2AF MANUAL 50-101-1

SECOND AIR FORCE

B-29 STANDARD PROCEDURES FOR RADAR OBSERVERS

29 JUNE 1945

Headquarters Second Air Force
Colorado Springs, Colorado
29 June 1945

1. 2AF Manual 50-101-1, "B-29 Training in Radar -- Standing Operating Procedures for Radar Observers", is published as a directive of Radar operating procedure. This publication supersedes 2AF Manual 54-101-4, 1 November 1944, pertaining to aerial instruction in Radar.

2. The changes and additions in this manual are based on changes in airplane equipment and improvements in operating procedures.

3. Criticism of this manual is encouraged and should be directed to the Commanding General, Second Air Force.

4. Extra copies of this manual may be obtained by request to this headquarters.

5. Initial distribution of this manual will be to all Very Heavy Training Wings, Very Heavy Training Stations, Very Heavy Combat Crews, and Very Heavy Bombardment Groups, this command.

BY COMMAND OF MAJOR GENERAL WILLIAMS:

C. E. DUNCAN
Colonel, Air Corps
Chief of Staff

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SECTION I - RADAR LOGS

A. FORM 38

1. Form 38 is a Radar Operator's Report and must be compiled according to instructions given in AAF Regulation 15-38, dated 15 May 1944.

2. Form 38 is filled in by the Radar Observer and provides a report of radar operation for each flight, recording tactical use, radar operation time and unsatisfactory radar operation. It also provides the Radar Observer with information that radar check list has or has not been completed by the radar mechanic before take-off time. If possible, the airplane radar maintenance should be assigned to one particular radar mechanic and that man should meet the airplane to discuss the mission with the operator. Form 38 should take care of this, but many times this discussion can save time in maintenance.

B. NAVIGATION LOG

1. General: Records of flights by radar navigational methods will be kept in Radar Navigational Log.

a. The Radar Observer will be required to record at fifteen minute intervals a D/R log entry. A radar check point including identification, distance and bearing will be entered at least twice per hour.

b. The Radar Observer will also be required to plot his position as determined from the radar scope and connect points as drawn to indicate track made good. This information will be used by the briefing officers during the interrogation period immediately following the completion of the mission.

A. GENERAL

1. Radar, if properly employed, will prove an invaluable aid to navigation by permitting the determination of fixes and checks through clouds, fog, overcast, or darkness, and the scanning of much greater distances than could be possible by any other method. It enables the Radar Observer to determine accurate ground speeds, tracks and winds under all conditions of visibility. The radar display gives both range and bearing to all check points.

2. As in pilotage, the Radar Observer must compute approximate ETA's to various radar targets or check points and determine the approximate time and position at which they will appear on the scope.

3. Dead reckoning (DR), using radar as the only aid, consists of the time required to travel a given distance along a radar plot, comparing results with a plot made from the average time, heading, and the average true air speed for the same time, and, from the triangle, the wind and drift can be obtained. By employing radar fixes, it is simple to figure track and distance traveled. By plotting the track of a given check point on an E-6B computer, data for DR using radar may be read directly.

4. It should be understood that radar pilotage is exactly the same as visual pilotage except that the radar screen is relied on instead of visual reference to the ground to locate check points.

B. SCOPE INTERPRETATION

1. It must be understood that radar measures slant range to targets. Only for distances of 20 miles or less is the difference between ground range and slant range appreciable. The ground range may be determined by:

a. Chart (see appendix).

b. E-6B computer (rectangular coordinates).

c. Ground range computer.

2. Returns from land and water.

a. Bodies of water approximate a plane surface. Almost all of the radar energy striking the water is reflected away at a supplementary angle to that which it strikes the surface and is not returned to the antenna. Therefore, water areas appear dark on the scope.

b. Land surfaces, on the other hand, are always uneven and present many surfaces which will reflect part of the energy to the antenna. Land, therefore, will give a brighter return than water.

c. The area beneath the aircraft, whether it is land or water, will generally be the brightest area on a scope. This central return is referred to as "normal ground or sea return".

d. Coastlines or islands that have prominent cliffs or bluffs along the shoreline, appear at a distance as bright lines. Land and water contrasts are the quickest and easiest to identify for use in radar pilotage and navigation.

e. Clouds, under certain conditions of ionization with precipitation occuring within or below the cloud formation, will give a bright return, in some cases, completely obscuring the return from targets beyond it.

3. Returns from lakes and rivers.

a. Bodies of water or other level horizontal surfaces appear black and the far banks give a brighter appearance than the near banks. This is because the ground on the near bank presents a poor surface for reflection as the beam strikes it nearly tangental. Thus, the shore of the body of water nearest the aircraft has a tendency to appear darker than the surrounding land. The contrast between the water surface and the far bank is great, going abruptly from the very dark to the very bright, a sharp transition.

4. Returns from mountains, valleys and peaks.

a. The return from the land gradually grows brighter as the beam falls on the more vertical slopes of

the mountain range near the ridge, and as the aspect of the mountain becomes more favorable for reflection. The far slope is in a complete shadow due to the blocking of the beam by the mountain. Hence, it will appear very dark on the scope.

b. There is a sharp contrast from a bright return to a very dark return at the ridge line of the mountain range. An isolated mountain peak will appear as a bright spot in the ground return similar to a small town, but there will be a very dark shadow behind it which will gradually blend into the tone of the ground return. These dark areas can be differentiated from small lakes, as the brightest return from a lake will be from the far shore.

5. Returns from cities, towns, and airfields.

a. Large cities give a much brighter and more consistent return than smaller cities as they usually contain larger buildings with more reflecting surfaces. Within the confines of the larger cities are targets of varying degrees of brilliance. These do not appear stable as their relative brilliance will change as the aircraft moves over the city. It is generally possible, however, to find one or two areas within the city that will give consistently strong returns regardless of the angle of approach or relative location of the aircraft.

6. Returns from railroads and highways.

a. Railroads and highways do not consistently appear on the scope, except in unusally flat and level country.

b. When they appear, they show as bright returns, generally as a narrow bright line which may be interrupted for short distances. The gain must be set low so that target return may be differentiated from the ground return.

c. Except in unusual cases, rails or ties do not cause reflection of the beam. The strongest part of the return is caused by the reflection from embankments or fills on which the roadway is built. Therefore, those roads and railroads that run perpendicular to the radar beam are more apt to give returns than

railroads and highways running parallel.

C. RADAR FIXES

1. Accuracy of radar as a navigational aid is proportional to:

a. Training
b. Experience
c. Ability

of Observer using the equipment.

2. Identification of targets to be used in fixes may be accomplished by:

a. Establishment of the aircraft's position through dead reckoning.

b. Comparison of the position of the plane on the map with the image on the P.P.I. screen, looking for any peculiar characteristics which may facilitate identification of target.

c. Selection of cities or targets by the above procedure which may be viewed on the P.P.I. screen.

d. Plotting the aircraft's course on the chart as other well identified radar targets come into view on the P.P.I. screen. Greater accuracy will be accomplished by intelligent use of equipment so that sharply defined targets will be available on P.P.I. screen.

3. Three methods for plotting a fix in sequence of preference:

a. Range and Bearing.

(1) Read bearing and range to target from P.P.I. screen.

(2) Using the reciprocal of the bearing angle, draw a line from the target on chart with Weems plotter.

(3) Draw an arc whose radius is equal to the range, using the target as the axis, intersecting the line on the

chart. The intersection will indicate the location of the aircraft at the time the bearing was made.

b. Bearing only.

This is a very accurate method but requires the identification of two or more targets and is similar to the method used in Radio Navigation, using the radio compass.

c. Range only.

Using the range only from several targets will produce the least desirable fix, but this method may be used in the event of failure of azimuth stabilization.

d. Combination.

Any combination of the above procedures may be used to increase the accuracy of the fix.

D. DETERMINING DRIFT, WIND AND GROUND SPEED

1. It is the responsibility of the radar observer to maintain continual wind, drift and ground speed data. At a distance of 50 miles (or more) before reaching the IP, a final check of ground speed, drift and wind should be made. The above information is the data which the bombardier will insert into the bombsight for determination of the release angle. After passing the IP and during the approach to the target, the Radar Observer determines the final heading to cause the track of the aircraft to intersect the target.

2. Determining wind and ground speed, wind direction and velocity between fixes.

a. Ground speed may be determined between any two fixes by using the interrelation of time, speed and distance. Track may be measured between fixes plotted on the chart. Knowing the ground speed and track and determining the true heading and true air speed from the aircraft's instruments, the vector problem for average wind direction and velocity may be solved from the triangle on the E-6B computer.

b. Air Position Indicator (A.P.I.) method. This method makes use of the air position indicator, which

provides readings of latitude and longitude proportional to the true air speed. To determine the direction and velocity of the wind, the following steps must be taken:

(1) Plot a radar fix on a map or chart and adjust the A.P.I. so that its latitude and longitude correspond with the readings on the chart.

(2) After flying a definite course for a given time, a second radar fix is selected and plotted on the chart; the A.P.I. latitude and longitude are read and plotted. The difference between the actual position and the A.P.I. position will give the velocity and direction of wind for the time of the run, by the solution of the triangle.

(3) Using the back of the E-6B, from the formula the velocity of unknown wind will be:

$$\frac{\text{Magnitude of Wind for Run}}{\text{Time of Run}} = \frac{\text{"X" Wind}}{\text{One Hour of Time}}$$

Examples: 1. $\frac{5 \text{ miles}}{12 \text{ minutes}} = \frac{25 \text{ miles}}{\text{one hour}}$

2. $\frac{37\frac{1}{2} \text{ miles}}{1\frac{1}{2} \text{ hours}} = \frac{25 \text{ miles}}{\text{one hour}}$

(4) The direction measured from the A.P.I. position to the actual position is direction of the wind.

(5) Average ground speed may be determined by applying the wind vector to the average true air speed made good.

c. Wind Direction and Velocity by Target Timing. The ground speed, by target timing method, occupies a place in radar pilotage comparable to the position of the double drift in dead reckoning navigation. It is not necessary to identify the target on which the run is to

be made. Thus, track and ground speed, wind direction and velocity may be determined independent of the use of an air plot. The approximate position would aid in identifying targets from which fixes could be obtained to determine the exact position. The method of determining data should be as follows:

(1) Adjust bearing line so that it is coincident with target.

(2) Follow target with bearing line until target is centered on the first range mark. (Be sure all delay is out.)

(3) Leave bearing line stationary and record time that target crosses twenty mile marker. Also record bearing line position.

(4) Record the time, bearing and range each time the target crosses successive range marks.

(5) Operation of E-6B for determining ground speed and drift.

