

NOT TO BE TAKEN INTO THE AIR.

BOMBER COMMAND OPERATIONAL PROCEDURE - NAVIGATION.

PART I - PREPARATION.
PART II - ACTION BEFORE TAKE-OFF.
PART III - ACTION AFTER TAKE-OFF.

INTRODUCTION.

1. The procedure described within is for the guidance of pilots and navigators; especially those with limited experience of operations. It is recommended as providing the simplest means of locating a target and returning to base.
2. Although the procedure is designed primarily to assist navigators, it should be realised that the navigation of an aircraft under war conditions is achieved by the co-operation of all members of the crew. The planning and execution of the navigation is, therefore, a crew responsibility and not purely the duty of the navigator, whose role is to direct and co-ordinate the navigational effort of each member of the crew.
3. No procedure can be devised to cover all the difficulties a navigator may have to overcome. The amplifying notes may, however, assist pilots and navigators in assessing the possible difficulties and in deciding on the best countermeasures.
4. It is not intended that crews should adhere rigidly to this procedure, but regard it as the foundation on which to build from their own initiative and experience.

Procedure.

PART I - PREPARATION.

1. Draw on the plotting chart, the track direct from the navigational departure point to the target.
2. Study carefully the forecast weather conditions in relation to this track, together with the synoptic chart.
3. Study carefully the intelligence data in relation to this track.
4. Study carefully the available navigational aids in relation to this track.
5. Having 2, 3 and 4 in mind, select prominent landmark on British coast near point where direct track to target crosses the coast.
6. Draw in track from navigational departure point to prominent landmark on British coast, on both plotting chart and topographical maps.
7. Having 2, 3 and 4 in mind, select prominent landmark on enemy coast near point where direct track to target crosses the enemy coastline.
8. Draw in track from prominent landmark on British coast to prominent landmark on enemy coast.
9. Having in mind 2, 3 and 4, study the 1/250,000 or 1/500,000 map and select landmarks near direct track at suitable intervals.
10. Plot in position of selected landmarks on the plotting chart, naming them "Landmark 1", "Landmark 2", etc.

Notes.

PART I - PREPARATION.

1. (a) For security reasons departure should not be taken from the base aerodrome, but from some well known landmark not less than 5 miles away from the aerodrome.

(b) This direct track is merely for the purpose of planning the flight and is seldom, if ever, followed.
2. Whenever possible, discuss probable weather developments with the Meteorological Officer; especially in deciding the method of departure and the action to be taken in computing upper winds should the forecast winds prove to be inaccurate.
3. This data is of the utmost importance in planning the actual route to be followed. It may conveniently be entered on the plotting chart and topographical maps. Consult the Station Intelligence Officer as to the amount and type of data that may be plotted.
4. (a) Consult the Station Navigation Officer and the Station Signals Officer regarding the aids available and the amount and type of data that may be entered on the plotting chart and topographical maps.

(b) The advice of the Station Signals Officer should be sought on the probable accuracy of the radio aids covering the direction of flight.
5. The distance of the prominent landmark from the direct track should be governed by the landmarks available and their prominence.
- 6.
7. The distance of the prominent landmark from the direct track should be governed by the landmarks available and their prominence.
- 8.
9. The distance between the selected landmarks should be governed by forecast weather conditions, speed of the aircraft and availability of landmarks.
- 10.

Procedure.

11. Having in mind 2, 3 and 4, study the 1/250,000 or 1/500,000 map and the target map, and select a final landmark near target, within a radius of 25 miles if possible.
12. Plot the final landmark on the plotting chart and name it "Target Landmark".
13. Draw in tracks joining prominent landmark on enemy coast, through "landmarks" to the "Target landmark", on both plotting chart and topographical maps.
14. Draw in tracks for a square search on both plotting chart and topographical maps in case the "Target Landmark" is not sighted on E.T.A.
15. Study carefully the topographical maps and the target map and note likely landmarks within the area covered by the square search.
16. Draw in track joining "Target Landmark" to target, on the plotting chart, topographical maps and target map.
17. Plan return tracks in the same manner as for the outward flight, naming the final landmark "Base Landmark". Pay particular attention to the tracks for the square search from the "Base Landmark".
18. Complete Flight Plan on Form 441 for the chosen tracks, but do not, at this stage, worry about the course, ground speed and time columns.
19. Study the plotting chart, topographical maps and target map, together with Form 441, until such time as a complete mental picture of the flight is formed.

Notes.

