NCWG10-12.02.A

Paper for Consideration by NCWG

Best Practices for Creation and Maintenance of ENC-Derived Paper Nautical Charts

Submitted by:	United States (NOAA)
Executive Summary:	This paper presents the best practices and issues to consider for the creation and maintenance of ENC-derived paper nautical charts, which NOAA calls, NOAA Custom Charts. Although developed by NOAA, some or all of the guidance may also be applicable for other hydrographic offices, agencies, and companies that are developing ENC-derived nautical charts.
Related Documents:	NCWG10 meeting documents listed under NCWG10-08
Related Projects:	IHO NCWG Baseline Symbology Project Team (BSPT)

Introduction / Background

The objective of the guidance presented is to facilitate the production of paper nautical charts that are functionally similar to traditional charts described and specified in the IHO S-4, *Regulations for International (INT) Charts and Chart Specifications of the IHO.*

The U.S. National Oceanic and Atmospheric Administration (NOAA) has written a *Best Practices for Creation and Maintenance of ENC-Derived Paper Nautical Charts* document (see Addendum), which provides general guidance and recommendations for entities wishing to produce ENC-derived paper nautical charts in an automated or semi-automated manner.

The content should be considered as "best practices," rather than mandatory requirements. Every chart production system is different and the guidance presented here may be more applicable to some systems and situations than to others.

Only the content of the document is included. That is, the cover and other front material is not part of the addendum to this paper.

Analysis/Discussion

Twenty-three separate topics are presented, including best practices to maintain, issues to consider, and chart characteristics to obtain while creating ENC-derived paper nautical charts. Nautical charts that follow this guidance are more likely to meet U.S. Coast Guard – or other national marine regulatory agency – requirements for chart carriage. ENC-derived paper nautical chart production methods that do not consider these matters may not support safe marine navigation.

As cartographic technology and techniques advance and the production of S-101 based ENC data becomes available, ENC-derived charts may become even more like the much admired, hand-crafted traditional nautical charts that have been produced for centuries. In the meantime, while it is hoped that ENC-derived charts are just as useful for marine navigation as traditionally crafted paper nautical charts, some characteristics of ENC-derived charts, such as minor (but still legible) overprinting of labels or the placement of all chart notes outside the neatline, must be accepted if the benefits of automation are to be realized.

A few of the benefits include, complete synchronization of the paper chart with similar scale ENC content at the time a chart is created, as well as freeing cartographers to focus their efforts on improving electronic navigational chart coverage or for other purposes related to electronic navigation.

The NCWG BSPT has developed and recommended a standard set of colours to use for ENC-derived charts and is creating a standard baseline set of S-4 symbols in SVG format – the same format used for S-101 ECDIS symbology. The NOAA best practices document recommends adopting the BSPT colours, SVG symbols, and the associated portrayal rules. This will further the uniformity of ENC-derived chart products.

Conclusions
This general guidance, specific to the creation of ENC-derived paper nautical charts – in addition to the generic paper nautical chart requirements and guidance found in S-4 – can provide greater consistency for ENC-derived charts created from any ENC data by any chart producer.

Recommendations
All hydrographic offices, agencies, and companies that are developing ENC-derived nautical charts should consider adopting these or similar guidelines for automated chart production.

Justification and Impacts
Greater consistency of ENC-derived charts.

Action Required of NCWG
The NCWG is invited to:

a. note the paper.
b. continue to support the efforts of the NCWG BSPT.

NCWG10-12.02.A

ADDENDUM

NOAA Technical Memorandum

Best Practices for Creation and Maintenance of ENC-Derived Paper Nautical Charts

Table of Contents

Figures

Tables

Abstract

This document provides general guidance and recommendations for hydrographic offices, government agencies, and commercial enterprises wishing to produce ENC-derived paper nautical charts in an automated or semi-automated manner. The content should be considered as “best practices,” rather than mandatory requirements. Every chart production system is different and the guidance presented here may be more applicable to some systems and situations than to others.

Key Words: navigation, electronic navigational chart, paper nautical chart.

Introduction

The objective of this guidance is to facilitate the production of paper nautical charts that are functionally similar to traditional charts described and specified in the International Hydrographic Organization (IHO) S-4, *Regulations for International (INT) Charts and Chart Specifications of the IHO*. However, fully realizing the aesthetics achieved in nautical charts created by cartographers is currently unobtainable through automation. While it is hoped that ENC-derived charts are just as useful for marine navigation, some characteristics of ENC-derived charts, such as minor (but still legible) overprinting of labels or the placement of all chart notes outside the neatline, must be accepted if the benefits of automation are to be realized. A few of the benefits include, complete synchronization of the paper chart with similar scale ENC content at the time a chart is created, as well as freeing cartographers to focus their efforts on improving electronic navigational chart coverage or for other purposes related to electronic navigation.