(a) Set 0 of square grid under grommet of E-6B.

(b) Set compass rose to first true bearing.

(c) Place "X" at ground range distance measured on vertical center line of square grid.

(d) Rotate compass rose to second true bearing and place second "X" at second ground range distance.

(e) Repeat for all other range and bearings.

(f) Rotate compass rose until a mean line through series of "X's" lines up parallel to vertical line

of square grid with compass rose indicating track nearest the true heading.

(g) The index now reads the track being made good, and the difference between the true heading and this track is the drift.

(h) The distance traveled is read by placing the zero line of the square grid at the top "X" and reading the distance at the lower "X". The ground speed may then be determined by dividing the distance traveled by the elapsed time on the back of the E-6B.

(6) Determining wind from the E-6B.

(a) Place grommet of compass rose on true air speed.

(b) Set true heading on compass rose.

(c) End of wind vector is point of intersection of ground speed arc and drift line.

(7) This wind is given to the bombardier in knots from degrees true. The bombardier converts the wind to statute miles per hour from degrees true and sets it in the ABC computer.

3. Methods of figuring drift.

a. On course drift may be determined at any time that an echo appears within 15 degrees of the longitudinal axis of the aircraft at a distance of not less than 15 miles. The formula to be used is:

$$(B_1 - B_2) \times (R - 1) + B_1 = \text{Drift}$$

where:

B_1 = First bearing taken
B_2 = Second bearing taken

R - Reciprocal of the proportional distance traveled between B_1 and B_2 as compared to distance between B_1 and location of plane.

Thus:

Assuming that echo appears at 30 miles and 7° R; after a time it travels to 20 miles and 10° right. The drift in this case would be:

$$(B_1 - B_2)x(R - 1) + B_1 = \text{Drift}$$
$$(7^\circ R - 10^\circ R) \times (3 - 1) + 7^\circ R = \text{Drift}$$
$$3^\circ L \times 2 + 7^\circ R = \text{Drift}$$
$$6^\circ L + 7^\circ R = 1^\circ R$$

This solution can be obtained by placing information on the E-6B without regard to time.

b. Methods of determining drift on particular types of equipment may be found under the SOP of that equipment.

E. BEACON HOMING

1. Radar and radio beacons are similar. In both types the beacons may be placed at a known coordinate or at the home base.

2. It is possible to locate a beacon at a maximum range of 300 nautical miles (the working range may be much less) for the purpose of homing or to measure the range and bearing for a fix.

3. For beacon operation, the beacon controls must be ON and the tuning control adjusted manually. Preflight check by operator should include tuning in of base beacon wherever possible. Slight deviation of this tuning in flight may be necessary for best beacon reception since beacon frequencies may vary slightly.

4. The beacon signals are usually received in coded form for identification purposes. The code will be viewed on the screen as a series of arcs of varying length, depending on the setting of the receiver gain and proximity of beacons. The reduction of gain will cause the signal to appear as a series of coded dots.

If the beacon code is 2-1-2, two dots will appear near each other; then one separated by a larger space followed by two more spaced as the first two. The Radar Observer can home in on the coded dots and reach the beacon station safely. It will be necessary for him to determine corrections that are needed to compensate for drift in order to keep the aircraft on the track line. The distance must be read from the nearest signal. The Radar Observer may then determine an E.T.A. to the beacon station.

5. In searching for beacons, it is well to remember that a maximum range limit depending on the altitude is determined by the curvature of the earth. At 3000 feet altitude, the beacon is hidden by the earth at a range of about 60 miles. At 30,000 feet altitude, maximum theoretical range is about 250 miles.

F. BEACON FIXES

1. The beacon is "tuned in" in the same manner as in beacon homing.

2. Single Beacon Fix: After "tuning in" the beacon, the Radar Observer can measure the distance to the first return and also read the bearing from the plane. This will give him the data to plot his position as in radar fixes.

G. FLUXGATE COMPASS

1. There are two methods of presenting the pattern of signals on the PPI screen. In the first method - stabilization "OFF"- the top of the scope represents the true heading of the aircraft, and as the heading changes, the pattern of the tube also shifts. In order to compare the pattern with a map, it is necessary to reorient the map continually since the heading changes and recognition of signals is most difficult.

2. In the second method - stabilization "ON" - the output of the fluxgate compass is tied into the AP4-13 in such a way that the top of the scope represents north, either true or magnetic, depending on whether variation has been set into the compass. This greatly facilitates comparison with a map since the pattern is always fixed

in relation to north, regardless of the heading of the aircraft as represented by the lubberline. With azimuth stabilization "OFF", the lubberline would remain 0° at all times. Bearings read with stabilization "ON" are true with variation set in on the fluxgate compass, while with stabilization "OFF", they are relative bearings.

3. Stabilization may be turned "OFF" only when antenna is not spinning. (See official check list for APQ-13.) If, with stabilization "OFF", the heading line does not return to 0°, it can be adjusted by means of the zero-set adjustment on the control box.

SECTION III - BOMBING

A. INTRODUCTION

1. The bombing procedure as outlined in this section is adaptable to all types of radar bombing using H_2X or similar equipment. Minor variations in procedure as required for bombing with special equipment are outlined in the SOP for the particular set.

2. The successful use of this procedure depends upon close coordincation between Airplane Commander, Bombardier and Radar Observer, upon the careful adherence by this team to a fixed procedure, and upon their experience in working together.

3. Crew Responsibilities.

a. The Airplane Commander uses the automatic pilot to keep the airplane on a precision course, maintains a constant air speed and altitude, and makes the required turns until the arrival at the target area.

b. The Radar Observer keeps the equipment operating at peak efficiency and adjusts the equipment to give maximum definition of check points and the radar target area. He will transmit to the bombardier all information necessary for presetting bombsight data and signal bombardier as to time of original check point and all subsequent check points. He will direct the aircraft on a collision course with the target.

B. STANDING OPERATING PROCEDURE - RADAR BOMBING

1. Purpose.

a. To provide dependable blind bombing using radar data.

b. To incorporate the optical bombsight for:

(1) Quick changeover to visual bombing.

(2) Integration of radar range data for determining bomb release time.

c. To eliminate differences in procedure for solving the direct bombing problem.

2. Equipment.

a. Navigator.

(1) Usual navigation equipment.

(2) Navigator's target folder.

b. Radar Observer.

(1) Screw driver and flashlight.

(2) Maps required for mission to be flown.

(3) Radar slant range---optic angle tables (see appendix) or Nosmo attachment.

(4) Radar Observer's target folder.

c. Bombardier.

(1) Norden or S-1, M-2 bombsight.

(2) AB computer attached to bombsight.

(3) Navigation equipment and target folder.

(4) Bombing tables.

3. Responsibilities and duties.

a. Navigator.

(1) Control heading of aircraft until IP has been identified.

(2) Furnish bombardier with following information:

(a) Wind direction and velocity.

(b) Drift.

(c) True heading.

(d) Ground speed and altitude.

(3) Maintain a continuous record of the aircraft's position.

b. Radar Observer.

(1) Operate equipment for peak efficiency.

(2) Supply bombardier with altitude above target.

(3) Maintain a DR plot using radar as an aid and be able to control the flight in an emergency.

(4) Control heading of aircraft from time that IP is identified until completion of the bombing run.

(5) Furnish bombardier with following information:

(a) Briefed angle for original setting of bombsight optics.

(b) The intersection of the target with the appropriate pre-set bomb release pip.

(c) Intersection of target with bomb release pip when said pip is set at slant range subtending each subsequent sighting angle to be checked for rate corrections.

c. Bombardier.

(1) Prepare equipment for bombing.

(2) Take over for visual run if possible.

(3) Pre-set data in AB computer and bombsight.

(4) Drop bombs with bombsight regardless of visibility.

4. Operational solution of the bombing problem.

a. Time: Within last hour before bombs away.

b. Airplane Commander will:

(1) Maintain steady flight.

(2) Hold aircraft at briefed altitude above target.

(3) Maintain proper air speed during bomb run.

(4) Allow no unnecessary deviation from above.

c. Radar Observer will:

(1) Have completed air calibration check of set.

(2) Keep equipment operating at peak efficiency.

(3) Obtain absolute altitude.

(4) Compute radar wind.

(5) Compute drift and heading for proposed course to target.

(6) Inform bombardier of 3, 4 and 5 above.

(7) Determine allowance for turn at IP.

(8) Identify target as it comes within range.

(9) Set up bomb release pip at predetermined position for bombsight rate motor switch-on.

(10) Set course marker on course of bombing run.

(11) Advise pilot of new heading for IP turn with bombing run drift included. (See appendix.)

(12) At IP, less turn allowance, request pilot to turn.

(13) Scan target area to locate and identify target.

(14) Using quadruple correction, kill drift in order to fly collision course to target.

(15) Notify bombardier of approach of point for turning on rate motor switch.

(16) Check for drift and make necessary correction.

(17) Call for switch-on of rate motor at intersection of target with bomb release pip.

(18) Announce successive values of the sighting angle as determined by passage of target over bomb release pip.

e. Bombardier will:

(1) Set in correct disc speed and trail in the bombsight for the bombing altitude.

(2) Set up AB computer to obtain tangent of dropping angle and drift for the anticipated heading of the bomb run.

(3) Pre-set the data obtained above on the bombsight.

(4) When plane comes on course to target, insure that all switches on the bombsight are "on" except rate motor switch. Level bubbles and keep gyro uncaged.

(5) Make sure that the telescope index is positioned in accordance with the value set up at the briefing and clutch on.

(6) At the predetermined signal from the radar observer, turn rate motor switch "on".

(7) As the radar observer calls in successive values of the sighting angle, check those values against the

position of the telescope index as it travels forward.

(8) Reposition the telescope index in accordance with angles called by the radar observer.

(9) Have trigger up before indices meet to release bombs.

(10) Be constantly on the alert to take over the complete visual sighting operation in the event the target becomes sufficiently visible.

C. TARGET IDENTIFICATION

1. Student should be required to fly over unfamiliar territory and identify target area given at briefing. A proficiency grade may be given, based on the rapidity of recognition.

D. SIMULATED BOMBING (Using Radar as a Sighting Device)

1. Simulated bombing, using radar as sighting device, will be conducted on targets of opportunity throughout flying training.

2. However, for scoring the simulated radar bombing, the mission must be planned. Briefing must be thorough, and all bombing will be on targets designated by the briefing officer.

3. Procedures as outlined in Section II and III will be used for reaching the target area for the radar bombing run.

4. Scoring Methods.

a. Two methods are used for bomb scoring of simulated bombing attacks.

(1) Aerial camera.

