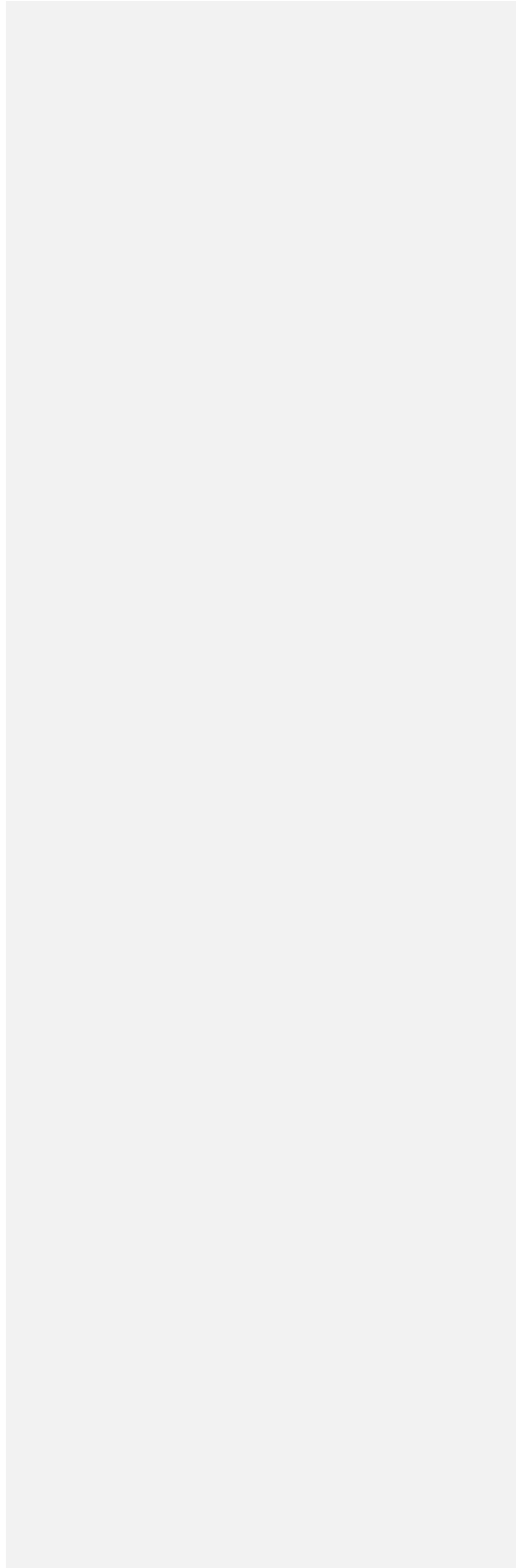


S-100 - Part 16A

HARMONISED PORTRAYAL OF S-100 PRODUCTS

Contents

1	Scope.....	1
2	Conformance	1
3	References	1
3.1	Normative references	1
3.2	Informative references.....	2
4	Introduction	2
4.1	Organisations and standards	3
4.2	Application systems concepts and limitations	6
4.2.1	ECDIS concept and limitations.....	Error! Bookmark not defined. 6
4.2.2	Integrated Navigation Systems (INS).....	Error! Bookmark not defined. 7
4.2.3	Electronic Chart Systems (ECS)	67
4.2.4	Other systems	68
5	General principles.....	78
5.1	Symbol harmonisation.....	79
5.2	Visual interoperability	810
5.3	De-cluttering strategies	810
6	Display Organisation and Operation.....	911
6.1	Display of significant features.....	Error! Bookmark not defined. 11
6.2	Operating modes.....	912
7	Colours	912
7.1	Colour assignment	1012
7.2	Colour tokens, profiles and palettes.....	1013
8	Text.....	1014
9	Pick reports.....	1114
10	Alerts and Indications	1115
11	Portrayal harmonisation between new versions of product specifications	1215
12	Dual-fuel systems	Error! Bookmark not defined. 15
13	Type approval considerations.....	Error! Bookmark not defined. 16
13.1	Minor deviations from registered symbols.....	Error! Bookmark not defined. 16
14	Portrayal considerations for product specification development (informative)	Error! Bookmark not defined. 17
14.1	Content harmonisation	Error! Bookmark not defined. 17
14.2	Harmonisation of portrayal catalogues.....	Error! Bookmark not defined. 17
15	Specifications for the display screen	1218
15.1	Physical display requirements.....	1218
15.2	Guidelines for reproducing features and symbols.....	Error! Bookmark not defined. 18
15.2.1	Size and complexity	Error! Bookmark not defined. 18
15.2.2	Zooming.....	Error! Bookmark not defined. 18
15.2.3	Summary of principles for reproducing features and symbols...	Error! Bookmark not defined. 19
15.3	Colour display capability.....	1219
	Appendix 16a-A Organisations and Standards	1420



1 Scope

This Part specifies the principles for harmonising portrayal and other presentational functionalities across different S-100 based data products for the purpose of improving the user experience and reducing ambiguities within systems utilising multiple S-100 based data products. It also describes the relevant International Maritime Organization (IMO) guidance and resources within International Hydrographic Organization (IHO) that support efforts in portrayal harmonisation. It does not address the portrayal process, functionality, or architecture, which are addressed in other S-100 Parts (especially 9 and 9A), but instead focuses on presentational design aspects, such as display organisation, colours, and symbology.

2 Conformance

This Part is not a profile of an ISO or other standard. Instead, it is based on – and, where possible, conforms to – specifications for the portrayal of Electronic Nautical Charts (ENCs) and general principles for ergonomics and Human-Computer Interaction (HCI). Much of this document is derived from the IHO S-52 standard, especially clauses 2, 3 and 4.

