NAVAL AIR TRAINING COMMAND

NAS CORPUS CHRISTI, TEXAS **CNATRA P-801 (Rev 02-93)**

STUDENT WORKBOOK
FOR
INSTRUMENT NAVIGATION



BASIC SNFO

1993

1542
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CNATRA P-801 (Rev 02-93)

Subject: STUDENT WORKBOOK FOR INSTRUMENT NAVIGATION, BASIC SNFO

1. CNATRA P-801 (Rev 02-93) PAT, “Student Workbook For Instrument Navigation, Basic Phase SNFO, T-34/T-2” is issued for information, standardization of instruction, and guidance of instructors and students in the Naval Air Training Command.

2. This publication will be used to supplement the curriculum at Training Squadron TEN.

3. Recommedations for changes shall be submitted to the Commander Training Air Wing SIX, Naval Air Station, Pensacola, FL 32508.

4. CNATRA P-801 (Rev.02-91) PAT is hereby cancelled and superseded.

W. R. LEDDY
Assistant Chief of Staff for
Training and Operations

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TABLE OF CONTENTS

SAFETY

There are no special safety precautions for the classroom portion of INAV. For the 1D23 trainers, electrical components are capable of providing electric shock hazards.

HOW TO USE THIS STUDENT GUIDE

This guide states all lesson objectives, gives instruction, examples, and all information the student needs to perform the objectives up to the standards. The student should read the units scheduled prior to class, answering questions, and solving problems at the end of each unit. The instructor's job is to amplify the material in the book, therefore the student should be ready to ask questions during class period. Studying and working problems with a group provides the student the best opportunity to grasp the material and be able to apply it.

FOREWORD

This coursebook is designed to guide you through your study assignments in the most logical sequence. It is broken into seven INAV units: Six units of instruction and one review unit. The Learning Objectives in each unit are stated in behavioral terms and identify exactly what you are expected to accomplish in this course. These are the standards you must meet before progressing any further in your training.

SCOPE

In other courses you have been introduced to Flight Information Publications, Flight Rules and Regulations, NATOPS, Meteorology and UHF Voice Communications. T he Instrument Navigation course will blend much of the knowledge you acquire in those courss and help prepare you for your INAV and AIRNAV flights at VT-10. In this course, you will learn how to use radio aids to navigation, to determine position and to maintain course during the departure, enroute and approach phases of flight. You will practice these skills, along with ATC Communications, in the 1D23 trainer. Terminal Objectives and Enabling objectives, are listed in CNATRAINST 1542.54.

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UNIT 1

INAV 1: RADIO AIDS TO NAVIGATION

Terminal Objectives, Enabling Objectives, and Enabling Steps are established by CNATRAINST 1542.54K.

TERMINAL OBJECTIVES:

C. Navigate an aircraft via visual references and navigation instruments with the assistance of a flight instructor.

ENABLING OBJECTIVES:

C.1 Maintain a specified course given radio aids to navigation and flight information publications (FLIP), with instructor assistance as required within 8 degrees or 3nm of course.

C.1.1 Identify aircraft position relative to an operable TACAN/VOR station, given a Tactical Air Navigation (TACAN)/VHF Omnidirectional Range (VOR) and FLIP, without error.

C.1.2 Recall the characteristics of radio aids to Navigation given an oral or written examination 80% accuracy.

SKILLS DEVELOPMENT UNIT: This academic unit interfaces with all INAV flights.

MODE OF INSTRUCTION: This unit is a classroom lecture presentation designed to acquaint you with the characteristics of radio aids to navigation. The lecture outline lists the characteristics you will be required to know.

INSTRUCTIONAL AIDS: Radial Magnetic Indicator (RMI)

REFERENCE: NATOPS Instrument Flight Manual

INSTRUMENT NAVIGATION

INTRODUCTION

Among the fundamental tools of the navigator are radio navigational aids. There are numerous types of radio navigational aids which generate such diverse information as position, bearing, range, and glideslope. All radio navigational aids consist of three essential components:

(1) a ground facility which transmits electromagnetic waves,

(2) a receiver in the aircraft which interprets the information transmitted by the ground facility and

(3) instrumentation in the aircraft to display this information to the aircrew.

Three radio navaids will be discussed in this unit: ADF (Automatic Direction Finder), VOR (VHF Omnidirectional Range), and TACAN (Tactical Air Navigation). These radio navaids will demonstrated or utilized during some phase of the VT-10 flight curriculum. Some combination of these radio navaids are carried aboard all naval aircraft.

AUTOMATIC DIRECTION FINDER (ADF)

The characteristics of ADF are:

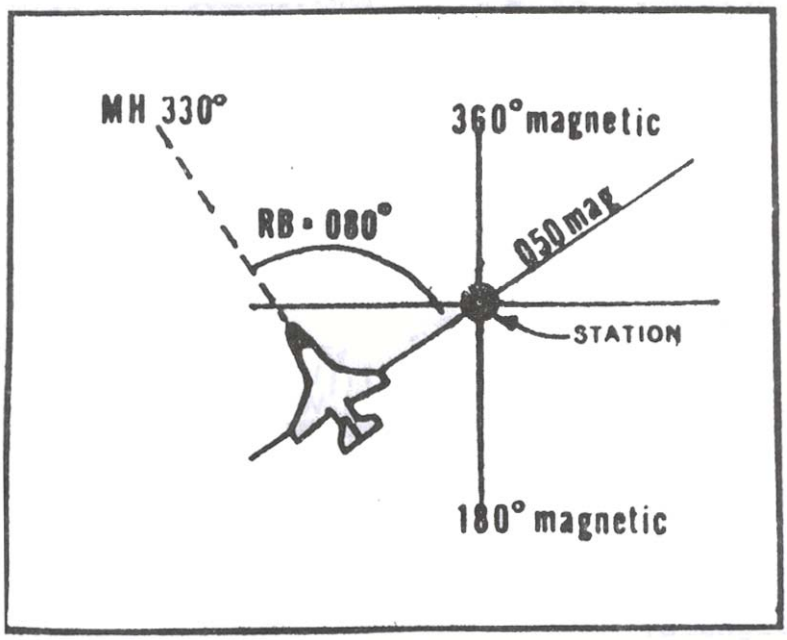
1. ADF's operate in the LF or UHF bands.

Although many new types of direction finding and homing equipment are coming into widespread use, the automatic direction finder (ADF) remains a basic and important piece of equipment for homing, tracking and course interception. ADF is a radio receiving system used to determine the direction of arrival of received radio signals from a nondirectional beacon (NDB). ADF receivers operate in different frequency ranges and are used in practically all naval aircraft. In the T-39 aircraft, the ADF systems operate in a segment of the UHF (Ultra High Frequency) band between 265.0 and 284.9 MHZ. The ADF position on the T-34 UHF radio does not function.

2. ADF always presents relative bearing information.

If the ADF needle is pointing to the 2 o'clock position, the station bears approximately 60º to the right. If it points to the tail of the aircraft, it bears 180º from the present heading. When properly functioning, the ADF bearing needle <u>always</u> points to the NDB station.

By adding the relative bearing (RB) obtained from the ADF bearing needle to the magnetic heading (MH) of the aircraft, a magnetic bearing (MB) to the station can be determined, RB + MH = MB (Figure 1).



RB = 080
MH = 330
410
− 360
MB = 050

Figure 1

3. In the T-39, ADF bearing information is displayed on a needle of the Electronic Horizontal Situation Indicator (EHSI).

The EHSI (Figure 2) displays aircraft magnetic heading with navigational bearing data and consists of a rotating compass card, two bearing pointers called No.l and No. 2 needles and a range indicator. The compass card is actuated by the aircraft compass system. Aircraft magnetic heading is displayed beneath the top index or "fiducial" marker. The No. 1 needle displays ADF information. The T-34's Radio Magnetic Indicator (RMI) is similar to a EHSI but no distance information is displayed.

When the aircraft compass system is functioning correctly, the ADF needle will display magnetic bearing to a selected NDB station. Although the ADF system still generates a relative bearing, the EHSI automatically solves the formula (magnetic bearing equals magnetic heading plus relative bearing) by constantly positioning the aircraft's magnetic heading at the top of the compass card.

NOTE: *In the event of a malfunction of the aircraft's compass system, the No. 1 needle will not indicate a magnetic bearing but will still point toward the station and continue to provide relative bearing.*

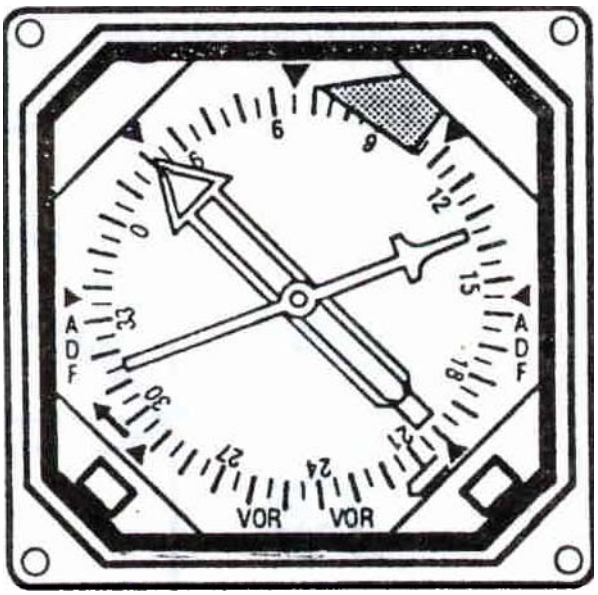


Figure 2

4. ADF's utilize a loop antenna to resolve the bearing of received signals.

The operation of an ADF is chiefly dependent upon the characteristics of the loop antenna. The loop consists of many turns of insulated wire on a metal form. The incoming radio waves will induce unequal and opposite voltages on the two sides of the loop. Servo motors will rotate the antenna to a position where the voltages are equal and opposite - this is the null position.

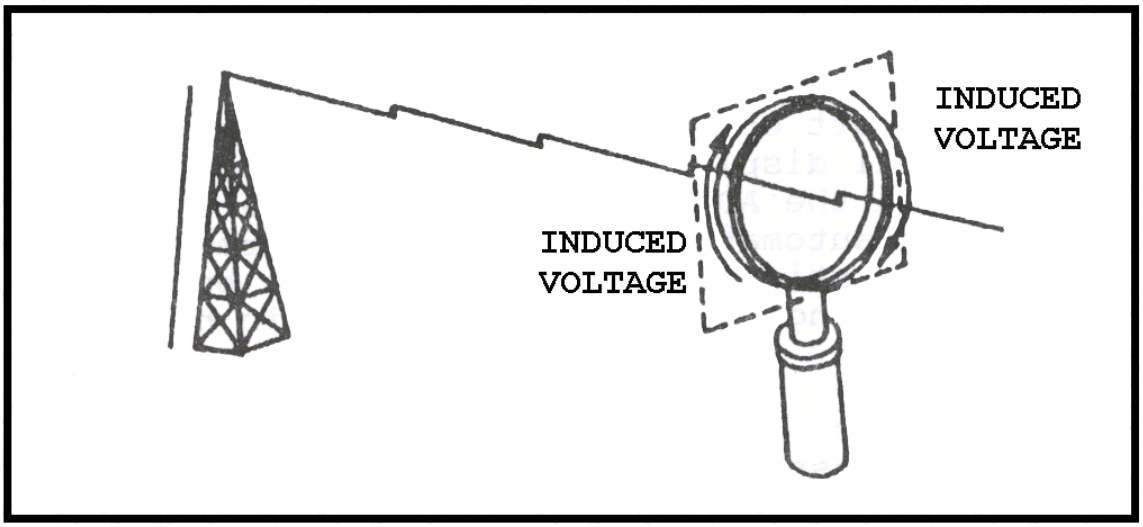
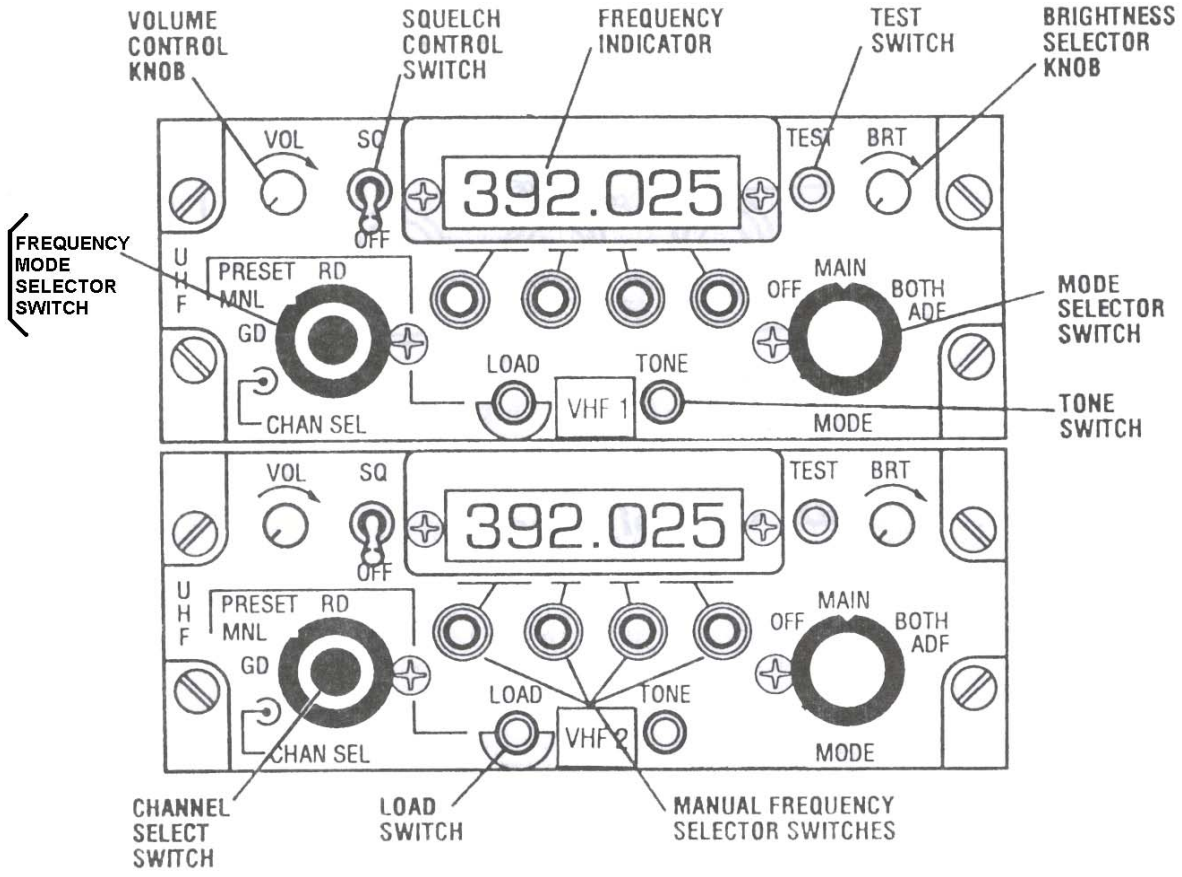


Figure 3

A sensing element then reads the position of the antenna, corrects for 180° ambiguities and displays the information on the #1 needle of the EHSI.

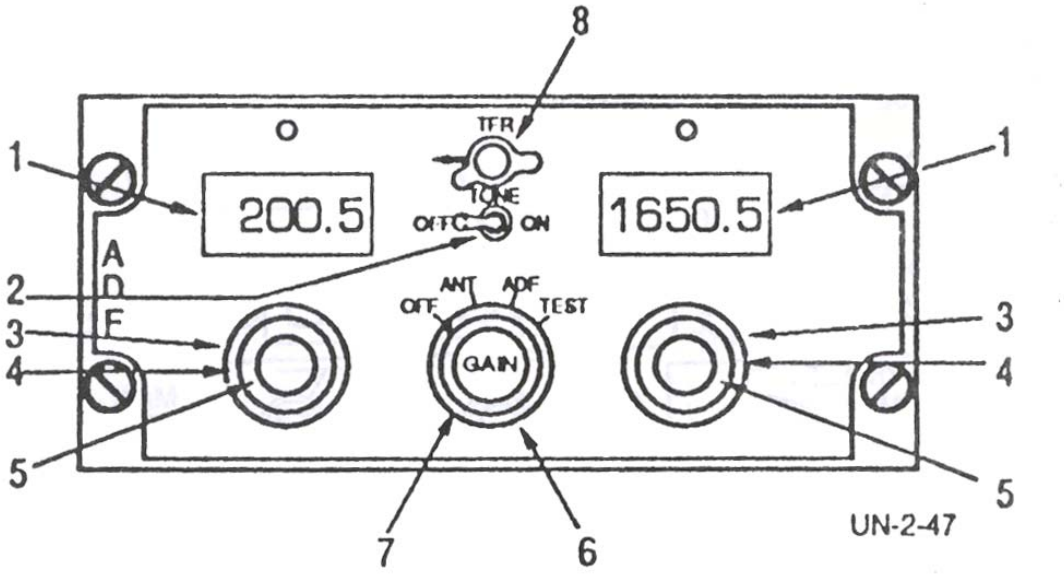
5. In the T-39 aircraft, ADF information is obtained in conjunction with the UHF transceivers (Figure 4).



Dual UHF Communication System Control Panels

Figure 4

UHF/NDB stations are found aboard all aircraft carriers and Navy and Marine Corps Air Stations. Complete operating instructions for ADF may be found in the appropriate NATOPS Manual for type aircraft.



ADF Control Panel

Figure 5

6. UHF/NDB navigational information is limited to line-of-sight range.

Curvature of the earth and/or geographic obstacles, such as mountains, limit UHF range. However, as altitude increases UHF range of reception increases.