(2) SCR-584.

b. Aerial camera.

(1) Use procedure as outlined in 2AF Electronic Intelligence Manual.

c. SCR-584.

(1) When available, SCR-584 will be used to plot the aircraft to the plotting room of the SCR-584 for marking the time. From this information and bombing tables, the theoretical impact point may be determined.

E. QUADRUPLE DRIFT CORRECTION PROCEDURE

1. The purpose of this procedure is to provide a convenient and accurate means of using the AN/APQ-13 and AN/APQ-7 equipment for correcting the error in drift angle in order to make good the course to the target during a bombing approach.

2. This procedure is as follows:

a. After completion of the procedure turn, when the target becomes visible on the scope, the distance in miles to the center of the scope is noted.

b. The bearing line is placed directly over the target and the azimuth noted. The target is allowed to travel one-quarter (¼) of this distance toward the center of the scope, and the bearing line is readjusted until it is again directly over the target. The difference in azimuth readings is multiplied by four (4) which gives the number of degrees for drift correction.

c. In order to kill the drift and correct the heading to the target, the pilot is told to turn the aircraft in the direction in which the bearing line was turned and by the amount ascertained by the foregoing procedure.

SECTION IV - RADAR PPI PHOTOGRAPHY

A. EQUIPMENT

1. Photographic equipment for Radar Aerial Training will consist of a scope camera for photographing the radar display and an aerial camera for scoring simulated radar bombing in addition to aerial photographs for reconnaissance purposes. Intervalometers may be used with either camera when applicable.

2. Purpose:

a. The photographs will be used to provide information for the briefings of future missions by interpreting the degree of accuracy of past missions, and pointing out the reasons for failure as a means of forestalling future troubles. This analysis will be made by Radar Intelligence Officers immediately following each radar mission. This will necessitate immediate processing of film after the mission.

b. Photographs should be taken on all radar landmarks and of all probable radar target areas. These photographs will be used as briefing material for future missions and may also be used for training purposes.

3. Duties:

a. During the training both the Navigator and Radar Observer will be taught to operate the scope camera.

b. The Bombardier will operate the aerial camera and associated equipment as in simulated optical bombing.

c. The station photographic officer will cooperate by assisting in the training of loading and exposure settings for the photographic equipment. In addition he will be responsible for processing all exposed film.

4. Procedure: (Exposures, Categories and Numbers)

a. Radar Navigational Check Points. Exposures

are to be made on optimum gain settings on 50 mile range at approximate 30 mile intervals. Additional exposures will be made of outstanding or critical landmarks.

b. Initial Point and Target. Exposures are to be made on optimum gain settings at ten second intervals through approach, bomb run and through target area when possible.

5. Titling:

a. For proper filing and indexing, titling will be done in the following manner:

Group	Squadron	Crew	Mission	Day	Month	Year	Altitude	Heading	Range	Latitude	Longitude
(504	389	44)	03	(20	8	44)	20,000	(218°T)	20	(40°30'N	65°08'W)

(504-389-44)03(20-8-44)20,000(218°T) 20(40°30'N-65°08'W)

Airplane No.	Geographical position photographed
567	(Kansas City)

567 (Kansas City)

6. Photo Log:

a. A radar scope photo log will be maintained to provide data not obtainable from charts, aerial photos, or navigator's log.

SECTION V - RESPONSIBILITY FOR INSTALLATIONS

A. SECURITY

1. The material contained in this document comes under the following security acts:

a. Espionage Act, 50 USC, 31 and 32 as amended.

b. AR-380-5, ARTS. 75 1/2 and 76 USN Regs. - 1920.

2. Destruction of Abandoned Material in the Combat Zone.

a. In case it should become necessary to prevent the capture of this equipment and when ordered to do so--destroy it so that no part of it can be salvaged, recognized or used by the enemy. (BURN ALL PAPERS AND BOOKS!)

b. Means:

(1) Explosives, when provided.

(2) Hammers, axes and sledges, machetes or whatever heavy objects are readily available.

(3) Burning by means of incendiaries such as gasoline, oil, paper or wood.

(4) Grenades or shots from available arms.

(5) Burying all debris or disposing of it in streams or other bodies of water where possible and when time permits.

c. Procedure:

(1) Obliterate all identifying marks. Destroy name plates and circuit labels.

(2) Demolish all panels, castings, switch and instrument boards.

(3) Destroy all controls, switches relays, connections and meters.

(4) Rip out all wiring and cut interconnections of electrical equipment. Smash gas, oil and water-cooling systems in gas engine generator, etc.

(5) Break up all operating instruments such as keys, phones, microphones, etc.

(6) Destroy all classes of carrying cases, straps, containers, etc.

(7) Bury or scatter all debris.

DESTROY EVERYTHING!

B. SAFETY

1. High voltages in all radar equipment may prove fatal to operating and maintenance personnel when contacted directly at certain points with operating voltages applied. The following precautions should always be observed:

a. Only qualified personnel, who understand the circuits, voltage points and existing potentials at these points, should endeavor to check or calibrate radar equipment, especially when a safety cover has to be removed to make said checks.

b. Whenever possible, through continuity of similar check procedures, the equipment should be checked with operating voltages off. This procedure will tend to protect both the equipment and the personnel.

c. In the event it becomes necessary to check voltages at high voltage points, the procedure should be carried on with the utmost care. Conducting wires to the meter used and test prods used should be covered with good insulating material of sufficient depth to withstand this high voltage.

BE CAREFUL--ELIMINATE HAZARDS--STAY ALIVE.

SECTION VI

STANDING OPERATING PROCEDURE FOR THE AN/APQ-13

A. GENERAL DESCRIPTION OF THE EQUIPMENT

1. The AN/APQ-13 radar system is designed primarily for high altitude area bombing through the detection of land targets, although it may be used for detecting any surface target and other aircraft. The set will operate day or night and through an overcast, under temperatures ranging from about minus 40° to plus 125° Fahrenheit, and with relative humidity as high as about 90 per cent. The best operating altitude ranges from 15,000 feet to 35,000 feet.

2. The equipment functions as follows: An antenna of the spinner type is mounted in a radome below the fuselage. This antenna sends out a beam and also receives the reflected signals while rotating through 360° in azimuth. The reflected signals are relayed through the equipment to a cathode ray tube of the oscilliscope (PPI type). This tube or scope provides a visual means of locating and identifying targets. The fluxgate compass is interconnected with this system so that true north always appears at the top of the scope when azimuth stabilization is in use. The system operates over five ranges; 4, 10, 20, 50 and 100 nautical miles. A sweep delay plus an altitude delay may be employed to increase the range to approximately 300 nautical miles for beacon operation.

3. The range markers may be placed on the scope at either one or five mile intervals with set operation on any range. A computer box is also provided to enable one to place a bomb release pip on the scope. Either direct or synchronous bombing can be done with this equipment.

B. TURN ON PROCEDURE

1. Check to see that the following switches are in the position shown before turning on the equipment.

a. Control Box.

CONTROL	POSITION
(1) Power	OFF
(2) Trans.	OFF
(3) Ant. Cont.	OFF
(4) Rec. Tuning	CCW
(5) Rec. Gain	CCW
(6) Range Nautical Miles	10
(7) AFC Off, AFC On, Beacon	AFC OFF
(8) Test Meter Switch	Xtal

b. Azimuth Control Box.

CONTROL	POSITION
(1) Azimuth Stab.	OFF
(2) Sector Scan	OFF
(3) Heading Marker	OFF
(4) Sweep Delay Miles	"0"

c. Indicators.

CONTROL	POSITION
(1) Bright Control	CCW
(2) Scale Illumination	CCW

d. Computer.

CONTROL	POSITION
(1) On-Off (Bomb Release Marker)	OFF
(2) Normal - Cal Zero	Normal above 15,000 feet. Cal zero below 15,000 feet.

e. Synchronizer.

CONTROL	POSITION
(1) Range Marker Nautical Miles	OFF

f. Range Unit.

CONTROL	POSITION
(1) Power On-Off	ON
(2) Calibrate	Normal

g. To Operate.

CONTROL	POSITION
(1) Power "ON" (Control Box)	There must be a (3) minute wait before the "Trans On" button is pressed.
(2) Meter Selector Switch (Control Box)	Xtal voltage can now be measured and adjusted by RCVR Tuning to be between .6 and 1.1 milliamperes.
(3) Bright Control (Indicators)	Turn clockwise until sweep or trace appears on the PPI screen.
(4) Antenna Search (Control Box)	Held in the CW position for several revolutions until selsyns in the antenna and indicators are synchronized.

(5)	Focus (Indicator)	Adjusted for maximum sharpness of sweep.
(6)	Centering (Indicator)	Adjust H Centering and V Centering until sweep starts at intersection of drift lines on the plastic scale.
(7)	Bright Control (Indicators)	Turn fully CCW to protect scopes.
(8)	Trans ON-OFF (Control Box)	"ON"
(9)	Meter Switch (Control Box)	Trans I (should read between 6-8 milliamperes)
(10)	Bright Control (Indicators)	Turn clockwise until sweep is barely visible.
(11)	Ant. Cont, On-Off (Control Box)	"ON"
(12)	RCVR Gain (Control Box)	Turn clockwise until noise appears.
(13)	Meter Switch AFC ON-OFF Beacon (Control Box)	AFC used to measure AFC voltage.
(14)	Meter Switch AFC ON-OFF Beacon (Control Box)	Rep. used to measure rep. voltage.
(15)	RCVR Tuning (Control Box)	Turn clockwise until best target returns appear.
(16)	Ant. Cont. (Control Box)	Off - this is done so that the operator can tune for best target return with RCVR tuning.

(17)	Ant. Tilt (Control Box)	Switch is now regulated for further maximum indication of target return.
(18)	Meter Switch AFC ON-OFF Beacon (Control Box)	AFC - ON
(19)	Bright (Indicator)	Operator adjusts for desired intensity.
(20)	RCVR Gain (Control Box)	To give desired intensity on scope.
(21)	Scale Illumination (Indicator)	As desired by operator.
(22)	Range Nautical Miles (Control Box)	Range desired by operator.
(23)	Range Marker (Synchronizer)	On or off as desired by operator.
(24)	Heading Marker (Azimuth Control Box)	On
(25)	Azimuth Stab. (Azimuth Control Box)	On
(26)	Sweep delay (Azimuth Control Box)	Desired position.
(27)	Sector Scan (Azimuth Control Box)	Can be used if desired.
(28)	Altitude Control (Computer)	At planes radar altitude.

h. For Beacon Operation

CONTROL	POSITION
(1) AFC ON-OFF, Beacon	Beacon

i. Procedure for Turning Off.

