CHAPTER 2

"It is established for a custom of the sea that if a ship is lost by default of the lodesman, the mariners may, if they please, bring the lodesman to the windlass and cut off his head without the mariners being bound to answer before any judge, because the lodesman had committed high treason against the undertaking of the pilotage, and this is the judgement."

Twenty-Third Article of the Laws of Oleron 1190
Quoted in Schofield

General Information and Overview

Introduction

This chapter provides additional general information about nautical charts together with specific information about the schematic layout of a nautical chart, the chart title block, chart projections, types (and scale) of charts, chart overlap (and related matters), latitude and longitude axes, vertical and horizontal datums, isogonic lines and the compass rose, chart colors, chart lettering, and other miscellaneous charting conventions. Where appropriate, comments on the utility of this information are included, as are practical tips on how to use this information.

Many specialized terms used in this chapter are defined in the Glossary in appendix A. Abbreviations are included in appendix B. Names enclosed in parentheses (e.g., Bowditch) refer to sources listed at the end of this chapter that contain additional relevant detail or useful general discussions.

It is recommended that the reader have a nautical chart and Chart No. 1 at hand when studying the contents of this and subsequent chapters.

Chart No. 1

As noted in Chapter 1, *Chart No. 1, Nautical Chart Symbols, Abbreviations, and Terms (9th ed.),* provides an indispensable description of the symbols (both national and international) and many of the conventions used on the nautical chart. Chart No. 1 should be carried aboard all vessels. The contents of Chart No. 1 provide a useful framework for organizing this manual. Although space constraints do not permit inclusion of Chart No. 1 in its entirety in this manual, many illustrative excerpts are provided.

Chart No. 1 is organized into various sections, each providing information on one or more groups or classes of symbols and conventions used on the nautical chart. For example, general information is included in Section A (Chart Number, Title, Marginal Notes); information on positions, distances, directions, and the compass is presented in Section B; topographic features in Sections C through G; hydrographic information in Sections H through O; aids and services in Sections P through U; and alphabetical indices in Sections V through X. Within each Section of Chart No. 1 there are several subsections, and numerous individual symbols are presented within each subsection. For example, Section F contains port information, which is further subdivided into hydraulic structures, harbor installations, canals, transshipment facilities, and public buildings. Within the subsection on harbor installations F14 is the specific symbol used to depict a pier or jetty. Where appropriate, these sections and symbols are provided (e.g., F14) in the text or headings of this manual to refer the reader to the relevant section or symbol listed in Chart No. 1.

Charts published in the United States include those produced by NOAA, NOS—for U.S. waters—and NIMA, for other areas of the world. Symbols used by each agency are depicted in Chart No. 1.

Because of the importance of Chart No. 1, it is worthwhile to summarize briefly the schematic layout of this chart. Figure 2–1 illustrates this layout. Item 1 in this figure is the section ("Rocks, Wrecks, Obstructions"), and item 2 the section designation ("K" in this illustration). Item 3 denotes the subsection ("Wrecks"), and item 4 ("Supplementary National Symbols") provides a reference to any supplementary national symbols given at the end of each section. As the name implies, supplementary national symbols are unique to each country (e.g., those listed in Carte No. 1, Chart 5011) and do not conform to the standard symbols authorized by the IHO. Although not officially listed by the IHO, these supplementary national symbols have been retained for the convenience of chart users in each country. Standardized symbols facilitate chart use by mariners from different countries, while supplementary national symbols provide the flexibility to describe country-specific features and reflect historical charting practices.

Item 5 in figure 2–1 provides a cross-reference to terms contained in other relevant sections of Chart No. 1. In this illustration, the Plane of Reference for Depths, found in Section H, is relevant to information given in Section K. Item 6 (column 1) identifies the standard number which follows the "Standard List of Symbols, Abbreviations, and Terms" defined by IHO.

Item 7a in figure 2–1 is the symbol or representation as used on charts produced by NOAA. In many cases, the identical symbol is also used by NIMA. If not, as in this example, the NIMA symbol is provided in an additional column (item 7b). Item 8 ("Stumps of posts or piles, fully submerged") is a written description of the various terms or abbreviations associated with this symbol. Item 9 presents the chart symbol as prescribed/recommended by the IHO. Finally, item 10 presents the corresponding symbols that may appear on NIMA reproductions of foreign charts.

The reader interested principally in using NOAA charts should focus on items 1, 2, 3, 4, 5, 6, 7a, and 8 as shown in this excerpt from Chart No. 1.

Schematic Layout of a Nautical Chart

To begin, it is useful to examine the schematic layout of the nautical chart and to review the overall format, including the textual material given in the chart. According to the *Desk Reference Guide,*

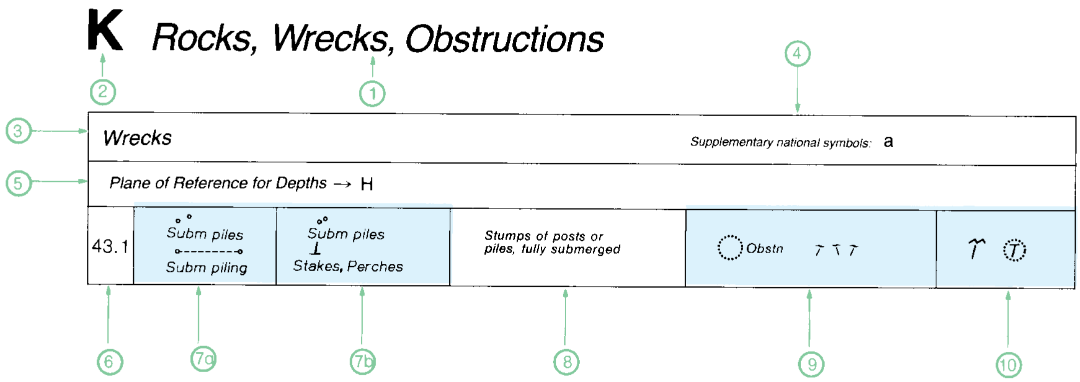
> "The chart format is the general plan of organization or arrangement of a nautical chart including the layout of the margin notes, border, title block, and insets."

Figure 2–2 presents the overall format of a nautical chart, and figure 2–3 provides additional explanatory information. The most important items shown in figures 2–2 and 2–3 are summarized in this chapter.

Number, Title, and Marginal Notes (A)

Item 1 in figure 2–2 is the chart number (412 in this illustration) in the (U.S.) National Chart Series, and item 3 is the corresponding chart number in the International Chart Series (if any). The system used for charts produced by both NOAA and NIMA assigns numbers to charts based upon the scale and the geographic area of coverage of the chart. One- to five-digit chart numbers are used. Details of the numbering convention can be found in several sources (e.g., Bowditch). For the most part, mariners using NOAA charts will be concerned with five-digit

Schematic Layout of Chart 1



1	Section.
2	Section designation.
3	Subsection.
4	Reference to "Supplementary national symbols" at the end of each section.
5	Cross reference to terms in other sections.
6	Column 1: Numbering following the New "Standard List of Symbols, Abbreviations, and Terms" of the IHO.
7a	Column 2: Representation used on charts produced by the National Ocean Service (NOS). In certain instances, the representation is clarified by a label on the chart.
7b	Column 3: Representation used on charts produced by the Defense Mapping Agency (DMA). In certain instances, the representation is clarified by a label on the chart. Note: When the NOS and DMA symbols are identical, Column 2 and Column 3 are combined to show only one set of symbols.
8	Column 4: Description of symbol, term, or abbreviation.
9	Column 5: Representation following the "Chart Specifications of the IHO".
10	Column 6: Representation of symbols that may appear on DMA reproductions of foreign charts.

Fig. 2-1. Schematic Layout of Chart No. 1

A Chart Number, Title, Marginal Notes

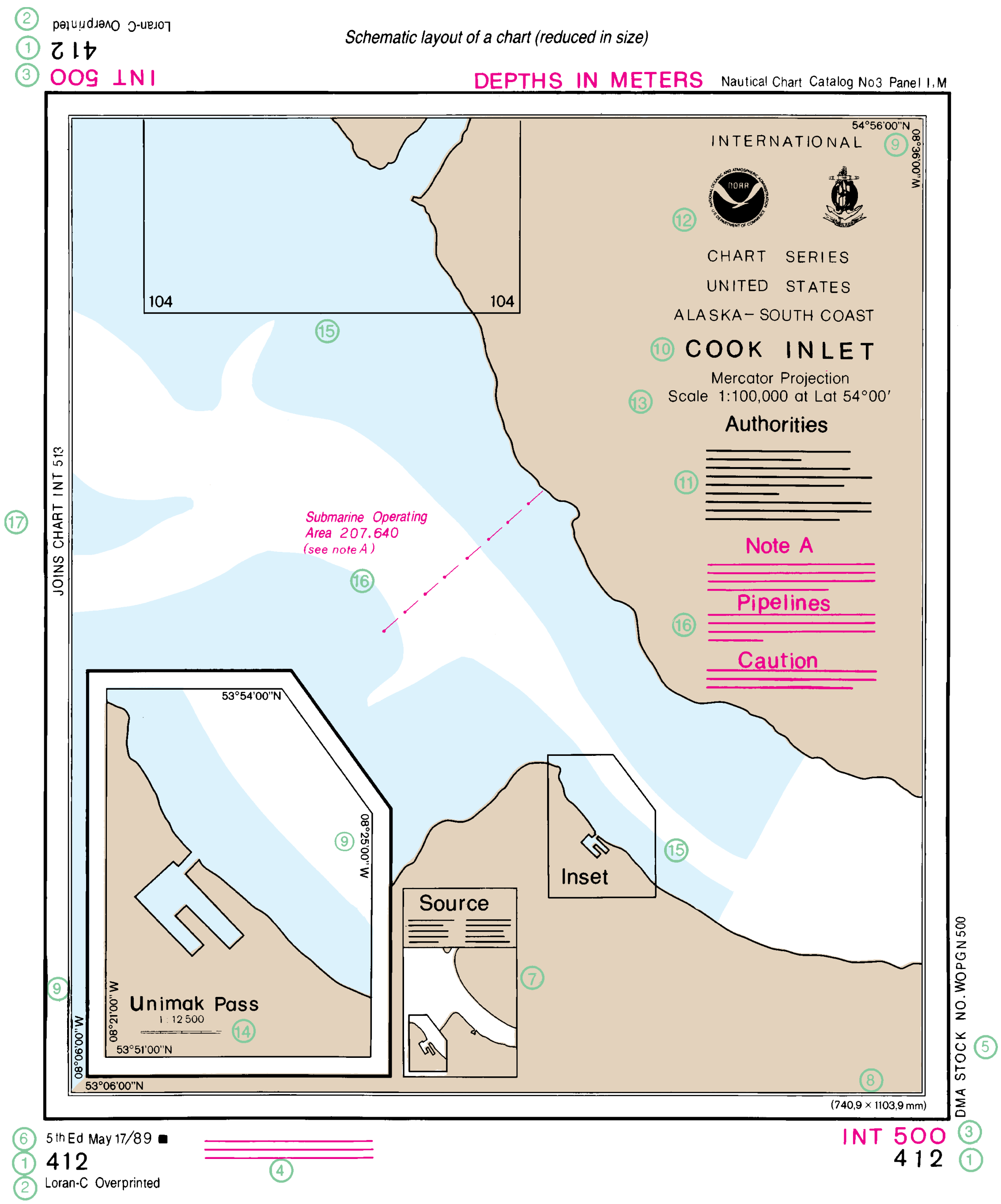


Fig. 2–2. Schematic Layout of a Nautical Chart

A *Chart Number, Title, Marginal Notes*

Magnetic Features → B	Tidal Data → H	Decca, Loran-C, Omega → S

	Chart number in national chart series
1	Identification of a latticed chart (if any): D for Decca LC for Loran-C Om for Omega
2	Chart number in international chart series (if any)
3	Publication note (imprint)
4	Stock number
5	Edition note. In the example: Fifth edition published in May, 1989
6	Source data diagram (if any). For attention to navigators: use caution where surveys are inadequate
7	Dimensions of inner borders
8	Corner co-ordinates
9	Chart title } May be quoted when ordering a chart, in addition to chart number
10	Explanatory notes on chart construction, etc. To be read before using chart
11	Seals: In the example, the national and International Hydrographic Organization seals show that this national chart is also an international one. Purely national charts have the national seal only. Reproductions of charts of other nations (facsimile) have the seals of the original producer (left), publisher (center) and the IHO (right)
12	Projection and scale of chart at stated latitude. The scale is precisely as stated only at the latitude quoted
13	Linear scale on large-scale charts
14	Reference to a larger-scale chart
15	Cautionary notes (if any). Information on particular features, to be read before using chart
16	Reference to an adjoining chart of similar scale
17	

Source: Chart No. 1

Fig. 2–3. Items of Interest in Figure 2–2

chart identification numbers, which are drawn to a scale (see below) of 1:2,000,000 and larger. Chart numbers and their respective areas of coverage are presented in the nautical chart catalog.

Latticed Charts (A)

Item 2 in figure 2–2 indicates whether or not a navigational lattice is overprinted on the chart and, if so, the type of lattice. For example, the legend "LORAN–C OVERPRINTED" informs the mariner that Loran–C TD data are superimposed on the chart, the legend "D" that Decca information is included, and the legend "OMEGA OVERPRINTED" indicates that Omega information is provided.

Although Decca and Omega navigation systems are used extensively in other parts of the world, Loran–C is of particular importance to mariners in U.S. waters. In view of the importance of this system, many NOAA charts are overprinted with Loran–C TD data. Most modern Loran–C receivers are able to convert from TDs to latitude and longitude, but use of TDs is still recommended for highest accuracy *(Loran–C User Handbook)* so a TD lattice is handy.