VHF OMNIDRECTIONAL RANGE (VOR)

VOR is a major improvement over the ADF. It has become the mainstay of civil aviation because of its simplicity and reliability. Military aircraft (especially the larger types) are sometimes equipped with VOR, although it is rare to find a VOR in a tactical Navy jet. In VT-10, the T-34 and T-39 aircraft have VOR.

The characteristics of VOR are:

1. VOR operates in the lower half of the VHF band. VOR frequencies are between 108.0 and 117.9 MHZ and are relatively free from atmospheric disturbances.

2. VOR presents magnetic bearing information. The produced signal is aligned to magnetic north. Because your aircraft uses a compass system that is also aligned to magnetic north, there are no inconsistencies in the presentation.

3. VOR is limited to line of sight range. VHF radio waves travel only in straight lines and do not have the ability to bounce off the atmosphere. Your VOR reception will depend on the absence of obstacles between your aircraft and the VOR station. 1QODQ’

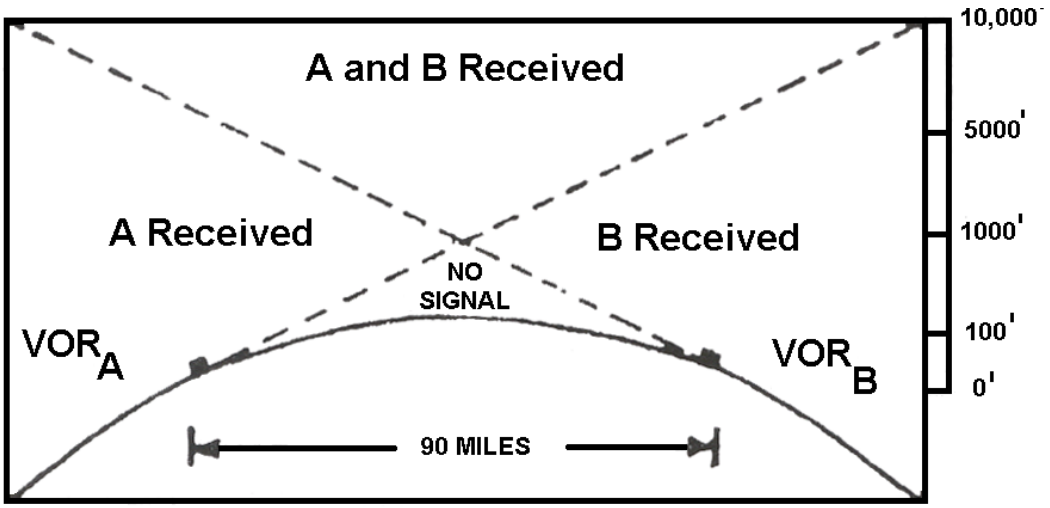


Figure 6

The curvature of the earth will sometimes be a limiting factor in VOR reception, especially at lower altitudes (See Figure 6 above). Reception range increases with aircraft altitude and is about 40nm at 1,000' AGL. VOR facilities are spaced about 90 miles apart to ensure adequate navigational coverage over an airway.

4. In the T-34, VOR bearing information is displayed on the #1 needle of the RMI. The displayed information has an accuracy of ±1°.

5. VOR identification signal. All VORs transmit an audio signal which allows the aircrew to positively determine if the VOR station to which they are tuned is actually the one desired. The signal may be Morse code, corresponding to the 3 - letter identifier of the station; it may be a recorded voice which in plain English states the name of the facility; or it may be a combination of both. The receiver in the aircraft is capable of voice reception. The recorded message described above is one type of voice message it can receive. If necessary, however, many VOR stations are capable of sending actual voice transmissions. A VOR equipped aircraft will not normally receive voice transmission over its VOR equipment; however, in the event of two-way radio failure it does possess that capability. The aircraft has the capability to receive voice communications only. VOR stations which are not capable of making voice transmissions have their frequency underlined on the enroute charts.

TACTICAL AIR NAVIGATION (TACAN):

TACAN is quite similar to VOR; however, it represents an improvement over the VOR and provides the aircrew with improved accuracy and a means of determining distance from the selected station. It will be your primary means of instrument navigation here at VT-10.

The characteristics of TACAN are:

1. TACAN operates in the UHF Band. UHF frequencies, like VHF frequencies, are also relatively free from atmospheric disturbances and are limited to line of sight of reception. Therefore, the Earth's curvature and aircraft altitude will affect your ability to receive the TACAN signal.

The TACAN system employs 256 two-way operating channels (1X through 126Y) which correspond to UHF frequencies spaced 0.5 MHZ apart.

2. TACAN presents magnetic bearing information. The information presented is virtually identical to that presented by the VOR.

3. In the T-34 aircraft, TACAN bearing is displayed on the #2 needle. The displayed information is accurate to + 3/4°.

4. TACAN identification signal. TACANs can only transmit the Morse code corresponding to their 3-letter identifiers. TACANs are never capable of voice transmission.

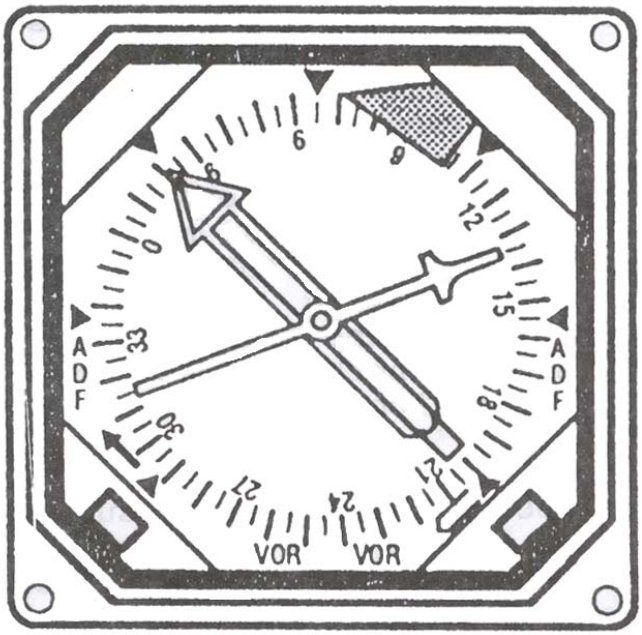


Figure 7

5. TACAN is subject to 40° lock off. TACAN ground stations produce their bearing information through a series of pulses which are spaced 40° apart. A properly functioning airborne

TACAN receiver has the ability to interpret these pulses and to properly display correct TACAN magnetic bearing to the aircrew. With a weak airborne receiver however, a

misinterpretation of the received signal may occur and the displayed bearing will be 40° (or some multiple of 40°) off the proper bearing.



Figure 8

Although some newer TACAN receivers have built-in self-test equipment which displays a warning to the aircrew whenever a 40° lockoff occurs, most TACAN receivers in present usage do not have this capability; therefore, it is imperative that a 40° lockoff be recognized by the aircrew. A 40° lockoff can be confirmed by comparing the TACAN bearings generated by ADF or VOR receivers which are not susceptible to the 40° lockoff. The aircrew should always maintain situational awareness (i.e., a rough DR position) which will enable them to recognize a 40° lockoff on the TACAN in the event of nonavailability of ADF, VOR, or other crossreferences to the TACAN bearing. Once a 40° lockoff is recognized, rechannelizing the airborne equipment will cause unlock and allow the set another chance to lock onto the proper bearing. A forty-degree lockoff will have no effect upon distance indications.

6. TACAN incorporates Distance Measuring Equipment (DME)

DME is an integral part of a TACAN. When you select a TACAN channel you are simultaneously tuning your TACAN to the azimuth and DME of that particular TACAN station.

In order for you to utilize DME, your TACAN must be in the T/R (transmit/receive) mode. The DME is obtained by transmitting a signal to the ground TACAN station. That signal is processed by the ground station which then sends your TACAN box a reply signal. Based on the relationship between your aircraft position, the position of the ground station and the time it takes for these signals to travel back and forth, your DME indicates the actual "SLANT RANGE" between your aircraft and your selected TACAN station.

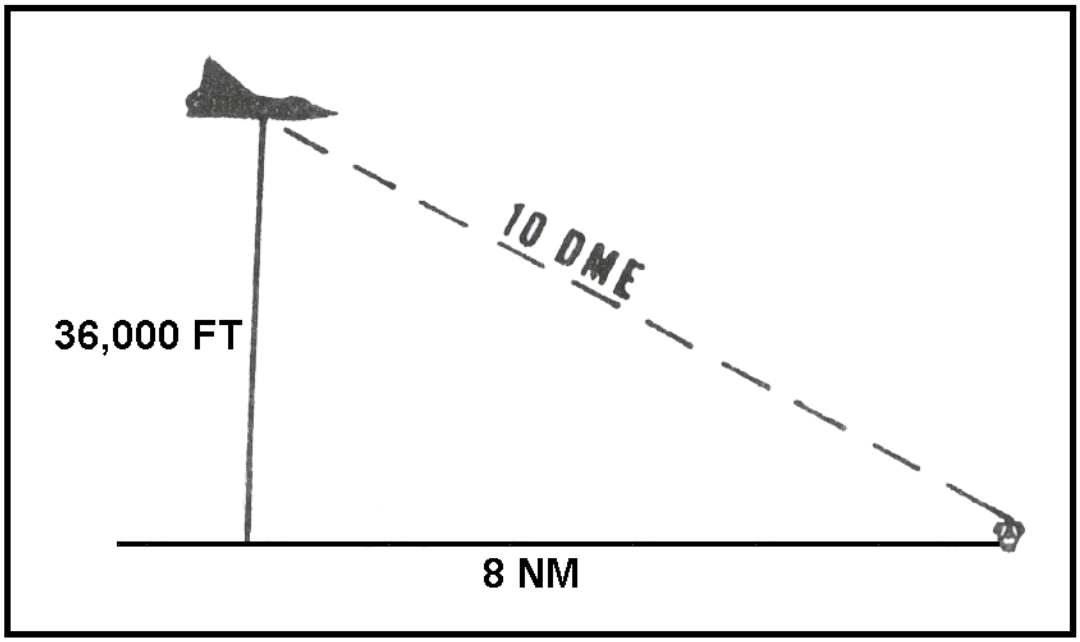


Figure 9

In the above illustration (Figure 9), although your position over the ground is 8nm from the TACAN station, your RMI and DME indicator will indicate 10 DME, your slant range from the station.

At most distances from the TACAN station this range difference is negligible; however, when the aircraft is directly overhead the TACAN station, the slant range will equal the aircraft's altitude in nautical miles.

7. TACAN can be used to provide distance between two aircraft.

The air-to-air mode of the TACAN can provide distance from one aircraft to another. In the A/A mode, the TACAN transmits and receives slant range distance in nautical miles to another aircraft. No magnetic bearing information is generated in the A/A mode. When using the A/A mode each aircraft must tune. its TACAN channel 63 channels apart from the other aircraft. A good gouge number to use is 29/92.

VORTAC

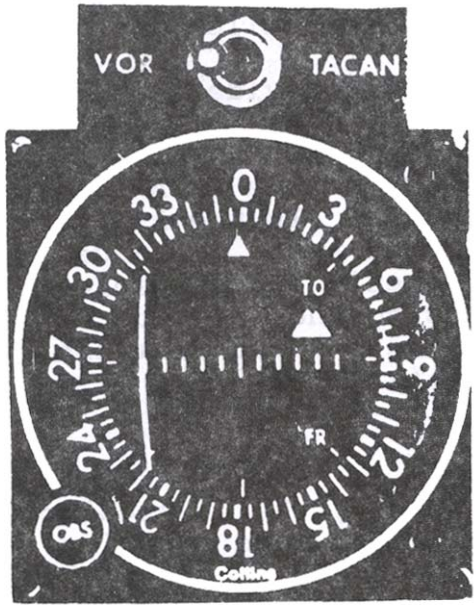
A VORTAC is, quite simply, the physical presence of both a TACAN and a VOR station in the same location. When a TACAN equipped aircraft tunes in the channel of the VORTAC station, it is actually tuning to the TACAN portion of the facility. When a VOR equipped aircraft tunes the 4-digit VHF frequency, it is utilizing the VOR portion. Neither navaid (VOR or TACAN) affects the display of the other physically co-located navaid.

IND-350

The IND-350 (Figure 10) is the secondary navigation instrument in the VOR/TACAN system and serves as an aid in interpreting the RMI. Its components consist of a Course Deviation Indicator (CDI), a TO-FROM indicator, an OBS (Omni Bearing Selector), and a VOR/TACAN selector switch.

The IND-350 uses VOR or TACAN magnetic bearing to show the aircraft's position in relation to a selected course. The selected course is set with the OBS knob. The course deviation indicator (vertical bar) will be centered if the aircraft is actually on the selected course. For an off course condition the bar will be displaced to one side or the other. The TO-FROM indicator shows whether the selected course, if flown, will take you to TO or FROM the station. The VOR/TACAN switch enables the pilot to select VOR or TACAN information for display on the CDI. If both the IND-350 and the RMI are operating and a course discrepancy is noted between them, the RMI indication is more reliable.

NOTE: *If there is a discrepancy between the RMI and CDI needles, rely on the RMI needle.*



IND-350

VOR/TACAN Switch

Figure 10

SUMMARY

We have seen and discussed the basic radio aids to navigation utilized by all naval aircraft. There are far more advanced systems in use today, e.g. inertial navigation, Loran, Omega systems, etc., and these will be studied later in your naval aviation training. It is imperative that a thorough understanding of these fundamental radio navigation aids is attained because TACAN and VOR are the primary means of navigation during NFO training flights at VT-10.

UNIT1 REVIEW

INAV 1: RADIOS AIDS TO NAVIGATION

1. ADF equipment will always generate _____ bearing.

2. The ADF needle points _____ the station.

3. Given a relative bearing of 060° and a magnetic heading of 350°, calculate magnetic bearing.

a. 290°
b. 050°
c. 060°
d. 120°

4. T-39 ADF's operate in the_____and_____frequency bands.

5. Reception range of the VOR is based upon aircraft_____.

6. VOR generates a_____bearing.

7. What is the accuracy of VOR?_____.

8. TACAN stands for_____.

9. TACAN utilizes the _____ frequency band.

10. Name the three modes of operation of the TACAN control box.
_____
_____
_____

11. What mode of the TACAN provides magnetic bearing and range information?
_____

12. TACAN stations transmit_____bearing information.

13. When forty-degree luckoff is recognized, the aircrew should _____the TACAN equipment.

14. VORTAC combines a_____and _____ station.

15. The number two needle on the T-34 RMI displays_____ bearing to a _____station.

16. As you approach a TACAN station, the difference between slant range and ground range

a. Increases
b. Decreases

17. BDHI stands for_____ and
RMI stands for_____ and
HSI stands for_____.

18. VORs are subject to 40° lockoff.

a. True b. False

19. The use of the TACAN air-to-air mode provides:

a. Bearing to another aircraft
b. Range to another aircraft
c. Bearing and range to another aircraft

20. To use the TACAN air-to-air mode, each aircraft must select "A/A" and channelize their TACANs_____channels apart.

ANSWER SHEET

INSTRUMENT NAVIGATION

INAV 1: RADIO AIDS TO NAVIGATION

1. Relative
2. To/toward
3. 050"
4. UHF and LF
5. Altitude
6. Magnetic
7. +l"
8. Tactical Air Navigation
9. UHF
10. Receive, transmit/receive, air to air
11. T/R
12. Magnetic
13. Rechannelize 1
14. . VOR, TACAN
15. Magnetic, TACAN
16. a. Increases
17. Bearing Distance Heading Indicator, Radio Magnetic Indicator, Horizontal Situation Indicator.
18. b. False
19. b. Range to another aircraft
20. 63

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INAV 2: NAVAID POSITIONING, TEXT

Terminal Objectives, Enabling Objectives, and Enabling Steps are established by CNATRAINST 1542.54K.

TERMINAL OBJECTIVE:

C. Navigate an aircraft via visual references and navigation instruments with the assistance of a flight instructor.

ENABLING OBJECTIVES:

C.1.1. Identify aircraft position relative to an operable TACAN/VOR station, given a Tactical Air Navigation (TACAN)/VHF Omnidirectional Range (VOR) and FLIP, without error.

SKILLS DEVELOPMENT UNIT: This academic unit of instruction interfaces with INAV flights. The final performance check for this learning objective is INAV-8X.

MODE OF INSTRUCTION: This unit is a classroom lecture and demonstration presenting the steps and procedures required to determine your geographical position using a NAVAID.

INSTRUCTIONAL AIDS:

1. CR-2 Computer
2. RMI Facsimile

REFERENCES:

1. Airman's Information Manual
2. NATOPS Instrument Flight Manual

INTRODUCTION

It is essential to the safety of any flight that you be able to relate your T A C A N or VOR derived position to your actual geographic position. Additionally, should the navaid fail, you must be able to utilize remaining operable navigation equipment, visual or dead reckoning navigation to ensure the safe completion of your flight.

TACAN OPERATION

There are three steps to follow when operating the T A C A N .

Step One: Ensure that the power switch is in the T/R position.

NOTE: *The T-34 TACAN Control Panel does not have a receive position; however, with other TACAN control panels, the receive postion will only provide azimuth information.*

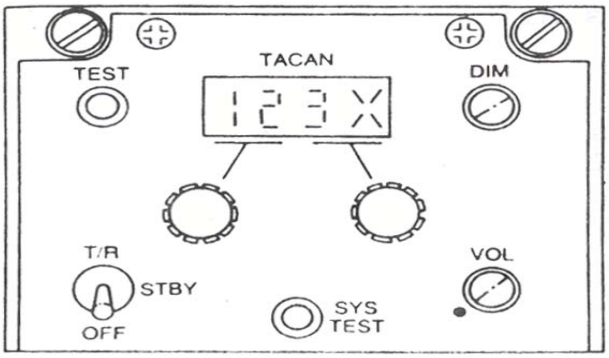


Figure 1

Step Two: Set in the correct TACAN channel for the area in which you are operating.

