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Document Title: Operational Research in Bomber Command

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Date(s): Not Dated.

Document Type/Physical Description: Type-written manuscript, 622 pgs.

Fonds/Collection Name: Ronnie Shephard Fonds

Series: Operational Research and Strategic Bombing

File/Box Number: Box 2

Original Archival Reference: N/A

Item Description: This is a draft manuscript of a lengthy report compiled by the RAF Bomber Command Operational Research Section, probably some time in 1945. The report was authored by Dr. Basil Dickins, a rising star in the field of physics who served as Section head during the war. Using a thematic approach it explores in excellent detail the challenges inherent in strategic bombing, making it a valuable source for both historians of air power and those studying Europe in the Second World War.

Keywords: Bomber Command; Operational Research; Operations; Technique; Bombing; Navigation

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CHAPTER 12

INVESTIGATIONS INTO THE USE OF H2S AS AN AID TO BOMBING

The Principle of H2S

H2S was an airborne centimetric radar equipment which performed its main functions independently of any ground beacons. Developed from A.S.V. radar, its purpose was to present the operator with a map of the terrain over which the aircraft was flying in terms of characteristics such as coastlines, rivers, towns, hills and so on. These characteristics were distinguished by the relative strength of echoes returned from them by pulsed radio energy transmitted from the aircraft. The transmission was beamed in the vertical plane and scanned in the horizontal plane by means of a rotating reflector or scanner, so that in one complete rotation of the scanner (occupying one or two seconds) 670 or more pulses were emitted which 'illuminated' in turn successive sectors of the terrain below the aircraft. Echoes were received by the scanner during the periods between pulse transmission, and the source of these echoes could be identified and the positions determined from the relative strength of the echoes, the time delay of their arrival from the original pulse transmission, and the bearing of the scanner. To present this information logically to the operator, a 'plan position indicator' or P.P.I. was used in which a rotating radial time base swept in synchronism with the transmission from the scanner. The echoes were made to appear as a brightening of the trace on the cathode ray tube, so that as the scanner rotated a map was built up on the tube which corresponded in intensity to the characteristics of the terrain below. A variable range marker, which was incorporated into the picture and appeared as a bright ring, together with a transparent engraved bearing plate mounted in front of the cathode ray tube, allowed the operator to determine the range and bearing of the aircraft from any identified landmark, and a heading marker which appeared as a bright radial line in the picture enabled him to guide the aircraft towards a town and then carry out a blind bombing run. Briefly, these were the essentials of the H2S equipment, but numerous refinements were added in later versions to simplify its use or increase its accuracy. Mark IV, for example, broke away from the principles of range and bearing measurement used in earlier versions, although it still retained the P.P.I. type presentation described above.

Development of Operational Techniques

In the summer of 1942 the first aircraft to be fitted with H2S were allotted to No. 1418 Flight (which later became the Bombing Development Unit) for the initial service trials of the equipment. Air Staff requirements for H2S had specified that it should be possible to detect and home on to a built up area from a distance of 15 miles at 15,000 feet, and that the system should be accurate enough to ensure that when bombing with it, the bombs would fall in the area selected as the target. The directive for the trials was framed in the first place to discover the best bombing technique to be used and the accuracy that could be obtained with that technique, but although the value of H2S as an aid to navigation was not fully realised at that time the trials were also to investigate its possibilities in that direction. To assist in the execution and the analysis of the results, an O.R.S. representative was attached to No. 1418 Flight.

In the course of the service trials, several features of the equipment became clear. Owing to the difficulties of interpreting the P.P.I. picture it was not easy to use and required a training period of at least 20 hours - even then some operators failed to become proficient. It showed great promise, however, as a navigation aid, although its success as such was very much dependent on good dead reckoning work, again due to the limitations of the P.P.I. picture. Its use as a blind bombsight was disappointing. When the trials were completed, the O.R.S. representative was transferred to the Pathfinder Force to assist in the training of the first squadrons to be equipped, and the results of the trials were analysed by the O.R.S. at Headquarters, Bomber Command. Bomber Command O.R.S. Reports Nos. S.83 (1) and S.84 (2) discussed the bombing results and made a comparison with those obtained by the squadrons during training. It was shown that the accuracy achieved was the same in both trials and training, and that over a series of runs the average operator would be able to drop 50 per cent of his bombs within the mean radius of the main built up area of the town selected as the target.

