RADAR DETECTION OF ICE

Radar can be an invaluable aid in the detection of ice if used wisely by the radar observer having knowledge of the characteristics of radar propagation and the capabilities of his radar set. The radar observer must have good appreciation of the fact that ice capable of causing damage to a ship may not be detected even when the observer is maintaining a continuous watch of the radarscope and is using operating controls expertly.

When navigating in the vicinity of ice during low visibility, a continuous watch of the radarscope is a necessity. For reasonably early warning of the presence of ice, range scale settings of about 6 or 12 miles are probably those most suitable. Such settings should provide ample time for evasive action after detection. Because any ice detected by radar may be lost subsequently in sea clutter, it may be advisable to maintain a geographical plot. The latter plot can aid in differentiating between ice aground or drifting and ship targets. If an ice contact is evaluated as an iceberg, it should be given a wide berth because of the probability of growlers in its vicinity. If ice contacts are evaluated as bergy bits or growlers, the radar observer should be alert for the presence of an iceberg. Because the smaller ice may have calved recently from an iceberg, the radar observer should maintain a particularly close watch to windward of the smaller ice.

ICEBERGS

While large icebergs may be detected initially at ranges of 15 to 20 miles in a calm sea, the strengths of echoes returned from icebergs are only about $^1/_{60}$ of the strengths of echoes which would be returned from a steel ship of equivalent size.

Because of the shape of the iceberg, the strengths of echoes returned may have wide variation with change in aspect. Also, because of shape and aspect, the iceberg may appear on the radarscope as separate echoes. Tabular icebergs, having flat tops and nearly vertical sides which may rise as much as 100 feet above the sea surface, are comparatively good radar targets.

Generally, icebergs will be detected at ranges not less than 3 miles because of irregularities in the sloping faces.

BERGY BITS

Bergy bits, extending at most about 15 feet above the sea surface, usually cannot be detected by radar at ranges greater than 3 miles. However, they may be detected at ranges as great as 6 miles. Because their echoes are generally weak and may be lost in sea clutter, bergy bits weighing several hundred or a few thousand tons can impose considerable hazard to a ship.

GROWLERS

Growlers, extending at most about 6 feet above the sea surface, are extremely poor radar targets. Being smooth and round because of wave action, as well as small, growlers are recognized as the most dangerous type of ice that can be encountered.

In a rough sea and with sea clutter extending beyond 1 mile, growlers large enough to cause damage to a ship may not be detected by radar. Even with expert use of receiver gain, pulse length, and anti-clutter controls, dangerous growlers in waves over 4 feet in height may not be detected.

In a calm sea growlers are not likely to be detected at a range exceeding 2 miles.

RADAR SETTINGS FOR RADARSCOPE PHOTOGRAPHY

Radar settings are an important factor in preparing good quality radarscope photography. A natural tendency is to adjust the radar image so that it presents a suitable visual display, but this, almost invariably, produces poor photographic results. Usually the resulting photograph is badly overexposed and lacking in detail. Another tendency is to try to record too much information on one photograph such that the clutter of background returns actually obscures the target images. In both cases, the basic problem is a combination of gain and intensity control. A basic rule of thumb is if imagery looks right to visual inspection, it will probably overexpose the recording film. As a rule of thumb, if the image intensity is adjusted so that weak returns are just visible, then a one sweep exposure should produce a reasonably good photograph.

The following list of effects associated with various radar settings can be used as an aid in avoiding improper settings for radarscope photography:

(1) Excessive brightness produces an overall milky or intensely bright appearance of the images. Individual returns will bloom excessively and appear unfocused. It becomes difficult to distinguish the division between land and water, and ground and cultural returns.

(2) Improper contrast results in a lack of balance in the grey tonal gradations on the scope, greatly degrading the interpretive quality.

(3) High gain results in "blooming" of all bright returns adversely affecting the image resolution. High gain also causes the formation of a "hot spot" at the sweep origin.

(4) Low gain results in a loss of weak to medium returns. The result will be poor interpretive quality where there are few bright targets illuminated due to absence of definitive target patterns on the scope.

(5) Excessively bright bearing cursors, heading flashes, and range markers result in wide cursors, flashes, and markers which may obscure significant images.

(6) Improper radarscope or camera focus will result in extremely fuzzy or blurred imagery.

Before transiting hazardous waters, the prudent navigator should develop a feasible plan for deriving maximum benefit from available navigational means. In developing his plan, the navigator should study the capabilities and limitations of each means according to the navigational situation. He should determine how one means, such as cross-bearing fixing, can best be supported by another means, such as fixing by radar-range measurements.

The navigator must be prepared for the unexpected, including the possibility that at some point during the transit it may be necessary to direct the movements of the vessel primarily by means of radar observations because of a sudden obscurity of charted features. Without adequate planning for the use of radar as the primary means for insuring the safety of the vessel, considerable difficulty and delay may be incurred before the navigator is able to obtain reliable fixes by means of radar following a sudden loss of visibility.

An intended track which may be ideal for visual observations may impose severe limitations on radar observations. In some cases a modification of this intended track can afford increased capability for reliable radar observations without unduly degrading the reliability of the visual observations or increasing the length of the transit by a significant amount. In that the navigator of a radar-equipped vessel always must be prepared to use radar as the primary means of navigating his vessel while in pilot waters, the navigator should effect a reasonable compromise between the requirements for visual and radar fixing while determining the intended track for the transit.

