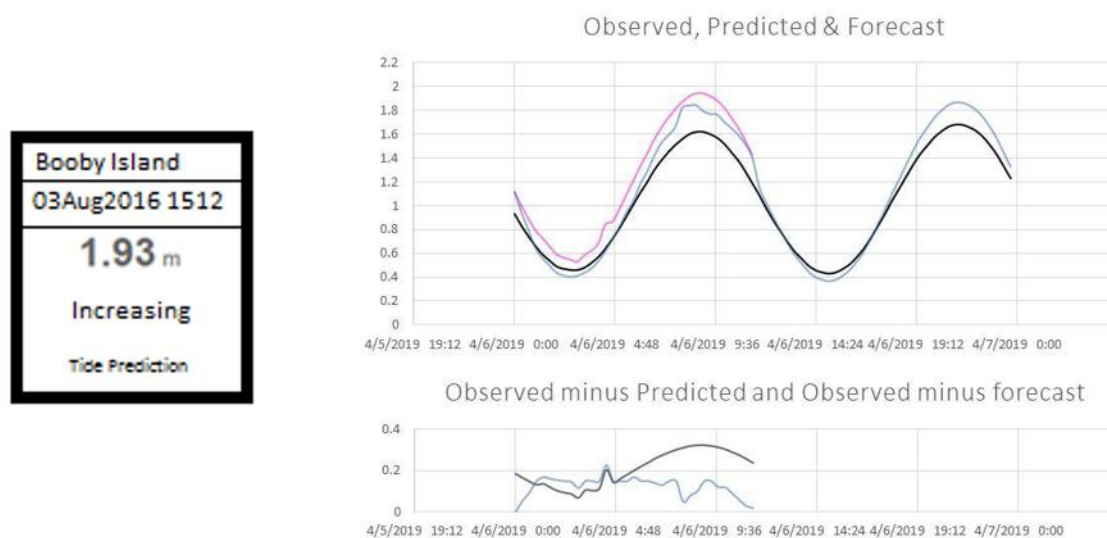
Figure C-8 - Examples of special formats: Water level at a station (L) and graphic showing time series of water level data (R)

C-16 Alerts and Indications

IMO Resolution MSC.232(82) states in 11.3 and 11.4 and their sub-paragraphs how an ECDIS should respond to risk of crossing, dangers, prohibited areas or areas with special conditions. Appendix 4 and Appendix 5 of the same resolution provide details about the areas for which an ECDIS should detect incursions and provide an alert or indication.

All Product Specifications which are intended for navigation should specify any feature combinations that match one or more of the areas for which alarm or indication should be given to ensure there is a harmonized implementation of alarms and indications in navigational products. Such specification could be done using a machine-readable Alerts and Indication Catalogue.

C-17   Use of Context Parameters

The Portrayal Register in the IHO GI Registry contains a list of predefined context parameters used in S-100 Portrayal Catalogues. Manufacturers may add additional parameters, but should not change the names, roles, or data types or predefined parameters, or substitute other parameters of the same scope.

The Portrayal Catalogue for a product contains the set of known parameters which may be used in the portrayal processing for that product. This set may be different for different products[13]. Context parameters are used for passing portrayal-related configuration information and user settings to portrayal processing, and the values of context parameters may therefore be changed by user functions, including those defined in the IMO Performance Standards, in this document, or manufacturers' custom user functions.

In order to be able to use the official Portrayal Catalogue for a data product, manufacturers must implement all the context parameters listed in the Portrayal Catalogue. The context parameters used in a Portrayal Catalogue are listed in the **<context>…</context>** section of the Portrayal Catalogue XML file.

Context parameters may be added or removed by updates to the Portrayal Catalogue. Context parameters which cannot be automatically associated with ECDIS display functions or user interface features must be exposed to the Mariner for use.

C-17.1   Context parameters for ECDIS functionality

Context parameters are used in Portrayal Catalogues for implementing mandatory and optional ECDIS functionality mandated by the IMO Performance Standards. Since they are used by rules in the IHO Portrayal Catalogue, they should be implemented without change by manufacturers in order to maintain compatibility with the IHO Portrayal Catalogue.

C-18   Dual-fuel systems

Dual-fuel systems are systems that use both older (pre-S-100) and newer (S-100) data products that contain the same type of information (for example, S-57 and S-101 ENCs).

All stakeholders should anticipate a transition period during which new S-100 formats increasingly replace older formats.

An S-100 ECDIS must be able to handle both S-57 and S-101 ENCs during the transition period.

C-18.1   Display of data available in both new and legacy formats

In general, systems should give newer formats priority over the older formats, and utilise data from the older format only when there is no coverage of the new format data at an appropriate scale (that is, when the display scale is out of the scale bounds in dataset metadata).

S-101 ENC data should always be given priority over S-57 ENC data when both S-101 and S-57 ENCs provide data coverage at the Mariner's set display scale.

The question of handling simultaneous display of data in old and new formats is still to be addressed by the IHO at the time this document is being written. In the interim, systems should:

1)   Indicate when the screen is displaying older-format data.
2)   Indicate the boundary between new and old-format datasets if both new and old formats are being simultaneously displayed (one part of the screen is displaying new-format data and another old-format data).

---

[13] For example, S-101 (ENC) requires the parameter "Safety Depth", but S-123 (Marine Radio Services) does not encode any depth information and therefore cannot use "Safety Depth", so it may not be listed in S-123 Portrayal Catalogues.

3) Anticipate that the portrayal of newer formats aligns with the portrayal of the older formats during the transition period, so that dual-fuel capable systems will not show significant differences in portrayal of what is essentially the same data in different formats or between different regions where S-100 adoptions are occurring at different paces.

C-18.2   Display of additional information layers

The display of additional information layers is generally driven by mariner need. The Interoperability Catalogue concept for ECDIS (see S-100 Part 16 and S-98) is based on using S-101 ENCs as the base layer. Therefore, in areas without S-101 ENC data, manufacturers and data producers should expect additional information layers to be displayed as overlays over S-57 ENC data.

The converse is also allowed - data in legacy formats may be displayed as overlays over S-101 data.

In both cases, the applicable requirements in the IMO Performance Standards must still be met, especially requirements about not degrading the route monitoring display.

C-18.3   Concurrent applicability of S-52 and S-57

Dual-fuel capable systems should continue to use the principles defined in S-57 and S-52 for the presentation of chart data that conforms to S-57 instead of S-101. The principles in S-101 and this Annex should be concurrently applied where S-101 data is displayed. This includes the case where one part of the chart window has S-101 data as the chart layer and another has S-57 data as the chart layer - S57/S-52 apply to the portion where S-57 data is the chart layer and S-101 and this Annex apply where S-101 data is the chart layer.

Overlays of S-100-based non-ENC data over S-57 chart data are left to manufacturer discretion, pending development of guidance by the IHO. Where S-100-based non-ENC datasets are overlaid over S-57 data, they should be treated as "additional information" in the sense of IMO MSC.232(82), including the requirement to avoid degrading the display of ENC information. Activation of the new functionalities described in this Annex for screen regions where S-100 data is overlaid over S-57 ENCs is left to manufacturer discretion, pending the development of guidance by the IHO. For example, S-98 interoperability need not be implemented in the absence of an S-101 base layer, but graphical indexes can still be displayed for non-ENC S-100 products and thinning for an S-111 (Surface Currents) grid can still be applied even if it overlays S-57 data.

MSC.232(82) and other applicable IMO standards continue to apply to the "S-57 portion" of the display, and, in the absence of updated IMO standards specifically for S-100-based data, also to the "S-101 portion" of the display. The IEC standards should continue to be used for testing, with necessary extensions to test for the "S-101 portion" of the display, pending IEC update of the IEC standards for S-100-based displays and this Annex.

This Annex is designed to allow such integrated displays. Note in particular:

- The IMO functions continue to be used. This Annex describes their applicability to S-100-based data and defines additional functions for S-100-based data. Any additional functions that apply only to S-100-data should be deactivated for S-57 data.
- The IMO display categories and viewing groups for S-57 data are carried over into this Annex and include the same feature information for each group as in S-52.
- Where S-101 changed S-57 modelling, the replacement features have been assigned to the same viewing group as before.
- Features that are wholly new in S-101 compared to S-57 are assigned to new viewing groups.
- Features from new non-S-101 data products are assigned to new viewing groups.
- The principles for chart furniture and miscellaneous display elements (scale boundaries, limits of data, safety contour, depth zones, update identification, legend, etc) are the same in S-52 and this Annex.
- Additional functionalities such as graphical indexes, data quality indication, etc, are independent of the legacy/modernised nature of the information. To minimise clutter and maximise compatibility with legacy data, the functionalities for modernised data are defined so they can

act on/with only ENC data in the first place, and on/with other S-100-based data only upon additional or different operator action. For example, the graphical indexes requirement (clause C-12.2) is separated into sub-requirements, one for ENCs and the other for other S-100-based products.

- The names of colour tokens are the same. (Future versions of this Annex may add additional colour tokens, but should retain the S-52 set.)

Note that some things required for complete compatibility of S-57/S-52 and S-101 presentations cannot be controlled in this Annex, depending as they do on the harmonisation of Portrayal Catalogues with S-52 symbology, colour tables, and lookup tables. Among these are the shapes and dimensions of symbols and the colour coordinates assigned to colour tokens.

C-19 Type approval considerations

Manufacturers, type-approval authorities, and above all Mariners, are always encouraged to contact the IHO over any improvements, criticisms, questions or comments that they may have about the ECDIS display, in order that the Specifications can be kept effective and up to date.

C-20 Specifications for the display screen

C-20.1 Physical display requirements

The requirements for the main graphic display are:

Size:	Minimum effective size of the area for chart display: 270 x 270 mm (IMO MSC 232(82) 10.2).
Resolution:	Minimum lines per mm (L) given by L=864/s, where s is the smaller dimension of the chart display area. (e.g. for the minimum chart area, s=270 mm, the resolution L = 864/270 = 3.20 lines per mm, giving a "picture unit" size of 0.312 mm)
Colours:	64

The specifications above permit a chart display whose minimum resolution (lines/mm) may vary depending on the size of the display. Maintaining a clearly readable chart display under this flexibility imposes certain requirements on the display software, which are described in clause C-10.2.

Information should be displayed in the ECDIS on one or more physical screens, which may be divided into more than one chart display. Information may be displayed automatically, on demand or as a result of Mariner's selection.

The physical size of the screen(s) should be appropriate to viewing conditions. Larger screens may be more suitable for situations where the operational viewing distance is higher, because the larger physical area of the display offsets the reduction of on-screen geographical extent that is caused by the greater zoom levels and symbol sizes necessitated by greater viewing distances.

Redraw during route monitoring to follow the ship's progress, including scale changes due to change in the scale of the chart information, should take less than 5 seconds. Demands by the Mariner that cannot be predicted by the ECDIS, such as draw at a different scale or in a different area may take more than 5 seconds. In the latter case:

- The Mariner should be informed;
- The display should continue route monitoring until the new information is ready to draw within 5 seconds.

C-20.2 Colour reproduction

Absolute accuracy in colour reproduction is not required but relative colour fidelity is important. To ensure clear contrast between colour-coded features the display screen should be calibrated before use, and this calibration should as far as possible be maintained while in service. If this is not done, lines, symbols, and area shades may become indistinct, and information may then be lost or become misleading.

C-20.3   Display requirements for colours

[Content is from the following sections of S-52 6.1.1:

4.1   General

4.2   Colour Assignment: Content directly under this S-52 heading is now in clause C-16.2 (Selection of colours (informative) and will not be repeated here.]

4.2.2   Bright Sunlight or Night viewing - Use of filters, etc.

4.2.3   Display calibration and verification.

4.2.4   Colour control; contrast and brightness controls.

4.2.4.1 Effect of controls.

4.2.4.2. Use of the controls.

4.2.4.3. Initial setting of the controls.

4.2.4.4. Re-adjustment of the controls.

4.2.4.5. Setting the controls for route monitoring.

Section 4.2.6 (The colour scheme - colour tokens) has been rewritten as "C-14.2" and section 4.2.7 (Transparency) is included as "C-14.4 Transparency" and those sections will not be repeated here.]

C-20.3.1   General

The ECDIS manufacturer can use any technology to build the display as long as their display fulfils the requirements of this Specification.

C-20.3.2   Bright sunlight or night viewing - use of filters, etc

The information-carrying capability of the ECDIS display is curtailed at the extremes of bright sunlight and night viewing. The reasons, and some remedies, are described in this section.

Bright sun. Some of the strong ambient light on the bridge is reflected off the back of the display screen face plate and arrives at the Mariner's eye mixed with the light generated by the monitor which carries the image of the ECDIS display. This display image is further diluted by light entering the Mariner's eye directly from the brightly-lit bridge. The effect is to make the display look washed out; contrast between features may be severely reduced. In the extreme case of sunlight shining directly on the screen, no information at all will be visible. In addition, reflections on the face of the monitor from objects close to the screen, particularly a Mariner's white shirt, may mask parts of the display.

The ECDIS display should be situated where direct sunlight will not shine onto it, nor into the eyes of the mariner looking at it. A visor around the face of the screen may help. A filter may also help, (because it attenuates the sunlight twice, both when incident and when reflected, whereas the monitor image is attenuated only once). Low attenuation neutral density filters may be used, such as a 2 times attenuation filter designated (logarithmically) "0.3 ND". Polarised filters should be an advantage. Ideally, the bridge windows should have glare reducing glass and the inside of the bridge should have non-reflecting paint.

Night. The need to preserve night vision requires that the illumination from the screen be reduced to a lower level than is desirable from considerations of clear viewing. The light level from night colour tables is below that which provides full contrast capability. Consequently some area-fill colours are indistinguishable on the night display, as noted in S-52 Edition 6.1.1 section 3.2.2 (2), and colours of lines may be difficult to distinguish.

An additional problem for a CRT type of monitor is that the R,G & B guns of the CRT may drop to the cut-off point at these very low DAC (digital to analog converter) voltages, particularly on an ageing CRT. Because good quality neutral filters reduce illumination without significantly affecting colour, and even tend to enhance contrast their use is recommended for the night display.

C-20.3.3   Display calibration and verification

The ECDIS display should be calibrated initially in order to transform the CIE colour table coordinates to screen coordinates. The main components of the ECDIS display are the monitor and the image generator. Both the monitor and the image generator used to drive the ECDIS display can be calibrated

together as a colour generating unit. Another alternative is to calibrate separately both the monitor and image generator.

The following international standards describe methods for calibration of a monitor's RGB values to produce an output. Other methodologies may be followed, but the same verification test requirements apply regardless of method.

> CIE 122-1996 *Technical Report: The Relationship between Digital and Colorimetric Data for Computer-Controlled CRT Displays.*
>
> IEC 61966-3:2000 *Multimedia systems and equipment -Colour measurement and management - Part 3: Equipment using cathode ray tubes*, Edition 1.
>
> IEC 61966-4:2000 *Multimedia systems and equipment-Colour measurement and management – Part 4: Equipment using liquid crystal display panels*, Edition 1.

The ECDIS display calibration should be verified for type approval of all monitors. Colour control, contrast and brightness controls

There are a variety of technologies available for monitors to be used for ECDIS display. Different technologies have different methods to control colour, contrast and brightness, but some basic rules apply for all of them.

C-20.3.3.1   Effect of controls.

The contrast control of a display generally shortens or extends the range of luminance available, making the display appear darker or brighter.

On the other hand, the brightness control shortens or extends the range of colour saturation available by adding white (which extends the range by making colours other than black less saturated), or subtracting white (colours become darker, more saturated.)

To the viewer, it has much the same apparent effect as contrast, but it achieves this by altering the colour contrast of the colour tables between foreground and background colours, and this may result in some features becoming harder to see, particularly at night. More importantly, making the night display more saturated may drop some dark colours below the cut-off point, into black, thus losing distinctions such as shallow versus deep water.

C-20.3.3.2   Use of the controls.

Colour tables are provided for day, dusk and night. The mariner should be provided with the control to make fine adjustments between these tables; the calibration position should be marked as a reference for this.

For a CRT type of monitor the brightness control should be pre-set; that is, used only when essential, with provision to return to the calibrated setting. LCD and other monitor technologies have a variety of controls. The general principle is that all available controls should have a provision to return to the calibrated settings and that only appropriate controls should be made available for the Mariner.

The ECDIS manual should carry a warning that careless use of the display controls may adversely affect the visibility of information on the display.

C-20.3.3.3   Initial setting of the controls.

The controls should be set up in preparation for initial calibration, and their positions marked at that time (for example, by a detent) so that they are recoverable.