CONTROL	POSITION
(1) Ant. Cont.	OFF
(2) Sector Scan	OFF
(3) Azimuth Stab.	OFF - wait until sweep comes to rest before turning Ant. Cont. ON again
(4) Trans.	OFF
(5) Power	OFF

C. PREFLIGHT CHECK

1. Prior to take off the radar equipment should be checked by either a radar mechanic or the radar observer. In view of the loss of training time and flying time caused by malfunctions in the air resulting from discrepancies that should have been found before take off, it is an absolute necessity that the equipment be preflighted.

2. Effective 1 May 1944 as prescribed in AAF Reg 15-38, forms 38, 38A, 38B and 38C will be used by AAF personnel as a service record on radar equipment.

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a. Form 38 provides a report of radar operation for each flight recording tactical use, radar operation time and any unsatisfactory radar operation. Form 38 informs the radar operator, before take off, that radar check list has been completed by mechanics and provides a record for Headquarters, Air Service Command of first echelon maintenance performed before or after each flight. This form will be used to facilitate maintenance and to furnish operational data to Headquarters, AAF.

b. Form 38A provides a running inventory of radar equipment in aircraft with total hours operation of each unit of radar equipment.

c. Form 38B provides the basis for all second, third and fourth echelon maintenance data entered on form 38C.

d. Form 38C reports all second, third and fourth echelon maintenance on radar equipment to Headquarters, Air Service Command for maintenance information and analysis.

D. INFLIGHT MAINTENANCE

1. If it is found during flight that the equipment is not operating properly or fails entirely, use the following procedure.

a. Turn off the equipment and check all connecting cables between the various units.

b. Check with Engineer to see that proper power is being supplied by generators.

c. Check the main junction box for burned out fuses. Spare fuses are attached to the cover of the box. Additional fuse locations to be checked are in the Antenna Unit Inverter, Azimuth Control Box and Range Unit.

d. If the scope picture is indistinct, move the Ant. Tilt control back and forth until best picture is obtained.

e. If picture disappears from scope, check the transmitter; it sometimes kicks off.

f. If, with AFC on, the picture becomes indistinct, adjust the AFC voltage screw on the Synchronizer Unit.

g. If sweep line does not rotate in phase with the antenna, turn Azimuth Stab. off, then rotate the antenna at least six complete revolutions by holding the Search switch in the "CW" position.

h. In case of failure of Azimuth Stab., Sector Scan, Sweep or Target returns - check fuses.

E. NAVIGATION PROCEDURE

1. The radar observer is concerned primarily with pilotage and dead reckoning. To navigate an airplane, the drift, drift correction and methods of determining wind direction and velocity must be known.

a. The radar observer, by doing scope pilotage and using the bearing scale and range markers on various check points along the course, can obtain radar fixes. With the time and distance between fixes and an E-6B computer, he can determine his ground speed. By using his true heading, true air speed, ground speed and average track (line drawn through his fixes), he can determine his wind direction and velocity.

b. Another method of determining wind direction and velocity may be worked out by using the A.P.I. in conjunction with a radar fix. Through a predetermined procedure with the navigator, the radar observer obtains the coordinates from the A.P.I. at the same time of his fix. By plotting the coordinates of the A.P.I. and the coordinates of the radar fix and determining the bearing of the radar fix from the air position, he can obtain the wind direction. By measuring the distance and applying it to the time the wind has been affecting the plane, he can determine the wind velocity.

c. A third method of determining the wind direction and velocity is by taking a wind run. In this method the observer picks up an echo on the twenty mile range and takes the bearing, distance and time. As the return crosses his scope he keeps taking bearings and distances (switching to lower ranges if necessary). When the echo leaves the scope (20 mile range), he again takes the time.

d. With this information and an E-6B computer, he is ready to solve his problem. Using the back of the computer and with the square grid position of the computer slide under the transparent window, he plots his bearings. The bearing is placed under the True Index and he marks off the distance along the center line from the grommet toward the True Index marker. The bearing scale is then rotated and the second bearing plotted in

a similar manner. For best results at least six bearings should be plotted. The compass rose should then be rotated until all the points parallel the center line. The reading opposite the True Index marker is the track being made good. The distance covered should be measured by counting the number of units between the first and last bearing. This should be compared with the elapsed time between the first and last bearing to obtain ground speed. Enough information should now be available (true heading, true air speed, ground speed and track) to find wind direction and velocity.

F. BOMBING PROCEDURE

1. In order to drop bombs successfully on a given target, we must have two things:

a. Proper course.

b. Correct instant for release.

2. It is, then, the radar observer's job to take over at the IP and navigate the plane over the target. Even though the bombs are to be dropped through an overcast, the bombardier should be ready to take over in case there is a break in the overcast in the target area. The reason for this is that optical bombing is usually much more accurate than radar bombing, if the target is visible to the bombardier. The observations made with the radar set can be used to set up the proper sighting angle for the bombsight so that if there is a break in the clouds, the cross hairs will be lined up on the target within the limits of the accuracy of the radar observation.

3. It is the job of the radar observer to supply the bombardier with the altitude of the plane above the target, the ground speed on bomb run, the wind direction and velocity and time to start rate motor. The bombardier then sets up his sight for bombing and awaits the signal from the Radar Observer to start his rate motor.

4. The radar observer then positions the computer drum so that the slant range corresponding to the telescopic angle of 70^{o} is coincident with the marker at the top of the drum. He next turns on his bomb release marker and looks in his scope. He navigates the ship toward

the target and watches the bomb release circle. When the target and bomb release circle intersect, he notifies the bombardier who has his telescope indices set at 70°. The bombardier then starts his rate motor. The radar observer next moves the computer drum to the slant range corresponding to the next telescopic angle and again watches the bomb release circle. When it intersects the target, he calls the angle to the bombardier who then checks his telescope indices. If the telescope is driving too fast or too slow, he makes a correction. This procedure is repeated at various angles until the indices on the bombsight are about to meet. The bombardier sees to it that the trigger is up and the bombs are automatically dropped by the sight. The radar observer then prepares to take up his radar navigation again.

5. The method for determining absolute altitude with the AN/APQ-13 is as follows:

a. Normal Cal zero switch at Cal zero.

b. Bomb release pip in ON position.

c. Turn computer drum until the inside rim of the bomb release pip is just coincident with the inside rim of the altitude circle.

d. Read slant range in nautical miles at top of computer drum.

e. Multiply this value by 6080 feet to get absolute altitude in feet.

SECTION VII

STANDING OPERATING PROCEDURE FOR THE AN/APQ-7

A. GENERAL DESCRIPTION OF EQUIPMENT

1. This SOP has been developed to provide a guide for the use of AN/APQ-7 for navigation and bombing. Radio set AN/APQ-7 is an "X" band radar set designed primarily for installation in very heavy bombers. It functions as search equipment and has proven very satisfactory for high altitude bombing through an overcast or at night against either land or water targets. The systems operate over two (2) fixed ranges (0-80) and (0-160) statute miles, and a third range, designated 30 miles, which is expansive from (0-10) to (0-30) miles. The antenna is fixed in position under the aircraft and greatly resembles a small wing. This antenna scans electrically in azimuth through a 60° sector, that is 30° to left and 30° to the right of the heading of the aircraft. By using the antenna scan switch it is possible to scan the entire 60° or 30° left or 30° right as desired. Oscilloscopes are used to give a ground plan indication of the targets to the radar observer and to the navigator who has an auxiliary scope. This equipment also contains a computer to solve the bombing problem. Absolute altitude, ground speed, type of bomb and range wind (difference between ground speed and true air speed either plus or minus up to 100 miles) are set into the set. Absolute altitude can also be determined with this equipment by using a Push to Set Alt button. A special attachment known as Nosmo is attached at the operator's position to allow synchronization with the optical bombsight. Nosmo consists of two boxes. One box contains a switch which positions the bomb release marker corresponding to the sighting angle value set in. The other box contains two altitude adjustment knobs and a switch to cut the attachment in or out.

B. GENERAL OPERATING PROCEDURE

1. Operator's Indicator.

a. See that the following controls are in position indicated.

SWITCH	POSITION
(1) Transmitter	Off
(2) Inverter	Off
(3) Ant on - Ant off	Ant Off
(4) Ant scan	F (left position)
(5) Ant Scan Test	Normal (midposition)
(6) Intensity (Main scope)	Full CCW
(7) Intensity ("A" scope)	Full CCW
(8) Ext trigger	Int.
(9) Ext Video	Int.
(10) A. J.	Off
(11) Rec. Gain and Range Exp.	Loc.
(12) Rec. Gain	Full CCW
(13) Rel. Intensity	Full CCW
(14) Range Intensity	Full CCW
(15) Meter Switch	+ 600 V
(16) Range Scale Miles	160
(17) AFC	Off
(18) SW1 (Radar Norden Control Box	Radar

b. To turn set on and tune up Operator's Indicator.

SWITCH	POSITION
(1) Airplane Generators	Check with Engr to see that generators are turned on and functioning

properly.

(2) Inverter — Push ON button. Check to see that voltage does not exceed + 900 V and that it drops to + 700 V (± 10% allowance).

(3) Check meter readings as follows:

Meter Switch Position	Range Scale	Meter Reading
+ 600 V	160	700 ± 10%
+ 300 V	30 or 80	600 (actual 300) ± 10%
+ 120 V	30 or 80	240 (actual 120) ± 10%
- 300 V	30 or 80	600 (actual 300) ± 10%
Xtal 1	30 or 80	6 to 12 (Read maximum value as Rec tune knob is rotated).

NOTE: Do not adjust voltages unless they are badly off. Make small adjustments, if necessary, after the set has been operating at least fifteen (15) minutes, and the airplane is not climbing steeply. + 600 V is adjusted by the INV 1 ADJ screw on the control unit; other voltage adjustments are on low voltage rectifier unit.

	SWITCH	POSITION
(4)	Intensity and Focus (A scope)	Adjust for suitable trace on "A" scope.
(5)	Vert Center ("A" scope)	Adjust if necessary.

(6)	"A" Gain ("A" scope)	Full clockwise.
(7)	Ant on - Ant off	Switch to Ant on. Turn up intensity (Main Scope) until trace is visible and check that sweep covers both halves of the scope.
(8)	Scale Illumination	Turn to bright or dim as desired.
(9)	Cursor Illumination	Turn to bright or dim as desired.
(10)	Counter Illumination	Off-dim or bright as desired.
(11)	Meter Switch	Mag I.
(12)	Transmitter ON. (Three (3) minutes must have elapsed since turning on Inverter).	Press button. Check meter readings as shown below.