Nautical charts overprinted with a Loran–C lattice are identified in the nautical chart catalog with the letter "C" enclosed with a circle in front of the chart number. Loran–C TDs are usually provided on charts with 1:80,000 scale (see below) and smaller upon request of the USCG. Loran–C lattices are not shown on harbor or harbor entrance charts at scales of 1:50,000 or larger and over most inshore areas or inland waters because the navigational accuracy is adversely impacted by interference caused by land and/or building structures.

Edition (A)

The chart edition, shown as item 6 in figure 2–2, is one of the most important items of information given on the chart. The original date of issue (not shown in figure 2–2) of a new chart is printed at the top center margin. The edition number (e.g., 5th ed. May 17/89 in figure 2–2) is printed in the lower left-hand corner of the chart. New editions are published when, at the time of printing, the corrections from previous editions are too numerous or too extensive to be reported in the NM. Criteria for allocation of survey and chart compilation effort are given in table 2–1. A new chart edition supersedes all earlier editions. The date shown is the same as that of the latest NM to which the chart has been corrected. In this illustration, the 5th edition has been corrected through May 17, 1989. (Mariners sometimes overlook this important point, charts are corrected to the date shown, not to the *date of purchase.* Therefore, it is generally necessary to make corrections on a newly purchased chart.) A *revised print* published by NOAA may contain corrections which have been published in NM but does not supersede the current edition of the chart. The date of the revision is shown to the right of the edition date. Thus, for example, 5th ed. May 17/89; Revised June 20/94, indicates that this chart was revised in June 1994. A *reprint,* issued to replace depleted stocks, is an exact duplicate of the current issue with no changes in printing or publication dates.

A study by the NRC, indicated that nominal print cycles for NOAA charts range from 6 months to 12 years. In practice, new editions are initiated by the cumulative number of chart corrections, significant format or regulation changes, new basic data (e.g., survey data), low shelf stock, and available resources. Not all chart corrections are critical; critical chart corrections include changes in aid to navigation, obstructions, shoaling, and certain cultural and facility changes. According to NRC, 30 to 70 changes trigger a new edition.

Reconstructed, Provisional, and Preliminary Charts

Three other types of charts, reconstructed charts, provisional charts, and preliminary charts, are worthy of mention. According to the *Nautical Chart Manual:*

- A *reconstructed* chart, is one that is completely recompiled on a new projection. This is issued when the accumulation of new information is sufficiently extensive to affect most of an existing chart, or if there are changes to the chart limits, or the chart is produced using computer supported compilation and scribing techniques. A reconstructed chart is issued as a new edition.

Chart reconstruction is used to improve the quality of the chart and to incorporate any new symbols and conventions developed over the years. Changes in type style, particular symbols, and cartographic philosophy accumulate and evolve over the years with the result that older charts contain a mixture of type styles and may include outdated symbols (e.g., symbolized depth curves rather than labeled solid lines, excessive use of road symbols rather than urban tint, etc.) and conventions. Moreover, the chart reproduction process may cause a gradual deterioration of the image (e.g., line thickening, symbols becoming less distinct, etc.) to the point that certain symbols are difficult to recognize. When a chart is reconstructed, the symbology and chart conventions are updated along with the necessary revisions (e.g., relocated buoys, new wrecks, shoaling, etc.) typically noted in the NM or the LNM.

- A *provisional* chart is a special chart for which there is an urgent need. The chart is labeled "PROVISIONAL CHART" in the upper and lower margin or at a prominent location inside the upper and lower border.

- A *preliminary* chart is one for which there is an urgent requirement that cov-

Table 2-1. Criteria Used to Set Priorities for Survey and Chart Compilation Effort

1. What is the cumulative number of NM or LNM corrections to the present edition?
2. How safe (or hazardous) to navigation is the area?
3. What type of craft frequent the area?
4. What is the volume of traffic in the area?
5. What resources are available for field surveys?
6. Where are the field resources and when can they be made available?
7. Which supporting data (e.g., tide, photogrammetry, geodesy) can be supplied?
8. What are the weather conditions in the area?
9. What comments have been received from the field regarding the adequacy of present charts?
10. What production resources are available to translate field data to charts and for subsequent chart compilation?
Source: Adapted with minor modification from the Nautical Chart Manual.

ers a region where some or all of the survey data fail to meet modern standards. Survey deficiencies might include small scale, outmoded or nonstandard survey techniques, obsolete, unprocessed, or unapproved data, or other factors which cause the survey data to be below customary standards for the scale of the chart. Not all preliminary charts are published in full color. Additionally, the source diagram (see Chapter 4) alerts the mariner to the provisional nature of the data, and a separate warning note is included. An illustrative warning note is shown below,

WARNING
PRELIMINARY CHART

"All of the data on this preliminary chart is considered to be of marginal quality for modern charts. Many of the depths were taken by leadline in the early 1900s, so uncharted shoals are likely in this area. Navigators should use this chart with extreme caution and report discrepancies or hazards to..."

From the above, it is clear that preliminary charts should be used with particular care. However, the fact that the chart may include some data of marginal quality does not mean that all data are suspect. If the preliminary chart has a source diagram (see Chapter 4), this diagram should be consulted to determine which areas of the chart may contain data of marginal or unverified quality. Mariners may be able to select routes which avoid these areas. Alternatively, the mariner might choose a greater "safety margin" (e.g., depth allowance) in selecting routes, navigate with especial vigilance, navigate at reduced vessel speeds, and employ other appropriate measures to reduce risk.

–Importance of Current and Corrected Charts

Coote recounts one opinion on the use of current charts:

> "In 1950 I joined Fandango for the Santender Race returning via a race to Belle Ile and cruising home... I looked over the charts [provided by the owner] and found that they had all been bought... in June 1934. The suggestion that sixteen years and a World War might have outdated some of the musty old charts was brushed aside... by the owner [with the statement] 'I believe that the rocks don't move, so what's the matter with you'."

This idiosyncratic view is colorful but foolhardy; most mariners agree that it is essential to use the current edition/revision of the chart, updated to include all corrections given in the NM or LNM. Use of obsolete editions for navigation could be dangerous; buoys are moved, other ATONs may have changed location or characteristics, new hazards (e.g., obstructions, wrecks) may have been identified, natural changes to hydrography may have occurred, and areas and limits (see Chapter 7) may have been changed. Indeed, as noted above, the accumulated number of chart corrections is one of the principal determinants of NOAA's decision to prepare a new edition.

If prudence alone is not sufficient motivation to ensure that a vessel is equipped with appropriate and corrected charts, mariners should be aware that carriage of such charts is a legal requirement for certain classes of vessels. According to 33 *Code of Federal Regulations* (CFR) Part 164, self-propelled vessels of 1,600 or more gross tons (when operating in the navigable waters of the United States except the St. Lawrence Seaway) are obligated (Section 164.33(a), *et seq.*) to carry (among other things) corrected marine charts of the area which are of a large enough scale and have enough detail to make safe navigation of the area possible.

The NOAA publication, *Dates of Latest Editions* (issued quarterly), provides a list of the current editions of each chart. Techniques for making chart corrections are discussed in several sources (e.g., Bowditch, Farrell, Maloney, Markel).

Source Diagram (A)

A source diagram (item 7 in figure 2–2) indicates the scale and date of hydrographic surveys upon which the nautical chart is based. Source diagrams and their utility are discussed in more detail in Chapter 4.

Neat Line Dimensions (A)

The size of a nautical chart is related to the chart scale (see below) which is dependent upon the amount of detail (geographic and cultural features, hydrography, etc.) that is charted to provide a concise, legible, graphic representation of the necessary data. The chart dimensions also reflect the sizes of printing presses found in nations around the world which reprint and reissue NOAA charts. The internationally accepted size "A0" paper has outside dimensions of 841 mm x 1189 mm and is one of the standard sizes used by NOAA.

The *neat line* is the inner border of the chart. The dimensions of the neat line (item 8 of figure 2–2 or 740.9 mm x 1103.9 mm for this particular chart) are printed at the base of the chart. Neat line dimensions, in concert with the chart scale, enable calculation of the geographic area covered by the chart.

Chart Title, Authorities Note, and Seal (A)

Item 10 of figure 2–2 is the chart title (Cook Inlet in this illustration). Although charts are generally ordered by chart number, the chart title serves as an additional identifier. The nautical chart catalog shows the area covered by each NOAA chart, and the corresponding chart number and title. Chart titles cannot be used alone (in lieu of chart numbers) because many place names (and chart names) are common throughout the world. According to one source (Coote), for example, there is a St. John in Newfoundland, New Brunswick, Antigua, the Red Sea, Florida, the Virgin Islands, Liberia, and near Hong Kong!

Item 11 of figure 2–2 contains the AUTHORITIES note. This note identifies the sources of data (e.g., NOAA, USACE, U.S. Navy, etc.) used in the compilation of the chart, explanatory notes on chart construction, and related material.

Item 12 is the chart seal. In the example shown in figure 2–2, the NOAA and IHO seals show this to be an international as well as national chart. Purely national charts have the national seal only. Reproductions of charts of other nations (facsimile) have the seals of the original producer (left), publisher (center), and IHO (right).

Projection and Scale (A)

Item 13 in figure 2–2 (located just below the chart title) identifies the type of chart projection (e.g., Mercator) and the chart scale. Projections and their relevance are discussed below.

–Projections

From earliest times, cartographers have been faced with the theoretically impossible task of accurately representing a spheroid (the earth) on a flat plane, a task referred to as projection. As the science of cartography evolved, numerous projections were developed, each with advantages and disadvantages. A complete discussion of these various projections is beyond the scope of this manual, but can be found in several of the references given at the end of this chapter (Air Navigation, Bowditch, Brown, Maloney, Naval Training Command, Snyder, and Voxland).

For nautical charts of other than high-latitude or polar regions, the Mercator projection is favored. This is because meridians of longitude are parallel straight lines, as are parallels of latitude. These straight lines intersect at right angles, making a convenient rectangular grid. Directions and geographic coordinates are easily read on this grid. A straight course line (rhumb line or loxodromic curve) drawn on the Mercator chart can actually be run; the rhumb line track will pass all features along that line exactly as they are charted. This is a great advantage in coastal navigation because the straight line represents a planned course and readily indicates the distance at which dangers will be passed abeam if this course is maintained.

The rhumb line is not the shortest distance between two points (a great circle), and either calculation or an auxiliary chart is required to determine great circle courses if a Mercator chart is used. However, the difference in distance between the rhumb line and the shorter great circle is very small for all but the longest voyages. Radio waves and light travel along great circles, which means that radio bearings taken some distance from the transmitter need to be corrected. Radio bearing corrections are tabulated on some nautical charts and can also be found in the *U.S. Coast Pilot* and other references (Bowditch).

In a more general context, the chief disadvantage of the Mercator projection is that it distorts the relative size of land areas—particularly for land masses located near the poles—other projections are superior in this regard. Indeed, one author (Monmonier) has argued (presumably tongue-in-cheek) that the Mercator projection has served the aims of political propagandists seeking to magnify the Communist threat, because this projection exaggerates the relative size of the former Soviet Union relative to countries situated at lower latitudes. (One can only marvel at the political prescience of Gerhard Mercator in anticipating this application when he developed the projection in the year 1569!) Whatever its other merits or faults, the utility and convenience of the Mercator projection for most marine navigation applications are unequalled.

For this reason, nearly all NOAA nautical charts are based upon the Mercator projection. The polyconic projection is used on some NOAA Great Lakes charts, but these charts are being converted to Mercator projections as resources permit.

Relevant attributes of Mercator and polyconic charts are summarized in table 2–2. As a practical matter, differences between these projections are only apparent on small-scale charts (see below). On large-scale charts, virtually identical plotting techniques are used.

The chief differences between small-scale Mercator and polyconic charts are:

- Distance is most accurately measured at or near the mid-latitude of the course on the Mercator chart. Distance scales (see below) are shown in nautical miles on Mercator charts, and in statute miles on polyconic Great Lakes charts.

- For all intents and purposes, great circles plot as straight lines on the polyconic chart. However, true directions from any point on the polyconic chart should be measured from the nearest meridian or nearest compass rose (see below). As noted, great circles do not plot as straight lines on Mercator charts. Instead, great circle courses must be calculated (or read from a polyconic or Gnomonic projection) as a series of points and transferred to the Mercator chart. Details of plotting great circle courses on Mercator charts are given in the references (Bowditch, Maloney).

- True directions (rhumb lines) can be measured with respect to any meridian or parallel (or any compass rose) on the Mercator chart, although in practice the nearest compass rose is used if magnetic courses are desired, because the magnetic variation varies with location on the chart.

- Plotting geographic positions is somewhat simpler on the Mercator chart, because meridians and parallels intersect at right angles. Great Lakes polyconic charts include a graphic plotting interpolator for the most accurate measurements of latitude and longitude.

Table 2-2. Key Characteristics of Projections Used in NOAA Nautical Charts

Attribute	Projection Type: Mercator	Projection Type: Polyconic
Invented by:	Gerard Mercator (the Latinized form of DeCremer or Kremer) in 1569.	Ferdinand Hassler, first director of the Coast Survey (later U.S. Coast and Geodetic survey) about 1820.
Poles:	Cannot be shown.	Points.
Projection:	Cylindrical.	Series of cones.
Conformality:	Conformal.	No, but approximately so.
Distance Scale:	Variable (measure at mid-latitude).	True along the central meridian and along each parallel.
Distortion of Shapes and Areas:	Increases away from equator.	Free of distortion only along central meridian. Extensive distortion for small-scale charts.
Angle Between Parallels and Meridians:	90°	Variable.
Appearance of Parallels:	Parallel straight lines unequally spaced.	Arcs of nonconcentric circles nearly equally spaced.
Appearance of Meridians:	Parallel straight lines equally spaced.	Curved lines (nearly straight) converging towards the pole and concave to the central meridian.
Straight Line Crosses Meridians:	Constant angle (rhumb line).	Variable angle (approximately great circle).
Great Circle:	Curved line (except at equator and Meridians).	Straight line (approximately)
Rhumb Line:	Straight line	Curved line
Used for:	Nearly all marine navigation charts produced by NOAA.	Some Great Lakes charts; being replaced by Mercator as resources permit.
True Direction Measured at:	Any place on chart; nearest compass rose most convenient.	Nearest meridian or compass rose.