C-20.3.3.4   Re-adjustment of the controls.

In case the controls go out of adjustment in use, they may be re-adjusted on-board ship by means of the Colour Differentiation Test Diagram described in clause C-20.5 and provided by the IHO.

C-20.3.3.5   Setting the controls for route monitoring

The ECDIS display carries far more detail than a radar display, and requires correspondingly more attention to the correct selection of colour table and the correct adjustment of the controls.

This particularly affects the black-background displays, and is critically important at night, because all colours of the night table, particularly those for large areas, have to be set very dark to avoid loss of night vision, and if the control is turned down too far these colours will disappear into the black background. As a result, chart information will be lost.

The situation will be worse if one of the day tables is improperly dimmed for use at night, instead of switching to the night table.

It is important that the display be adapted to lighting conditions on the bridge by selecting the correct colour table: "Day" for bright sunlight; "Day" or "Dusk" for general daylight viewing; "Dusk" for twilight; and "Night" for the night-darkened bridge.

The controls should only be used for fine adjustment within the appropriate colour table.

To ensure that the controls are always set to a level above that at which information will be lost, the black-adjust symbol BLKADJ should be available to the Mariner, treated as "Standard display", to be called up at any convenient point on the screen. The instructions for its use by the Mariner should be incorporated in the "Users instructions" for the ECDIS.

Below is an example of instructions for a CRT type of Monitor:

> 1. First, set contrast to a maximum, brightness to a minimum. Look at the black-adjust symbol. Then either:
>
> 2A. If the centre square is not visible, turn up the brightness until it just appears;
>
> or
>
> 2B. If the centre square is clearly visible (with contrast at maximum, brightness at minimum), turn the contrast down until the inner square disappears, then turn contrast back up until the inner square is just visible again.

(If the above adjustment is not successful, select a more appropriate colour table and repeat this procedure.)

The "black level" is now correctly set. If a brighter display is required use the contrast control, but it is better not to re-adjust the controls unless lighting conditions on the bridge change.

Note that the black-adjust symbol should be displayed to check that the inner square remains visible on the following occasions:

- Every time that the brightness or contrast controls are adjusted.
- Every time that the display is switched to the night colour table.

Below is an example of instruction for LCD type of Monitor. The LCD type of monitor used in this example has only one mariner control, which is called brilliance. Internally the monitor has also other controls available for service engineers. These internal controls include also controls named as contrast and brightness.

> 1. First, set brilliance to calibration position. Look at the black-adjust symbol.
>
> Then either:
>
> 2A. If the centre square is not visible, turn up the brilliance until it just appears;
>
> or
>
> 2B. If the centre square is clearly visible, turn down the brilliance until the inner square disappears, then turn brilliance back up until the inner square is just visible again.

(If the above adjustment is not successful, select a more appropriate colour table and repeat this procedure.)

The "black level" is now correctly set. If a brighter display is required use the brilliance control, but it is better not to re-adjust the controls unless lighting conditions on the bridge change.

Note that the black-adjust symbol should be displayed to check that the inner square remains visible on the following occasions:

- Every time that the brightness or contrast controls are adjusted.
- Every time that the display is switched to the night colour table.

It is recommended that the BLKADJ symbol be displayed automatically all the time that the night colour table is selected, with a Mariner over-ride to remove it if necessary.

C-20.4   Colour display capability

Colour displays should be capable of at least 256 luminance steps in each of red, green and blue.

For night performance it is essential that the hardware has a graphics card capable of giving "blacker than black"; that is, complete control of colour, and that the software can control that function.

For CRT type of monitor cathode (beam) current stabilisation is desirable, to prevent dark colours dropping below the cut-off point.

C-20.4.1   Colour conversion tolerances and tests

C-20.4.1.1   Tolerances

The tolerances quoted below apply only to the process of converting CIE colour coordinates to RGB values, and so should be evaluated shortly after the ECDIS leaves the manufacturer's plant.

Considerable operational experience will be needed before it will be possible to state colour maintenance tolerances for ECDIS on-board ship.

The colour tables developed have been selected to ensure maximum colour discrimination between features. Colour discrimination depends on both the colour difference and the luminance difference between two colours. Colour science (as represented by the CIE colour convention) has defined colour difference units ΔE^*. The ΔE^* metric is a measure of the overall discrimination (including both colour and luminance differences). As a metric for ECDIS colour accuracy, a measure of the discrimination in colour alone, excluding luminance differences has been defined as a subset of ΔE^* referred to as $\Delta(u^*,v^*)$.

$$\Delta(u^*,v^*) = \text{SQRT} [(u2^*-u1^*)2 + (v2^*-v1^*)2]$$
$$\Delta E^* = \text{SQRT} [(L2^*-L1^*) + (u2^*-u1^*)2 + (v2^*-v1^*)]$$

Calculations of L^*, u^*, and v^* must be made using as reference the chromaticity and luminance specified for the brightest white colour token in the respective colour table (Y0, u0, y0); where Y0 is the luminance in units of cd/m2. Note: this is not the brightest white of the monitor.

Note: "Δ" represents the Greek letter "Delta", although it may appear differently on some computers.

The tolerances for the conversion of the colour tables from the CIE colours defined in these specifications to the actual RGB values for the ECDIS CRT are defined in three terms:

   1. Overall discrimination between actual colours within the converted table: ΔE^*. This is to ensure that all the colours within the RGB table remain discriminably separate; that is, that the relative colour distinctions have been maintained.

   2. Colour discrimination differences between the defined and the actual values: $\Delta(u^*,v^*)$. This is to ensure that the actual RGB colours resulting from the conversion remain reasonably close to the CIE colours defined in the specifications; that is, that the blues stay blue and the greens stay green.

   3. Luminance differences between the defined values and the actual values: L. This is to ensure that the luminance remains the same within acceptable limits.

Note: The CIE L*u*v* human perception colour model, which is the source of the tolerances described above, has not yet been evaluated at the low luminances of the night colour table, at which the less colour-sensitive rods of the eye take over from the daytime cones. Consequently these tolerances should not be applied to the night table; and for type-approval purposes they are restricted to the bright sun table.

Colour tolerance values:

1. The discrimination difference between any two colours displayed (except those with a tabular ΔE^* less than 20) should be not less than 10 ΔE^* units.

Token	Colour (x, y, L)	Token	Colour (x, y, L)	ΔE*
DEPMD	(.27 .30 65) pale blue	CHWHT DEPDW UIBCK	(.28 .31 80) white	11
CHBRN	(.42 .45 30) brown	ADINF	(.41, .47 35) yellow	14

DEPMS	(.24 .26 55) medium blue	DEPVS UIAFD	(.22 .24 45) medium blue	17
DEPMD	(.27 .30 65) pale blue	CHGRF NODTA (S-52 Ed 3.3 colours have greater ΔE)	(.28 .31 45) faint grey	18

Table C-30 - Tolerance exceptions

2. The difference between the colour displayed and the CIE colour defined in these specifications should be not greater than 16 Δ(u*,v*) units. If a monitor is independently tested, then the difference must not be greater than 8 Δ(u*,v*) units.

3. The luminance of the colour displayed should be within 20% of its specified value. Black is a special case and the luminance of it must not be greater than 0.52 cd/m² for bright sun colour table.

C-20.4.1.2 Instrumental calibration verification test

For CRT displays, an instrumental test to check that the results of the colour conversion calibration are within tolerance should be made by displaying the colours of the Day colour table (restricted to colour pairs of tabular ΔE* greater than 20); measuring their CIE coordinates x,y and L; and applying a tolerance test. For LCD displays the instrumental test should be applied to all three colour tables.

Note that since the tolerance test is intended solely to check successful colour calibration, and not to test colour maintenance at sea, this test should be performed on the bench in the manufacturer's or type-approval authority's plant under normal conditions of temperature, humidity and vibration.

Manufacturers of ECDIS can choose between two different methods of colour calibration.

The first method is a test of a monitor as part of an integrated system. In this method both the monitor and the image generator parts of ECDIS display are tested together.

The second method is an independent test of the monitor. In this method the monitor and the image generator of ECDIS display are separately tested against a reference (that is, the monitor is tested against a reference image generator and the image generator is tested against a reference monitor). The second method has tighter tolerance for displayed colour than the first method (see clause C-20.4.1.1).

C-20.5 Colour differentiation test diagram

A multi-purpose colour differentiation test diagram is illustrated in Figure C-9. This consists of 20 squares each coloured with one of the 4 main background colour fills (such as shallow water blue); and each having a diagonal line in one of the six important foreground colours (such as mariner's orange). Each diagonal line is 0.64mm.

The diagram is in the form of a dataset and so can be displayed using any of the three colour palettes. This diagram is intended:

1) For use by the Mariner to check and if necessary re-adjust the controls, particularly for use at night;

2) For use by the Mariner to verify that an ageing display remains capable of providing the necessary colour differentiation; and

3) For initial colour verification of the day, dusk and night colour tables.

Both the Colour Test Diagram and the instructions for its use (see clause C-20.7) should be made available to the Mariner.

In addition, a grey scale is described in clause C-20.7 for use by maintenance technicians in checking colour tracking in an ageing display.

The Colour Differentiation Test diagram is intended for use off-line. It is not needed during route monitoring.

Note that the Colour Differentiation Test Diagram will not be true to colour unless it is projected on a calibrated screen and is generated using the digital format provided by IHO, which correctly reproduces the colour tokens of the Presentation Library.

The colour differentiation diagram is required in "Day" and "Dusk" colours so that the Mariner can verify that the ECDIS display monitor has the colour differentiation capability needed to distinguish between the various colour-coded areas, lines and point symbols of the ECDIS display. Both diagrams will be provided online by the IHO and should be downloaded by manufacturers for supply with ECDIS software. The diagrams will not be true to colour unless they are projected on a calibrated monitor and are generated in a manner which correctly reproduces the colour tokens.
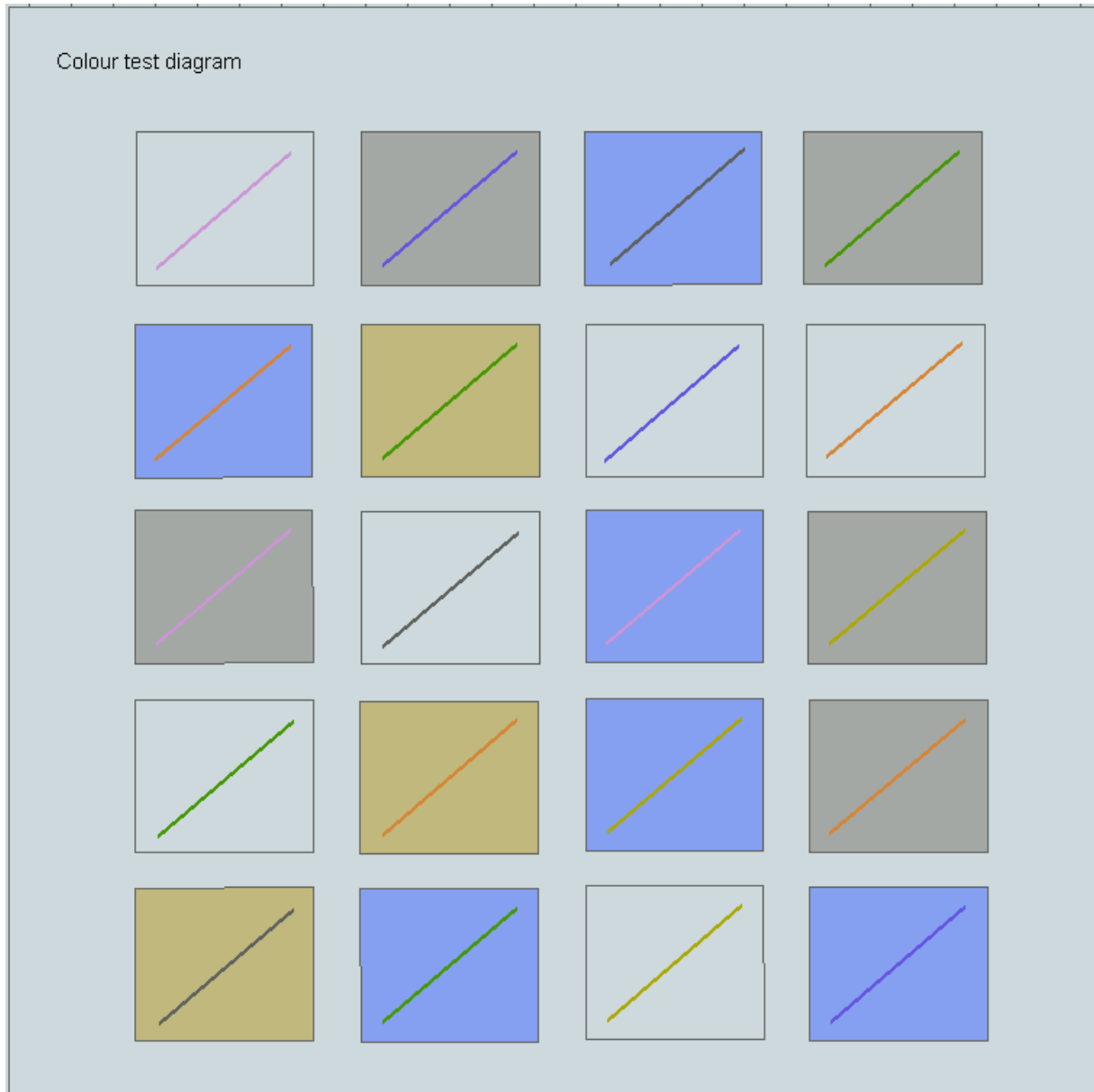

Figure C-9 - Colour differentiation diagram - Day

[NOTE: For illustrative purposes only. The diagrams from the IHO web site should be downloaded for testing.]

C-20.6   ECDIS Chart 1

The IHO provides ECDIS Chart 1 in digital form, a graphical index of ECDIS symbols including both simplified and paper-chart point symbols; and also the symbolized lines and area boundary linestyles.

This is intended to familiarize the Mariner with the colour and symbol coding used by the ECDIS. The symbols are grouped according to INT1, which is familiar to the Mariner, but are numbered with a look-up sheet, not labelled. Manufacturers should provide linking by cursor interrogation between the symbols and the explanations given in ECDIS Chart 1.

Since Product Specifications for data products used on ECDIS will be updated at different times, there will be a supplementary "Chart 1" for each data product other than ENC that is intended for use in ECDIS.

The ECDIS Chart 1 and its supplements are intended for use off-line and in route planning. They are not needed during route monitoring, when the Mariner can use cursor enquiry to find the meaning of symbols.

The ECDIS Chart 1 and its indexing list of symbol names and meanings arranged numerically, together with the colour differentiation test diagrams, are intended for the Mariner's use. The use of the Colour Differentiation Test Diagrams is described in C-20.5. A separate plot of symbols arranged alphabetically and an indexing list of symbol names and meanings arranged alphabetically will be provided for the manufacturer's use.

Note that because colour printing and copying is not completely true to the original, a hard-copy version of Chart 1 does not accurately represent the colour requirements of the IHO Colour and Symbol Specifications.

In addition, symbol size may change in copying. To ensure correct size, all symbols illustrated must be scaled by the factor required to make symbol CHKSYM01 measure 5mm by 5mm.

C-20.7   Use of ECDIS Chart 1 and Colour Test Diagram

C-20.7.1   Specification for ECDIS Chart 1 and the Colour Test Diagram

C-20.7.1.1   Definition (for this specification only)

A Chart 1 dataset must be displayed so as to fill all of the standard ECDIS display area (that is, the minimum 270 x 270 mm chart area).

C-20.7.1.2   Description and purpose

The ECDIS Chart 1 and the Colour Differentiation Test are diagrams for use by the Mariner which are provided in the form of ENC-like files.

The ECDIS chart 1 is intended to familiarise the Mariner with the symbology used on ECDIS. The Mariner must be able to display each cell, and by cursor-pick get a read-out of the meaning of any symbol shown.

The Colour Differentiation Test diagram is intended for display using the day or dusk colour tables so that the Mariner can check that the ECDIS monitor is providing adequate colour performance. It is also used in type-approval testing. Instructions for its use are given in the sections below.

The ECDIS Chart 1 includes the CHKSYM which is intended for checking the correct size of the symbols during the type approval. The width and height of the CHKSYM is 5.0 mm.

The line width of the diagonal line in the Colour Differentiation Test diagram is specified as 0.6 mm wide. The line width must be checked during the type approval.