As the automation of ENC-derived charts is developed, there may be representations of a few features specified in S-4 that are inordinately difficult to automate, for which an equally useful portrayal of the feature could be developed to support automation. In these cases, it may be prudent to modify the specification of the feature's portrayal across all chart applications or specify an alternative representation to be used in automated chart production.

Some national preferences and practices, implemented in conventional chart production systems, have intentionally created charts that diverged somewhat from certain S-4 specifications. These differences are shown in the "Representation following national specification" column of national editions of INT1 or Chart 1 documents that serve as legends for national chart symbology. This guidance is not intended to enforce compliance with S-4. The expectation is that any chart producing entity would have the same latitude for deviating from S-4 in creating ENC-derived charts, as required by national needs, as they have had in traditional chart production.

1. Electronic Navigational Chart Data Formats

ENC-derived charts may be created from ENC data specified by either the original S-57 product specification in the *IHO Transfer Standard for Digital Hydrographic Data* or the new S-101 *ENC Product Specification*. The data used should be of the most current ENC revisions available. Although charts may be said to be derived "directly" from ENC data, it is more likely that the data must be transformed into a format and structure that the system using the ENC data may more easily read and manipulate, called a System Electronic Navigational Chart (SENC). This enables the software being used to create the paper chart image more efficiently.

2. Projection

ENC-derived paper charts should use a Mercator Projection, as traditional paper charts do. This preserves angles – straight lines have a constant compass direction, and distances may easily be scaled from the latitude ticks in the rectangular graticule.

3. Trans-Boundary Data

Charts that cross boundaries of ENC coverage maintained by different producers – whether they are international maritime boundaries or not – pose challenges in creating seamless ENC-derived charts. The logistics of sharing and updating ENCs between agencies presents potential issues with copyrights and how to provide secure and timely access to the data. The alternative is creating derived charts where portrayal of the coverage abruptly ends at the data boundary. This approach is counter to traditional nautical chart scheming in which chart coverage overlaps to enable mariners to transfer a ship's position to an adjoining chart as the vessel nears a chart's edge. If complete chart coverage is to be rendered in ENC-derived charts, bilateral or multilateral data sharing agreements for transboundary ENC cells will be necessary. Figure 1 shows an example of missing data on a NOAA custom chart, where U.S. NOAA ENC coverage is portrayed and the area where the Canadian Hydrographic Service (CHS) provides ENC coverage is blank.