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Furthermore, there was some evidence that this percentage would be constant and independent of the size (within reasonable limits) of the town attacked. The technique that had been adopted for bombing was known as the '30 second line method'. In this the aircraft was homed directly towards the target with the range marker ring set so that the release point should be reached 30 seconds after the target cut the ring, but the experience of H2S operators showed that in spite of the advantages of this technique, much of the difficulty of making an accurate bombing run was due to the fading and distortion of the target response, which took place on the P.P.I. at close range. A great deal of the T.R.E. development of the equipment was therefore devoted to improving the scanner and presentation which would preserve the definition in the centre of the P.P.I. So far as operational equipment was concerned, this work might be said to have culminated in the Mark III* - the main version of the three centimetre H2S which was in general use in Pathfinder Force by the summer of 1944. Both Pathfinder Force training results and the subsequent Bombing Development Unit trials of Mark IIIA showed that although considerable skill was still required to interpret the close range picture, it was possible under good conditions to follow the target response right in to the release point and so avoid the use of a 30 seconds timed run. The bombing results for the Mark IIIA quoted in Bombing Development Unit Report No. 30 Part 2,(1) showed that over a series of runs an operator would be able to drop 50 per cent of his bombs within two-thirds of the mean radius of the built up area.

H2S Mark IIIA, however, was never available in sufficient quantity before the end of the war, for it to be fitted into the whole of the Main Force, and even the Pathfinder Force were not able to make the best use of it until a year after it was first put into operational use. During this intervening period much effort was applied by the O.R.S. to the problem of increasing the accuracy and widening the application of the equipment by improved bombing techniques rather than by technical developments. The basis of most of the techniques proposed was that while a response at close range was distorted, broken up or generally difficult to interpret, the same response was usually

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clear and well defined at about ten miles range, so that if bombing could be carried out with reference to some feature of this range there was every hope that it would at least be easier if not more accurate than with the direct method. Besides providing an alternative of the direct method for bombing towns, these techniques allowed H2S to be used for bombing targets in which the responses from the aiming point were indistinguishable from that of the surrounding area, i.e. in cases where the aiming point was in the centre of a very large town such as Berlin, or in open country, or, as in high level mining, at some point in an area of water. From their nature these techniques became known as reference point methods.

As a sequel to their initial trials of H2S, the Bombing Development Unit experimented with the use of the Ground Position Indicator (G.P.I.) with H2S, and developed a system of bombing with the two which constituted the first reference point method to be tried in practice. The method then adopted was to home the aircraft by H2S to a given range and bearing from some suitable reference point, and with the graticule set up to the corresponding position on the chart, to start the G.P.I. when that position was reached. From then on the aircraft was guided to the release point by the G.P.I. alone. The results of the trials of this method were discussed in Bombing Development Unit Reports No. 7, Parts 13 and 17,(1) in which it was shown that it would be suitable for attacking large defended targets but that against a small town the accuracy achieved would be less than that obtained by direct bombing. The method had various limitations and weaknesses, and several modifications were subsequently proposed to get over these difficulties. The first of these (described in Bomber Command O.R.S. Memo No. M.22)(2) was designed for immediate use by the Pathfinder Force and used the Air Position Indicator (A.P.I.) in place of the G.P.I., since at that time no G.P.I.s were to be ready for several months. In principle, it was similar to the original method and suffered from all its weaknesses, but as far as is known it was never given a full practical trial, and its only justification disappeared when the G.P.I. became available to the Pathfinder Force.

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(2) The use of H2S and API for Blind Bombing

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A second modification, proposed and used operationally with considerable success by the Pathfinder Force, used the G.P.I. as in the original method but aimed at greater accuracy on the principle that the aircraft's position could be determined more accurately for synchronising the G.P.I. by taking a fix than by homing to a given range and bearing. With this method the graticule was set up on the reference point and the G.P.I. started at the moment that the H2S fix was taken (i.e. a measurement of the range and bearing of the aircraft from that reference point). The aircraft was then guided to the release point by the G.P.I., the aiming point on the G.P.I. chart having been displaced in the meantime from its true position by the range and reciprocal bearing of the fix.