This Part is based on specifications that evolved from studies and discussions by IHO, IMO, International Electrotechnical Commission (IEC), and manufacturers. These efforts resulted in a set of related standards and specifications promulgated by IHO, IMO, and IEC, which are cited in the references section of this Part and summarised in Clause 4.1. The general principles for ergonomics and human-computer interaction (HCI) have been described in various HCI and ergonomics publications.

3 References

3.1 Normative references

- A.1021(26) Code on Alerts and Indicators (2009), IMO Resolution A.1021(26), 2009.
- 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 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.
- SOLAS V Safety of Life at Sea, Chapter V, Safety of Navigation, SOLAS Chapter V, 2002.

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

3.2 Informative references

- CSS2 Cascading Style Sheets, Level 2 (CSS2) Specification, W3C Recommendation 12-May-1998, REC-CSS2-19980512, World Wide Web Consortium, May 1998. URL: <http://www.w3.org/TR/1998/REC-CSS2-19980512> (retrieved 2020-08-12).
- CSS2.1 Cascading Style Sheets Level 2 Revision 1 (CSS 2.1) Specification, W3C Recommendation 07-June-2011, REC-CSS2-20110607, World Wide Web Consortium, June 2011. URL: <http://www.w3.org/TR/2011/REC-CSS2-20110607> (retrieved 2020-08-12).
- IALA G1105 Shore-side Portrayal Ensuring Harmonisation with E-Navigation Related Information, International Association of Marine Aids to Navigation and Lighthouse Authorities, Edition 1, 2013.
- 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 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.
- IMPA-PPU Guidelines on the Design and Use of Portable Pilot Units, International Maritime Pilots' Association, 2016.
- ISO 19117 Geographic Information - Portrayal. ISO Standard 19117 Edition 2, 2012.
- RTCM 10900.6 RTCM standard 10900.6 for Electronic Chart Systems (ECS), Radio Technical Commission for Maritime Services, July 2015.
- S-4 IHO Publication S-4, Regulations of the IHO for International (INT) Charts and Chart Specifications of the IHO, Edition 4.8.0, October 2018. (Parts B and C in particular.)
- S-52 IHO Publication S-52, Specifications for Chart Content and Display Aspects of ECDIS, Edition 6.1.1.1, June 2015.

4 Introduction

In any system where several types of data products and sensor inputs will be used on a common screen, there is a need to harmonise their portrayal in the user interface. Harmonisation is needed to ensure users are not misled by, for example, contradictory symbology, text or colours. Harmonisation also is also needed to reduce the risk of the screen becoming overloaded with information. Portrayal harmonisation is also needed to reduce the user burden in terms of training requirements and the quantity of visual variables which must be memorised and considered in assessing information displayed on screens, and to give improved predictability for system implementors. The IMO has developed guidance for presentation of e-Navigational related information and this guidance should be leveraged for any portrayal harmonisation framework.

This Part contains portrayal harmonisation that describes how S-100-based products should be used and displayed simultaneously. It is an overarching statement of principles which applies generally to all S-100-based Product Specifications. Since this does not depend on particular Product Specifications, flexibility is possible in the approach to designing and developing portrayal, and user interfaces, which should make it unnecessary to amend all involved product specifications should any additional product specifications be identified, or any portrayal rules need amendment.

One important aspect of this guidance is defining the classes of user system to which any guidance applies, as there are a great variety of potential users of S-100-based products. For purposes of portrayal harmonisation, this document divides applications and systems into the following broad categories (in practice often a matter of configuration and task rather than equipment or software):

- ECDIS, INS, and similar navigation display systems and applications - primarily used for voyage planning and monitoring, and collision avoidance, with ENC as primary geographical data; covered by SOLAS and require type approval for meeting carriage requirements;
- Electronic Charting Systems (ECS) and similar systems and applications (e.g. Portable Pilot Units (PPU)) - primarily used for route monitoring and voyage planning, with ENC or equivalents as the primary data; type approval not required;
- Other types of S-100 based user systems and applications, including shore systems.

Most S-100 based product specifications to date have been developed for ECDIS. ECDIS is a long-established and well documented concept, and since other users of S-100-based products are likely to know how the ECDIS concept relates to their systems, ECDIS is therefore the best-known user system upon which to model the portrayal harmonisation guidance.

Given the importance of ECDIS and other navigation displays (for route monitoring or voyage planning) to marine transport, this Part defines principles focused on such navigation displays as well as more general principles intended for other application domains.

4.1 Organisations and standards

Several organisations are involved in developing standards and guidelines for portrayal, alerts and indications, and other user interface elements. Figure 16a-1 below depicts the main organisations which contribute to the development of user interface standards and other specifications, and the main influences between different kinds of standards/specifications. The current set of standards and specifications relevant to portrayal and the user experience can be characterised as follows:

- Presentation, performance, and user experience standards for ECDIS and INS are generally developed under IMO control, and include standards and guidelines for display and user interaction, including alerts. Specification of navigation-related symbols, including chart symbols, have generally been assigned to IHO as the subject matter experts.
- The framework for data content and display is defined in IHO standards, primarily in the form of the S-100 standard, supplemented by the IHO Geospatial Information (GI) registry as a repository of data object concepts, type definitions, and symbology. S-100 also provides an abstract specification for visual interoperability for displaying multiple products on the same screen; the only concrete specification for interoperability at the time of writing is S-98, which covers EDCIS interoperability.
- Specifications for individual data products are produced by several organisations depending on the specific domain. Standards covering geographic data and marine services are developed by IHO, weather and ice-related product specifications is generally under WMO responsibility, navigational warnings are an IHO/IMO joint effort by the WWNWS sub-committee, specifications for Inland ENCs are produced by the Inland ENC Harmonisation Group (IEHG), and IEC manages a standard for route exchange¹.
- A product specification should include the symbols and portrayal rules for the data product, however where this is not included, the system can specify the portrayal rules for the resulting products. System specified portrayal rules should also follow the portrayal harmonisation guidance.
- Standards for testing operation and performance of equipment and systems are developed under IEC control.

