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Date: 4 August 1944
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HEADQUARTERS
IX TACTICAL AIR COMMAND (REAR)
OPERATIONAL RESEARCH SECTION

ORS Report No. 47

APO 595 U S Army
25 June 1944

REPORT ON THE MISSION OF THE PATHFINDER AIRCRAFT OF THE PATHFINDER SCHOOL, IX TROOP CARRIER COMMAND, DURING OPERATION NEPTUNE, JUNE 5/6, 1944.

Scope of Report: -

It was the responsibility of the Pathfinder School, IX Troop Carrier Command, accurately to drop at least one of three airborne pathfinder teams on each of six designated dropping zones (DZ) in the Cherbourg Peninsula at definite times, in order that these zones might be marked properly, by lighted tee and by radar beacon, at the time of arrival of the main body of airborne troops approximately one-half later. The further responsibility of dropping at least one of two pathfinder teams on one of the above DZ's, in order to mark a glider landing zone (LZ) at some distance from the DZ, was added shortly before the operation was scheduled to take place.

The special equipment available to carry out this mission, the conditions under which it was necessary to operate, the plan of operation, and the degree of success achieved, are the subject of this report.

Special Equipment: -

Special equipment, installed in the C-47 pathfinder aircraft for the use of the navigator, was the following:

(a) Gee. This is a navigational system by which the position of the aircraft is located by the intersection of two hyperbolas, each of which is determined by the difference in the distances between the aircraft and two fixed ground stations. The accuracy obtainable with this system depends upon the distance to the ground stations and the angle at which the hyperbolas intersect. In the vicinity of the DZ'S in the Cherbourg Peninsula, it is of the order of 400 yds for an error in reading of 0.01 in the arbitrary Gee scale. This equipment is susceptible to jamming and it is reported that one hour is sufficient time for the enemy to measure any new frequency and to begin jamming it.

(b) Rebecca. This is an equipment for interrogating and receiving a signal from a beacon, Eureka. Beacon range can be read directly, and the direction obtained by a pip matching technique.

(c) SCR-717-C. This is an S band search type of radar, having a 360° angle of search in azimuth and a PPI type of presentation. The beam width between half power points is approximately 10° in aximuth and the pulse length approximately 1½ micro-seconds. Ranges available are 4, 20, 50, and 100 nautical miles. On the four mile scale, zero range is represented by a circle of about 1" diameter rather than by a point, thus providing better azimuth discrimination at close range.

Because of the fact that the spinner is installed below the fuselage about half way back, two prominent shadows, due to the propellors, appear on the PPI about 20° on each side of the heading. These add to the difficulty of interpreting the presentation in the forward (most important) direction. Ground equipment for use with the above was:

(a) Eureka. This is the portable beacon which is the complement of Rebecca.

(b) Bups. This is a portable S band beacon which may be used with SCR-717-C or any S band radar.

All navigators at the Pathfinder School had had at least 25 hours experience on Gee, of which 12½ hours was with an instructor, and most of them had had considerably more time. All were competent operators.

Experience in operating SCR-717-C, for most navigators, ranged between 15 hours and 45 hours, the extremes being 7 hours and 6 hours. None would have experienced any difficulty in the interpretation of shipping, islands, or well marked coast line, although few had attempted much in the interpretation of the presentation over land. For the purpose of this mission the latter was not necessary.

The twenty most experienced navigators were used for this mission.

General Plan of Operations: -

The general operational plan required that troop carrier aircraft assemble in the vicinity of their airfields, that they follow a prescribed route identified by check points equipped with radar beacons and coded lights to the DZ's, and that they return by a prescribed route.

E.T.A's (Estimated Time of Arrival) for each check point and DZ, and altitudes to be flown on each part of the route were given.