–Chart Scale

The *scale* of the chart is the ratio of a given distance on the chart to the actual distance that it represents on the earth. Scale is expressed in various ways. The most common expression is a simple ratio or fraction known as the *representative fraction.* For example, a scale of 1:40,000 or 1/40,000 means that one unit (e.g., one inch) on the chart represents 40,000 of the same unit(s) on the surface of the earth. This scale is also termed the “natural” or “fractional” scale. A chart covering a relatively large area is called a “small-scale chart,” and one covering a relatively small area is termed a “large-scale chart.” To remember the difference between small scale and large scale, it is helpful to think of a small-scale chart as presenting only a small amount of detail and a large-scale chart as presenting a large amount of detail.

On a chart based upon the Mercator projection (the type shown in figure 2–2), the scale varies with the latitude. This variation is only noticeable on a chart covering a relatively large distance in a north–south direction. *On such a chart, the scale at the latitude in question should be used for measuring distances.*

Table 2–3 provides relevant scale information for various scales used in the preparation of nautical charts. For each chart scale, table 2–3 shows the number of nautical miles represented by 1 inch in length and its reciprocal, the length of 1 nautical mile in inches. This table

Table 2–3. Relevant Scale Information

Chart Scale 1	1 Inch in Nautical Miles	1 Nautical Mile in Inches	Coverage Square NM[1]	Nautical Chart Type[2]	
				Conventional	Small Craft
5,000	0.069	14.58	6	Harbor	
10,000	0.137	7.29	24	1:50,000 and	
20,000	0.274	3.65	96	larger	1:10,000 to
30,000	0.411	2.43	217		1:80,000
40,000	0.549	1.82	385		
50,000	0.686	1.46	601		
60,000	0.823	1.22	866	Coastal	
70,000	0.960	1.04	1,179	1:50,000 to	
80,000	1.097	0.91	1,540	1:150,000	
90,000	1.234	0.81	1,949		
100,000	1.371	0.73	2,406		
150,000	2.057	0.49	5,413		
200,000	2.743	0.36	9,623		
300,000	4.114	0.24	21,651	General	
400,000	5.486	0.18	38,491	1:150,000 to	
500,000	6.857	0.15	60,142	1:600,000	
600,000	8.229	0.12	86,605		
700,000	9.600	0.10	117,879		
800,000	10.972	0.09	153,964	Sailing	
900,000	12.343	0.08	194,861	1:600,000 and	
1,000,000	13.715	0.07	240,569	smaller	
2,000,000	27.430	0.04	962,274		
3,500,000	48.002	0.02	2,946,965	International	
10,000,000	137.149	0.01	24,056,854		

Notes:

[1] Assumes standard neat line size of 750 mm x 1,100 mm for AO paper.

[2] ICW charts are at a scale of 1:40,000.

also shows the area covered (in square nautical miles) by the chart, assuming neat line dimensions of 750 mm x 1,100 mm (one of the standard chart sizes). Thus, for example, on a chart with a scale of 1:10,000 (a large-scale chart), the area covered by the chart is approximately 24 square nautical miles, 1 inch on the chart is approximately equal to 0.14 nautical miles, and 1 nautical mile is approximately 7.3 inches in length.

–Chart Types

No one chart scale is adequate to serve all purposes. Nautical charts vary in scale with the importance of the geographic area, the purpose for which the chart is designed, and the necessity for clearly showing all dangers within that area. NOAA charts include small-craft charts, conventional charts, ICW, and marine facilities charts.

Small-craft charts, identified by the letters "SC" in the nautical chart catalog, are described below:

- *Small-craft charts,* published at scales ranging from 1:10,000 to 1:80,000, are designed for easy reference and plotting in limited spaces. Although normally used by operators of small craft, these charts provide the only chart coverage for all other marine users in some areas. These charts include the items normally depicted on other nautical charts together with details of special interest to small-craft operators, such as enlargements of harbors; tide, current, and weather data; rules-of-the-road information; locations of marine facilities and anchorages; courses and distances. Types of small-craft charts include: *folio charts* (consisting of two to four sheets printed front and back, folded, and bound in a protective cardboard jacket); *area charts* (versions of conventional charts overprinted with additional small-craft information); *route charts* (published in a single long, narrow sheet printed front and back and folded); *modified route charts; recreational charts;* and *canoe charts* (a chart series of the Minnesota–Ontario border lakes providing information relevant to those who use canoes, kayaks, and similar craft).

Conventional charts are flat (rather than folded) and depict the nature and shape of the coast (see Chapter 3), depth of the water (see Chapter 4), general configuration and character of the bottom (see Chapter 4), prominent landmarks (see Chapter 6), port facilities (see Chapter 3), cultural details, dredged channels, ATONs (see Chapter 5), marine hazards, magnetics (described below), areas and limits (see Chapter 7), and seaward boundaries (see Chapter 7). The five classifications of conventional nautical charts include:

- *International charts* (such as that illustrated in figure 2–2) include a series of five small-scale charts covering the Northeastern Pacific Ocean and the Bering Sea at scales of 1:3,500,000 or 1:10,000,000 compiled to internationally standardized cartographic specifications. The navigational information presented on these charts includes depth curves, soundings, nautical symbols, and related data.

- *Sailing charts,* published at scales smaller than 1:600,000, are intended for planning voyages and for fixing the mariner's position as the coast is approached from the open ocean or for sailing along the coast between distant ports. The shoreline and topography are generalized, and only offshore soundings, principal navigational lights and buoys, and landmarks visible at considerable distances are shown. Figure 2–4 contains an excerpt from NOS Chart No. 13003 (Cape Sable to Cape Hatteras). This sailing chart is drawn to a scale of 1:1,200,000. In the right-hand corner, some depth and ATON information is depicted at the entrance to the Delaware Bay. No soundings, depth contours (see Chapter 4), or ATONs (see Chapter 5) are given for the Chesapeake Bay, and the city of Annapolis is depicted with only a city symbol (see Chapter 7).

- *General charts,* published at scales ranging from 1:150,000 to 1:600,000, are intended for coastal navigation when a course is well offshore but can be fixed by landmarks, lights, buoys, and characteristic soundings. Figure 2–5 contains an excerpt from NOS Chart No. 12260 (Chesapeake Bay, Northern Part) showing a portion of the area covered in figure 2–4. This general chart is drawn to a scale of 1:197,250. Soundings and ATONs in the Chesapeake Bay are shown, but Annapolis is still depicted with only a city symbol, and very little detail is presented in the vicinity of the Severn River.

- *Coast charts,* published at scales ranging from 1:50,000 to 1:150,000, are intended for nearshore navigation, entering or leaving bays and harbors, and in navigating the larger inland waterways. Some coast charts omit detail in areas that are covered by larger scale charts. For example (Chapman), Narragansett Bay appears on NOS Chart 13218, but no hydrography, ATONs, etc., are depicted. A small note refers the user to a larger scale chart. Figure 2–6 contains an excerpt from NOS Chart No. 12270 (Eastern Bay and South River) depicting a portion of the area covered in the preceding two figures. This chart is drawn to a scale of 1:40,000, slightly larger than a coast chart scale. Much more detail is presented on this chart. City streets, landmarks for position fixing, ATONs, soundings, and some harbor detail (e.g., piers, etc.) are clearly shown.

- *Harbor charts,* published at scales of 1:50,000 and larger, are intended for navigating in harbors and smaller waterways and for anchorage. Harbor charts present more numerous soundings than are shown on smaller scale charts and *all* ATONs to maximize the accuracy of positions determined from plotted bearings. Figure 2–7 contains an excerpt from NOS Chart No. 12283 (Annapolis Harbor). This harbor chart is drawn to a scale of 1:10,000. Individual buildings at the U.S. Naval Academy are shown as are details important to the mariner intending to anchor in this area.

NOAA publishes ICW (inside route) charts at a scale of 1:40,000, which depict the inside route from Miami, FL, to Key West, FL, and from Tampa, FL, to Anclote Anchorage, FL.

Finally, NOAA publishes *marine facilities charts.* According to the *Nautical Chart Manual,*

> [Marine facilities charts] "are conventional charts with small-craft marine facility information overprinted on the chart and presented in tabular form on the back. These are produced for major port areas where facility information for a wide area, such as Narragansett Bay or Galveston harbor, is useful for the mariner."

Marine facility charts are identified with the letters "MF" in the nautical chart catalog.

–A Mix of Charts Necessary

The prudent navigator carries a mix of sailing or general charts for overall voyage planning (if a long distance voyage is contemplated), coast charts for actual use (e.g., intended tracks and DR plots) for the longer runs, and harbor charts for entering ports and trips up smaller rivers and creeks. For example, on a hypothetical voyage from Bermuda to Annapolis, sailing and general charts would be used for offshore navigation, coast charts for the trip up the Delaware Bay, through the C & D Canal (although a large-scale chart of this canal is published), and down the Chesapeake Bay, and the Annapolis Harbor chart for final approach and anchoring or docking. Continuing the example (Chapman), the best overall route up or down the Chesapeake Bay is more easily plotted on two

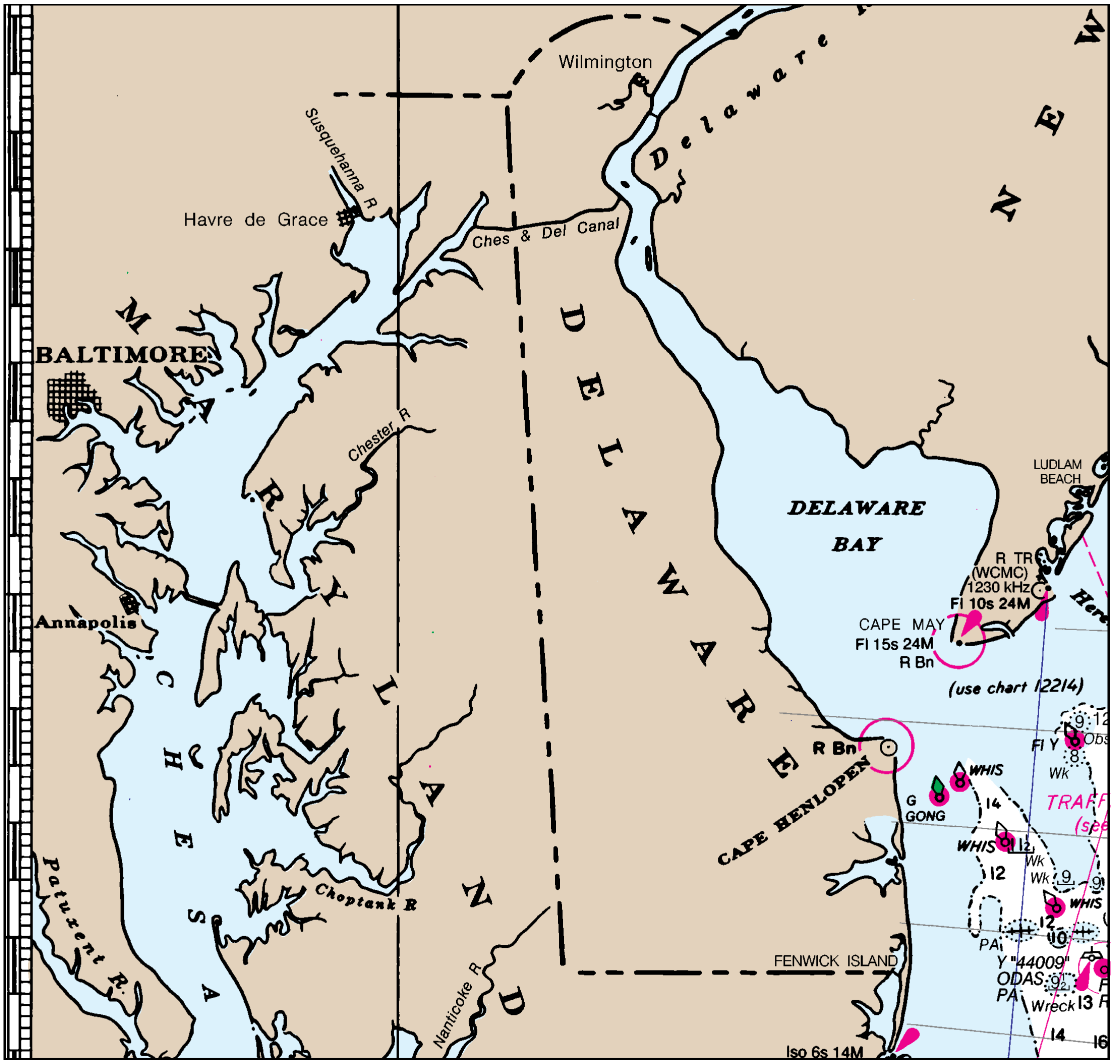


Fig. 2–4. Excerpt from NOS Chart No. 13003
(Cape Sable to Cape Hatteras)
Drawn to a Scale of 1:1,200,000

general charts (NOS Charts 12220 and 12260), rather than on a series of five coast charts (NOS Charts 12221 to 12273) covering the same area. The coast and harbor charts are appropriate for the actual trip.