The various categories of standards and specifications are generally interrelated and often co-dependent. IMO navigation and safety standards refer to IHO symbology for representing geographic features, IHO symbology is defined taking into account user interface guidelines in IMO standards, and the IEC operational, performance, and testing standards influence and are influenced by both IMO and IHO documents. Individual product specifications are based on the S-100 framework and are referenced by

¹ Other organisations are also developing S-100-based standards for information exchange, of varying relevance to portrayal and user interaction, shipboard or onshore. The list of product specifications in Figure 16a-1 is representative, not comprehensive.

testing guidelines. Product specifications are based on the S-100 framework and the features and attributes in their data models, as well as the symbols and colours they specify for portrayal of the data, should all be in registered in the IHO GI Registry. These interrelationships are depicted in [Figure 16a-1](#)~~Figure 16a-1~~.

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 Part and a mandatory requirement in an applicable cited standard, the requirement in the standard supersedes the guidance in this Part.

Summaries of the various standards and specifications are provided in Appendix A.

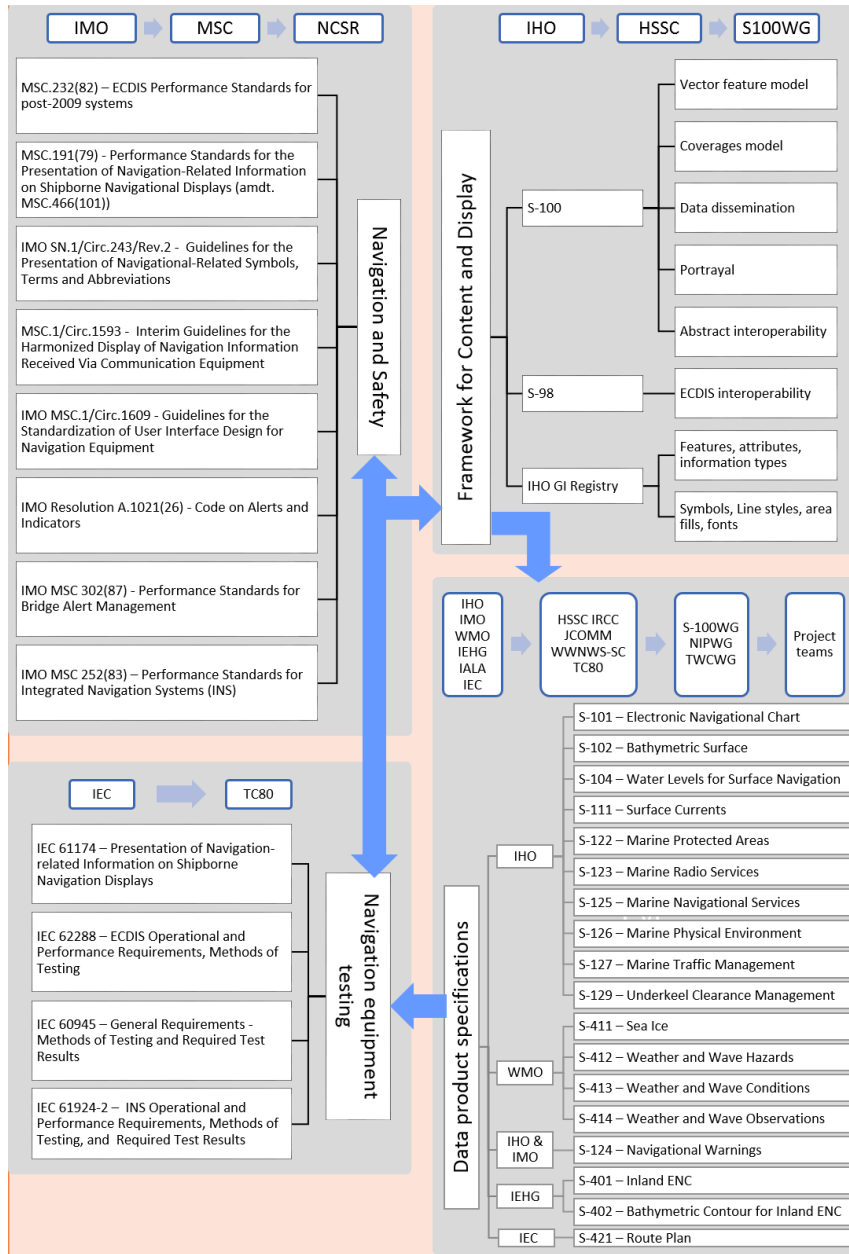


Figure 16a-14 – Overview of organisations, specifications, and user interface standards

Commented [JP1]: KR: Suggest adding Colour in the portrayal of IHO GI Registry (Figure 16a-1).

Suggest to add the S-128 in the list of IHO PS

Suggest to add S-200 series in the list of PS

Suggest to include S-100 schema in terms of the framework for content and display.

Commented [JP2R1]: ACTION: JP to update figure to make it less detailed.

Commented [JP3]: FR: It should be mentioned that the (incomplete) list of S-100 based products specifications is for illustration only.

Commented [JP4R3]: TDB on when we get a new diagram.

4.2 Application systems concepts and limitations

This clause describes the concept and limitations of the main types of application systems covered by this Part. ECDIS and INS are covered in S-98 and the focus of this clause is on considerations that affect content and behaviour of other systems.