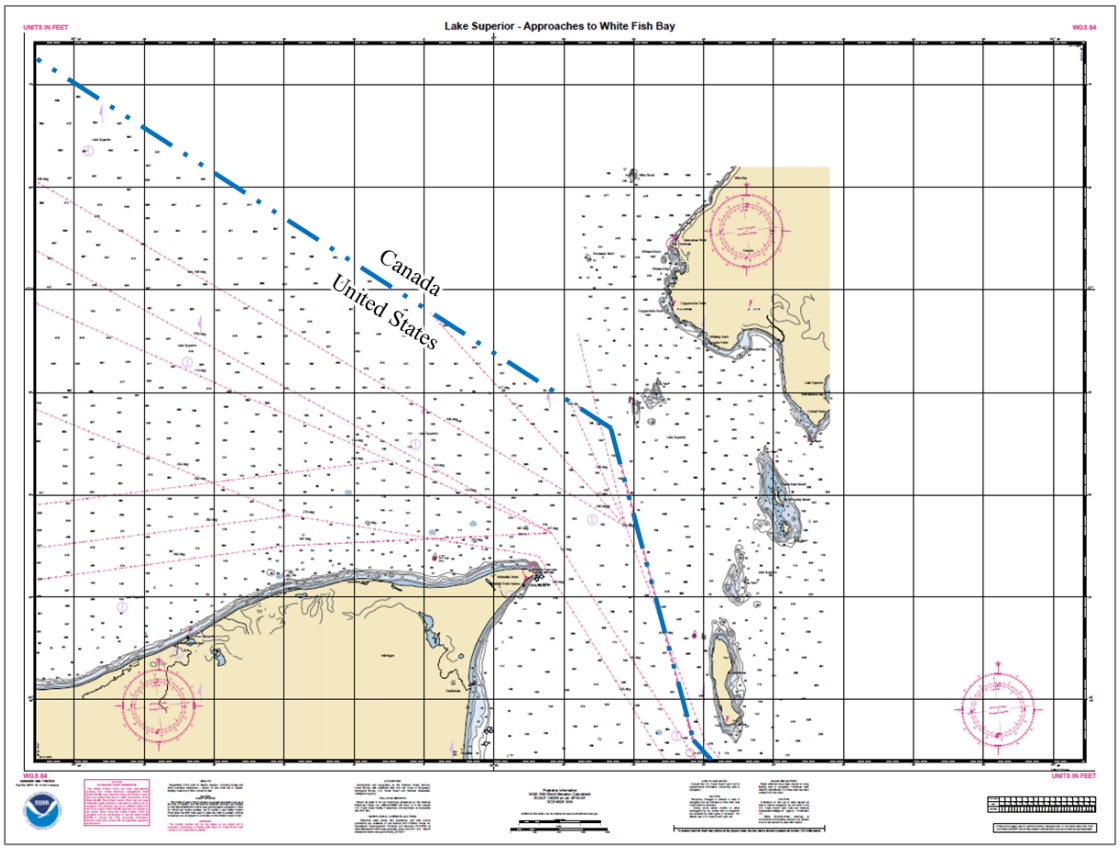

Figure 1. NOAA custom chart of White Fish Bay in Lake Superior, showing the international border in blue and a blank area, north of the border, where Canadian Hydrographic Service ENC coverage is not portrayed.

Through an existing agreement the U.S. currently has responsibility for part of the ENC approach usage band 4 coverage north of the international border in this area, as shown by the red polygons in Figure 2. NOAA and CHS are each refining their own ENC-derived chart production methods and are aware of the problem of creating charts along the international border, but have not yet arrived at a solution to resolve the issue.

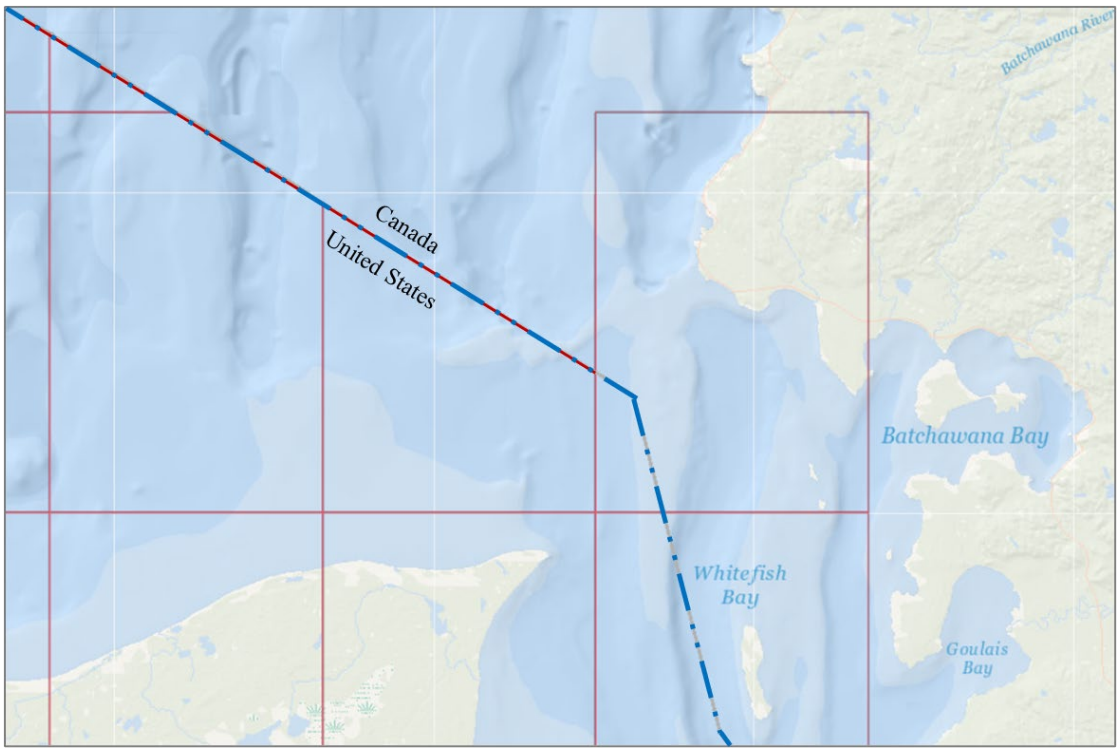

Figure 2. U.S. Canada international border through White Fish Bay,
shown by blue dashed line and U.S. band 4 ENC coverage shown by red polygons.

4. Symbology

Standard symbols, colors, and presentation rules are the basis for the consistent portrayal of ENC data on Electronic Chart Display and Information Systems (ECDIS). The same is true for the automated production of paper charts derived from ENC data, in which the chart image is printed onto paper instead of being displayed on a computer screen.

The IHO Nautical Cartography Working Group (NCWG), which maintains the S-4 specification, established a Baseline Symbology Project Team (BSPT) that is developing a standard set of digital symbols in Scalable Vector Graphics (SVG) format. SVG is an especially useful format for defining complex graphics. These SVGs are based on the existing traditional paper chart symbols specified in IHO S-4. Adoption of the BSPT symbols and portrayal rules for ENC-derived charts will ensure compliance with S-4 paper chart specifications — with a few exceptions for depiction of features that may not currently lend themselves to automation. National preferences and practices may also necessitate the use of some alternative symbols and portrayal rules, but if they are implemented in the same SVG and rule formats used by the BSPT, the same chart generating engine may be used for the baseline and national symbols alike.