The designations and positions of the various check points and DZ's, together with the Eureka and Bups coding follows, the coordinates in parenthesis being approximate:

Designation	Latitude	Longitude	Gee Coordinates	Eureka Code	Bups Code
	° ' "	° ' "			
N. Witham	(52 48)N	(00 33)W		-	
Atlanta	52 22 45 "	01 22 15 "		K	
Burbank	52 04 38 "	01 52 40 "		F	
Cleveland	51 46 25 "	02 22 35 "		B	
Elko	50 54 51 "	02 11 30 "		D	
Flatbush	50 30 43 "	02 27 23 "		G	1 - 1
Gallup	50 08 30 "	02 42 00 "		L	
Hoboken	49 45 30 "	02 56 30 "		C	1 - 2
Peroria	49 26 52 "	01 49 32 "		-	
DZ "A"	(49 25 --)	(01 16 --)	39.251	9.332	A
"C"	(49 23 --)	(01 15 --)	39.187	9.294	C 1 - 1
"D"	(49 20 --)	(01 16 --)	39.074	9,333	D
"O"	(49 25 --)	(01 21 --)	39.102	9.589	-
"N"	(49 23 --)	(01 25 --)	38.957	9.749	-
"T"	(49 26 --)	(01 24 --)	39.047	9.714	-
Paducah	49 29 58"	01 09 20"		-	
Spokane	49 43 30"	01 04 15"		-	

In Figure I are shown the positions of the DZ's and of the Command corridor, ten miles wide, defined by the check points, between the south coast of England and the Cherbourg Peninsula.

While it was necessary for the main column of troop carrier aircraft to remain within the corridor, the pathfinder aircraft were permitted to leave the corridor after passing Gallup and to turn either inside or outside Hoboken, if this should be necessary to gain or lose time. It was also permitted for them to return on a reciprocal course rather than via Paducah and Spokane.

Pathfinder Plan of Operations: -

In general, the operational plan for the pathfinder aircraft in this mission was in keeping with the principle underlying the training of the crews. This was that no navigational method was to be used to the exclusion of another, but that all means available (Gee, Rebecca-Eureka, 717-C, D.R., contact) should be used together so that, in the event that one, or even several, should become unavailable during a mission, the mission still could be carried out satisfactorily.

Navigation to and from the Cherbourg Peninsula area was to be carried out in the conventional manner, using Gee, and the radar and visual beacons installed at the various check points.

Plan for Approaching and Dropping on DZ's "A", "C", & "D".

For the approach to DZ's, "A", "C", and "D" a simple Gee homing procedure was adopted. Landfall was to be made approximately ten miles south of Peoria after which a northeasterly course was to be flown until a short distance from the Gee lattice line through the DZ. A turn was then to be made which would cause the final approach to the DZ to be made along the proper lattice line, and the drop was to be made on Gee, or preferably, by visual identification of the DZ. SCR-717-C was to be used primarily to maintain a course half way between Alderney and Guernsey Islands so as to be out of effective range of the heavy anti-aircraft defenses installed there, and for making landfall. Visual checks were to be made of the course over land assisted, when possible, by the use of 717-C.

The first, (north easterly) part of the course over the Cherbourg Peninsula was planned to be just beyond the range of the heavy anti-aircraft defenses to the north, thus giving distances for the final run-in, after the turn of approximately five miles for DZ "A", seven miles for DZ "C", and nine miles for DZ "D". In these distances it was felt that necessary corrections could be made to the course so that the approach would be made along the proper lattice line, providing no great error had been made at the turn.

Figure 2 shows DZ's "A", "C", and "D" and the courses by which they were to be approached.

Plan for Approaching and Dropping on DZ's, "O", "N", and "T"

To have adopted a simple Gee homing procedure in the case of DZ's, "O", "N", and "T" and to have provided sufficient distance for the final run in after the turn would have necessitated a course after landfall directly across an area well defended by heavy anti-aircraft artillery. Consequently a complex Gee homing procedure was adopted in which the course from landfall to DZ was a straight line making approximately equal angles with the two sets of lattice lines. This resulted in approximately equal rates of change for the B and C signals which should, therefore, always be at approximately equal distances from the target position.