The value of radar for navigation in pilot waters is largely lost when it is not manned continuously by a competent observer. Without continuous manning the problems associated with reliable radarscope interpretation are too great, usually, for prompt and effective use of the radar as the primary means of insuring the safety of the vessel. The continuous manning of the radar is also required for obtaining the best radarscope presentation through proper adjustments of the operating controls as the navigational situation changes or as there is a need to make adjustments to identify specific features.

With radar being used to support visual fixing during a transit of hazardous waters, visual observations can be used as an aid in the identification of radar observations. Through comparing the radar plot with the visual plot, the navigator can evaluate the accuracies of the radar observations. With radar actually being used to support visual fixing, the transition to the use of radar as the primary means can be effected with lesser difficulty and with greater safety than would be the case if the radar were not continuously manned and used to support visual fixing.

While the navigational plan must be prepared in accordance with the manning level and individual skills as well as the navigational situation, characteristics of navigational aids or equipment, characteristics of radar propagation, etc., the navigator should recognize the navigational limitations imposed by lack of provision for continuous manning of the radar. A transit, which may be effected with a reasonable margin of safety if the radar is manned continuously by a competent observer, may impose too much risk if provision is not made for the continuous manning of the radar.

The provision for continuous manning of the radar by a designated and competent observer does not necessarily mean that other responsible navigational personnel should not observe the radarscope from time to time. In fact the observations by other navigational personnel are highly desirable. According to the navigational plan, the designated observer may be relieved by a more experienced and proficient observer in the event that radar must be used as the primary means of insuring the safety of the vessel at some point during the transit. In such event the observer who has been manning the radar should be able to brief his relief rapidly and reliably with respect to the radar situation. Assuming that the previous observer has made optimum range settings according to plan at various points on the track, the new observer should be able to make effective use of the radar almost immediately. If this more proficient observer has been making frequent observations of the radarscope, aided by comment of the observer continuously manning the radar, any briefing requirements on actually relieving the other observer should be minimal.

If radar is to be used effectively in hazardous waters, it is essential that provisions be made for the radar observer and other responsible navigational personnel to be able to inspect the chart in the immediate vicinity of the radar indicator. The practice of leaving a radar indicator installed in the wheelhouse to inspect the chart in the chartroom is highly unsatisfactory in situations requiring prompt and reliable radarscope interpretation. The radar observer must be able to make frequent inspections of the chart without undue delays between such inspections and subsequent radar observations. A continuous correlation of the chart and the PPI display is required for reliable radarscope interpretation.

If the navigational plot is maintained on a chart other than that used by the radar observer for radarscope interpretation, the observer's chart should include the basic planning data, such as the intended track, turning bearings, danger bearings, turning ranges, etc.

In planning for the effective use of radar, it is advisable to have a definite procedure and standardized terminology for making verbal reports of radar and visual observations. At points on the track where simultaneous visual and radar observations are to be made, the lack of an adequate reporting procedure will make the required coordination unduly difficult. Reports of radar observations can be simplified through the use of appropriate annotations on the chart and PPI. For example, a charted rock which is identified on the PPI can be designated as “A”; another radar-conspicuous object can be designated as “B,” etc. With the chart similarly annotated, the various objects can be reported in accordance with their letter designations.

SPECIAL TECHNIQUES

In that the navigator of a radar-equipped vessel always must be prepared to use radar as his primary means of navigation in pilot waters, during the planning for a transit of these waters it behooves him to study the navigational situation with respect to any special techniques which can be employed to enhance the use of radar. The effectiveness of such techniques usually is dependent upon adequate preparation for their use, including special constructions on the chart or the preparation of transparent chart overlays.

The correlation of the chart and the PPI display during a transit of confined waters frequently can be aided through the use of a transparent chart overlay on which properly scaled concentric circles are inscribed as a means of simulating the fixed range rings on the PPI. By placing the center of the concentric circles at appropriate positions on the chart, the navigator is able to determine by rapid inspection, and with close approximation, just where the pips of certain charted features should appear with respect to the fixed range rings on the PPI when the vessel is at those positions. This technique compensates for the difficulty imposed by viewing the PPI at one scale and the chart at another scale. Through study of the positions of various charted features with respect to the simulated fixed range rings on the transparency as the center of the simulated rings is moved along the intended track, certain possibilities for unique observations may be revealed.

Identifying Echoes

By placing the center of the properly scaled simulated range ring transparency over the observer’s most probable position on the chart, the identification of echoes is aided. The positions of the range rings relative to the more conspicuous objects aid in establishing the most probable position. With better positioning of the center of the simulated rings, more reliable identification is obtained.

Fixing

By placing the simulated range ring transparency over the chart so that the simulated rings have the same relationship to charted objects as the actual range rings have to the corresponding echoes, the observer’s position is found at the center of the simulated range rings.

Under some conditions, there may be not be enough suitable objects and corresponding echoes to correlate with the range rings to obtain the desired accuracy.

This method of fixing should be particularly useful aboard small craft with limited navigational personnel, equipment, and plotting facilities. This method should serve to overcome difficulties associated with unstabilized displays and lack of a variable range marker.