Up till the end of the war only enough G.P.I.s had been manufactured to equip the Pathfinder Force, and so a third method was adopted by the squadrons engaged in high level minelaying. This required no G.P.I., and consisted simply in homing to a given range and bearing from the reference point, the range and bearing being calculated to give the position of the release point for the specified conditions of bombing. Without the G.P.I. it lacked the tactical freedom of the other methods, but this was not vital for mining and there was some compensation in the fact that it could be slightly more accurate than the original method by avoiding the errors of the G.P.I. There was, however, one other weakness of the method; the bearing plate could not be used simultaneously to show both the bearing from the reference point and the track of the aircraft. Many suggestions were put forward to overcome this difficulty, and a contribution to these was made in Bomber Command O.R.S. Report No. S.157.[1] One proposal made in this report was that the range and bearing should be set up on the P.P.I. by adjustment of the horizontal and vertical shift controls so that the reference point would finally lie under the centre of the bearing plate. This was very similar to the arrangements for reference point bombing made in the design of Mark IV H2S.

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After the Command had gained some general experience in the use of reference point methods, it was decided that the Bombing Development Unit should carry out trials to compare the accuracy that could be achieved with these and direct methods for both Mark II and Mark IIIA (the two equipments then in operational use). The results of the trials which took place in the summer of 1944, were discussed in the Bombing Development Unit Report No. 56, Part 1.(1) In general, it was found that with each method of bombing, errors with Mark IIIA were about two-thirds those with Mark II, and that except when attacking a very small town, bombing with H2S and the G.P.I. was as accurate and sometimes more accurate than direct bombing, both methods giving appreciably better results than homing to a range and bearing.

The essence of all reference point methods was the determination of the range and bearing of a response, and a large proportion of the Bombing Development Unit trial was therefore devoted to an investigation of the fixing accuracy of H2S. During this investigation many abnormal errors were observed which were mainly associated with bearing rather than with range measurements, and since similar effects had been found by the Pathfinder Force in the course of a parallel investigation, the O.R.S. decided to make a special study of the problem. The results of the analysis of both the Bombing Development Unit and the Pathfinder Force flights together with evidence from ground tests and operational photographs of the P.P.I. were discussed in Bomber Command O.R.S. Report No. S.194.(2) In view of large bearing errors found, which were attributed mainly to the design and maintenance of the equipment, the report recommended that T.R.E. should consider incorporating a bearing marker which would be in future Marks similar to the heading marker and could be controlled by the operator, and that in the meantime maintenance personnel should give greater attention to accurate setting up of the equipment.

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Late in 1944 a new bombing technique was proposed for H2S. This made use of Gee-H, and since by that time both equipments were in common use and there was some urgency to have the scheme working operationally, the Service trials were carried out by No. 514 Squadron during their training. A description of the technique is given in Bomber Command O.R.S. Report No.S.204,(1) which served also as an instruction for training. The technique was designed to provide a means of bombing in those areas of the beacon coverage where the ordinary Gee-H was impracticable either because the lattice angle of cut was very small or because the range was very great and only one beacon was likely to be received. To cater for this need it was proposed that the aircraft should carry out a normal Gee-H run using the warning point method, tracking by means of the available beacon, but determining the moment of reaching the warning point by H2S instead of by a 'release' beacon. From the H2S point of view the technique was effectively another reference point method but with the major difficulty of tracking the aircraft accurately removed. To avoid the errors of bearing measurements, the H2S was to be used only to determine the moment when the aircraft was at a given range from the reference point, which for the greatest accuracy was chosen ahead or astern rather than on the beam of the aircraft. Bomber Command O.R.S. Report No. S.213(2) discussed the results achieved with the technique using H2S Mark IIIA and Gee-H Mark I, and showed that in practice bombing 50 per cent of the bombs dropped within about one quarter mile of the aiming point. This accuracy was not far short of that achieved by Gee-H alone.

To conclude this account of the Service trials, one other bombing technique might be mentioned, although it was only tried out over this country just before the end of the war. During the Service trials of H2S Mark VI which were carried out by two squadrons of the Command, it was found that very good grouping was obtained on each detail in practice bombing, but that large systematic errors along track were occurring which were believed to be due to errors of the range marker calibration. To get over this difficulty the O.R.S proposed a 'House' system of bombing, in which the time taken for a response to

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travel the diameter of the range marker ring was used to compute the delay required between the moment the target cut the ring and the release of bombs. The results of bombing runs carried out with this method showed that the systematic errors had been successfully eliminated.