Dropping was to be by visual identification of the DZ or by Gee, visual checks of the course were to be obtained when possible, and SCR-717-C was to be used as in the case of the other DZ's.

Figure 3 shows DZ's "O", "N", and "T" and the courses by which they were to be approached.

Methods Actually Used for Approaching and Dropping in DZ's

DZ "A": - Gee was used after landfall, and the drop was made on gee. No recognizable landmarks were seen during the last four miles of the course, but a visual check was obtained at the turn. The navigators of the three aircraft agree that the drop was made approximately 400 yards to the right of the course and it is estimated that the paratroopers probably landed within 100 yards of the point desired, on account of the wind. The drop was made 4 minutes early.

DZ "C", flight No. 1: -- Only two of the three aircraft in this flight made landfall due to probable mechanical failure of one motor in the third. Both the run in and the drop were made on Gee. A visual check was obtained at the turn and (by one aircraft) when passing St. Mere Eglise, but not at the DZ.

The accuracy of the drop is estimated to be that of Gee, which is given as 400 yards by the Gee Accuracy Survey, and which, under the conditions existing at the time, probably was of the order of 600 yards.

DZ "C", flight No. 2 -- Gee was used for the approach, but the flight overshot the turn somewhat. The drop was made on the visual identification of the DZ by means of the adjacent roads.

DZ "D": -- The first part of the run in was made on Gee. However, due to an error in the Gee setting made by the navigator of the No. 1 aircraft, the proper turn was not made and the flight continued in the north easterly direction until it had passed the coast. The pilot thereupon turned right and followed the coast to the bay near Carentan, where he turned inland over Carentan and then in a northerly direction over the DZ, which was recognized. He then returned to the DZ, and the drop was made on visual identification.

At the time of the drop the navigator obtained a Gee fix from which it was determined that the drop was made 500-600 yards south, and somewhat to the east. This was confirmed by the navigators of the other two aircraft. The drop was made one minute late and would have been made, except for the navigational error, approximately six minutes early.

DZ "O": -- Gee was used for the approach but, due to an error in heading during the first part of the run in, the final approach was made on a course of 150°, approximately parallel to the Gee lattice lines. The drop was made on Gee, with a good visual check, and took place 6½ minutes early. It was estimated that the drop took place slightly beyond the desired point. Information from the ground troops is to the effect that every man of the three pathfinder teams dropped was within 300 yards of the centre of the DZ.

DZ "N": -- The approach and drop were made on Gee, with a good visual check of the DZ. All navigators agreed on the position at the time of drop, which was made exactly on time.

DZ "T": -- Landfall was made somewhat to the north of the IP and the approach and drop were made on Gee, with a visual check at the DZ. The altitude at the time of drop was rather greater than had been planned but the crews were confident that the pathfinder teams landed in the DZ area.

Comments:

1. All nineteen aircraft making landfall completed their missions and all drops were made in the DZ's at approximately the correct times.

2. A tendency to arrive at the DZ's before the time planned is indicated. This may have been due to the existence of a stronger tail wind than had been forecast.

3. Two of the four flights planning to use a simple Gee homing procedure overshot the turn. In one case this was due to a mistake in setting in the Gee coordinates of the DZ, but in the other the setting appears to have been correct.

4. In the case of one flight planning to use a complex Gee approach, an error in heading immediately after landfall resulted in the flight passing over more heavily defended territory (but fortunately with no disastrous results) and in the final approach to the DZ being made almost parallel to the lattice lines.

5. One flight, having crossed the coast at the recommended altitude, failed to lose altitude rapidly enough to be at the desired altitude over the DZ.

6. From the number of departures from the original plan, none of which were due to external causes, it would appear that further practice in simple and complex Gee homing procedures, both at constant and changing altitudes, would result in even more efficient pathfinder operation.