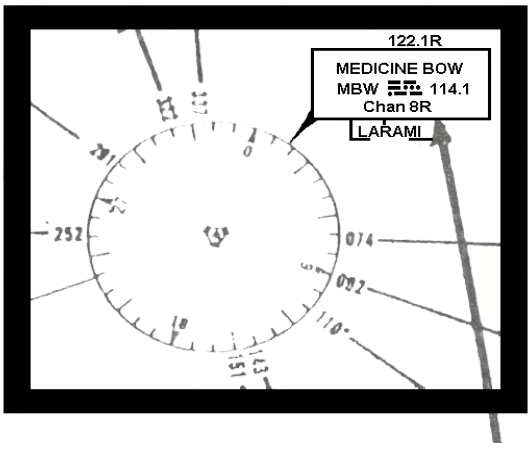


Figure 2

For Medicine Bow you would set in channel 88X (Figure 2). Although aircraft equipment allow for selection of "Y" TACAN channels, there are very few of these in the continental U.S.

Step Three: Adjust the volume control and positively identify the TACAN station by its Morse code identifier.

NOTE: *If the Morse code identifier is off the air, that particular station is not reliable as a navigational aid and another navaid should be utilized. The Morse code identifiers are presented in FLIP documents: Low Altitude Enroute Charts, Approach Plates and Enroute Supplements. Morse code identifiers are not present on Hiqh Altitude Enroute Charts.*

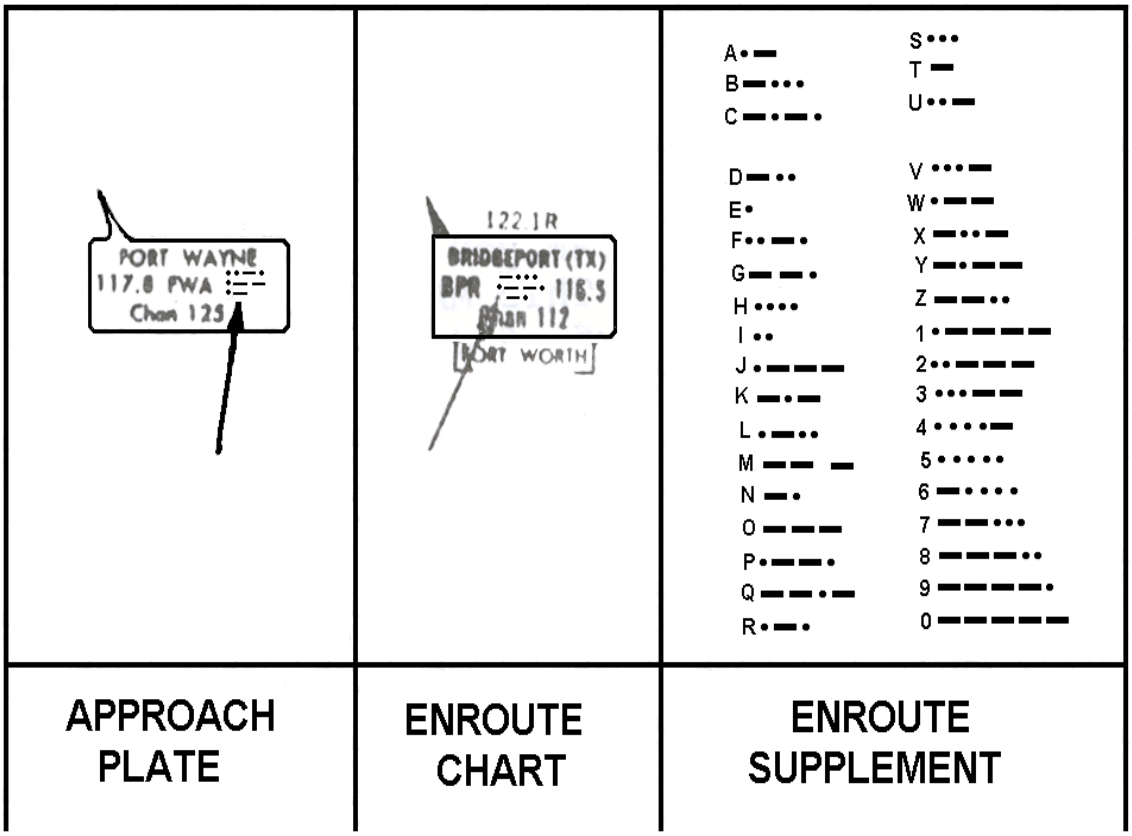


Figure 3

POSITIONING

A radial is a magnetic bearing from a VOR or TACAN station.

Radials are always numbered in three digits beginning with 001° and extending clockwise through 360° (Magnetic North).

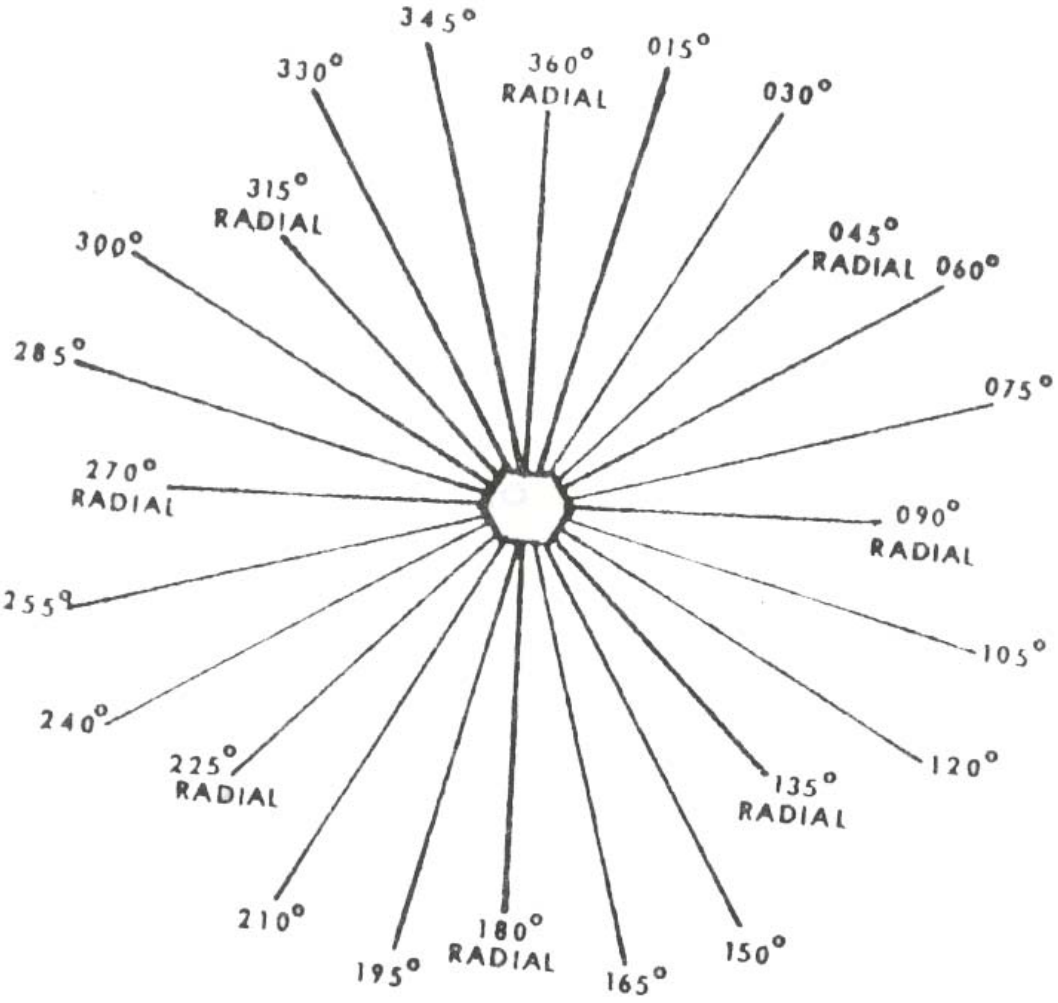


Figure 4

Your position can be determined by noting which of the 360 radials emanating from the TACAN you are on by referring to the tail of the number 2 needle. This MAG bearing from the station coupled with the direct readout of distance (slant rage) presents an exact location of your aircraft from a specified navaid.

For example, the instruments depicted on the following page indicate that the aircraft is on the 260° radial 163 nautical miles from the TACAN.

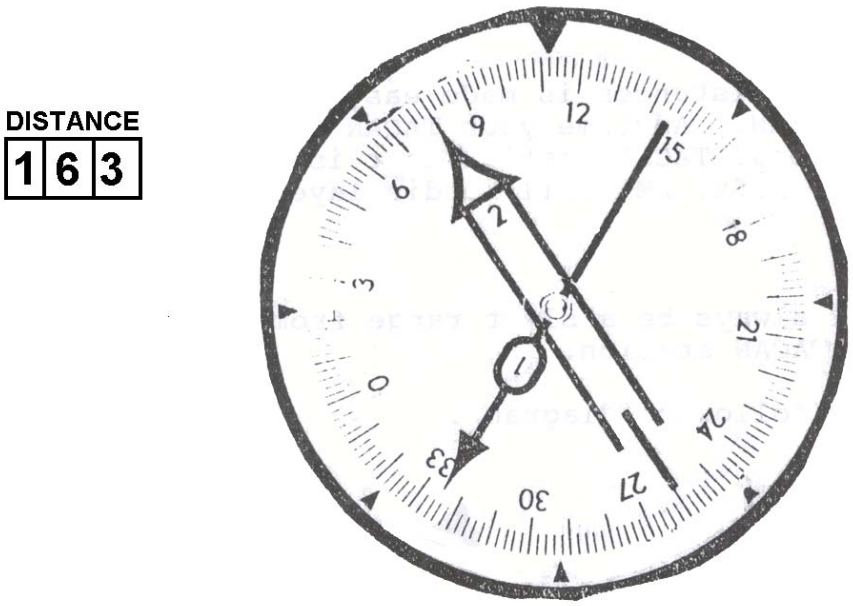


Figure 5

It should also be noted that the aircraft is heading 110°. The heading of the aircraft, however, is not related to determining your radial.

NOTE THE FOLLOWING:

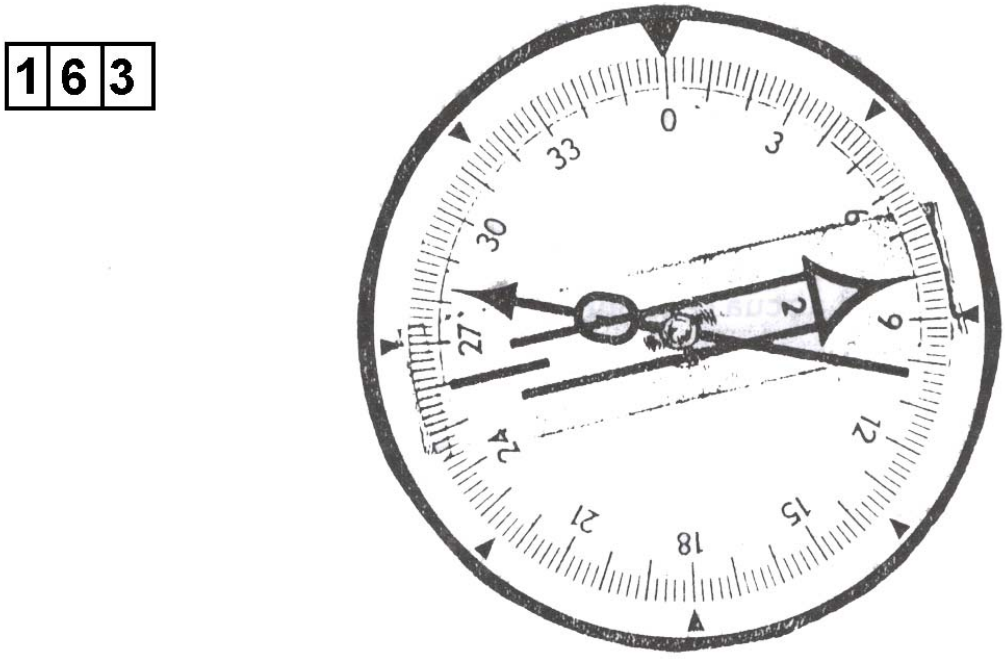


Figure 6

Note that in this instance, the position of the aircraft has not changed (i.e. it is still on the 260° radial at 163 NM form the TACAN station). The only thing that has changed is the heading, which is now 360°.

Distance computation

Computation of distances is made easy for us by the DME portion of the TACAN. Anytime your TACAN is in the T/R mode and tuned to a functional TACAN station that is within reception range of your aircraft, DME will be displayed.

Slant Range

The DME will always be a slant range from the aircraft's position to the TACAN station.

Consider the following diagrams.

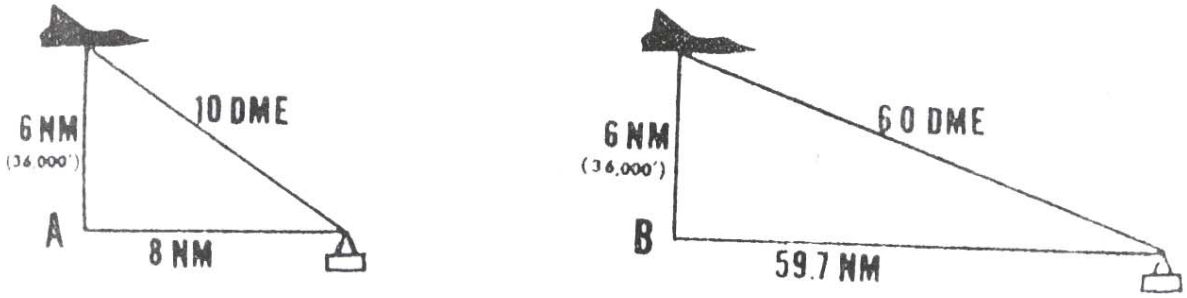


Figure 7

Both diagrams depict an aircraft at 36,000 feet (6nm) above the Earth. The aircraft in diagram (A) has 10 DME displayed, yet in just 8nm it will be overhead the TACAN station. The aircraft in diagram B at the same altitude, displays 60 DME. It will pass over the TACAN station in 59.7nm. It should be apparent that we are simply solving for the third side of a right triangle. As the distance away from the TACAN increases DME will nearly equal actual ground range to the TACAN.

Distance Between Radials

In the diagram on the following page, the symbol for a VORTAC is displayed with selected radials emanating from it. A circle is drawn around the VORTAC and its radials at a point 60nm from its center. Utilizing geometry this time, we can determine that the circumference of the circle is 2 R or 2 x 3.1415 x 60 = 377. Recalling now that each TACAN (and VOR) possesses 360 radials we can establish this relationship: at 60nm from any TACAN station the distance between each radial is:

$$\frac{377}{360} \text{ or } 1.05\text{nm}$$

We'll simplify the quotient and establish this general rule of thumb:

At 60nm from a TACAN station, radials are 1nm apart. This relationship exists from the TACAN station itself for as far as that TACAN is within range of reception, and the relationship is linear.

Therefore, at 20nm, the radials are 20/60 or 1/3nm apart; at 45nm they are 45/60 or 3/4nm apart and at 90nm they are 90/60 or 1 1/2nm apart, etc.

The understanding of this relationship is important for it is the analysis of your present position defined in terms of radial/ DME as contrasted with your desired position (radial/DME) that will determine how far off course you are.

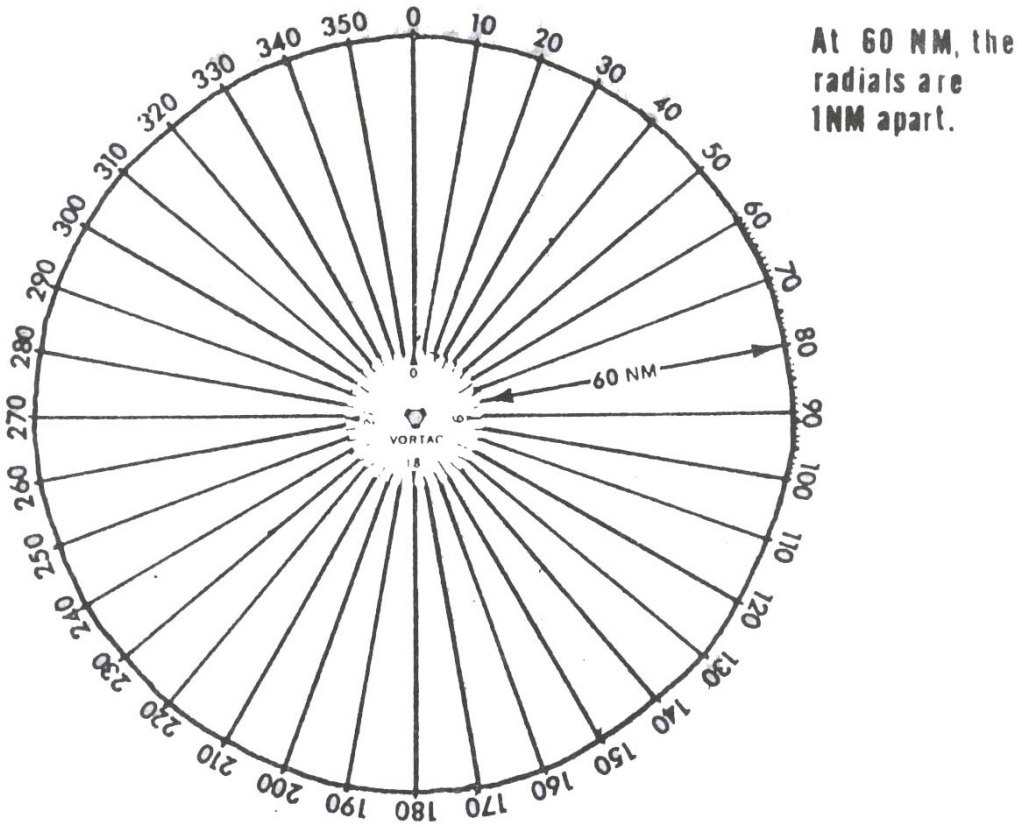


Figure 8

Geographic Positioning

As an NFO you will have to do more than fix your position with relation to a TACAN station. Once you've established your TACAN position you must relate that position to a point on the Earth.

