

CHAPTER 4

NAUTICAL CHARTS

CHART FUNDAMENTALS

400. Definitions

A **nautical chart** represents part of the spherical earth on a plane surface. It shows water depth, the shoreline of adjacent land, prominent topographic features, aids to navigation, and other navigational information. It is a work area on which the navigator plots courses, ascertains positions, and views the relationship of the ship to the surrounding area. It assists navigators in avoiding dangers and arriving safely at their destination.

Should a marine accident occur, the nautical chart in use at the time takes on legal significance. In cases of grounding, collision, and other accidents, charts become critical records for reconstructing the event and assigning liability. Charts used in reconstructing the incident can also have tremendous training value.

Originally hand-drawn on sheepskin, traditional nautical charts have for generations been printed on paper. **Electronic Charts** consisting of a digital data base and a display system are commonly in use today and are replacing paper charts aboard many vessels. An electronic chart is not simply a digital version of a paper chart; it introduces a new navigation methodology with capabilities and limitations very different from paper charts. The electronic chart is the legal equivalent of the paper chart if it meets certain International Maritime Organization specifications. See Chapter 5 - ECDIS for a detailed information regarding electronic charts.

401. Projections

Because a cartographer cannot transfer a sphere to a flat surface without distortion, he or she must project the surface of a sphere onto a **developable surface**. A developable surface is one that can be flattened to form a plane. This process is known as **chart projection**. If points on the surface of a sphere are projected from a single point, the projection is said to be **perspective** or **geometric**.

As the use of electronic charts becomes increasingly widespread, it is important to remember that the same cartographic principles that apply to paper charts apply to their depiction on video screens.

402. Selecting a Projection

Each projection has certain preferable features. However, as the area covered by the chart becomes smaller, the differences between various projections become less noticeable. On the largest scale chart, such as that of a harbor, projections are practically identical. Some desirable properties of a projection are:

1. True shape of physical features
2. Correct angular relationships
3. Equal area (Represents areas in proper proportions)
4. Constant scale values
5. Great circles represented as straight lines
6. Rhumb lines represented as straight lines

Some of these properties are mutually exclusive. For example, a single projection cannot be both conformal and equal area. Similarly, both great circles and rhumb lines cannot be represented on a single projection as straight lines.

403. Types of Projections

The type of developable surface to which the spherical surface is transferred determines the projection's classification. Further classification depends on whether the projection is centered on the equator (equatorial), a pole (polar), or some point or line between (oblique). The name of a projection indicates its type and its principal features.

The **Mercator projection** is classified as a **cylindrical projection** upon a plane, the cylinder tangent along the equator. Similarly, a projection based upon a cylinder tangent along a meridian is called **transverse** (or inverse) **Mercator** or **transverse** (or inverse) **orthomorphic**. The Mercator is the most common projection used in maritime navigation, primarily because rhumb lines plot as straight lines.

In a **simple conic projection**, points on the surface of the earth are transferred to a tangent cone. In the **Lambert conformal projection**, the cone intersects the earth (a secant cone) at two small circles. In a **polyconic projection**, a series of tangent cones is used.

In an **azimuthal** or **zenithal projection**, points on the earth are transferred directly to a plane. If the origin of the

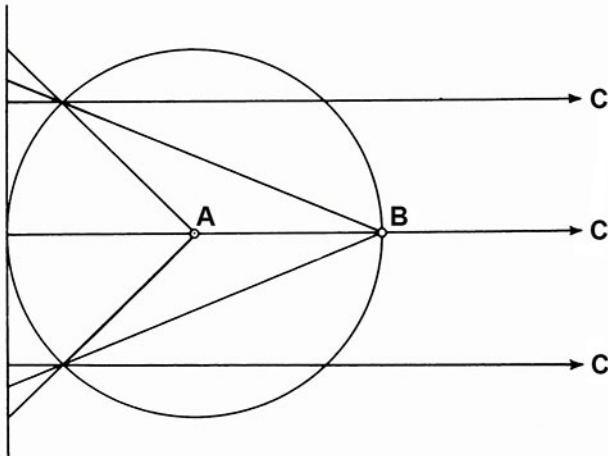


Figure 403. Azimuthal projections: A, gnomonic; B, stereographic; C, (at infinity) orthographic.

projecting rays is the center of the earth, a **gnomonic projection** results; if it is the point opposite the plane's point of tangency, a **stereographic projection**; and if at infinity (the projecting lines being parallel to each other), an **orthographic projection**. The gnomonic, stereographic, and orthographic are **perspective projections**. In an **azimuthal equidistant projection**, which is not perspective, the scale of distances is constant along any radial line from the point of tangency. See Figure 403.

Cylindrical and plane projections are special conical projections, using heights infinity and zero, respectively.

A **graticule** is the network of latitude and longitude lines laid out in accordance with the principles of any projection.

404. Cylindrical Projections

If a cylinder is placed around the earth, tangent along the equator, and the planes of the meridians are extended, they intersect the cylinder in a number of vertical lines. See Figure 404. These parallel lines of projection are equidistant from each other, unlike the terrestrial meridians from which they are derived which converge as the latitude increases. On the earth, parallels of latitude are perpendicular to the meridians, forming circles of progressively smaller diameter as the latitude increases. On the cylinder they are shown perpendicular to the projected meridians, but because a cylinder is everywhere of the same diameter, the projected parallels are all the same size.

If the cylinder is cut along a vertical line (a meridian) and spread out flat, the meridians appear as equally spaced vertical lines; and the parallels appear as horizontal lines. The parallels' relative spacing differs in the various types of cylindrical projections.

If the cylinder is tangent along some great circle other than the equator, the projected pattern of latitude and longitude lines appears quite different from that described above,

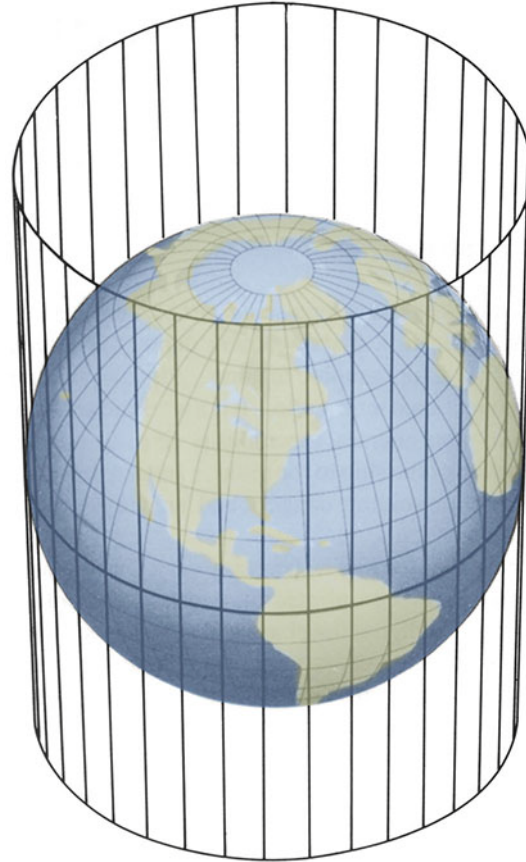


Figure 404. A cylindrical projection.

since the line of tangency and the equator no longer coincide. These projections are classified as **oblique** or **transverse projections**.

405. Mercator Projection

Navigators most often use the plane conformal projection known as the **Mercator projection**. The Mercator projection is not perspective, and its parallels can be derived mathematically as well as projected geometrically. Its distinguishing feature is that both the meridians and parallels are expanded at the same ratio with increased latitude. The expansion is equal to the secant of the latitude, with a small correction for the ellipticity of the Earth. Since the secant of 90° is infinity, the projection cannot include the poles. Since the projection is conformal, expansion is the same in all directions and angles are correctly shown. Rhumb lines appear as straight lines, the directions of which can be measured directly on the chart. Distances can also be measured directly if the spread of latitude is small. Great circles, except meridians and the equator, appear as curved lines concave to the equator. Small areas appear in their correct shape but of increased size unless they are near the equator.

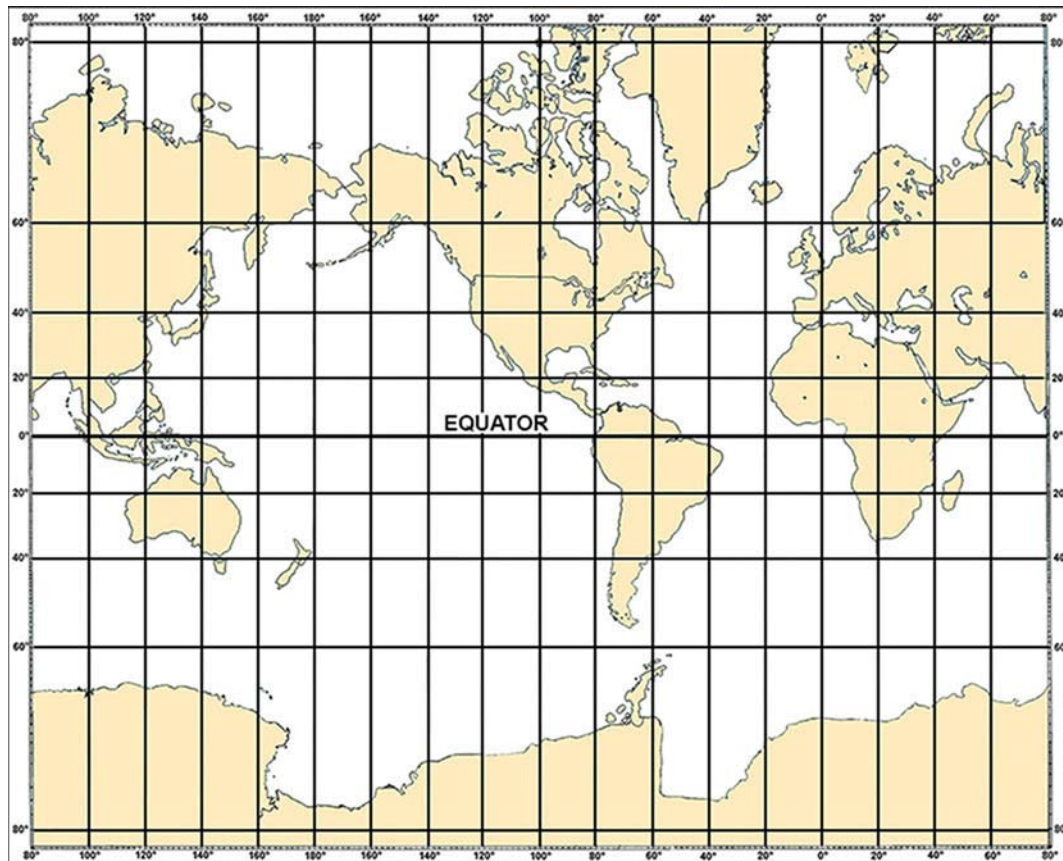


Figure 406. A Mercator map of the world.

406. Meridional Parts

At the equator a degree of longitude is approximately equal in length to a degree of latitude. As the distance from the equator increases, degrees of latitude remain approximately the same, while degrees of longitude become progressively shorter. Since degrees of longitude appear everywhere the same length in the Mercator projection, it is necessary to increase the length of the meridians if the expansion is to be equal in all directions. Thus, to maintain the correct proportions between degrees of latitude and degrees of longitude, the degrees of latitude must be progressively longer as the distance from the equator increases. This is illustrated in Figure 406.

The length of a meridian, increased between the equator and any given latitude, expressed in minutes of arc at the equator as a unit, constitutes the number of meridional parts (M) corresponding to that latitude. Meridional parts, given in Table 6 for every minute of latitude from the equator to the pole, make it possible to construct a Mercator chart and to solve problems in Mercator sailing. These values are for the World Geodetic System (WGS) ellipsoid of 1984.

407. Transverse Mercator Projections

Constructing a chart using Mercator principles, but with the cylinder tangent along a meridian, results in a **transverse Mercator** or **transverse orthomorphic projection**. The word “inverse” is used interchangeably with “transverse.” These projections use a fictitious graticule similar to, but offset from, the familiar network of meridians and parallels. The tangent great circle is the fictitious equator. Ninety degrees from it are two fictitious poles. A group of great circles through these poles and perpendicular to the tangent great circle are the fictitious meridians, while a series of circles parallel to the plane of the tangent great circle form the fictitious parallels. The actual meridians and parallels appear as curved lines.

A straight line on the transverse or oblique Mercator projection makes the same angle with all fictitious meridians, but not with the terrestrial meridians. It is therefore a fictitious rhumb line. Near the tangent great circle, a straight line closely approximates a great circle. The projection is most useful in this area. Since the area of minimum distortion is near a meridian, this projection is useful for charts covering a large band of latitude and extending a relatively short distance on each side of the tangent meridian. It is sometimes used for star charts showing the evening sky at various seasons of the year. See Figure 407.

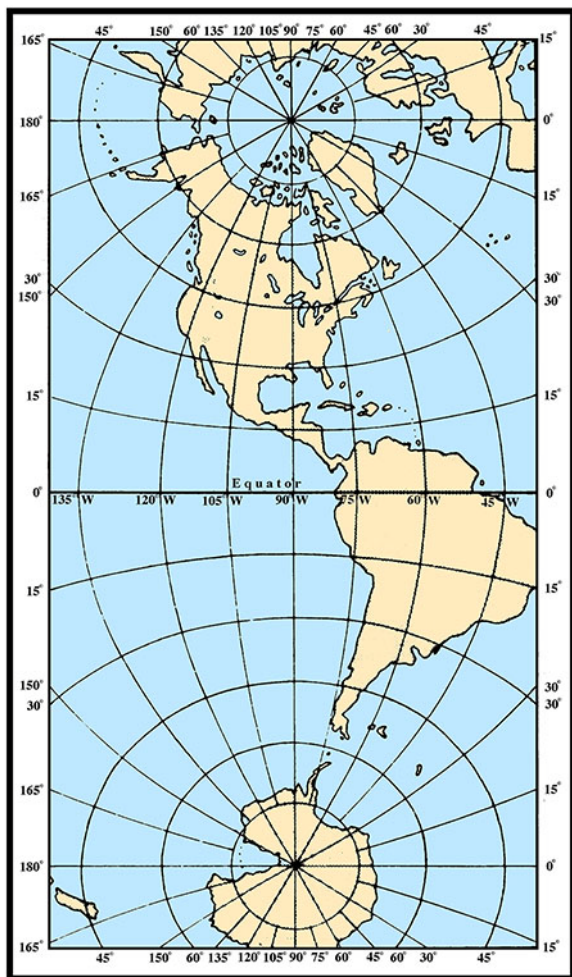


Figure 407. A transverse Mercator map of the Western Hemisphere.

408. Universal Transverse Mercator (UTM) Grid

The **Universal Transverse Mercator (UTM)** grid is a military grid superimposed upon a transverse Mercator graticule, or the representation of these grid lines upon any graticule. This grid system and these projections are often used for large-scale (harbor) nautical charts and military charts.

409. Oblique Mercator Projections

A Mercator projection in which the cylinder is tangent along a great circle other than the equator or a meridian is called an **oblique Mercator** or **oblique orthomorphic projection**. See Figure 409a and Figure 409b. This projection is used principally to depict an area in the near vicinity of an oblique great circle. Figure 410, for example, shows the great circle joining Washington and Moscow. Figure 409c shows an oblique Mercator map with the great circle

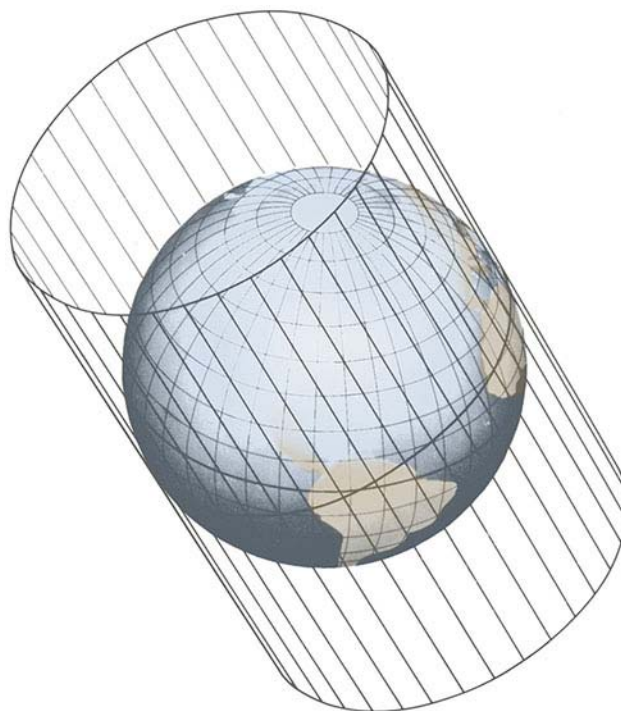


Figure 409a. An oblique Mercator projection.

