121. TRACKING AIRCRAFT OVER LAND WITH FIRE CONTROL RADARS. In the June 1945 issue of CIC Magazine (pages 5-9), under the title "Gunnery Radar Tracks Over Land", possible methods of utilizing fire control radars in tracking aircraft over land were outlined. As stated there:

"During recent months Jap aircraft have been taking more and more advantage of the limitations of our ship radars when we operate in restricted areas near land. Many suicide attacks have been made from directions where aircraft are afforded protection from easy detection by the mass of land echoes cluttering up the search radar scopes. This type of attack undoubtedly will be employed even more against future amphibious and shore bombardment operations, and it is imperative that ships take advantage of the utmost capabilities of all radar equipments in detecting and tracking aircraft over or near land, so that fighter planes and guns can be placed on target at the earliest possible moment.

"This is a problem for both search and fire control radars. Search radars have the advantage of 360 degree coverage in bearing as compared to the small sectors scanned by fire control radars; but, on the other hand, fire control radars generally provide much better discrimination. As a result, fire control radars should often be capable of detecting and tracking aircraft echoes in

limited sectors when the aircraft echoes are completely concealed in the land clutter on the search radar scopes. Special techniques may be required, but the critical nature of the problem justifies - even makes mandatory - the use of any possible method which will lead to earlier detection and tracking."

122. It is recommended that the article in CIC Magazine be read carefully and that the suggested techniques for tracking aircraft over land with fire control radars be thoroughly tested whenever an opportunity is presented. The degree of success attained will probably depend to some extent upon the type of shoreline or topographical features of the terrain against which the methods are employed. It is requested that information on successful techniques be forwarded to the Bureau where results can be analyzed and information promulgated to all fleet units concerned. It is suggested that information of this type be submitted with the monthly performance and operational reports on fire control radars. In order that accurate analyses may be made, the reports should include all available information on own ship's positions (or track), target track, contour maps of the land area, director elevation, radar results obtained and how obtained, and the problems involved in radar tracking.

123. In addition to the advantage of better discrimination, fire control radar antennas for main and secondary batteries are stabilized and can be elevated partially to eliminate land echoes, while still providing radar coverage over the scanned sector down to the surface of the land. For main battery radars of the Mark 8 and Mark 13 types, in particular, it is believed that much useful information can be obtained during periods when these equipments are normally idle or not being used for main battery fire control. With the decrease in availability of surface targets, it is highly desirable that the excellent discrimination and plan view presentations (B-scopes) of these equipments be employed in helping to meet the menace of suicide attacks. As an added step in this direction provisions are being made on some ships for the main battery radars to supply range and bearing information to the computer Mark 1.

124. The accompanying photographs of land echoes on the B-scope, precision sweep of radar Mark 8 Mod. 3 are included as illustrations of the capabilities of this type of equipment in tracking aircraft targets near or over land and in spotting projectile splashes near the beach. The text accompanying these photographs refers to the chart on page 48.

125. <u>RADAR EQUIPMENT MARK 32 MOD. 1</u>. Radar equipment Mark 32 Mod. 1 provides target identification in connection with fire control radars. As described in Bulletin 2-44, paragraphs 95-98, the equipment consists of the standard BN radar plus a special lobe switching antenna, attached to the antenna of the Mark 4 or Mark 12, and a special identification indicator installed in the director over the rangefinder.

126. Radar Mark 32 Mod. 1 range accuracy will be approximately the same as that of the associated radar Mark 4 or 12; bearing accuracy, with the beam of 40°, will be approximately 2°. The new equipment will thus provide ready identification in the gun director Mark 37 for targets being tracked by radars Mark 4 or 12.

127. Radars Mark 32 Mod. 1 are now being installed in gun directors Mark 37 with radar equipments Marks 4 and 12. As noted in the reference above it was also intended to install them in main battery directors in connection with radars Marks 3, 8 and 13. Present plans, however, call for their installation in heavy AA directors only, since identification features in main battery directors are not considered necessary.

101. Mark 8 Radar - Operation at High Speed Scan. Several ships have reported extremely limited use of high speed scan with the Mark 8 radar. This practice is probably a holdover from the early days of the equipment, when instructions against too liberal use were promulgated because of the short life of the scanning mechanism of the first eight antennas (approximately 200 hours at high speed). As a result of replacements, improvements, and experience, the average life of antennas is now known to be much greater (about 10 times the above figure). Consequently, high speed may be used as freely as desired.

102. Low Sensitivity in Mark 8 Radar Equipment. Considerable difficulty has been experienced in locating and correcting the cause of low sensitivity in Mark 8 radar equipment. The forthcoming change to the RADAR MAINTENANCE BULLETIN (Change No. 17) issued by the Bureau of Ships, will contain valuable information as to the procedure to be followed in correcting the cause of such inferior performance.

103. Radar Tactics and Advantageous Bearing. When ships are in column and presenting to the enemy target angles of about 090° (see Figure 7), accurate radar train on any particular one of them is impossible with radars comparable to the Mark 3 and Mark 4 types, unless the distance between the ships is so great that only a single ship occupies a half beam width. For the case illustrated the most probable direction of radar train will be in the free space, as indicated. Odd numbers of ships might lead to radar train on the middle ship, but differential reflections would probably cause the pips to fluctuate in such an irregular manner that even this would be highly improbable. When the ships are in column at target angles of about 000°, however, train indications on each ship will be independent of reflections from the other ships, provided that the distance between ships is 400 yards or greater. Consequently, any ship in the column of Figure 7b may be trained on accurately.

104. This effect suggests several practical possibilities in tactics. For example, if ships are maneuvered so as to present as small range differences as possible, the enemy is given little opportunity to establish accurate bearings or bearing rates. Similarly, planes attacking in groups in line of bearing make it difficult to get accurate radar bearing data. It might be noted that the advantage in use of radar obtained in the manner described is comparable to the well-known gunnery advantage derived from the maneuver of crossing the enemy's T. It is assumed, of course, that the enemy's radars are subject to

limitations similar to those of our own Mark 3 and Mark 4. The excellent target discriminating ability of the Mark 8 radar, however, makes it extremely unlikely that enemy ships can maneuver in any way to prevent accurate radar tracking. For further data on this equipment see USS ALABAMA's report, paragraph 99.

33. Time Lag in Firing Stop Mechanisms of 40mm Mounts. As a result of a recent accident on a battleship, the Bureau has issued Circular Letter No. G15-43 relative to altering the firing stop cams on 40mm twin and quad mounts. It has been found that after a 40mm mount is trained or elevated into a non-firing sector as determined by the firing stop cam, approximately 1/4 second may elapse before the firing stop mechanism becomes operative. When the mount is training or elevating at maximum rates, it is possible that a shot may be fired approximately 8° within the non-firing sector in deflection and 6 $1/2^{\circ}$ in elevation. The above-mentioned letter calls for the cutting of new firing stop cams where vital equipment will be endangered by the firing of projectiles 8° within the present non-firing sectors. Gun directors, lightly armored and non-armored mounts, the pilot house, and radar antennas are considered to be vital equipment, as well as any other equipment which the discretion of the commanding officer may indicate to be such. It should be noted especially that where maximum depression is increased before bulwarks are cut down (see paragraph 34) there is a danger that projectiles will be fired through the upper portion of the bulwark. The hazard attending this possibility can be reduced by taking special care that no ammunition is stowed at any position on the bulwark where there is a chance of its being struck by a projectile of one's own gun.

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