As a general matter, the mariner is well advised to use the largest scale chart of the area, as this chart presents the greatest amount of detail. Many mariners carry harbor charts for other harbors along the intended route as insurance against the possibility that mechanical malfunctions, weather, fuel shortages, medical emergencies, or other unforeseen events make a diversion to an alternate harbor advisable (Blewitt).

Failure to carry sufficient charts to accommodate possible diversions can have serious consequences from both safety and legal standpoints, as numerous case studies of commercial vessel strandings (Cahill) illustrate. In retrospect, it is virtually impossible to justify the loss of a multimillion dollar tanker (or even a $50,000 cabin cruiser) for the lack of a $14 chart! Although today's civil penalties for a lack of prudence are less draconian than that listed in the opening quotation of this chapter, these are harsh enough to command attention.

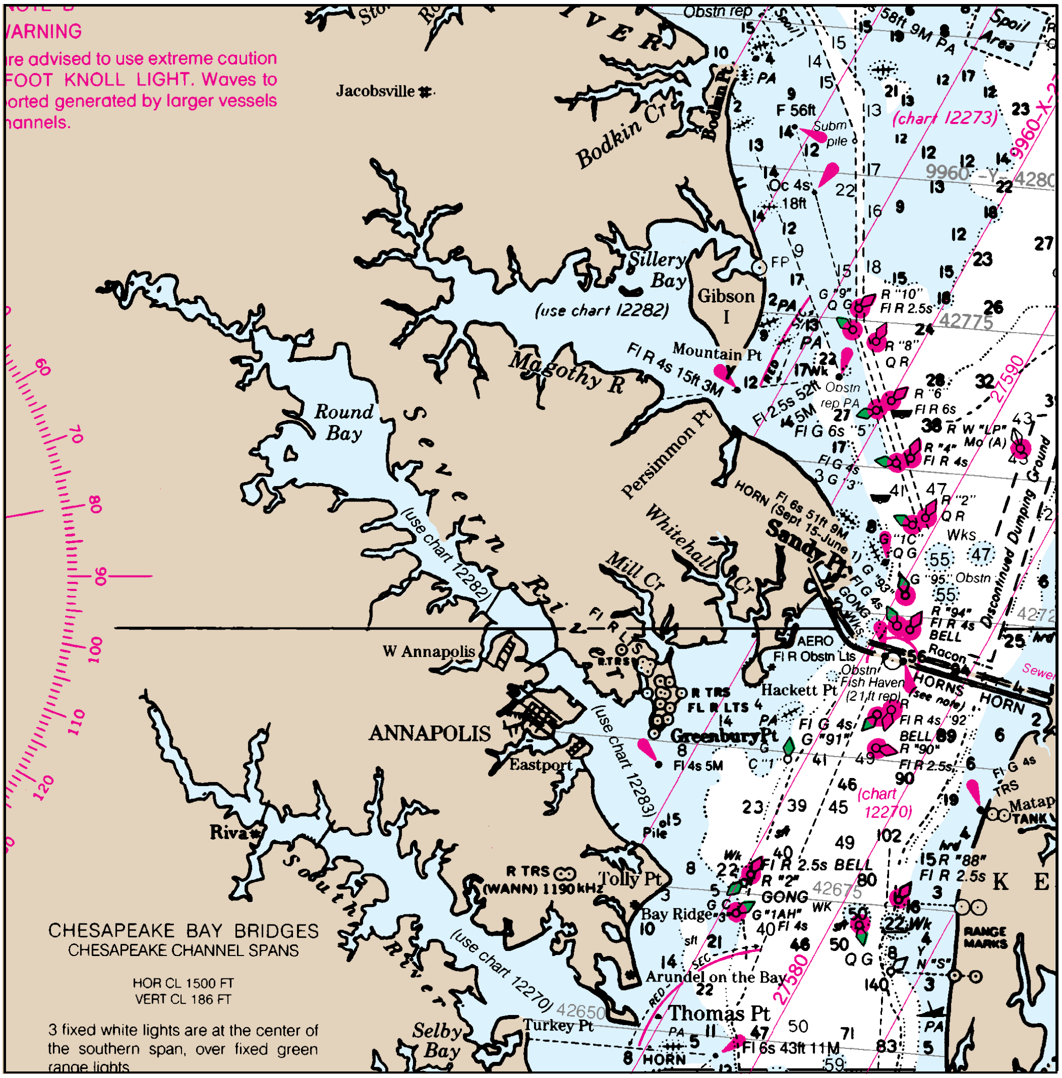


Fig. 2–5. Excerpt from NOS Chart No. 12260 (Chesapeake Bay, Northern Part) Drawn to a Scale of 1:197,250

A Brief Aside, Chart Storage and Care—Rollers versus Folders

As noted, conventional charts are sold as flat sheets, and typically shipped rolled in cardboard tubes, whereas small-craft charts are prefolded to simplify stowage problems on small craft. Most mariners would agree that, ideally, conventional charts should be stored flat—in a draftsman's cabinet—provided adequate space exists. However, many vessels (and, indeed, most recreational vessels) do not have sufficient space to accommodate flat storage of conventional charts.

There is no general consensus on how best to store conventional charts in cramped quarters. Rather, the world of navigators (or, at least, the world of navigation textbook writers) appears to be fundamentally divided on whether to roll or fold these charts. "Rollers" (see Chapman, Graves) argue that conventional charts should be rolled if possible, claiming that the disadvantage of the ends curling is more than outweighed by the longer life of a chart if it is not creased. "Folders" (Campbell) argue that it is difficult to plot on a rolled chart and offer numerous suggestions on how best to fold charts

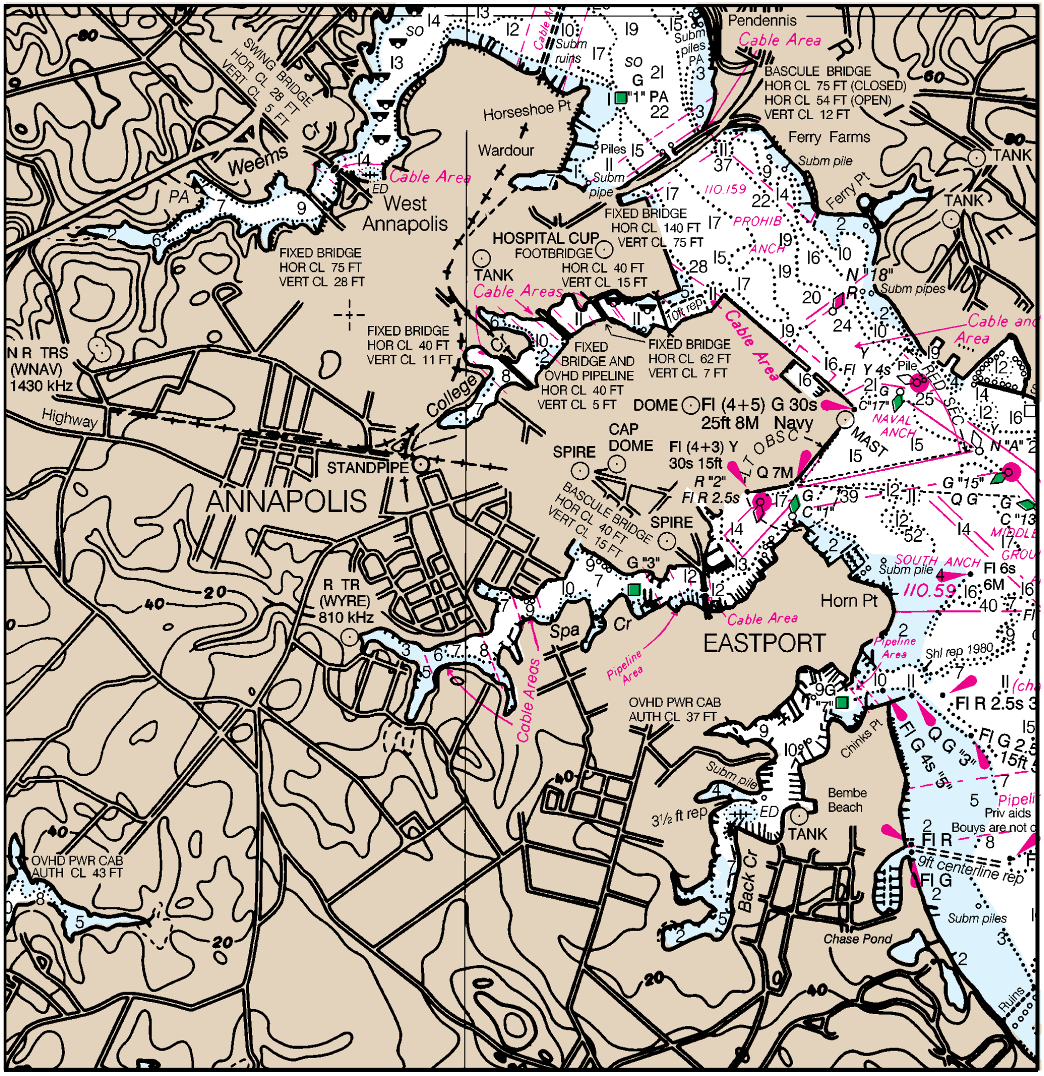


Fig. 2–6. Excerpt from NOS Chart No. 12270 (Eastern Bay and South River) Drawn to a Scale of 1:40,000

(e.g., in four sections, each about the size of an average navigation desk on a yacht, with the printed side facing out). In the end, this reduces to a matter of personal preference.

If there is controversy between "rollers" and "folders," there is unanimity that charts should be stored in a convenient but dry area in the vessel. Damp storage areas often result in mildew damage, and water spray creates bubbles, folds, and resulting distortions when the chart finally dries out. Durable as it is, the paper on which nautical charts are printed cannot stand repeated cycles of water spray, let alone water immersion.

Linear and Logarithmic Speed Scales (A)

Item 14 on figure 2–2 is a linear scale, often provided on chart insets (see below) and larger scale charts. The *linear scale* (also termed a *bar scale*) is found on Mercator charts (or insets) with chart scale of 1:80,000 and larger (1:120,000 and larger for polyconic projections). Bar scales enable the user to measure distances (in nautical miles, statute miles (on Great Lakes charts), yards, and meters) quickly with a pair of dividers. The linear scale is used in lieu of the latitude scale at the side of the chart. Figure 2–8 (top) shows an example of a bar scale.

Logarithmic speed scales, shown in figure

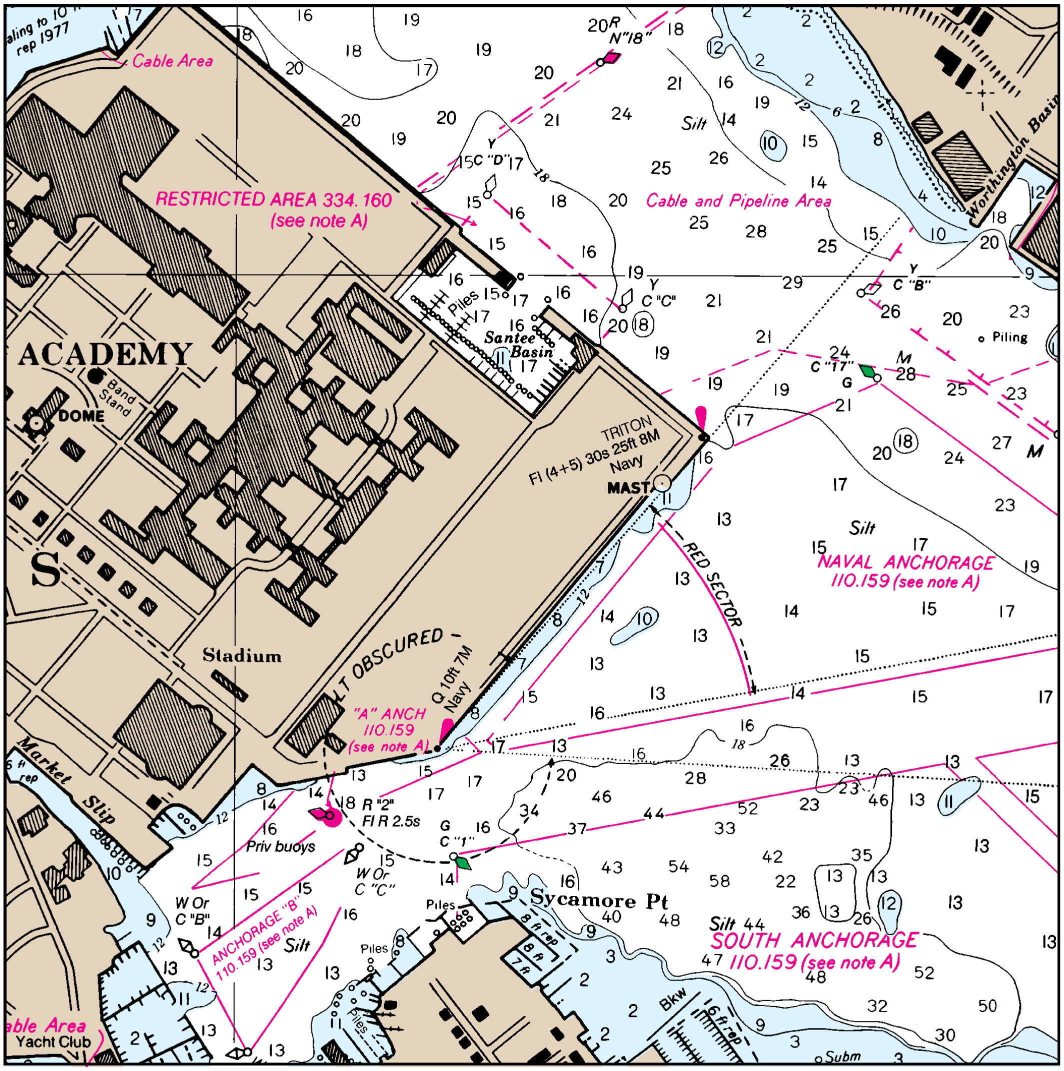


Fig. 2–7. Excerpt from NOS Chart No. 12283 (Annapolis Harbor) Drawn to a Scale of 1:10,000

2–8 (bottom), are also printed on these charts. The *logarithmic speed scale* is an ingenious nomograph to solve *time-speed-distance* (TSD) computations. It is used to calculate speed, based upon the distance and time run. To find the speed, one point of a pair of dividers is placed on the distance run (in any unit) and the other on minutes run. Without changing the divider spread, the right point of the divider is placed on the number 60; the left point of the dividers will then indicate the speed in units per hour. Thus, for example, if a vessel travels 4 nautical miles in 15 minutes, the calculated speed is 16 knots.