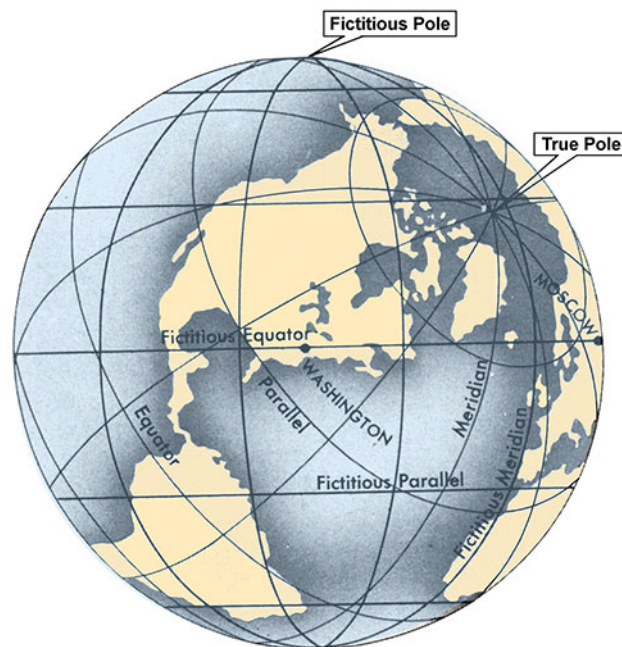


Figure 409b. An oblique Orthomorphic projection.

between these two centers as the tangent great circle or fictitious equator. The limits of the chart of Figure 410 are indicated in Figure 409c. Note the large variation in scale as the latitude changes.

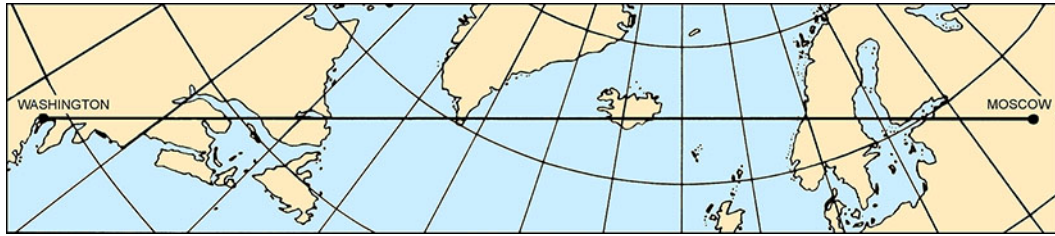


Figure 409c. An oblique Mercator map based upon a cylinder tangent along the great circle through Washington and Moscow. The map includes an area 500 miles on each side of the great circle. The limits of this map are indicated on the Mercator map of Figure 410.

410. Rectangular Projection

A cylindrical projection similar to the Mercator, but with uniform spacing of the parallels, is called a **rectangular projection**. It is convenient for graphically depicting information where distortion is not important. The principal navigational use of this projection is for the star chart of the

Air Almanac, where positions of stars are plotted by rectangular coordinates representing declination (ordinate) and sidereal hour angle (abscissa). Since the meridians are parallel, the parallels of latitude (including the equator and the poles) are all represented by lines of equal length.



Figure 410. The great circle between Washington and Moscow as it appears on a Mercator map.

411. Conic Projections

A **conic projection** is produced by transferring points from the surface of the earth to a cone or series of cones. This cone is then cut along an element and spread out flat to form the chart. When the axis of the cone coincides with the axis of the earth, then the parallels appear as arcs of circles, and the meridians appear as either straight or curved lines converging toward the nearer pole. Limiting the area covered to that part of the cone near the surface of the earth limits distortion. A parallel along which there is no distortion is called a **standard parallel**. Neither the transverse conic projection, in which the axis of the cone is in the equatorial plane, nor the oblique conic projection, in which

the axis of the cone is oblique to the plane of the equator, is ordinarily used for navigation. They are typically used for illustrative maps.

Using cones tangent at various parallels, a secant (intersecting) cone, or a series of cones varies the appearance and features of a conic projection.

412. Simple Conic Projection

A conic projection using a single tangent cone is a **simple conic projection** (Figure 412a). The height of the cone increases as the latitude of the tangent parallel decreases. At the equator, the height reaches infinity and the cone becomes a cylinder. At the pole, its height is zero, and the

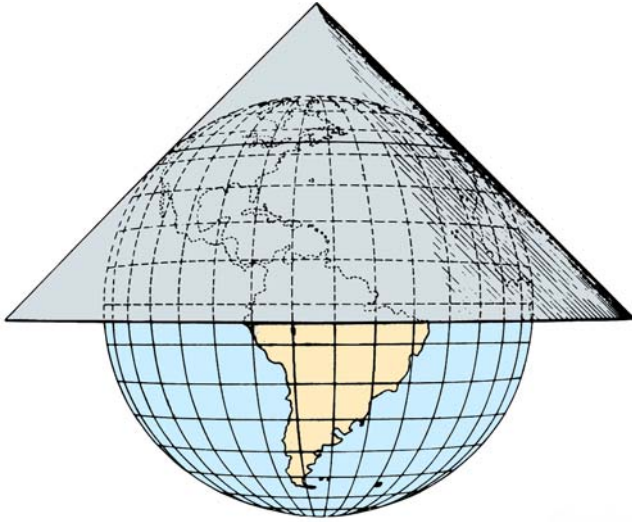


Figure 412a. A simple conic projection.

cone becomes a plane. Similar to the Mercator projection, the simple conic projection is not perspective since only the meridians are projected geometrically, each becoming an element of the cone. When this projection is spread out flat

to form a map, the meridians appear as straight lines converging at the apex of the cone. The standard parallel, where the cone is tangent to the earth, appears as the arc of a circle with its center at the apex of the cone. The other parallels are concentric circles. The distance along any meridian between consecutive parallels is in correct relation to the distance on the earth, and, therefore, can be derived mathematically. The pole is represented by a circle (Figure 412b). The scale is correct along any meridian and along the standard parallel. All other parallels are too great in length, with the error increasing with increased distance from the standard parallel. Since the scale is not the same in all directions about every point, the projection is neither a conformal nor equal-area projection. Its non-conformal nature is its principal disadvantage for navigation.

Since the scale is correct along the standard parallel and varies uniformly on each side, with comparatively little distortion near the standard parallel, this projection is useful for mapping an area covering a large spread of longitude and a comparatively narrow band of latitude. It was developed by Claudius Ptolemy in the second century AD to map just such an area: the Mediterranean Sea.

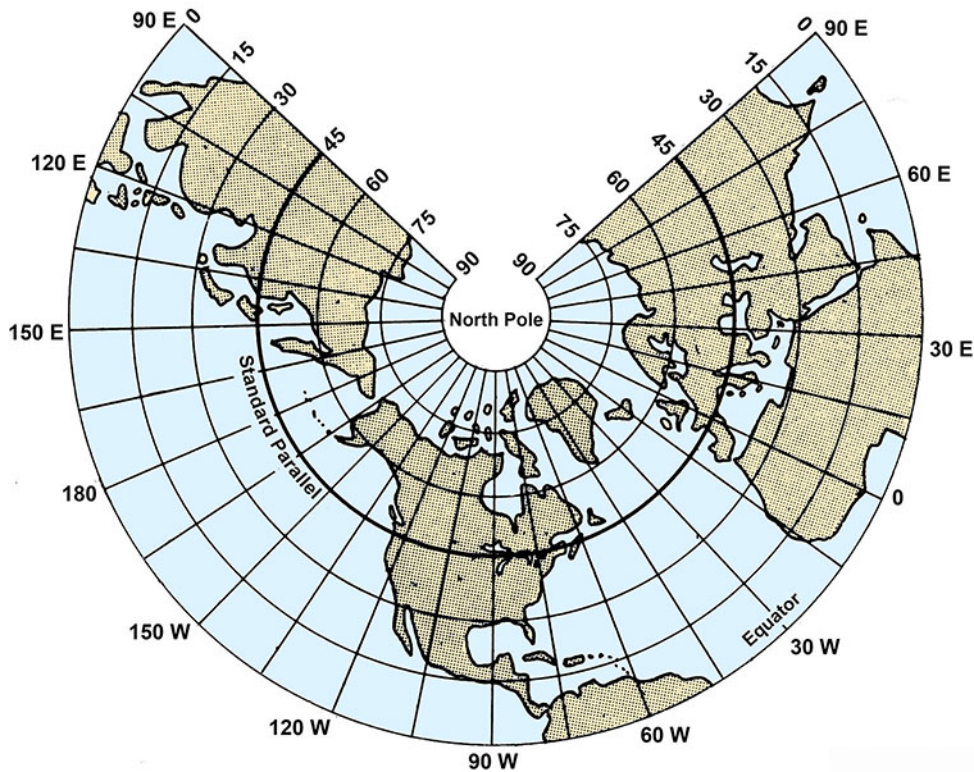


Figure 412b. A simple conic map of the Northern Hemisphere.

413. Lambert Conformal Projection

The useful latitude range of the simple conic projection can be increased by using a secant cone intersecting the earth

at two standard parallels (see Figure 413). The area between the two standard parallels is compressed, and that beyond is expanded. Such a projection is called either a **secant conic** or **conic projection with two standard parallels**.

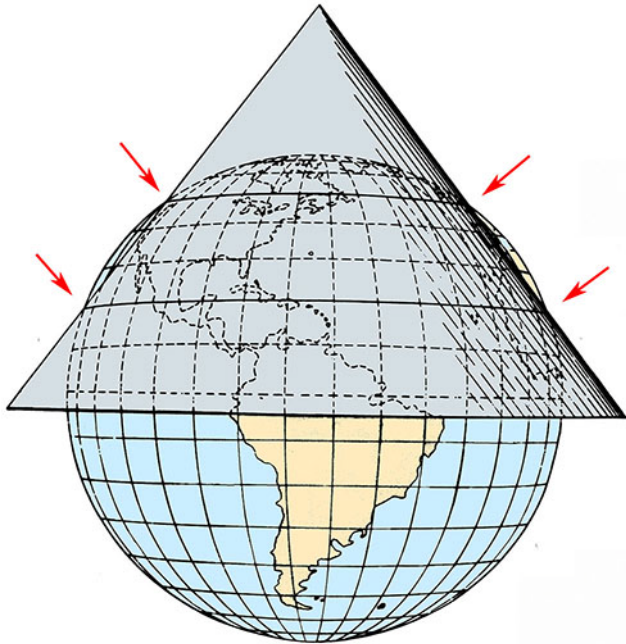


Figure 413. A secant cone for a conic projection with two standard parallels.

If in such a projection the spacing of the parallels is altered, such that the distortion is the same along them as along the meridians, the projection becomes conformal. This modification produces the **Lambert conformal projection**. If the chart is not carried far beyond the standard parallels, and if these are not a great distance apart, the distortion over the entire chart is small.

A straight line on this projection so nearly approximates a great circle that the two are nearly identical. Radio beacon signals travel great circles; thus, they can be plotted on this projection without correction. This feature, gained without sacrificing conformality, has made this projection popular for aeronautical charts because aircraft make wide use of radio aids to navigation. Except in high latitudes, where a slightly modified form of this projection has been used for polar charts, it has not replaced the Mercator projection for marine navigation.

414. Polyconic Projection

The latitude limitations of the secant conic projection can be minimized by using a series of cones. This results in a **polyconic projection**. In this projection, each parallel is the base of a tangent cone. At the edges of the chart, the area between parallels is expanded to eliminate gaps. The scale is correct along any parallel and along the central meridian of the projection. Along other meridians the scale increases with increased difference of longitude from the central meridian. Parallels appear as nonconcentric circles, meridians appear as curved lines converging toward the pole and concave to the central meridian.

The polyconic projection is widely used in atlases, particularly for areas of large range in latitude and reasonably large range in longitude, such as continents. However, since it is not conformal, this projection is not traditionally used in navigation.

415. Azimuthal Projections

If points on the earth are projected directly to a plane surface, a map is formed at once, without cutting and flattening, or “developing.” This can be considered a special case of a conic projection in which the cone has zero height.

The simplest case of the **azimuthal projection** is one in which the plane is tangent at one of the poles. The meridians are straight lines intersecting at the pole, and the parallels are concentric circles with their common center at the pole. Their spacing depends upon the method used to transfer points from the earth to the plane.

If the plane is tangent at some point other than a pole, straight lines through the point of tangency are great circles, and concentric circles with their common center at the point of tangency connect points of equal distance from that point. Distortion, which is zero at the point of tangency, increases along any great circle through this point. Along any circle whose center is the point of tangency, the distortion is constant. The bearing of any point from the point of tangency is correctly represented. It is for this reason that these projections are called **azimuthal**. They are also called **zenithal**. Several of the common azimuthal projections are perspective.

416. Gnomonic Projection

If a plane is tangent to the earth, and points are projected geometrically from the center of the earth, the result is a **gnomonic projection** (see Figure 416a). Since the projec-

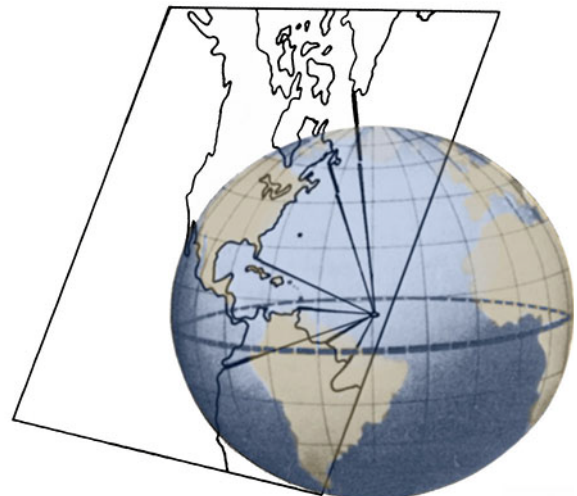


Figure 416a. An oblique gnomonic projection.

tion is perspective, it can be demonstrated by placing a light at the center of a transparent terrestrial globe and holding a flat surface tangent to the sphere.

In an **oblique gnomonic projection** the meridians appear as straight lines converging toward the nearer pole. The parallels, except the equator, appear as curves (Figure 416b). As in all azimuthal projections, bearings from the point of tangency are correctly represented. The distance scale, however, changes rapidly. The projection is neither conformal nor equal area. Distortion is so great that shapes, as well as distances and areas, are very poorly represented, except near the point of tangency.

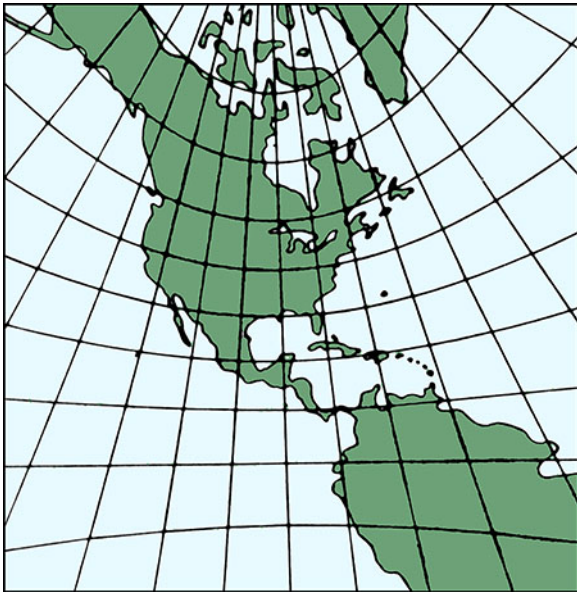


Figure 416b. An oblique gnomonic map with point of tangency at latitude 30°N , longitude 90°W .

The usefulness of this projection rests upon the fact that any great circle appears on the map as a straight line, giving charts made on this projection the common name **great-circle charts**.

Gnomonic charts are most often used for planning the great-circle track between points. Points along the determined track are then transferred to a Mercator projection. The great circle is then tracked by following the rhumb lines from one point to the next. Computer programs which automatically calculate great circle routes between points and provide latitude and longitude of corresponding rhumb line endpoints are quickly making this use of the gnomonic chart obsolete.

417. Stereographic Projection

A **stereographic projection** results from projecting points on the surface of the earth onto a tangent plane, from a point on the surface of the earth opposite the point of tangency (see Figure 417a). This projection is also called an **azimuthal orthomorphic projection**.

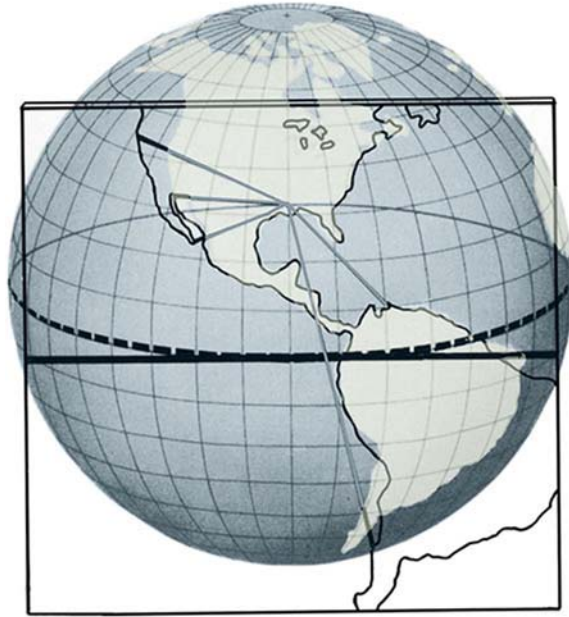


Figure 417a. An equatorial stereographic projection.