Training

Following the success of the training scheme for Gee in operational squadrons, which was issued in June 1942, similar instructions were prepared with the introduction into the Service of both H2S and Gee-H. Each of these instructions described a series of exercises which were to be carried out, giving details of the methods to be used in their planning and execution, with particular attention to the methods of assessing and recording the results, and to any special observations required for analysis purposes. The object of this was twofold; by specifying all the relevant conditions of the exercises in this way the squadron instructor was able more readily to assess the individual in relation to other pupils on a basis of the results he achieved, and secondly the O.R.S. was able to collect a large mass of homogeneous data in the form most convenient for analysis.

Bomber Command O.R.S. Report No. S.101,(1) giving instructions for H2S training, was drawn up on these lines with the assistance of the Bombing Development Unit Training Flight, which had been responsible for the training of squadron instructors since the end of 1942. When a large sample of results had been returned to the O.R.S. they were analysed and Bomber Command O.R.S. Report No. S.130(2) was written discussing the conclusions drawn from the work. Also analysed in this report were some of the results obtained by squadron instructors under training at Bombing Development Unit. It was found that although earlier Bombing Development Unit training results had fallen rather short of the accuracy obtained on trials, the introduction of the waveguide scanner in Mark II had improved the results for the period under consideration (winter 1943/44) and that the accuracy in both Bombing Development Unit training and Main force training was such that about 50 per cent of the bombs could be expected to fall within the mean radius of the

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main built up area - in other words the same standard that had been achieved in trials and Pathfinder Force training with the original equipment (see Bomber Command O.R.S. Report Nos. S.83 and S.84). Two other facts were confirmed from these reports. Apart from variations caused by particular towns there was general relation between the 50 per cent error of bombing and the size of the town attacked - in fact they were approximately equal for a wide range of targets. Secondly, there was evidence that the drift of the aircraft was being ignored in making a bombing run, and it was therefore recommended that a track marker should be incorporated into the P.P.I. in addition to the heading marker as soon as production permitted, and that as an interim measure squadron instructors should place greater emphasis on making correct allowance for drift.

Other instructions prepared for H2S training can be summarised as follows; A revised version of Bomber Command O.R.S. Report S.101 was issued in the summer of 1944 as Bomber Command O.R.S. Report No. S.166.(1) This incorporated such modifications as were necessary in view of new methods originating with Headquarters No. 5 Group, and issued by that Group, dealing with exercises to be carried out with Mark IIIA using various bombing techniques. Another scheme was prepared in conjunction with No. 4 Group, for high level mining exercises.(2) This was issued as Bomber Command O.R.S. Report No. B.228, but unfortunately it was not carried through owing to the unavoidable limitation on training hours in force at that time. The instructions for training in the H2S/Gee-H technique and the analysis of the results obtained in Bomber Command O.R.S. Report Nos. S.204 and S.213 have already been mentioned in connection with service trials.

The O.R.S. was particularly interested in another aspect of H2S training - the training of blind marker crews of the Pathfinder Force. Owing to the specialised duties of these crews the Pathfinder Force adopted exacting tests during 1944 by which they could be graded for ability. One test was to carry out a series of simulation bombing runs on a variety of towns in the U.K. Partly for the information of the Pathfinder Force and partly for record purposes, the O.R.S. analysed a sample of the results obtained on these bombing runs,

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(1) A.H.B./II/69/215(C).

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and found that for crews graded best using Mark III, 50 per cent of bombs would have fallen within half the mean radius of the main built up area. Thus the accuracy obtained was just twice as good as the Pathfinder Force's original training results, and although part of the improvement was to be attributed to the equipment, crew selection was clearly effective. A discussion of this analysis was given in Bomber Command O.R.S. Memo No. M.24.(1) In the summer of 1944 No. 5 Group, which at that time was also employing Pathfinder methods operationally, decided to adopt similar selection methods for their crews. A scheme was accordingly prepared by the O.R.S. in conjunction with Headquarters No. 5 Group on the basis of the experience of the Pathfinder Force. For reference, the details of this scheme have been published as Bomber Command O.R.S. Memo No. M.20.(2) Broadly speaking it involved analysis of both the training and operational results of a crew in navigation and bombing - an analysis which was to be carried out within the group.

Operations

The work done by the O.R.S. on the tactical use of H2S on bombing operations is described in Chapter 3. In this chapter we are concerned only with the study of the operational accuracy of the equipment as such. Naturally these two aspects have been closely related, and in describing the background in which the work had been done it is necessary to refer occasionally to the tactical side of the problem.