Notes and Cautions

Item 16 on figures 2–2 and 2–3 refers to cautionary notes (if any) depicted on the nautical chart. These notes, *which should be read before using the chart,* present a variety of general and particular information. Specific notes and their meaning are discussed throughout this manual. Table 2–4 provides a sample of notes taken from various nautical charts which illustrates the type of information provided. Notes may be located at or near the title block as shown in figure 2–2, but may also be located anywhere on the chart where they do not obscure navigationally relevant data or information.

Chart Overlap, Insets, and Related Matters

There is an old military adage (Heinl) to the effect that battle is a process which always takes place at the junction of two maps. Many navigators believe that this maxim applies equally to nautical charts. Before a vessel crosses from waters described by one chart to those covered by another, it is necessary to extend the course to the adjoining chart. Moreover, the course has to be selected so as to maintain a safe distance from charted hazards and take advantage of ATONs and landmarks depicted on the adjoining chart. As the vessel crosses into waters depicted on the adjoining chart, the navigator must be able to plot fixes rapidly on the next chart in sequence. If electronic fixes are available (e.g., from a GPS or Loran–C receiver), the fixes are easily plotted on the appropriate chart. However, if visual bearings are used, plotting fixes may be more difficult if the vessel's position is near a chart border.

–Measures to Minimize Confusion: The Chartmaker's Perspective

NOAA uses four methods to minimize problems associated with the transition from one chart to another.

- First, nautical charts are sized and aligned (insofar as possible) to ensure that dangerous passages are not located near the chart borders. This lowers the likelihood of a vessel entering a hazardous area when it is necessary to shift from one chart to the next.

- Second, nautical charts are deliberately drawn so as to overlap slightly. Adjoining charts of the same scale, particularly coastal charts, generally have an inch or two of overlapping coverage. The amount of overlap varies from chart to chart and is sufficient to include enough common prominent features, important aids to navigation, etc., to facilitate the quick transfer of a plotted course and position from one chart to the next in sequence. The detail presented on overlapping charts of the same scale is identical or nearly so.

- Third, if (despite efficient location and overlap) there are still important features located just outside the chart border, a border break (sometimes

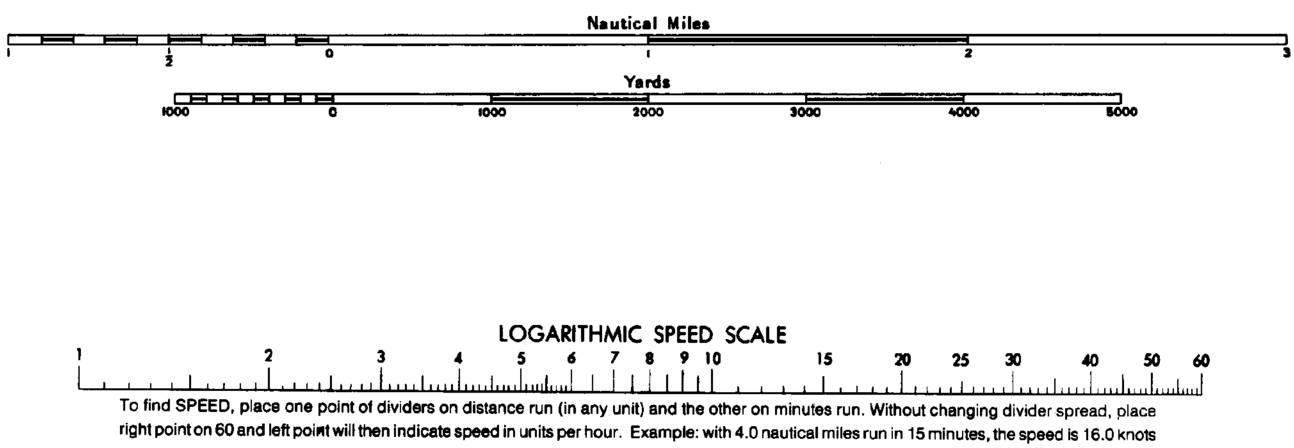


Fig. 2–8. Bar Scales and Logarithmic Speed Scales Shown on Selected Nautical Charts

Table 2–4. Illustrations of Various Notes and Cautions Found on NOAA Charts

NOTE C
Strong currents exist between buoys creating hazardous navigating conditions. Use extreme caution

CAUTION
Extremely heavy tide rips and strong currents may be encountered in the vicinity of the islands shown on this chart.

CAUTION
Improved channels shown by broken lines are subject to shoaling, particularly at the edges.

NOTE A
Navigation regulations are published in Chapter 2, U.S. Coast Pilot ___. Additions or revisions to Chapter 2 are published in the *Notices to Mariners*. Information concerning the regulations may be obtained at the Office of the Commander, ___ Coast Guard District ___ , __, or at the Office of the Division Engineer, Corps of Engineers in ___, __. Refer to charted regulation section numbers.

RACING BUOYS
Racing buoys within the limits of this chart are not shown hereon. Information may be obtained from the U.S. Coast Guard District Offices as racing and other privately maintained buoys are not all listed in the U.S. Coast Guard *Light List*.

NOTE B DANGER AREA
Area is open to unrestricted surface navigation but all vessels are cautioned neither to anchor, dredge, trawl, lay cables, bottom, nor conduct any other similar type of operation because of residual danger from mines on the bottom.

WARNING
The prudent mariner will not rely solely on any single aid to navigation, particularly on floating aids. **See:** U.S. Coast Guard *Light List* and U.S. *Coast Pilot* for details.

RADAR REFLECTORS
Radar reflectors have been placed on many floating aids to navigation. Individual radar reflector identification on these aids has been omitted from this chart.

CAUTION
Only marine radiobeacons have been calibrated for surface use. Limitations on the use of certain other radio signals as aids to marine navigation can be found in the U.S. Coast Guard *Light Lists* and *Defense Mapping Agency Publication 117.*

NOAA VHF - FM WEATHER BROADCASTS
The National Weather Service stations listed below provide continuous marine weather broadcasts. The range of reception is variable, but for most stations is usually 20 to 40 miles from the antenna site.

CAUTION
FISH TRAP AREAS AND STRUCTURES
Mariners are warned that numerous uncharted duck blinds and fishing structures, some submerged, may exist in the fish trap area. Such structures are not charted unless known to be permanent.

CAUTION
BASCULE BRIDGE CLEARANCES
For bascule bridges, whose spans do not open to a full upright or vertical position, unlimited vertical clearance is not available for the entire charted horizontal clearance.

CAUTION
Temporary changes or defects in aids to navigation are not indicated on this chart. **See:** *Notice to Mariners*.

During some months or when endangered by ice, certain aids to navigation are replaced by other types or removed. For details see U.S. Coast Guard *Light List*.

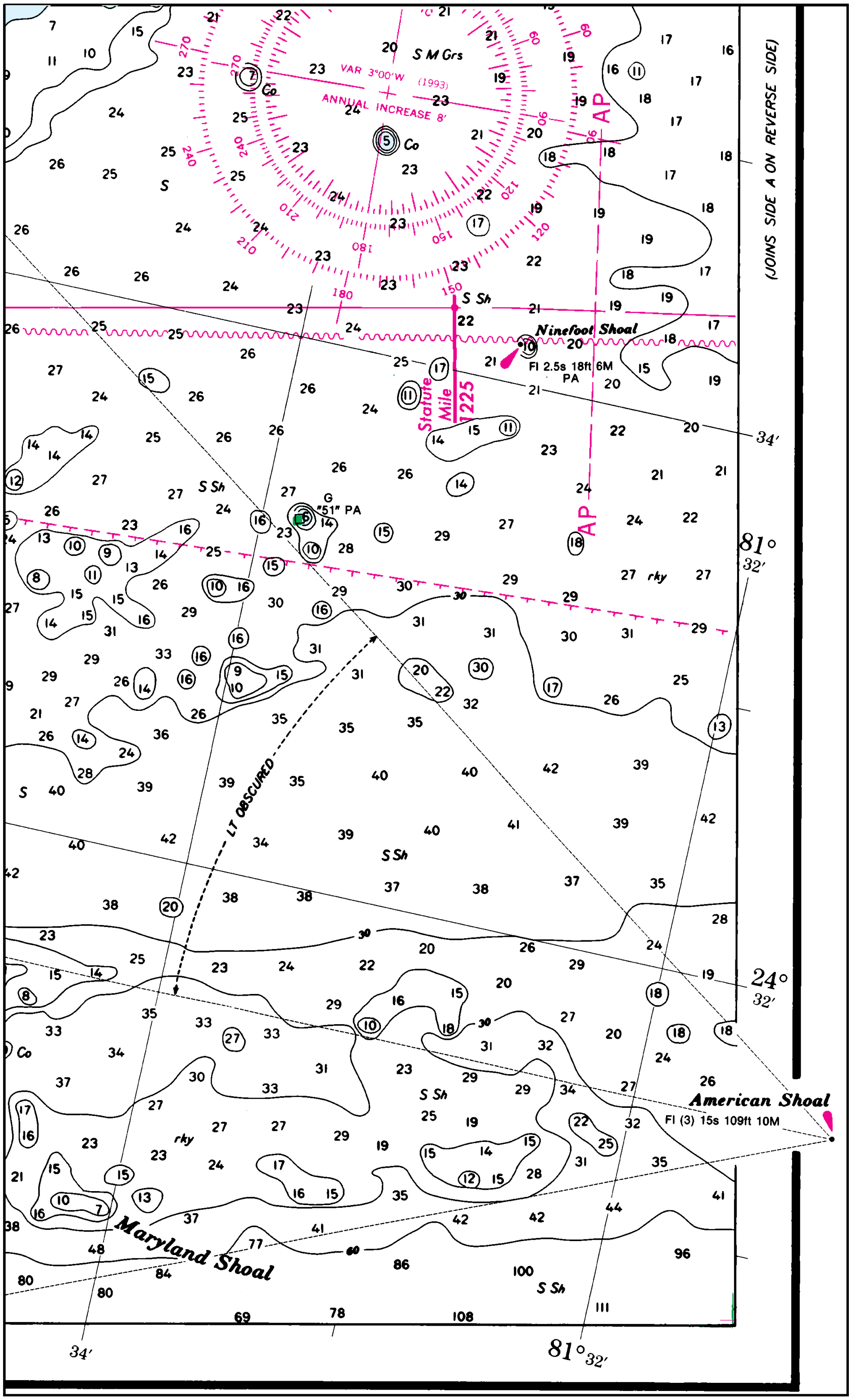
also called an extrusion, extension, or blister) is used. The *border break,* as the name implies, is an extension of the charted area outside of the chart neat lines to depict particularly important feature(s). Figure 2–9 presents an excerpt from NOS Chart No. 11445 (Sugarloaf Key to Key West), an ICW chart, which includes a border break. Note in the lower right-hand corner of this illustration that the *American Shoal* light is actually located outside the chart border. Because this light is deemed important to navigation, a border break is used to show it on this chart. Border breaks are also used to eliminate the need for printing an additional chart. For example, figure 2–10 contains an excerpt from NIMA Chart No. 28160 (Tela to Pelican Keys). The border break in this metric chart avoids the necessity of printing another chart just to depict the small portion of the *Bahia De Amatique* (Honduras Bay) near the *Temash River.*

- Fourth, notes (and sometimes diagrams) are provided on the nautical chart to identify the adjoining chart(s) so that the user can quickly identify the appropriate chart. This is done in various ways. For example, notes (e.g., *JOINS CHART 12214,* if the adjoining chart is to the same scale, or *CONTINUED ON CHART 12311* if the adjoining chart is of a different scale) printed in black italic capital letters outside the neat line of the nautical chart identify the adjoining chart. Refer to item 17 in figure 2–2. (Cross-reference to join points on small craft and ICW charts is facilitated by a dashed magenta section line, e.g., line AP - - - AP in figure 2–9, which is also displayed on the adjoining chart.) In cases where a larger scale chart of the same area is available a note (e.g., *chart 12284)* is printed in lower case italic magenta type at or near the boundary of the larger scale chart on the smaller scale chart. (Hydrographic detail may be suppressed on the smaller scale chart in this case.) In some cases the larger scale information may be presented in an inset (see, for example, item 15 in figure 2–2), in which case the inset will be printed somewhere on the chart so as not to obscure navigationally relevant information. Finally, chart outlines and diagrams are also used to display larger scale overlapping or adjoining chart coverage on smaller scale charts. The intent is to provide the user with a complete reference to larger scale chart coverage. This is done either by providing an outline of boundaries of the larger scale chart on the smaller scale chart (as shown by item 15 in figure 2–2) or by providing a convenient chart index diagram which shows the available larger scale charts. Figure 2–11 contains a chart diagram found on NOS Chart No. 12260 which shows the boundaries of the larger scale charts available for this area.