In the following figure, the physical location of a TACAN is printed on a TPC. If we are tuned into that TACAN and we find ourselves on the 325° radial at 18 DME, we can accurately fix our position on the chart.

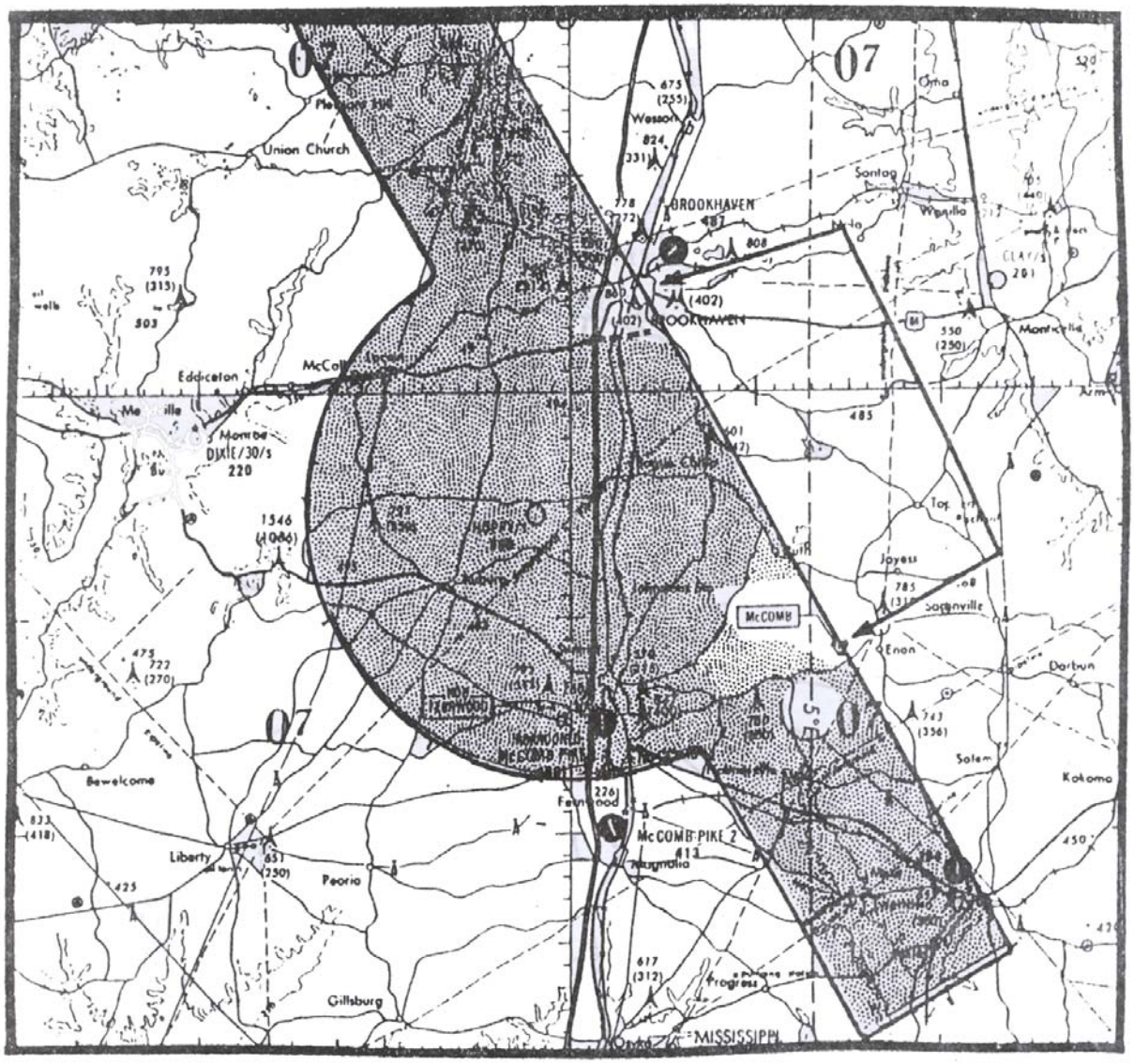


Figure 9

Recalling that radials are magnetic bearings, however, we must be especially careful, in areas of high magnetic variations, to correct for the magnetic variation and accurately plot our true position if using a TPC.

We now find that the McComb 325/18 means more than numbers--it means we are overhead the city of Brookhaven. This information is especially useful for orienting oneself and answering the most basic question any navigator should ask himself: "Where am I?"

2-8 NAVAID POSITIONING

GONE OF CONFUSION

The line-of-sight transmission pattern from a VOR or TACAN station creates an area directly overhead the facility where azimuth signal reception is very weak or random. This area is called the "cone of confusion". Although the azimuth information displayed is considered to be unreliable, the DME is not affected and will continue to display slant range to the station. The cone of confusion for a TACAN is much larger than that of the VOR, and at 40,000 feet, the TACAN's cone of confusion encompasses a 15 nm diameter about the TACAN station.

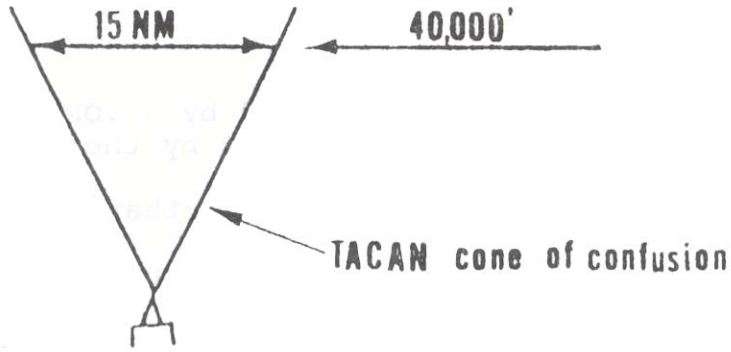


Figure 10

When you analyze the diagram, it should be obvious that the diameter of the cone is a function of altitude. Understanding this concept will help eliminate potential navigational problems in close proximity of the NAVAID.

At 30,000 feet, we could expect less time in the cone; however, at 50,000 ft. we could expect a long time period of unreliable TACAN or VOR azimuth information. Within the cone of confusion, the behavior of the TACAN or VOR azimuth will be completely random. It will oscillate from side to side and will not present accurate information. It is important to recognize when you have entered the cone, so as not to follow the unreliable indications of the needle.

The DME, however, will continue to behave in a predictable manner and the numbers displayed will continue to decrease until the aircraft is directly overhead the TACAN station. At this point you have reached "minimum DME". As noted earlier, this number will be equal to your AGL altitude in nautical miles. Upon reaching this point your DME will not continue to decrease. Rather, after minimum DME is observed, it will again increase in the same predictable manner that it decreased as you were headed inbound to the station.

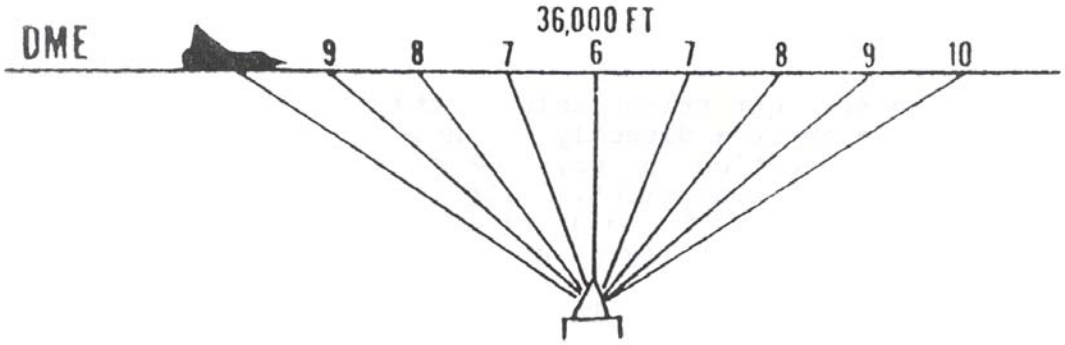


Figure 11

VOR OPERATION

The azimuth information displayed by a VOR is virtually identical to the information displayed by the TACAN.

The operation of the VOR is simpler than that of the TACAN:

1. Ensure that the power switch is on. (Figure 12)
2. Set in the correct VHF frequency.

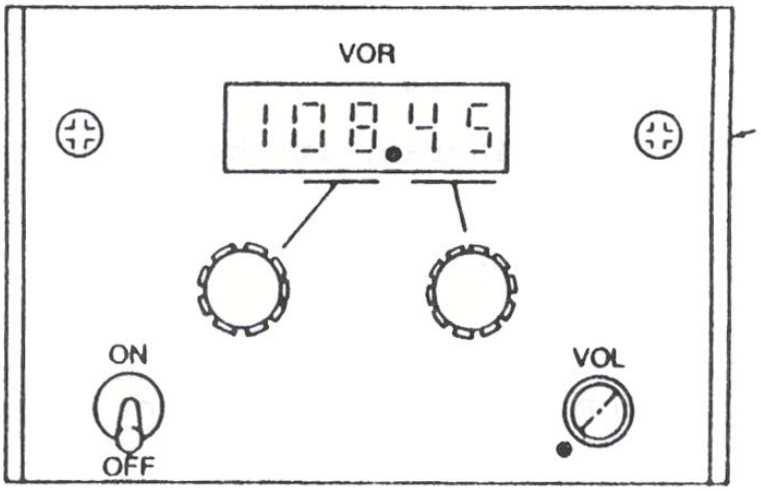


Figure 12

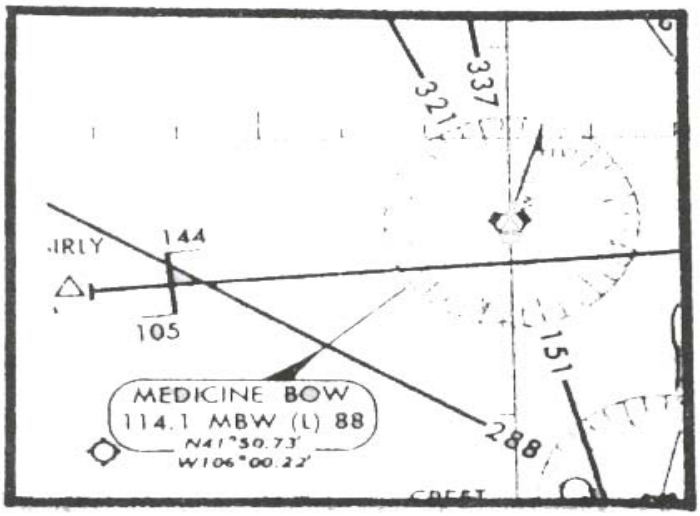


Figure 13

For Medicine Bow, you would set in 114.1. (Figure 13)

3. Adjust the volume control and positively identify the VOR station by its Morse code identifier, or by listening to a recording which states the name of the navaid ("MEDICINE BOW VOR").

Just as with the TACAN identification procedure, VORs must be properly identified or an alternate navaid should be selected. The applicable frequencies and Morse Code identifiers can be found where you would find similar information concerning TACANs.

VOR's can be used interchangeably with TACANS; however, two facts should be remembered:

1. Most Navy fleet aircraft do not carry a VOR.

2. DME information is not available with only a VOR; therefore, fixing your position utilizing VORs is considerably more time consuming and difficult.

VOR/DME

TACAN and VOR systems are independent of each other. The TACAN provides azimuth and DME; the VOR provides only azimuth. Most civilian aircraft do not have TACAN; however, they may have DME. A civilian aircraft can use VOR azimuth and TACAN DME from a VORTAC facility and receive a display virtually identical to the display in a TACAN equipped military aircraft.

LINES OF POSITION

One definition of a fix is the intersection of two lines of position (LOP). An aircraft equipped with two navigation sources (such as the T-34) can obtain two lines of position from different navaids. The intersection of these lines will provide a fix. Although this will not be your primary means of navigation, it is a backup and should be used when primary systems have been degraded.

SUMMARY

TACAN's supply all the information you need to identify your geographic position. They provide magnetic bearing and distance from the selected TACAN station. VOR's are quite similar to TACANs in that magnetic bearing is provided; however, VORs are not equipped with DME. Each of these navigation facilities generate radials which are numbered clockwise from 001° to 360" and any aircraft tuned in to a particular navaid will find itself on one of these radials.

UNIT REVIEW

INAV 2: TACAN POSITIONING

1. Radials are numbered (clockwise/Counter-clockwise), beginning at _____ and extending to _____.

2. If you desire to be on the 090/30 nm and you are on the 095/30, how many miles off course are you? _____.

3. To plot true position when using TACAN radials, _____ must be applied _____.

4. The cone of confusion decreases as altitude increases.

   a. True b. False

5. How will you know if you are in the cone of confusion?

_____
_____

6. In the T-34, which of the following are affected by the cone of confusion?

   a. VOR Azimuth c. UMF
   b. TACAN Azimuth d. Slant range

7. The VOR utilizes the #l. needle.

   a.. True b. False

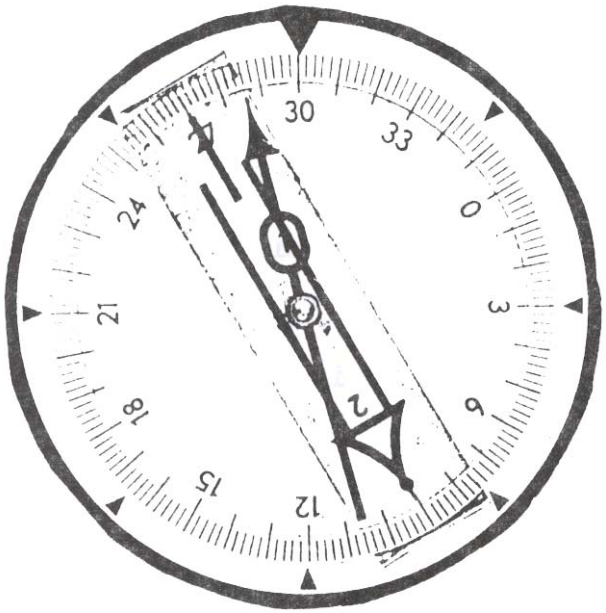
8. You take off from NAS Pensacola, glance down at your DME, and note that the numbers are not moving. What is the possible problem?_____.

9. You tune in a VOR and everything looks good but you can't receive the Morse code identifier. After turning up the volume and still not receiving the Morse code identifier, what should you do?

_____.

10. The aircraft whose RMI is depicted below is on which TACAN radial?

a. 300°
b. 270°
c. 180°
d. 090°



ANSWER SHEET

INAV 2: TACAN POSTIONING

1. Clockwise, 001°; 360°
2. 1/2 nm
3. Magnetic variation
4. b. False
5. TACAN or VOR needle unlocks and behaves in unpredictable manner
6. Both a and b
7. True
8. Not in T/R position of TACAN
9. Switch to another navaid
10. b. 270°

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NAV 3: RADIAL TRACKING AND COURSE CONTROL

Terminal Objectives, Enabling Objectives, and Enabling Steps are established by CNATRAINST 1542.54.

TERMINAL OBJECTIVE:

C. Navigate an aircraft via visual references and navigation instruments with the assistance of a flight instructor.

ENABLING OBJECTIVE:

C.1. Maintain a specified course, given radio aids to navigation and Flight Information Publications (FLIP) with instructor assistance as required within 8 degrees or 3, nm of course.

ENABLING STEPS:

C.1.3 Determine the aircraft position relative to a course.

C.1.4 Make recommendations to intercept and maintain desired course utilizing standard corrections to compensate for drift.

C.1.5 Define radial.

C.1.6 Determine difference between radial, course, and aircraft heading.

C.1.7 Determine the aircraft position relative to a course.

C.1.8 Make recommendations to intercept and maintain desired course utilizing standard corrections to compensate for drift.

C.1.9 Discuss characteristics of airway navigation.

C.1.10 Discuss characteristics of direct navigation (TACAN to TACAN).

C.1.11 Determine wind velocity and direction by calculating ground speed and crab angle.

C.1.12 Discuss characteristics and use of a CDI.

SKILLS DEVELOPMENT UNIT: This academic unit of instruction interfaces with trainers TP and flights FAM 2-8 AND VNAV 1-3.

INSTRUCTIONAL AIDS:

1. CR-2 computer
2. RMI facsimile

REFERENCES:

1. Airman's Information Manual
2. NATOPS Instrument Flight Manual

INTRODUCTION

Specific courses are assigned or published to facilitate smooth traffic flow and to provide terrain and obstacle clearance. In order to maintain the proper course during the departure, enroute (on or off airways) or approach phases of flight, it is necessary to first understand the principle of radial tracking.

RADIAL TRACKING

A radial is a magnetic bearing extending from a VOR, TACAN or VORTAC station.