C-20.7.1.3   Mode of use

These diagrams are supplementary features of the ECDIS, intended for use off-line or during route planning. Because they occupy the entire display they must not be used during route monitoring. If the Mariner needs to find the meaning of a symbol during route monitoring, they must use cursor-picking.

The operation of these diagrams is not subject to the draw-speed requirements of route monitoring.

C-20.7.1.4   Content and Encoding

[Add description after the datasets have been updated for S-100.]

C-20.7.1.5   Revisions

Revisions will be made by whole file replacement; that is, by issuing a new edition.

C-20.7.1.6   Packaging

The data files may be downloaded from the IHO web site.

C-20.7.1.7   Presentation

The README files give some specific Mariner settings, such as safety contour, that are required to give the correct display.

The ECDIS Chart 1 and Colour Test diagram cells must be displayed full-screen (meaning the "minimum standard" screen, 270 x 270 mm), that is at or larger than the compilation scale. Otherwise features such as centred symbols may not be correctly illustrated.

The Mariner must be able to cursor-pick on any symbol on the Chart 1 display and get a text read-out of the symbol meaning.

C-20.7.2   Displaying the Colour Test Diagram

C-20.7.2.1   Introduction; providing the diagram

The colour generating capability of any type of display screen will deteriorate with age and the Colour Differentiation Test diagram is provided to enable the Mariner to verify that the display screen still retains the colour differentiation capability needed to distinguish between the various colour-coded areas, lines and point symbols of the ECDIS display.

The diagram will not be true to colour unless it is projected on a calibrated monitor and is generated using the ENC colour profiles.

Two methods of providing the diagram are:

a) Use the file labelled "C1WOO" containing the Colour Differentiation Test Diagram. This file must be drawn so that the extent of the imaginary chart data covers the entire ECDIS display. Because the file uses pseudo-cartographic objects it must be displayed using the special Portrayal Catalogue provided for the digital ECDIS Chart 1.

b) Use the graphics file illustrated in Figure C-9 as a model. Based on this model, reproduce the same pattern of rectangles and lines on the screen, but present them in the correct colours using the colour tokens given in the S-101 colour profiles provided by the IHO.

The diagram consists of twenty numbered squares extending over the whole of a 270 x 270 mm screen. Each square is coloured with one of the four main background area shades (such as shallow water blue, DEPVS), and each carries a two-pixel wide diagonal line in one of the important line or symbol foreground colours (such as planned route red, PLRTE). These are arranged as follows:

Four main background colours:

DEPVS	(shallow water blue)	squares 3, 5, 11, 15, 18, 20.
DEPDW	(deep water, white or black)	squares 1, 7, 8, 10, 13, 19.
LANDA	(land colour)	squares 6, 14, 17.
NODTA	(no data shade: radar, navigation safety lines and chartwork must be visible on the no-data part of a display)	squares 2, 4, 9, 12, 16.

Six important foreground colours:

DEPSC	(safety contour grey)	squares 3, 10, 17.
NINFO	(orange, Mariner's information)	squares 5, 8, 14, 16.
ADINF	(yellow, manufacturer's information)	squares 12, 15, 19.
TRFCD	(magenta, traffic lanes and area boundaries)	squares 1, 9, 11.
RADLO	(the lower luminance radar green)	squares 4, 6, 13, 18.
RESBL	(blue, provisionally reserved for traffic info from transponder, VTS etc.)	squares 2, 7, 20.

Note: Remember that a TIFF, PDF or other source will not be true to colour unless it has been specifically modified to access the colour tokens and colour tables used by the ECDIS.

C-20.7.2.2 Test description

The dusk and night tables should be checked subjectively by means of the colour differentiation test diagram, which is provided as an S-101 file (.tif file diagrams must not be used for this purpose), as follows:

(1) The person carrying out the test should have passed the Isihara colour blindness test, or other test used to qualify bridge watch keepers, and should adapt to night viewing for 10 minutes before checking the night display;

(2) The controls should be set to their calibrated settings;

(3) While the display is off, adjust the ambient light reflected from white paper positioned on the display screen to the following values:

Colour profile	Light level
Day	200 cd/sq. m
Dusk	10 cd/sq. m
Night	darkness (the ECDIS display is the predominant light source)

Preferably use natural daylight for the day table;

(4) Under each of the above conditions, display the appropriate colour differentiation test diagram for the colour profiles.

Select each table in turn and ensure that:

- Each foreground diagonal line is clearly distinguished from its background; and
- The foreground lines representing yellow, orange, magenta (purple), green, blue and grey may be clearly identified.

C-20.7.2.3 Using the diagram

The Colour Test must be applied on the day and dusk colour tables.

Before the Colour Test diagram is used, the black-adjust symbol BLKADJ01 must be brought up on the screen and the contrast and brightness controls (or equivalent controls for an LCD) must be adjusted as follows:

1. First, set contrast to a maximum, brightness to a minimum. Look at the black-adjust symbol. Then either:

2A. If the centre square is not visible, turn up the brightness until it just appears;

or

2B. If the centre square is clearly visible (with contrast at maximum, brightness at minimum), turn the contrast down until the inner square disappears, then turn contrast back up until the inner square is just visible again.

(If the above adjustment is not successful, select a more appropriate colour table and repeat this procedure).

The "black level" is then correctly set. If a brighter display is required use the contrast control, but preferably do not adjust the controls unless lighting conditions on the bridge change.

The test consists of being able to distinguish the background colours and to pick out the like foreground colours, that is to say that squares 3, 5, 11, 15, 18 and 20 all have a shallow water blue background, and that squares 3, 10 and 17 have a grey line.

Note: The test above uses the black-adjust symbol for the purpose of a type approval test. The other purpose of the black-adjust symbol BLKADJ01 is to allow the Mariner to adjust the display for ambient illumination on the bridge of a ship. An ECDIS must have the black-adjust symbol displayed whenever the mariner is adjusting the display (that is, depending on the technology of the display brilliance, brightness, contrast, etc), as required by clause C-20.3.

C-20.7.3 Grey Scale

A grey scale may be used by service technicians to detect display ageing or other display performance issues.

Eight grey strips are recommended, spaced between the minimum and the maximum luminance for each of the five mandatory colour tables.

The bit levels or signal levels producing the grey levels are evenly spaced from the level producing white to the level producing black. In order to select the appropriate grey level from a large set of available grey levels, use one of the following models:

1) Bit Levels in Software: Given n levels of grey that can be displayed on a screen, with 0 for black and $w = n - 1$ for white. We want to select a subset of m levels that are as evenly spaced as possible. The interval between the n levels to create m levels is $\Delta V = w/(m-1)$, which may not be an integer. So, the levels to select are the (integer) values of $V_i = int[(i-1) \Delta V]$ for $i = 1, 2, ...,$ m, or $V_i= 0, int(\Delta V), int(2\Delta V), int(3\Delta V), ..., int[(m-1) \Delta V]$, with $int[(m-1) \Delta V] = w$ for white. For example, if there are $n = 256 = 2^8$ levels from which we select $m = 8$ levels, white is $w = 255$; the interval is $\Delta V = 36.4286$, and the chosen levels are: 0, 36, 73,109, 146, 182, 219, 255.

2) Analog Signal Levels: For analog signals, if Vw is the white level and Vb is the black level, then for m levels the signal step size is $\Delta V = (Vw - Vb)/m$ and $V_j= Vb + j\Delta V$.

C-21   Dataset Management

This clause covers dataset management on the ECDIS to the extent that it affects the user experience and portrayal processing.

C-21.1   Multiple product versions and portrayal

The ECDIS must be able to carry and use multiple versions of the Feature Catalogue for a product. Catalogue management is based on the version number of the Product Specification and Catalogues. For example, the ECDIS will need to carry all valid Catalogues that are used for datasets that have been produced from an earlier edition of a Product Specification; but may retire a superseded version after the last such dataset has been cancelled.

See Appendix C-2 for loading and ingest processes including SSE Codes relating to Product Specification and Interoperability Catalogues.

IHO Publication S-97 recommends that the versioning of Product Specifications follow the same rules as S-100, which uses a three-part version number (*Edition.Revision.Clarification*). The significance of each component is summarised below.

- Edition: New Editions introduce significant changes, such as the ability to support new functions or applications; or the introduction of new constructs or data types. New Editions are indicated by incrementing the *Edition* component of the version number and resetting the other components to 0.

- Revision: Revisions introduce substantive semantic changes. Changes in a Revision ensure backward compatibility with previous versions within the same Edition. A Revision, for example, may introduce new features and attributes, but will not delete a feature or attribute. New Revisions are indicated by incrementing the *Revision* component of the version number and resetting the *Clarification* component to 0.

- Clarification: Clarifications are non-substantive changes. Typically, Clarifications remove ambiguity; correct grammatical and spelling errors; amend or update cross references; and/or insert improved graphics, spelling, punctuation and grammar. Clarifications must not cause any substantive semantic changes. Changes in a Clarification are minor and ensure backward compatibility with the previous versions within the same Edition. Clarifications are indicated by incrementing the Clarification component of the version number.

The consequences for portrayal are:

1) It should be possible to process datasets conforming to an earlier Revision within the same Edition, with the Feature and Portrayal Catalogues for the latest Revision in that Edition.

2) It should be possible to process datasets conforming to an earlier Revision or Clarification within the same Edition with the Feature and Portrayal Catalogues for the latest.

3) A Portrayal Catalogue for a new Clarification can always rely on earlier versions of the Feature Catalogue within the same Edition. (Note that an old Feature Catalogue cannot be relied on for

processing the dataset for a newer Revision. That is OldDataset+OldFC+NewPC is processable, but NewDataset+OldFC+NewPC is not.)

4) It should be possible to process datasets conforming to a Clarification with the Feature and Portrayal Catalogues for an earlier Clarification within the same Edition and Revision.

5) The significance of changes to only a Portrayal Catalogue (without a concomitant change to the Product Specification or Feature Catalogue) can be more difficult to classify (as a New Edition, Revision, or Clarification), because in addition to data model semantics, human factors effects for user interfaces and IMO guidance about compatibility, text abbreviations, etc, must also be considered.

In general, the IHO and/or Type Approval Authority should be consulted to determine the significance of the change. This also applies to Revisions planned by Project Teams.

C-21.2   Dataset overlaps and gaps

C-21.2.1   Overlaps and gaps in ENC coverage

There may be cases where ENCs in the same scale range overlap. Such may be the case at agreed adjoining producer data limits, where, if it is difficult to achieve a perfect join, a 5 metre overlapping buffer zone may be used.

Where an overlap of two or more datasets exists the ECDIS must only display one dataset for the overlap area and provide a permanent and persisting indication "overlap".

Similarly, there may cases be where gaps in ENC coverage exist.

C-21.2.2   Overlaps and gaps in other data products

Overlaps in datasets of the same scale range in products other than the ENC should be indicated by a non-permanent indication "Overlap in ??? data" (where ??? is the abbreviation for the data product). If interoperability has been activated, the Interoperability Catalogue may have a rule to break the tie, in which case an indication is not needed.

Coverage gaps in products other than the ENC can be expected and should not be indicated.

C-21.3   Guidance on updating S-100 datasets on ECDIS

C-21.3.1   Introduction

In a previous Edition (3rd Edition, December 1996), S-52 Appendix I provided guidance for the updating service and the ECDIS to support the updating of ENCs issued through a Regional ENC Coordinating Centre (RENC). Following a HSSC-requested review by the ENC Updating Working Group (EUWG), guidance related to ENC updates production by HOs and their distribution was mainly integrated into Edition 2.0.0 of IHO publication S-65 *ENC Production, Maintenance and Distribution Guidance* and Edition 3.0.0 of IHO Publication S-57 Appendix B.1, Annex A *Use of the Object Catalogue for ENC*. Beginning with Edition 4.0.0 (April 2012), S-52 Appendix I was limited to describing guidance for the processing of automatic and manual ENC updates by ECDIS.

The current Editions of S-57 and S-65 continue to apply to the production and data delivery for S-57 ENC updates. S-52 Appendix I continues to apply to the processing of S-57 updates on ECDIS.

The guidance in S-52 Appendix I has been updated for S-100 datasets on ECDIS and is provided in clauses C-21.3.2–C-21.3.5 below. Except for C-21.3.5 (support file updates), which is a new requirement for support files, and the addition of language relating to authentication, the requirements are the same as S-52 Edition 6.1.1 with the language updated to include data products other than ENCs.

Some products may require or permit the use of data protection. Whether data protection has been applied to a dataset can be determined from the dataset discovery metadata in the exchange catalogue file (see S-100 Part 17). Digital signatures and authentication are described in S-100 Part 15. The protection method is indicated in dataset discovery metadata (S-100 Part 17; it should also be documented in individual Product Specifications. At present there is only one method specified in S-100, which is described in Part 15. S-100 Part 15 should be referenced for authentication and integrity checks.

C-21.3.2   General requirements

a) **Data Integrity**. The ECDIS should be able to process updates to S-100 data products without degradation of the information content of the dataset or dataset update. For example, all information regarding attributes, logical relationships, geometry, and topology must be accounted for.

b) **Verification of Application**. The ECDIS should provide a method to ensure that updates have been correctly applied to the SENC (or other appropriate database for products held outside the SENC). Those updates are either an official data product update integrated into the SENC display; an update to non-official products installed on the system; or temporary information that was entered manually.

c) **Integrated/Non-integrated Updates Distinction**. Updates should be clearly distinguishable on the display. Once accepted, integrated updates to ENCs should be indistinguishable from ENC data. Non-integrated updates (that is, those entered manually) shall be distinguishable as described in clause C-12.11.1. Updates to non-ENC data shall be treated as described in C-9.1.3 and C-12.11.4.

d) **Storage Separation**. ECDIS should store all updates separately from the original datasets. However, such separate storage may utilize the same data storage device.

e) **Recall for Display**. It should be possible on demand to review previously installed updates.

f) **Compatibility**. Updates to S-100 products must comply with the applicable Product Specification.

g) **Non-interference**. ECDIS should be able to receive updates without interfering with its current operation.

h) **Log File**. ECDIS should keep a record of updates, including time of application and identification parameters described in the applicable Product Specification, through a log file. The log file should contain, for each update applied to or rejected by the SENC, the following information:

   .1 date and time of application/rejection;

   .2 complete and unique identification of update as described in the applicable Product Specification;

   .3 any anomalies encountered during application;

   .4 type of application: manual/automatic.

i) **Update out of sequence**. The ECDIS should warn the user when an update is applied out of sequence, terminate the update operation and restore the SENC as it was before the application of the update file.

NOTE (informative): Sequences are determined by the update and Edition numbers, not by issue date and time. However, sequential updates should have issue date/time combinations that are consistent with the sequence of updates as determined by the update and Edition numbers. Issue date/time are given in dataset discovery metadata in the Exchange Catalogue (see S-100 Part 17). Note that time is optional. Note also that it is possible for the date/time for two or more consecutive updates to be the same - in fact for data that are frequently updated, such as water levels, the date will be the same for many consecutive datasets.

C-21.3.3   Automatic Update

a) **Interface**

   (i) **Fully Automatic Updates**. The ECDIS should be capable of being interfaced to an appropriate telecommunication network.

   (ii) **Semi-automatic Updates**. The ECDIS should be capable of receiving official updates in standard IHO format by CD-ROM and from any other interface or data storage media that are provided with the ECDIS for that purpose and through telecommunication.

b) **Reception of Updates**

   (i) Update data shall be recorded automatically in the update storage of the ECDIS.

   (ii) The identification of the Issuing Authority of the update should be checked for conformance with the corresponding identifier of the dataset being updated.

(iii) If any errors are detected from the receiving device, the reception procedure shall be terminated and the update flagged invalid in the record of updates. The user should be informed of the corruption.

c) **Sequence Check**. The following sequence number checks should be performed at the time of application, for sequential and cumulative updates:

.1 File extension of the update;

.2 Update number of the update;

.3 Update sequence number of the individual records in the update. Refer to the relevant Product Specification for details on how the sequence numbers are encoded in the update.

d) **Authentication and Integrity Check**. If the Product Specification uses data protection and therefore requires the use of digital signatures, the ECDIS should authenticate updates using the applicable procedures. In some cases, updates that do not pass the authentication and integrity check should not be applied. The user should be informed of any authentication anomalies. Update authentication-related messages for the user may be combined or throttled to avoid flooding the user, but should all be logged in the log file (see appendix C-2).

e) **Consistency Check**. The mariner should be warned of any previous updates which have not been successfully applied.

f) **Geographic Applicability**. Updates not relating to a dataset within the set of datasets in the ECDIS may be discarded.

g) **Summary Report**. A summary report for each of the Issuing Authority's official update files should be given after completion of receipt containing at least:

.1 Identification of Issuing Authority;

.2 Update numbers of the update files;

.3 Dataset Identifiers of datasets affected;

.4 Edition number and date of dataset involved;

.5 Number of updates in the affected dataset.

h) **Review of ENC Updates**. It should be possible for the Mariner to review the updates applied through displaying the SENC contents with the updates highlighted.

i) **Modification of Updates**. Rejection or amendment of an update by the Mariner shall be achieved by the manual update method. The questionable update should be noted as an anomaly in the Log File (see clause C-21.3.2(h)).

j) **Formatted Non-integrated Updates**, for example a temporary military exercise area, will be processed as manual updates.

k) **ECDIS Update Status Report.** It should be possible for the user to inspect and demonstrate the up to date status of all datasets held within the ECDIS against a complete list supplied by a service provider. Details of the required update status reports for both electronic chart and nautical publications datasets are given in Appendix C-3

C-21.3.4   Manual Update

a) **Keying and Symbology**. The ECDIS should enable manual entry of updates for non-integrated presentation on the display. A capacity should exist to enable the mariner to:

.1 Enter the update so it can be displayed as described in this Annex.