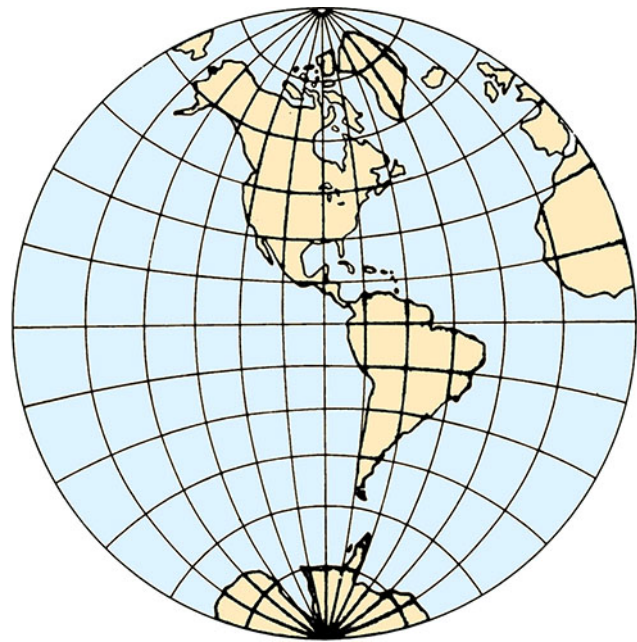


Figure 417b. A stereographic map of the Western Hemisphere.

The scale of the stereographic projection increases with distance from the point of tangency, but it increases more slowly than in the gnomonic projection. The stereographic projection can show an entire hemisphere without excessive distortion (see Figure 417b). As in other azimuthal projections, great circles through the point of tangency appear as straight lines. Other circles such as meridians and parallels appear as either circles or arcs of circles.

The principal navigational use of the stereographic projection is for charts of the polar regions and devices for mechanical or graphical solution of the navigational triangle. A **Universal Polar Stereographic (UPS)** grid, mathematically adjusted to the graticule, is used as a reference system.

418. Orthographic Projection

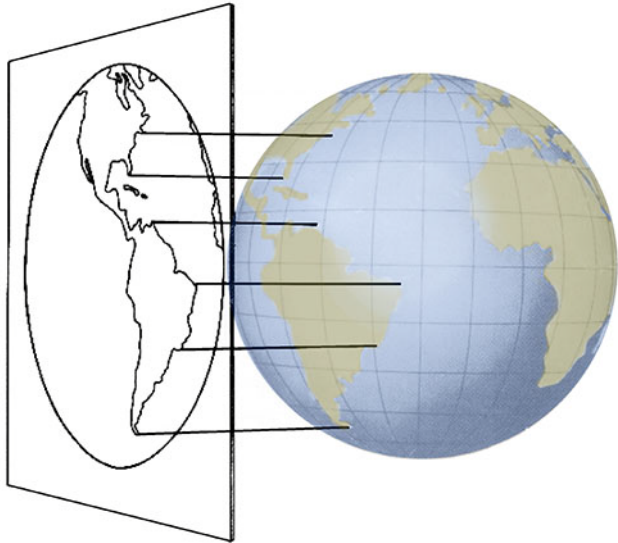


Figure 418a. An equatorial orthographic projection.



Figure 418b. An orthographic map of the Western Hemisphere.

An **orthographic projection** is created by projecting terrestrial points from infinity to a tangent plane (see Figure 418a). This projection is not conformal, nor does it result in an equal area representation. Its principal use is in naviga-

tional astronomy because it is useful for illustrating and solving the navigational triangle. It is also useful for illustrating celestial coordinates. If the plane is tangent at a point on the equator, the parallels (including the equator) appear as straight lines. The meridians would appear as ellipses, except that the meridian through the point of tangency would appear as a straight line and the one 90° away would appear as a circle (see Figure 418b).

419. Azimuthal Equidistant Projection

An **azimuthal equidistant projection** is an azimuthal projection in which the distance scale along any great circle through the point of tangency is constant. If a pole is the point of tangency, the meridians appear as straight radial lines and the parallels as equally spaced concentric circles. If the plane is tangent at some point other than a pole, the concentric circles represent distances from the point of tangency. In this case, meridians and parallels appear as curves.

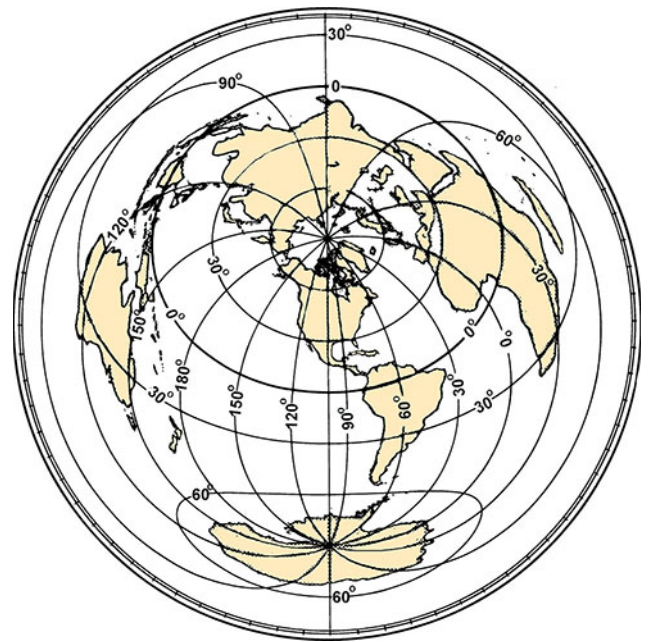


Figure 419. An azimuthal equidistant map of the world with the point of tangency latitude 40°N , longitude 100°W .

The projection can be used to portray the entire earth, the point 180° from the point of tangency appearing as the largest of the concentric circles. The projection is not conformal, equal area, or perspective. Near the point of tangency distortion is small, increasing with distance until shapes near the opposite side of the earth are unrecognizable (Figure 419).

The projection is useful because it combines the three features of being azimuthal, having a constant distance scale from the point of tangency, and permitting the entire

earth to be shown on one map. Thus, if an important harbor or airport is selected as the point of tangency, the great-circle course, distance, and track from that point to any other point on the earth are quickly and accurately determined. For communication work with the station at the point of

tangency, the path of an incoming signal is at once apparent if the direction of arrival has been determined and the direction to train a directional antenna can be determined easily. The projection is also used for polar charts and for the star finder, No. 2102D.

POLAR CHARTS

420. Polar Projections

Special consideration is given to the selection of projections for polar charts because the familiar projections become special cases with unique features.

In the case of cylindrical projections in which the axis of the cylinder is parallel to the polar axis of the earth, distortion becomes excessive and the scale changes rapidly. Such projections cannot be carried to the poles. However, both the transverse and oblique Mercator projections are used.

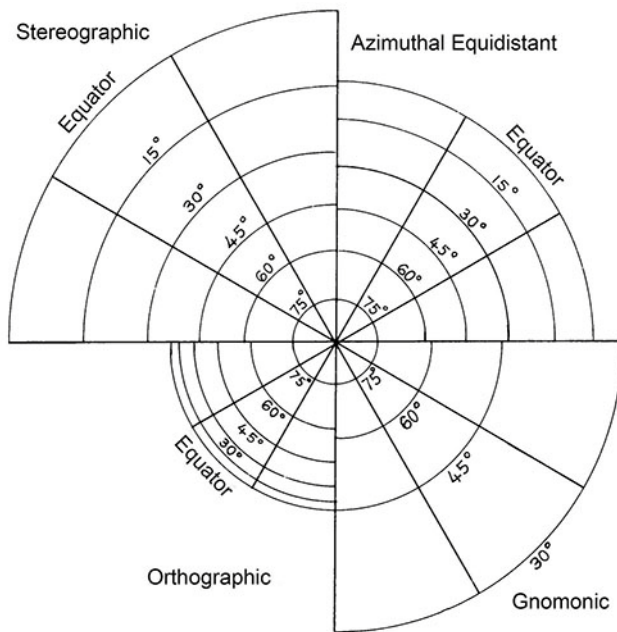


Figure 420. Expansion of polar azimuthal projections.

Conic projections with their axes parallel to the earth's polar axis are limited in their usefulness for polar charts because parallels of latitude extending through a full 360° of longitude appear as arcs of circles rather than full circles. This is because a cone, when cut along an element and flattened, does not extend through a full 360° without stretching or resuming its former conical shape. The usefulness of such projections is also limited by the fact that the pole appears as an arc of a circle instead of a point. However, by using a parallel very near the pole as the higher standard parallel, a conic projection with two standard par-

allels can be made. This requires little stretching to complete the circles of the parallels and eliminate that of the pole. Such a projection, called a **modified Lambert conformal** or **Ney's projection**, is useful for polar charts. It is particularly familiar to those accustomed to using the ordinary Lambert conformal charts in lower latitudes.

Azimuthal projections are in their simplest form when tangent at a pole. This is because the meridians are straight lines intersecting at the pole, and parallels are concentric circles with their common center at the pole. Within a few degrees of latitude of the pole they all look similar; however, as the distance becomes greater, the spacing of the parallels becomes distinctive in each projection. In the polar azimuthal equidistant it is uniform; in the polar stereographic it increases with distance from the pole until the equator is shown at a distance from the pole equal to twice the length of the radius of the earth; in the polar gnomonic the increase is considerably greater, becoming infinity at the equator; in the polar orthographic it decreases with distance from the pole (Figure 420). All of these but the last are used for polar charts.

421. Selection of a Polar Projection

The principal considerations in the choice of a suitable projection for polar navigation are:

1. Conformality: When the projection represents angles correctly, the navigator can plot directly on the chart.
2. Great circle representation: Because great circles are more useful than rhumb lines at high altitudes, the projection should represent great circles as straight lines.
3. Scale variation: The projection should have a constant scale over the entire chart.
4. Meridian representation: The projection should show straight meridians to facilitate plotting and grid navigation.
5. Limits: Wide limits reduce the number of projections needed to a minimum.

The projections commonly used for polar charts are the modified Lambert conformal, gnomonic, stereographic, and azimuthal equidistant. All of these projections are similar near the pole. All are essentially conformal, and a great circle on each is nearly a straight line.

As the distance from the pole increases, however, the distinctive features of each projection become important.

The modified Lambert conformal projection is virtually conformal over its entire extent. The amount of its scale distortion is comparatively little if it is carried only to about 25° or 30° from the pole. Beyond this, the distortion increases rapidly. A great circle is very nearly a straight line anywhere on the chart. Distances and directions can be measured directly on the chart in the same manner as on a Lambert conformal chart. However, because this projection is not strictly conformal, and on it great circles are not exactly represented by straight lines, it is not suited for highly accurate work.

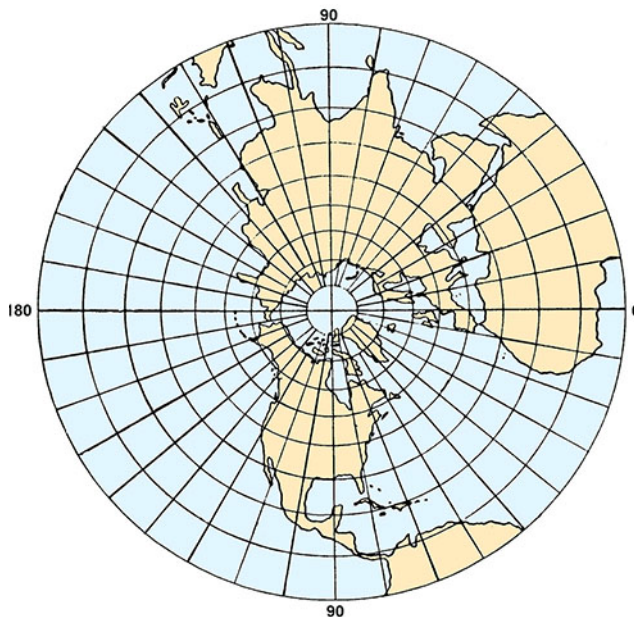


Figure 421. Polar stereographic projection.

The polar gnomonic projection is the one polar projection on which great circles are exactly straight lines. However, a complete hemisphere cannot be represented upon a plane because the radius of 90° from the center would become infinity.

The polar stereographic projection is conformal over its entire extent, and a straight line closely approximates a great circle (see Figure 421). The scale distortion is not excessive for a considerable distance from the pole, but it is greater than that of the modified Lambert conformal projection.

The polar azimuthal equidistant projection is useful for showing a large area such as a hemisphere because there is no expansion along the meridians. However, the projection is not conformal and distances cannot be measured accurately in any but a north-south direction. Great circles other than the meridians differ somewhat from straight lines. The equator is a circle centered at the pole.

The two projections most commonly used for polar charts are the modified Lambert conformal and the polar stereographic. When a directional gyro is used as a directional reference, the track of the craft is approximately a great circle. A desirable chart is one on which a great circle is represented as a straight line with a constant scale and with angles correctly represented. These requirements are not met entirely by any single projection, but they are approximated by both the modified Lambert conformal and the polar stereographic. The scale is more nearly constant on the former, but the projection is not strictly conformal. The polar stereographic is conformal, and its maximum scale variation can be reduced by using a plane which intersects the earth at some parallel intermediate between the pole and the lowest parallel. The portion within this standard parallel is compressed, and that portion outside is expanded.

The selection of a suitable projection for use in polar regions depends upon mission requirements. These requirements establish the relative importance of various features. For a relatively small area, any of several projections is suitable. For a large area, however, the choice is more difficult. If grid directions are to be used, it is important that all units in related operations use charts on the same projection, with the same standard parallels, so that a single grid direction exists between any two points.

SPECIAL CHARTS

422. Plotting Sheets

Position plotting sheets are "charts" designed primarily for open ocean navigation, where land, visual aids to navigation, and depth of water are not factors in navigation. They have a latitude and longitude graticule, and they may have one or more compass roses. The meridians are usually unlabeled, so a plotting sheet can be used for any longitude. Plotting sheets on Mercator projection are specific to latitude, and the navigator should have enough aboard for all latitudes for their voyage. Plotting sheets are less expensive

than charts.

A plotting sheet may be used in an emergency when charts have been lost or destroyed. Directions on how to construct plotting sheets suitable for emergency purposes are given in Chapter 28 - Emergency Navigation.

423. Grids

No system exists for showing the surface of the earth on a plane without distortion. Moreover, the appearance of the surface varies with the projection and with the relation

of that surface area to the point of tangency. One may want to identify a location or area simply by alpha-numeric rectangular coordinates. This is accomplished with a **grid**. In its usual form this consists of two series of lines drawn perpendicularly on the chart, marked by suitable alpha-numeric designations.



Figure 423. Map Projections Catalog.
<http://www.csiss.org/map-projections>

A grid may use the rectangular graticule of the Mercator projection or a set of arbitrary lines on a particular projection. **The World Geodetic Reference System (GEOREF)** is a method of designating latitude and longitude by a system of letters and numbers instead of by angular measure. It is not, therefore, strictly a grid. It is useful for operations extending over a wide area. Examples of the second type of grid are the **Universal Transverse Mercator (UTM)** grid, the **Universal Polar Stereographic (UPS)** grid, and the **Temporary Geographic Grid (TGG)**. Since these systems are used primarily by military forces, they are sometimes called military grids.

For more information on chart projections see The Map Projections Catalog. The catalog offers examples of a broad range of publicly available projection types.

CHART SCALES

424. Types Of Scales

The **scale** of a chart is the ratio of a given distance on the chart to the actual distance which it represents on the earth. It may be expressed in various ways. The most common are:

1. A simple ratio or fraction, known as the **representative fraction**. For example, 1:80,000 or 1/80,000 means that one unit (such as a meter) on the chart represents 80,000 of the same unit on the surface of the earth. This scale is sometimes called the **natural** or **fractional** scale.
2. A **statement** that a given distance on the earth equals a given measure on the chart, or vice versa. For example, "30 miles to the inch" means that 1 inch on the chart represents 30 miles of the earth's surface. Similarly, "2 inches to a mile" indicates that 2 inches on the chart represent 1 mile on the earth. This is sometimes called the **numerical scale**.
3. A line or bar called a **graphic scale** may be drawn at a convenient place on the chart and subdivided into nautical miles, meters, etc. All charts vary somewhat in scale from point to point, and in some projections the scale is not the same in all directions about a single point. A single subdivided line or bar for use over an entire chart is shown only when the chart is of such scale and projection that the scale varies a negligible amount over the chart, usually one of about 1:75,000 or larger. Since 1 minute of latitude is very nearly equal to 1 nautical mile, the latitude scale serves as an approximate graphic scale. On most nautical charts the east and west borders are subdivided to facilitate distance measurements.

On a Mercator chart the scale varies with the latitude. This is noticeable on a chart covering a relatively large distance in a north-south direction. On such a chart the border scale nearest the latitude in question should be used for measuring distances.

Of the various methods of indicating scale, the graphical method is normally available in some form on the chart. In addition, the scale is customarily stated on charts on which the scale does not change appreciably over the chart.

The ways of expressing the scale of a chart are readily interchangeable. For instance, in a nautical mile there are about 72,913.39 inches. If the natural scale of a chart is 1:80,000, one inch of the chart represents 80,000 inches of the earth, or a little more than a mile. To find the exact amount, divide the scale by the number of inches in a mile, or $80,000/72,913.39 = 1.097$. Thus, a scale of 1:80,000 is the same as a scale of 1.097 (or approximately 1.1) miles to an inch. Stated another way, there are: $72,913.39/80,000 = 0.911$ (approximately 0.9) inch to a mile. Similarly, if the scale is 60 nautical miles to an inch, the representative fraction is $1:(60 \times 72,913.39) = 1:4,374,803$.