4.2.1 Electronic Chart Systems (ECS)

ECS is a common denominator for all systems that portray electronic charts. RTCM 10900.6 defines Electronic Chart System as an electronic navigation system which complies with the requirements it sets or in IEC 62376. ECS systems may meet the ECDIS requirements, have additional functionality or be a simple tablet or phone with a GNSS function and capability to show electronic charts. RTCM 10900.6 gives a grading of ECS systems from Class A through D; where Class A is equal to an ECDIS backup and Class D is any device "intended to plot the position of ships that do not operate offshore. They are not required to have all of the functionality of a Class C ECS. They are required to display electronic chart information and plot a ship's position, but are not required to display eMSI, or to monitor the ship's position or to provide voyage planning or voyage monitoring functionality".

The graphical appearance of charted areas on the screen is usually similar to that of an ECDIS, with elements (e.g., borders or off-graphic indicators) added. These systems will generally also have additional data products loaded, for example official products containing Marine Protected Areas or Marine Radio Services, or unofficial products such as points of interest (POI) to leisure craft users.

ECS may provide functionality not available on ECDIS and while ECS may not be as constrained as ECDIS, such systems, if intended for shipboard use (e.g. Portable Pilot Units (PPU)), should, as far as practicable, follow the same principles for symbology and colours. Their text display elements, display organisations, pick reports, and user interfaces may be more elaborate than ECDIS (so as to allow users more access to information or more detailed information), but should have compatible structure and functionality (e.g., similar prominence for significant features, user interface labels and menu items should have the same meanings).

This principle is based on reducing, as far as possible, the cognitive switching penalty² when switching from planning to monitoring tasks on shipboard. The constraints in this clause are therefore less applicable to systems not intended for shipboard use (though *actual* use versus *intended* use must be considered).

4.2.2 Other systems

Portrayal harmonisation is also beneficial in other systems, such as those that cover shore-side and specialised systems not intended for onboard route monitoring or ship movement monitoring or control, or other tasks allocated to an ECDIS, INS, or ECS. An example of such shore side systems is Vessel Traffic Management Information System (VTMIS). VTMIS can be regarded as an extension of a Vessel Traffic Service (VTS), since its main purpose is an Integrated Maritime Surveillance system. VTMIS incorporates other resources to allow associated services and other stakeholders to directly share VTS data or access to certain subsystems in order to increase the effectiveness of port or maritime activity operations as a whole, but may not relate to the purpose of the VTS itself.

VTMIS are generally specified individually to the specific VTS but may be governed by national or regional regulations. For example, Directive 2002/59/EC of the European Parliament governs VTS inspections of European Maritime Safety Authority (EMSA) member countries. IALA provides guidance about portrayal of data and information in shore-side systems, including VTMIS (e.g. G1105 – Shore-side Portrayal Ensuring Harmonisation with E-Navigation Related Information).

Generally, ENC charts form the base layer in a VTMIS and other data sources form layers of additional information or enhanced information to aid the VTMIS operator in monitoring and decision making. Examples of additional layers included radar and AIS for target tracking, AIS-ASM (AIS Application Specific Messages) for sensor information such as met-hydro information, air gaps and special zones such as irregular speed zones. Moreover, radio services may form an integral layer for service assistance. Other examples include

² See, for example, "Multitasking: Switching costs", American Psychological Association <<https://www.apa.org/research/action/multitask>>.

MSI such as navigational warnings and meteorological warnings. Oceanographic information such as surface currents and water level may also be important layers.

5 General principles

IMO Guidelines for the Presentation of Navigational-Related Symbols, Terms and Abbreviations (SN.1/Circ.243/Rev.2) notes in section 15, the principles applied when designing the appendices to the guidelines. Not all these principles are directly applicable to harmonisation of portrayal between data products as they are mainly applicable for Human Machine Interfaces. However, even the principles that are not directly applicable still provides important indirect guidance that can positively influence portrayal harmonisation. Particularly noteworthy principles are:

- consistency in use of symbols and patterns referencing Appendix 2 which provides information on icons, symbols and abbreviations that require standardization. Consistency enables recognition and detectability across the user interfaces of different navigation systems. Humans react positively to patterns and logical groups of items, and use categories to search for individual bits of information. User testing can identify groupings and patterns of information that should be prioritized for consistency. Patterns incorporate the way in which someone uses information and the types of information that are grouped together.
- using location and grouping for consistency provides for recognition. Human perception and search work faster with cues than complete recall, especially when aided by consistency. The user must recognize where information is, or how to perform a process. In performing functions, the user should not need to recall where something is located, or the process for doing something. This is the ability for the user to recognize an event, process or information flow rather than recall the detail of how to get to that point. This is integral to usability.
- prevent errors by ensuring users always see navigational critical information. Prevent errors, emergency exit – Continuous testing during development will identify possible error paths that can be removed. Users should be aware of how to navigate back to the start of a process, and also be aware of where they are in that process. The user should always be able to see navigation critical information even if layers of information are interwoven with the ENC/Radar.

Portrayal harmonisation must also consider if there should be a fixed set of layers that must be within the scope of the rules or if the rules should be more flexible to accommodate additional layers, such as future products or regional specialities. For example:

- a fixed list of layers gives predictability for implementers, since most variables are known and can be accounted for.
- a fixed list of layers is inflexible since new layers cannot be added without creating a new version of the rules and implementers may need to update user systems to add new layers.
- a flexible list of layers necessitates that the rules be more general and therefore easier to maintain, with less likelihood of having to create a new version of the rules for new layers. Also, users may create their own combinations and add layers as per need, such as in regional special circumstances.
- a flexible list of layers gives implementors less predictability of what layers to expect with higher possibility of unexpected layer combinations. This necessitates more testing and more flexible user settings to accommodate user defined layer combinations, and avoid clutter that impact system usability.