.2 Ensure all update text information relevant to the new condition and to the source of the update, as entered by the Mariner, is recorded by the system for display on demand.

b) **Indications and Alarms**. The ECDIS should be capable of sensing indications and alarms related to non-integrated (manual) updates, just as it does for integrated updates.

c) **Presentation**. Manual updates shall be displayed as described in this Annex, clause C-9.7.

d) **Text**. It should be possible to enter text into the ECDIS.

e) **Archiving of Manual Updates**. It should be possible to remove from the display any manual update. The removed update should be retained in the ECDIS for future review until commencement of the next voyage, but will not be otherwise displayed.

C-21.3.5 Support file updates

When a feature pointing to a text, picture or application file is deleted or updated so that it no longer references the file, the ECDIS software should check to see whether any other feature references the same file, before that file is deleted.

C-21.4 New editions, re-issues, and updates of datasets

The method for detecting whether a dataset is a New Edition, re-issue, cancellation, termination, or update is contained in the Exchange Set metadata field S100_Purpose.

The default treatment of each is described below; note that individual Product Specifications may not implement all types of dataset state. All datasets include an issue date, and optionally an Edition and update number.

- New dataset – install new dataset and any included updates and record for tracking purposes.

- New Edition – replace numbered old Edition and its updates with the New Edition. The information in clause C-13.6 about the use of New Editions and re-issues for certain coverage data products should be kept in mind

- Update – apply the numbered update and retain for tracking purposes. See C-21.3. Where updates cannot be applied a permanent indication "Chart information not up to date" shall be available in the chart display area when such a chart is in use (either displayed on chart area or used as largest scale available for chart related alerts and indications). This is also covered by the ECDIS Update Status Report, Appendix C-3.

- Re-issue - replace the original datasets and its updates up to the date of the issue with the reissued dataset. Retention of the old issue should be as specified in the Product Specification. The information in clause C-13.6 about the use of New Editions and re-issues for certain coverage data products should be kept in mind. After a re-issue, subsequent updates may be incorporated from this reissue or from the original data kept continuously updated.

- Cancellation – delete the cancelled dataset and its updates. The system shall report any dataset(s) that have been identified as cancelled at load time. A message shall be displayed informing the user of the dataset name. Depending on the method adopted by the OEM for managing cancelled datasets one of the following conditions must be observed: (1). The cancelled dataset cannot be viewed in the ECDIS; (2). The cancelled dataset can be viewed in the ECDIS with the warning message specified "Dataset <name> has been cancelled and may not be up to date. Under no circumstances should it be used for primary navigation".

- Termination - delete the terminated dataset and its updates.

Keep in mind the guidance about updating support files (C-21.3.5) when replacing or deleting a dataset.

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Appendix C-1
Relationship to S-52
(informative)

C-1-1   Relationship to S-52 provisions

The table below describes the relationship between the operative clauses in S-52 and this Annex.

S-52 clause(s)	New clause(s)	Notes
1 Introduction		Divided between Part 16a and this Annex
1.2 Concept and Limitations of ECDIS	C-4.2	Also in Part 16a
2. Organising the Display	C-9	
2.1 General Considerations		
2.1.1 Design Considerations		
2.1.2 The diversity and flexibility of ECDIS		
2.1.3 Colour discrimination…		
2.2 Operational Considerations		
2.3 Organising the Display		

Table C-1-1 - Relationship to S-52

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Appendix C-2
S-100 Data Import Error Codes and Explanations
(informative)

Loading, Updating, Authentication and Decryption error codes and messages are defined in this section.
It is expected that application developers may also support the error conditions with an appropriate error message.

When an error occurs, this can in some instances, prevent further processing of data.

Error Code	Error Message
SSE 101	*Self Signed Key is invalid*
SSE 102	*Format of Self Signed Key file is incorrect*
SSE 103	*Signed Data Server Certificate is invalid*
SSE 104	*Format of SA Signed DS Certificate is incorrect*
SSE 105	*SA Digital Certificate (X509) file is not available. A valid certificate can be obtained from the IHO website or your data supplier*
SSE 106	*The SA Signed Data Server Certificate is invalid. The SA may have issued a new public key or the dataset may originate from another service. A new SA public key can be obtained from the IHO website or from your data supplier*
SSE 107	*SA signed DS Certificate file is missing. A valid certificate can be obtained from the IHO website or your data supplier"*
SSE 108	*SA Digital Certificate (X509) file incorrect format. A valid certificate can be obtained from the IHO website or your data supplier*
SSE 109	*Dataset Resource Digital Signature is invalid*
SSE 110	*Dataset Permits not available for this Data Server. Contact your data supplier to obtain the correct permits.*
SSE 111	*Dataset Permit not found. Load the permit file provided by the data supplier.*
~~SSE 112~~	*~~Dataset Permit format is incorrect. Contact your data supplier and obtain a new permit file.~~*
SSE 113	*Dataset Permit is invalid (checksum is incorrect) or the Dataset Permit is for a different system". Contact your data supplier and obtain a new or valid permit file.*
SSE 114	*Incorrect system date, check that the computer clock (if accessible) is set correctly or contact your system supplier.*
SSE 115	*Subscription service has expired. Please contact your data supplier to renew the subscription licence*
~~SSE 116~~	*~~ENC CRC value is incorrect. Contact your data supplier as ENC(s) may be corrupted or missing data.~~*
SSE 117	*User Permit is invalid (checksum is incorrect). Check that the correct hardware device (dongle) is connected or contact your system supplier to obtain a valid User Permit.*
SSE 118	*HW_ID has incorrect format*
~~SSE 19~~	*~~Permits are not valid for this system. Contact your data supplier to obtain the correct permits~~*
SSE 120	*Subscription service will expire in less than 30 days. Please contact your data supplier to renew the subscription licence*
SSE 121	*Decryption failed no valid dataset permit found. Permits may be for another system or new permits may be required, please contact your supplier to obtain a new licence*
SSE 122	*One or more of the SA Digital Certificate or Domain Controller certificates (X509) have expired. A new SA public key can be obtained from the IHO website or from your data supplier*
SSE 123	*Non sequential update, previous update(s) missing try reloading from the base media. If the problem persists contact your data supplier*
SSE 124	*~~Dataset Signature format incorrect, contact your data supplier~~*
SSE 125	*The permit for dataset < name> has expired. This dataset may be out of date and MUST NOT be used for Primary NAVIGATION*

SSE 126	*This Dataset is not authenticated by the IHO acting as the Scheme Administrator*
SSE 127	*Dataset <dataset name> is not up to date. A New Edition, Re-issue or Update for this cell is missing and therefore MUST NOT be used for Primary NAVIGATION*
	[Added for S-100 Support]
SSE128	*Error installing <file name>. The format or content could not be validated and it could not be installed*
SSE129	*This Catalogue is not authenticated by the IHO acting as the Scheme Administrator*
SSE130	*Warning: Dataset <dataset name> is not up to date. A New Edition or Update for this cell is missing*
SSE131	*Error: No Feature Catlaogue or Portrayal Catalogue could be found for dataset <dataset name>*
SSE132	*Signature Path can not be validated. One or more of the Domain Controller or SA digital certificates is missing or invalid*
SSE133	*Version mismatch between <dataset> and <catalogue>. Only <catalogue version> is supported for data of this type (<product>)*
SSE134	*This Exchange Set is not authenticated by the IHO acting as the Scheme Administrator*
SSE135	*This Permit file is not authenticated by the IHO acting as the Scheme Administrator*

Table C-2-1 - Error codes and messages

SSE 101 must be returned when a self signed key (SSK) cannot be validated against the public stored as part of the SSK. The data server must check that its own SSK is valid before sending it to the SA. The SA will confirm the data server SSK before returning the SA signed data server certificate.

SSE 102 must be returned if the SSK is wrongly formatted or if mandatory elements are missing. SA and data servers must complete this check.

SSE 103 must be returned if the Signed data server certificate does not authenticate correctly against the SA public key or any Domain Controller Intermediaries. This validation process must be carried out by the SA or Domain Controller before supplying it to the data server. The data server must also validate a received certificate. The data client must validate the digital signature against any file prior to its use.

SSE 104 must be returned if the SA signed data server certificate is wrongly formatted. This must be carried out by the data server on receipt from the SA.

SSE 105 must be returned if there is no SA certificate installed on the data client.

SSE 106 must be returned if the SA digital certificate (public key) does not validate against the following:

- SA digital certificate will not validate against the SA public key.
- One or more of the Domain Controller certificates do not validate against the SA certificate.

SSE 107 must be returned if the SA signed data server certificate is not available to the data server for checking or is not present in the Exchange Set Catalogue file when the data client attempts to authenticate it.

SSE 108 must be returned if the SA public key held in the SA digital certificate is wrongly formatted or the certificate file is unreadable.

SSE 109 must be returned if any resources (dataset or supplementary file) in the Exchange Set Catalogue do not authenticate against the SA authenticated data server public key or Domain Controller authenticated public key contained in the Exchange Set Catalogue metadata.

SSE 110 must be returned if there are no dataset permits available for a particular data server corresponding to encrypted data within the Exchange Set being loaded.

SSE 111 must be returned if there are no permits installed on the system for a required dataset.

~~**SSE 112** must be returned if the dataset permits are formatted incorrectly.~~

SSE 113 must be returned if the calculated CRC of an individual dataset permit does not validate against the CRC held in that cell permit. [Data Clients] This may be a HW_ID problem, corruption during transmission or the permits are for a different system.

SSE 114 must be returned if the system date does not agree with the date obtained from any alternative, reliable date source; for example, GPS. [Data Clients]

SSE 115 must be returned if the expiry date of the dataset permit has an earlier date than that obtained from the validated system date. [Data Clients]

~~**SSE 116** must be returned if the calculated CRC value of the ENC (after decryption and uncompressing) does not validate against the corresponding CRC value in the CATALOG.031 file. This also applies to the unencrypted signature, text and picture files. [Data Clients] NO CRCs]~~

SSE 117 must be returned if the CRC contained in the User Permit does not validate against the calculated CRC of the extracted HW_ID. [Data Servers]

SSE 118 must be returned if the if the decrypted HW_ID extracted from the User Permit is incorrectly formatted. [Data servers]

~~**SSE 119** must be returned if the HW_ID stored within the hardware/software security device cannot decrypt the cell permits being loaded or already installed on the system. [not used anymore]~~

SSE 120 must be returned if the subscription licence is due to expire within 30 days or less.

SSE 121 must be returned if a valid dataset key (decryption key) cannot be obtained from the relevant dataset permit to enable the system to decrypt the corresponding dataset.

SSE 122 must be returned if the SA Digital Certificate or any of the intermediate Domain Controller Certificates have expired. Expired is when the X.509 *"Valid to"* date in the certificate is older than the validated system date.

SSE 123 must be returned if a dataset update being imported is not sequential with the latest update already contained in the SENC for any given dataset. Under these conditions the update process (for the dataset) must be terminated and the ECDIS is to display a warning when the dataset is displayed stating that it is not up to date and should not be used for navigation.

SSE 125 must be returned if the stored permit for any given dataset has expired. It should be possible to view the dataset but a permanent warning message must be displayed informing the user; for example, *"The permit for dataset <name> has expired. This dataset may be out of date and MUST NOT be used for Primary NAVIGATION"*.

SSE 126 must be returned if a signed resource (dataset, catalogue or permit) in an Exchange Set is authenticated against a certificate or public key file stored on the Data Client other than the one provided by the SA. In a chain of digital signatures the root certificate must be the SA certificate.

SSE 127 must be returned if the status of the dataset being viewed is not up-to-date in respect of the latest installed S-128 Catalogue dataset loaded or maintained on the system. A permanent warning message must be displayed on screen informing the user; for example, *"dataset <cell name> is not up to date. A New Edition, Re-issue or Update for this dataset is missing and therefore MUST NOT be used for Primary NAVIGATION"*.

SSE 128 must be returned if one or more dataset resources (datasets, catalogues or permits) could not be loaded because the contents could not be validated according to the versions of the (XML) Schemas installed on the system. Only conformant content may be loaded onto any S-100 system.

SSE 129 must be returned if the Catalogue to be installed (Feature, Portrayal or Interoperability) has not been directly authenticated by the Scheme Adminstrator.

~~**SSE 130** must be returned if the status of one or more non-ENC datasets or supplementary files being viewed is not up-to-date in respect of the latest installed S-128 catalogue dataset loaded or maintained on the system. A warning message must be displayed on screen informing the user, e.g. *"Warning: dataset <dataset name> is not up to date. A New Edition or Update for this dataset is missing"*.~~

SSE 131 must be returned if a dataset has no Feature Catalogue or Portrayal Catalogue installed.

SSE 132 must be returned if an intermediate digitalSignatureValue for a resource (whether dataset, supplementary file or permit) fails validation.

SSE 133 must be returned if the dataset being installed is of a version which is not identical to a Feature Catalogue or Portrayal Catalogue installed on the system.

SSE 134 must be returned if the CATALOG.XML digital signature (CATALOG.SIG) cannot be authenticated against the Scheme Adminstrator's certificate, either through the data server's signed public key or any specified intermediate Domain Controllers. The contents of the Catalogue shall not be installed if the signature is invalid.

SSE 135 must be returned if the PERMIT.XML digital signature (PERMIT.SIG) cannot be authenticated against the Scheme Adminstrator's certificate, either through the data server's signed public key or any intermediate Domain Controllers.

The flow diagrams in this Appendix show the conditions under which the SSE codes are displayed. These diagrams only relate to processes carried out on the ECDIS for import of exchange set contents. Data Server and Scheme Administrator processes are not defined here.

Exchange Set Installation on ECDIS.

The following Figure shows the sequence of actions to import Exchange Set contents. These contents are all digitally signed, and may optionally be encrypted.