Range Scale	Mag I
30	7 ± 1
80	8 ± 1
160	5 ± 1
ALL RANGES (BEACON)	10 ± 1

NOTE: Transtat may be adjusted with screw driver if readings are too high or too low. Adjust to 8 mils on the 80 mils scale.

(13)	Intensity (Main scope)	Turn clockwise until sweep is visible, then reduce until sweep is just not visible. NOTE: This is done with REC

		GAIN full CCW.
(14)	Video Gain	Set to about mid position.
(15)	Receiver Gain	Set for about one-quarter inch of noise on the "A" scope, or until the sweep becomes visible (but not bright) on the main scope.
(16)	Receiver Tune	Turn slowly until brightest signals appear on main scope.
(17)	Intensity (Opr Ind)	Full CCW
(18)	Video GAIN	Full CCW
(19)	Rec Gain	Turn CW until noise appears on "A" scope 3/4 the amplitude of the main bang (Transmitter pulse).
(20)	Video Gain	Turn CCW until signals on "A" scope are just under full limiting or until the heads of the signals taper off without losing amplitude.
(21)	Intensity (Opr Ind)	Turn CW until signals appear on main scope against a dark background. NOTE: Video Gain should now be in such adjustment as

		not to require frequent tuning. Video Gain too high will cause blooming and loss of detail; Video Gain too low will cause the picture to appear dim and flat.
(22)	AFC	Switch to ON. The picture should remain the same. If signals disappear or become weaker leave AFC ON and try varying REC TUNE. If this does not help, AFC is too far out of adjustment. In this case, switch AFC to OFF and readjust REC TUNE. Check REC TUNE at intervals.
(23)	Receiver Gain	Adjust for best picture on main scope. Settings will vary with type of detail desired (land and water boundaries, built up areas, hill shadows), range of observations and altitude. NOTE: In general, a high REC GAIN setting is desirable for land and water boundaries and hill shadows, and a low REC GAIN for built up areas.
(24)	Cursor Line and Scale Adjustment	Set the ANT SCAN TEST SWITCH (bottom

of control box) in #2 position (right). This places a bright sweep trace (heading marker) at zero degrees. Expand the sweep to ten (10) miles. Align the CURSOR parallel with the bright trace. Now adjust the CURSOR SCALE until zero (0) is directly above the cursor line.

(25) Hor and Vert Center — After the above adjustment is made, adjust HOR AND VERT CENTER controls so that the bright trace coincides with the cursor line and the bottom of the sweep trace is at the pivot point of the cursor. Return ANT SCAN TEST SWITCH to NORMAL (middle position).

(26) Altitude Determination. — When airplane reaches operating altitude and is in level flight, set ALT DIAL as given below. This setting should be made at intervals during a mission because it is necessary to give a correct picture on the scope as well as to set the correct data into the bombing computer.

(a) SW1 (on Radar-Norden Control Box) — RADAR

(b) REL Intensity — Turn clockwise until release line is visible on main scope. Blip will show on "A" scope.

(c) Hor Cent ("A" scope) — Adjust until release marker blip is near center of "A" scope.

(d) Push to Set Alt. — Press down.

(e) Alt (knob) — Turn until left edge of first ground echo rides up on and adds to top of release marker on "A" scope.

(27) Range Intensity. — If range marks are desired, turn clockwise until they appear. Range marks are ordinarily used all the time except on the bombing run. They mark slant range intervals of 5 statute miles on the 30 mile range scale and 10 statute miles on the 80 and 160 mile scales.

(28) Range Scale — 30, 80 or 160 as desired.

(29) Range Expansion. — Expand 30 mile range scale as desired.

(30) To tune in Radar Beacons:

(a) Meter Switch — Xtal I

(b) AFC — B

(c) Rec Gain — Counter-clockwise until noise almost disappears on main scope.

(d) Rec Tune — Set for maximum meter reading. Watch scope carefully. If no beacon signals are observed, rotate REC TUNE knob

		very slowly over the range where XTAL I shows on the meter.
(31)	AJ(Anti-jamming Switch)	To reduce the effect of interference from other radar sets or of intentional jamming, switch AJ to ON and increase VIDEO GAIN. This procedure can also be used to advantage in a congested area to make the edges of a target stand out.

c. To turn off set.

(1)	Fill out radar maintenance report.	
(2)	INTENSITY (All Oscilliscopes)	Full CCW
(3)	Ant - off. Ant On	Ant Off
(4)	Transmitter Off	Press
(5)	Inverter off	Press

2. Navigator's Indicator.

a. Pre-operation Checks.

	CONTROL	POSITION
(1)	Intensity	Full CCW
(2)	Receiver Gain	Full CCW
(3)	Range Expansion	Full CCW
(4)	Range Intensity	Full CCW
(5)	Video Gain	Full CCW

b. Tune Up and Normal Operation.

	CONTROL	POSITION
(1)	Intensity	Check with Radar Observer to see that the set, including transmitter is turned on. Turn INTENSITY up until sweep is visible, then turn INTENSITY back until sweep is just not visible.
(2)	Video Gain	Turn clockwise until best picture is observed on scope. If a good picture is not obtained, check with Radar Observer to see what is appearing on his scope. NOTE: VIDEO GAIN too high will cause blooming and loss of detail; VIDEO GAIN too low will cause the picture to appear dim and flat.
(3)	Range Intensity	Turn clockwise until range markers appear. Both range and release markers are controlled by this knob.
(4)	Scale Illumination	Turn to BRIGHT or DIM as desired.
(5)	Cursor Illumination.	Turn to BRIGHT or DIM as desired.
(6)	Cursor Line and Scale Adjustment.	Ask Radar Observer to place ANT SCAN TEST switch in #2 (right) position. Adjust

		CURSOR LINE AND SCALE as in Section VII, B, paragraph 1b(24).
(7)	Hor and Vert Center	With ANT SCAN TEST switch as above, adjust HOR AND VERT CENTER controls, as in Section, B,. paragraph 1b(25). Ask Radar Observer to return ANT SCAN TEST SWITCH to normal (mid position).
(8)	Rec Gain and Range Expansion (Opr Ind).	This switch on the operator's indicator puts either the Radar Observer or the Navigator in control of receiver gain and range expansion. In the LOC position (up) the REC GAIN and RANGE EXPANSION knobs on the operator's indicator affect both scopes while the REC GAIN and RANGE EXPANSION knobs on the navigator's indicator are inoperative. In the NAV position (down) the controls on the navigator's indicator affect both scopes while those on the operator's indicator are inoperative. Ask the Radar Observer for control of these functions when required and notify him when no longer required.
(9)	Rec Gain	When this control is operative, use as in

Section VII, B, paragraph 1b(23).

(10) Range Expansion — When this control is operative, use to expand picture as desired.

C. PREFLIGHT CHECK

1. Prior to take off the radar equipment should be checked by either a radar mechanic or the radar observer himself. In view of the loss of training time and flying time caused by malfunctions in the air resulting from discrepancies that should have been found before take off, it is an absolute necessity that the equipment be preflighted.

2. Effective 1 May 1944, AAF forms 38, 38A, 38B, and 38C will be used by AAF personnel as a service record on radar equipment as specified by AAF Regulation 15-38.

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c. Form 38B provides the basis for all second, third and fourth echelon maintenance data entered on Form 38C.

d. Form 38C reports all second, third and fourth echelon maintenance in radar equipment to Headquarters, Air Service Command for maintenance information

or analysis.

D. INFLIGHT MAINTENANCE

1. Emergency operation in flight.

a. If the equipment fails in flight, make an inspection and tighten all cable connectors. Many causes of faulty operation can be traced directly to loose connections. Special emphasis should be placed on the high voltage connectors. They must be tightly screwed together and the rubber faces of the plugs and jacks must be clean. Should such a connector fail, it will be charred by the arc and will usually need to be replaced.

CAUTION!

Turn system off completely before disconnecting cables.

b. Next make a routine check of all fuses in Junction Box J-51/APQ-7. A set of spare fuses is contained inside the removable cover of this unit. The spare supply should be kept complete at all times and all replacements must be of the correct size and ampere rating for proper protection. Notify the radar maintenance crew of all blown and replaced fuses.

c. If the oscilloscope pattern is improperly centered or indistinct, the following procedure may be carried out by the radar operator:

(1) Check that the ANT ON - ANT OFF switch is in the "ANT-ON" position and the ANT SCAN is on "F".

(2) Turn the "Range Scale Miles" knob to "30" and the "Range Expansion" knob to "10".

(3) Turn the "AFC" knob to "Alt O".

(4) Adjust the "Focus" control for the operator's or navigator's oscilloscope as required to give a clear sharp trace. It is desirable to stop the antenna scan while this is being done.

(5) Adjust "H" Centering and "V" Centering

controls to put apex of the scan sector at the origin of the Cursor (transmitter on).

(6) Do not attempt to adjust any of the calibrating controls under the cover plate on the front of the operators indicator as these require the use of special testing equipment and technique.

d. If the brightness of the sweep trace on the oscilloscope changes as it scans through zero degrees (dead ahead), the operator may correct the condition by making the following adjustments.

(1) With the transmitter at "Off" check that the "ANT-ON - ANT-OFF" switch is on "ANT-ON" and the "ANT SCAN" switch is at "F".

(2) Adjust the "SCAN ZERO START" screw driver control on the control until the trace does not brighten appreciably as the scan moves toward zero degrees (dead ahead).

(3) Adjust the "SCAN ZERO STOP" screw driver control on the control unit until the trace does not brighten at dead ahead and is not followed by a dark sector after the scan goes through dead ahead. NOTE: "SCAN ZERO START" affects the scan as it approaches the center from either left or right. "SCAN ZERO STOP" affects the scans as it leaves the center from either left or right.

e. If the sweeps on the oscilloscopes are abnormal, check the meter reading for the + 600 V position of the meter selector switch. If it is not 700 volts, adjust the "INV-2 ADJ" screw driver control on the control unit until this reading is obtained.

f. If the modulator tends to "kick out" due to operation of the overload relay, turn the screw driver adjustment on the voltage regulator counter-clockwise. If

this does not correct the condition, turn off the set and do not attempt to operate.

g. If echoes are unsatisfactory and the receiver is properly tuned, the trouble may be due to low output power; this will usually be evidenced by a low "MAG I" reading. It may be possible to correct this condition by the following procedure.

(1) Adjust the screw driver control on the voltage regulator until the overload relay operates and turns off the modulator.

(2) Back off the voltage regulator control until the modulator functions normally as evidenced by a constant "MAG I" reading.