Portrayal harmonisation guidelines apply to both vector and coverage type data as far as practical.

5.1 Symbol harmonisation

Symbols are used to visually convey information and when utilized in the same environment, e.g. marine, need to convey consistent information regardless of which product they are used in. As noted in IMO SN.1/Circ.243/Rev.2, “consistency enables recognition and detectability across the user interfaces of

different navigation systems. Humans react positively to patterns and logical groups of items, and use categories to search for individual bits of information. User testing can identify groupings and patterns of information that should be prioritized for consistency. Patterns incorporate the way in which someone uses information and the types of information that are grouped together". Symbols should therefore be harmonised for products used in the same general class of system/application to ensure the risks of contradictory messages are reduced as much as possible.

Symbols should be designed in accordance with the guidance within IMO SN.1/Circ.243/Rev.2 and IHO S-4. These two documents should be the first source of finding portrayal for features that need visualization in a navigation system. If suitable symbology is not found in either of these documents, the IHO Nautical Cartography Working Group (NCWG) is tasked with coordinating portrayal for IHO related products and may be able to offer assistance. Given IHO's leadership in defining the portrayal of the chart, all organizations that produce data products intended for the navigation screen or related systems should coordinate the development of any new symbology with IHO NCWG.

New symbology should be tested within the product itself, and also in all expected product combinations to ensure sufficient harmonisation and that any risk of ambiguities is sufficiently addressed.

5.2 Visual interoperability

The Interoperability Catalogue Model, see Part 16, is a framework that can be used to create a catalogue of rules for how to combine a set of layers. This set can be a fixed list or a flexible approach.

The S-100 product specifications may have only considered portrayal harmonisation with ENC, is also a S-100 Product Specification. Therefore, when several layers are visualized simultaneously there is a risk of clutter that may obscure significant features and increase the risk of unsafe operation. The Interoperability Catalogue Model framework should be utilized to limit the number of simultaneous on-screen layers to a logical set, for example by using the preconfigured combination function in normal operating mode, whilst permitting more flexibility for users with specialized requirements. Logical sets can be viewed as those layers useful in a particular operation. Within a logical set significant features should be given priority. Significant features may be regarded as those features that must not be turned off at any moment during important operations, such as route monitoring in navigation systems. In ECDIS and ENC significant features are considered to be in the display base. In other S-100 based products and systems there may also be significant features and these should be considered in the same spirit as the display base defined in the IMO ECDIS performance standard (Resolution MSC.232(82)). Great care should be taken when combining layers to minimise the risk of obscuring any significant feature. Considerations should be given to making the use of the pre-defined combinations of Product Specifications concept to limit the possible combinations, and to assign viewing group layers to specific pre-defined combinations of Product Specifications.

5.3 De-cluttering strategies

All S-100 based product specifications that include portrayal need to consider decluttering strategies. This is necessary to reduce the risk of clutter when conforming data products are utilized in user systems either in isolation or as a layer within a larger ecosystem. Any S-100 based products used in isolation may cause screen clutter in a system when used at a scale where the screen density of the data content start interfering with each other. Similarly, when S-100 based data products are used as layers in a system, the data density may be such that the content start interfering with each other due to quantity of content even at larger scales due to quantity of content. Either scenario needs to be considered by product specification developers and system implementers, and mitigation strategies need to be employed.

One clutter mitigation strategy that can be employed is to introduce scale bands in the products to limit data density at the various scale ranges by generalization at lower scales, including thinning for raster data, while including the greatest detail at the largest scales. This method works best on the individual product series as it cannot account for impacts of any other layers, but adding scale bands can be part of an overall clutter mitigation strategy for the most feature dense products.

A second mitigation strategy can be adding scale minimum and scale maximum attributes to portrayed feature classes to turn off less significant information at either small scales or large scales. The scale

Commented [JP5]: IIC: I don't believe introducing scale usages reduces clutter. Scale bands are a good way of reducing the number of distinct datasets for an area of coverage and for assigning particular features to a scale banding within a geographic area. This doesn't reduce clutter but can form the foundation for organising coverage over a region and avoiding unnecessary overlaps.

Adjust Paragraph

Commented [JP6R5]: ACTION: JP to propose new words

minimum attribute is used as a limit to indicate the scale at which portrayal of a feature is turned off as the screen is scaled to smaller scales, for example by turning off point symbols that start interfering with each other due to density at smaller scales. The scale maximum attribute is used to turn off the feature portrayal at large scales, for example large areas that may be considered of less significance at large scales and can cause clutter, for example by area patterns. This method works best on the individual product series as it cannot account for impacts of any other layers, but can be part of an overall clutter mitigation strategy. Producers should ensure consistency between products.

Configuring an interoperability catalogue can be a third mitigation strategy by defining rules for how predefined combinations of products should interact, by for example turning off less significant features in one product to enable easier identification of more significant features in other products. Interoperability catalogues can also be used to define rules for combining data from different products into hybrid features that can eliminate the need to portray multiple copies of the original data. Utilization of an interoperability catalogue is most suitable for situations where multiple layers interact and are at risk of causing screen clutter.

These three strategies are not mutually exclusive and any combination of them can be utilised as well as in combination with other methods for clutter mitigation. Additional strategies are discussed in the subsequent sections.

6 Display Organisation and Operation

Some systems have detailed specifications and requirements established, e.g. ECDIS. Other systems may have less strict rules and requirements but may follow similar patterns in full or in parts of other performance standards. Examples of such systems can be Portable Pilot Units (PPU) which may follow some of the ECDIS performance standards because they are both used in the same environment and utilize much of the same data, additionally PPUs may have local adaptations to the regions they are utilized in. In general, the parts of portrayal guidance that relate to display organization and system operation are applicable to all S-100 based product specifications regardless of the intended systems that will use the S-100 based data that derive from these product specifications (though systems may provide elaborations on basic organisations, as outlined in Clause 4.2.2 of this Part).