For encrypted data the following process is first used to establish the validity of the permit.xml and its contents in respect of the end user's subscription details. This is only for use with datasets which are encrypted and should be carried out prior to dataset file decryption according to S-100 Part 15.
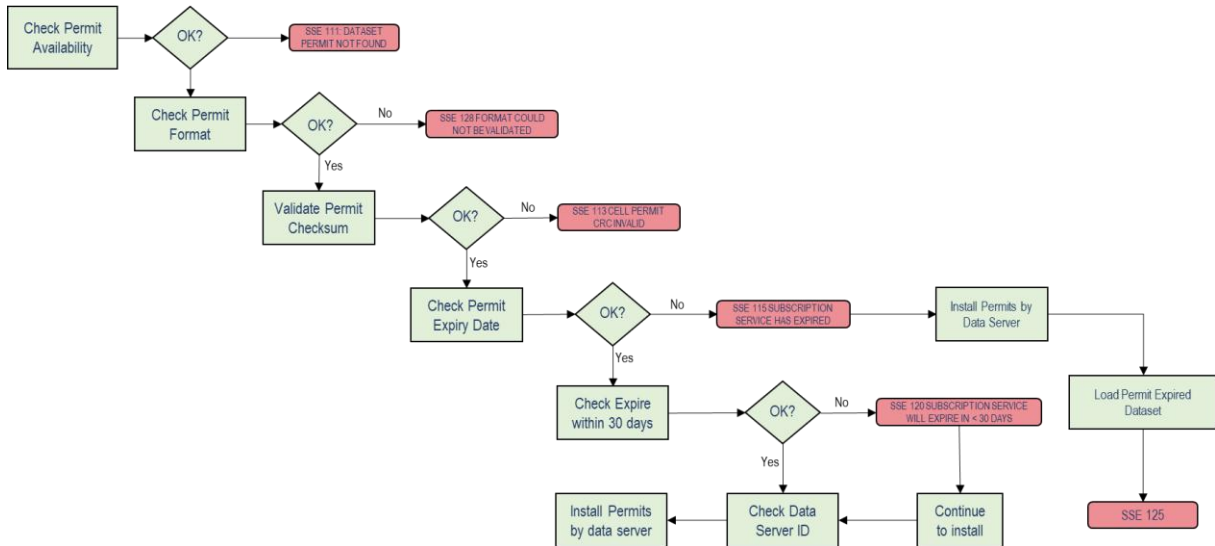

Figure C-2-10 - Check for permit validity prior to decryption

Once encryption and compression has been processed the digital signatures for all Exchange Set contents to be imported can be processed. These signatures can form a chain of authentication and the following flow Figure illustrates how such signatures should be processed.
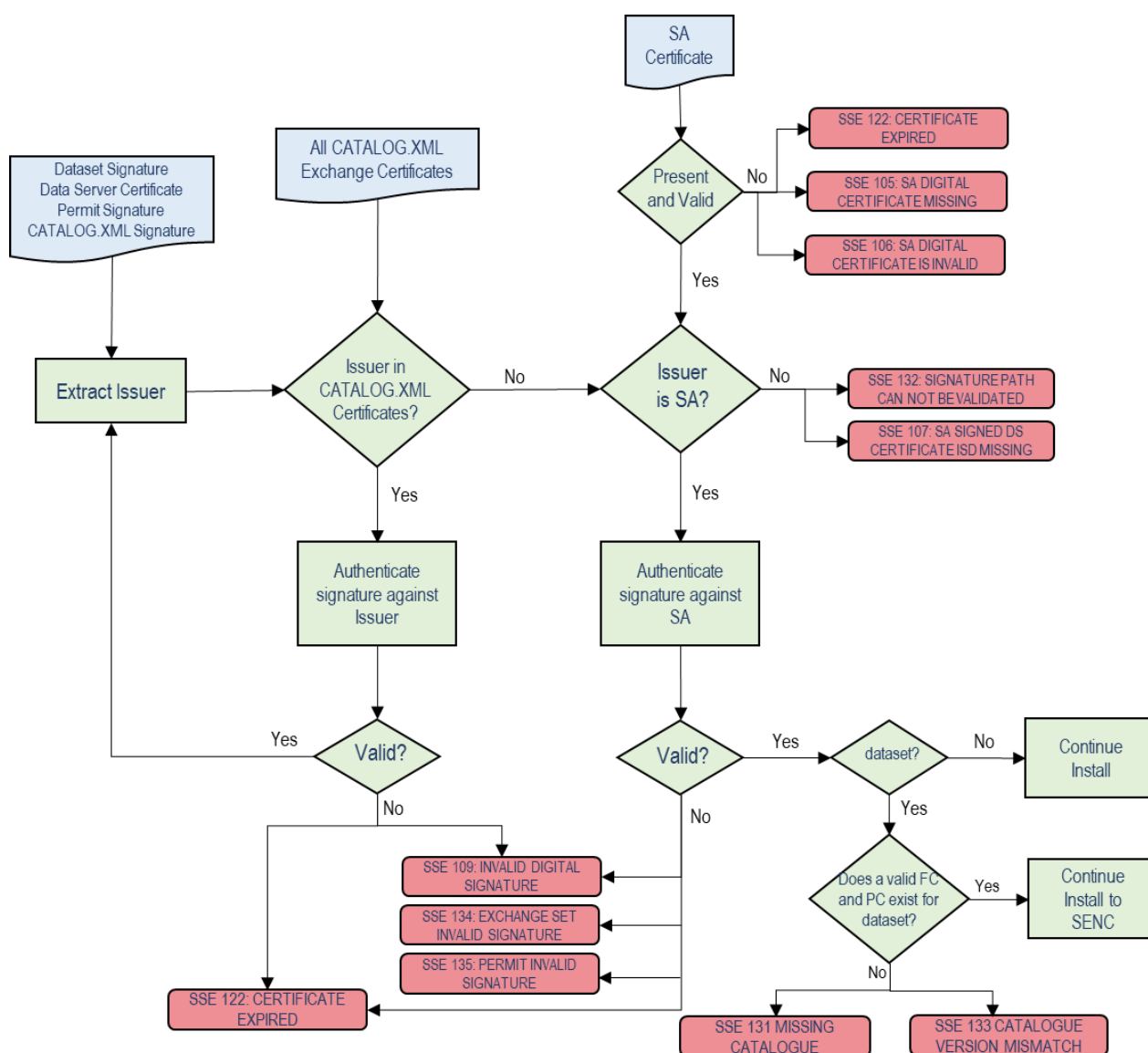
Figure C-2-2 - Authentication of Exchange Set CATALOG.XML, permits and dataset components

Under S-100 Part 15 datasets and other Exchange Set components can have multiple digital signatures, with each signature referenced to a signed public key certificate. The Exchange Set contains all relevant certificates with the exception of the SA digital certificate which is installed separately by the end user.

Using the flow shown in Figure C-2-2 the chain of certificates for dataset components, permits and the catalog.xml itself can be authenticated.

Full documentation of the authentication processes and technical details are contained in S-100 Part 15.

Certain Exchange Set contents control the behaviour of the ECDIS and may only be digitally signed by the Scheme Administrator. These categories of content, the Feature Catalogues, Portrayal Catalogues and Interoperability Catalogues should be authenticated using the following process. IHO standards determine the content and revision of such Catalogues.
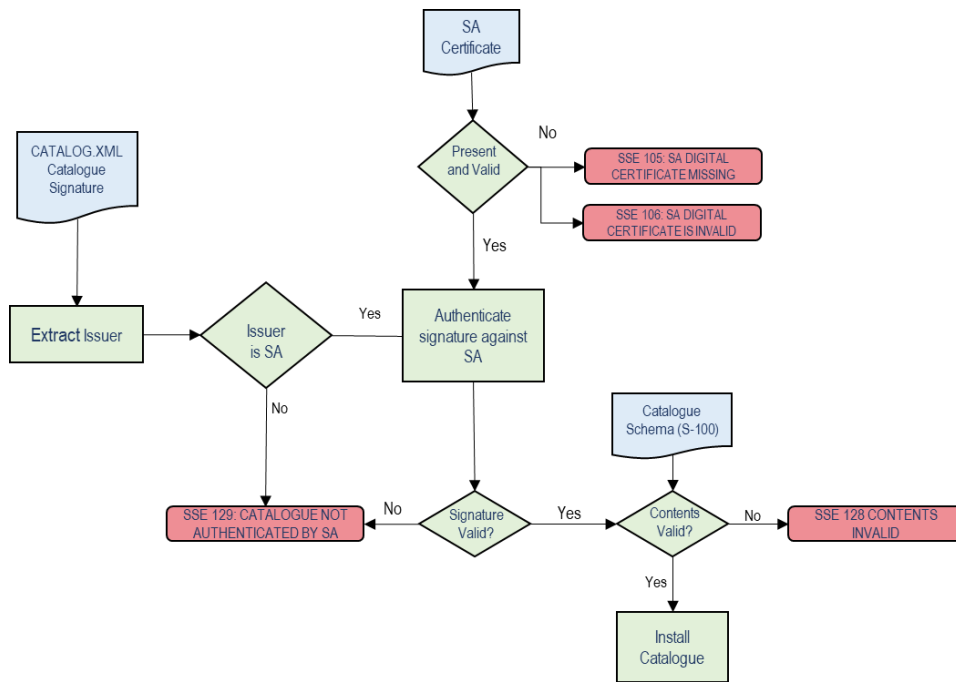
Figure C-2-3 - Authentication of Feature, Portrayal and Interoperability Catalogues

Appendix C-3
ECDIS Update Status Reports
(informative)

Purpose

This Appendix elaborates the definition of an "up to date" dataset. This is required by the IMO Performance Standards and all ECDIS users are required to be able to demonstrate to a vetting inspector that their ECDIS and its installed datasets are "up to date".

This Appendix specifies the format and content of an "Update Status Report" which will demonstrate the revision status of datasets within the SENC of the ECDIS. There are two Update Status Reports required:

1. An ENC Update Status Report, which reports the contents of electronic charts and directly related information.
2. An ENP (Electronic Nautical Publication) Update Status Report which reports the status of ENPs

Use and Responsibility

An Update Status Report is designed as a concise and standardised format to assist end users in satisfying themselves that their data is "up to date" and help satisfy inspection requirements in that respect.

The report is designed for two individual use cases:

1. To ensure that all navigational data loaded into the SENC is up to date for a section of a particular route
2. To ensure that all navigational data loaded into the SENC is up to date.

All S-100 datasets use Edition and, sometimes, update numbers to denote their individual revision (see S-100 Part 17 for details). These numbers uniquely identify how up to date a dataset is. The difficulty with using Edition/update numbers in isolation is that they do not document the date of revision of all datasets relative to the installation date of a data server's service giving the end user no indication of whether a dataset (or a collection of datasets) is up to date with respect to the last dataset installed.

S-100 supports the creation and distribution of IHO S-128 data which provides an issue date within its metadata for an entire data service as well as a snapshot of the Edition and update information for all component datasets within a data service. The issue date of the last delivered S-128 dataset is used in each update status reports to provide a reference date for every dataset either on a section of the vessel's route or for the SENC as a whole.

The driving use case for the Update status report is that an inspector (for example flag State, port State or vetting) or end user can check that an ECDIS is up to date with respect to the last dataset installed from each data server's data within the SENC.

Note that this report specification is not a concrete definition of what an "up to date" dataset (or ECDIS) is; it only shows a status of each dataset with respect to the last data installed on the system. If a period of time has passed since the last update then some data may well be "out of date" relative to the time the report is run – the report only records the up to date status relative to the last data installed (the date being defined by the issue date of the latest S-128 dataset). The equipment manual should explain terms "up to date" and "out of date".

This report only reports the status of datasets delivered as part of a data service using S-100 Part 17 Exchange Set metadata and (as part of dual-fuel mode) IHO S-57 datasets (as illustrated in the hybrid Exchange Set in S-100 Part 17, clause 17-4.2). Where other S-100 datasets are installed on the system from other sources (for example, Unencrypted ENCs) then they should be displayed with a status of "unknown". The Equipment manual should explain terms "unknown".

This Appendix provides a specification for a report which can be run on a compliant ECDIS to determine the status of S-100 datasets held within the SENC.

Report Definitions

Report Contents

Two reports are required:

1. An ENC Update Status Report, which reports the contents of electronic charts and directly related information. This report shows the status of IHO S-100 datasets of the following product types:
   a. ENC, either S-101 or S-57
   b. S-102
   c. S-104

2. An ENP (Electronic Nautical Publication) Update Status Report which reports the status of ENPs. All other S-100 products (with the exception of S-128 itself) installed in the SENC are in this category.

The report name at the top of the report header shows the type of Report being produced.

Report Filters

The Update status report defined in can take one of two forms:
1. A report detailing the status of all datasets within the SENC of the ECDIS for the appropriate type (ENC or ENP). This shows the status of the datasets with respect to the date contained in the S-128 dataset of the last update for each data server's service installed.
2. A report detailing the status of each S-100 dataset along a predefined section of a route contained within the ECDIS.

Example

An example of an Update Status Report for current ECDIS with S-57 ENCs is shown in the Figure C-3-1, followed by an illustrative revised report for S-100 datasets in Figure C-3-2. The example shown is an ENC Update Status Report.

Vessel Name:	HMS Goteborg
Identifier:	IMO 4653321
ENC Update Reference Date:	16 May 2013 : WK 24/2013
Date of Report:	1 Jun 2013
Content:	Filtered for Route Plan "Goteborg – Kiel"
Start WP:	Goteborg [57.7N,11.966667E]
End WP:	Kiel [54.333742N,10.159607E]

Chart Status Summary:

Chart Status:	Count
Total:	50
Up to Date	38/50
Not Up to Date	10/50
Withdrawn	2/50
Unknown	0/50

Data Server: GB				
Cell Name	Edition	Update	Issue Date	Status
DE316001	5	1	13 Mar 2013	Not Up to Date
DE416010	1	1	12 Apr 2012	Not Up to Date
DE416020	6	2	11 May 2012	Not Up to Date
DE416021	8	3	10 May 2012	Not Up to Date

Figure C-3-1 - Update Status Report – current report example

> **[*Revised Form]*
>
> *Report Name: Electronic Navigational Charts (ENC) Update Status Report*
>
> *Vessel Name:*
>
> *Identifier:*
>
> *Update Reference Date: (from S-128)*
>
> *Date of Report:*
>
> *Content: Filtered for Route Plan "Goteborg – Kiel"*
>
> *Start WP:*
>
> *End WP:*
>
> *Dataset Status Summary*

Data Server: XXXX					
Product	*Dataset Name*	*Edition*	*Update*	*Issue Date*	*Status*
S-101	*101US23495820*	*10*	*4*	*2020-01-02*	*Up to Date*
S-102	*102US29348021*				

Figure C-3-2 - Update Status Report - notional example for S-100 datasets

Report specification

The ENC Update Status Report is a formatted output from the ECDIS. It should be formatted to fit within the width of the ECDIS screen and, if printable, split into individual A4 pages.

Reports of both types (complete SENC contents and filtered by route) are divided into two sections:

  a) A header containing information on the vessel and report content selected (either filtered for a route (or part of a route) or for the entire SENC contents. This header contains vessel information and report reference dates followed by a summary totals for each report status.

  b) A table containing information for each cell within the chosen content type. This provides detailed information on each dataset within the chosen content category.

Report header

The data content of each of the header fields is defined in Table C-3-1 below:

Field Name.	Type	Source
1. Report Name	Text	Two Report names are possible depending on which Report is being shown. Either: - Electronic Navigational Charts (ENC) Update Status Report - Electronic Nautical Publications (ENP) Update Status Report
2. Vessel Name	Text	The name of the vessel as recorded within the ECDIS.
3. Identifier	Text	A unique identifier, the MMSI or vessel IMO number.
4. Update reference date	Date	The data used as the reference for the status of each of the cells. This is the issue date of the last S-128 dataset in the Exchange Set used to update the SENC. The date is taken from the latest S-128 datasets issueDate in the CATALOG.XML and is expressed in ISO8601 notation: [**YYYMMDDZHHMMSS**]

5. Date of report	Date	The date the Report was run.
6. Content	Text	Each Report can be optionally filtered for an individual route plan or report the full SENC contents for each Report type: - "Filtered for Route Plan XXX to YYY" where XXX and YYY are the textual names of the point of origin and destination on the chosen route. - Full SENC contents.
7. Start WP	Text	This field is only present if the Report is filtered for a route. It should comprise the textual name of the starting waypoint of the route (if one exists) and the lat/long coordinates of the waypoint. There is no fixed form that the coordinates should take.
8. End WP	Text	This field is only present if the Report is filtered for a route. It should comprise the textual name of the last waypoint of the route (if one exists) and its lat/long coordinates. There is no fixed form that the coordinates should take.

Table C-3-1 - Data content of header fields

Filtering of Update status report for route section

Where an Update Status Report is filtered for a route plan then the datasets of the appropriate type (ENC or ENP) in the SENC whose status are checked are defined by the intersection of the route corridor with the dataset boundaries (as defined by dataset's coverage features (or coverage defined in the S-100 CATALOG.XML within the SENC)).

The width of the filtering corridor is equal to the "user specified distance" implemented inside the ECDIS to fulfil IMO MSC.232(82) *11.3.5:*

"An indication should be given if the mariner plans a route closer than a user-specified distance from the boundary of a prohibited area or a geographic area for which special conditions exist (see appendix 4). An indication should also be given if the mariner plans a route closer than a user specified distance from a point object, such as a fixed or floating aid to navigation or isolated danger. "

This is not the same as the XTD distance.

Summary totals

The summary section of the Report follows directly after the header. The summary contains the following information:

1. The title: "Chart Status Summary".
2. Totals of cells with the relevant status in the order defined below.
   a. Total – the total number of datasets available in the SENC for the content type (ENC or ENP), selected for the Report (either full or filtered by route).
   b. Up to date – the total number of datasets (for the content selected) which have status "Up to date".
   c. Not up to date – the total number of datasets (for the content selected) which have status "Not up to date".
   d. Withdrawn – the total number of datasets (for the content selected) which have status "Withdrawn".
   e. Cancelled – the total number of datasets (for the content selected) which have status "Cancelled".

      f.   Unknown – the number of datasets for which a status cannot be determined for any reason.