A chart covering a relatively large area is called a **small-scale chart** and one covering a relatively small area is called a **large-scale chart**. Since the terms are relative, there is no sharp division between the two. Thus, a chart of scale 1:100,000 is large scale when compared with a chart of 1:1,000,000 but small scale when compared with one of 1:25,000.

As scale decreases, the amount of detail which can be shown decreases also. Cartographers selectively decrease the detail in a process called **generalization** when producing small scale charts using large scale charts as sources. The amount of detail shown depends on several factors, among them the coverage of the area at larger scales and the intended use of the chart.

425. Chart Classification by Scale

Charts are constructed on many different scales, ranging from about 1:2,500 to 1:14,000,000. Small-scale charts covering large areas are used for route planning and for off-shore navigation. Charts of larger scale, covering smaller areas, are used as the vessel approaches land. Several methods of classifying charts according to scale are used in various nations. The following classifications of nautical charts are used by the National Ocean Service (NOS).

Sailing charts are the smallest scale charts used for planning, fixing position at sea, and for plotting the dead reckoning while proceeding on a long voyage. The scale is generally smaller than 1:600,000. The shoreline and topography are generalized and only offshore soundings, principal navigational lights, outer buoys, and landmarks visible at considerable distances are shown.

General charts are intended for coastwise navigation outside of outlying reefs and shoals. The scales range from about 1:150,000 to 1:600,000.

Coastal charts are intended for inshore coastwise navigation, for entering or leaving bays and harbors of considerable width, and for navigating large inland waterways. The scales range from about 1:50,000 to 1:150,000.

Harbor charts are intended for navigation and anchorage in harbors and small waterways. The scale is generally larger than 1:50,000.

In the classification system used by the National Geospatial-Intelligence Agency (NGA), the sailing charts are incorporated in the general charts classification (smaller

than about 1:150,000); those coastal charts especially useful for approaching more confined waters (bays, harbors) are classified as approach charts. There is considerable overlap in these designations, and the classification of a chart is best determined by its purpose and its relationship to other charts of the area. The use of insets complicates the placement of charts into rigid classifications.

426. Small-Craft Charts

NOS publishes a series of small craft charts sometimes called "strip charts." These charts depict segments of the Atlantic Intracoastal Waterway, the Gulf Intracoastal Waterway and other inland routes used by yachtsmen, fishermen, and small commercial vessels for coastal travel. They are not "north-up" in presentation, but are aligned with the waterway they depict, whatever its orientation is. Most often they are used as a piloting aid for "eyeball" navigation and placed "course-up" in front of the helmsman, because the routes they show are too confined for taking and plotting fixes.

Although NOS small-craft charts are designed primarily for use aboard yachts, fishing vessels and other small craft, these charts, at scales of 1:80,000 and larger, are in some cases the only charts available depicting inland waters transited by large vessels. In other cases the small-craft charts may provide a better presentation of navigational hazards than the standard nautical chart because of better scale and more detail. Therefore, navigators should use these charts in areas where they provide the best coverage.

CHART ACCURACY

427. Factors Relating to Accuracy

The accuracy of a chart depends upon the accuracy of the hydrographic surveys and other data sources used to compile it and the suitability of its scale for its intended use.

One can sometimes estimate the accuracy of a chart's surveys from the source notes given in the title of the chart. If the chart is based upon very old surveys, use it with caution. Many early surveys were inaccurate because of the technological limitations of the surveyor.

The number of soundings and their spacing indicates the completeness of the survey. Only a small fraction of the soundings taken in a thorough survey are shown on the chart, but sparse or unevenly distributed soundings indicate that the survey was probably not made in detail. See Figure 427a and Figure 427b. Large blank areas or absence of depth contours generally indicate lack of soundings in the area. Operate in an area with sparse sounding data only if required and then only with extreme caution. Run the echo sounder continuously and operate at a reduced speed. Sparse sounding information does not necessarily indicate an incomplete survey. Relatively few soundings are shown

when there is a large number of depth contours, or where the bottom is flat, or gently and evenly sloping. Additional soundings are shown when they are helpful in indicating the uneven character of a rough bottom.

Even a detailed survey may fail to locate every rock or pinnacle. In waters where they might be located, the best method for finding them is a wire drag survey. Areas that have been dragged may be indicated on the chart by limiting lines and green or purple tint and a note added to show the effective depth at which the drag was operated.

Changes in bottom contours are relatively rapid in areas such as entrances to harbors where there are strong currents or heavy surf. Similarly, there is sometimes a tendency for dredged channels to shoal, especially if they are surrounded by sand or mud, and cross currents exist. Charts often contain notes indicating the bottom contours are known to change rapidly.

The same detail cannot be shown on a small-scale chart as on a large scale chart. On small-scale charts, detailed information is omitted or "generalized" in the areas covered by larger scale charts. The navigator should use the largest scale chart available for the area in which he or she is oper-

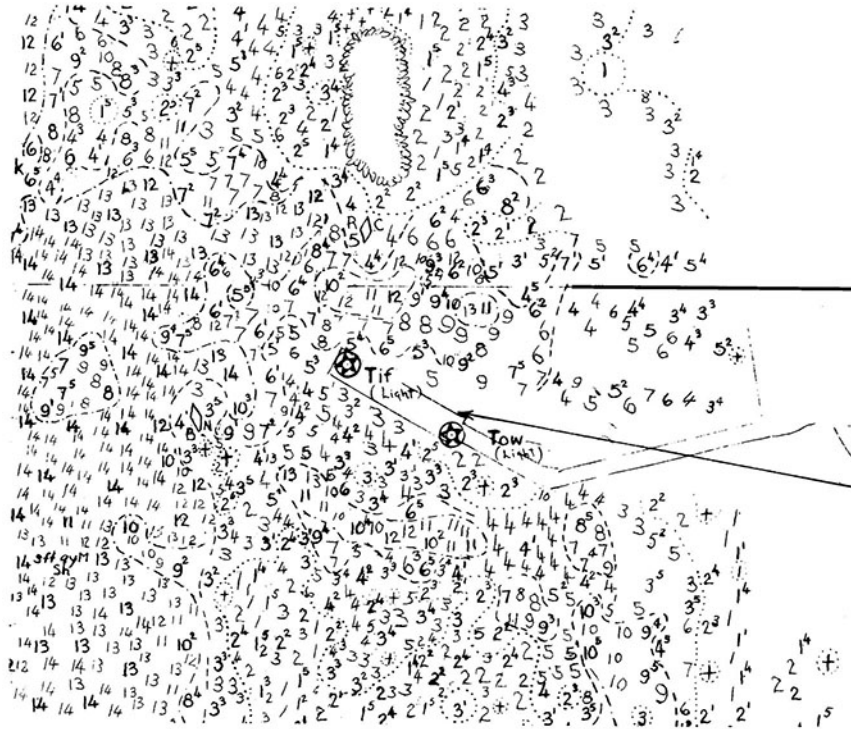


Figure 427a. Part of a "boat sheet," showing the soundings obtained in a survey.

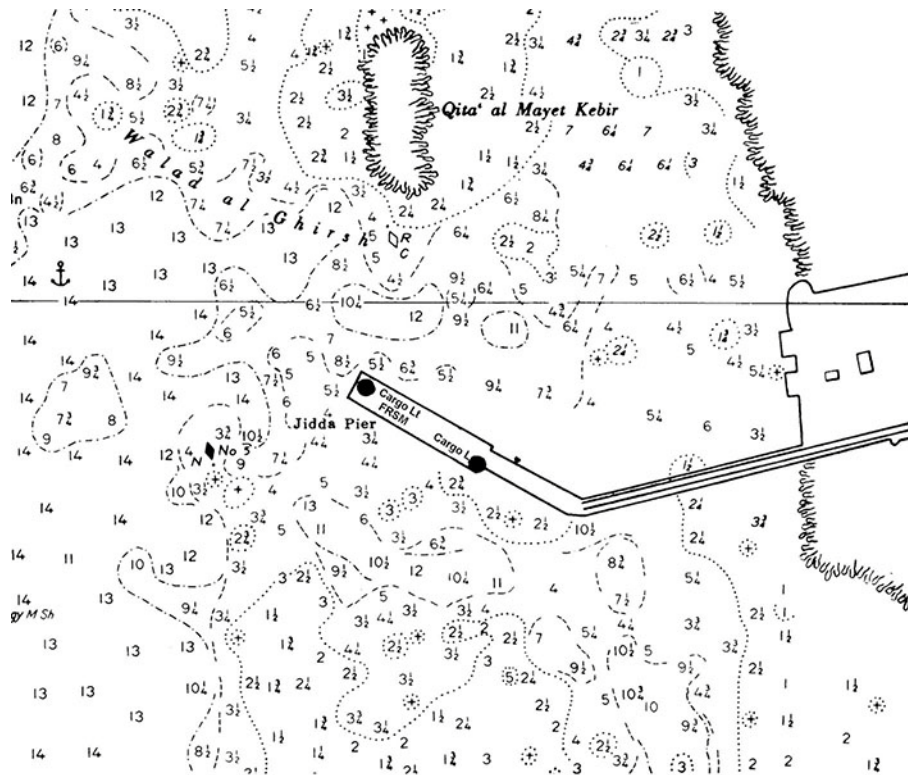


Figure 427b. Part of a nautical chart made from the boat sheet of Figure 427a. Compare the number of soundings in the two figures.

ating, especially when operating in the vicinity of hazards.

Charting agencies continually evaluate both the detail and the presentation of data appearing on a chart. Development of a new navigational aid may render previous charts inadequate. The development of radar, for example, required upgrading charts which lacked the detail required for reliable identification of radar targets.

After receiving a chart, the user is responsible for keeping it updated. Mariner’s reports of errors, changes, and suggestions are useful to charting agencies. Even with modern automated data collection techniques, there is no substitute for on-sight observation of hydrographic conditions by experienced mariners. This holds true especially in less frequently traveled areas of the world.

428. Source Diagrams and Zones of Confidence

All charts, whether paper or electronic, contain data which varies in quality due to the age and accuracy of individual surveys. A chart can be considered as a patchwork of individual surveys pieced together to form a single image. A **source diagram** only shows who supplied a survey, and possibly how old that survey is, but provides nothing about the quality of the survey. Where source diagrams are based on inexact and sometimes subjective parameters, a new **zone of confidence (ZOC)** system (exclusive to elec-

tronic charts in the United States) is derived more consistently, using a combination of survey data, position accuracy, depth accuracy, and sea floor coverage.

The ZOC assessments within each chart enable mariners to assess the limitation of the hydrographic data from which the chart was compiled and to assess the associated level of risk to navigate in a particular area. In ENC the various assessment areas and ratings appear across the entirety of the ENC and are therefore embedded in their true positions, rather than in a small diagram. This information layer can be displayed or hidden as planning and route monitoring requirements change.

Assessments are made based upon four criteria, following which a single ZOC rating is derived for each area of differing quality, based upon the lowest individually assessed criteria for that area. Individual criteria are:

1. Position accuracy.
2. Depth accuracy (in reference to what has been detected, not what might or might not have been missed).
3. Seafloor coverage, i.e. the certainty of feature detection (this is not related to depth accuracy, but relates only to what might or might not have been missed).
4. Typical survey characteristics.

<i>ZOC</i>	<i>Position Accuracy</i>	<i>Depth Accuracy</i>		<i>Seafloor Coverage</i>	<i>Typical Survey Characteristics</i>
A1	± 5 m	= 0.50 + 1% d		Full area search undertaken. All significant seafloor features detected and depths measured.	Controlled, systematic survey high position and depth accuracy achieved using DGPS or a minimum three high quality lines of position (LOP) and a multibeam, channel or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10	± 0.6		
		30	± 0.8		
		1000	± 10.5		
A2	± 20 m	= 1.00 + 2% d		Full area search undertaken. All significant seafloor features detected and depths measured.	Controlled, systematic survey high position and depth accuracy achieved less than ZOC A1 and using a modern survey echosounder and a sonar or mechanical system.
		Depth (m)	Accuracy (m)		
		10	± 1.2		
		30	± 1.6		
		1000	± 21.0		

Table 428. Zones of Confidence category explanations.

ZOC	Position Accuracy	Depth Accuracy		Seafloor Coverage	Typical Survey Characteristics
B	± 50 m	= 1.00 + 2% d		Full area search not achieved; uncharted features, hazardous to surface navigation are not expected but may exist.	Controlled systematic survey achieving similar depth but lesser position accuracies than ZOC A2, using modern survey echosounder, but no sonar or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10	± 1.2		
		30	± 1.6		
		100	± 3.0		
		1000	± 21.0		
C	± 500 m	= 2.00 + 5% d		Full area search not achieved, depth anomalies may be expected.	Low accuracy survey or data collected on an opportunity basis such as soundings on passage.
		Depth (m)	Accuracy (m)		
		10	± 2.5		
		30	± 3.5		
		100	± 7.0		
		1000	± 52.0		
D	Worse than ZOC	Worse than ZOC C		Full area search not achieved, large depth	Poor quality data or data that cannot be quality assessed due
U	Unassessed - The quality of the bathymetric data has yet to be assessed				

Table 428. Zones of Confidence category explanations.

Of these, the most important is the assessment of sea-floor coverage, as this determines how much clearance should be maintained between a ship's keel and the seabed in most areas, and where any additional precautions may need to be taken.

Each surveyed area will be assigned to one of five

quality categories for assessed data (ZOC A1, A2, B, C, D), with a sixth category used for data which has not been assessed (ZOC U). See Table 428 for an explanation of each category. The standard is detailed in the International Hydrographic Organization (IHO) S-57 Edition 3.1 Supplement 2, publication.

CHART READING

429. Chart Dates

NOAA charts have two areas where dates are shown. At the top center of the chart is the date of the first edition of the chart. In the lower left corner of the chart is the current edition number and date. Additionally, NOAA charts show the “cleared through” dates in the lower left corner of the chart to indicate what *Notice to Mariner* dates the chart is updated too (i.e. *Notice to Mariner* and *Local Notice to Mariner*). See Figure 429a. Any subsequent change will be published in the *Notice to Mariners*. Any notices which accumulate between the chart date and the announcement date in the *Notice to Mariners* will be given with the announcement.

NGA charts similarly have two dates as well. At the top center of the chart is the date of the first edition of the chart. In the lower left corner of the chart is the current chart edi-

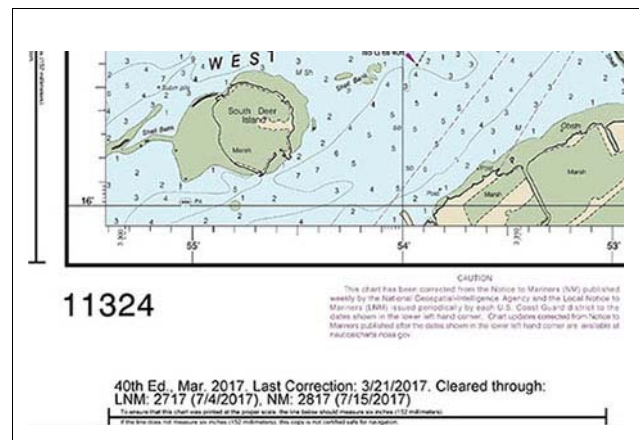


Figure 429a. NOAA chart dates.

tion number, date, and barcode information. See Figure 429b. The edition date will contain a statement indicating what Notice to Mariner the NGA chart has been corrected too. Any subsequent change will be published in the Notice to Mariners. Any notices which accumulate between the chart date and the announcement date in the Notice to Mariners will be given with the announcement. NGA charts do not contain a “cleared through” date like NOAA charts because NGA does not have a program in place for producing weekly digital updates to the chart files.

Certain NGA charts are reproductions of foreign charts produced under joint agreements with a number of other countries. These bilateral foreign chart reproductions will also include an NGA chart number, edition number, user note, and barcode information. These charts, even though of recent date, may not be based on the most recent edition of the foreign chart. Further, new editions of the foreign chart will not necessarily automatically result in a new edition of the NGA reproduction, especially in cases where the foreign chart is the better chart to use.

Comparing the difference of edition numbers and dates between the first and current editions on the chart, gives an indication of how often the chart is updated. Charts of busy areas are updated more frequently than those of less traveled areas. This interval may vary from 6 months to more than ten years for NOAA charts, and may be much longer for certain NGA charts in remote areas.

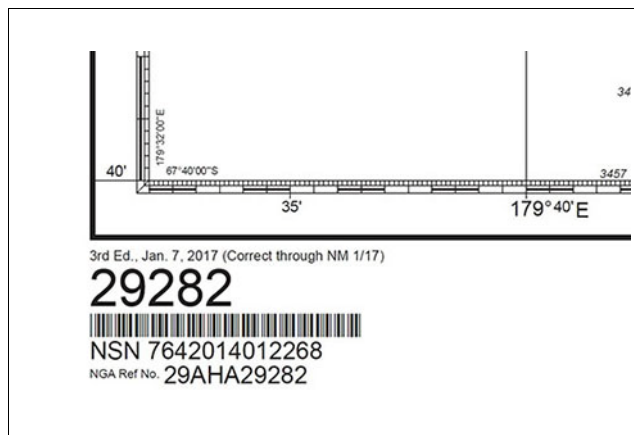


Figure 429b. NGA chart dates.