In January 1943 - a month before H2S was first used operationally - the O.R.S. prepared a note which outlined the various ways in which H2S might be used in bombing operations. Taking into account the accuracy of bombing achieved in trials and training and the effectiveness of past operations, it was concluded that the original policy of fitting H2S to all aircraft in the Main Force would lead to a considerably greater effectiveness of bombing than would be achieved by confining the equipment to the Pathfinder Force. However, the production of the equipment was so limited that for a time there were only sufficient sets to equip some 25 aircraft in the Pathfinder Force - clearly it was better to fit these aircraft first than not use the equipment

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at all until all aircraft could be fitted, and there is no doubt that whatever its shortcomings the use of H2S by the Pathfinder Force in those early days enabled attacks to be attempted which otherwise would not have been considered possible. It was not until October 1943 that more than 50 aircraft of the Main Force were equipped. The O.R.S. then proposed that as many of these trained crews as possible should be allowed to blind-bomb on selected attacks, and that their results (as assessed from night photographs) should be compared with those obtained on the same attacks by aircraft not fitted with H2S. The object of this experiment was to determine whether the policy then adopted to reserving the use of H2S to blind marking by the Pathfinder Force was entirely justified, or whether the argument for its use by the Main Force put forward at the beginning of the year was in fact sound. The proposals were agreed and the experiment tried, but it was found that the results were not conclusive. This was mainly because very few of the aircraft returned plottable photographs, and of those that did do so it was by no means certain from their reports that bombing had been carried out by H2S alone and that they had not been influenced by the Pathfinder Force marking.

In April 1944 the matter was again raised. It was by then generally agreed that the limitations of Mark II H2S were such that the Pathfinder Force were unable to achieve an appreciably greater bombing accuracy with that equipment than the Main Force. In view of the success of an all H2S attack carried out by the Pathfinder Force against Ludwigshafen in November of the previous year (see Bomber Command O.R.S. Report No. S.112)[1], it was decided to arrange a similar experiment for Main Force blind bombing at the earliest opportunity. After discussion with the Air Staff at Headquarters, the O.R.S. prepared a plan for the experiment, but owing to the tactical commitments of the Command it was not possible to carry it out until August when it was laid on for the night 12/13th with Brunswick as the target. A discussion of this attack was given in Bomber Command O.R.S. Memo No. M.23.[2] In general, the experiment was a failure - a failure as an experiment rather than a failure

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~~never experiment other than failure~~ as an idea - mainly through lack of experience of the crews, the majority of whom had been engaged exclusively on short range daylight attacks during the previous months and had therefore had little opportunity to practise with the equipment. Although it was agreed that the experiment should be repeated, no further opportunity arose before the end of the war.

During the first two years of its life, then, H2S was only extensively used as a blind bombing or marking device by the Pathfinder Force. The accuracy of this marking was a subject ~~for~~ to study by the O.R.S. for the whole of that time, and four main reports were written - at about six months intervals. The first of these (Bomber Command O.R.S. Report No.S.111)(1) covered the period from the first H2S operations in February 1943 to September 1943. It showed that the accuracy achieved was similar to that obtained in training in that over a series of attacks about 50 per cent of the markers were estimated to have fallen within the mean radius of the main built-up area of the target. The targets attacked, however, were somewhat larger than those used in training, so that the actual errors were greater. It also showed that as in training, operators were not making allowance for drift, thus confirming the need for a track marker on the P.P.I. One other important conclusion was that it was clear from the results and reports from operators that the targets attacked varied considerably as regards their suitability for H2S blind marking in that the quality of the response received was very much dependent on such things as the concentration of the built-up area and the topographical features surrounding the town. The apparent importance of this factor in the success of blind marking led the O.R.S. to take a particular interest in the nature of responses. The work on this subject is discussed below under 'Target Intelligence'.