2. No other inflight maintenance should be tried by the operator.

E. NAVIGATION PROCEDURE

1. General.

a. Standard Navigation Equipment will be carried by the Radar Observer.

(1) E-6B Computer

(2) Weems Plotter

(3) Dividers

(4) Stop Watch

(5) Maps and all other information necessary to a navigational mission.

(6) An AN/APQ-7 Ground Speed Computer.

b. It must be kept in mind that all calibrations of this equipment are in STATUTE MILES. Also, it must be remembered that all ranges indicated by the scope are SLANT RANGES, i.e., straight line distances from airplane to ground point. Slant range of twenty (20) miles or more is usually considered the same as

ground range. Smaller distances must usually be converted to ground range. A table for use in converting Slant Range to Ground Range at various altitudes is contained in the Appendix. For ground speed by target timing, the Ground Speed Calculator automatically takes care of ground range conversion.

c. The disadvantage of the limited (60°) scan of the AN/APQ-7 is somewhat offset by the ability of this equipment to present a map-like picture in more detail than can H2X (AN/APS-15 or AN/APQ-13). However, in order for the AN/APQ-7 to be used as effectively as H2X as an aid to navigation, the Radar Operator must be continually alert, since his "vision" is restricted to 30° each side from dead ahead.

d. The Radar Operator and the Visual Navigator work as a NAVIGATION TEAM. It is the duty of the Radar Operator to keep an up-to-date Radar Log and to supply the Navigator accurate fixes and information regarding drift and ground speed that can be obtained from the radar set. He must calculate wind and check these against the Navigator's wind calculations. The Navigator will, in turn, assist the Radar Operator in finding radar check points and in identifying indistinct returns. The Navigator is reponsible for the plane's course except during the bombing run.

2. Method of Obtaining Fixes.

All bearings measured with this equipment will be relative bearings. To obtain True Bearing the standard formula is : TRUE HEADING + RELATIVE BEARING = TRUE BEARING. The fix is obtained by plotting True Bearing and Ground Range to a known point.

3. Methods of Obtaining Winds.

a. Air Plot. This is the preferred method for determining wind.

(1) Fix and plot the aircraft's position on the map. This starting point fix is both air and ground position.

(2) At a later time, plot ground position using a radar fix and plot an air

position for the same instant of time.

(3) Measure the true bearing and the distance from the air position to the ground position. The bearing so obtained is the direction of the wind. The distance divided by the elapsed time equals the wind velocity.

b. Drift and Ground Speed on One Heading.

This standard method of finding wind can be used as check on the air plot method and in cases where reliable check points are not available. Ground speed can be determined by target timing (see paragraph 4a below), while a fairly accurate drift is usually available from observation of target motion on the scope. To obtain drift, simply watch a pin point for some time and align the cursor parallel with the apparent motion of the point. A more exact method of aligning the cursor to the drift angle is the following:

(1) Pick a pin point which is believed to be approximately on course.

(2) Align the cursor on this point and expand the sweep to place the point under the top marker on the cursor. Note the position of the cursor.

(3) Follow the point with the cursor until it reaches the center mark on the cursor.

(4) The amount the cursor was moved is the amount that the pin point was off course at the start. Set the cursor this amount from the starting value in the opposite direction. The cursor is now aligned to the drift angle and indicates the track.

4. Method of Obtaining Ground Speeds.

a. Ground Speed Calculator (Target Timing):

If a well defined target is picked out which is approximately on course, an accurate ground speed can be determined by timing the passage of the

target between two (2) range marks. The two (2) slant ranges measured must be converted to ground ranges, the difference taken and divided by the elapsed time. This computation is quickly and easily done by use of the AN/APQ-7 Ground Speed Calculator. Only targets which are on course within five degrees (5°) can be used for the timing process.

b. Ground Plot (Standard DR Procedure):

In cases where no suitable radar check points are available on course, it will often happen that check points a short distance off course will appear and can be used to obtain fixes. A ground speed determined for the two (2) most recent fixes is usually the most accurate attainable, providing the fixes are reliable and a sufficiently long time interval has elapsed between them. This method results in an average value for the ground speed over the time of sampling as contrasted with the spot value of ground speed provided by the Ground Speed Calculator.

F. BOMBING PROCEDURE

1. General.

a. The preferred method of bombing with the AN/APQ-7 equipment will be the synchronous method using the Sighting Angle Attachment. In this method the Radar Observer supplies sighting angle information to the Bombardier by means of which the Norden rate end can be adjusted in position and rate.

b. The Radar Observer is responsible for the ship's course unless a visual sighting is made by the Bombardier. The Bombardier is responsible for bomb release whether or not a visual sighting is made. This technique is considered to be the most desirable for the following reasons:

(1) It permits the same operating procedure (crew) to be specified for radar bombing and for visual bombing.

(2) In the case of targets obscured by smoke or partial cloud cover, the Norden bombsight will be correctly set up

from the sighting angle information. The Bombardier can then take advantage of any last minute visibility to make final corrections of visual bombing.

(3) The bombsight will release the bombs accurately even though the target return tends to break up or disappear at close range, or if the AN/APQ-7 equipment fails on the bomb run.

2. Procedure for Setting the Computer.

a. The computer, although not used for synchronous bombing, should be correctly set up in case direct bombing becomes necessary. This computer, when supplied with the correct values for altitude, ground speed, range wind, and bomb type, will automatically position the bomb release marker on the scope at the correct slant range for bomb release. The following is the procedure for setting these data into the computer:

(1) Wind. Obtain the best wind available from any one of several methods; air plot, bombsight, drift meter, or radar (see paragraph 3 Section E above).

(2) True Air Speed. I.A.S. corrected for altitude and temperature.

(3) Ground Speed. Obtain best possible ground speed and set into GROUND SPEED DIAL.

(4) Range Wind. Set difference between True Air Speed and Ground Speed into the RANGE WIND DIAL. If Ground Speed is the greater, the difference is set on the tail wind side. If Ground Speed is the smaller, the difference is set on the head wind side of the dial.

(5) Altitude. Check that SW1 on the sighting angle control box is on RADAR. Set the ALTITUDE DIAL by pressing the PUSH TO SET ALTITUDE button and manipulating the altitude knob until the leftward excursion of ground return runs up and is added to the top of the Altitude Blip on the "A" scope. (If the target elevation differs appreciably from the elevation of the terrain over which radar altitude is measured, the difference in elevation must be added to or subtracted from the ALTITUDE DIAL reading to obtain TARGET ALTITUDE for the same Corrected Barometric Altitude.)

(6) Bomb Type. Set on the BOMB TYPE SWITCH. A list of positions plotted against types of bombs follows:

POSITION	BOMB TYPE	WEIGHT
1	M38A2	100# Practice
2	M30	100#
3	M57	250#
4	MK17	325 Depth Charge
5	M43	500#
6	M58	500#
7	M44	1000#
8	M59	1000#
9	MK-I	1600#
10	M34	2000#
11	M56	4000#

b. In case direct rather than synchronous bombing is required, determine the release point by letting the target pass into the bomb release line until the release line is halving the target return. At this instant operate the remote bomb release switch.

3. Procedure for Obtaining Sighting Angles.

a. Turn switch SW1 on the Radar-Norden Control Box to ALTITUDE SET position.

b. Adjust the COARSE ALTITUDE knob until, on the "A" scope, the leftward excursion of the ground return runs up and is added to the top of the release blip. Fine adjustment can be made with the FINE ALTITUDE knob. This is exactly the same procedure that is used to set the ALTITUDE dial on the indicator unit. It should be

done just before reaching the I.P. except in cases where the elevation there differs by several hundred feet from the elevation of the target. In these cases a setting must either be made at the last possible minute, or else over some region where the absolute altitude above the terrain is the same as it will be over the target.

c. Turn switch SW1 to the NORDEN OPERATE position.

d. Turn the angle selector switch to the desired sighting angle.

e. Announce the sighting angle at the instant the target is halved by the marker line on the scope.

4. Procedure for Killing Drift.

a. Within a half hour of reaching the I.P. the Navigator will use the best wind available and the true air speed corresponding to the briefed indicated air speed to determine the heading and drift for the bomb run course.

b. On the turn at the I.P., or as soon thereafter as possible, the Radar Observer will set the previously determined drift on the azimuth scale of the AN/APQ-7 indicator with the cursor. When the turn at the I.P. is completed and the ship levels out, correct the heading until the target is under the cursor. Kill any remaining drift by the following procedure:

(1) If noticeable drift occurs early on the bomb run (about one-quarter of the original distance), make a quadruple correction; that is, give a heading correction four (4) times the angular displacement of the target from the cursor and in the same direction. After the turn, reset the cursor to the target.

(2) If the first definite displacement is noted about halfway through the bomb run, make a double correction; that is, give a heading correction that is twice the displacement and in the same direction. After the turn, reset the cursor to the target.

(3) If drift occurs late in the bomb run, make a turn equal to the displacement only.

c. Example: The ship is level, the target is under the cursor and the twenty (20) mile marker is over the target. At fifteen (15) miles, measure the amount the target has drifted and make a quadruple correction. If the target has drifted two (2) degrees right, correct the heading eight (8) degrees right and after the turn move the cursor six (6) degrees toward the left to center it on the target. At about twelve (12) miles, if the target has drifted one (1) degree left, correct the heading two(2) degrees left and move the cursor one (1) degree right to re-center the target under the cursor. From this point on, leave the cursor in place and simply correct the heading to keep the target under the cursor.

d. In making corrections late in the bombing run, it is important to remember the effect of a bank on the apparent position of the target. While the turn is being made, the target appears to move in the wrong direction. Observations must always be made while the airplane is level.

e. Another method of figuring drift is as follows. On course drift may be determined at any time that an echo appears within 15° of the longitudinal axis of the aircraft, at a distance of not less than 15 miles. The formula to be used is:

$$(B_1 - B_2) \times (R - 1) + B_1 = \text{Drift where}$$

B_1 = first bearing taken
B_2 = second bearing taken
R = reciprocal of the proportional distance traveled between B_1 & B_2 as compared to distance between B_1 and location of plane.

Therefore,

Assuming that echo appears at 30 miles

and 7° right after a time it travels to 20 miles and 10° right. The drift in this case would be

$$(B_1 - B_2) \times (R - 1) + B_1 = \text{Drift}$$
$$(7^\circ R - 10^\circ R) \times (3 - 1) + 7^\circ R = \text{Drift}$$
$$3^\circ L \times 2 + 7^\circ R = \text{Drift}$$
$$6^\circ L - 7^\circ R = \text{Drift}$$
$$1^\circ R = \text{Drift}$$

This solution can be obtained by placing information on the E-6B without regard to time.