6.1 Operating modes

Some systems (e.g., ECDIS) are designed with different colour modes to account for ambient light conditions on the bridge of the vessel. These modes support an operating environment that preserves the navigator's light sensitive vision which can be critical in spotting situations that impact safety of navigation, especially at night. All S-100 based product specifications that are intended for navigation screens should support the operating modes of the navigation system where the data product is intended to be used. Note that IMO/IEC performance requirements for certain systems, such as ECDIS, may require such support. Manufacturers and users of S-100 products whose portrayal catalogue does not have a suitable colour mode for any combination of system type and lighting conditions are invited to discuss the matter with IHO.

The IHO ENC Standards Maintenance Working Group (ENCWG) is tasked with managing S-52 - Specifications for Chart Content and Display Aspects of ECDIS which specify the portrayal rules for S-57 ENCs. The Nautical Cartography Working Group is tasked with coordinating portrayal. Jointly these two working groups may be a good source for advice on colour usage in different portrayal operating modes.

Given IHO's leadership in defining the portrayal of the nautical chart with the Nautical Cartography Working Group (NCWG), all organizations that produce data products intended for the navigation screen should coordinate their colour usage with IHO. Recommendations for colour usage in different portrayal operating modes on ECDIS will be published in an Annex to the IHO ECDIS interoperability specification.

7 Colours

Colours and combinations of colours often have specific meanings associated to them; this is also true for navigation displays. For example, on a chart black usually means a physical object or boundary (e.g. coast

line), while magenta usually means a non-physical object or boundary (e.g. restricted area boundary). Other examples include buoyage systems marks where combinations of yellow and black bands are used to indicate a cardinal direction from a known danger.

Another consideration with colour choices is that any symbology using red may be an issue for any system operated in night conditions as these symbols may become very difficult to distinguish in red ambient light often used to preserve night vision. Therefore the use of red should be avoided where possible and always used with a symbol shape that improves recognition. Adding text can also reduce risk of mix-ups.

With so many implications on colour choices for portrayal, it is important to ensure that the use of colour is harmonised between layers and systems to reduce the risk of giving the user ambiguous information. Product specifications should attempt to use existing colours registered within the IHO Portrayal Registry.

Given IHO's experience and leadership in defining the portrayal of the chart, all organizations that produce data products intended for the navigation screen should coordinate their colour usage with IHO. Within IHO the Nautical Cartography Working Group is tasked with coordinating portrayal.

7.1 Colour assignment

Colour assignments for ECDIS, INS, and any similar navigation systems covered by IMO Performance Standards must conform to S-98 Colour Assignments.

Colour assignments for bridge or charthouse systems not covered by IMO Performance Standards for navigation systems should conform to S-98 Colour Assignments, but may add other colour assignments as necessary for their purposes.

Colour assignments for other systems may conform to S-98 Colour Assignments, but may depart from or extend it, depending on application requirements or user environments.

7.2 Colour tokens, profiles and palettes

S-100 based product specifications use the S-100 portrayal concept which consists of several components that can be registered in the GI Registry and may therefore be shared among different product specifications. Colour tokens and colour profiles are examples of such shareable concepts. The colour tokens are used in portrayal catalogues to specify the particular variation of a general colour using an address in sRGB and/or CIE colour space coordinates. Historically, several colour tokens have been assigned to specific usages within ENC for concepts such as depth areas, land areas, regulated areas, buoys, lights, etc. These feature concepts may be reused in any S-100 based product specifications, which may also add their own colour tokens. This necessitates harmonisation of the use of colour tokens. When a feature concept is portrayed by two or more product specifications it is recommended that the same colour tokens are used in all portrayal catalogues.

8 Text

IMO MSC.191(79), as amended, requires in section 5.2.3 that text be presented using simple unambiguous language that is easy to understand. Navigation terms and abbreviations should be presented using the nomenclature defined in the Guidelines and encouraged their use for all shipborne navigational systems and equipment (see SN.1/Circ.243, as revised and Appendix 2 of IMO MSC.1/Circ.1609). Similarly, S-4 (Section 500 - Text: Language, Numbers, Abbreviations, Names, Styles and Fonts) has defined common navigation terms and abbreviations that are used in the presentation of navigational information. This textual guidance should jointly with the IMO guidance be used as a reference for harmonising the use of text in S-100 based Product Specifications intended for navigational use.

It is recommended that the guidance in IMO MSC.1/Circ.1609 be adhered to as it notes that when icons, terms and/or abbreviations are used, these must meet the requirements of the guideline. Moreover, it is noted that where a standard term, abbreviation, or icon is not available, another icon, term or abbreviation may be used, but these should not conflict with those listed in the aforementioned guideline. Therefore, where terms or abbreviations are not available in IMO MSC.1/Circ.1609; IHO S-4 and IMO SN.1/Circ.243, as revised, should be examined for suitable alternatives. Only when these guidelines have been examined and found to not contain the suitable terms or abbreviations, should considerations be given to creating new

terms or abbreviations. If new terms or abbreviations are created after due consideration of the above mentioned recommendations, efforts should be made to add the new terms or abbreviations to the suitable guideline to ensure harmonisation.

While the above mentioned IMO instruments are specifically intended for ECDIS, other classes of systems or applications intended for use in the marine context should use the same terms and abbreviations.