3.   The possibilities for each dataset's status are listed in Table C-3-2 below along with their definitions.

Data Server content tables

The detailed tables in each Report are arranged by data server – each separate data server or dataset data source within the SENC has its own separate table listing all datasets by content type (as reported in the "Content" field in the report header) and S-100 Product Specification order.

The detailed tables contain the following information:

1)   Title: Data Server Name – this is the data server identified by the S-128 Producer attribute.

2)   For each cell installed in the SENC from the data server:

    a)   Dataset Name – the name of the dataset. (DSNM).

    b)   Edition – the Edition of the dataset in the SENC (EDTN).

    c)   Update – the update number of the dataset in the SENC. If the product does not support updates, then this shall be labelled "-".

    d)   Issue Date – the issue date of the last applied update to the dataset in the SENC (or "-" where no updates are supported for the S-100 product).

    e)   Status – the status of the cell. The status may have one of four values determined according to the criteria in the following table:

Status	Specification
Up to date	This is where the SENC has all the latest Edition and (where supported by the S-100 Product Specification) update information for the dataset installed as defined by the latest S-128 dataset received from the data server. The reference date for the most up to date information is defined by the S-128 dataset issue date. The dataset update reference date must be within the last four weeks from the time of the Report execution or the cell shall be displayed as "Not up to date" regardless of its status as defined by the S-128 data.
Not Up to date	This is where the SENC has NOT installed all the latest update and/or New Edition for the cell. Again, the reference point for what should be installed is defined by the S-128 dataset issue date. If the reference date is older than four weeks then cells shall be displayed as "not up to date" by definition.
Withdrawn	The number of datasets which have been withdrawn by the data server or cancelled but which are still available within the SENC.
Unknown	Datasets for which a status cannot be determined for any reason. If the revision information in the latest S-128 dataset is incomplete for any reason then all datasets in the data server's service not included in the partial S-128 shall be deemed to be "Unknown" as no definitive information on them can be determined. S-128 content is required to specify the status of all datasets in a data server's service.

Table C-3-2 - Status values

Example of ENC update status report

Report Name: ENC Update Status Report

Vessel Name: HMS Goteborg

Identifier: IMO 4653321

Update Reference Date: 16 May 2013

Date of Report: 1 Jun 2013

Content: Full

Chart Status Summary:

Chart Status: Count

Total: 50

Up to Date 38/50

Not Up to Date 10/50

Withdrawn 2/50

Unknown 0/50

Table:

Data Server: XXXX

Product	Dataset Name	Edition	Update	Issue Date	Status
S-101	101US23495820	10	4	2020-01-02	Up to Date
S-102	102US29348021	8	-		

Example of ENP update status report

Report Name: Electronic Nautical Publications (ENP) Update Status Report

Vessel Name: HMS Goteborg

Identifier: IMO 4653321

Update Reference Date: 16 May 2013

Date of Report: 1 Jun 2013

Content: Full

Chart Status Summary:

Chart Status: Count

Total: 50

Up to Date 38/50

Not Up to Date 10/50

Withdrawn 2/50

Unknown 0/50

Table:

Data Server: XXXX					
Product	Dataset Name	Edition	Update	Issue Date	Status
S-123	123US3245394	5	-	2020-01-02	Up to Date
S-127	127US2345032	6	-		

Appendix C-4
User Selected Safety Contour and Water Level Adjustment
(informative)

C-4-1   User Selectable Safety Contour

C-4-1.1   Introduction

This Appendix defines how the "**User Selectable Safety Contour**" feature is defined and implemented.

User selectable safety contour means creation of the safety contour from the bathymetric grid data based on the value set by the user.

NOTE: Also, in the case of S-101 or S-57 the user sets the value for the safety contour, but if the exact fit is not found from the available depth information in S-101 or S-57 then the safety contour defaults to the next deepest which may be over 10 metres deeper situation than the situation based on the value set by the user.

In these processes an end user selects:

1. Suppression of certain S-101 features by S-102.
2. A Safety Contour value of their choice.

When a user selects a safety contour value, outside areas of S-102 coverage the source for the displayed safety contour is the existing S-101 ENC (or S-57 ENC in dual-fuel mode).

When the safety contour has been generated from S-102 data then the area over which it is generated, that is the S-102 coverage area, shall be surrounded by a boundary line using colour token DEPWL[14] see Figure C-4-1.

Figure C-4-1 - Boundary line of S-102 coverage

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[14] colour token DEPWL, xyL values are: DAY x= 0.15, y=0.15, L=30.0; DUSK x=0.15, y=0.15, L=7.5; NIGHT x=0.15, y=0.15, L=1.2

C-4-1.2   Data Constraints

1. Coverage – S-102 data is not expected to overlap, but in case of overlap the ECDIS should indicate an overlap by the text "OVERLAP" and the user should have the ability to select which producer in the overlapped area has priority and will be selected for processing safety contour.

2. No complex interpolation is done between points in the S-102 grid. Nearest neighbour is used to define the depth in each S-102 point's neighbourhood (that is, the same depth everywhere within the grid square), regardless of any interpolationType defined for the S-102 dataset (S-100 Part 8, clause 8-7.1.4), as illustrated by the following Figure:
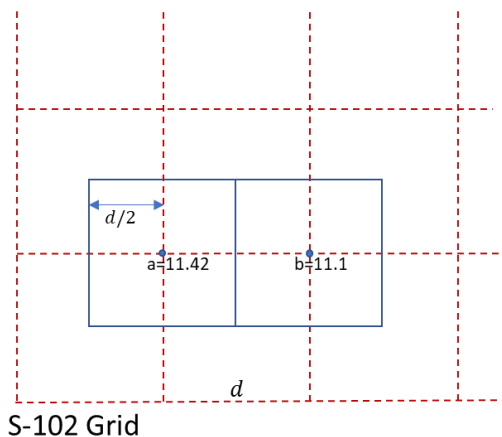
S-102 Grid

Figure C-4-2 - The extents of the S-102 points overlaid on the S-102 grid (grid spacing = 'd')
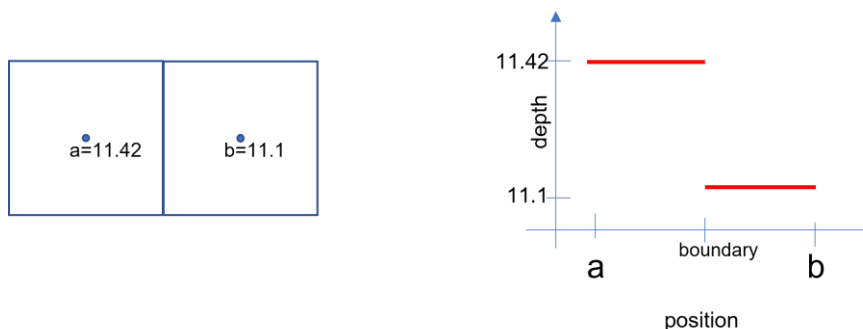
Figure C-4-3 - Extents of each S-102 points showing nearest neighbour interpolation (S-100 Part 8-7.1.4)

3. Only rectangular grids for S-102 are allowed. The method outlined may be extended to other grids; for example, triangular grids in the future.

4. User Selected Contour can only be processed in areas where the Sounding Datum of suppressed S-101 features is the same as the datum defined in the S-102 Coverage.

C-4-1.3   Implementation

The user may select S-102 to be used as the source of the depth information.

When S-102 is selected for use, in areas where S-102 coverage exists, the S-102 suppresses the following S-101 depth features,

1. Depth Area
2. Dredged Area
3. Depth Contour

The process to construct the safety contour then consists of a selection of common edges from rectangular extents for each S-102 dataset point, as shown in Figure C-4-4.
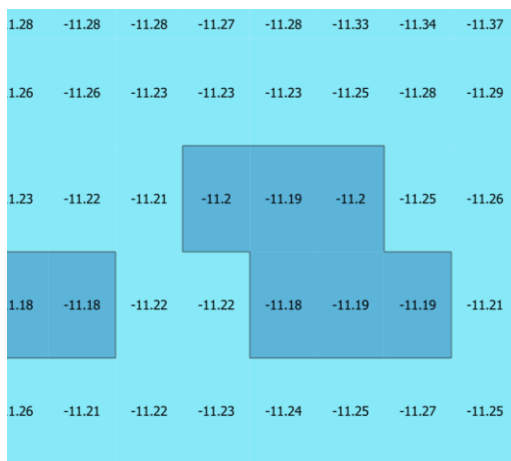
Figure C-4-4 - Common edges from rectangular extents

Common edges are selected when the S-102 points on either side of them lie on either side of the boundary of the safety contour value. In Figure C-4-5 below 11.5 metres is the threshold value set by the user.

Edges on the boundary of the dataset, or which lie on an edge common with undefined S-102 values, are selected if the S-102 value is less than or equal to the safety contour value; for example, see Figure C-4-5:
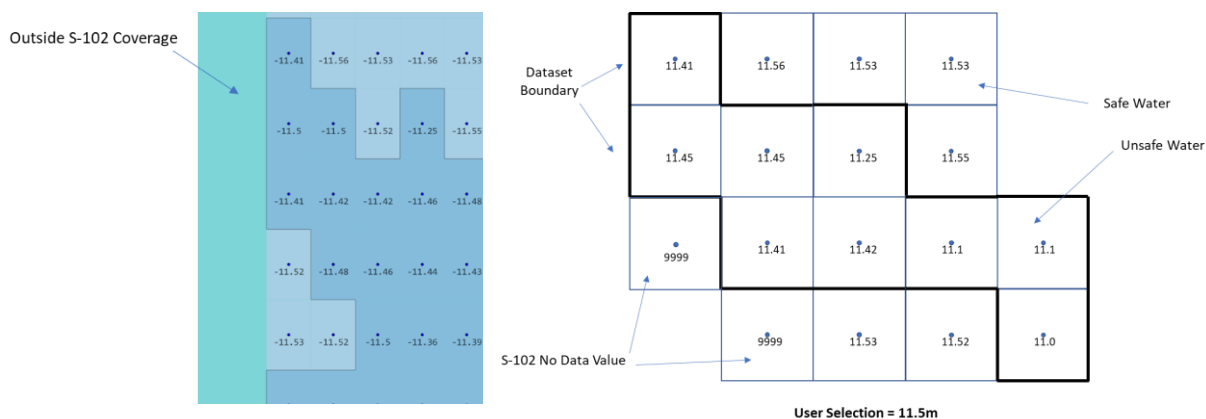

Figure C-4-5 - Edges from rectangular extents and at boundaries

The source of the displayed safety contour are the selected edges as defined. The areas of safe and unsafe water formed by the selected edges are used for processing of the safety contour related alarms under IMO MSC 232(82) 11.4.3, which the OEM must implement.

C-4-2   Water Level Adjustment

C-4-2.1   General

This section defines how the "**ECDIS Water Level Adjustment feature**" is implemented. Water Level Adjustment is referred to in this section as WLA.

C-4-2.2   Constraints on input data

1. Coverage – S-104 data is not expected to overlap, but in case of overlap the approach shall be same as for overlapping S-102 data. The ECDIS should indicate an overlap by the text "OVERLAP" and the user should have the ability to select which producer in the overlapped area has priority and will be selected for processing WLA.

2. As with S-102, each S-104 point is assigned a rectangular extent and no complex interpolation is done between the points in the S-104 grid.

3. For WLA processing all S-102 and S-104 data must be on the same vertical datum.

C-4-2.3   User inputs

The User may select WLA to be used as source of the depth information.

When WLA is selected for use, in areas where WLA coverage exists, the user selects one of three different WLA options:

1. WLA Option 1: WLA at a single datetime.
2. WLA Option 2: WLA for a single datetime period (from start datetime to end datetime).
3. WLA Option 3: WLA linked to an estimated route schedule. In this case the user also specifies:

    a. A distance parameter, the limit of the check area as specified by IMO MSC 232(82) 11.3.5.

    b. A time resolution t_u used to construct the individual WLA sections. This time resolution reflects the uncertainty or tolerance of the time schedule of the route, for example 10 minutes if the user assumes that they could follow the time schedule within 10 minutes.

C-4-2.4   Implementation - general

WLA can only be carried out in areas of S-104 coverage; for example, the red outline in figure C-4-6 below. WLA may be applied to S-101 features or after substitution of depths by S-102 defined in clauses C-4-1 and section C-4-3.1.
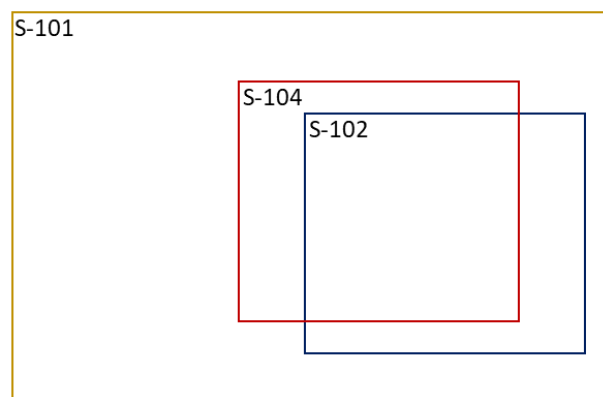
Figure C-4-6 - WLA can only be computed in areas where there is S-104 coverage.

Further WLA can only be carried out:

1. When WLA option 1 or WLA option 2 is selected, where the temporal extent of the S-104 overlaps the required datetime instant or period selected by the user
2. When WLA option 3 is selected, where the S-104 temporal extent of the S-104 overlaps the estimated time a part of the route; see figure C-4-16.

Where these conditions are not met the WLA processing is not carried out.

When WLA has been processed the area for which it is defined shall be surrounded by a boundary line using colour token DEPWL[15]); see Figure C-4-7.

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[15] Thick dark blue dash line, colour token DEPWL xyL values are: DAY x= 0.15, y=¬0.15, L=30.0; DUSK x=0.15, y=0.15, L=7.5; NIGHT x=0.15, y=0.15, L=1.2.
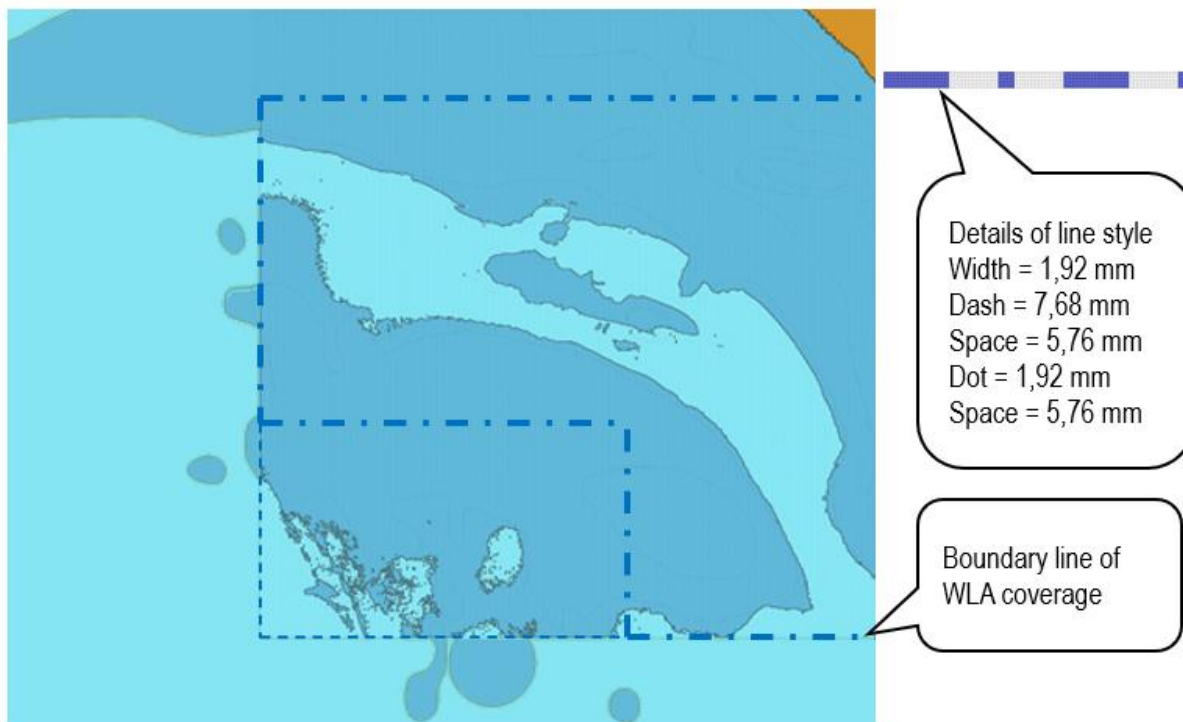
Figure C-4-7 - Boundary line of WLA coverage

NOTE: In this example S-102 coverage is larger than WLA coverage.