The second report in the series (Bomber Command O.R.S. Report No. S.189)(2) covered the period October 1943 to April 1944, during which time Mark III H2S had been introduced into the Pathfinder Force. It was found that over this period the accuracy obtained with Mark II was similar to that of the previous

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period when measured in terms of error alone, but that owing to the smaller size of the targets attacked it represented a fall in the percentage of markers on the built up area (34 per cent instead of about 50 per cent). No satisfactory explanation for this effect was found except perhaps the adverse conditions of winter operations. So far as Mark III was concerned, the accuracy was the same as for Mark II except for attacks on Berlin where there was some slight evidence that Mark III had achieved more than Mark II, possibly due to the use of reference point methods on that very difficult target. In general, the performance of Mark III was disappointing and contrary to expectations, although this was no doubt due partly to inadequate training and lack of experience among maintenance personnel. This fact was confirmed in the subsequent period from May 1944 to September 1944 (Bomber Command O.R.S. Report No. S.200)(1) when it was found that Mark III had settled down to a very much improved standard of accuracy, while Mark II had returned to its original standard.

H2S Minelaying

So far this chapter has only been concerned with the operational use of H2S as a blind bombing and marking device, but one other application of the equipment should be mentioned - namely high level minelaying. High level minelaying first became possible with the introduction of the parachute mine, and the possibilities of using H2S to make it a blind technique were soon realised. A reference point method of bombing was developed for H2S in which the position at which the mine had to be released under the specified conditions of height, heading etc., was calculated before take-off and given to the operator as a range and bearing from a convenient reference point. Subject to the slight modification adopted from time to time by the individual groups engaged on these mining sorties, this technique remained substantially the same from the time of its introduction. To assess the accuracy that had been achieved with this method of minelaying, use had to be made of the evidence of photographs taken of the P.P.I. with mine release, since no direct measurement of the position of the mine or aircraft could be obtained. Bomber Command O.R.S. Report No. S.179(2) discussed the analysis of a sample

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(1) A.H.B./II/69/215(D).

(2) A.H.B./IIH/241/10/91.

of these photographs and showed that subject to the errors inherent in the evidence, 50 per cent of the mines could have been expected to have fallen within one and a half miles of the aiming point - a standard comparable with that obtained on trials of the reference point method of bombing with H2S (see B.D.U. Report No. 56, Part 1).(1)

Target Intelligence

In the early days of H2S, little was known about the relation between the pattern of responses on the P.P.I. and the features on the ground which caused them, apart from the fact that open country gave a stronger response than areas of water and a weaker response than towns, but it was soon clear that the successful application of H2S to both bombing and navigation was dependent on a more detailed knowledge of this relation. At first there was little that could be done in the way of a systematic investigation over enemy territory owing to security limitations, and the only data available was that obtained from operational reports. For example, reports showed that whereas mountainous country like the Alps gave recognisable hill shadows which could be of help to navigation, the same shadowing effect from the hills around Stuttgart made the response from the town particularly difficult to identify on a bombing run. Other examples of this indirect approach to the problem were the deductions drawn in Bomber Command O.R.S. Report Nos. B.124(2) and B.129,(3) which were written after the unsuccessful attacks on Wilhelmshaven on 19/20 February 1943, and Hamburg on 3/4 March 1943, respectively. In the case of Wilhelmshaven it was found that a new and extensive housing area to the north had been mistaken for the town itself because the run it to the target was from the north and no maps marked the new built-up area. On the Hamburg attack the failure of the H2S marking was also attributed to misidentification. Operators had been briefed to use the neck in the river as a guide to finding the target, but owing to the low state of the tide and distortion on the P.P.I. the river appeared to be narrower than was actually the case, and a town some 10 miles downstream was mistaken for Hamburg. This property of H2S of distorting water boundaries was later investigated in trials (see B.D.U. Report No. 56, Part 2).(4)

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Since this information on response generally and of enemy responses in particular depended primarily on the slow accumulation of operators' reports, a quicker and more reliable method was required if the mistakes of Wilhelmshaven and Hamburg were to be avoided. One obvious solution which the O.R.S. strongly recommended was to lift the security ban, fit a few H2S aircraft with cameras photographing the P.P.I. and detail them for reconnaissance flights over enemy territory. The shortage of H2S aircraft at the time prevented it from being adopted in Bomber Command, but towards the end of 1943 the security ban was lifted and a number of Pathfinder Force aircraft were fitted with miniature cameras with the object of taking photographs on operational sorties. The U.S. Eighth Air Force also carried out this scheme with great success when they were faced with the same problem with their H2X equipment.