11. The selection of the final landmark is of great importance, as it is from this point that map reading is started for pin pointing the actual target.
- 12.
13. Under certain conditions it may be preferable to draw in the track direct from the prominent landmark on the enemy coast to the "Target Landmark" and thus avoid a number of alterations of course. In those circumstances the "Landmarks" would be used as guides and not as turning points.
14. (a) Details of how to plan a square search are given in A.P. 1234, Chapter (XIV), paragraphs 18 to 27.

(b) Plan the square search tracks on the minimum visibility that is likely to be encountered.
- 15.
- 16.
17. It is often preferable to draw in the track direct from the target to a prominent landmark on the enemy coast, but use should be made of prominent landmarks near to this track for checking purposes.
- 18.
19. (a) It is desirable to rub out all tracks drawn on the plotting chart for planning purposes, as opposed to those drawn in for the actual route to be followed. This will avoid confusion in the air.

(b) The following reminder should be entered, for the appropriate time and position, on the plotting chart and Form 441 - "FUZE BOMBS".

/Part II - Action before
Take-Off.

Procedure.

PART II - ACTION BEFORE TAKE-OFF.

1. Pilot and navigator decide on the method of departure, i.e.
 - (a) Climbing departure at pre-determined air speed
or
 - (b) Level departure at pre-determined height and air speed.

2. Calculate course, ground speed and E.T.A. for the initial track, based on forecast wind, and enter them in the Flight Plan on Form 441.

3. Calculate courses, ground speeds and E.T.A.s; based on the forecast winds, for the remaining tracks, including the square searches.

4. Ensure that the tracks drawn in on the pilot's and navigator's topographical maps are similar.

Notes.

PART II - ACTION BEFORE TAKE-OFF.

1. (a) Operational conditions usually dictate a climbing departure, but a level departure at pre-determined height and air speed eases the work of the navigator and gives him a chance of obtaining an accurate check on the forecast winds; therefore this method is advised whenever possible.

(b) If a level departure is decided on, the Meteorological Officer should be consulted as to the height at which the most accurate check on the forecast winds is likely to be obtained.

2. If a climbing departure is used it will be necessary to calculate on the wind at the height half way between the height of the base aerodrome and the height at which the British coast is to be crossed.

3. (a) It may seem a waste of time to make these calculations in view of possible inaccuracies in the forecast winds. Should the forecast winds, however, be accurate, much brain work in the air under arduous conditions will be saved. It is advisable always to cut down to a minimum the calculations to be made in discomfort in the air, by making all possible calculations on the ground in comfort.

(b) These calculations should be recorded in the most convenient form, but it is always advisable for the Captain, especially in single pilot aircraft, to have them recorded on Form 433A.

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/Part III - Action after take-off.

Procedure.

PART III - ACTION AFTER TAKE-OFF.

1. Proceed to navigational departure point and set course for prominent landmark on British coast.
2. Draw in air courses on the plotting chart throughout the whole flight and check D.R. position by drawing in mean wind velocity, for time in air since last definite visual fix, at least every half hour. As each visual fix is obtained plot the air position and so obtain an average wind velocity by joining the air position to the fixed position. Enter the data in the observation column of Form 441.
3. Check track and ground speed as often as possible by making intelligent use of position lines obtained by astro or radio means and by taking drifts whenever possible.
4. Note position on arrival at coast or on E.T.A.
5. Provided coast line is visible, DO NOT proceed without obtaining a definite visual fix.
6. From the fix obtained calculate the wind velocity.

Notes.

PART III -- ACTION AFTER TAKE-OFF.

1. The object of a bombing sortie is to drop the bomb load accurately at the right time and place. To achieve this object, wind determination is of prime importance, and it is the navigator who is charged with this responsibility.
2. (a) The importance of keeping an accurate plot of air positions cannot be over emphasised. In order to avoid confusion, air courses should be plotted in colour.

(b) At certain stages of the flight, i.e. during break away from the target, the navigator may find it difficult to record the data necessary for plotting the air courses. Under these conditions the pilot should note the courses steered and the time on each course; even approximate data is better than none at all.

(c) It is advisable to re-start the air plot after each definite visual fix. Some navigators keep a continuous air plot for the whole flight, in addition to separate plots between fixes. It is preferable to use a different colour for the continuous plot if this method is used.
3. (a) Remember the advice given by the Station Signals Officer on the probable accuracy of the radio aids covering the direction of flight. At this stage use should be made of our own Beacon Groups to obtain bearings and running fixes.

(b) Before attempting to take an astro sight, the navigator should warn the pilot to concentrate on maintaining accurate course, height and air speed; automatics should be used whenever possible.

(c) A close study of A.P. 1456, Chapter XXVIII, will help navigators in their choice and employment of position lines. Every navigator should be well versed in this Chapter.

