RADAR CHARTING

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The modern application of electronics has presented the mariner with valuable new aids in marine navigation. With shipboard radar equipment now being used to a considerable extent in modern navigation, radar has become one of the more important of the new aids. The value of this new aid depends largely upon the effectiveness with which information obtained from the radarscope can be associated with charts of the area. As buoys, beacons, or lighthouses can be identified on the chart at a glance so should the modern mariner be able to identify and use radar aids with equal facility.

Various approaches to radar charting have been considered in the Coast and Geodetic Survey and by other charting agencies of the United States. New charts could be designed, of course, but the most practical solution would be an adaptation of existing nautical charts modified for use in radar navigation. The adaptation of present charts, without in any way impairing their usefulness to the non-electronic navigator, eliminates the necessity of ships equipped with radar of carrying a second set of charts.

In adapting the nautical chart for use in navigating by radar an important consideration is that radar radiation approximates, at least in theory, a line of sight. Aside from the charting of radar aids, such as beacons, reflectors, or so-called radar conspicuous objects, the relief of land areas on the conventional chart must be treated cartographically in a manner that would best utilize topographic features for radar navigation. When the coastal features are within range of the radar equipment, an accurate delineation of the shoreline will in most cases be sufficient. This is particularly true in areas of rather steep shores where the shoreline will be well defined on the radarscope. Often-times a valley running at an angle to the beach will appear on the radarscope as a dark streak between two bright areas. This is due to the echo being returned only from the unobstructed portions of the ridges that are visible above the shoreline. Complete understanding of the relationship between the radarscope picture and the chart can be obtained only through experience.

The addition of contours emphazised by gradient tints and the charting of objects known to present images on the radarscope have been experimented with on charts of the Coast and Geodetic Survey. Along a low-lying coastline the addition of contours may be helpful to the navigator, but in many cases when making a landfall, a position from dead-reckoning or other aids will be necessary adjuncts to the accurate interpretation of the radarscope picture.

When the shoreline and contiguous bluffs are below the radar horizon, the navigator must make use of interior topography. The delineation of this topography presents the greatest problem to the cartographer. Consideration has been given to showing only prominent peaks or hills by hachures and to contouring

only the seaward faces of potential radar targets. This treatment has the advantage of keeping the chart cartographically simple and at the same time achieving economy in production.

Thus the principal factors considered in this problem have been the value of placing extensive contours and gradient tints on existing charts, the value of indicating horizon range on permanent radar targets, the most suitable scale or scales for use with all radarscopes, and the desirability of using separate radar charts or incorporating special features on conventional charts for use with radar. Another feature which has been considered as a possible target for radar is an abrupt tree-line along the coast. Future study of the problem may result in this feature being shown on charts in addition to contours or form lines.

The Coast and Geodetic Survey has published to date charts 238, 4110, 5020, 5021, 5022, 5110, 5111, 5112, 5113, 5114, 5115, 5116, 5117, 5118, and 6102, on which contours and gradient tints have been added. The contours are spaced at selected intervals usually at either 500- or 1000-foot spacings depending upon the scale of the chart. These charts are the conventional nautical charts with the special relief treatment added. On chart 6102, the shoreline and off-lying rocks, reefs, islands, and dangers are accentuated. The gradient tints used to emphasize land forms on the charts are shown in varying shades of brown and replace the conventional yellow land tint of the standard nautical charts.

After extensive experimentation a method was developed of printing the five gradient tint tones used to emphasize relief with only one printing plate. This procedure involves the use of screens in preparing the printing plate and was developed specifically to permit the reproduction of the gradient tinted charts without increasing the press runs.

The contours are compiled from large-scale topographic maps which have a closer contour interval than is necessary or desirable for a relatively small-scale chart. These contours as they appear on topographic maps are drawn primarily for topographic expression, but for the purpose of the radar chart the contour interval has been increased and the contours generalized in keeping with the scale of the chart. An illusion of relief often can be enhanced by a very slight shift in the position of the contours, particularly in charting shoulders and saddles. On the experimental charts produced by the Survey the relief stands out with clarity and the relative heights and masses of hills and mountains — the natural radar targets — can be determined quickly and easily.

The use of gradient tints to emphasize contours shown on nautical charts of the Survey is confined to coast charts of intermediate scale. Large-scale charts need no such treatment. The shore-line together with artificial and natural radar beacons and objects that are charted by conventional symbols have been found sufficient.

The U.S. Navy Hydrographic Office developed during the war and the period immediately following several types of radar charts. Reports are that most of these charts were found helpful but are not considered universally adequate since they do not lend themselves to use with all types of marine radar equipment. The Hydrographic Office has indicated that conclusions reached to date in the problem of radar charting are tentative and that future developments will depend upon comments received from actual users of radar in the United States Navy and Merchant Marine.

The Corps of Engineers, United States Army, produced a series of 124 radar navigation charts of the Ohio River from Aberdeen, Ohio, to Cairo, Illinois. The charts contain channel information as shown on the standard Ohio River navigation charts with an overprint of the radar images as they appear on the radarscope installed on river craft. The charts are printed on fluorescent paper and under daylight conditions radar images and all linework on the charts appear in white on a black background. When viewed at night under an ultraviolet (black) light the radar image and linework glow in light green, corresponding in color and intensity to the image appearing on the radarscope.

The U.S. Lake Survey has also given attention to the problem of radar charting. Conclusions arrived at by that agency indicate that an extra set of charts is not desirable and that no features should be added to the regular charts which would in any way impair their value as navigation instruments.

Field investigations were made for the purpose of producing an experimental radar chart. This work was carried on aboard a commercial vessel operating on a regularly scheduled round trip through the St. Marys River. The ship traveled the 60-mile route and return at a reduced speed of about six miles per hour. During the trip a camera was mounted on the radarscope and a group of photographs of the images appearing on the scope were taken at approximately one-half hour intervals in both the up and down bound channels. From each group of photographs the best picture was selected to make a mosaic of the entire river. Temporary objects, such as passing vessels, were deleted leaving a picture of those features that are observed in a radarscope at any given point. The mosaic thus produced was brought to the proper scale and fitted to the three charts published by the Lake Survey of the St. Marys River. The mosaic was overprinted in transparent fluorescent ink.

Navigators of radar-equipped vessels operating in the Great Lakes and connecting waterways that are equipped with radar may read the fluorescent overprint with a small ultraviolet ray lamp. The regular navigation chart is used under ordinary light with no impairment of features, and by switching on the special lamp a simulation of the radarscope image is obtained for any particular location.

These special experiments and resulting developments, together with reports received from chart users, seem to indicate that no special radar chart is needed. Experience in the Coast and Geodetic Survey has revealed that contours alone are not sufficient to portray relief for the mariner regardless of the interval used and the skill with which the lines are drawn. Moreover, the real value of interior topography in fixing a ship's position by radar has not been fully explored.

After intensive research, based on actual field conditions, provisions are being made to accentuate on nautical charts published by the Coast and Geodetic Survey those features found useful to radar navigation. The selected features include islets, offshore rocks, radar reflectors, and radar conspicuous objects, together with a prominent high-water line. Final solution of the problem will depend on the findings of navigators based on their experience gained in the actual use of radar under operating conditions as this new aid becomes more generally accepted.