Operation of Gee.

Three different RF units were used with the Gee equipment on this mission. Unit No. 27 provided operation on two frequencies previously unused, while units Nos. 24 and 25 provided operation on previously used frequencies.

Reports on Gee operation were not obtained from all navigators taking part in the mission. Those that were obtained are summarized in the following table: -

R.F. Unit No.	Flatbush to Cherbourg Penn. No. used	Flatbush to Cherbourg Penn. Interference	Over Cherbourg Peninsula No. Used	Over Cherbourg Peninsula Interference	Cherbourg Peninsula to Flatbush No. Used	Cherbourg Peninsula to Flatbush Interference
27	5	None	5	Slight inter-3 ference in 3 cases, one being CW & one railings		None
25	7	One case of 7 railings & CW which always could be read through. One case of slight interference, nature not specified.		Five cases of 8 interference so slight as to render use of anti jam switch unnecessary, railings, grass, & CW. One case of slight CW in which anti jam switch useless		None
24	3	None	3	One case of slight interference. One case in which anti jam switch was used with no interference.	5	None

Comments on Gee Operation.

1. Gee operated accurately during the whole of the mission.

2. There was no time, position or altitude at which Gee was unreadable or seriously interfered with. All R.F. units were used and altitudes were as low as fifty feet over the Cherbourg Peninsula.

3. No interference on any available frequency severe enough to require the use of the anti-jam switch was experienced.

4. Only two failures of Gee equipment occurred. One was due to flak and the other to a burned out fuze, which was replaced immediately.

Use of SCR-717-C

Between Flatbush and Hoboken: -- During this portion of the flight the altitude was less than 500 feet and, in general, was as low as possible consistent with avoiding salt spray on windshields which would reduce visibility. SCR-717-C was used for two main purposes: -

1. To get exact landfall out of Flatbush.

2. To locate shipping so as to avoid possible collision at the low altitudes flown.

Between Hoboken and the Cherbourg Peninsula: -- SCR-717-C was used by all navigators, in preference to Gee, in order to pass exactly midway between Alderney and Guernsey Islands. Both of these islands had heavy anti-aircraft artillery installations with ranges such that only a narrow corridor between the islands was safe from their fire. No aircraft reported being fired on from these islands during the mission.

Over the Cherbourg Peninsula: -- In only one case was SCR-717-C used without Gee prior to reaching the DZ. This was because the aircraft had become separated from the flight leader and SCR-717-C appeared to offer the quickest method of locating the position in the short time remaining.

In other instances 717-C was used as a check on Gee during the approach to the DZ, using coastline, bays, and inundated areas as check points. More extensive use of 717-C in this manner might have been made except for the fact that the presentation was poor due to the angle of ascent or descent.

In the case of the flight going to DZ "L", the navigator of the leading aircraft had used the wrong Gee coordinates of the DZ and did not discover his error until after the east coast of the Cherbourg Peninsula had been reached. The navigators of the other two aircraft had made the proper Gee setting for the DZ and made no changes in it, but used SCR-717-C to check their position and course while the flight leader was locating the DZ by visual means.

SCR-717-C was used by two navigators after the drop had been made as the quickest and most certain way of locating the nearest landfall out.

One aircraft had the compass put out of commission by flak while on the deck and under accurate machine gun fire. SCR-717-C furnished the only method of determining the best course out.

From Cherbourg Peninsula to Flatbush: -- The majority of the navigators made use of SCR-717-C to enable them to avoid a too close approach to shipping on the return trip, (some having had unpleasant experiences with friendly shipping in Sicily).

By the Aircraft which was forced to ditch: -- In the case of one of the twenty aircraft in this mission, one engine failed about four miles before reaching the Cherbourg Peninsula. After throwing out all heavy equipment, this aircraft was able to maintain an altitude of about 400 feet and attempted to return to the English coast. After about 40 minutes flight it appeared that the remaining motor would fail before reaching England, and it was decided to ditch.