–Measures to Minimize Confusion: The Navigator's Role

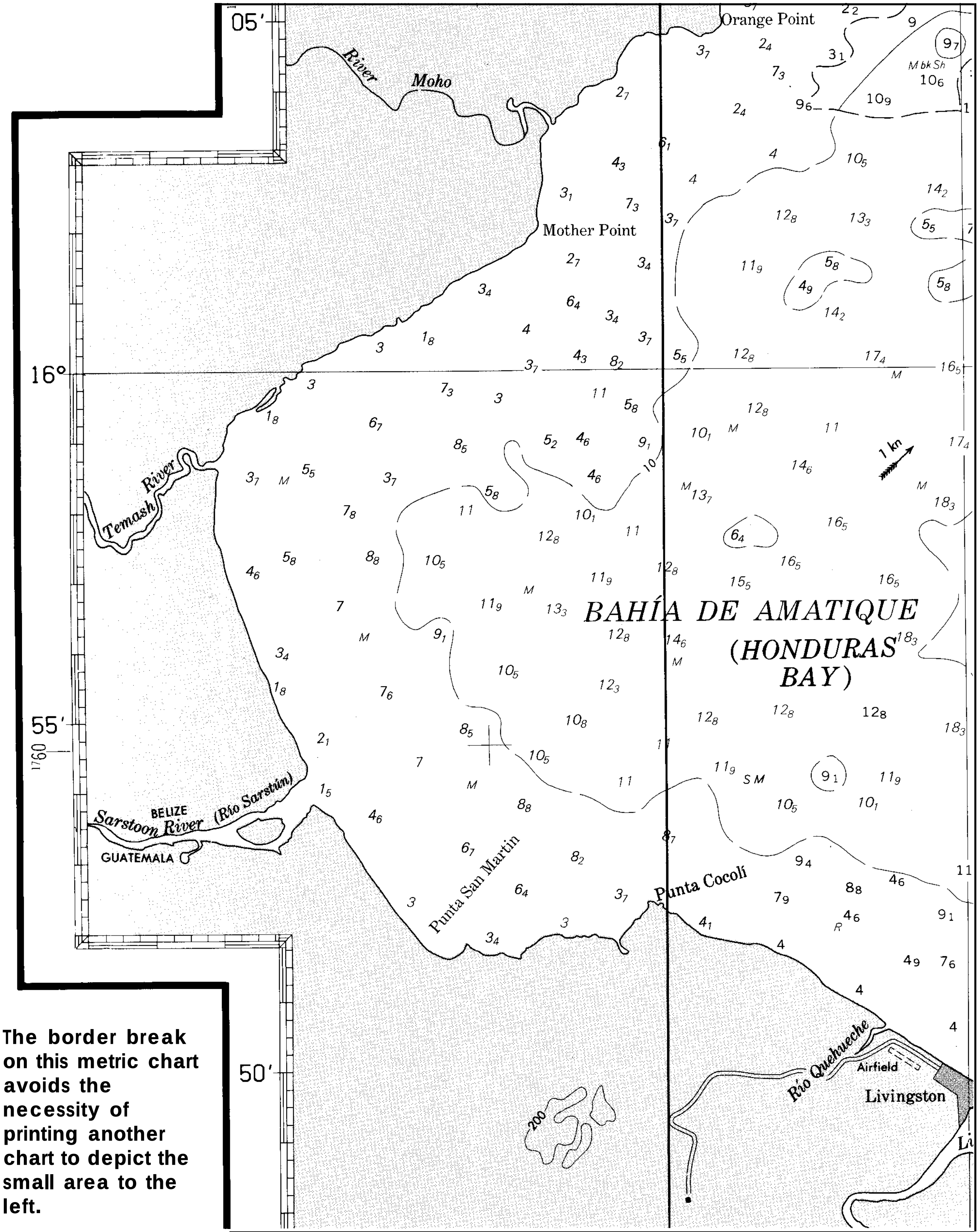
The navigator should also take steps to minimize any confusion that might occur when shifting from one chart to another.

- First, the proper adjoining (or larger scale) chart should be selected from the storage area so that it is readily at hand well before the chart is actually required. This is particularly important if the mariner is “single-handing” (traveling alone) or if the chart storage compartment is located some distance from the helm or plotting area. Indeed, it is a good idea to lay out all the required charts for a voyage prior to getting underway, labelling each with a removable gummed label with an attached sequence number. This procedure not only facilitates selection of the right chart, but also ensures that any missing charts are identified at the dock, rather than while underway. Few things are more frustrating than having to divert to an alternate harbor



This figure illustrates a border break to include an important light and the dashed magenta symbol (AP – – – AP) to cross-reference a position on the next chart. Note also the skewed projection.

Fig. 2–9. Excerpt from NOS Chart No. 11445 (Sugarloaf Key to Key West)



The border break on this metric chart avoids the necessity of printing another chart to depict the small area to the left.

Fig. 2–10. Excerpt from NIMA Chart No. 28162 (Tela to Pelican Cays)

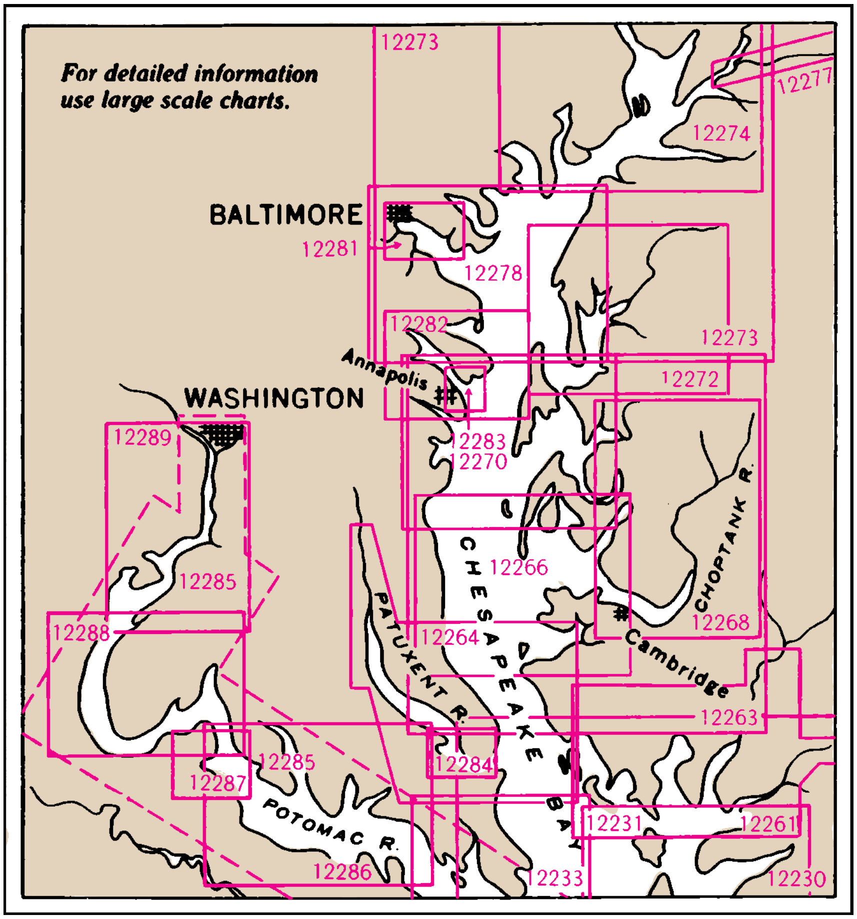


Fig. 2–11. Chart Diagram Found on NOS Chart No. 12260 Identifies Larger Scale Charts to be Used for Navigation

because the required chart is not aboard! (The alternative of pressing on without the missing chart in hopes that the channel is well-marked is so hazardous as to be unthinkable.)

- Second, the vessel's intended track should be plotted on the adjoining (or larger scale) chart before this chart is required. The DR plot should be drawn in while underway, but the intended track can be plotted beforehand. Where possible, the intended track should be laid out so as to minimize the necessity for accurate navigation in the immediate vicinity of a chart junction.

- Third, if using landmarks or ATONs for position fixing, the navigator should plan ahead to avoid selecting objects that are not shown on the same chart. For example, visual bearings on two objects not shown on the same chart cannot readily be plotted to obtain a fix. Alternatively, the navigator can designate a checkpoint or waypoint that is located in the overlap area common to both charts. Arrival at the waypoint signals the need to change charts. This is particularly convenient if a navigational receiver (e.g., GPS or Loran–C) with a waypoint alarm is used.

- Fourth, the navigator should fix the position of the vessel more frequently when in the vicinity of the chart junction.

- Fifth, the navigator should be particularly alert to any change in scale whenever shifting to another chart as, for example, when shifting from a coast chart to a harbor chart. Although adjoining charts are often drawn to the same scale, this is not always the case. Moreover, larger scale charts and chart insets always involve a change in scale. Attention to scale changes is particularly important if an external distance scale (e.g., a paraline plotter) is used. These instruments often have several distance scales scribed along the straight edge. It is a common error to use the wrong distance scale, particularly when transitioning to a chart with a different scale from that used previously. Use of the wrong distance scale translates into an incorrect DR plot with attendant hazards. To avoid this error, many navigators disregard the scribed distance scales on plotters and always measure distances with dividers using the latitude scales or the linear scale printed on the chart. (Separate latitude scales or linear scales are always printed on insets of a different scale.)

Navigators using commercial reproductions of portions of NOAA charts, especially those printed in relatively small booklets, soon learn that chart changes are more frequent and that it is often difficult to find the adjoining chart in the booklet.

Latitude, Longitude, Regular, and Skewed Projections

Each nautical chart will have lines marking parallels of latitude and meridians of longitude. (In the Mercator projection, as shown in table 2–2, latitudes are parallel straight lines, and meridians of longitude are likewise parallel straight lines.) These are used to measure the geographic location of any point on the chart in terms of latitude and longitude. The latitude scale is also used to measure distance; 1 nautical mile is equal to 1 minute of latitude. The interval between adjacent parallels and meridians depends upon the scale of the chart.

Latitude and longitude scales are marked with degrees and minutes. NOAA charts with a scale larger than 1:50,000 subdivide minutes into seconds or multiples of seconds. Small-scale charts subdivide minutes into tenths, fifths, or halves. Read these scales carefully. It is also important for the mariner to note the units of latitude/longitude readout of an electronic navigation receiver (e.g., GPS or LORAN-C) as these may differ from those used on the chart. For example, most electronic receivers measure latitude or longitude to degrees, minutes, and tenths (or hundreths) of minutes, rather than degrees, minutes, seconds.

Most conventional charts are oriented “north up” with latitude scales at the sides of the chart and longitude scales at the top and bottom. Some conventional charts and many small-craft charts are printed as a skewed projection so as to make the most efficient use of space. In these skewed (non-north up) projections, lines of latitude and longitude are not parallel to the borders of the chart. A *skewed projection* is illustrated in figure 2–9.

Depth Units and Vertical Datum

The units of depth (e.g., feet, fathoms, fathoms and feet, meters) employed on the chart are shown in the title block and in capital magenta letters at the top and bottom of the chart. As discussed in Chapter 4, NOAA charts are now published in both “traditional” (feet, fathoms, fathoms and feet) and metric units. In the future, charts with traditional units are being replaced by those charted in metric units. Kals offers an interesting anecdote on misreading depth units:

> “In Montreal I once conned the craft of a friend who had urgent business below. Avoiding the ship channel, I headed straight for our destination over soundings of 2, 3, and 4 fathoms. [Note 1 fathom is 6 feet.] No problem; his schooner drew only 5 feet. The river must have been well above datum level or I would have run her hard aground. The soundings were in feet!”

Not all such stories have such a happy ending. It is essential to check the depth units on the chart. This is especially important during the present transition period from conventional units to metric units.

The chart note regarding depth units also defines the vertical datum (typically mean lower low water for soundings and mean high water for heights) used on the chart, as discussed in more detail in Chapter 4.

To provide a ready source of unit conversion information, NOAA charts also include a depth conversion scale. This scale shows the correspondence between fathoms, feet, and meters. Figure 2–12 illustrates the depth conversion scale designed for horizontal placement. A similar scale has been designed for vertical placement. These scales are typically placed near the chart borders.

Horizontal Datum

The horizontal datum is shown just below the title block of the chart. The horizontal datum is a set of constants specifying the coordinate system used for geodetic control, that is, for calculating coordinates of points on the earth. Different horizontal datums use different ellipsoids to represent the earth's shape. Prior to widespread use of satellite systems for surveying and navigation, most countries developed an ellipsoid that fitted the curvature of the earth for the particular areas charted. In consequence, numerous datums were employed because the datum providing the best fit for one area might not provide the best fit for another.

Most NOAA charts are based upon the *North American Datum of 1983* (NAD 83), the current standard for U.S. nautical charts. This datum is quite close to the *World Geodetic System of 1984* (WGS 84). Other datums presently used on NOAA charts include the:

- *North American Datum of 1927*
- *North American Datum of 1902* (found only on some Great Lakes charts),
- *Old Hawaiian Datum,*
- *Puerto Rico Datum,*
- *Local Astronomic Datums,* and the
- *Guam 1963 Datum.*

With the exception of the charts of the Hawaiian Islands and other western Pacific islands (which will be compiled on WGS 84) all new charts and reconstructed NOAA charts are based on NAD 83.