In addition to the display of the boundary line of the WLA coverage there should be a permanent indication about application of WLA and the applied datetime, see details in WLA Options 1, 2 and 3.

OEMs are free to design their user interface. Usable ideas include for example mouse roller to change datetime, use of a slider to change datetime, or even to provide an animation from user selected start datetime to user selected end datetime.

C-4-2.5   Implementation of WLA Option 1 – WLA for a single datetime instant

WLA is based on S-104 values closest to the selected datetime instant. Each S-102 point has an extent of coverage which is closest to it. Each S-104 point, similarly has an extent. The adjustment of the S-102 values is calculated by adjusting each S-102 point by the shoalest of the S-104 values, for all S-104 points whose extent intersects the extent of the S-102 point.

When an S-104 record does not exist for the precise time specified the shoalest of the two S-104 adjacent values is selected from the S-104 dataset. S-104 values can only be selected within the temporal extent of the S-104 dataset. In the example shown in Figure C-4-8 below (S-104 values, "V" defined every 15 minutes and a user selected datetime of 07:24) the two values selected are 07:00 and 07:30, WLA would select 1.3m (the 07:00 value).
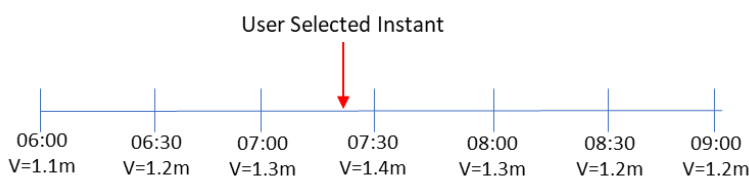

Figure C-4-8 - Selection of time-varying value

In Figure C-4-9 below, the S-102 point X is adjusted by the shoalest (that is, minimum) value of the S-104 values from (a), (b), (c) and (d) at the required datetime instant because the S-102 point extent overlaps the S-104 extents of a,b,c and d.
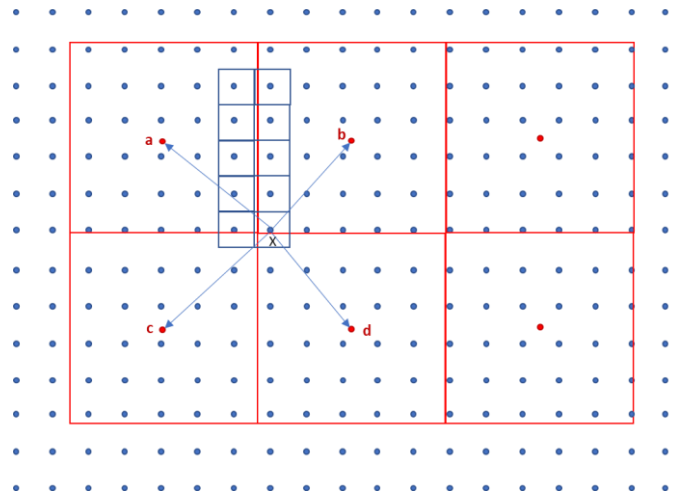
Figure C-4-9 - Adjustment of S-102 values by S-104

Format of the permanent indication is as below:

WLA 12:34 08 Nov 2021

C-4-2.6   Implementation of WLA Option 2 – WLA for a datetime range specified by the user as a time period

When WLA is based on a datetime range, then the process is identical to that followed for WLA Option 1 except each S-104 value selected is the shoalest of all values available in the S-104 within the selected time period.

All S-104 points contributing to the WLA must be defined across the time range required, otherwise the WLA is not computable and the user shall be informed. The S-104 records selected are those which lie either within the user defined time period; or before the start point of the time period and just after the end point of the time period. In the following examples:
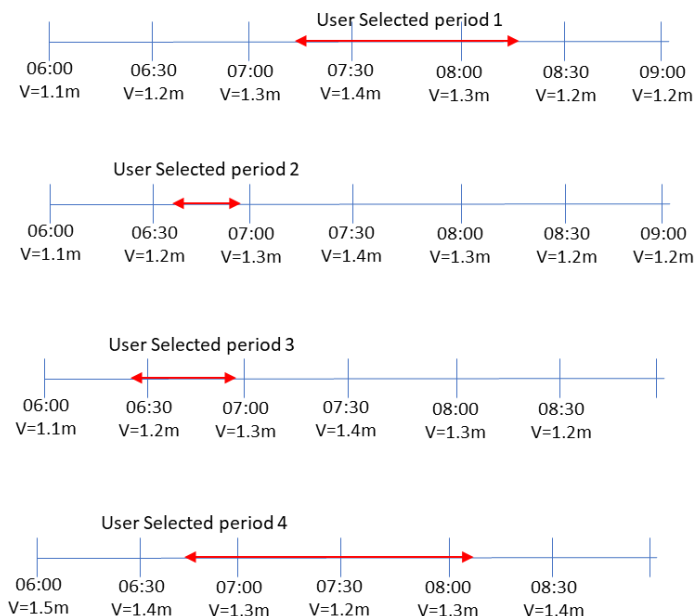
Figure C-4-10 - Examples of S-104 data selection

1. User selected period 1, four values are from 0700, 0730, 0800 and 0830 - WLA would select 08:30 value = 1.2m (even though the time period doesn't overlap).

2. User selected period 2, two values are from 0630 and 0700 - WLA would select 06:30 value V=1.2m (even though the time period doesn't overlap).

3. User selected period 3, three values are from 0600, 0630 and 0700 - WLA would select 06:00 V=1.1m (even though the time period doesn't overlap).

4. User selected period 4, five values are from 0630, 0700, 0730, 0800 and 0830 – WLA would select 07:30 V=1.2m.

When adjusting depth values the shoalest (smallest) value from the selected S-104 records shall be used in order to produce the safest WLA values.

Format of the permanent indication is as below:

WLA from 12:34 08 Nov 2021 to 14:56 08 Nov 2021

C-4-2.7 Implementation of WLA Option 3 – linking of WLA to a defined route with planned waypoints and times

When WLA is based on a route then the limit of check area around the route is set by the user as specified by IMO MSC 232(82) 11.3.5. The WLA is processed within this check area. The boundary of the area of the display where WLA has been carried out shall be displayed. In the process description this distance is referred to as 'a'.

A route could be either a Planned route or a Monitored route. Both could be processed for the WLA, but not at the same time in a single display area. In case of multiple display areas, it is possible that one area is WLA processed for Planned route and another area is WLA processed for the Monitored route.

For a Planned route the datetime period applied for the WLA process is based on the schedule of the planned route itself.

For a Monitored route the datetime period applied for the WLA process is user selectable either:

1. Based on the planned schedule of the monitored route itself; or
2. Based on the monitored route adjusted for the current own ship position.

The region of WLA is restricted to a distinguishable bordered polygon around the route. The process works as follows:

1. For each section of the route a series of estimated time markers is defined along the route at times $t_0 - t_n$. The diagram also shows the "limit of check area" as specified by IMO MSC 232(82) 11.3.5. Each time marker is delimited before and after by the time +/- half the user selected t_u interval so the rectangle in the diagram represents the extent of time t_1 which ranges from time $t_1 - \frac{t_u}{2}$ to $t_1 + \frac{t_u}{2}$. This is the WLA adjustment polygon corresponding to time t_1:
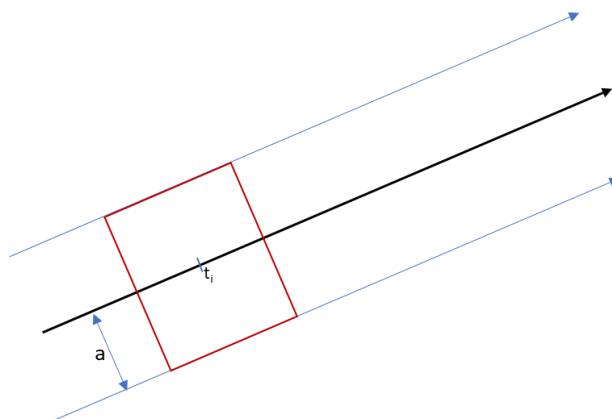

Figure C-4-11 - WLA adjustment polygon

2. Where the route follows a curved section the polygon formed is not a rectangle but an area defined by the user selected limit as shown by areas a and b:
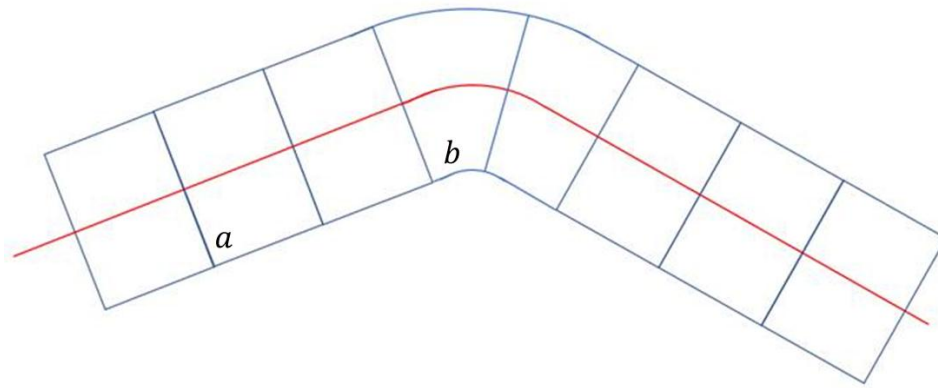
Figure C-4-12 - WLA adjustment polygon along curved section

3. The individual S-102 points (blue dots in Figure C-4-13 below) are assigned rectangular extents. For each WLA adjustment rectangle corresponding to each t_i the S-102 extents which spatially intersect are selected. A full example is shown in Figure C-4-13 for one of the WLA polygons.
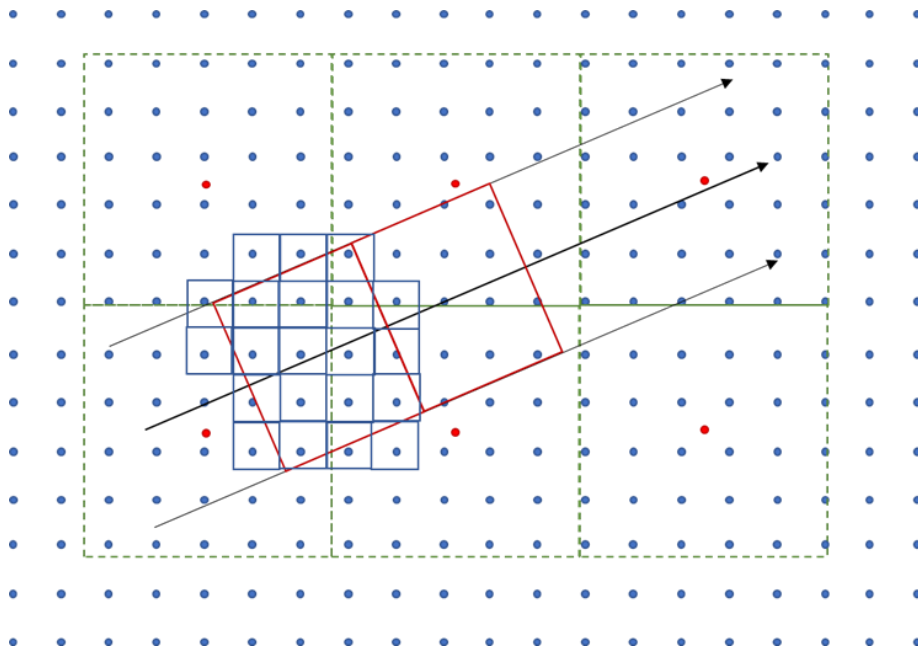

Figure C-4-13 - Grid cell selection

4. For each S-102 point whose extent intersects the WLA adjustment box the Water level is adjusted using a similar process to Option 1. The S-104 value used for adjustment is the shoalest value from each of the S-104 points whose extents intersect the S-102 point (as described in WLA Option 1) across the time period $(t_i - \frac{t_u}{2})$ and $(t_i + \frac{t_u}{2})$, In Figure C-4-14, illustrating this step, two S-102 points are adjusted by S-104 values in the time period $(t_1 - \frac{t_u}{2})$ and $(t_1 + \frac{t_u}{2})$, for calculation of t_1. S-102 point x is adjusted using values drawn from S-104 points a and b (because its extent intersects the extents of a and b) and S-102 point y is only adjusted with values from S-104 point b.
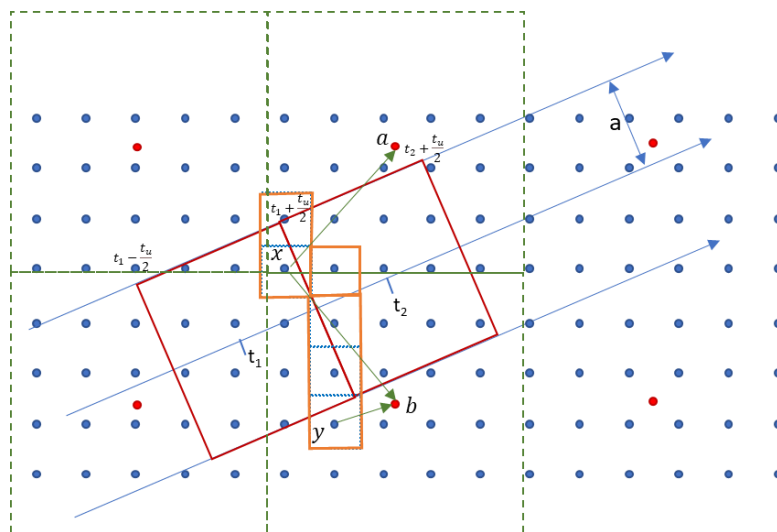
Figure C-4-14 - Selection of S-104 data

5. Each of the S-102 points are assigned the adjusted water level equal to the S-102 value + the calculated (shoalest) S-104 value as defined in the previous step.

6. Once the WLA polygon for time t_i is processed the WLA polygon for time t_{i+1} is processed.

7. S-102 points whose extents are intersected by the <u>both</u> the WLA polygon for t_i and t_{i+1} are assigned the shoaler of the two values, that is the shoalest of the S-104 values between the two time periods $(t_i - \frac{t_u}{2})$ and $(t_i + \frac{t_u}{2})$, and $(t_{i+1} - \frac{t_u}{2})$ and $(t_{i+1} + \frac{t_u}{2})$.

This completes the WLA process for polygon t_i. In Figure C-4-15 below the orange border shows S-102 points lying in WLA rectangles t_1 and t_2 and which would be assigned the shoaler of the two S-104 values corresponding to the t_1 and t_2 WLA process.
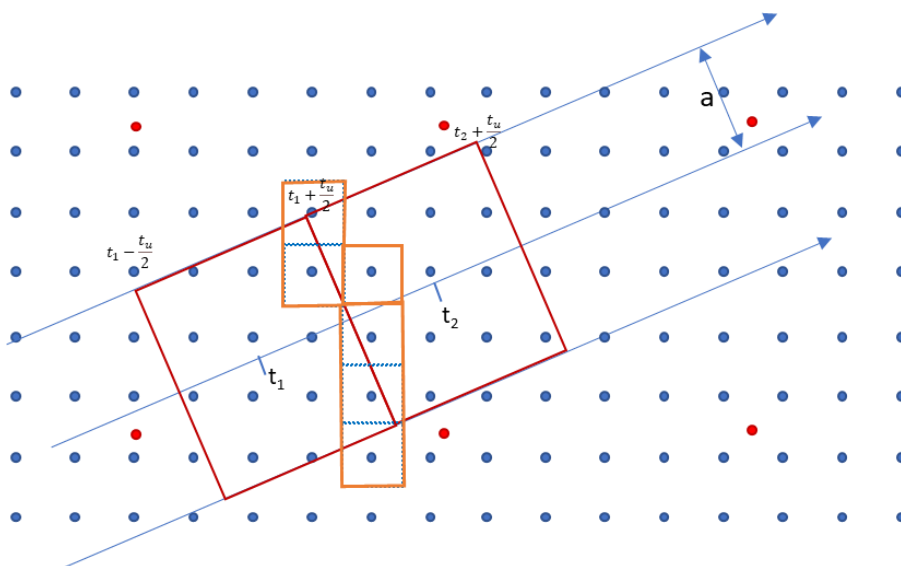

Figure C-4-15: Time-dependent adjustment of S-102 data with S-104 data

This process is extended to all t_i along the planned route.