New editions of charts are both demand and source driven. Receiving significant new information may or may not initiate a new edition of a chart, depending on the demand for that chart. If it is in a sparsely-traveled area, production priorities may delay a new edition for several years. Conversely, a new edition may be printed without the receipt of significant new data if demand for the chart is high and stock levels are low. Notice to Mariners corrections are always included on new editions.

430. Title Block

The chart title block should be the first thing a navigator looks at when receiving a new edition chart (refer to Figure 430). The title itself tells what area the chart covers. The chart's scale and projection appear below the title. The chart will give both vertical and horizontal datums and, if necessary, a datum conversion note. Source notes or diagrams will list the date of surveys and other charts used in compilation.

431. Shoreline

The shoreline shown on nautical charts represents the line of contact between the land and water at a selected vertical datum. In areas affected by tidal fluctuations, this is usually the mean high-water line. In confined coastal waters of diminished tidal influence, a mean water level line may be used. The shoreline of interior waters (rivers, lakes) is usually a line representing a specified elevation above a selected datum. A shoreline is symbolized by a heavy line. A broken line indicates that the charted position is approximate only. The nature of the shore may be indicated.

If the low water line differs considerably from the high water line, then a dotted line represents the low water line. If the bottom in this area is composed of mud, sand, gravel or stones, the type of material will be indicated. If the bottom is composed of coral or rock, then the appropriate symbol will be used. The area alternately covered and uncovered may be shown by a tint which is usually a combination of the land and water tint.

The apparent shoreline shows the outer edge of marine vegetation where that limit would appear as shoreline to the mariner. It is also used to indicate where marine vegetation prevents the mariner from defining the shoreline. A light line symbolizes this shoreline. A broken line marks the inner edge when no other symbol (such as a cliff or levee) furnishes such a limit. The combined land-water tint or the land tint marks the area between inner and outer limits.

432. Chart Symbols

Much of the information contained on charts is shown by symbols. These symbols are not shown to scale, but they indicate the correct position of the feature to which they refer. The standard symbols and abbreviations used on charts published by the United States of America are shown in *Chart No. 1, Symbols, Abbreviations and Terms used on Paper and Electronic Navigation Charts*. See Figure 432a for link.

Electronic chart symbols are, within programming and display limits, much the same as printed ones. The less expensive electronic charts have less extensive symbol libraries, and the screen's resolution may affect the presentation detail.

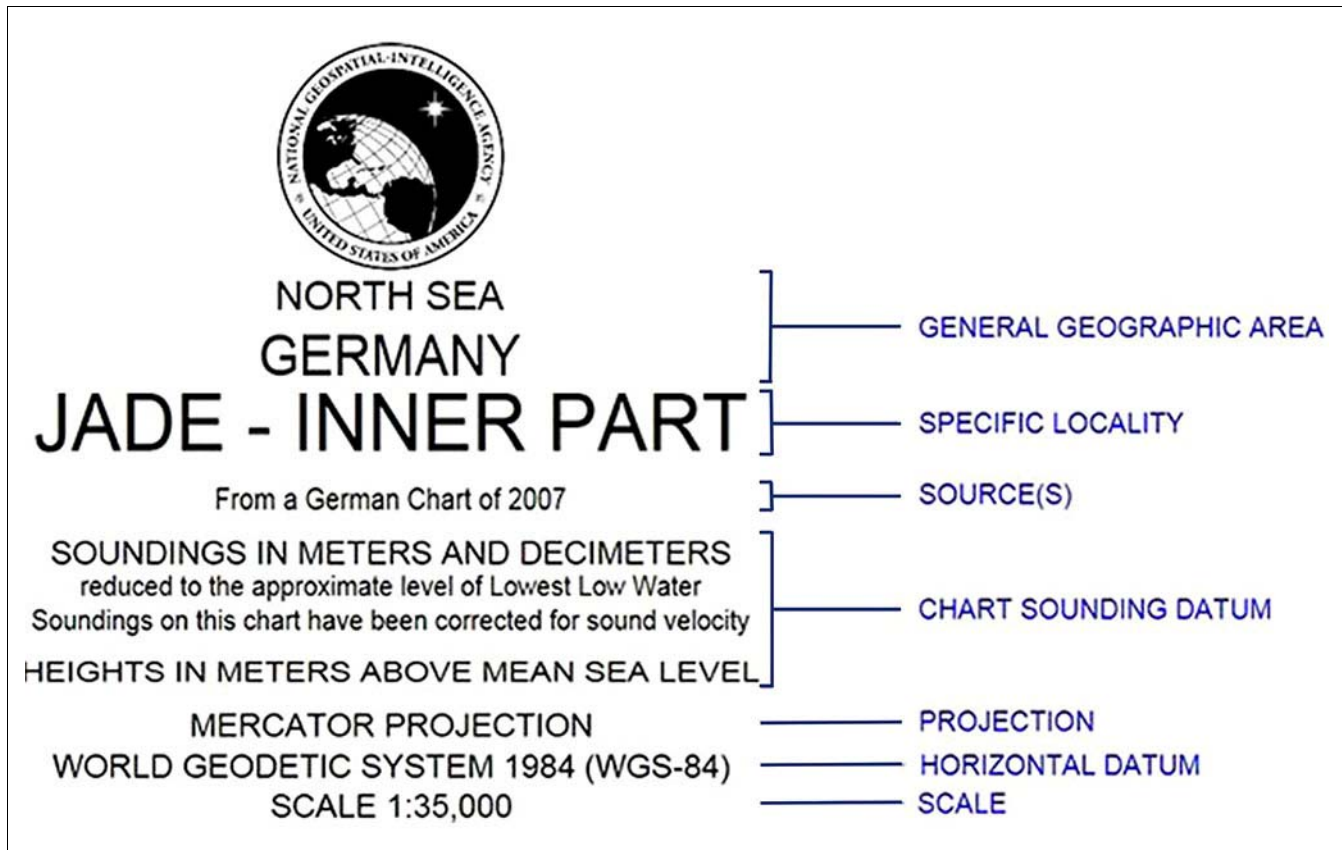


Figure 430. A chart title block.



Figure 432a. Link to Chart No. 1.

https://msi.nga.mil/NGAPortal/MSI.portal?_nfpb=true&_pageLabel=msi_portal_page_62&pubCode=0004

Most of the symbols and abbreviations shown in *U.S. Chart No. 1* agree with recommendations of the International Hydrographic Organization (IHO), these are often called INT1 symbols. The symbols and abbreviations on any given chart may differ somewhat from those shown in *U.S. Chart No. 1*. In addition, foreign charts may use different symbology. When using a foreign chart, the navigator should have available the Chart No. 1 from the country which produced the chart.

The symbols in *U.S. Chart No. 1* are organized by type in separate sections. For example, “natural features,” “landmarks,” “depths,” “rocks, wrecks, obstructions, aquaculture,” etc. Each section has a separate letter designator.

Information and examples of each symbol are dis-

played in eight columns. These show the IHO number code for the symbol; the INT1 symbol; a textual description of the symbol, term, or abbreviation; NOAA and NGA symbols if they are different from the INT1 symbol (the NOAA and NGA columns are combined if the charts from each of these agencies use the same symbol. If the symbols are different, two separate columns are shown). The next column shows any symbols used on foreign charts that NGA reproduces. The final two columns show the ECDIS symbols used to portray ENC data. The layout is explained in the introduction section of *U.S. Chart No. 1*.

Chart No. 1 is organized according to subject matter, with each specific subject given a letter designator. The general subject areas are General, Topography, Hydrography, Aids and Services, and Indexes. Under each heading, letter designators further define subject areas, and individual numbers refer to specific symbols. See Figure 432b.

Information in *Chart No. 1* is arranged in columns. The first column contains the IHO number code for the symbol in question. The next two columns show the symbol itself, in NOS and NGA formats. If the formats are the same, the two columns are combined into one. The next column is a text description of the symbol, term, or abbreviation. The next three columns contain the IHO standard symbolized on charts produced by NOAA or NGA. The last column contains the symbol used on electronic charts displayed on an ECDIS with a text description to the right of the symbol.

Section Key

A		Chart Number, Title and Marginal Notes	INT 500 412 Mercator Projection Scale 1:100,000 at Lat. 59°30' 7th Ed., Mar. 5/09 DEPTHS IN METERS
B		Positions, Distances, Directions and Compass	 Magnetic Variation 4°30' W 2011 (8° E) LOCAL MAGNETIC ANOMALY (see note)
C		Natural Features	
D		Cultural Features	 FIXED BRIDGE HOR. CL. 25 FT VERT. CL. 20 FT
E		Landmarks	
F		Ports	
H		Tides and Currents	 2.5 kn (see Note) Tide gage
I		Depths	 30 FEET APR 2011 212 3375 Unsurveyed 13 12 10 12 96 (2011) 10 9 9
J		Nature of the Seabed	 Gravel Rock
K		Rocks, Wrecks and Obstructions	 Wk 35 Rk Obstn Wk Masts Obstn Crib
L		Offshore Installations	 Z-44 FLY Prod Well Pipe (cov 240) Crib Well Name
M		Tracks and Routes	 Ra Ra VHF 80 270.5° <7.0m>
N		Areas and Limits	 Log boom Disposal Area Depths from survey of 2010 92 85
P		Lights	 FLWRG. 4s 21m 18-12M FLG 270°
Q		Buoys and Beacons	 Bn R
R		Fog Signals	 BELL Q(6)+LFl 15s HORN(1) 15s WHIS Fl 3s 70m 29M SIREN Mo(N) 60s
S		Radar, Radio and Satellite Navigation Systems	 Racon AIS CONSOL Bn 190 MHz MMF RD 269.5° RD
T		Services	 NWS SIG STA SS CG F Traffic-Sig
U		Small Craft (Leisure) Facilities	

Figure 432b. Contents of U.S. Chart No. 1.

433. Lettering

Except on some modified reproductions of foreign charts, cartographers have adopted certain lettering standards. Vertical type is used for features which are dry at high water and not affected by movement of the water; slanting type is used for underwater and floating features.

There are two important exceptions to the two general rules listed above. Vertical type is not used to represent heights above the waterline, and slanting type is not used to indicate soundings, except on metric charts. Section 434 discusses the conventions for indicating soundings.

Evaluating the type of lettering used to denote a feature, one can determine whether a feature is visible at high tide. For instance, a rock might bear the title “Rock” whether or not it extends above the surface. If the name is given in vertical letters, the rock constitutes a small islet; if in slanting type, the rock constitutes a reef, covered at high water.

434. Soundings

Charts show soundings in several ways. Numbers denote individual soundings. These numbers may be either vertical or slanting; both may be used on the same chart, distinguishing between data based upon different U.S. and foreign surveys, different datums, or smaller scale charts.

Large block letters at the top and bottom of the chart indicate the unit of measurement used for soundings. SOUNDINGS IN FATHOMS indicates soundings are in fathoms or fathoms and fractions. SOUNDINGS IN FATHOMS AND FEET indicates the soundings are in fathoms and feet. A similar convention is followed when the soundings are in meters or meters and tenths.

A **depth conversion scale** is placed outside the neat-line on the chart for use in converting charted depths to feet, meters, or fathoms. “No bottom” soundings are indicated by a number with a line over the top and a dot over the line. This indicates that the spot was sounded to the depth indicated without reaching the bottom. Areas which have been

wire dragged are shown by a broken limiting line, and the clear effective depth is indicated, with a characteristic symbol under the numbers. On NGA charts a purple or green tint is shown within the swept area.

Soundings are supplemented by **depth contours**, lines connecting points of equal depth. These lines present a picture of the bottom. The types of lines used for various depths are shown in Section I of *Chart No. 1*. On some charts depth contours are shown in solid lines; the depth represented by each line is shown by numbers placed in breaks in the lines, as with land contours. Solid line depth contours are derived from intensively developed hydrographic surveys. A broken or indefinite contour is substituted for a solid depth contour whenever the reliability of the contour is questionable.

Depth contours are labeled with numerals in the unit of measurement of the soundings. A chart presenting a more detailed indication of the bottom configuration with fewer numerical soundings is useful when bottom contour navigating. Such a chart can be made only for areas which have undergone a detailed survey

Shoal areas often are given a blue tint. Charts designed to give maximum emphasis to the configuration of the bottom show depths beyond the 100-fathom curve over the entire chart by depth contours similar to the contours shown on land areas to indicate graduations in height. These are called **bottom contour** or **bathymetric charts**.

On electronic charts, a variety of other color schemes may be used, according to the manufacturer of the system. Color perception studies are being used to determine the best presentation.

The side limits of dredged channels are indicated by broken lines. The project depth and the date of dredging, if known, are shown by a statement in or along the channel. The possibility of silting is always present. Local authorities should be consulted for the controlling depth. NOS charts frequently show controlling depths in a table, which is kept current by the *Notice to Mariners*.

The chart scale is generally too small to permit all soundings to be shown. In the selection of soundings, least depths are shown first. This conservative sounding pattern provides safety and ensures an uncluttered chart appearance. Steep changes in depth may be indicated by more dense soundings in the area. The limits of shoal water indicated on the chart may be in error, and nearby areas of undetected shallow water may not be included on the chart. Given this possibility, areas where shoal water is known to exist should be avoided. If the navigator must enter an area containing shoals, they must exercise extreme caution in avoiding shallow areas which may have escaped detection. By constructing a "safety range" around known shoals and ensuring their vessel does not approach the shoal any closer than the safety range, the navigator can increase their chances of successfully navigating through shoal water. Constant use of the echo sounder is also important.

Abbreviations listed in Section J of *Chart No. 1* are

used to indicate what substance forms the bottom. The meaning of these terms can be found in the Glossary of this volume. While in ages past navigators might actually navigate by knowing the bottom characteristics of certain local areas, today knowing the characteristic of the bottom is most important when anchoring.

435. Depths and Datums

Depths are indicated by soundings or explanatory notes. Only a small percentage of the soundings obtained in a hydrographic survey can be shown on a nautical chart. The least depths are generally selected first, and a pattern built around them to provide a representative indication of bottom relief. In shallow water, soundings may be spaced 0.2 to 0.4 inch apart. The spacing is gradually increased as water deepens, until a spacing of 0.8 to 1.0 inch is reached in deeper waters offshore. Where a sufficient number of soundings are available to permit adequate interpretation, depth curves are drawn in at selected intervals.

All depths indicated on charts are reckoned from a selected level of the water, called the **sounding datum**, (sometimes referred to as the **reference plane** to distinguish this term from the geodetic datum). The various sounding datums are explained in Chapter 35- Tides and Tidal Currents. On charts produced from U.S. surveys, the sounding datum is selected with regard to the tides of the region. Depths shown are the least depths to be expected under average conditions. On charts compiled from foreign charts and surveys the sounding datum is that of the original authority. When it is known, the sounding datum used is stated on the chart. In some cases where the chart is based upon old surveys, particularly in areas where the range of tide is not great, the sounding datum may not be known.

For most NOAA charts of the United States and Puerto Rico, the sounding datum is indicated as Mean Lower Low Water (MLLW). Most NGA charts are based upon mean low water, mean lower low water, or mean low water springs. The sounding datum for charts published by other countries varies greatly, but is usually lower than mean low water. On charts of the Baltic Sea, Black Sea, the Great Lakes, and other areas where tidal effects are small or without significance, the sounding datum adopted is an arbitrary height approximating the mean water level.

The sounding datum of the largest scale chart of an area is generally the same as the reference level from which height of tide is tabulated in the tide tables.

The chart datum is usually only an approximation of the actual mean value, because determination of the actual mean height usually requires a longer series of tidal observations than is normally available to the cartographer. In addition, the heights of the tide vary over time.

Since the chart datum is generally a computed mean or average height at some state of the tide, the depth of water at any particular moment may be less than shown on the chart. For example, if the chart datum is mean lower low

water, the depth of water at lower low water will be less than the charted depth about as often as it is greater. A lower depth is indicated in the tide tables by a minus sign (–).

436. Heights

The shoreline shown on charts is generally mean high water. A light's height is usually reckoned from mean sea level. The heights of overhanging obstructions (bridges, power cables, etc.) are usually reckoned from mean high water. A high water reference gives the mariner the minimum clearance expected.

Since heights are usually reckoned from high water and depths from some form of low water, the reference levels are seldom the same. Except where the range of tide is very large, this is of little practical significance.

437. Dangers

Dangers are shown by appropriate symbols, as indicated in Section K of *Chart No. 1*.

A rock uncovered at mean high water may be shown as an islet. If an isolated, offlying rock is known to uncover at the sounding datum but to be covered at high water, the chart shows the appropriate symbol for a rock and gives the height above the sounding datum. The chart can give this height one of two ways. It can use a statement such as "Uncov 2 ft.," or it can indicate the number of feet the rock protrudes above the sounding datum, underline this value, and enclose it in parentheses (i.e. (2)). A rock which does not uncover is shown by an enclosed figure approximating its dimensions and filled with land tint. It may be enclosed by a dotted depth curve for emphasis.

A tinted, irregular-line figure of approximately true dimensions is used to show a detached coral reef which uncovers at the chart datum. For a coral or rocky reef which is submerged at chart datum, the sunken rock symbol or an appropriate statement is used, enclosed by a dotted or broken line if the limits have been determined.