5. Procedure for Bombing Run.

a. Before the I.P. is reached the Radar Observer will set up the AN/APQ-7 computer for the ground speed and range wind for the bombing course, check the position of the Bomb Selector Switch, and set in the radar altitude.

b. He will then turn switch SW1 on the Radar-Norden Control Box to ALTITUDE SET and will set the Altitude knobs.

c. He will then turn switch SW1 to NORDEN OPERATE and set the angle selector switch to 70°.

d. The Bombardier will set into the bombsight the correct disc speed and trail for the bombing altitude. The AB computer will be set up to obtain the correct tangent of dropping angle and drift for the anticipated heading on the bomb run. The data so obtained will be preset on the bombsight.

e. Interphone will be cleared for use by Pilot, Bombardier and Radar Observer.

f. On the turn at the I.P., or as soon thereafter as possible, the Radar Observer will set the anticipated drift angle with the AN/APQ-7 cursor, identify target and start killing the remaining drift.

g. The Bombardier will insure that all bombsight switches except the rate motor switch are "ON"; level bubbles, keep gyro uncaged, and make sure that the telescope index is positioned at seventy degrees (70°).

h. Engage optic clutch.

i. The Radar Observer will, if the bombing run is long enough, check ground speed on the bomb run by use of the Ground Speed Calculator and will inform the Bombardier of the result. Using the best values of ground speed and wind, the Radar Observer will reset the AN/APQ-7 computer for ground speed and range wind, and also reset radar altitude. The Bombardier will check tangent of dropping angle. <u>NOTE</u>: The above checks on pre-set data are to be made if time permits or if the pre-set data are suspected to be inaccurate. The Radar Observer should give attention to KILLING DRIFT on the bomb run rather than to making final corrections on the pre-set data, providing the ground speed, drift and altitude computed for the bomb run course are believed to be reliable.

j. The Radar Observer will keep the Pilot and Bombardier informed of distance to target.

k. As the seventy degree (70°) point is approached, he will turn down fixed range marker intensity.

l. The Radar Observer will warn the Bombardier just before and then announce the instant the target is halved by the sighting angle marker. The Bombardier will turn on rate motor switch at this signal from the Radar Observer. The Radar Observer will turn the angle selector switch to the next position.

m. The Radar Observer will repeat this process at each sighting angle check point.

n. As the Radar Observer announces successive check points, the Bombardier will check the corresponding sighting angles against the position of the telescope index as it moves forward.

o. The Bombardier will reposition the telescope index to conform to readings called out by the Radar Observer.

p. If it is noted, after two (2) or more check

points, that there is a definite lag or gain in the travel of the telescope index against the values called out by the Radar Observer, the Bombardier will increase or decrease the rate by an amount proportionate to the relative degree of lag or gain.

q. Have trigger up before indices meet to release bombs.

r. Be constantly on the alert to take over the complete visual sighting operation in the event the target becomes sufficiently visible.

s. If for any reason it becomes necessary, the Radar Observer can turn switch SW1 on the Radar-Norden Control Box to RADAR, and release the bombs manually when the target crosses the release marker.

t. After "Bombs Away" the Radar Observer will return set controls to normal positions for navigation and immediately start navigational procedure again.

SECTION VIII - EMERGENCY PROCEDURES

A. DITCHING

1. Upon notification by co-pilot, acknowledge in turn: "RADAR OPERATOR DITCHING."
2. Remove parachute harness, flak suit and winter flying boots. Wear flying gloves. Check IFF setting.
3. Open rear ditching hatch and acknowledge to co-pilot, "REAR HATCH OPEN." Jettison loose equipment including camera.
4. Hold raft accessory kit stored in unpressurized section.
5. Take sitting position in unpressurized compartment against rear pressure bulkhead at right (facing aft) with hands and cushions behind head, knees flexed, feet braced.
6. Take raft accessory kit, then exit through rear emergency hatch.
7. If airplane is not afire, inflate life vest. Proceed atop fuselage to right wing.

B. BAIL OUT

1. Series of short rings on alarm bell means "PREPARE TO ABANDON SHIP."
2. One continuous ring means "BAIL OUT."
3. If operating from rear pressurized compartment, Radar Observer, on signal, will exit through rear entrance door. If operating from the flight deck, he will exit through nose wheel well (secondary exit through forward bomb bay.)

APPENDIX

RADAR OBSERVER'S FLIGHT PROFICIENCY CHECK B-29

Name	Rank	Crew & Organization

Subject	*	**	Remarks
PREFLIGHT			
1. Accomplishment of 2AF Official Radar Observer's Check List			
IN THE AIR			
2. Turn on and Tune up			
3. Calibration			
4. Adjustment of voltages and currents			
5. Identification of targets			
6. Dead Reckoning Procedure			
7. Radar Fixes			
8. Radar ground speed, track, and wind			
9. Use of the Air Plot			
10. Log book procedure			
11. Procedure turns			
12. Drift correction on bomb run			
13. Bombing technique			
14. Coordination with Navigator, Airplane Commander, and Bombardier			
15. Use of Interphone			
16. Turn off procedure			
17. Completion of Form 38			

* - Satisfactory
** - Needs Further Work

Instructor

COMMENTS:

APPENDIX

OFFICIAL RADAR OBSERVER'S CHECK LIST (AN/APQ-13)

B-29

BEFORE STARTING ENGINES

1. Parachute
2. Clothing
3. Oxygen Mask
4. Interphone
5. Life Preserver
6. Radome up
7. Pocket Screw Driver

AFTER TAKE-OFF

1. Indicator brightness fully CCW (both indicators).
2. Antenna-continuous, and AFC-Beacon switch off.
3. Gain control one-third on.
4. Sector scan switch off.
5. Normal-count test switch normal.
6. Sweep delay switch zero.
7. Azimuth stab switch off.
8. Altitude switch calib. zero.
9. Calibrate switch normal.
10. Check generator voltage and current with engineer.
11. Obtain authority from airplane commander and press button; power on.
12. Check A.C. voltmeter.
13. Check radar crystal current. (Tune as necessary).
14. Indicator brightness CW until sweep is visible. (both indicators.)
15. Search CW or CCW until sweep syncs-in. (both indicators.)
16. Antenna continuous switch on.
17. Heading switch on--heading line should be at zero degrees.
18. Azimuth stab. switch on.
19. Antenna continuous switch off. Stop antenna rotation when trace is on or near lubber line.
20. Azimuth stab. off. Wait until sweep stops moving before turning spinner on again. NOTE: Steps 19 and 20 will be followed in that order each time azimuth stabilization is turned off.
21. Check presence of 1 and 5 mile range marks.
22. Check presence of release marker (both indicators).
23. Sector scan switch on. Check width and limits of sector.

24. Sector scan switch off.
25. Check and adjust range delay, slope and zero.
26. Check and adjust altitude delay, slope and zero.
27. Press button trans. on.
28. Check A.C. voltmeter.
29. Check transmitter current (on 50 mile range, adjust transtat as necessary).
30. Tune for echoes (adjust tilt and gain as necessary.)
31. Lower radome with authority of airplane commander.
32. Check that sweep rotates smoothly.
33. Retune and adjust tilt and gain for echoes and best contrast.
34. Check proper operation of A.F.C.
35. Notify navigator that radar is ready.

BEFORE LANDING

1. Indicator brightness fully CCW (both indicators).
2. Retract radome.
3. Press button Power off.

AFTER LANDING

1. Crew inspection.
2. Malfunction report.

APPENDIX

OFFICIAL RADAR OPERATOR'S CHECK LIST (AN/APQ-7)

B-29

BEFORE STARTING ENGINES

1. Parachute
2. Clothing
3. Oxygen Mask
4. Interphone
5. Life preserver
6. Pocket screw driver
7. Navigation and bombing equipment

PRE-OPERATION CHECKS

1. Check that all INTENSITY and GAIN knob controls are in the full CCW position.
2. Press TRANS and INVERTER buttons OFF.

3.	ANT ON - ANT OFF	OFF
4.	ANT SCAN	F
5.	ANT SCAN TEST	NORMAL (mid position)
6.	EXT trigger	INT
7.	EXT video	INT
8.	AJ	OFF
9.	REC GAIN AND RANGE EXP	LOC
10.	AFC	OFF
11.	SW 1 (Radar-Norden control box)	RADAR
12.	Meter switch	+ 600 V
13.	Range scale miles	160

AFTER TAKE OFF TO TURN ON AND TUNE UP SET

1. Check generator voltage and current with engineer.
2. Obtain authority from airplane commander and press INVERTER ON button.
3. Check meter readings.
4. Adjust INTENSITY and FOCUS ("A" scope) for suitable trace on "A" scope.
5. Adjust VERT cent ("A" scope) if necessary.
6. "A" GAIN ("A" scope) FULL CLOCKWISE.
7. Turn INTENSITY knob (opr. ind.) clockwise until a trace is just visible
8. Turn SCALE ILLUM-CURSOR ILLUM to brighten or dim as desired.
9. ANT ON - ANT OFF switch to ANT ON and check that sweep goes from -30° to $+30^{\circ}$.
10. METER SELECTOR SWITCH to MAG I. Press button TRANS

ON. Check meter reading on all ranges. NOTE: Inverter must be ON 3 minutes prior to TRANS ON.

11. Adjust REC TUNE, REC GAIN, VIDEO GAIN and INTENSITY (opr ind) for bright signals on scope.
12. Reduce INTENSITY (opr ind) to full CCW position.
13. Turn VIDEO GAIN to full clockwise position.
14. Adjust REC GAIN until noise on "A" scope has 3/4 the amplitude of the main bang (transmitter pulse).
15. Reduce VIDEO GAIN until signals on "A" scope are just under full limiting or until the heads of the signals taper off with out losing amplitude.
16. Increase intensity on main scope until signals appear on dark background. NOTE: Frequent adjustments of VIDEO GAIN are not necessary.
17. AFC switch to ON position. Check operation.
18. Check cursor line and scale adjustment with ANT SCAN TEST SWITCH in No. 2 position.
19. Adjust CENTERING V (opr ind) so that transmitter pulse pip is setting just on the bottom cursor marker.
20. Adjust CENTERING H (opr ind) until sweep is centered on the base of the cursor line. Return ANT SCAN TEST to NORMAL for operation.
21. Turn RANGE INTENSITY knob clockwise. Check for range markers on all ranges. Check RANGE EXPANSION on 30 mile range.
22. Turn REL INTENSITY clockwise until release line is visible on scope.
23. Set SW 1 to NORDEN OPERATE. Range scale miles to 30. Turn SIGHTING ANGLE SELECTOR switch through all angles. Check presence of release line on main scope.