During these forty minutes, SCR-717-C was used in preference to Gee to keep away from the Channel Islands, to spot shipping and coastline so as to remain outside the command corridor, thus avoiding aircraft enroute to the Cherbourg Peninsula at the same altitude, and finally to pick out the destroyer near which to ditch.

Comments on Use of SCR-717-C

1. There were no equipment failures.

2. The equipment was of considerable value before the Cherbourg Peninsula was reached and after the drops were made.

3. More use probably would have been made of the equipment between landfall in and arrival over the DZ's had it not been for the excellent performance of Gee.

4. In several instances, where time was of the greatest importance, SCR-717-C was invaluable.

Rebecca-Eureka:

All aircraft were equipped with Rebecca, and Eurekas were installed at Atlanta, Burbank, Cleveland, Elko, Flatbush, Gallup and Hoboken. Eurekas also were set up on the DZ's by the pathfinder teams for the use of the main column.

No case of Rebecca failure was reported and all Eurekas at the check points were seen. Eurekas also were seen at DZ's "A", "C", "D" by crews of flights to DZ's "O", "N", "T", whose drop times were approximately an hour later than those for "A", "C", "D".

Bups

Bups beacons, for use with SCR-717-C, were installed at Flatbush and Hoboken, and at DZ "C" by the pathfinder team dropped there.

Of eight navigators attempting to see the one at Flatbush, only two were successful. The maximum range reported was six miles.

Of ten navigators attempting to see the one at Hoboken, only four were successful. One saw it at 30 miles range from an altitude of 2000 feet, but the maximum range reported for altitudes of 500 feet or below was 15 miles.

Of three navigators attempting to see the one at DZ "C" one was certain that he saw it, and one was not sure but thought he did.

Comments on Bups.

1. Bups operation appears to have been rather unsatisfactory, since relatively few navigators saw them.

2. The explanation of this may be that sufficiently serious attempts to see them were not made, since Bups beacons were considered to be reserve equipment, to be used in the event of Rebecca-Eureka failure.

3. It is probable that Bups and/or SCR-717-C were not exactly on the assigned beacon frequency.

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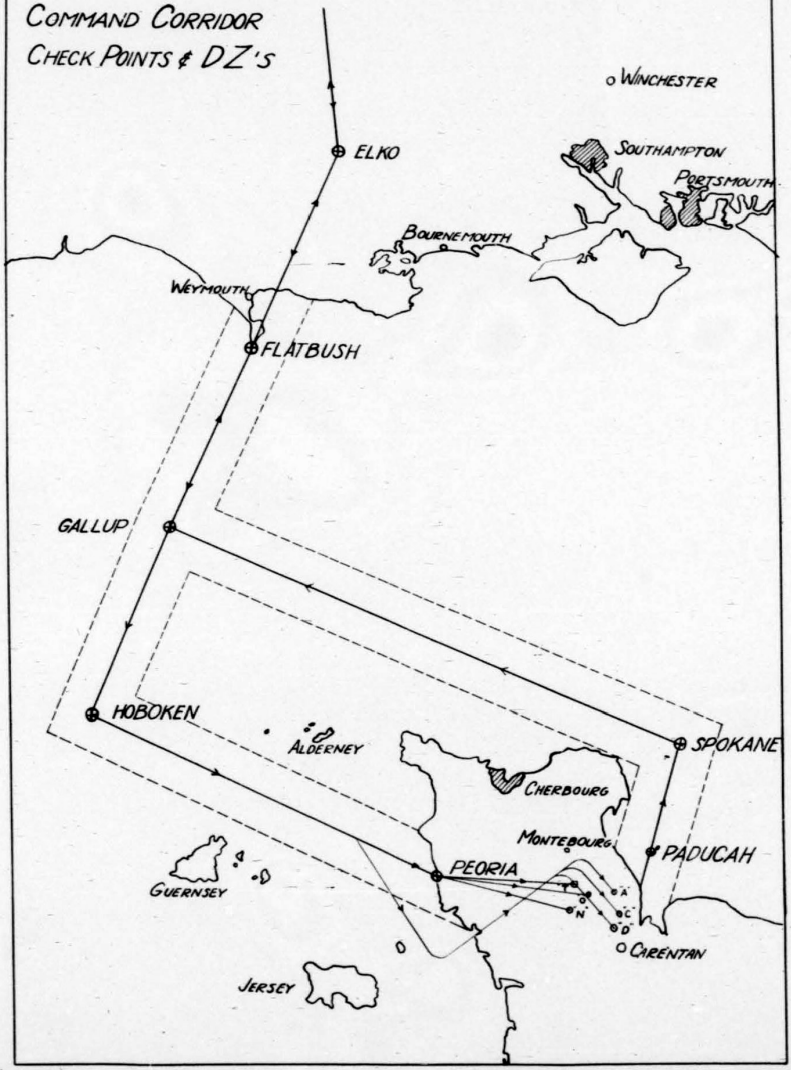
FIGURE 1
COMMAND CORRIDOR
CHECK POINTS & DZ'S