Figure C-4-16 below shows a border line around all the WLA processed S-102 grid cells. This border marks the boundary of the Water Level Adjustment area and requires portrayal to inform the user which

areas of the display are subject to WLA. This area is surrounded by a distinguishable boundary line using colour token DEPWL[16]).

Boundary line of
Water Level Adjustment (WLA) area

Grid within
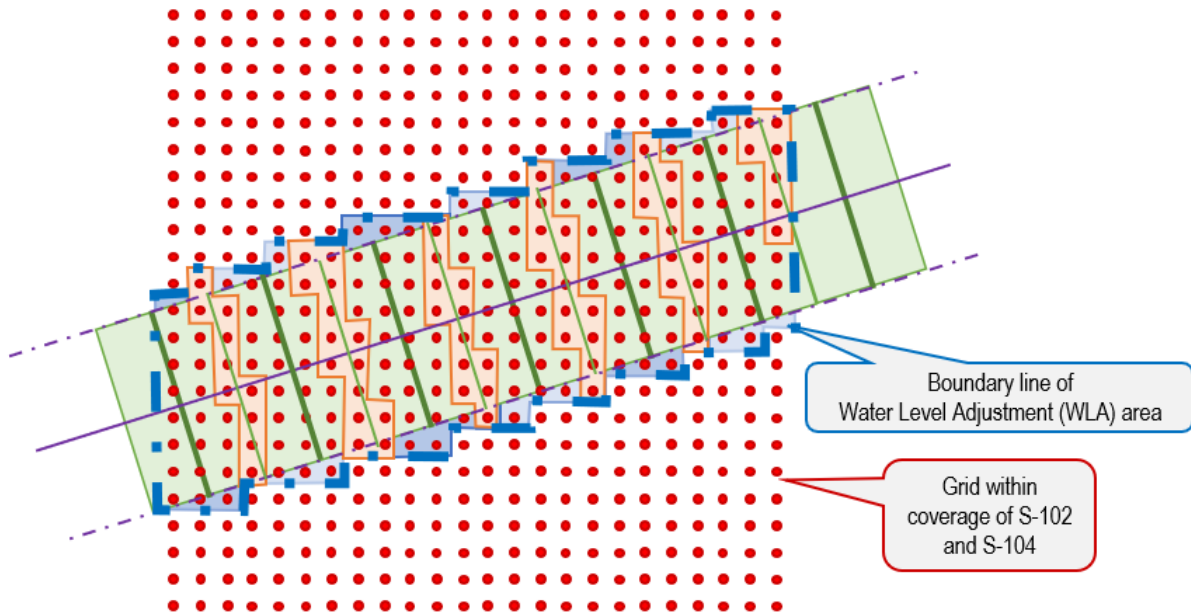coverage of S-102
and S-104

Figure C-4-16 - Boundary of adjusted area

Figure C-4-17 below shows how the rectangle is positioned in the middle of S-104 coverage area and at the edge of the S-104 coverage are.
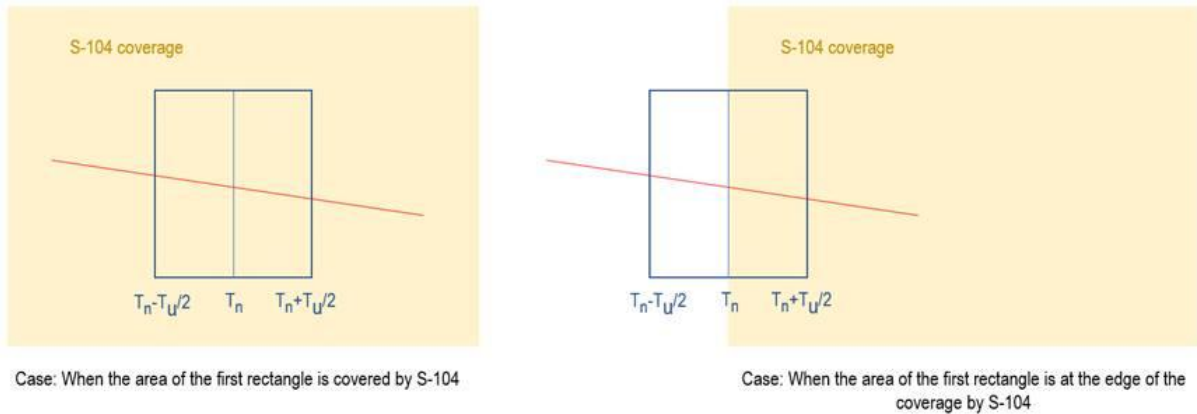

Case: When the area of the first rectangle is covered by S-104

Case: When the area of the first rectangle is at the edge of the coverage by S-104

Figure C-4-17 - Positioning in interior and at edge

Format of the permanent indication is as below:

WLA from 12:34 08 Nov 2021 to 14:56 08 Nov 2021

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[16] *thick dark blue dash dot line,* colour token DEPWL, xyL values are: DAY x= 0.15, y=¬0.15, L=30.0; DUSK x=0.15, y=0.15, L=7.5; NIGHT x=0.15, y=0.15, L=1.2

C-4-3   Treatment of depth and water level related S-101 features

C-4-3.1   Substitution and adjustment of depth values

C-4-3.1.1   General

In areas covered by only S-102, all depth values are substituted for all ENC features at all scales which have depth attribution (that is, the attribute *valueOfSounding* bound to them in the S-101 Feature Catalogue)

In areas where WLA is processed, all depth values are adjusted for all ENC features at all scales which have depth attribution (that is, the attribute *valueOfSounding* bound to them in the S-101 Feature Catalogue).

C-4-3.1.2   Areas covered by S-102 only or by both S-102 and S-104

Adjustment of different geographic primitives.

1. Point Features
    o   For Areas covered by S-102 only, a value for the attribute *valueOfSounding* shall be taken from the S-102 grid cell extents which intersects the point feature.
    o   For Areas covered by S-102 and S-104, the value for attribute *valueOfSounding* is taken from the S-102 grid cell extents which intersect the point feature. WLA is then applied to this value using S-104 records selected from the S-104 grid cell intersecting the point feature. The S-104 value selected is as defined in sections C-4-2.5, C-4-2.6 and C-4-2.7.

2. For Curve and Surface features
    o   For Areas covered by S-102 only, the value for *valueOfSounding* shall be the shoalest value of all S-102 grid cells whose extents intersect the feature's geometry within the S-102 coverage available. If the curve or surface feature is not completely within the S-102 then the value defined is the shoalest resulting from the original feature value in S-101 attribute and the value selected from the intersecting S-102 grid cells.
    o   For Areas covered by S-102 and S-104, the value for *valueOfSounding* is first selected, as the shoalest value of all S-102 grid cells whose extents intersect the feature's geometry. WLA adjustment is then applied to this value by selecting the shoalest value from all intersecting S-104 grid cells. The value selected is as defined in clauses C-4-2.5, C-4-2.6 and C-4-2.7. If the curve or surface feature is not completely within the S-104 coverage then the adjusted value is the shoalest value resulting from the original feature value in S-101 attribute and the WLA adjusted value.
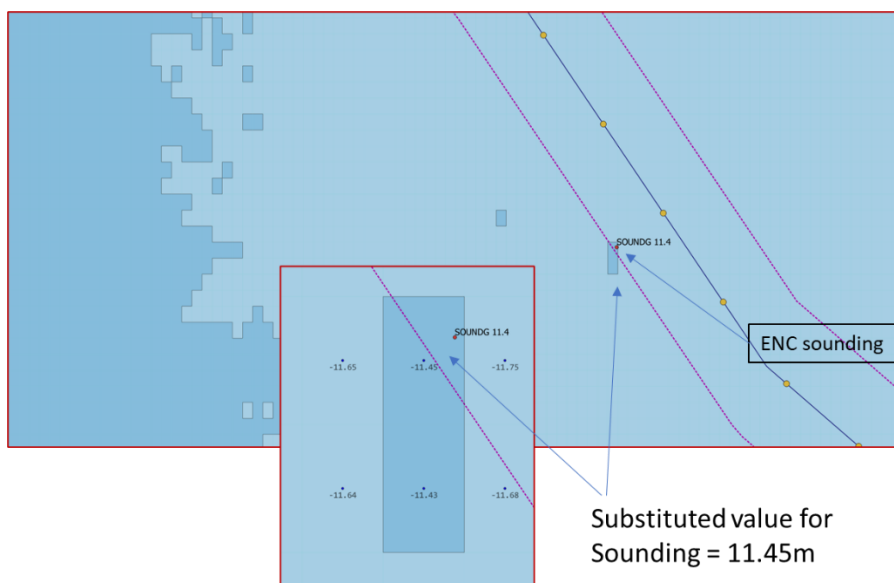

Figure C-4-18 - Substitution of sounding value from S-102

Shoalest values of all S-102 point extents intersecting S-102 Coverage = 11.0m
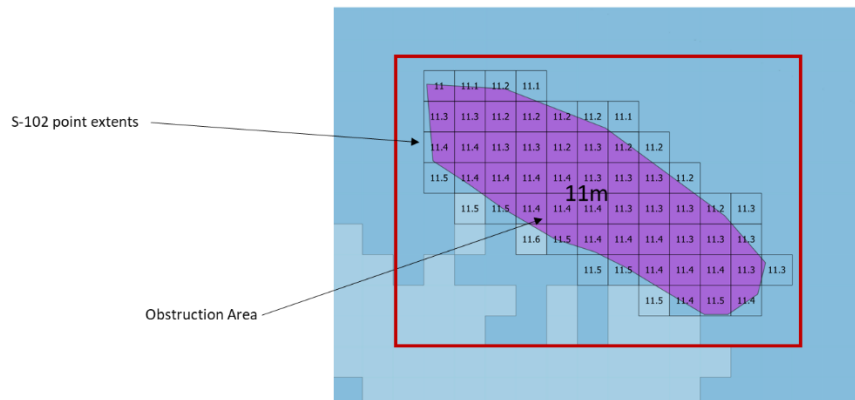valueOfSounding for Obstruction feature in the S-102 Coverage area = 11.0m

Figure C-4-19 - Substitution of *valueOfSounding* attribute in S-101 Obstruction from S-102 data

The S-101 features for which this depth substitution is required in S-102 coverage areas are listed, (items 1,2 and 3 are also used as sources for indications under IMO MSC 232(82) 11.4.6).

1. Underwater/Awash Rock
2. Wreck
3. Obstruction
4. Foul Ground
5. Marine Farm/Culture
6. Soundings (either individual soundings or those which are part of an array) substituting the S-102 grid cell whose extents intersect the sounding position for the defined ZCOO (ISO8211).

If the depth substituted S-101 feature is covered by S-104, then WLA is processed using same method as for the underlying depth area.

Depth values shall also be substituted for the attribute *depthRangeMinimumValue* in other S-101 features. These are:

1. Gate
2. Berth
3. Dry Dock
4. Floating Dock
5. Dredged Area
6. Swept Area
7. Pipeline Submarine/On Land
8. Recommended Track
9. Fairway
10. Recommended Route Centreline
11. Two-Way Route Part
12. Deep Water Route Centreline
13. Deep Water Route Part

For all features with substituted (and possibly adjusted values), the ECDIS Pick Report shall indicate the substituted/adjusted value and its source. The format and portrayal of depths and drying heights (that is, number of decimals, etc) is unchanged.

For example, for S-102 only covered area:

Value Of Sounding 12.3 m [S-102]

When an S-101 attribute has been WLA adjusted the pick report shall indicate the WLA adjusted value, source and time/date. The format of time date is: hh:mm dd mmm yyyy.

For example, for both S-102 and S-104 covered area:

Value Of Sounding 15.5m [WLA 12:34 08 Nov 2021]

Value Of Sounding 15.5m [WLA from 12:34 08 Nov 2021 to 14:56 08 Nov 2021]

C-4.3.1.3 Areas covered by only S-104

In areas with only S-104 coverage WLA adjustment of depth values shall be performed using the S-104 data for all features within the S-104 coverage area using the method for the different geographic primitives as described in the previous section C-4.3.1.2. When S-101 features are not completely within the S-104 data coverage the adjusted value is the shoalest value resulting from original depth value in the S-101 attribute and the WLA adjusted value.

The S-101 features for which attribute values are adjusted are:

1. Depth Area
2. Dredged Area
3. Depth Contour
4. UnderwaterAwashRock
5. Wreck
6. Obstruction
7. FoulGround
8. MarineFarmCulture
9. Soundings (either individual soundings or those which are part of an array) substituting the S-102 grid cell whose extents intersect the sounding position for the defined ZCOO (ISO8211).

Depth values shall also be adjusted for Depth Range Minimum Value and Depth Range Maximum Value in other S-101 features. These are:

1. Gate
2. Berth
3. Dry dock
4. Floating dock
5. Dredged area
6. Swept area
7. Pipeline submarine/on land
8. Recommended track
9. Fairway
10. Recommended route centreline
11. Two-way route part
12. Deep water route centreline
13. Deep water route part

For all features with adjusted values, the pick report shall indicate the adjusted value and its source. The format and portrayal of depths and drying heights (i.e. number of decimals, etc.) is unchanged.

For example,

Value Of Sounding 15.5m [WLA 12:34 08 Nov 2021]

Value Of Sounding 15.5m [WLA from 12:34 08 Nov 2021 to 14:56 08 Nov 2021]

C-4-3.2   Adjustment of heights and vertical clearance values

Any vertical measurement which is referenced to the same vertical datum as the S-104 data, either by the dataset metadata VDAT or **Vertical Datum** meta feature shall be adjusted using the intersecting S-104 grid cell water level value. This shall be applied on any features within the coverage of S-104. Where a feature is not completely within the S-104 coverage the adjusted value is the minimum value resulting from the original feature value in S-101 attribute and the WLA adjusted value. Adjustment is defined for the following S-101 features:

1. Building.

   2. Span Fixed

   3. Span Opening

   4. Conveyer

   5. Cable Overhead

   6. Pipeline, Overhead

   7. Tunnel

   8. Wind Turbine

   9. Gate

   10. Crane

   11. Light All Round; Light Sectored; Light Fog detector; Light Air Obstruction.

The simple attributes adjusted are *height* and *verticalClearanceValue*. When adjusting height or clearance values the largest value from the selected S-104 records shall be used in order to produce the safest values.

The user shall be given a permanent indication that the Water Level (S-104) values have adjusted attributes in the data display. Where values are not adjusted due to an incompatibility of vertical datums in the data, the user shall be given a similar permanent notification.

When either *height* or *verticalClearanceValue* in S-101 have been substituted or adjusted the ECDIS Pick Report shall indicate the substituted value, source and time/date. The format of the height or vertical clearance values (that is, number of decimals, etc) is unchanged.

For example:

   Vertical Clearance Value 5.3 m Mean Sea Level [WLA 12:34 08 Nov 2021]

   Value Of Vertical Clearance 15.5m Mean Sea Level [WLA from 12:34 08 Nov 2021 to 14:56 08 Nov 2021]

C-4-3.3   Alerts and indication details

Substituted or adjusted values in ENCs at the largest scale shall be used as input to any alarm/indication processing. These may or may not be the same as the substituted values which are portrayed as shown in Figure C-4-20 below which shows an illustration of the graphical highlight (red boundary and red transparent fill) for the intersected safety contour.
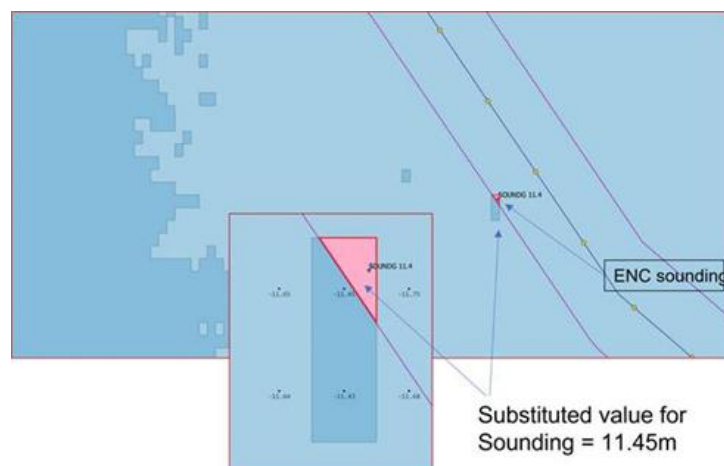

Figure C-4-20 - Graphical highlight for intersected safety contour

C-4-3.4   Legend details

The legend shall additionally indicate the vertical datum of S-102 and S-104. If the vertical datums are the same then a single indication is enough to cover S-101, S-102 and S-104.