Ultimately, these paper chart baseline symbols may join the SVGs developed for the display of S-101 ENC data, which are cataloged in the IHO Geospatial Information (GI) Registry. The Registry contains several registers of hydrographic related information, including a portrayal register. Information contained in the GI Registry can be freely accessed. Thus,

any chart producer will be able to use the baseline SVGs for paper chart production. This will enable consistency across all ENC-derived charts that use SVGs obtained from the register.

5. Colors

Color is an inherent characteristic of chart symbology. Creating the SVG symbols described above could not be accomplished without ascribing a specific color to each graphic element (point, line, area fill, or pattern) of each symbol. S-4 specifies and shows examples of the symbols and colors to be used on paper nautical charts. It specifically names half a dozen color hues to be used for various purposes, but does not describe the chroma (saturation) or value (lightness) of the colors. To facilitate creating a baseline set of SVG symbols, the BSPT reviewed the paper chart color palettes used by several hydrographic offices and has recommended using the set of color definitions shown in Annex A. This set of colors, or any other colors used to create ENC-derived charts should be red-light readable to enhance chart legibility at night on a darkened bridge.

6. Portrayal Rules

The IHO S-52 *Specifications for Chart Content and Display Aspects of ECDIS* and the S-101 *Portrayal Catalog* each provide rules to select the appropriate symbol to portray any valid ENC feature and feature attribute value combination in ECDIS. The NOAA ENC Viewer simulates the ECDIS portrayal of S-57 ENC data. These ENC portrayal rules cannot be used to depict ENC data on paper nautical charts, because there are more symbols used on paper charts than there are in an ECDIS. This is because additional feature information may be obtained in an ECDIS in what is called a “pick-report” after querying the ENC data. Paper charts cannot be queried and thus often use labels and additional symbols to further differentiate related features that might have only one symbol in an ECDIS. The NOAA Chart Display Service simulates the portrayal of ENC data as it would look on a NOAA ENC-derived paper chart created with the online NOAA Custom Chart application.

The BSPT is adapting the LUA scripting language used in the S-101 *Portrayal Catalog*, tailoring the code to enable the portrayal of ENC data with paper chart symbology (S-4 SVG symbols). To take advantage of these S-4 portrayal LUA scripts, chart producers may need to modify their production software to read the scripts or recode the same logic into another language that is compatible with their production system. The former approach will be more efficient in the long run as a “plug and play” ability to read any updates to the LUA scripts would require minimal modifications to the production system.

7. Scale

The optimum scale for any S-57 ENC-derived paper chart matches the compilation scale of the ENC data from which the paper chart is derived. The S-101 *ENC Product Specification* replaces the compilation scale attribute used in S-57 with minimum, optimum, and maximum display scales (see Annex B). The further the scale of an ENC-derived paper chart is from these ENC data scales, the greater the chance there is for an ENC-derived chart to be cluttered with densely packed soundings and other features (if the ENC-derived chart scale is smaller than the ENC

data scale) or for the chart to have an insufficient level of detail normally expected for the scale of the chart (if the ENC-derived chart scale is larger than the ENC data scale).

Creating an ENC-derived chart at a scale that is slightly larger or slightly smaller than the ENC data scale may still be acceptable in many cases. This is especially true for deviations from the S-57 ENC compilation scale, which although not defined, S-57 ENC data could still be considered to have “minimum” and “maximum” display scales that are slightly smaller or larger than the data’s compilation scale. More research may be required to determine what these thresholds are. Similar to a hydrographic source diagram or zone of confidence diagram, creation of an “ENC source diagram” showing the ENC compilation or optimum display scales and possibly ENC cell names of the data from which a chart is derived would be useful.

8. Graphic Scale

All ENC-derived charts must provide the chart’s scale as a ratio, such as 1:100,000 and in a graphical scale in the units of distance that are used on the chart. A line of known length (the U.S. uses six inches) should also be printed along the bottom and along one of the sides of the chart. This enables users to quickly determine if a chart has been printed at the correct size.

9. Digital File Format

ENC-derived chart images must be created in a format that may readily be sent to a printer or plotter to render the image at the chart’s “actual size.” A number of digital formats could be used, but the Portable Document Format (PDF) is a popular format that can easily be plotted or transmitted digitally.

Using a geospatially referenced format is acceptable to facilitate use of ENC-derived chart images for non-navigational purposes in geographic information systems (GIS) or other applications. However, digital images of ENC-derived charts should not be used for electronic navigation. Unlike the IHO specified raster navigational chart (RNC) digital chart format, ordinary ENC-derived chart images do not have the properties designed into RNCs, such as individual graphic panels for each chart note, that enabled their safe use in ECDIS and other navigation systems.