Several different symbols mark wrecks. The nature of the wreck or scale of the chart determines the correct symbol. A sunken wreck with less than 30 meters of water over it is considered dangerous and its symbol is surrounded by a dotted curve. The curve is omitted if the wreck is deeper than 30 meters. The safe clearance over a wreck, if known, is indicated by a standard sounding number placed at the wreck. If this depth was determined by a wire drag, the sounding is underscored by the wire drag symbol. An unsurveyed wreck over which the exact depth is unknown but a safe clearance depth is known is depicted with a solid line above the symbol.

Tide rips, eddies, and kelp are shown by symbol or legend. Piles, dolphins (clusters of piles), snags, and stumps are shown by small circles and a label identifying the type of obstruction. If such dangers are submerged, the letters "Subm" precede the label. Fish stakes and traps are shown when known to be permanent or hazardous to navigation.

438. Aids to Navigation

Aids to navigation are shown by symbols listed in Sections P through S of *Chart No. 1*. Abbreviations and additional descriptive text supplement these symbols. In order to make the symbols conspicuous, the chart shows them in size greatly exaggerated relative to the scale of the chart. "Position approximate" circles are used on floating aids to indicate that they have no exact position because they move around their moorings. For most floating aids, the position circle in the symbol marks the approximate location of the anchor or sinker. The actual aid may be displaced from this location by the scope of its mooring.

The type and number of aids to navigation shown on a chart and the amount of information given in their legends varies with the scale of the chart. Smaller scale charts may have fewer aids indicated and less information than larger scale charts of the same area.

Lighthouses and other navigation lights are shown as black dots with purple disks or as black dots with purple flare symbols. The center of the dot is the position of the light. Some modified facsimile foreign charts use a small star instead of a dot.

On large-scale charts the legend elements of lights are shown in the following order:

<i>Legend</i>	<i>Example</i>	<i>Meaning</i>
Designation	"6"	Light number 6
Characteristic	F1(2)	group flashing; 2 flashes
Color	R	red
Period	10s	2 flashes in 10 seconds
Height	80m	80 meters
Range	19M	19 nautical miles

The legend characteristics for this light would appear on the chart:

"6" F1(2) R 10s 80m 19M

As chart scale decreases, information in the legend is selectively deleted to avoid clutter. The order of deletion is usually height first, followed by period, group repetition interval (e.g. (2)), designation, and range. Characteristic and color will almost always be shown.

Small triangles mark red daybeacons; small squares mark all others. On NGA charts, pictorial beacons are used when the IALA buoyage system has been implemented. The center of the triangle marks the position of the aid. Except on Intracoastal Waterway charts and charts of state waterways, the abbreviation "Bn" is shown beside the symbol, along with the appropriate abbreviation for color if

known. For black beacons the triangle is solid black and there is no color abbreviation. All beacon abbreviations are in vertical lettering.

Radiobeacons are indicated on the chart by a purple circle accompanied by the appropriate abbreviation indicating an ordinary radiobeacon (R Bn) or a radar beacon (Ramar or Racon, for example).

A variety of symbols, determined by both the charting agency and the types of buoys, indicate navigation buoys. IALA buoys (see Chapter 7- Short Range Aids to Navigation) in foreign areas are depicted by various styles of symbols with proper topmarks and colors; the position circle which shows the approximate location of the sinker is at the base of the symbol.

A mooring buoy is shown by one of several symbols as indicated in *Chart No. 1*. It may be labeled with a berth number or other information.

A buoy symbol with a horizontal line indicates the buoy has horizontal bands. A vertical line indicates vertical stripes; crossed lines indicate a checked pattern. There is no significance to the angle at which the buoy symbol appears on the chart. The symbol is placed so as to avoid interference with other features.

Lighted buoys are indicated by a purple flare from the buoy symbol or by a small purple disk centered on the position circle.

Abbreviations for light legends, type and color of buoy, designation, and any other pertinent information given near the symbol are in slanted type. The letter C, N, or S indicates a can, nun, or spar, respectively. Other buoys are assumed to be pillar buoys, except for special buoys such as spherical, barrel, etc. The number or letter designation of the buoy is given in quotation marks on NOS charts. On other charts they may be given without quotation marks or other punctuation.

Aeronautical lights included in the light lists are shown by the lighthouse symbol, accompanied by the abbreviation "AERO." The characteristics shown depend principally upon the effective range of other navigational lights in the vicinity and the usefulness of the light for marine navigation.

Directional ranges are indicated by a broken or solid line. The solid line, indicating that part of the range intended for navigation, may be broken at irregular intervals to avoid being drawn through soundings. That part of the range line drawn only to guide the eye to the objects to be kept in range is broken at regular intervals. The direction, if given, is expressed in degrees, clockwise from true north.

Sound signals are indicated by the appropriate word in capital letters (HORN, BELL, GONG, or WHIS) or an abbreviation indicating the type of sound. Sound signals of any type except submarine sound signals may be represented by three purple 45° arcs of concentric circles near the top of the aid. These are not shown if the type of signal is listed. The location of a sound signal which does not accompany a visual aid, either lighted or unlighted, is shown by a small

circle and the appropriate word in vertical block letters.

Private aids, when shown, are marked "Priv" on NOS charts. Some privately maintained unlighted fixed aids are indicated by a small circle accompanied by the word "Marker," or a larger circle with a dot in the center and the word "MARKER." A privately maintained lighted aid has a light symbol and is accompanied by the characteristics and the usual indication of its private nature. Private aids should be used with caution.

A light sector is the sector or area bounded by two radii and the arc of a circle in which a light is visible or in which it has a distinctive color different from that of adjoining sectors. The limiting radii are indicated on the chart by dotted or dashed lines. Sector colors are indicated by words spelled out if space permits, or by abbreviations (W, R, etc.) if it does not. Limits of light sectors and arcs of visibility as observed from a vessel are given in the light lists, in clockwise order.

439. Land Areas

The amount of detail shown on the land areas of nautical charts depends upon the scale and the intended purpose of the chart. Contours, form lines, and shading indicate relief.

Contours are lines connecting points of equal elevation. Heights are usually expressed in feet (or in meters with means for conversion to feet). The interval between contours is uniform over any one chart, except that certain intermediate contours are sometimes shown by broken line. When contours are broken, their locations are approximate.

Form lines are approximations of contours used for the purpose of indicating relative elevations. They are used in areas where accurate information is not available in sufficient detail to permit exact location of contours. Elevations of individual form lines are not indicated on the chart.

Spot elevations are generally given only for summits or for tops of conspicuous landmarks. The heights of spot elevations and contours are given with reference to mean high water when this information is available.

When there is insufficient space to show the heights of islets or rocks, they are indicated by slanting figures enclosed in parentheses in the water area nearby.

440. Cities and Roads

Cities are shown in a generalized pattern that approximates their extent and shape. Street names are generally not charted except those along the waterfront on the largest scale charts. In general, only the main arteries and thoroughfares or major coastal highways are shown on smaller scale charts. Occasionally, highway numbers are given. When shown, trails are indicated by a light broken line. Buildings along the waterfront or individual ones back from the waterfront but of special interest to the mariner are shown on large-scale charts. Special symbols from *Chart*

No. 1 are used for certain kinds of buildings. A single line with cross marks indicates both single and double track railroads. City electric railways are usually not charted. Airports are shown on small-scale charts by symbol and on large-scale charts by the shape of runways. The scale of the chart determines if single or double lines show breakwaters and jetties; broken lines show the submerged portion of these features.

441. Landmarks

Landmarks are shown by symbols in *Chart No. 1*.

A large circle with a dot at its center is used to indicate that the position is precise and may be used without reservation for plotting bearings. A small circle without a dot is used for landmarks not accurately located. Capital and lower case letters are used to identify an approximate landmark: “Mon,” “Cup,” or “Dome.” The abbreviation “PA” (position approximate) may also appear. An accurate

landmark is identified by all capital type (“MON,” “CUP,” “DOME”).

When only one object of a group is charted, its name is followed by a descriptive legend in parenthesis, including the number of objects in the group, for example “(TALLEST OF FOUR)” or “(NORTHEAST OF THREE).”

442. Miscellaneous Chart Features

A measured nautical mile indicated on a chart is accurate to within 6 feet of the correct length. Most measured miles in the United States were made before 1959, when the United States adopted the International Nautical Mile. The new value is within 6 feet of the previous standard length of 6,080.20 feet. If the measured distance differs from the standard value by more than 6 feet, the actual measured distance is stated and the words “measured mile” are omitted. Periods after abbreviations in water areas are omitted

TIDAL INFORMATION						
Place	Position		Height above datum of soundings			
			Mean High Water		Mean Low Water	
	N. Lat.	E. Long.	Higher	Lower	Lower	Higher
			meters	meters	meters	meters
Olongapo	14°49'	120°17'	. . . 0.9 0.4 0.0 0.3 . .

Figure 442a. Tidal box.

because these might be mistaken for rocks. However, a lower case i or j is dotted.

Commercial radio broadcasting stations are shown on charts when they are of value to the mariner either as landmarks or sources of direction-finding bearings.

Lines of demarcation between the areas in which international and inland navigation rules apply are shown only when they cannot be adequately described in notes on the chart.

Compass roses are placed at convenient locations on Mercator charts to facilitate the plotting of bearings and courses. The outer circle is graduated in degrees with zero at true north. The inner circle indicates magnetic north.

On many NGA charts magnetic variation is given to the nearest 1' by notes in the centers of compass roses. The annual change is given to the nearest 1' to permit correction of the given value at a later date. On NOS charts, variation is to the nearest 15', updated at each new edition if over three years old. The current practice of NGA is to give the magnetic variation to the nearest 1', but the magnetic information on new editions is only updated to conform with the latest five year epoch. Whenever a chart is reprinted, the magnetic information is updated to the latest epoch. On some smaller scale charts, the variation is given by isogonic lines connecting points of equal variation; usually a separate line represents each degree of variation. The line of

zero variation is called the agonic line. Many plans and insets show neither compass roses nor isogonic lines, but indicate magnetic information by note. A local magnetic disturbance of sufficient force to cause noticeable deflection of the magnetic compass, called local attraction, is indicated by a note on the chart.

Currents are sometimes shown on charts with arrows giving the directions and figures showing speeds. The information refers to the usual or average conditions. According to tides and weather, conditions at any given time may differ considerably from those shown.

Review chart notes carefully because they provide important information. Several types of notes are used. Those in the margin give such information as chart number, publication notes, and identification of adjoining charts. Notes in connection with the chart title include information on scale, sources of data, tidal information, soundings, and cautions. Another class of notes covers such topics as local magnetic disturbance, controlling depths of channels, hazards to navigation, and anchorages.

A datum note will show the geodetic datum of the chart (Do not confuse with the sounding datum. See Chapter 2 - Geodesy and Datums in Navigation). It may also contain instructions on plotting positions from the WGS 84 or NAD 83 datums on the chart if such a conversion is needed.

NANTUCKET HARBOR							
Tabulated from surveys by the Corps of Engineers - report of June 1972 and surveys of Nov. 1971							
Controlling depths in channels entering from seaward in feet at Mean Low Water					Project Dimensions		
Name of Channel	Left outside quarter	Middle half of channel	Right outside quarter	Date of Survey	Width (feet)	Length (naut. miles)	Depth M. L. W. (feet)
Entrance Channel	11.1	15.0	15.0	11 - 71	300	1.2	15
Note.-The Corps of Engineers should be consulted for changing conditions subsequent to the above.							

Figure 442b. Tabulations of controlling depths.

Anchorage areas are labeled with a variety of magenta, black, or green lines depending on the status of the area. Anchorage berths are shown as purple circles, with the number or letter assigned to the berth inscribed within the circle. Caution notes are sometimes shown when there are specific anchoring regulations.

Spoil areas are shown within short broken black lines. Spoil areas are tinted blue on NOS charts and labeled. These areas contain no soundings and should be avoided.

Firing and bombing practice areas in the United States territorial and adjacent waters are shown on NOS and NGA charts of the same area and comparable scale.

Danger areas established for short periods of time are not charted but are announced locally. Most military commands charged with supervision of gunnery and missile firing areas promulgate a weekly schedule listing activated danger areas. This schedule is subjected to frequent change; the mariner should always ensure they have the latest sched-

ule prior to proceeding into a gunnery or missile firing area. Danger areas in effect for longer periods are published in the *Notice to Mariners*. Any aid to navigation established to mark a danger area or a fixed or floating target is shown on charts.

Traffic separation schemes are shown on standard nautical charts of scale 1:600,000 and larger and are printed in magenta.

A logarithmic time-speed-distance nomogram with an explanation of its application is shown on harbor charts.

Tidal information boxes are shown on charts of scales 1:200,000 and larger for NOS charts, and various scales on NGA charts, according to the source. See Figure 442a.

Tabulations of controlling depths are shown on some NOS harbor and coastal charts. See Figure 442b.

Study *Chart No. 1* thoroughly to become familiar with all the symbols used to depict the wide variety of features on nautical charts.

REPRODUCTIONS OF FOREIGN CHARTS

443. Modified Facsimiles

Modified facsimile charts are modified reproductions of foreign charts produced in accordance with bilateral international agreements. These reproductions provide the mariner with up-to-date charts of foreign waters. Modified facsimile charts published by NGA are, in general, reproduced with minimal changes, as listed below:

1. The original name of the chart may be removed and replaced by an anglicized version.
2. English language equivalents of names and terms on the original chart are printed in a suitable glossary on the reproduction, as appropriate.
3. All hydrographic information, except bottom characteristics, is shown as depicted on the original chart.
4. Bottom characteristics are as depicted in *Chart No. 1*, or as on the original with a glossary.
5. The unit of measurement used for soundings is shown in block letters outside the upper and lower neatlines.
6. A scale for converting charted depth to feet, meters, or fathoms is added.
7. Blue tint is shown from a significant depth curve to the shoreline.
8. Blue tint is added to all dangers enclosed by a dotted danger curve, dangerous wrecks, foul areas, obstructions, rocks awash, sunken rocks, and swept wrecks.
9. Caution notes are shown in purple and enclosed in a box.
10. Restricted, danger, and prohibited areas are usually outlined in purple and labeled appropriately.
11. Traffic separation schemes are shown in purple.
12. A note on traffic separation schemes, printed in black, is added to the chart.
13. Wire dragged (swept) areas are shown in purple or green.
14. Corrections are provided to shift the horizontal datum to the WGS (1984).

INTERNATIONAL CHARTS

444. International Chart Standards

The need for mariners and chart makers to understand and use nautical charts of different nations became increasingly apparent as the maritime nations of the world developed their own establishments for the compilation and publication of nautical charts from hydrographic surveys. Representatives of twenty-two nations formed a Hydrographic Conference in London in 1919. That conference resulted in the establishment of the **International Hydrographic Bureau (IHB)** in Monaco in 1921. Today, the IHB's successor, the **International Hydrographic Organization (IHO)** continues to provide international standards for the cartographers of its member nations. (See Chapter 1 - Introduction to Marine Navigation, for a description of the IHO.)

Recognizing the considerable duplication of effort by member states, the IHO in 1967 moved to introduce the first **international chart**. It formed a committee of six member states to formulate specifications for two series of international charts. Eighty-three small-scale charts were approved; responsibility for compiling these charts has subsequently been accepted by the member states' Hydrographic Offices.

Once a Member State publishes an international chart, reproduction material is made available to any other Member State which may wish to print the chart for its own purposes.

International charts can be identified by the letters INT before the chart number and the IHO seal in addition to other national seals which may appear.

PRINT ON DEMAND CHARTS

445. NOAA Print-on-Demand Paper Charts

NOAA's paper nautical charts are available as "print-on-demand," up-to-date to the time of purchase. Coast Survey reviews charts weekly, and applies all critical corrections specified in Notices to Mariners. NOAA print-on-demand paper charts must be printed by NOAA-certified agents to meet the requirements for the mandatory carriage of nautical charts.



Figure 445. NOAA Print-on-Demand charts.
<http://www.charts.noaa.gov/InteractiveCatalog/nrnc.shtml>

446. NOAA PDF Nautical Charts

NOAA provides about a thousand high-resolution printable nautical charts - almost the entire NOAA suite of charts - as PDF files. The PDF nautical charts are exact images of NOAA's traditional nautical charts. Coast Survey checks each chart weekly, and applies all critical corrections. Most charts can be printed from any plotter capable

of plotting 36" width to achieve 1:1 scale. (NOTE: Mariners using paper charts to meet chart carriage requirements under federal regulations should use printed charts provided by NOAA-certified print-on-demand vendors).



Figure 446. NOAA PDF charts.
<https://nauticalcharts.noaa.gov/>

447. NGA Enterprise Print on Demand Service (ePODs)

The Enterprise Print on Demand Service (ePODs) is NGA's effort to expedite and modernize the creation of legacy chart formats based on geospatially enabled database information. ePODs is a revolutionary concept that utilizes evolutionary methods to provide hardcopy charts built from digital data to the customer. ePODs are print-ready nautical chart files generated directly from existing vector data sets of foundation feature data. The system produces print-ready files that can be delivered directly to DoD and other authorized customers, or stored at a Remote Replication Service (RSS) sites for printing products "on demand."

CHART NUMBERING

448. The Chart Numbering System

NGA and NOS use a system in which numbers are assigned in accordance with both the scale and geographical area of coverage of a chart. With the exception of certain charts produced for military use only, one- to five-digit numbers are used. With the exception of one-digit numbers, the first digit identifies the area; the number of digits establishes the scale range. The one-digit numbers are used for certain products in the chart system which are not actually charts.