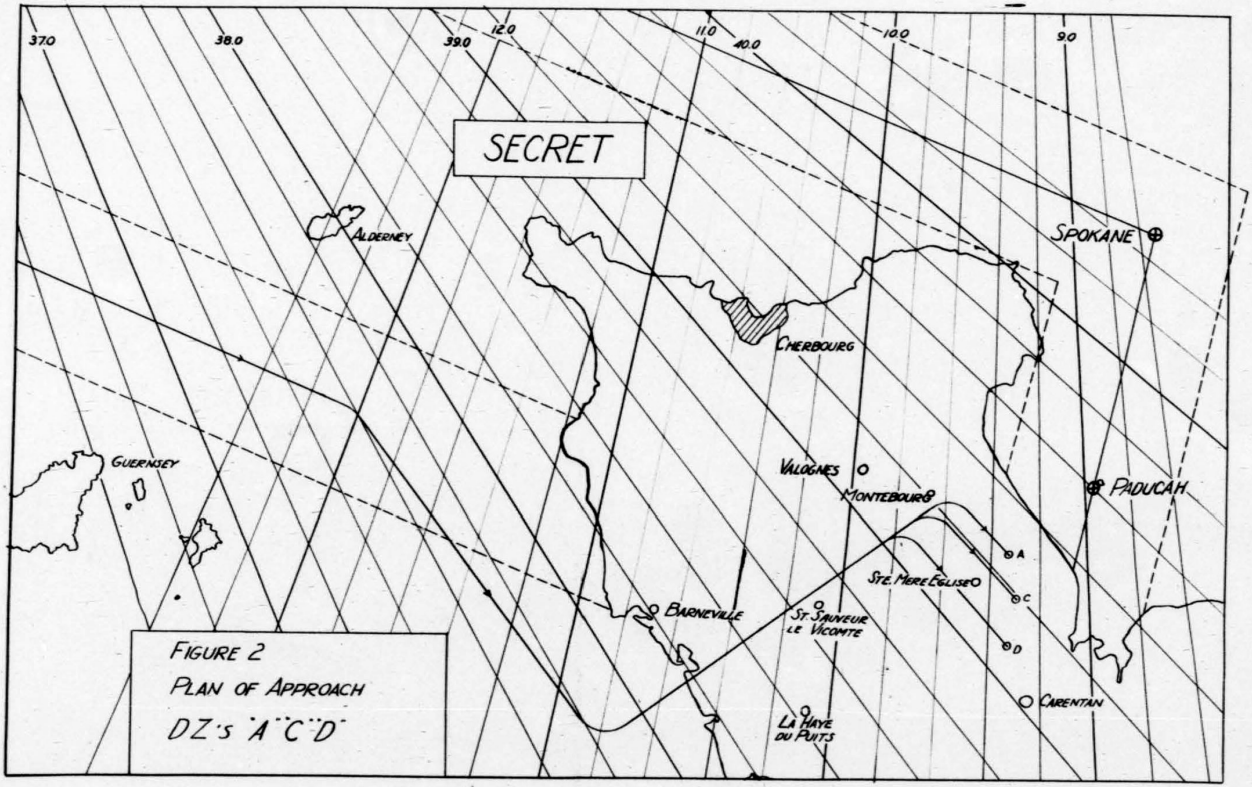


FIGURE 2
PLAN OF APPROACH
DZ's "A" "C" "D"