At this stage P.P.I. photography began to assume importance in another role. This was to provide a plot of the position of the aircraft at any time, independent of weather conditions. If synchronized with bomb release, a P.P.I. photograph was clearly a valuable supplement to the night photograph as an immediate assessment of the success of a raid, and it was therefore decided to fit cameras to as many H2S aircraft as possible throughout the Command. For the guidance of the personnel who were to be responsible for plotting them, the O.R.S. prepared a note (Bomber Command O.R.S. Report No. S.121) (1) outlining the basic principles of H2S in their relation to P.P.I. photographs. An account of some of the difficulties to be encountered and the errors involved in plotting is given in Bomber Command O.R.S. Report No. S.179.(2) This report was actually written in connection with H2S mine-laying, but so far as the P.P.I. photography was concerned the problems of plotting were much the same as in bombing operations. It showed that the position of the aircraft could not be determined very accurately in this way, and that since there was no automatic synchronisation with bomb or mine release the plot was much less reliable than the ordinary night photograph. The O.R.S. recommended that automatic synchronisation should be made a requirement for P.P.I. cameras, but owing to difficulties of production this feature was not available before the end of the war.

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(2) A.H.B./IIH/241/10/91.

As a result of this extensive fitting of P.P.I. cameras throughout the Command, many useful photographs were obtained, so that towards the end of the war records of the responses received had been collected for a large number of German towns. One group of photographs was a series taken over Berlin during the winter attacks of 1943/44, and to assist in planning and briefing for subsequent operations on this target these were assembled, together with maps and notes on their interpretation and issued by the O.R.S. as a 'target intelligence folder'. The O.R.S. later produced a similar folder of photographs made over this country, for the information of operators under training. The value of such folders having been demonstrated, the work was handed over to the Air Staff at Headquarters to continue.

This type of operational photography, however, was not a satisfactory basis for a general investigation into the relation between the responses received and the features causing them since H2S operators were not concerned as much with photography as with the job of making a successful bombing run. Because of this natural pre-occupation, the standard of photography was seldom high and the conditions such as gain setting, position of the aircraft and so on, could not be controlled to suit the investigator. For this reason it was decided to initiate trials over this country to obtain the required information, and since Berlin was then the principal target of the Command, London was chosen as the most suitable area for investigation. The flying and photography was carried out by the Bombing Development Unit, and the results were examined by the O.R.S. Bomber Command O.R.S. Report No. S.106 (1) described the experiment and discussed the conclusions drawn from the results. Reference should be made to this report for particular details, but no striking discoveries were made and the results mainly confirmed the observation of experienced operators, so that the chief value of the experiment was in reducing what was already known to a few into a systematic form and making the information available to all operators.

/During

(1) A.H.B./IIH/258/3/36.

Summary

During the early days of H2S there was much discussion on the scale of introduction into Bomber Command. It was held by some that it was so difficult to use that it should be restricted to the more skilled crews of the Pathfinder Force. The O.R.S. while agreeing with the difficulty of interpretation, envisaged that as later marks became available the equipment would prove easier to operate and therefore held the view that every aircraft should be equipped so that ultimately each could bomb the target independently. The O.R.S. felt that pathfinding, involving the use of flares and markers, could be no more than an interim technique, as it was so dependent on reasonably good weather conditions.

The policy adopted was of course for every aircraft to be fitted, but the equipment did not reach the hoped for stage of development whereby blind bombing could be universally adopted. The O.R.S. made every effort to determine by analysis of results obtained by odd crews during normal attacks, whether blind bombing by main force crews would prove to be accurate as pathfinder-led attacks and pressed many times for a few experimental attacks to be laid on to provide firm data on this question. Although as has been stated one or two attacks were made, the conditions mitigated against reliable results being obtained. While, therefore, it is unfortunate that the question was not settled satisfactorily, as there were many who considered that H2S should have been used for blind bombing, such evidence as the O.R.S. was able to amass tended to confirm that no increase in effectiveness would have been obtained by this procedure with the marks of H2S then available. In fact, the reverse would have been the case. The ultimate aim that every aircraft should be its own 'pathfinder' however, remained.

Although the success of raids carried out with its aid to pathfinding did not reach the consistent high standard achieved by Oboe, H2S was of great value to the Pathfinder Force. It was also of great value to the main force as a navigational aid, particularly in regions beyond the coverage of Gee (see Chapter 8 on Navigation). Therefore, although H2S failed to meet the original operational requirement, it played a vital role in Bomber Command's operations.