–Relevance of Horizontal Datum

For navigators using radar or visual means for position fixing, the particular datum used is merely an academic curiosity. However, for those using electronic navigation systems, such as GPS or LORAN-C, the chart datum is potentially more relevant. This is because the mathematical conversion routines employed in these receivers to convert the received signals (e.g., LORAN-C TDs) to latitude and longitude depend upon the assumed datum. A shift from one datum to another could shift the position of the apparent fix by an amount ranging from meters to miles. One source (Brogden) notes that, outside the United States, it is commonplace to find differences of half a mile to a mile between GPS fixes and a local chart.

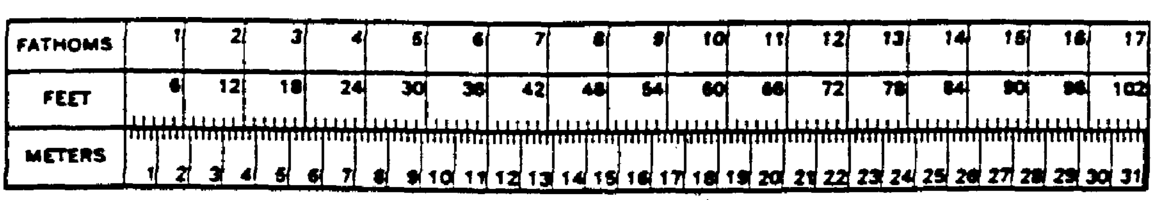


Fig. 2–12. Depth Conversion Scale for Horizontal Placement

Most modern makes and models of GPS and LORAN-C receivers have the capability of shifting from one datum to another (Dahl, Brogden), often offering a wide selection (as many as 50 to 100) of alternate datums. *If the vessel's navigation receiver is so equipped, it should be set to match the datum used on the nautical chart of the area.*

Direction and Magnetics (B)

True and magnetic information is provided on nautical charts to enable mariners to measure direction and determine magnetic courses. This information is provided in various ways. Latitude and longitude lines provide north–south and east–west orientation. The mariner can determine true direction from either parallels of latitude or meridians of longitude with the aid of various commercially available course plotters. True and magnetic directions are provided with one or more compass roses (B70) located on the chart. Magnetic information is also displayed by the use of isogonic (lines of equal magnetic variation) lines (B71) shown on the chart.

–Compass Roses (B70)

A compass rose, as illustrated in figure 2–13 (top), is placed on nautical charts to help mariners plot bearings and lay out courses. As a point of interest, the use of the compass rose to indicate true and magnetic directions is a tradition dating back several centuries. As noted by Brown, "The earliest known rose to indicate compass variation appeared on a map in the *Cosmographiae Introductio* of Apianus printed at Ingolstadt in 1529."

On the modern nautical chart, the compass rose consists of two concentric graduated circles:

- The outer circle (true rose), graduated in increments from 0° through 360°, is aligned with true north. (Depending upon the scale of the chart, the increments may be 1°, 2°, or 5°.) The star symbol atop the 0° mark presumably denotes Polaris, the north star.

- The inner circle (magnetic rose), also graduated in increments of 1°, 2°, or 5° and labeled MAGNETIC, is aligned with magnetic north. The arrow atop the magnetic scale points to magnetic north. A second set of graduations within the inner (magnetic rose) circle is graduated in the older 32-point system (1 point = 11.25°). Half points and quarter points are also given.

- Another label (e.g., VAR 4° 15'W (1985) ANNUAL DECREASE 8', in figure 2–13), shows the magnetic variation (4°15'W) for the charted area as of a specified date (January 1, 1985), and the annual increase or decrease to permit adjustment to the current date. This is necessary because magnetic variation is not constant, but rather changes due to the fluctuations of the earth's magnetic fields.

Use of the compass rose for measuring courses or bearings is explained in numerous texts (e.g., Bowditch, Dutton) and is not discussed here. Compass roses are positioned on a chart so as to be convenient to the most important navigational areas, and at sufficiently frequent intervals so that all water areas are within the reach of the parallel ruler. If the compass rose is positioned on a land area, some topographic detail may be removed to reduce chart clutter. Compass roses are not placed in water areas at the entrance to a harbor, at or near hazards to navigation in the water, nor do the graduations obscure relevant soundings.

Compass roses are printed in magenta on all new charts and new editions. Some existing charts, especially those with magenta Loran–C lines, have compass roses printed in black. These will be converted to magenta when new editions are published.

–Local Magnetic Disturbance Notes

Local magnetic disturbances, which may cause substantial deflections of the compass, occur quite commonly in shallow water near

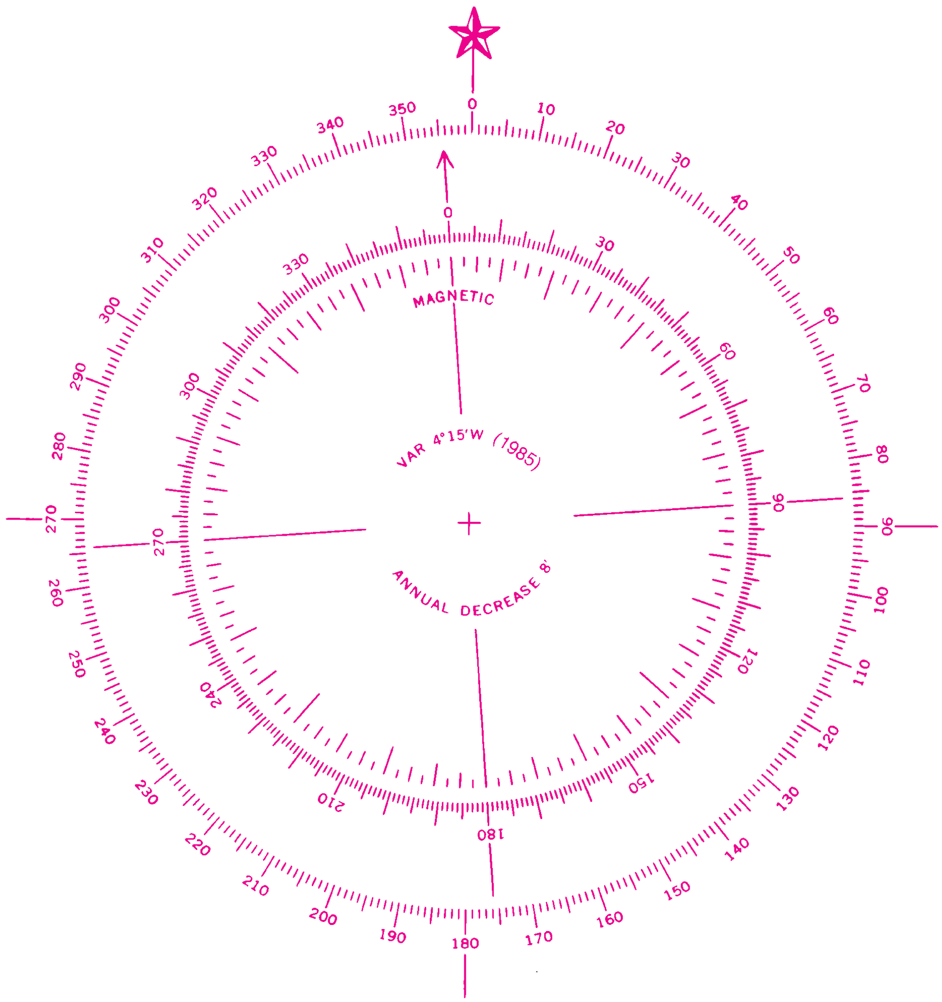
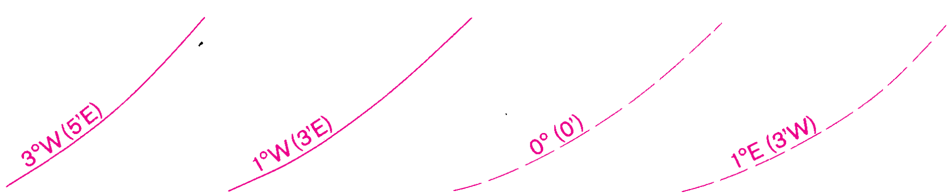
70	*Compass rose, normal pattern (smaller patterns of compass rose may be used)*
	Magnetic Variation (example): 4° 15′ W 1985 (8′ E) *on magnetic north arrow means Magnetic Variation* 4° 15′ W *in* 1985, *annual change* 8′ E *(i. e. magnetic variation decreasing* 8′ *annually).* 
71	*Isogonic lines*
	Magnetic Variation Curves are for 1985 *The Magnetic Variation is shown in degrees, followed by the letter W or E, as appropriate, at certain positions on the curves. The annual change is expressed in minutes with the letter W or E and is given in brackets, immediately following the variation.* 

Fig. 2–13. Compass Rose (B70) and Isogonic Lines (B71) Shown on Nautical Charts

mountain masses. Notes, printed in magenta, alert the mariner to these areas wherever deviations of 2° or more (3° in Alaska) exist. Here are two examples:

LOCAL MAGNETIC DISTURBANCE

Differences from normal variation of as much as 5° have been observed in Gastineau Channel in the vicinity of Lat. 58°15'.

LOCAL MAGNETIC DISTURBANCE

Differences of 12° or more from normal variation may be expected in X Channel in the vicinity of Z point.

If space constraints prevent inclusion of the entire note, the full note is placed elsewhere on the chart and the following reference note (in magenta) is placed in the area of the disturbance:

LOCAL MAGNETIC DISTURBANCE
(SEE NOTE)

–Isogonic Lines (B 71)

Magnetic variation is shown by isogonic lines on smaller scale charts. Isogonic lines are lines connecting points of equal magnetic variation. The line passing through points having zero variation is termed the *agonic line.*

Isogonic lines are shown on those charts drawn to scale at which a variation of 1° will result in a distance between adjacent lines of less than 12 inches. Each isogonic line is labeled with the amount and direction of variation, and the date of the variation. As shown in the example given below, charts with isogonic lines carry a magenta note stating the name of the mathematical model used for computation, the year the model was computed, and the year the charted isogonic lines represent.

MAGNETIC VARIATION

Magnetic variation curves are for 1992 derived from 1990 World Magnetic Model and accompanying secular change. If additional change is in the same direction as variation it is additive and the variation is increasing. If annual change is opposite in direction to the variation it is subtractive and the variation is decreasing.

Additional Information

Certain charts (e.g., small-craft and marine facilities charts) provide a variety of additional relevant information in the form of notes, tables, and pictures of harbors, landmarks, or ATONs. Examples of additional information found on small-craft charts include:

- A tide note (H 30) which provides information on tide heights, and daily tide tables are often printed on the jacket of small-craft charts.

- Marine facility tabulations (U 32), such as that illustrated in figure 2–14, provide information on tides, depth, services, and supplies found at various locations shown on the chart.

- Several charts include additional technical tables, such as a radio bearing conversion table, to correct measured bearings to Mercator bearings, a table of distances to the horizon as a function of the height of eye of the observer, a conversion table from degrees to compass points and vice versa, or a table for determination of wind speed from observed sea conditions.

- Several charts provide tables of port-to-port distances which are useful for voyage planning.