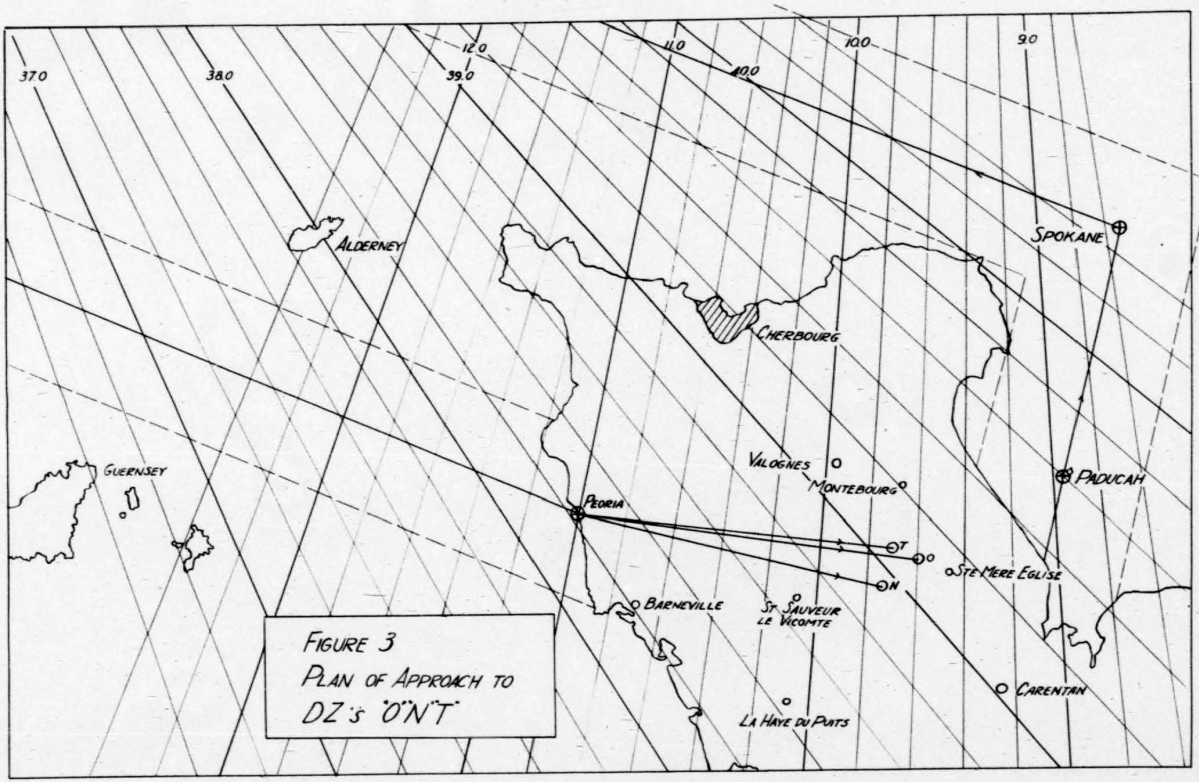


FIGURE 3
PLAN OF APPROACH TO
DZ's "O" "N" "T"