Radials are numbered in three digits beginning with 001° and extending clockwise through 360° (magnetic north). See Figure 1.

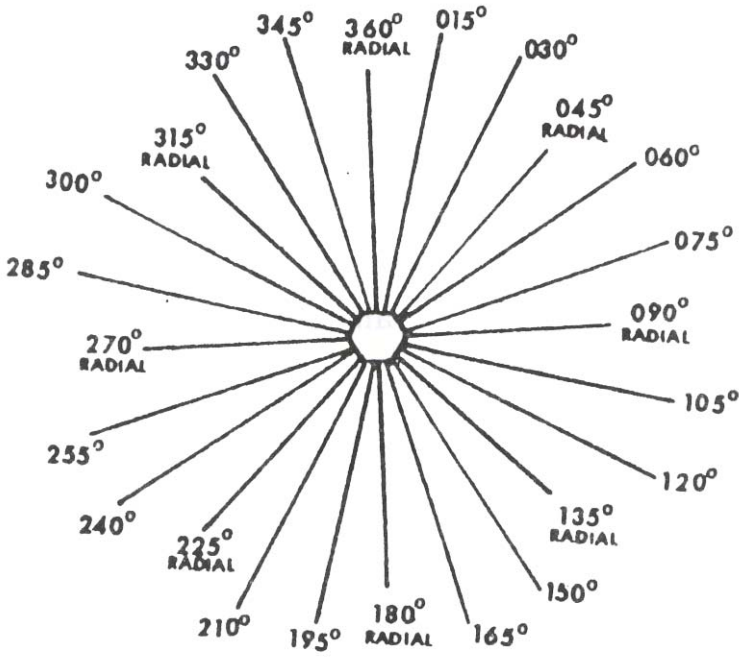


Figure 1

The course an aircraft flies directly outbound from a navaid is the same as its radial. (See Figure 2).

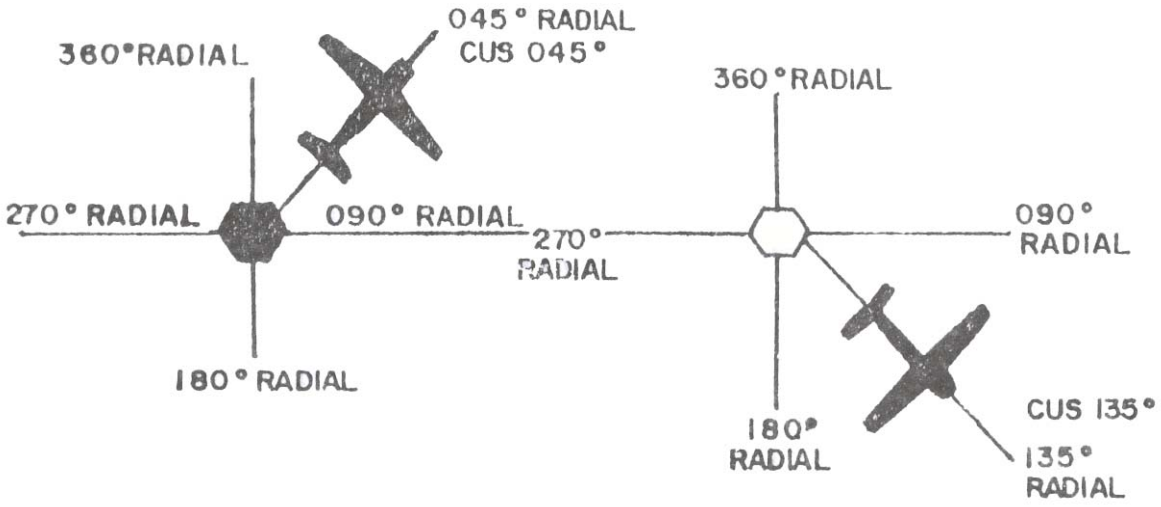


Figure 2

The aircraft pictured below are flying outbound from the station on the 270° R and 180° R, respectively. Their courses are 270° and 180°. (See Figure 3).

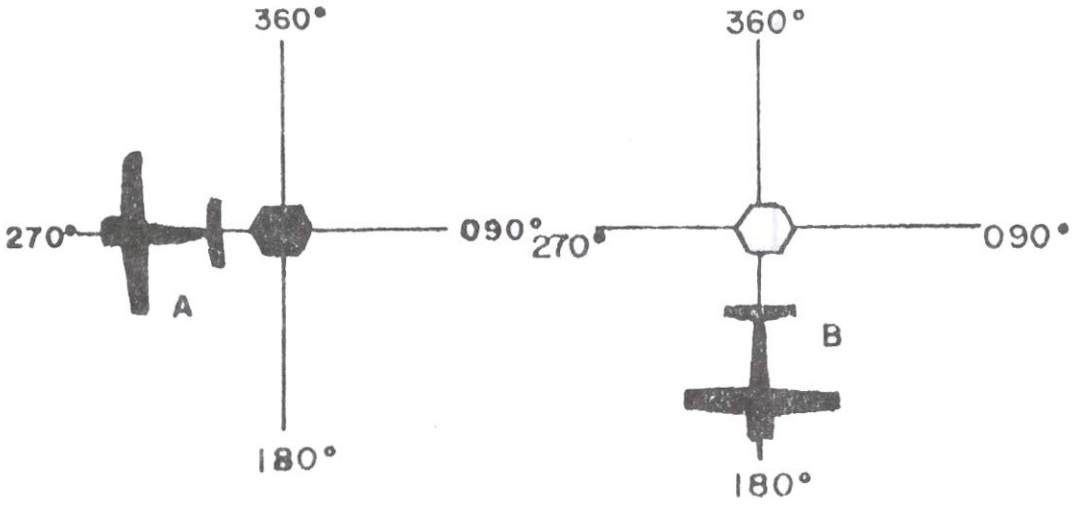


Figure 3

The course an aircraft flies inbound to the station is the reciprocal of that radial along which it is flying. In Figure 4, aircraft A is on the 090° radial; however, its course is 270°. Aircraft B is flying a course of 180° and is on the 360° radial.

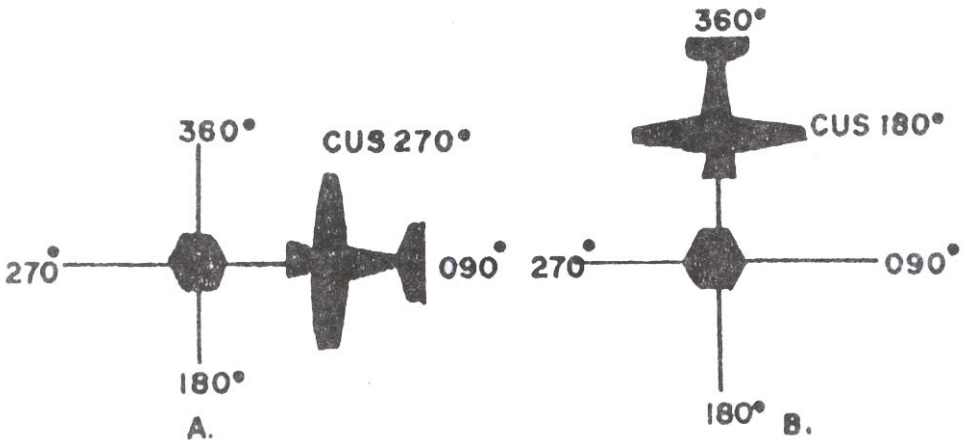


Figure 4

The aircraft pictured below are flying inbound on the 270° R and 180° R, respectively. Their respective courses are 090° and 360°.

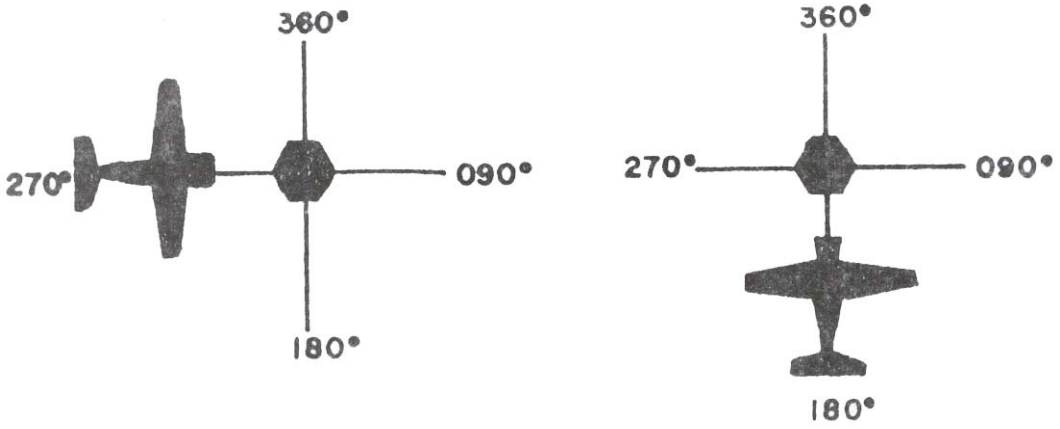


Figure 5

In the cockpit, the two situations (inbound and outbound on a radial) appear on the RMI as the illustrated below.

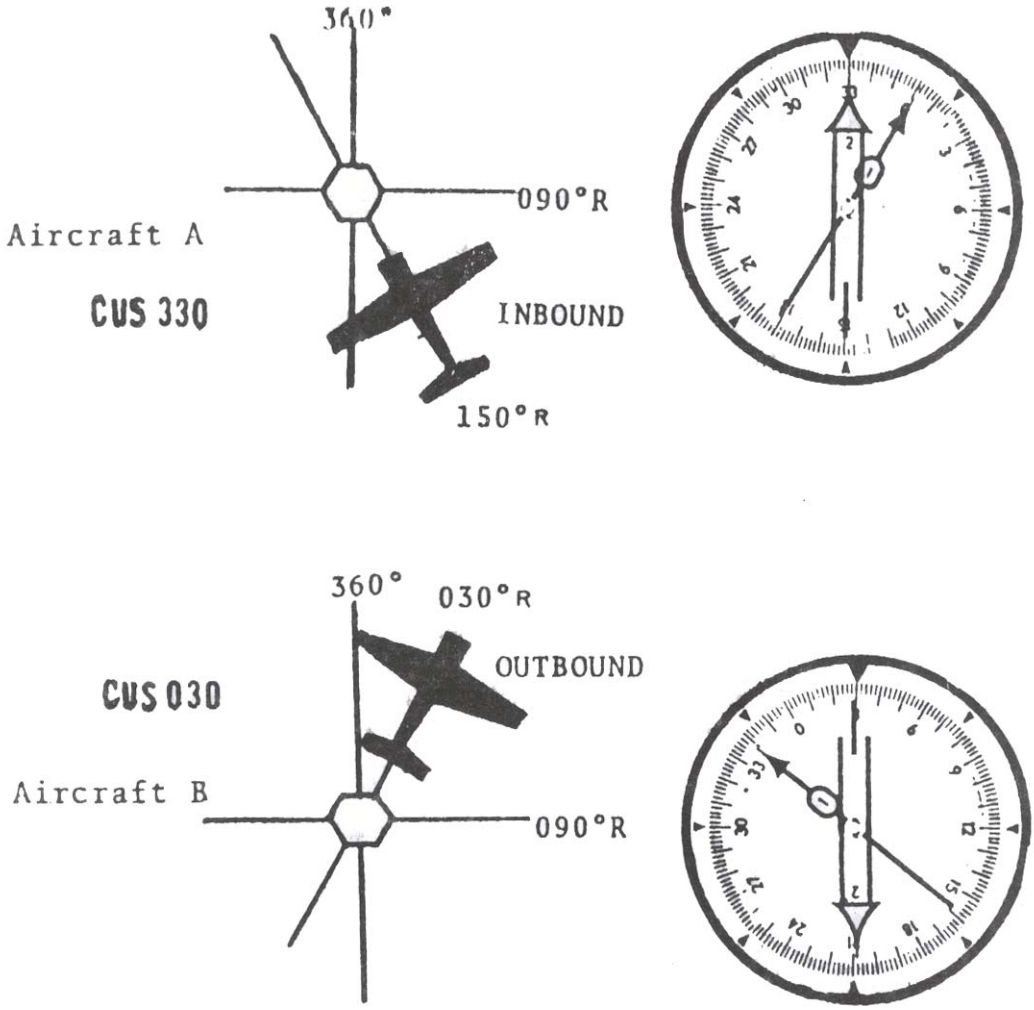


Figure 6

Assuming no wind, whenever the head of the needle is under the heading indexer (Aircraft A, Figure 6), the aircraft is flying directly to the station.

Whenever the tail of the needle is under the heading indexer (Aircraft B, Figure 6), the aircraft is flying away from the station.

Figure 7 depicts the RMI for the corresponding aircraft position relative to a navaid.

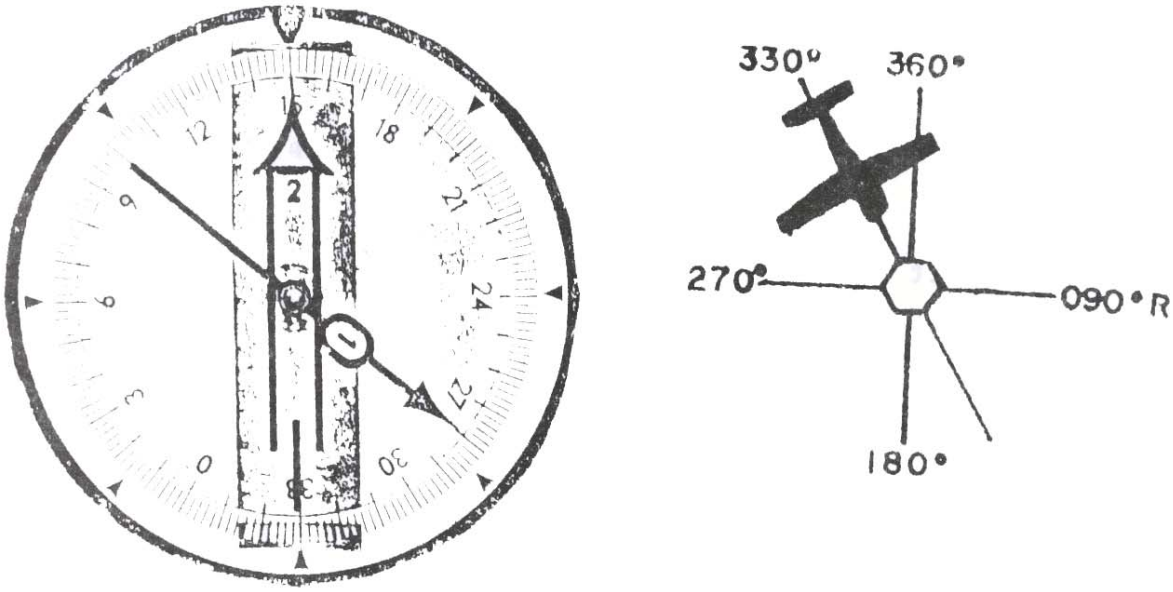


Figure 7

Here is another example of RMI presentation and aircraft position. Note the aircraft heading and position of the #2 needle.

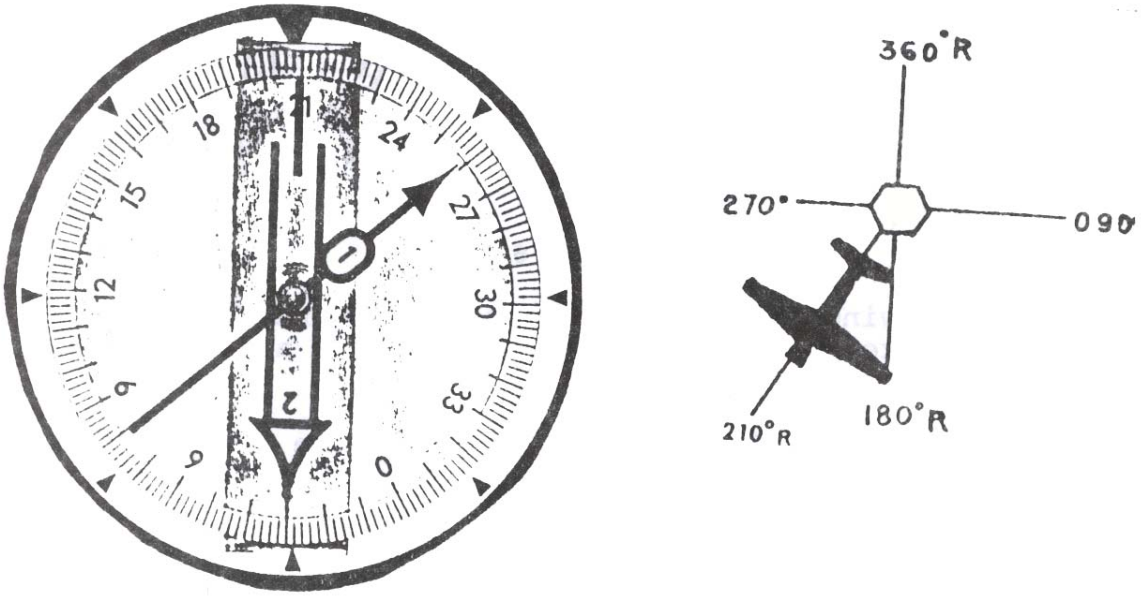


Figure 8

Your most frequent utilization of radial tracking will occur in conjunction with airways navigation. Airways navigation consists of flying assigned radials and courses between navaids. These are found on the enroute charts.