NO	LOCATION	TIDES		DEPTH		SERVICES					BOAT RENTAL					SUPPLIES				
				APPROACH-FEET(REPORTED)	ALONGSIDE-FEET(REPORTED)	ELECTRICITY-MOORINGS-BERTHS (TRANSIENTS)	RAMP SURFACED-NATURAL	REPAIRS HULL-MOTOR-RADIO	MARINE RAILWAY-FEET	LIFT CAPACITY-TONS	CANOE-ROW-MOTOR	CHARTER-HOUSE-SAIL	FOOD-LODGING-CAMPING	TOILETS-SHOWERS-LAUNDRY / PUMP-OUT STATION	WINTER STORAGE WET-DRY	NAUTICAL CHART SALES	WATER-ICE	GROCERIES-HARDWARE	BAIT-TACKLE	DIESEL OIL-GASOLINE
1	MIAMI BEACH MAR					B E					M	C S	FL	TSL P	W	C	WI	GH	BT	DG
2	LANGER'S MARINA			14	6			MR	30	5								H		
2B	*66 MARINA*			*14*	*14*								*F*	*T*		*C*	*WI*	*GH*	*BT*	*DG*
8	MERRILL STEVENS			10	6	B E		HM	30					TS	WD		WI	H		DG
10	DINNER KEY MARINA	1 7	+¾	7	4	B E	S					C S		TSL P	W		WI			
11	DINNER KEY MARINA			7	4	B E	S					C S		TSL P	W		WI			
12	DINNER KEY MARINA			7	4	B E	S					C S		TSL P	W		WI			
13	SEMINOLE RAMP						S													
16A	HOMESTEAD BAY			5	5	E	S			6			F	T P	W		WI	G	BT	DG
18	ELLIOT KEY HBR			3	6	B					C		C	TSL			I			
23	ANCHORAGE RESORT			6	6	B E					C		FL	TSL			I			
24	*GIBERT'S MOTEL MAR*			10	10	B E	S	M					FL	TSL			WI		BT	DG
25B	RESCUE SERVICE			5	12	BM	S	HMR		5				TS	WD		W	H		
26	GARDEN COVE MAR	2.2	+¾	3	10	B				4			F				WI		BT	DG
28A	ROWELL 'S MARINA			6	30		S	HM						T		C	I	H	BT	G
29	TWIN HARBORS			3	8	BME	S		60		M	S	LC	TSL	WD		WI	H		G
33	CORAL REEF PARK	1.1	+3¼	5	20	BM	S				C M	CHS	F C	TS		C	WI			DG
34A	AMERICA OUTDOORS			5	5	B E	S				CR	S	F C	TSL	W	C	WI	GH	BT	DG
35	UPPER KEYS S C			6		B	SN					S	F	TS			WI			
35C	OCEAN DIVERS, INC			5	20	B E	S				M	C S	F	S		C	WI	G		DG
35D	MARINA DEL MAR			4	30	BME					M	S	F	TSL			WI			DG
37A	ROCK HARBOR MAR	2.2	+½	4	6	B E	S	R					LC	TS	WD		WI	H	BT	G
38	MANDALAY FISH C	2.2	+½	4	3	B E	S	M			CRM	C S	FLC	T	WD		WI	GH	BT	G
38B	CURTIS MARINE,INC.			4	2	B E								TSL				H		
39	CAMPBELL'S MAR	2 2	+½	4	4	B E		HM		16				TSL P	WD		W	H		DG
44	PLANTATION KEY			5	5			HMR		3	M			T		C	WI	H	BT	G
45	PLANTATION YCHT			5	5	B E	S				C	C S	FL	TSL			WI			DG
49	CALOOSA COVE MARINA			6	6	B E		M		27	M	C	FL	TSL	WD	C	WI	GH	BT	DG
51	HOLIDAY ISLE M	2 1	+¾	5	8	B E	S				M	C	FL	TSL		C	WI	GH	BT	DG
54	ISLAMORADA Y C			4	5	B E	S					C	F	TSL	W		WI			
56A	CORAL BAY MARINA			5	6	B E	S	HMR		60		H	FLC	TSL	WD	C	WI	GH		
56	CARIBEE BOAT SALES			4	4			M		5					D	C	WI	H		G
57	BAYSIDE MARINA			3.	5 5	B E		HM		3½	C M		F	TS	WD	C	WI	H	BT	G
57A	MAX 'S MARINA			5	6	B		HMR		30				T	WD	C	W			DG
58	BUD N MARYS MAR	2.0	+¾	4½	6	B E		HM		12	M	C	FLC	T	D	C	WI		BT	DG
58B	RENT-A-BOAT INC			6	7	BME	S	M		10	M	C	F	T	WD	C	WI		BT	DG
64	OUTDOOR RESORTS			4			S							TSL		C	WI	GH	BT	G
65	EDGEWATER MOTEL	0.9	+1¾	7	3½							C	L				I		B	
69	DUCK KEY MARINA			16	55	B E	S				M	C S	F	TSL P		C	WI	GH	BT	DG
71	*KEY COLONY BCH*			*8*	*8*	*B E*					*M*	*C*	*F*	*T L*	*W*	*C*	*WI*	*GH*	*BT*	*DG*
71A	THE BOAT HOUSE	1.0	+8¼	5	5	B		HM		26				TS	WD	C	WI	H		DG
71B	HOLIDAY INN MAR			4	5	BME	S				RM	C S	FL	TS P			WI	G	BT	DG
74	LAGOON MOTEL M			2			S					C	F	T L			WI		B	G
77	BAYLES BOATYARD	0.8	+6¾	7	7			HMR		50				TS	WD			H		G
78	MARATHON BOATYD	1.5	+1½	8	15	B E		HMR		60				TS		C		G		DG
79	FARO BLANCO MAR	0.8	+6¾	7	12	B E	S	HMR					FL	TSL	W	C	WI	H	BT	DG
80	HALLS MOTEL			3	5	B	S	M			M	C	FL	L	W	C	WI	G	BT	G
86	KNIGHT KEY CGR			3	5		S						LC	TSL P	D		I		BT	G
86B	*CLYDES 7 MILE MAR*			*5*	*4*						*M*	*C*					*WI*	*H*		*G*
87	PINELLAS MARINE			8	7									T			WI	GH	BT	DG
88	OCEANSIDE MAR	1 5	+1½					HMR		7				T				H		
89	FARO BLANCO MARINA			8	8	B E	S						FL	TSL P		C	WI	G	BT	
89A	SUNSHINE KEY M			5	5	B E	S				M	C	F C	TSL	WD	C	WI	GH	BT	DG
90	FLAMINGO LODGE&MAR			5	6	B E	S				CRM	H	F C	TS P		C	WI	G	BT	DG
91	MARATHON SEAFOOD			8	12	BM		HMR		30			F	TS	WD				B	DG

(+)DENOTES HOURS LATER (-)DENOTES HOURS EARLIER
THE LOCATIONS OF THE ABOVE PUBLIC MARINE FACILITIES ARE SHOWN ON THE CHART BY LARGE MAGENTA NUMBERS.
THE TABULATED "APPROACH-FEET(REPORTED)" IS THE DEPTH AVAILABLE FROM THE NEAREST NATURAL OR DREDGED CHANNEL TO THE FACILITY.
THE TABULATED "PUMPING STATION" IS DEFINED AS FACILITIES AVAILABLE FOR PUMPING OUT BOAT HOLDING TANKS.

THIS TABULATION WAS PRODUCED USING COMPUTER ASSISTED METHODS.

Fig. 2–14. Marine Facilities Tabulation Found on NOS Chart 11451 (Miami, to Marathon and Florida Bay)

Although this same information is available in a variety of companion publications, such as the *U.S. Coast Pilot* or the *Tide Tables,* recreational boaters typically appreciate its inclusion on the nautical chart (NRC). Interestingly, many professional mariners, who normally have these other reference publications, would prefer “less cluttered” charts (NRC), an illustration of the trade-offs made by NOAA in deciding what to include.

Lettering Styles (Vertical versus Slant Type)

Chart features depicted in vertical type include the names of topographic features and fixed objects which extend above high water. Slant (italic) type is used for names of hydrographic features, including names of water areas, underwater features, and floating aids.

Use of Color on Charts

Color is used on nautical charts to call the mariner's attention to key features and to facilitate chart interpretation. NOAA uses five colors (some with different shades) to depict chart features and other information: black, blue, gold, green, and magenta. The general color conventions on NOAA charts are as follows:

- *black* is used for most symbols, printed information (e.g., notes, titles, certain Loran–C TDs, etc.), to outline shores, topographic features, and depth contours;
- *blue* (in one or more tints) is used to depict shallow water areas, the boundaries of certain regulated areas (see Chapter 7), and Loran–C TDs;
- *gold* (buff) is used to show land areas, and a darker screened tint is used to show built-up areas, such as cities (on charts published by NIMA, land areas are shown in a screened black that appears to be gray);
- *green* is used to depict areas that cover and uncover depending upon the stage of the tide (e.g., marches, mud flats, sand bars, etc.), another shade of green is used to depict green buoys and daybeacons;
- *magenta* is used to depict red buoys and daybeacons, lighted buoys, and important caution and danger symbols, compass roses, and recommended course (if given), Loran–C TDs; and finally
- *white* (the natural color of the chart paper) is used to depict deep-water areas, dredged channels, etc.

Symbols and Abbreviations

As noted, a standardized set of symbols is used to represent the various features depicted on nautical charts. These symbols are shown in Chart No. 1 and discussed throughout this manual. Numerous standardized abbreviations are used on nautical charts to conserve space. These abbreviations, together with others used in this manual, are shown in appendix B.

Use of Charts

Throughout this manual the proper use of nautical charts is explored at length. Two concluding comments are relevant here.

First, the mariner should keep in mind that, aesthetics aside, the modern-day nautical chart is a working tool. In earlier times, charts were highly valuable documents printed on animal skins, parchment, and other valuable materials. The navigator's determinations of course and distance measurements, plots of dead reckoning positions, fixes, etc., were typically made on separate pieces of paper. Distances and courses (the sailings) were determined by calculation, not actual plotting. Technical progress and economies of scale have changed the chart from an object of veneration to a working tool. Intended tracks, DR plots, bearings, fixes, distance measurement, ranges of visibility of lights, etc., are now plotted on the chart, rather than laborious calculation. So don't be afraid to use the chart, and annotate it appropriately for the voyages you plan to take.

Second, the chart should be studied carefully before it is actually put to use. The legends should be read, scale determined (particularly if the scale changes from chart to chart), and all notes and symbols read and understood. On an actual voyage, particularly in congested and potentially dangerous waters, there may be little time to consult additional documents to determine the significance of a particular chart symbol, note, or legends. The horizontal datum should be noted and the GPS or LORAN-C receiver checked to ensure that this datum is being used. Latitude and longitude scales should be reviewed as these differ from chart to chart. Depth units should be checked and a realistic danger sounding selected (see Chapter 4) and marked on the chart. The navigator might wish to annotate the chart with additional relevant information, such as arcs of visibility of lights, prominent ranges, landmarks, facilities, danger bearings, and other relevant information from the chart or other sources such as the tide or tidal current tables, *Light List,* or *U.S. Coast Pilot.* As noted earlier, the charts should be laid out and sequenced to ensure that all necessary charts are aboard and that they can be retrieved expeditiously and in the correct order.

"Part of the responsibility for the continuing accuracy of charts lies with the user. If charts are to remain reliable, they must be corrected as indicated by the Notice to Mariners. *In addition, the user's reports of errors and changes and his suggestions often are useful to the publishing agencies in correcting and improving their charts. Navigators and maritime activities have contributed much to the reliability and usefulness of the modern nautical chart. If a chart becomes wet, the expansion and subsequent shrinkage when the chart dries are likely to cause distortion."*

Bowditch

References

Admiralty Charts and Publications. *Symbols and Abbreviations Used on Admiralty Charts, Chart 5011,* Edition 1, Hydrographic Office, Taunton, Somerset, TA 1 2DN, United Kingdom, 1991.

Blewitt, M., *Navigation for Yachtsmen,* David McKay Company, Inc., New York, NY, 1976.

Brogden, B., "Defining Terms, Since All Chart Datums Are Not Interchangeable, Electronic Positions Should Be Used Carefully," *Ocean Voyager,* 1994, pp. 16, *et seq.*

Brown, L. A., *The Story of Maps,* Dover Publications, Inc., New York, NY, 1979.

Cahill, R. A., *Strandings and Their Causes,* Fairplay Publications, London, UK, 1985.

Campbell, S., *The Yachting Book of Practical Navigation,* Dodd, Mead and Company, New York, NY, 1985.

Canadian Hydrographic Service. *Chart No. 1/Carte No. 1 Symbols Abbreviations Terms,* Minister of Fisheries and Oceans Canada, January 1992.

Coote, J. O., *Yacht Navigation—My Way,* W. W. Norton & Company, New York, NY, 1987.

Dahl, B., *The User's Guide to GPS, The Global Positioning System,* Richardson's Marine Publishing, Evanston, IL, 1993.

Defense Mapping Agency, Hydrographic/Topographic Center. *American Practical Navigator, An Epitome of Navigation (Bowditch),* Publication No. 9, NIMA Stock No. NV PUB 9 V1, Bethesda, MD, 1995.

Departments of the Air Force and the Navy. *Air Navigation,* AMF 51–40, NAVAIR 00–80V–49, Washington, DC, 1983.

Eyges, L., *The Practical Pilot, Coastal Navigation by Eye, Intuition, and Common Sense,* International Marine Publishing, Camden, ME, 1989.

Farrell, C., *Fell's Official Guide to Small Boat Navigation,* Frederick Fell Inc., New York, NY, 1962.

Graves, F., *Piloting,* International Marine Company, Camden, ME, 1981.

Hobbs, R. R., *Marine Navigation, Piloting and Celestial and Electronic Navigation,* Third Edition, Naval Institute Press, Annapolis, MD, 1990.

Human Technology, Inc. *Desk Reference Guide: Specifications Unit, Chart and Map, Feature: Format.* Report developed for National Ocean Service, Charting and Geodetic Services, Marine Chart Branch, Under Contract OPM-85-77, McLean, VA, October 1985.

——: *Graphics.*
——: *Specifications.*

Heinl, R. D., *Dictionary of Military and Naval Quotations,* Naval Institutes Press, Annapolis, MD, 1966.

Kals, W. S., *Practical Navigation,* Doubleday & Company, Garden City, New York, NY, 1972.

Larkin, F. J., *Basic Coastal Navigation,* Sheridan House, Dobbs Ferry, New York, NY, 1993.

Maloney, E. S., *Chapman Piloting,* 60th Edition, Hearst Marine Books, New York, NY, 1991.

———. *Dutton's Navigation and Piloting,* Fourteenth Edition, Naval Institute Press, Annapolis, MD, 1985.

Markell, J., *Coastal Navigation for the Small Boat Sailor,* Tab Books, Blue Ridge Summit, PA, 1984.

Monmonier, M., *How to Lie with Maps,* The University of Chicago Press, Chicago, IL, 1991.

National Research Council. *Charting a Course Into the Digital Era, Guidance for NOAA's Nautical Charting Mission,* National Academy Press, Washington, DC 1994.

Naval Training Command. *A Navigation Compendium,* NAVTRA 10494–A, U. S. Government Printing Office, Washington, DC, 1972.

Schofield, B. B., *Navigation and Direction, The Story of HMS Dryad,* Kenneth Mason, Homewell, UK, 1977.

Snyder, J. P. and P. M. Voxland, *An Album of Map Projections,* U.S. Geological Paper 1453, U.S. Government Printing Office, Washington, DC, 1989.

Toghill, J., *Coastal Navigation,* W. W. Norton & Company, New York, NY, 1987.

U.S. Department of Commerce, Coast and Geodetic Survey. *Nautical Chart Manual, Volume One: Policies and Procedures,* Seventh Edition, Washington, DC, 1992.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, and Department of Defense, National Imagery and Mapping Agency. *Chart No. 1 United States of America Nautical Chart Symbols Abbreviations and Terms,* Ninth Edition, Washington, DC, January 1990.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, *The Boat Show Briefing Book,* External and Cooperative Affairs Group, Mapping and Charting Branch, Riverdale, MD, 1993.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service. *Dates of Latest Editions, Nautical Charts & Misc. Maps,* Silver Spring, MD, October 1, 1994 (issued quarterly).

U.S. Department of Transportation, United States Coast Guard, *LORAN-C User Handbook,* COMDTPUB P16562.6, Washington, DC, 1992.