Number of Digits	Scale
1	No Scale
2	1:9 million and smaller
3	1:2 million to 1:9 million
4	Special Purpose
5	1:2 million and larger

Table 448a. Chart Numbering

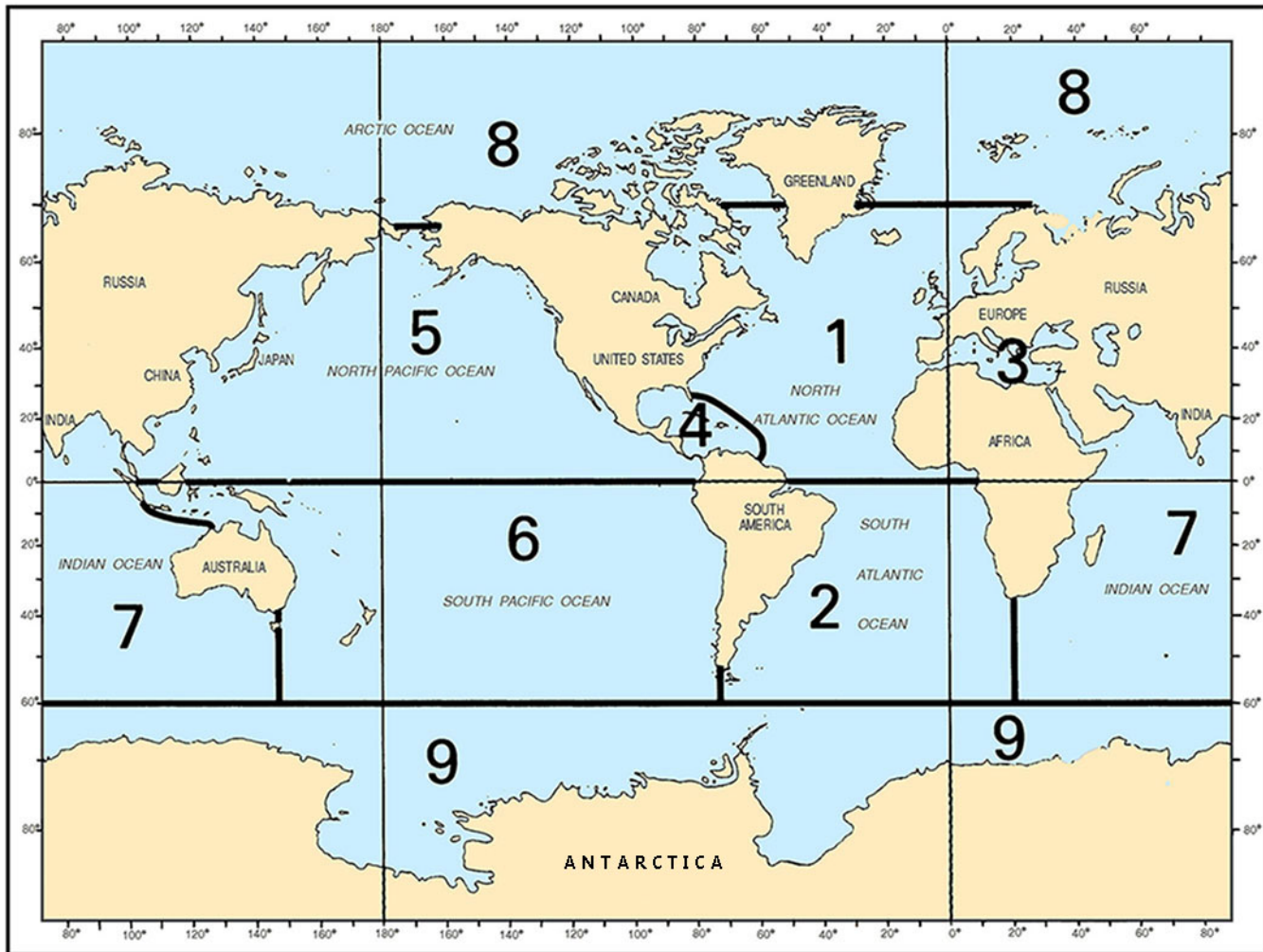


Figure 448b. Ocean basins with region numbers.

Two- and three-digit numbers are assigned to those small-scale charts which depict a major portion of an ocean basin or a large area. The first digit identifies the applicable ocean basin. See Figure 448b. Two-digit numbers are used

for charts of scale 1:9,000,000 and smaller. Three-digit numbers are used for charts of scale 1:2,000,000 to 1:9,000,000.

Due to the limited sizes of certain ocean basins, no

charts for navigational use at scales of 1:9,000,000 and smaller are published to cover these basins. The otherwise unused two-digit numbers (30 to 49 and 70 to 79) are assigned to special world charts.

One exception to the scale range criteria for three-digit numbers is the use of three-digit numbers for a series of position plotting sheets. They are of larger scale than 1:2,000,000 because they have application in ocean basins and can be used in all longitudes.

Four-digit numbers are used for non-navigational and special purpose charts, such as chart 4149, *Straits of Florida*.

Five-digit numbers are assigned to those charts of scale 1:2,000,000 and larger that cover portions of the coastline rather than significant portions of ocean basins. These charts are based on the regions of the nautical chart index. See Figure 448c.

The first of the five digits indicates the region; the second digit indicates the subregion; the last three digits indicate the geographical sequence of the chart within the subregion. Many numbers have been left unused so that any future charts may be placed in their proper geographical sequence.

In order to establish a logical numbering system within the geographical subregions (for the 1:2,000,000 and larger-scale charts), a worldwide skeleton framework of coastal charts was laid out at a scale 1:250,000. This series was used as basic coverage except in areas where a coordinated series at about this scale already existed (such as the coast of Norway where a coordinated series of 1:200,000 charts was available).

Within each region, the geographical subregions are numbered counterclockwise around the continents, and within each subregion the basic series also is numbered counterclockwise around the continents. The basic coverage is assigned generally every 20th digit, except that the first 40 numbers in each subregion are reserved for smaller-scale coverage. Charts with scales larger than the basic coverage are assigned one of the 19 numbers following the number assigned to the sheet within which it falls. Figure 448d shows the numbering sequence in Iceland. Note the sequence of numbers around the coast, the direction of numbering, and the numbering of larger scale charts within the limits of smaller scales.

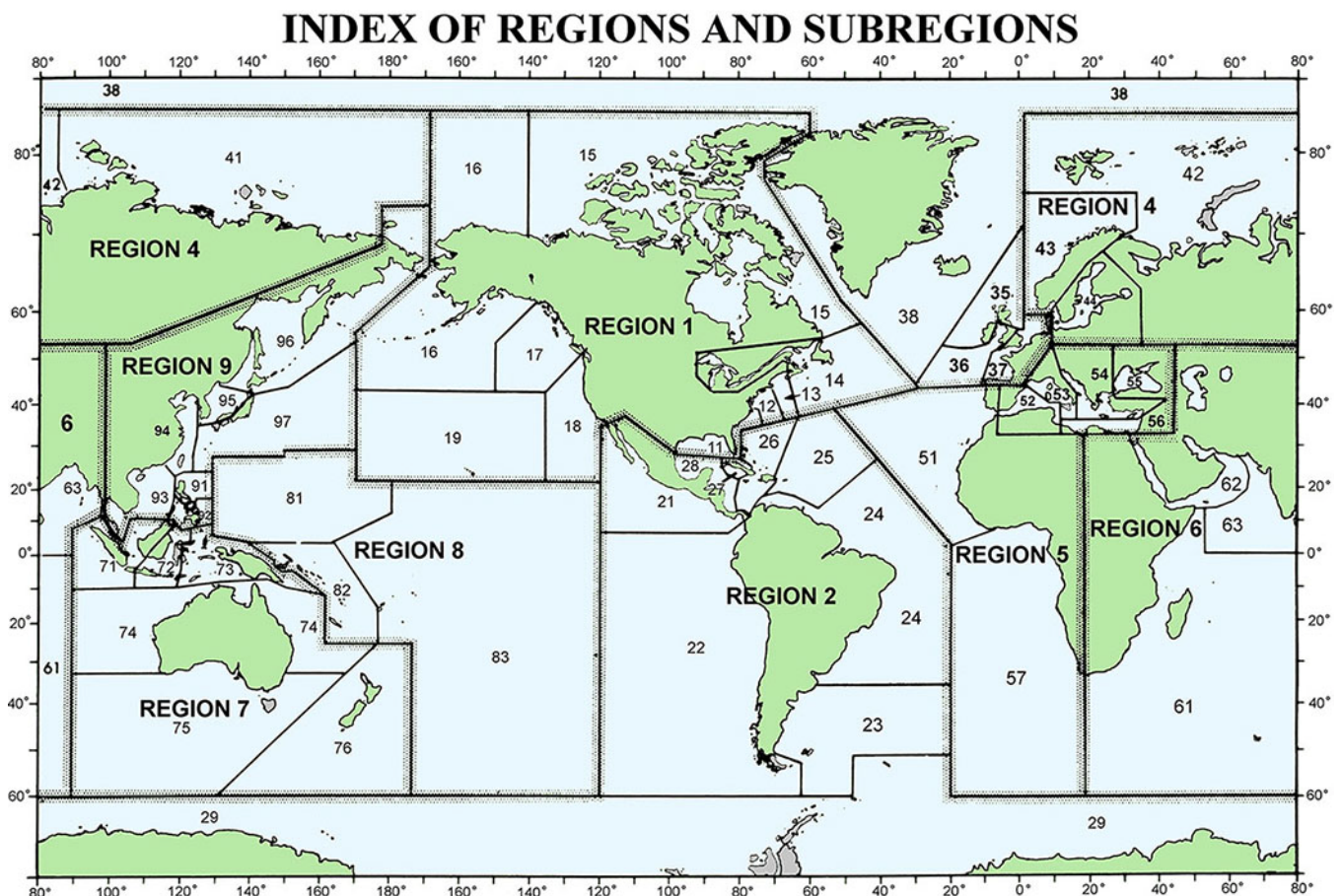


Figure 448c. Regions and subregions of the nautical chart index.

Certain exceptions to the standard numbering system have been made for charts intended for the military. Bottom contour charts depict parts of ocean basins. They are identified with a letter plus four digits according to a scheme best shown in the catalog, and are not available to civilian navigators. Combat charts have 6-digit numbers beginning

with an “8.” Neither is available to civilian navigators.

Five-digit numbers are also assigned to the charts produced by other hydrographic offices. This numbering system is applied to foreign charts so that they can be filed in logical sequence with the charts produced by the NGA and the NOS.

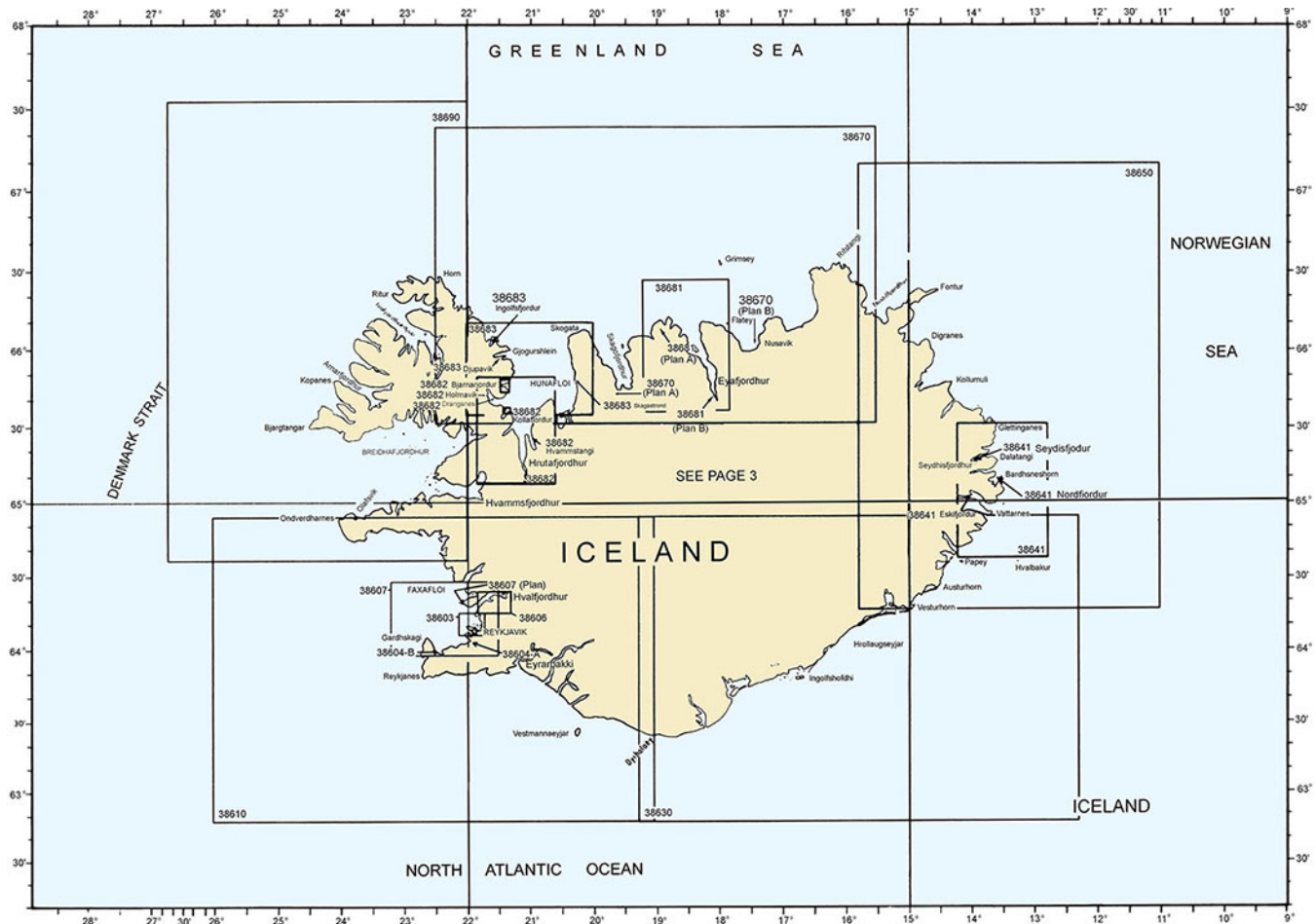


Figure 448d. Chart coverage of Iceland, illustrating the sequence and direction of the U.S. chart numbering system.

449. Catalogs and Stock Numbers

The *NGA/DLIS Catalog of Maps, Charts and Related Products* is available on CD only. It is reserved for military and government agencies, which possess access to limited distribution data. New versions of the catalog are released every six months with corrections published in the weekly *Notice to Mariners*. The standalone CD is interactive with a robust Table of Contents. The digital catalog has the ability to pan across the Pacific Ocean. Military navigators receive their nautical charts and publications automatically; civilian navigators purchase them from chart sales agents.

NOAA charts are available digitally through its *Nautical Products Catalog* or by selecting one of the five regional chart catalogs. There is also a print-at-home option for NOAA chart catalogs. By visiting the NOAA nautical



Figure 449. NOAA Nautical Chart Catalogs. <http://www.charts.noaa.gov/ChartCatalog/MapSelect.html>

charts and publications website, users can select their region of interest and download a PDF. The *Nautical Product Catalog* provides access to paper charts (RNC & PDF) as well as Electronic Charts (ENC). See Figure 449 for a link to the NOAA chart catalog.

The stock number and bar code are generally found in

the lower left corner of a NGA chart. The first two digits of the stock number refer to the region and subregion. These are followed by three letters, the first of which refers to the portfolio to which the chart belongs; the second two denote

the type of chart: CO for coastal, HA for harbor and approach, and OA for military operating area charts. The last five digits are the actual chart number.

USING CHARTS

450. Preliminary Steps

Before using a new edition of a chart, verify its announcement in the *Notice to Mariners* and correct it with all applicable corrections. Read all the chart's notes; there should be no question about the meanings of symbols or the units in which depths are given. Since the latitude and longitude scales differ considerably on various charts, carefully note those on the chart to be used.

Place additional information on the chart as required. Arcs of circles might be drawn around navigational lights to indicate the limit of visibility at the height of eye of an observer on the bridge. Notes regarding other information from the light lists, tide tables, tidal current tables, and sailing directions might prove helpful.

451. Maintaining Charts

A mariner navigating on an uncorrected chart is courting disaster. The chart's print date reflects the latest *Notice to Mariners* used to update the chart; responsibility for maintaining it after this date lies with the user. The weekly *Notice to Mariners* contains information needed for maintaining charts. Radio broadcasts give advance notice of urgent corrections. Local *Notice to Mariners* should be consulted for inshore areas. The navigator must develop a system to keep track of chart corrections and to ensure that the chart they are using is updated with the latest correction.

For vessels still using paper charts a convenient way of keeping this record is with a **Chart/Publication Correction Record Card** system. Using this system, navigators do not immediately update every chart in their portfolio when they receive the *Notice to Mariners*. Instead, they construct a card for every chart in their portfolio and notes the corrections on this card. When the time comes to use the chart, they pull the chart and the chart's card, and they makes the indicated corrections on the chart. This system ensures that every paper chart is properly corrected prior to use.