ENROUTE CHARTS

Every flight you will fly at VT-10 will in some way involve the use of a navaid. It may be a local hop during which you take off and stay within 50 nm of Pensacola, or it may be a cross country flight to the West Coast. In both cases you will come to depend on navaids for establishing your position and therefore a means of returning to base or other destination.

The routes between navaids are called AIRWAYS. In the low altitude structure (up to but not including 18,000' MSL) they are called Victor airways. From 18,000' MSL to FL 450, they are called Jet Routes.

Note that a compass rose on an enroute chart is oriented to Magnetic North; therefore, all radials emanating from the navaid are magnetic radials (See Figure 9).

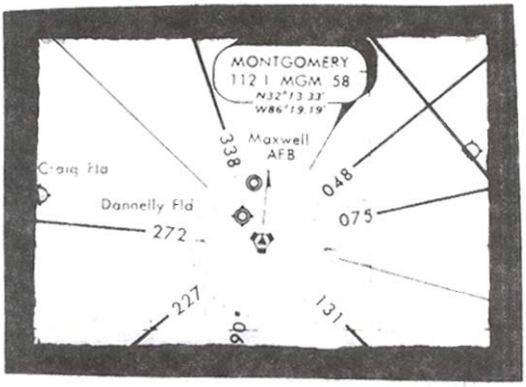


Figure 9

Navigation from one VOR, TACAN or VORTAC station to another by means of radials is referred to as radial tracking navigation.

A course is a magnetic track to be flown over the ground either to or from the radio navigational facility (TACAN, VOR or VORTAC stations). As we have seen, a radial extends only FROM a station, a course is either TO or FROM a station.

Note in the following figure (Figure 10) that the jet routes connecting the different navaids have radial values assigned to them. Extending from the top portion of the New Orleans compass rose is the 351° radial. If we flew outbound from MSY toward MCB, our course and radial would both be 351°.

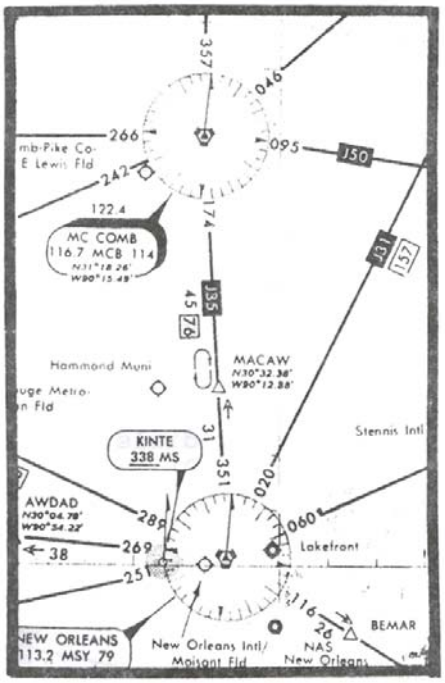


Figure 10

However, as we fly inbound to McComb, we must track the 174° radial of MCB. The course will be 354°, the reciprocal of 174°.

If a jet route or victor airway exists between two TACANs along your route of flight, you are expected to utilize that airway for the flight. In VT-10, you will fly airways whenever possible.

To fly from Semmes to Crestview, you must navigate along J-2. J-2 is defined by radials from both VORTACs, that is, the Semmes 081° radial and the Crestview 263° radial. (Figure 11)

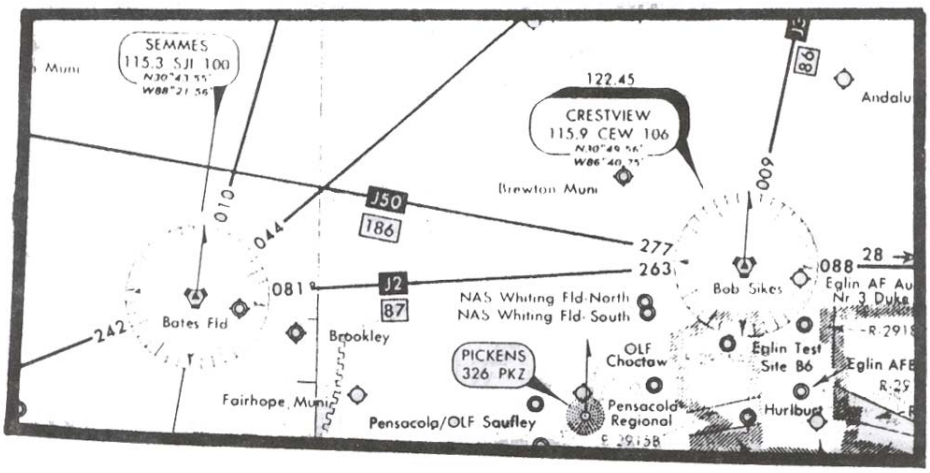


Figure 11

Here is a simplified account of a flight from Semmes to Crestview:

1. Tune and identify the Semmes VORTAC.
2. Fly on its outbound radial for half the distance of the jet route segment.

NOTE: In this case the radial and the course are both 081° magnetic.

3. At the halfway point (43.5 DME), tune and identify the Crestview VORTAC.
4. Fly inbound on the 263º radial of the Crestview VORTAC.

NOTE: In this case the radial is 263º and the inbound course is the reciprocal, or 083º.

It should be mentioned that while the chart (Figure 11) shows the J-2 route as a straight line, the course actually differs by 2º. This is caused, in part, by a change in the Earth's magnetic variation between the navaids.

Continuing east from Crestview towards Tallahassee on J-2, you will notice that the airway is NOT a straight line. It has a "Dog Leg" 80 (28+52=80) miles east of Crestview. (Figure 12)

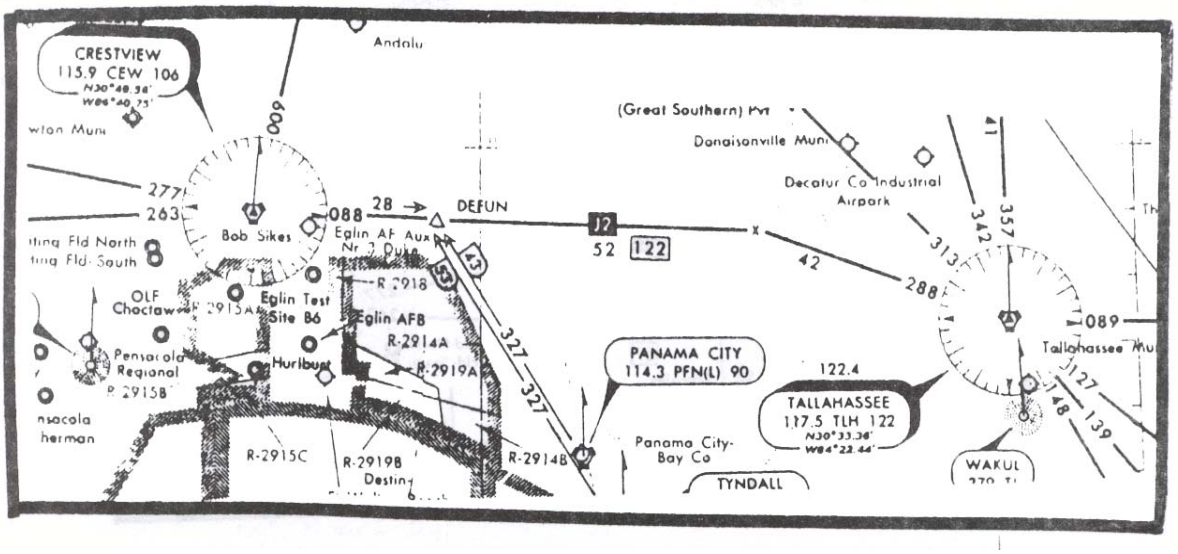


Figure 12

The procedures for flying this leg of J-2 are basically the same as the Semmes to Crestview leg. In this case the position at which you change navaids differs from the "halfway" rule. When flying J-2 from Crestview to Tallahassee, change navaids at the mileage breakdown point depicted on the chart. Your inbound flight to Tallahassee would be on the 288° radial (Course = 108°).

Another exception to the rule of changing navaids halfway along your route of flight occurs when you encounter a "changeover point". Figure 13 depicts J-118 between Memphis and Chattanooga. If you were flying easterly along J-118 you would not switch your navaid at half the distance (238/2=119). You would switch it at the changeover point (130 DME).

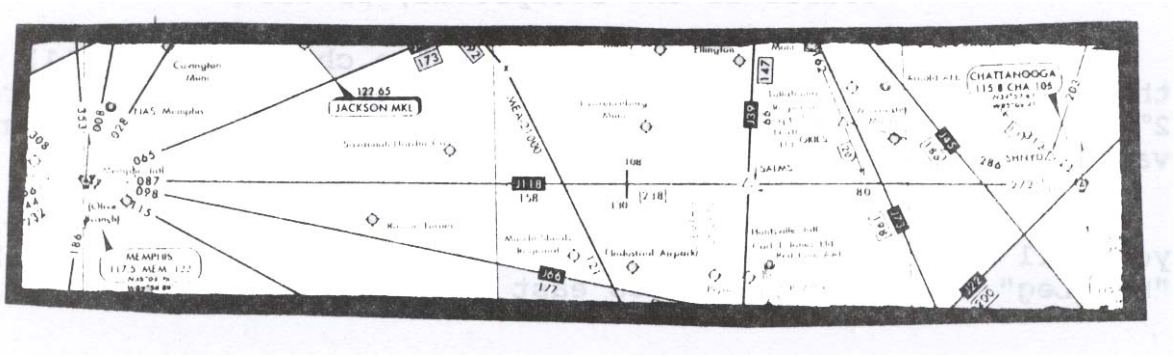


Figure 13

When planning a flight as well as completing a DD-175 flight plan, airways may be entered or exited at: NAVAIDS, NAMED INTERSECTIONS, or NAMED FIXES. In actual flight, ATC may vector you on or off an airway as necessary. A fix is a geographical position determined by visual reference to the surface, or in the case of Instrument Navigation, by reference to one or more radio NAVAIDS. A single NAVAID could reference a fix by use of radial and DME. In Figure 12, "DEFUN" is a named fix defined by the Crestview VORTAC R-088 at 28 DME. An intersection is a point defined by any *combination* of courses, radials, or bearings of <u>two</u> or more navigational aids.

In the following example (Figure 14), you could file to enter J-52 at GRW or IGB. These VORTACS define a segment of J-52. Note that only the airways that use a navaid have numerical designations for the radials adjacent to its compass rose.

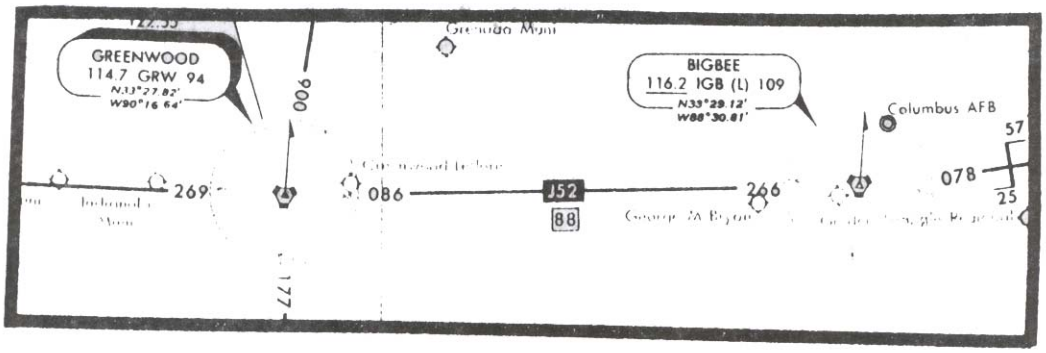


Figure 14

Now, take a careful look at the next example (Figure 15). You can NOT file to enter/exit J-63 at the Hancock (HNK) VORTAC. Note the line representing the airway circumvents the navaid and there are no radial designations for J-63 in the vicinity of HNK. This "loop" indicates that Hancock is NOT part of J-63.

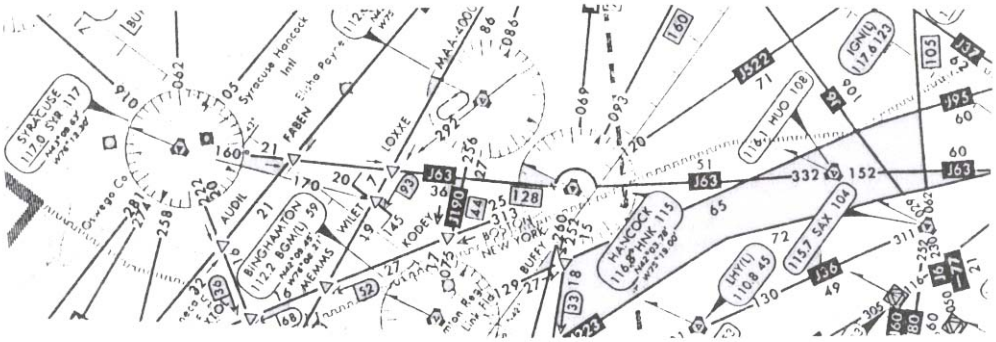


Figure 15

Figure 16 is another example. You can not enter/exit J-70 at Spokane (GEG). The airway line cuts through the compass rose and there are no radial designations for J-70 in the vicinity of GEG. This indicates that Spokane is NOT part of J-70.

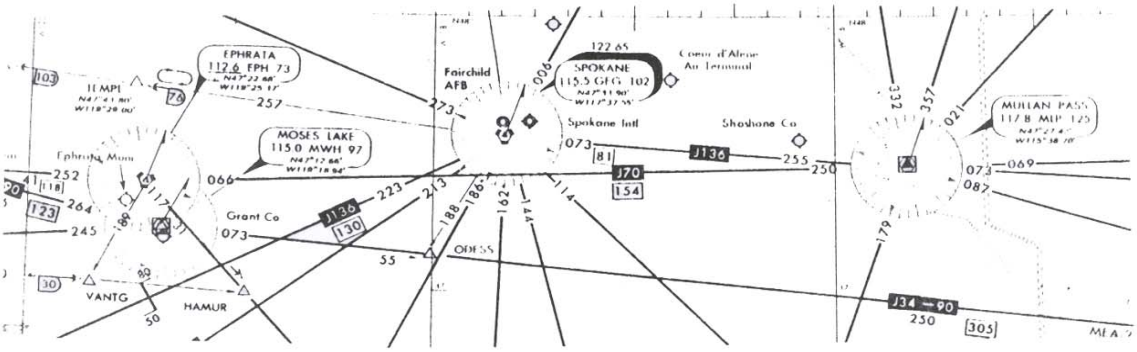


Figure 16

Let's turn our attention to intersections. The AIM (Airman's Information Manual) defines intersection as:

> A POINT DEFINED BY ANY COMBINATION OF COURSES, RADIALS OR BEARINGS OF TWO OR MORE NAVIGATION AIDS.

Application of this definition to enroute charts has provided two types of intersection: NAMED and UNNAMED. NOBEL is a "NAMED" intersection. (Figure 17)

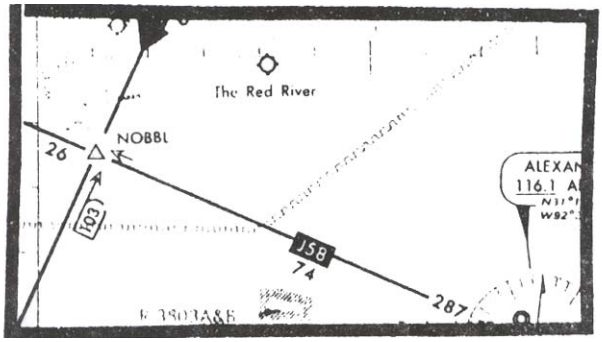


Figure 17

West of RAPID CITY are two UNNAMED intersections. (Figure 18)

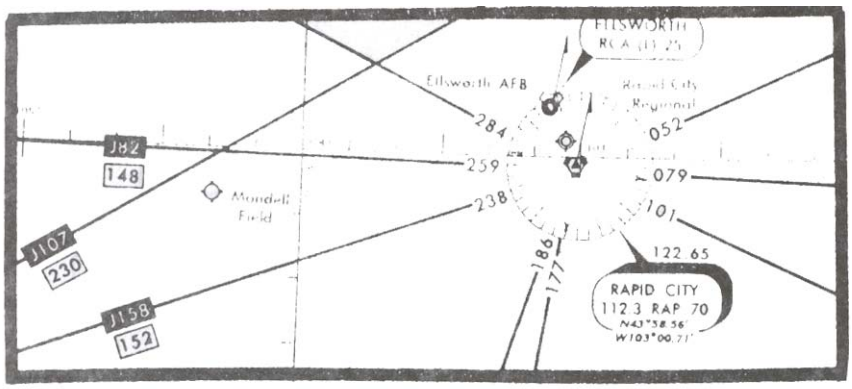


Figure 18

You may enter and exit the airways system at NAMED intersections if they are part of the airway. NOBBL is part of the airways represented by the line adjacent to it (Figure 17). You may NOT enter the airway system at a NAMED intersection if it is NOT part of the airway. BOWLIN is NOT part of an airway. (Figure 19)

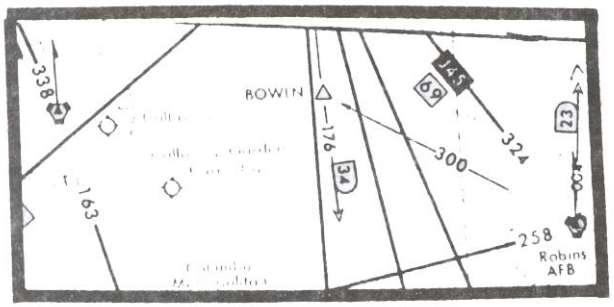


Figure 19

DIRECT NAVIGATION

If your desired route of flight crosses an area where an airway does not exist, you are usually able to fly DIRECT. Again referring to the ATM, flying DIRECT is:

> STRAIGHT LINE FLIGHT BETWEEN TWO NAVIGATIONAL AIDS, FIXES, POINTS OR ANY COMBINATION THEREOF.