10. Saving Chart Design Parameters

Although not required, it is useful to have a means to save individual ENC-derived chart characteristics, including:

Table 1. ENC-derived chart characteristics

Producer name	Paper size
Creation date	Orientation
Title	Position and extent
Number	Shallow water tint depths
Scale	Position and size of compass roses

This facilitates quickly recreating a chart of the same design with updated ENC data at a later date, as well as the ability to transmit a chart design – or even an entire chart scheme – to other locations for printing. ENC-derived chart images can easily be 50 megabytes, while the same chart's design parameters can be stored in a text file of just a few kilobytes.

NOAA uses "chart catalogs" to store chart parameters in GeoJSON files, a text file format used for encoding a variety of geographic data structures using JavaScript Object Notation. An example of a chart catalog holding two 1:350,000 chart designs covering New York and Boston is shown in Annex C.

11. Paper Chart Media

ENC-derived charts should be printed on paper or other media that is comparable to the current requirements for printing traditional paper nautical charts, whether by a plotter or by lithographic processes. This includes requirements for being relatively stable – not easily torn and not susceptible to excessive stretching or shrinking – ability to easily take on and erase penciled plot lines and notes, ink that does not smear or rub off and is somewhat water resistant.

The paper size used for charts should also be suitable for plotting courses, fixing a vessel's position, and providing enough overlap with adjoining charts to enable transferring one's position from one chart to the next while underway. ISO A0 (33" x 46 ¾"), ANSI E (34" x 44"), and plotter roll 36" x 48" are popular nautical chart sizes. ENC-derived charts on paper sizes smaller than these would be difficult to plot courses and a ship's position on.

12. Chart Carriage Regulations

Each national maritime regulatory agency (often the coast guard) establishes its own rules and regulations regarding the types of nautical charts that must be carried aboard regulated vessels. This commonly includes Electronic Navigational Charts and traditionally produced paper nautical charts. ENC-derived paper nautical charts are a relatively new development and many regulatory agencies have not yet established policies on the use of these charts. However, as the quality and prevalence of ENC-derived charts increases, it is likely that they will also increasingly be accepted as meeting chart carriage requirements. The announcement of the cessation of traditional paper nautical chart production by some hydrographic offices will likely accelerate this acceptance.

13. Graticule

Graticules on ENC-derived charts, regardless of the chart scale or paper size, should show at least two lines of latitude and two lines of longitude with the appropriate gradations and labels in degrees, minutes and seconds, or degrees and decimal minutes. The IHO INT 2, *Borders, Graduation, Grids and Linear Scales* provides excellent examples and specifications for various grids that are appropriate for different scale charts. ENC-derived charts should have chart borders, grids and labels comparable, if not the same as those specified in INT 2.

14. Compass Roses

All compass roses must fit completely within the chart neat line, be appropriately spaced and not obstruct important information. Compass roses should show single degree marks for 360 degrees, for both true north and magnetic north. Magnetic variation (or declination) and annual change must be shown for the position at the center of each compass rose as of the date the chart is created. Normally, two or three compass roses are sufficient. Up to five may be appropriate for small scale charts printed on especially large sheets.

15. Aids to Navigation Labels

The characteristics (color and shape) of aids to navigation and associated light characteristics (flash rate, color, etc.), as well as the name and number of each aid must be clearly displayed nearby and easily associated with the aid. Characteristics on smaller scale charts and in areas that are particularly cluttered, may use a smaller set of characteristics, such as just an aid's name or number and color. A limited degree of text overprinting is allowed for charts automatically derived from ENC data, but only if the labels remain legible and do not obscure other text or important features.

16. Depths

The preferred unit for depths on ENC-derived charts is meters – the same unit used to encode depths to one decimal place in ENCs. If the option is provided to display depths in feet or fathoms, depth values must always be rounded down (shoaler) when converting depths from meters.

17. Heights

Heights of bridge, overhead cable and overhead pipe clearances, lights, drying heights, and other objects for which heights are labeled shall be shown in meters when the user selects metric units and shall be shown in feet when the user selects units of fathoms or feet for depths. When in feet, height values must always be rounded down (shorter) when converting heights from meters.

18. Topographic Data and Transportation Infrastructure

Topographic data, such as elevation contours, shape lines, and spot heights should be shown on ENC-derived charts where relief has an effect on navigation, such as influencing the nature of winds or currents, providing shelter on the lee side of rises, or where topographic features can assist in orienting a mariner, especially in remote areas where few other landmarks exist. Prominent peaks should be labeled when the data is available.

Nearshore road and railroad features that are visible from offshore are also useful references, especially in remote areas where few other landmarks exist and should also be shown.

In some areas, these topographic and transportation network features may not be encoded in the ENC data used to create ENC-derived charts. In these cases, overlaying other sources of this information – with enough transparency so as to not obstruct the underlying chart data – may be an acceptable option. Some data or data services are available for use with an open license for

free. Others will require appropriate licensing or other use agreements for a fee to use copyrighted material.