BEFORE LANDING

To turn set off:

1. REC GAIN full counter-clockwise.
2. INTENSITY (all oscilloscopes) full counter-clockwise.
3. Press ANT OFF button.
4. Press TRANS OFF button.
5. Press INVERTER OFF button.

AFTER LANDING

1. Crew inspection.
2. Malfunction report (form 38).

APPENDIX

PROCEDURES TURNS

A. USING PROCEDURE TURN CHART

1. The purpose of the chart is to aid the radar observer in estimating the proper allowances for making a procedure turn. No allowance is made for wind effect and it is not intended that the airplane pass over the IP. The airplane will turn inside of the IP and onto the intended track. The chart is applicable for a $\frac{1}{2}$ needle width (15°) turn.

2. Two methods may be used to accomplish this:

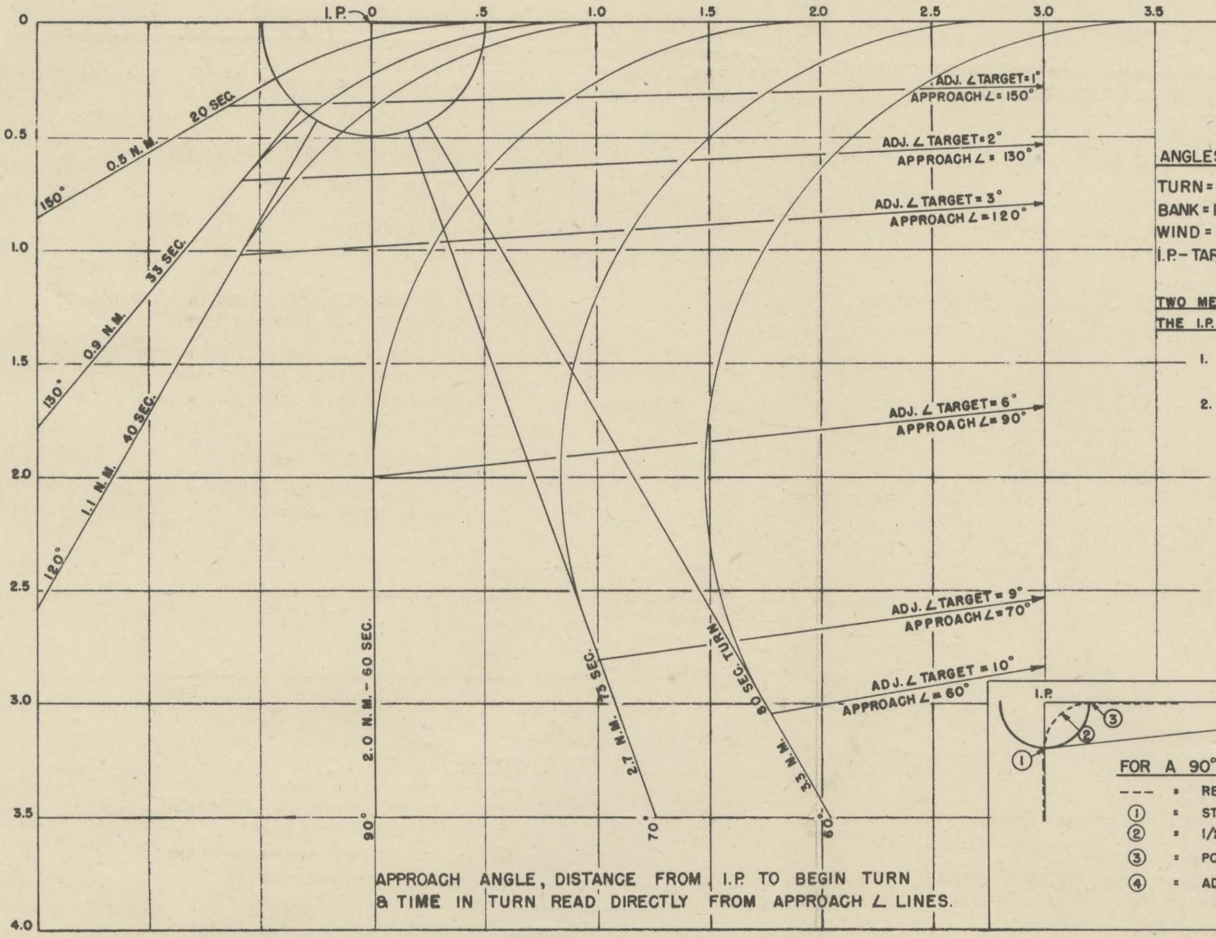
   a. Method I: Adjustment angle.
   Example: TH to IP is 90°. Intended track is 0°. Therefore, the approach angle is 90°. For an approach angle of 90° obtain from the chart the adjustment angle, which is 6°. Adjust bearing marker to 6° on azimuth scale. As the target crosses the bearing marker begin procedure turn.

   b. Method II: Distance from IP.
   Example: TH to IP is 90°. Intended track is 0°. The approach angle is 90°. For an approach angle of 90°, obtain from the chart distance from IP to begin turn, which is 2 N.M. Begin coordinated turn when airplane is 2 N.M. from IP.

SLANT RANGE CHART

The chart included in this appendix may be used to determine Slant Ranges which correspond to given bombsight telescope (optic) angles for synchronous bombing. In addition, it may be used for the conversion of Slant Ranges to horizontal Ranges. To measure the slant range corresponding to the telescope angle, swing the point of intersection (altitude and telescope angle) about zero to the true range scale at the top of the chart. The slant range to the point of intersection is then read directly from the scale.

PROCEDURE TURNS WITH "O" WIND



APPROACH ANGLE, DISTANCE FROM I.P. TO BEGIN TURN & TIME IN TURN READ DIRECTLY FROM APPROACH ∠ LINES.

(N. M. = NAUTICAL MILES)

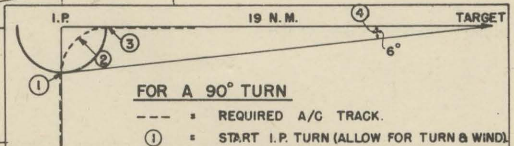
ANGLES, DISTANCE & TIME BASED ON:

TURN = 1/2 NEEDLE WIDTH
BANK = 15°
WIND = Ø (ZERO)
I.P. - TARGET = 19 NAUTICAL MILES

TWO METHODS OF MAKING THE PROPER ALLOWANCE FOR THE I.P. PROCEDURE TURN ARE SHOWN:

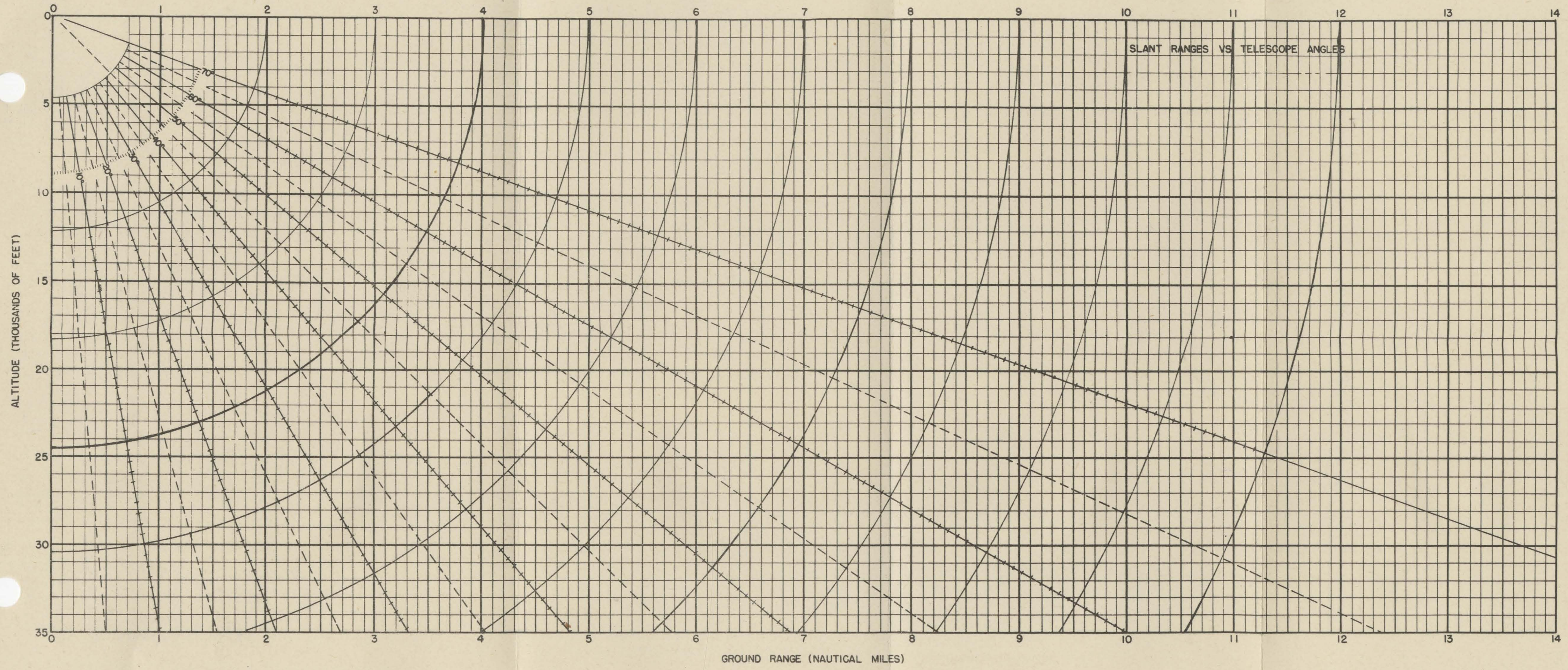
1. THE ANGLE THE HEADING LINE MUST BE WITH RESPECT TO THE BRIEFED COURSE.
2. THE DISTANCE (NAUTICAL MILES) BEFORE REACHING I.P.

ALLOWANCE FOR WIND MUST BE MADE BY RADAR OBSERVER.



FOR A 90° TURN

--- = REQUIRED A/C TRACK.
① = START I.P. TURN (ALLOW FOR TURN & WIND).
② = 1/2 NEEDLE WIDTH TURN.
③ = POSITION WHEN REACHING BRIEFED TRACK.
④ = ADJUSTMENT ANGLE TARGET.


SLANT RANGES VS TELESCOPE ANGLES
ALTITUDE (THOUSANDS OF FEET)
GROUND RANGE (NAUTICAL MILES)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
5
10
15
20
25
30
35
10°
20°
30°
40°
50°
60°
70°