In the illustration below (Figure 20), it is permissible to request clearance, to fly: ALEXANDRIA direct JACKSON

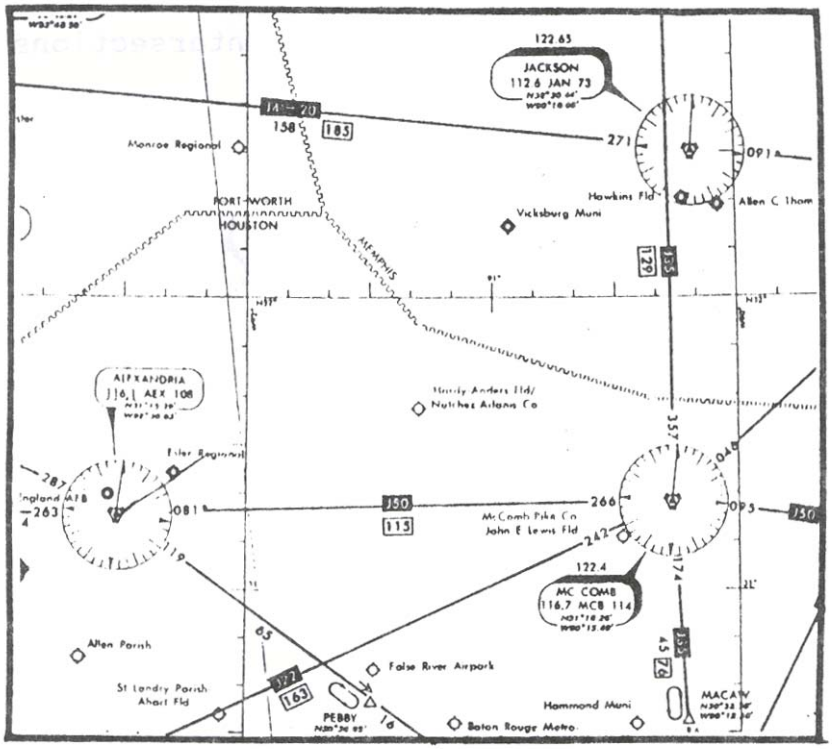


Figure 20

Measuring from the AEX compass rose will give you a course of approximately 050°.

The procedure for flying direct is slightly different from airways flight. Anytime you are filed direct to a TACAN station, the straight-line course from your chart is the one you will be expected to maintain. When you tune up the navaid, determine the inbound course and maintain it. In the next example (Figure 21), assume that your clearance reads: "J-4 MEI direct SJI..."

Upon arriving near Meridian:

1. Turn the aircraft toward the preflighted course to SJI (approximately 160°).
2. Tune and identify the Semmes Vortac.
3. Fly the course that is indicated by the head of the #2 needle once you are wings-level on heading 160 and compensate for any wind that is present.

"High" class navaids have a minimum guaranteed reception range of 130nm.

If the direct leg is greater than 130 nm, you may have to fly outbound on the preflighted radial until within 130nm of the next NAVAID, then switch over and fly inbound as stated above.

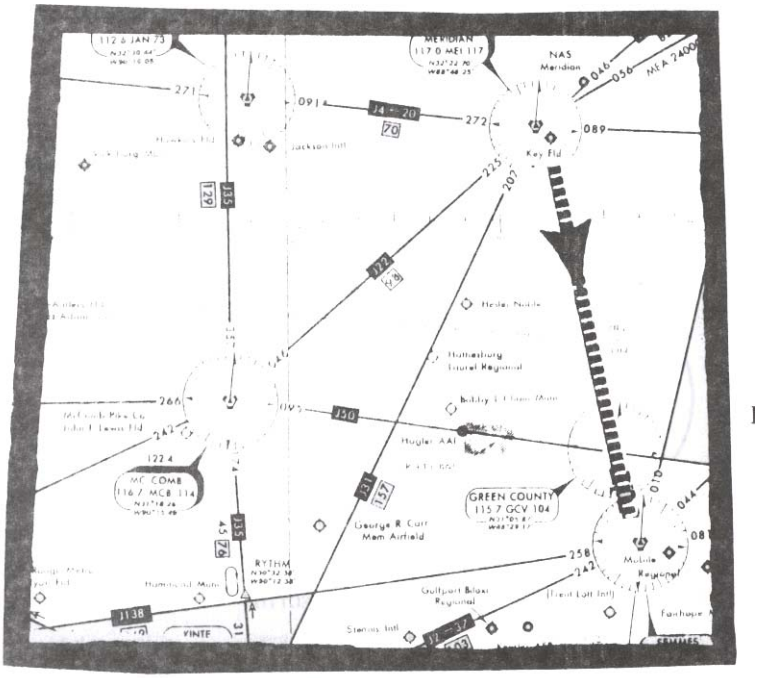


Figure 21

STATION PASSAGE

One very important facet of airways navigation is the determination of when you have passed directly over a navaid. This event is called station passage. Station passage is a crucial point in airways flights because in most cases, a course and heading change will be required in addition to the associated procedures required in VT-10.

Station passage occurs the moment the aircraft passes directly over the navaid. Recalling the characteristics of VORs and TACANs, when station passage occurs you will be in the cone of confusion.

As you enter the cone of confusion, the #2 needle will deflect and become unreliable. When you reach directly overhead the navaid, station passage will be indicated by minimum DME if using TACAN or by needle deflection with VOR. Minimum DME, when the DME stops decreasing and begins increasing, is the best indication of station passage. (Figure 22)

Because 1 nm approximates 6,000' in altitude, you can expect station passage/minimum DME to occur at the DME which is equal to your AGL altitude divided by 6,000'. Station passage at FL 310, for example, would occur at 5.2 DME (assuming the station is at or near sea level).

Thus, any heading change required upon passing overhead a station is usually initiated at minimum DME. Due to navigational error, there are times your aircraft will not pass directly overhead the navaid. In these cases, when your DME stops decreasing and starts to increase again, you have come as close to the navaid you ever will and you have experienced station passage. It is now your responsibility to turn the aircraft to the outbound heading.

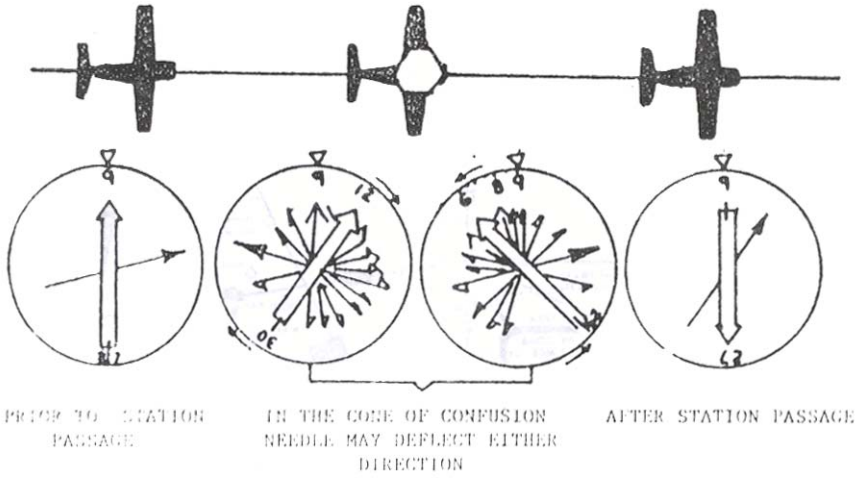


Figure 22

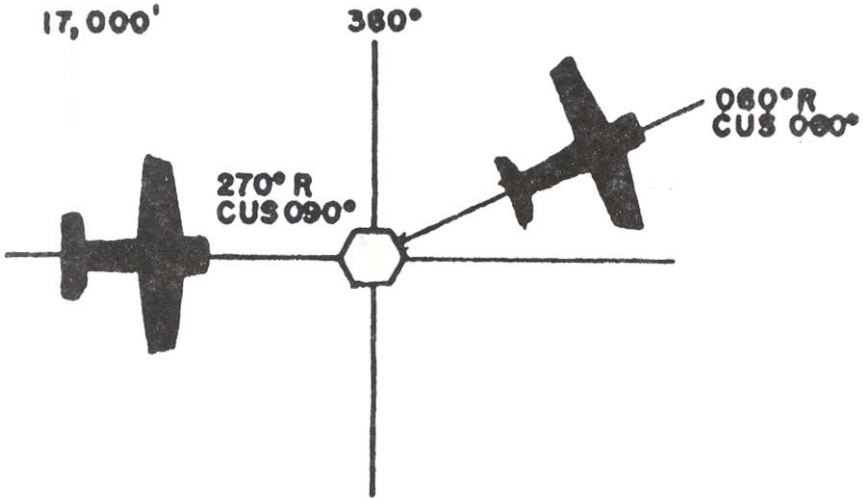


Figure 23

You should initiate the turn in Figure 23 above at approximately 2.8 DME (minimum DME).

LEADING TURNS

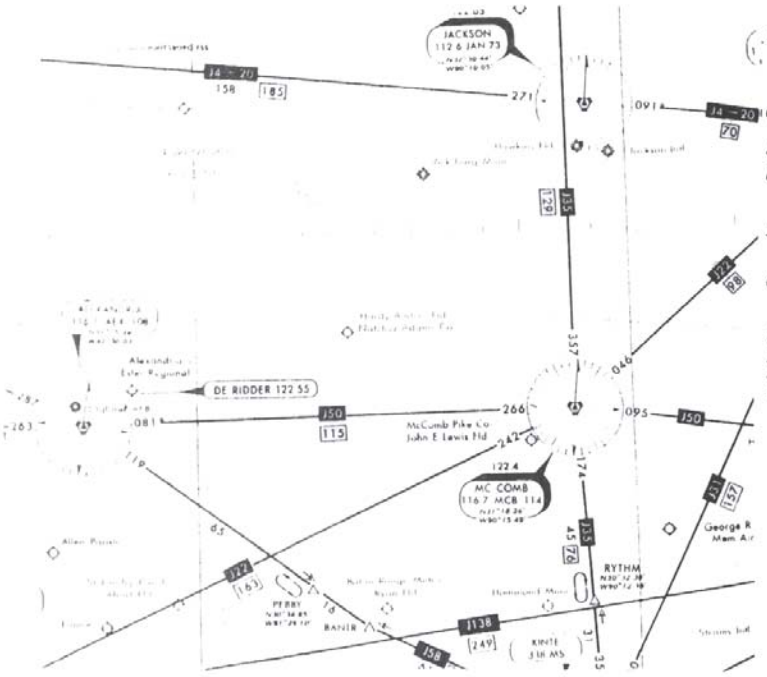
The chances of turning overhead a fix or navaid and ending up exactly on the desired outbound course are quite slim primarily due to aircraft turn radius and winds. Consequently, we lead turns so as to arrive on the desired course upon rolling wings-level. We lead turn onto airways and onto direct legs. There are two situations: turning at a navaid and turning at a fix not located at a navaid.

For turns at a navaid, lead the turn by minimum DME plus 1/2 of 1% of ground speed. In this case "Mark On Top" shall be defined as the TACAN needle passing either 90° benchmark (wingline) on the RMI.

When turning at a fix not located at a NAVAID, simply lead the turn by 1/2 of 1% of ground speed. In either case only lead turns that are greater than 30°.

Examples: Figures 24 and 25.

Keep in mind that even though both of the following examples are turns onto direct legs, we must also lead turns onto airways. If you are turning onto an airway, and even after properly leading the turn you roll wings-level and find yourself not on the airway (due to gusting winds or nonstandard rate of turn or whatever), you must turn to intercept the airway in an expeditious manner. If you are turning onto a direct leg, simply lead the turn as described above, tune and identify the "new" TACAN station, and as you roll wings-level fly the course indicated by the head of the #2 needle.



lustrates a turn at a

Turbo 15, cleared...J50
Alexandria, Direct
Jackson. . ."

Alt: 24000 ft

GS: 440 kts

Start turn at min DME
plus 1/2 of 1% of GS, ie.
at 6.2 DME

Figure 24

The following example (Figure 25) illustrates a turn at a fix not located at a navaid:

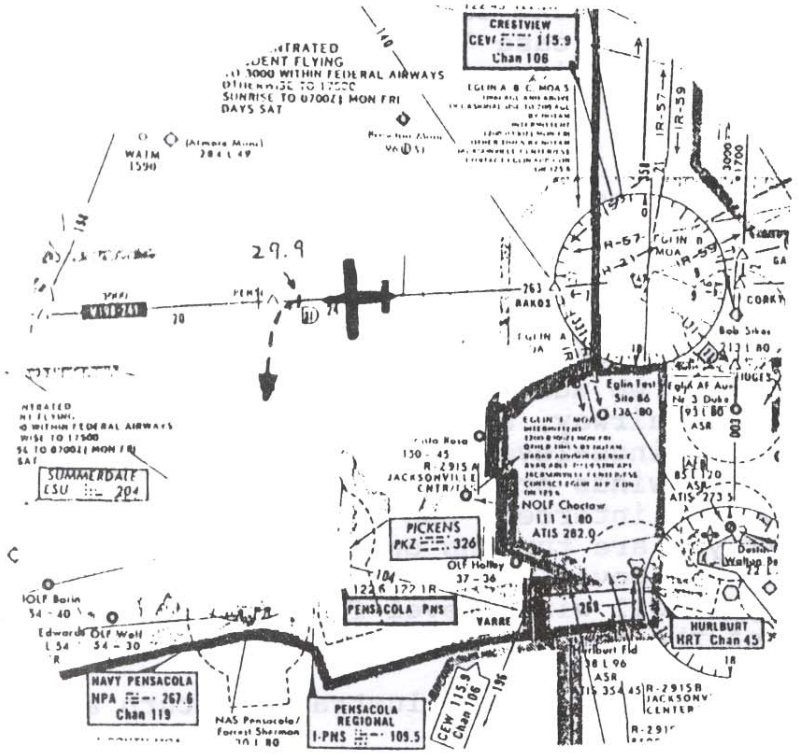


Figure 25

You must be able to visualize your navigational situation from the indications on the RMI, keeping in mind that your position can be defined from the tail of the #2 needle. There are three rules regarding course corrections. THESE RULES APPLY TO NO-WIND SITUATIONS. They are the basic principles for determining corrections to return to course; however, the presence of wind will cause you to modify these rules as the need occurs.

Rule One: The tail of the #2 needle always moves in the direction of turn and the head of the #2 needle will always move in the opposite direction of turn (heads will fall, tails will rise).

That is to say, in all cases while tracking outbound from the navaid if you want the tail of the #2 needle to move to the left, turn to a heading that is left of the tail of the needle. If you want it to move to the right, turn to a heading that is right of the tail of the needle. The situation is opposite while tracking inbound to a navaid. If you want the head of the #2 needle to move to the left, turn to a heading that is right of the head of the needle; if you want it to move to the right, turn to a heading that is left of the head of the needle.

In Figure 26, you are proceeding outbound from the navaid heading 180º, maintaining a course of 185". (Remember when radial tracking outbound from a station, the radial and course are the same). If you want to intercept the 190"R, you need the tail of the needle to move to the right. Turn to the right of the tail of the needle.

Now that you know in what direction to turn, how far should you turn? Of the two rules which govern the amount of turn, one involves tracking outbound only, while the other involves tracking inbound only. The two can not be interchanged.

Rule Two: In order to intercept a certain radial when tracking outbound, determine the difference in degrees between the radial you are on and the radial you desire. Apply the difference in the proper direction (according to Rule One) to the radial you want to intercept.

In Figure 26, Rule Two gives a heading of 190° + 5° = 1950.

In Figure 27, you are on the 090ºR but want to establish yourself on the 090ºR. You want the tail of the needle to swing left, so the turn will be to a heading left of the tail. The difference between 093ºR and 090ºR is 3º. Utilizing rule two applying 3° to the desired radial results in a heading of 087°. Therefore, if you turn to 087°, you will intercept the 090º radial.

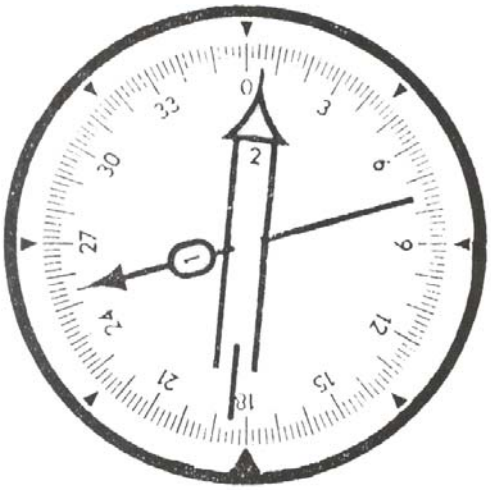


Figure 26

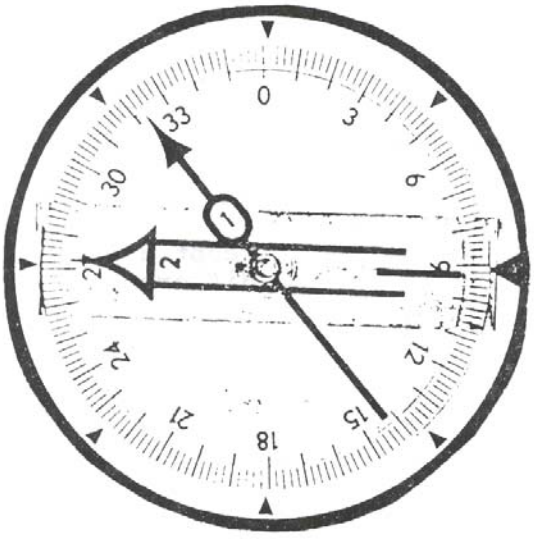


Figure 27

In Figure 28, if we wanted to intercept the 330°R we would apply rule two. Since we are presently on the 350°R and we desire to be on the 330° R (20° left of 350°) we must turn the aircraft 20° left of 330° to 310°. Once established on a heading of 310°R, the tail of the needle will move left and eventually reach the 330" R.