19. Chart Notes

All notes that are appropriate for the area covered by the ENC-derived charts must be provided and may be displayed in the chart margins, on the back of the chart, or on separate pages. The note content may be extracted directly from the ENC data being used to make the chart or from a separate geospatially enabled notes database. Examples of ENC-derived chart note placement are shown in Annex D.

20. Automation Note

ENC-derived charts may be rendered directly from ENC data without any other intervention or "finishing" by cartographers to realign text or make other adjustments. Thus, it may be appropriate to provide an "Automation Note." The note used by NOAA is shown in Figure 3.

AUTOMATED CHART GENERATION

This NOAA Custom Chart has been automatically rendered from NOAA Electronic Navigational Chart (NOAA ENC®) data. Mariners using this NOAA Custom Chart are advised that this is a static reproduction of the NOAA ENC®. This NOAA Custom Chart has not been individually quality checked or adjusted for optimal use for navigation. The portrayal may be at a different scale from that of the original NOAA ENC®. Mariners are advised to use caution when using this NOAA Custom Chart for navigation and are encouraged to use the latest NOAA ENC® to access the most up-to-date information. Mariners must also comply with all applicable regulatory requirements.

Figure 3. NOAA Custom Chart Automation Note.

21. Anchorages and Other Areas with Additional Encoded Information

ENC-derived charts are not queryable as ENCs are in ECDIS and other navigation systems. Thus, the portrayal of centered symbols for certain area features in ECDIS, such as anchorages, restricted areas, and other areas for which additional textual information has been encoded, must be replaced or augmented with labels describing the nature of restrictions or other information that would be available in a ECDIS "pick report." Table 2, shows some of the centered symbols that ECDIS displays within area features, for which additional information, cautions, or restrictions must be shown on ENC-derived charts. On U.S. charts this often includes a reference to specific sections of the U.S. Code of Federal regulations (CFR).

Table 2. Some ECDIS centered symbols for areas with additional information, cautions, or restrictions.

	Anchorage
	Prohibited or restricted anchorage, with other cautions, with other information
	Area where entry is prohibited or restricted or to be avoided, with other cautions, with other information

	Area where fishing or trawling is prohibited or restricted, with other cautions, with other information
	Cautionary area, with further information
	Area with minor restrictions or information notices

22. Chart Creation Date

The date and time when ENC data is extracted to create an ENC-derived chart should be clearly shown in the margin of the chart. This timestamp will either show when the chart was originally created or when the chart was updated and re-exported.

23. Updating ENC-Derived Charts

Some have suggested printing an expiration date on ENC-derived charts, but this is insufficient to ensure the currency of a chart. A new danger to navigation could manifest itself even as the new chart is being printed. Once a chart is created, there must be a means to notify users of critical corrections, either to hand-correct the chart or to re-create the chart with updated ENC data. Notices to mariners are not issued for ENCs from which the charts are derived. Changes to ENCs are released through ENC update files that are applied to the base ENC (.000) files in ECDIS and other navigation systems.

There are a number of ways in which changes to ENCs may be identified, such as keeping logs of corrections as changes are applied within an ENC production database or digital comparisons of different editions or ENC update files. No matter how changes are identified, each agency producing ENC-derived charts that are to be used for navigation must ensure that users may either access a list of instructions to hand correct their chart, or at least be made aware of when critical corrections have been made to the ENC data used to make their chart, so that the user may obtain a new version of the chart, revised with the latest, updated ENC data.

One example is the online NOAA Navigation Updates application, which enables users to input their NOAA Custom Chart design parameters from a GeoJSON catalog file. The application then queries a NOAA database to retrieve metadata about any changes to ENC data over the chart's extent, since the data on which the ENC-derived chart was created or last updated. This information is displayed textually in a table and graphically in a webmap.

Summary

This document presents 23 topics, including best practices to maintain, issues to consider, and chart characteristics to obtain while creating ENC-derived paper nautical charts. Nautical charts that follow this guidance are more likely to meet U.S. Coast Guard – or other national marine regulatory agency – requirements for chart carriage. ENC-derived paper nautical chart production methods that do not consider these matters will not support safe marine navigation.

As cartographic technology and techniques advance and the production of S-101 based ENC data becomes available, ENC-derived charts may become even more like the much admired, hand-crafted traditional nautical charts that have been produced for centuries.