(d) On long sea crossings, drifts taken by the rear gunner on flame floats at an altitude of approximately 3,000 ft. are very reliable. These drifts should be taken at the last possible moment before the float disappears from view.

(e) The Drift Recorder Mk. II will enable the navigator to obtain accurate drifts and ground speeds.
4. It is often helpful to note the direction in which the coast line runs in determining the position of the aircraft.
5. Air courses must be carefully plotted if a deviation is found to be necessary in obtaining a visual fix; otherwise a wind found from the Air Plot will be inaccurate.
- 6.

Procedure.

7. Compare calculated wind velocity with forecast wind. If winds agree, accept forecast wind for 2nd leg. If winds disagree appreciably, calculate new winds for 2nd leg.

8. Compute the wind velocity at height half way between height of aircraft and height to which it is desired to climb. Calculate course, ground speed and E.T.A. from British coast to prominent landmark on enemy coast.
9. Set course for enemy coast.
10. If operational height is reached before crossing enemy coast, alter course and adjust E.T.A. to allow for:
 - (a) change of wind at operational height,
and
 - (b) change in air speed from climbing to cruising.

11. Note position on arrival at enemy coast or on E.T.A. Provided coast line is visible make every effort to obtain a definite visual fix.

12. From the fix obtained calculate the wind velocity.
13. Compare calculated wind with forecast wind and act as in para. 7, Part III.
14. Calculate course, ground speed and E.T.A. from fix on enemy coast to "Landmark 1", or to "Target Landmark" if proceeding direct.
15. Set course for "Landmark 1", or "Target Landmark" if proceeding direct.

Notes.

7. It is not possible to give a definite rule for re-calculating the upper wind velocities should the first wind found not agree with the forecast wind. The Meteorological Officer will, however, be able to give advice on this point according to the weather conditions obtaining at the time of flight. As a rough guide, an allowance of 2° veer and 2 m.p.h. increase per 1,000 ft. can be made, though this basis for re-calculation should only be used as a last resort.
- 8.
- 9.
10. (a) It is advisable to plot the D.R. position at the point of levelling out by calculating the distance run along the track from the prominent landmark on the British coast or by laying off the mean wind from the air position, if a climbing departure through cloud has been necessary.
(b) Owing to the length of time taken by a heavily loaded bomber aircraft to settle down after changing from climbing to cruising air speed, it is better to allow some little time to elapse before actually altering course and adjusting E.T.A. A recommended time allowance is 5 minutes. This time allowance should, of course, be taken into account when calculating the D.R. position at the levelling out point.
11. (a) It is often helpful to note the direction in which the coastline runs in determining the position of the aircraft. See also Note 5, Pt. III.
(b) While from the navigational aspect it is highly desirable to obtain a definite fix on the enemy coastline, it is inadvisable to spend much time searching for a pin point owing to the risk of interception by enemy fighters.
- 12.
- 13.
- 14.
15. If at any time height or air speed is altered, make the necessary adjustments to the course and E.T.A.

Procedure.

16. If ground is visible, Captain and 2nd pilot should start map reading on arrival at enemy coast and pass each definitely identified position to the navigator. Captain and 2nd pilot should, if possible, continue map reading until arrival at enemy coast on return journey.
17. If the ground is invisible, try to obtain a position line or fix by either astro or radio means, and adjust course as necessary.

18. Calculate course, ground speed and E.T.A. between each landmark, using calculated winds if visual fixes are obtained and forecast or computed winds if weather conditions prevent visual fixing.
19. If "Target Landmark" is not sighted on E.T.A. do a square search until position is fixed.
20. On arrival at "Target Landmark" or at fixed position, calculate wind and set course for target.

21. Set the wind velocity on the bombsight during the approach to the target.
22. On completion of bombing, return to base by similar procedure as for outward flight, using D.R. supplemented by navigational aids.

Notes.

16.

17. (a) The navigator must decide from all the evidence available whether the accuracy of an astro or radio fix warrants a large alteration of course.

(b) The accuracy of an astro fix depends upon the experience and skill of the navigator, combined with extremely accurate flying on the part of the pilot.

(c) At this stage accurate and reliable bearings and running fixes may be obtained from beacons disposed within 100 miles of the aircraft's track.

18.

19. To fly aimlessly is the worst possible method of trying to fix position.

20. (a) Whenever possible a wind should be found over the "Target Landmark" by multiple drifts, as this is the only means of ensuring that the wind used for bombing is that prevailing over the target area. Unfortunately, enemy activities usually make wind finding over the target area inadvisable; navigators should however, take every opportunity of getting a wind near the target.

(b) The wind found by track and ground speed between two fixes is an average wind and not necessarily that prevailing over the target.