Electronic and printed chart correction card forms are available through the NGA Maritime Safety Information web portal under the miscellaneous products tab. See Figure 451 for the link.

With *Notice to Mariners* available on the internet, mariners have the ability to see all applicable corrections to a chart by a specified date range, all corrections and also for multiple charts at a time.

A Summary of Corrections, containing a cumulative listing of previously published *Notice to Mariners* corrections, is published annually in 5 volumes by NGA. Thus, to



Figure 451. Chart correction forms.

https://msi.nga.mil/NGAPortal/MSI.portal?_nfpb=true&_pageLabel=msi_portal_page_69&prodCode=03

fully correct a chart whose edition date is several years old, the navigator needs only the Summary of Corrections for that region and the notices from that Summary forward; the navigator does not need to obtain notices all the way back to the edition date. See Chapter 6, Nautical Publications, for a description of the Summaries and *Notice to Mariners*.

When a new edition of a chart is published, it is normally furnished automatically to U.S. Government vessels. It should not be used until it is announced as ready for use in the *Notice to Mariners*. Until that time, corrections in the *Notice* apply to the old edition and should not be applied to the new one. When it is announced, a new edition of a chart replaces an older one.

Commercial users and others who don't automatically receive new editions should obtain new editions from their sales agent. Occasionally, charts may be received or purchased several weeks in advance of their announcement in the *Notice to Mariners*. This is usually due to extensive re-scheming of a chart region and the need to announce groups of charts together to avoid lapses in coverage. The mariner bears the responsibility for ensuring that their charts are the current edition. The fact that a new edition has been compiled and published often indicates that there have been extensive changes that cannot be made by hand corrections.

452. Using and Stowing Charts

Use and stow charts carefully. This is especially true with digital charts contained on electronic media. Keep optical and magnetic media containing chart data out of the sun, inside dust covers, and away from magnetic influences. Placing a disk in an inhospitable environment may destroy the data.

Make permanent corrections to paper charts in ink so that they will not be inadvertently erased. Pencil in all other markings so that they can be easily erased without damaging the chart. Lay out and label tracks on charts of

frequently-traveled ports in ink. Draw lines and labels no larger than necessary. Do not obscure sounding data or other information when labeling a chart. When a voyage is completed, carefully erase the charts unless there has been a grounding or collision. In this case, preserve the charts without change because they will play a critical role in the investigation.

When not in use, stow charts flat in their proper portfolio. Minimize their folding and properly index them for easy retrieval.

453. Chart Lighting

Mariners often work in a red light environment because red light is least disturbing to night adapted vision.

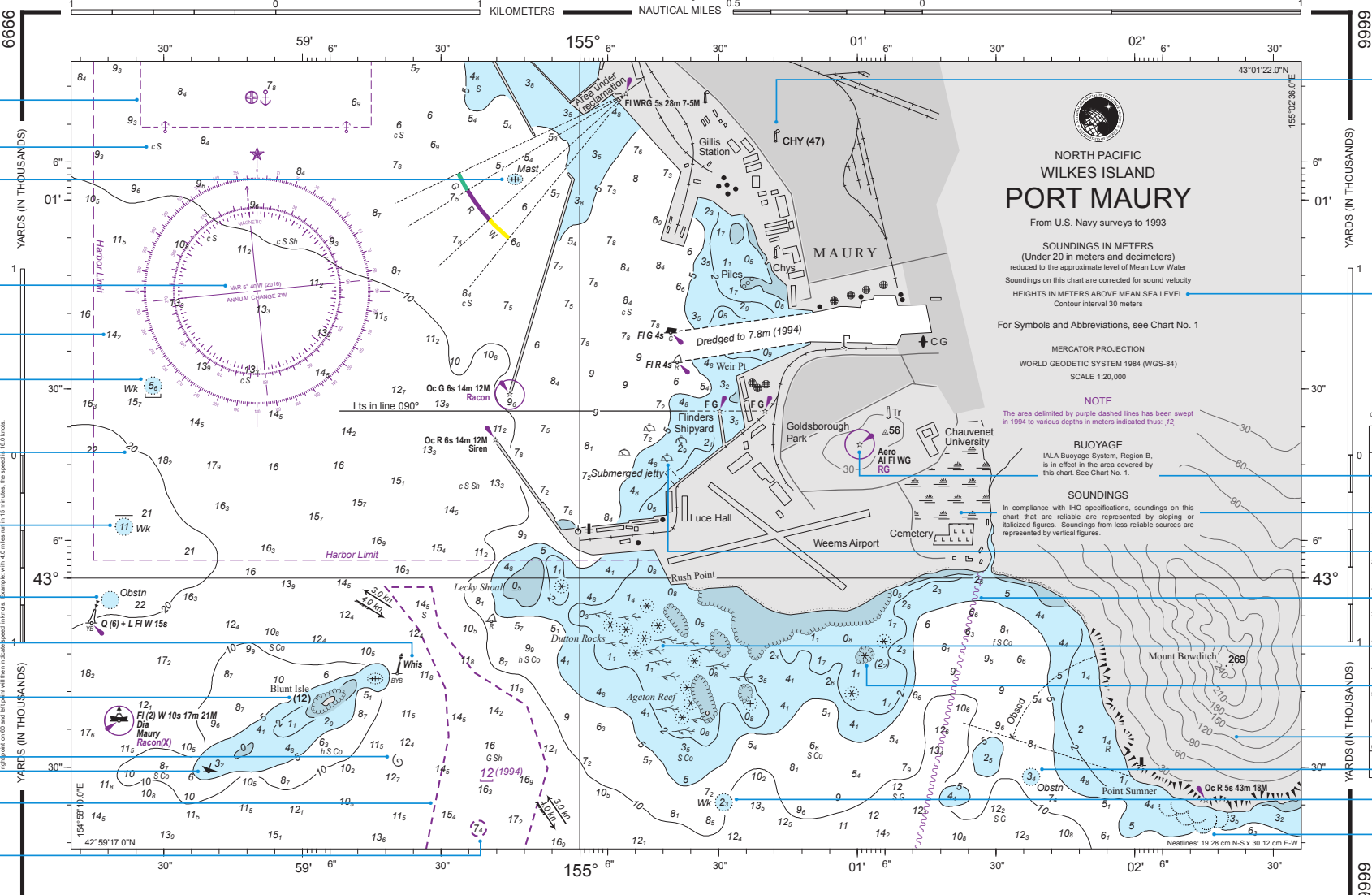
Such lighting can significantly affect the appearance of a chart. Before using a chart in red light, test the effect red light has on its markings. Do not outline or otherwise indicate navigational hazards in red pencil because red markings disappear under red light.

454. Port Maury Sample Chart

U.S. Chart No. 9999 - Port Maury (Wilkes Island, North Pacific) is produced by NGA and NOAA for training purposes. This fictitious sample of a nautical chart depicts a typical harbor area. The chart symbology is annotated to include references to U.S. Chart No. 1 and is meant to be a beginners guide and teaching reference to students of marine navigation.

SOUNDINGS IN METERS

1st Ed. Aug. 1971



- Limit of quarantine anchorage (N12.8)
- Sea bottom consists of coarse sand (J32, J1)
- Dangerous wreck with only mast visible (K25)
- Compass rose with magnetic variation (B70)
- Sounding in meters and decimeters (H10)
- Wreck over which depth is cleared by wire drag (K27)
- Depth curves in meters (I30)
- Unsurveyed wreck over which the exact depth is unknown but is considered to have a safe clearance to depth shown (K30)
- Obstruction over which depth is unknown (K40)
- Sound signal (R15)
- Height of island in meters above mean sea level (K10)
- Eddies (H45)
- Wreck showing portion of hull above sounding datum (K24)
- Swept area adequately sounded (swept by wire drag to depth indicated) (I24)
- High obstruction above swept depth (I24)

- Chimney, conspicuous (E22)
- Logarithmic Speed Scale usually shown here (1:40,000 and larger)
- Heights of land and conspicuous objects are given in meters above Mean Sea Level, unless otherwise stated in the title of the chart.
- Aeronautical light and radio direction finding station (P60)
- Marsh area (C33)
- Mooring buoy (Q40)
- Submarine cable (L30.1)
- Kelp (J13.2)
- Rock which covers and uncovers with height above chart sounding datum (K11)
- Topographic contours (C10)
- Obstruction over which depth is known (K41)
- Dangerous wreck over which depth is known (K26)
- Breakers (K17)

8th Ed., Sept. 3, 2016 (Correct through NM 3616)
9999

 NSN 7642019999999
 NSN 7642019999999

References to U.S. Chart No. 1 are shown in parentheses.

SOUNDINGS IN METERS

Prepared and published by the
 NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY
 © Copyright 2016 by the United States Government

WARNING
 The prudent mariner will not rely solely on any single aid to navigation, particularly on floating aids. See paragraph No. 1 of Notice to Mariners No. 1 or Sailing Directions Planning Guides for information relative to NGA charts.

Port Maury
 SOUNDINGS IN METERS - SCALE 1:20,000

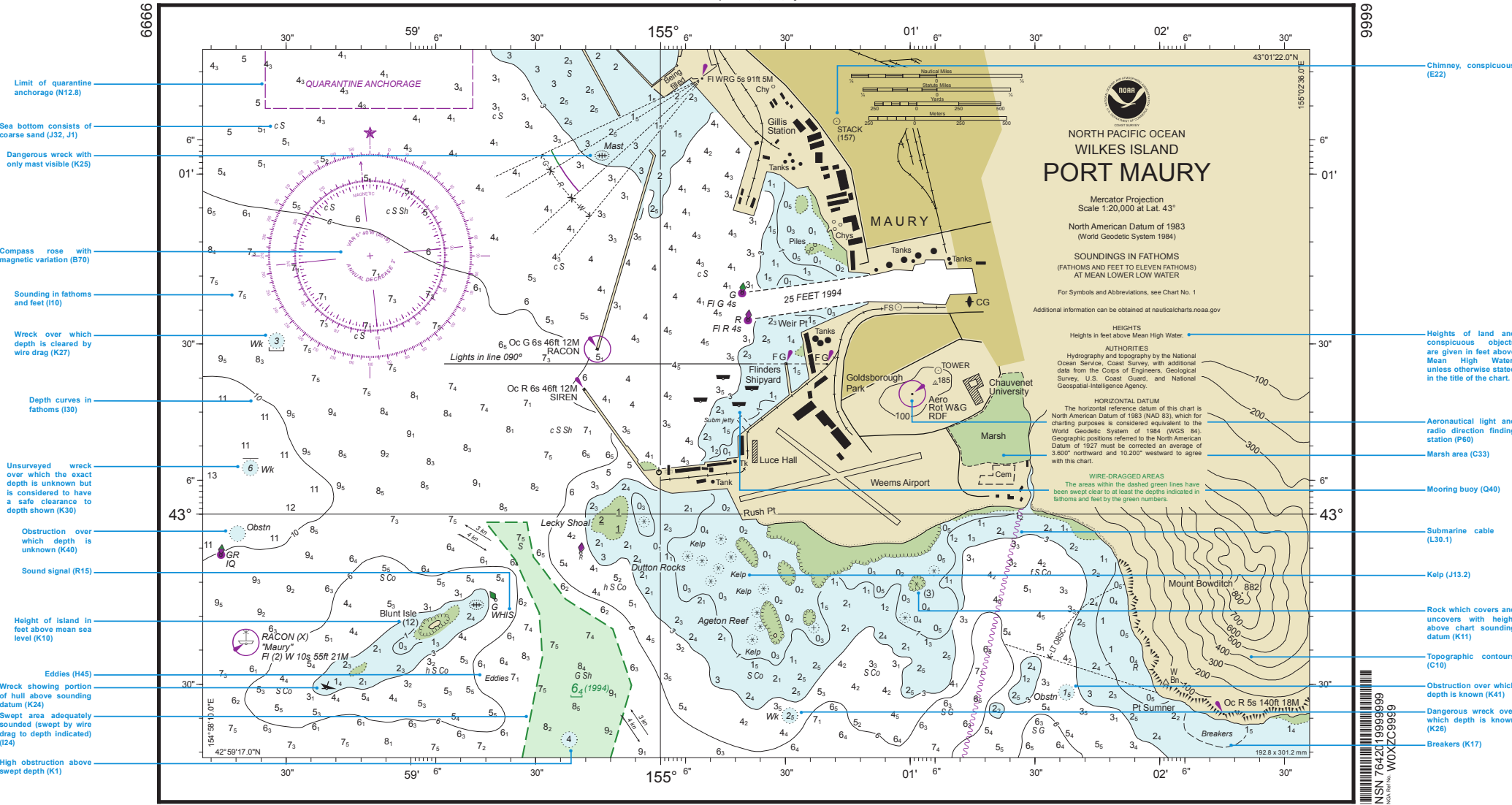
USERS SHOULD REFER CORRECTIONS, ADDITIONS, AND COMMENTS TO NOAA MARITIME OPERATIONS DESK. TOLL FREE 1-800-368-5858. COMMERCIAL: 202-366-5858. FAX: 202-366-5859. SEND EMAIL TO NAVSATC@NOAA.gov. USE CONTACT LINES FOR DNG AND MARITIME WEBSITES LOCATED AT www.navy.mil/dnng OR WRITE TO OFFICE OF MARITIME SAFETY, NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY, MAIL STOP N65, 7600 GEORGETOWN DRIVE, SPRINGFIELD VA 22150-7500.

NOAA encourages users to submit inquiries, discrepancies or comments about this chart at <http://www.nauticalcharts.noaa.gov/staff/contact.htm>.

SOUNDINGS IN FATHOMS

(FATHOMS & FEET TO 11 FATHOMS)

Formerly C&GS 4198, 1st Ed., Aug. 1971



- Limit of quarantine anchorage (N12.8)
- Sea bottom consists of coarse sand (J32, J1)
- Dangerous wreck with only mast visible (K25)
- Compass rose with magnetic variation (B70)
- Sounding in fathoms and feet (H10)
- Wreck over which depth is cleared by wire drag (K27)
- Depth curves in fathoms (I30)
- Unsurveyed wreck over which the exact depth is unknown but is considered to have a safe clearance to depth shown (K30)
- Obstruction over which depth is unknown (K40)
- Sound signal (R15)
- Height of island in feet above mean sea level (K10)
- Eddies (H45)
- Wreck showing portion of hull above sounding datum (K24)
- Swept area adequately sounded (swept by wire drag to depth indicated) (I24)
- High obstruction above swept depth (K1)

- Chimney, conspicuous (E22)
- Heights of land and conspicuous objects are given in feet above Mean High Water, unless otherwise stated in the title of the chart.
- Aeronautical light and radio direction finding station (P60)
- Marsh area (C33)
- Mooring buoy (Q40)
- Submarine cable (L30.1)
- Kelp (J13.2)
- Rock which covers and uncovers with height above chart sounding datum (K11)
- Topographic contours (C10)
- Obstruction over which depth is known (K41)
- Dangerous wreck over which depth is known (K26)
- Breakers (K17)

NORTH PACIFIC OCEAN
WILKES ISLAND
PORT MAURY

Mercator Projection
 Scale 1:20,000 at Lat. 43°

North American Datum of 1983
 (World Geodetic System 1984)

SOUNDINGS IN FATHOMS
 (FATHOMS AND FEET TO ELEVEN FATHOMS)
 AT MEAN LOWER LOW WATER

For Symbols and Abbreviations, see Chart No. 1
 Additional information can be obtained at nauticalcharts.noaa.gov

HEIGHTS
 Heights in feet above Mean High Water.

AUTHORITIES
 Hydrography and topography by the National Ocean Service, Coast Survey, with additional data from the Corps of Engineers, Geological Survey, U.S. Coast Guard, and National Geospatial-Intelligence Agency.

HORIZONTAL DATUM
 The horizontal reference datum of this chart is North American Datum of 1983 (NAD 83), which for charting purposes is considered equivalent to the World Geodetic System of 1984 (WGS 84). Geographic positions referred to the North American Datum of 1927 must be corrected an average of 3.800' northward and 10.200' westward to agree with this chart.

WIRE-DRAGGED AREAS
 The areas within the dashed green lines have been swept clear to at least the depths indicated in fathoms and feet by the green numbers.

8th Ed., Sep. 2016
9999

Last Correction: 9/3/2016. Cleared through:
 LNM: , NM: 3616 (9/3/2016)

References to U.S. Chart No. 1 are shown in parentheses.

CAUTION
 This chart has been corrected from the Notice to Mariners (NM) published weekly by the National Geospatial-Intelligence Agency and the Local Notice to Mariners (LNM) issued periodically by each U.S. Coast Guard district to the dates shown in the lower left hand corner. Chart updates corrected from Notice to Mariners published after the dates shown in the lower left hand corner are available at nauticalcharts.noaa.gov.

Published at Washington, D.C.
 U.S. DEPARTMENT OF COMMERCE
 NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMINISTRATION
 NATIONAL OCEAN SERVICE
 COAST SURVEY

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.

Port Maury
 SOUNDINGS IN FATHOMS - SCALE 1:20,000

9999

FATHOMS	FEET	METERS
1	6	1.1
2	12	2.1
3	18	3.1
4	24	4.1
5	30	5.1
6	36	6.1
7	42	7.1
8	48	8.1
9	54	9.1
10	60	10.1
11	66	11.1