Annex A – NCWG Paper Chart Baseline Color Palette

Table 3. NCWG Paper Chart Baseline Color Palette, showing color names, primary uses and RGB values

Primary Use	Name	Sample	Red	Green	Blue
Coastline	Black		0	0	0
Land	Buff		251	240	198
Land infrastructure	Grey		195	194	186
Topography	Brown		119	86	42
Urban areas	Light Grey		215	209	195
Intertidal	Intertidal Green		193	222	199
Depth contours	Contour Blue		23	136	186
Shallowest depth area(s)	Dark Blue		133	207	235
2nd Shallowest depth area(s)	Medium Blue		177	225	244
3rd Shallowest depth area(s)	Light Blue		221	242	253
Deeper depth areas	White		255	255	255
Compass rose and aids	Nautical Purple		156	59	142
Traffic separation	Light Purple		229	158	233
Red aids	Red		237	28	36
Orange aids	Orange		247	148	62
Yellow aids	Yellow		255	218	0
Green aids and areas	Green		0	176	133

Annex B – ENC Display and Compilation Scales

Table 4. Allowed S-101 minimum, optimum, and maximum display scales

S-101 Scales
1:10,000,000
1:3,500,000
1:1,500,000
1:700,000
1:350,000
1:180,000
1:90,000
1:45,000
1:22,000
1:12,000
1:8,000
1:4,000
1:3,000
1:2,000
1:1,000

S-57 compilation scales into which U.S. NOAA ENCs are being standardized as the product is being reschemed into gridded, rectangular cells. These will become the S-101 optimum scales used when NOAA transitions from S-57 ENC production.

Table 5. Standard Reschemed NOAA ENC Compilation Scales

ENC Usage Band	Navigational Purpose	ENC Compilation Scales
1	Overview	1:10,000,000 1:3,500,000
2	General	1:1,500,000 1:700,000
3	Coastal	1:350,000 1:180,000
4	Approach	1:90,000 1:45,000
5	Harbor	1:22,000 1:12,000
6	Berthing	1:4,000 1:2,000

Other standard S-57 compilation scales that will not be used for NOAA ENCs:

1:8,000 1:3,000 1:1,000

Annex C – NOAA geoJSON Catalog File


```
{
 "type": "FeatureCollection",
 "features": [
  {
   "type": "Feature",
   "geometry": {
    "type": "Point",
    "coordinates": [
     -69.10338325464923,
     41.730518867155254
    ]
   },
   "properties": {
    "Date": "2024-06-28T19:27:47.593Z",
    "Unique_Id": "Boston and Georges Bank_350000_E_Landscape_-69.103_41.731_Feet_depthZoneFour_shallow5.0_safety11.0_deep17.0",
    "Updates": "",
    "Title": "Boston and Georges Bank",
    "Scale": 350000,
    "Page_Size": "ANSI E",
    "Orientation": "Landscape",
    "Center_Coordinates": "41.731°N 69.103°W",
    "Depth_Units": "Feet",
    "Depth_Zone_Tints": "Four",
    "Shallow_Tint": "5.0",
    "Safety_Tint": "11.0",
    "Deep_Tint": "17.0",
    "CompassRose1": [
     -70.87020775369044,
     41.88906275987292
    ],
    "CompassRose2": [
     -67.13576258199186,
     42.704939334194535
    ],
    "CompassRose3": [
     -67.88924153001881,
     40.83466914478275
    ]
   }
  },
  {
   "type": "Feature",
   "geometry": {
    "type": "Point",
    "coordinates": [
     -72.51160518682289,
     40.75176722868868
    ]
   },
   "properties": {
    "Date": "2024-05-22T20:38:29.118Z",
    "Unique_Id": "Long Island Sound and New Jersey_350000_E_Landscape_-72.512_40.752_Feet_depthZoneFour_shallow5.0_safety11.0_deep17.0",
    "Updates": "None",
    "Title": "Long Island Sound and New Jersey",
    "Scale": 350000,
    "Page_Size": "ANSI E",
    "Orientation": "Landscape",
    "Center_Coordinates": "40.752°N 72.512°W",
    "Depth_Units": "Feet",
    "Depth_Zone_Tints": "Four",
    "Shallow_Tint": "5.0",
    "Safety_Tint": "11.0",
    "Deep_Tint": "17.0",
    "CompassRose1": [],
    "CompassRose2": [],
    "CompassRose3": []
   }
  }
 ]
}
```