9 Pick reports

IMO Circular 1609 notes that “large variations in the user interfaces of electronic equipment can significantly inhibit an operator’s effectiveness in performing navigational tasks. Where there is significant variation in buttons, icons, actions, workflows, processes, units of measure or location of information, there is a commensurate increase in the time required for equipment familiarization and the risk of operational error, particularly in challenging navigational situations”. Pick reports have historically been defined for the individual product specification or by the implementor, leaving room for ambiguity that has led to difficulties for users. Additional challenges for the user may occur when two or more products that are being used simultaneously have conflicting configurations for pick reports. Similar complications can also be encountered when different systems in use have significantly different user interfaces for the same type of data. This would also require additional training to familiarize users with products that can be safety critical. Harmonised portrayal pick reports should therefore be a goal for any system that will use S-100 based products.

Pick reports should allow access to information from all visible/enabled underlying products. Data should be organized to facilitate navigation through complex reports in a manner that is logical when considering the layer order displayed on the screen. Human Machine Interface (HMI) strategies should be well-thought-out to make the task of reviewing the pick report requiring as little effort as possible for the user. This can be facilitated by harmonised look and behaviour across products and systems when used in the same operational mode or same context. This implies that product specifications remain flexible on how pick reports are designed. Flexibility should also be given to permit some variation between operation modes where appropriate. Pick reports should have a sort order that reflects the priority of the products on the screen.

10 Alerts and Indications

All product specifications that are intended for a navigation context should specify any feature combinations that match one or more of the areas for which alert or indication should be given to ensure there is a harmonised implementation in user systems. Such specification could be done using a machine-readable alerts and indication catalogue, but caution is needed as this catalogue will likely be developed for one specific system, such as ECDIS. Therefore, implementers may find that some of the content of an alerts and indication catalogue is not applicable for a non-ECDIS system and only a subset should be utilized. This may also necessitate development of additional system specific alerts or 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. In Appendix 4 and Appendix 5 of the same resolution details of which areas ECDIS should detect and provide an alert or indication for are given. This guidance is sufficiently high level that it should be useful for most S-100 based products and other relevant systems, and should therefore be consulted when designing alerts and indications.

Within IHO the ENC Standards Maintenance Working Group (ENCWG) is tasked with managing S-52 - Specifications for Chart Content and Display Aspects of ECDIS which specify the portrayal rules for S-57 ENC. This includes guidance for which feature attribute combinations should be considered to match the IMO ECDIS Performance Rules on alerts and indications. Given IHO’s leadership in defining the portrayal of the chart, and the interdependence of portrayal with other safety critical behaviour of systems, all organizations that produce data products intended for the navigation screen should coordinate their alert and indication rules with IHO.

11 Portrayal harmonisation between new versions of product specifications

S-100 based product specifications are largely maintained using the S-100 maintenance regime, which classifies revised versions as clarifications, corrections, or new editions. These categories correspond to increasing significance and complexity. New functions are generally recommended to be in a new edition. This means that new portrayal elements, such as new symbols, may require a new edition of a product specification. The reasons behind such new symbology can be varied, such as changes to IMO guidelines, new user requirements or new technology. When new editions are required, it is important to carefully consider the impact of any portrayal change, as significant changes may have major consequences on equipment and users. If there is proper justification for a significant change to portrayal between versions of a product specification, appropriate means should be taken to communicate these changes with sufficient time for users and systems to adapt. The standard lifecycle process detailed in IHO Resolution 2/2007, as amended, should be adhered to for IHO products; other organisations should either use the same process or adopt an equivalent process.

12 Specifications for the display screen

This clause describes general requirements for display screens. More detailed requirements are provided in specific standards applicable for different classes of systems. For example, IMO MSC 232(82) specifies the requirements for ECDIS.

12.1 Physical display requirements

The minimum effective size of the geographic portion of the display should be such that key information is generally visible without scrolling the display and user interaction directly with the geographic display, if any, is possible without requiring excessive user concentration under typical conditions.

The details of how this principle applies to particular systems should be determined by analysing user tasks and user performance under expected and critical environmental conditions. Touch target sizes should take typical viewing distances into account.

Particular classes of systems may have minimum sizes set by controlling standards, for example, MSC 232(82) requires for ECDIS that the minimum effective size of the chart presentation for route monitoring is at least 270 mm x 270 mm.

12.2 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 "blackier than black", i.e. complete control of colour, and that the software can control that function.

Displays must be capable of maintaining colour discrimination between symbols defined in the portrayal catalogues for the data products which may be used for tasks performed on the display. Typical users should be able to distinguish between colours which may be specified for the symbols they encounter in the performance of the task using the display.

Particular classes of systems may be subject to specific standards for colour conversion tolerances. For example, the ECDIS standards for colour conversion tolerances and colour calibration are described in the applicable ECDIS requirements, performance and test standards.

Specifications for particular classes of systems (in particular, ECDIS) may include a colour differentiation test diagram. 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;
- 3) for initial colour verification of the day, dusk and night colour tables.

Appendix 16a-A Organisations and Standards

16a-A.1 International Organisations and Standards

The IMO has issued recommendations and guidelines on how to present navigation related information. Of particular significance are the documents noted below.

- MSC.191(79), Recommendation on Performance Standards for the Presentation of Navigation-Related Information on Shipborne Navigational Displays, specifies the presentation of navigational information on the bridge of a ship, including the consistent use of navigational terms, abbreviations, colours and symbols, as well as other presentation characteristics. It also addresses the presentation of navigation information related to specific navigational tasks by recognizing the use of user selected presentations in addition to presentations required by the individual performance standards adopted by the Organization.
- IMO SN.1/Circ.243/Rev.2, Guidelines for the Presentation of Navigational-Related Symbols, Terms and Abbreviations, stems from a compelling user need for greater standardization to enhance usability across navigation equipment and systems. Significant variation between systems and equipment produced by different manufacturers has led to inconsistency in the way essential information is presented, understood and used to perform key navigation safety functions. Improved standardization of navigation systems will provide users with more timely access to essential information and functions that support safe navigation.