(c) If a square search has been necessary, the easiest method of calculating the wind is by joining the air position at the end of the search to the fix obtained.

21. Whenever found, the "multiple drift" wind should be set.

22. (a) As much care should be taken on the return flight as for the outward flight. Do not stop navigating by D.R. until the base is actually sighted.

Procedure.

23. Maintain the D.R. plot, Navigation Log and plot of air tracks until the base is sighted.
24. Try to obtain a position line or fix by astro or radio means about 50 miles from the British coast in order to ensure a good "lead in".
25. If British coastline is visible, DO NOT proceed without obtaining a definite visual fix.
26. If no visual fix is made on British coast, obtain a radio fix or position line and set course for "Base Landmark".
27. If radio fix is unobtainable, set course from D.R. position on E.T.A. British coast.
28. If "Base Landmark" is not sighted on E.T.A., start a square search and request a Q.D.M. On receipt of the Q.D.M. set course making the necessary allowance for wind velocity. Obtain further Q.D.M.s. from base if necessary.

Notes.

22. (b) Remember the limitations of the radio aids and do not place blind reliance on these aids. Use them intelligently and they will prove most valuable, but remember that many an aircraft has been lost through relying on radio aids. H.F. D/F is unreliable over 100 miles; therefore it is courting trouble to ask for Q.D.M.s. while still over enemy territory. M.F. D/F is unreliable over 300 miles; therefore it is stupid to ask for a fix while over Berlin. Furthermore, although the M.F. D/F Organisation may be used to provide assistance to navigation, it must be realised that if used considerably for this purpose, its value as a safety service is prejudiced. On the other hand the utmost use should be made of Beacon Services as an aid to navigation, as there is no limit to the number of aircraft which may use beacons at any one time.
- (c) Remember that D.R. is the basis of air navigation and if conscientiously applied will not lead to great inaccuracies; it relies only on the human brain, which is far more reliable than any mechanism yet devised by man.
23. The importance of this cannot be over emphasised.
24. (a) This is particularly important if existing weather conditions indicate that a sight of the British coast is unlikely.
- (b) While flying on a westerly course, Polaris can be used to advantage.
25. (a) It is often helpful, especially around the British Isles, to note the direction in which the coastline runs in determining the position of the aircraft. See also Note 5, Part III.
- (b) If petrol is really short, it may be preferable to try and obtain a fix inland.
26. The following means of obtaining radio assistance at this stage are listed in order of priority:-
- (a) Position line or running fix from our own Beacon Groups.
 - (b) M.F. Fix.
 - (c) Q.D.M.s., if within range of 60 miles of H.F. Unit.

27.

28.

Procedure.

29. If Q.D.M.s. are unobtainable, use R/T Emergency Procedure (Darky) during square search. After fixing position, set course for base or other aerodrome.
30. If contact is lost with base or if it is not sighted within a total period of 30 minutes after E.T.A. "Base Landmark", request assistance from Regional Control and act on the instructions of the Regional Control Officer.
31. In the double event of a complete W/T breakdown and failure to sight the "Base Landmark" on E.T.A., start a square search but do not, at first, increase the size of the squares, i.e. maintain position approximately. Check back to last fix, preferably visual, and note the average wind velocity found at that point from comparison of air position and fixed position. Apply this wind velocity, for the appropriate period of time, to the air position as plotted on E.T.A. "Base Landmark" and thus obtain a D.R. position.
32. Inform Captain of Aircraft of the D.R. position and estimate of its accuracy. The Captain of aircraft should then decide on the best course of action having regard to the D.R. position, its probable accuracy, and the "existing conditions", such as time of day or night, remaining endurance, and prevailing weather conditions.

Notes.

29.

30. (a) It is far better to be directed by Regional Control, while still having plenty of petrol in the tanks, than to fly about aimlessly until the tanks run dry.

(b) Give the Regional Control Officer a chance by obeying his instructions and remember that there may be other aircraft also needing assistance.

(c) Do not set too much store on returning to the home aerodrome. It is better to land safely and in comfort at another aerodrome than to try and find the "home" aerodrome under bad weather conditions, and end up by having to "bale out".

31.

32. (a) In assessing the accuracy of the D.R. position, calculate on the basis of 10% for the distance run since last fix.

(b) It is not possible to give advice covering all possible variations of the term "existing conditions". The one sound rule, however, is to decide on a definite course of action and stick to it. The various aids that can be used are:

- (i) Aerial Lighthouses and Landmark Beacons.
- (ii) Searchlight pointer organisation.
- (iii) Triangular course procedure.

(c) Remember that aimless wandering usually ends in disaster.