Annex D – Chart Note Placement Examples

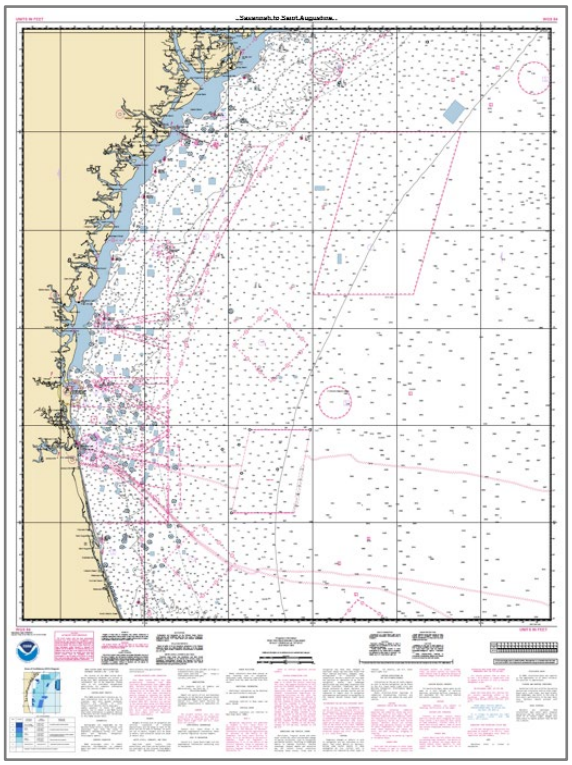

Figure 4 ENC-derived chart with all notes placed in the chart margin

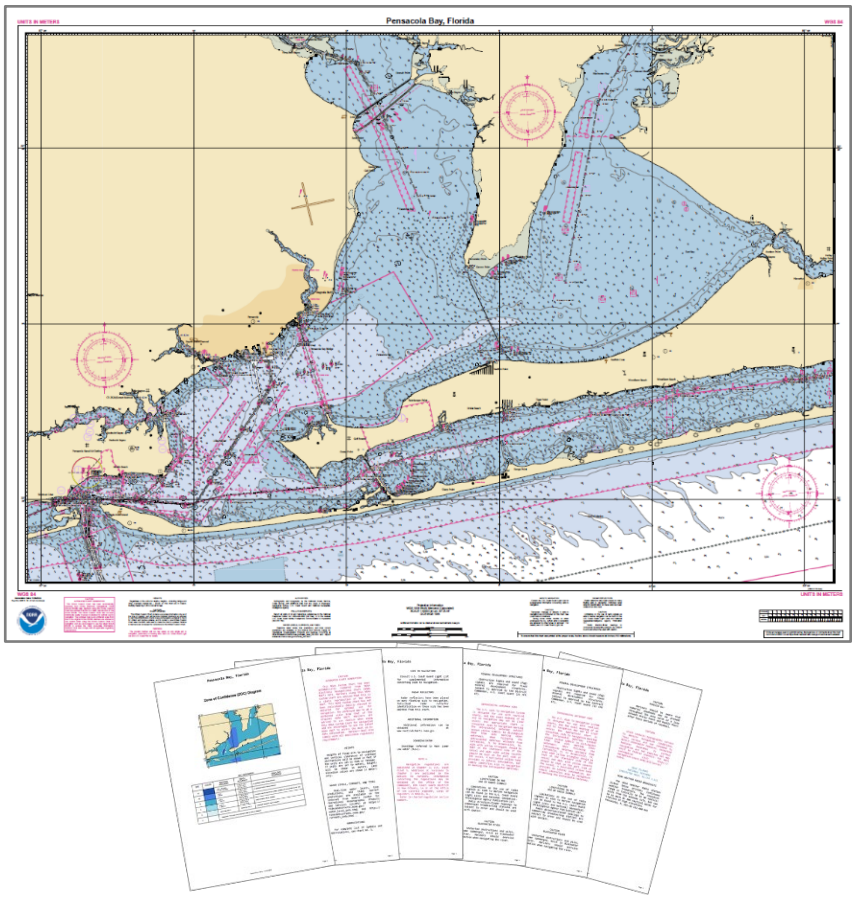

Figure 5. ENC-derived chart with notes placed on separate letter-size pages

Acknowledgements

The author would like to thank Colby Harmon and Steven Soherr of the National Oceanic and Atmospheric Administration, Office of Coast Survey, and Sebastian Carisio and Joseph Naylor, of the National Geospatial-Intelligence Agency, Maritime Safety Office for their contributions to developing and documenting these best practices.

References

Documents

Available on the IHO Standards and Specifications website at: https://iho.int/en/standards-and-specifications:

INT 2 Borders, Graduation, Grids and Linear Scales

S-4 Regulations for International (INT) Charts and Chart Specifications of the IHO

S-52 Specifications for Chart Content and Display Aspects of ECDIS

S-57 Transfer Standard for Digital Hydrographic Data, “S-57 ENC Product Specification”

Available on in the IHO Geospatial Information Registry at: https://registry.iho.int/productspec/view.do?idx=203&product_ID=S-101&statusS=5&domainS=ALL&category=product_ID&searchValue=t

S-101 ENC Product Specification

S-101 Portrayal Catalogue

IHO Geospatial Information Registry at: https://registry.iho.int.

IHO Geospatial Information Portrayal Register at: https://registry.iho.int/portrayal/list.do.

Websites

NOAA Chart Display Service at: https://nauticalcharts.noaa.gov/NCDSviewer/

NOAA Custom Chart application at: https://devgis.charttools.noaa.gov/pod.

NOAA ENC Viewer at: https://www.nauticalcharts.noaa.gov/enconline/enconline.html.

NOAA Navigation Updates application at: https://distribution.charts.noaa.gov/navigation-updates.