MSC.191(79) and guidelines in SN.1/Circ.243/Rev.1 continue to apply as follows:

- To radar equipment, electronic chart display and information system (ECDIS) and integrated navigation systems (INS) installed before 1 January 2024; and
- To all other navigational displays on the bridge of a ship installed before 1 July 2025.

MSC.191(79), as amended by resolution MSC.466(01), and guidelines in SN.1/Circ.243/Rev.2 are to be applied to equipment installed on or after the dates specified above³.

- MSC.1/Circ.1593, Interim Guidelines for The Harmonized Display of Navigation Information Received Via Communication Equipment, provides interim guidelines for the display of navigation-related information received via communication equipment. It aims to ensure that information is displayed in an efficient, reliable and consistent format, in a manner that is easily interpreted to support decision-making. These Guidelines supplement the Performance standards for the presentation of navigation-related information on shipborne navigational displays (resolution MSC.191(79)) in regard to the presentation of navigation information received via communication equipment. The use of these Guidelines will ensure that navigation information received via communications equipment is displayed in a harmonised manner on the ships' navigational bridge.
- IMO MSC.1/Circ.1609, Guidelines for the Standardization of User Interface Design for Navigation Equipment, apply to Integrated Navigation Systems (INS), Electronic Chart Display and Information Systems (ECDIS) and radar equipment. They may also be applied to other electronic navigation equipment, and navigation sensors, where applicable, to improve standardization and usability. The aim of the Guidelines is to promote standardization of user interfaces to help meet user needs. The Guidelines have been developed in close collaboration with an international association of equipment manufacturers to ensure its efficient implementation. These Guidelines also aim to leave room for future innovation and development while still addressing the primary user need for standardization and usability. Improved standardization of the user interface and information used by seafarers to monitor, manage and perform navigational tasks will enhance situation awareness and safe and effective navigation.
- IMO Resolution A.1021(26), Code on Alerts and Indicators (2009), defines a classification of alerts (as emergency alarms, alarms, warnings, and cautions) and provides general design guidance and

³ Anticipated dates are as of March 2020. Dates may be revised by IMO, and should be confirmed from the latest relevant IMO resolution/circular.

principles for achieving uniformity of type, location and priority for required alerts and indicators, as prescribed by SOLAS, other international conventions, shipping codes, and IMO performance standards and guidelines.

- IMO MSC 302(87), Performance Standards for Bridge Alert Management, describes performance standards for harmonising the priority, classification, handling, distribution and presentation of alerts.
- IMO MSC 252(83), Performance Standards for Integrated Navigation Systems (INS) describes requirements for the integration of navigational information, task-related requirements, alert management, and documentation requirements for an INS. These requirements supplement the performance standards for individual components. MSC 232(86) applies to equipment installed in 2011 and after; its predecessor, Annex 3 of MSC 86(70), applies to equipment installed from 2000 to 2010.

The IEC Technical Committee TC80 have developed standards for equipment, general and performance requirements, methods of testing, and symbols for selected non-geographic information (e.g., ship activity, AIS, and radar information).

- IEC 61174 specifies the performance requirements, methods of testing and required test results of equipment conforming to IMO performance standards. This standard is based upon the performance standards of IMO resolution MSC.232(82). Reference is made, where appropriate, to IMO resolution MSC.232(82). It also includes relevant extracts from IHO publications (S-32, S-52, S-57, S-61, S-63 and S-64).
- IEC 62288 specifies the general requirements, methods of testing, and required test results, for the presentation of navigation-related information on shipborne navigational displays in support of IMO resolutions MSC.191(79) and MSC.302(87).
- IEC 60945 describes testing methods, operational tests and required test results for shipborne navigational equipment and electronic navigational aids. It is based on IMO Resolution A.694(17). IEC 60945 also covers shipborne radio equipment as well as addressing potential electromagnetic interference from other types of equipment.
- IEC 61924-2 describes requirements for the design, manufacture, integration, methods of testing and required test results for an INS to comply with the IMO requirements of MSC.252(83).

IHO standards and specifications describe data products, data content, data updating, and display, symbols and representations for geographic information, natural conditions, navigational hazards, and selected non-geographic information such as regulatory and administrative information.

ECS is a common denominator for all systems that portray electronic charts. RTCM 10900.6 defines Electronic Chart System as an electronic navigation system which complies with the requirements set forth in this standard or in IEC 62376. ECS systems may meet the ECDIS requirements (e.g., backup ECDIS) or be a simple tablet with a GNSS function. RTCM 10900.6 gives a grading of ECS systems from Class A through D; where Class A is equal to an ECDIS backup and Class D is any device "intended to plot the position of ships that do not operate offshore. They are not required to have all of the functionality of a Class C ECS. They are required to display electronic chart information and plot a ship's position, but are not required to display eMSI, or to monitor the ship's position or to provide voyage planning or voyage monitoring functionality".

Portable Pilot Units (PPU) – The International Marine Pilots Association (IMPA) has issued a Guideline on the Design and Use of Portable Pilot Units. The guideline is high level, but stress that pilotage is a local matter and therefore no PPU solution can meet all needs in all pilotage areas. Therefore, PPU's are tailored to a particular pilotage area and there are a number of configurations that may be utilised.

Shore-side and specialised systems not intended for onboard route monitoring or ship movement monitoring or control, or other tasks allocated to an ECDIS, INS, or ECS see IALA G1105 – Shore-side Portrayal Ensuring Harmonisation with E-Navigation Related Information.