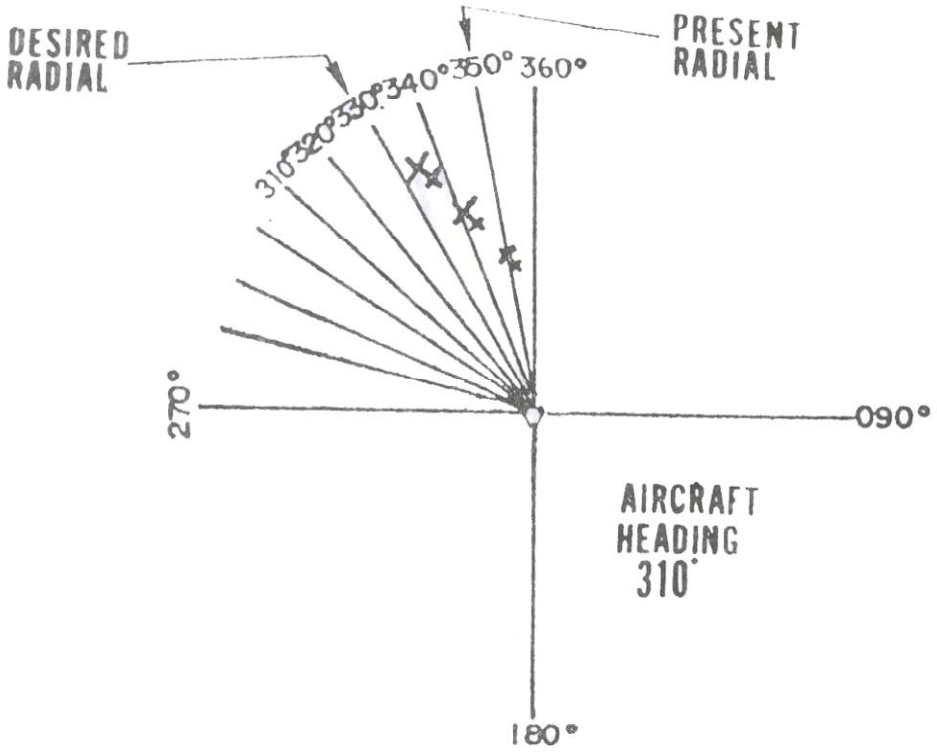


Figure 28

Now let us shift our discussion to tracking inbound on a radial. Tracking inbound will differ in some ways from the techniques you have already learned. Instead of using the tail of the #2 needle you will now be using the head. The head behaves in a manner different from the tail.

Rule Three: In order to intercept a certain course, determine how many degrees to the right or left the head of the #2 needle must move, and then turn that same number of degrees to the opposite side of the head of the #2 needle. (i.e. the head falls)

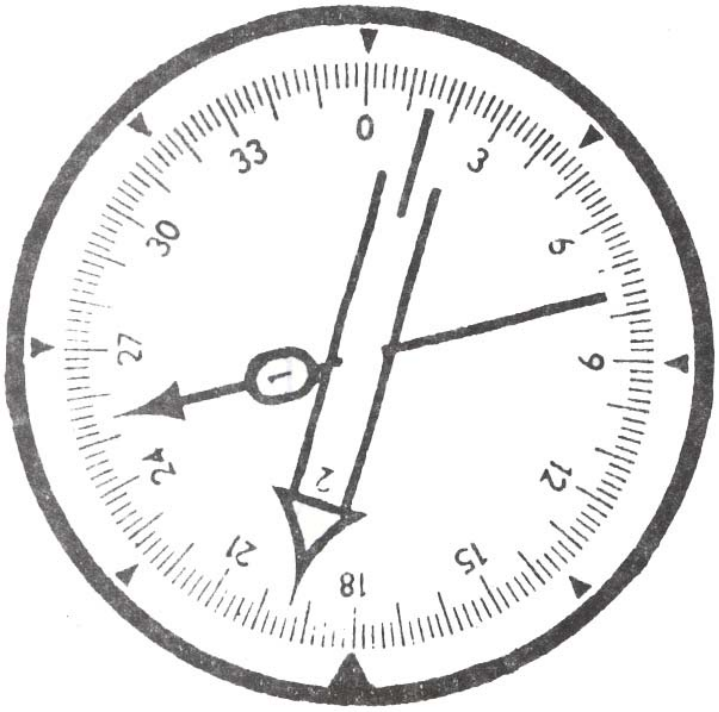


Figure 29

In the figure above (Figure 29), the aircraft is on the 015° radial heading 180°. To intercept the 360° radial and maintain an inbound course of 180°, you need to determine the proper direction and amount of turn in order to comply.

Working with the top half of the RMI only, we note that the head of the #2 needle must move 15° to the left from 195 to 180°. Therefore, all we have to do is turn 15° to the right of the present position of the needle to 210°. Shortly, we will note that the head of the needle will start moving toward 180°.

As the head of the #2 needle approaches the desired course, turn the aircraft back to a heading to maintain that course.

In the previous example, we found it necessary to convert radials to inbound courses. If you are flying from CEW to MGM, 43 nm out of CEW you must switch your TACAN ahead to MGM. Your RMI should resemble Figure 30.

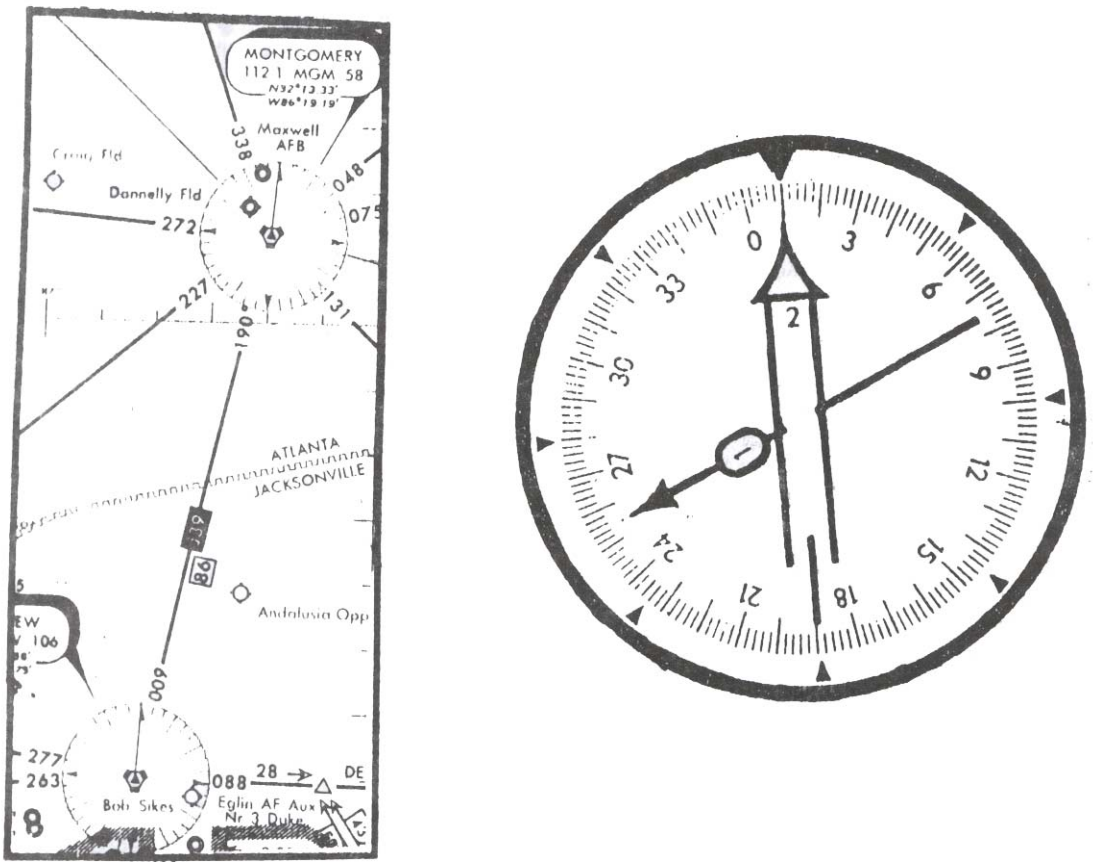


Figure 30

The head of your number 2 needle should be resting on 010°. If it is not, you must turn your aircraft according to rule three and ensure that it moves to 010º.

If it were on 016º, you have to turn to 022º to make it move to 010º. If it were on 005º, you would have to turn to 360º to get on course. As the needle approaches 010°, turn back to a heading to maintain the needle on 010º.

The rate at which the needle will move will be a direct function of your DME from the navaid, the amount of correction and the direction/velocity of wind.

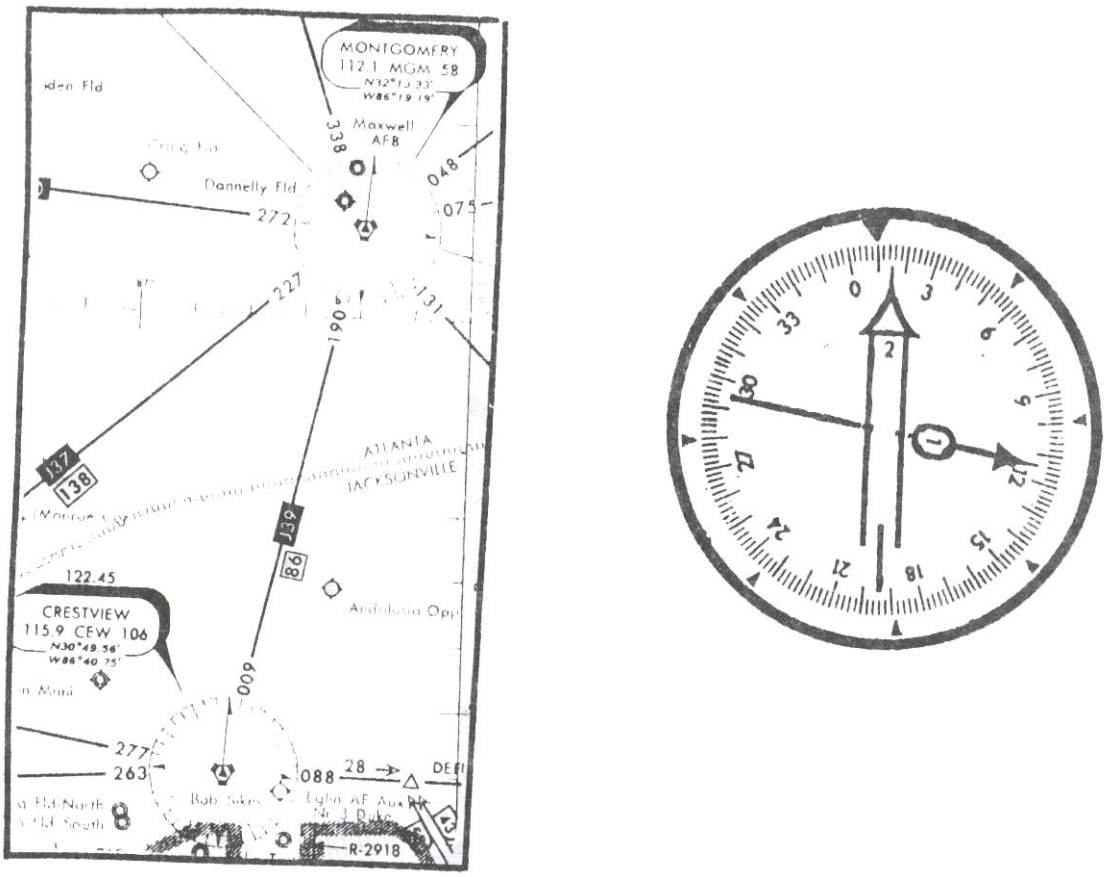


Figure 31

In Figure 31, you are trying to fly J-39, but you are on the 195ºR of MGM. At 30 DME you are left of course by 2 ½ nm. Therefore, when you turn that aircraft to 020º to correct your navigational error, you should realize that to get back on course you will have to cross 2 1/2 nm of airspace. If the aircraft were on the same radial at 10 DME however, you would only have to cross a little less than 1 nm of airspace. In this case, you are moving your aircraft the same number of radials as in the first case. But, because the radials are more closely spaced nearer the station, you would be back on course sooner since you will only be crossing 1 nm instead of 2 ½ nm. Thus, the head of the #2 needle, would move toward 010° more quickly.

This correlation of distance from the station with the distance between radials must be kept in mind whenever making course corrections, otherwise the behavior of the #2 needle may not be in accordance with your expectations.

The practical application of the above discussion deals with choosing the proper time to take out the course correction and turn back to the original course. Based on the above examples, a good rule of thumb is that when close to a station, you will be crossing radials rapidly; therefore, you must take your correction out in time to avoid overshooting your course. When further away, the radials are spaced further apart, so you can wait longer.

In either case, it is important to scan the rate of movement of the needle and develop a feel for when you should terminate your course correction and turn back to course.

COURSE CONTROL

Now that you know how to intercept the desired radial/course, you must maintain it. Until now situations have not taken wind into account. When wind is involved, a drift from course occurs. This is true only if there is a crosswind component. A pure head or tailwind will only slow you down or speed you up. Thus when you have a wind that is a crosswind, a heading into the wind (CRAB) is necessary to maintain your radial (course) or else the following happens:

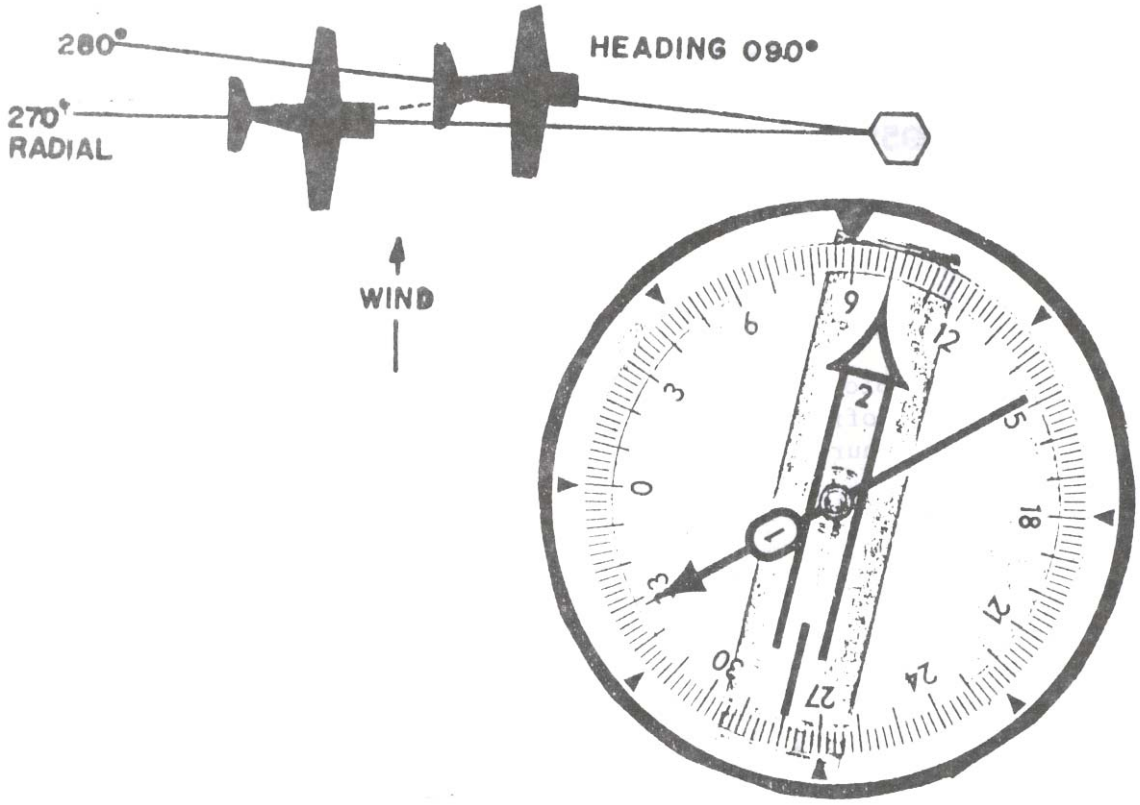


Figure 32

As you can see, you drift off course.

Observe what has happened to the aircraft in Figure 32. The student was trying to maintain an inbound course of 090°: tracking inbound on the 270° radial. His heading was 090°. A wind from his right side pushed him north, and shortly thereafter he found himself on the 280°R. He drifted north of course because he was not compensating for the crosswind. Note the head of the #2 needle pointing at the direction of crosswind. The head will always point at the direction of crosswind before you have applied crab to compensate for the crosswind.

If you have a crosswind, you will have to crab to stay on your desired course. If you are blown off course, you must correct back to course while still crabbing for the crosswind.

When you find that the wind has affected you, you must get back on course. Determine how you got off course and then apply a crab to compensate. If you continue to get blown off course you must increase your crab until you have compensated for the wind. Observe the aircraft in Figure 33. It has been blown off course and has taken several tries to finally establish itself on course.

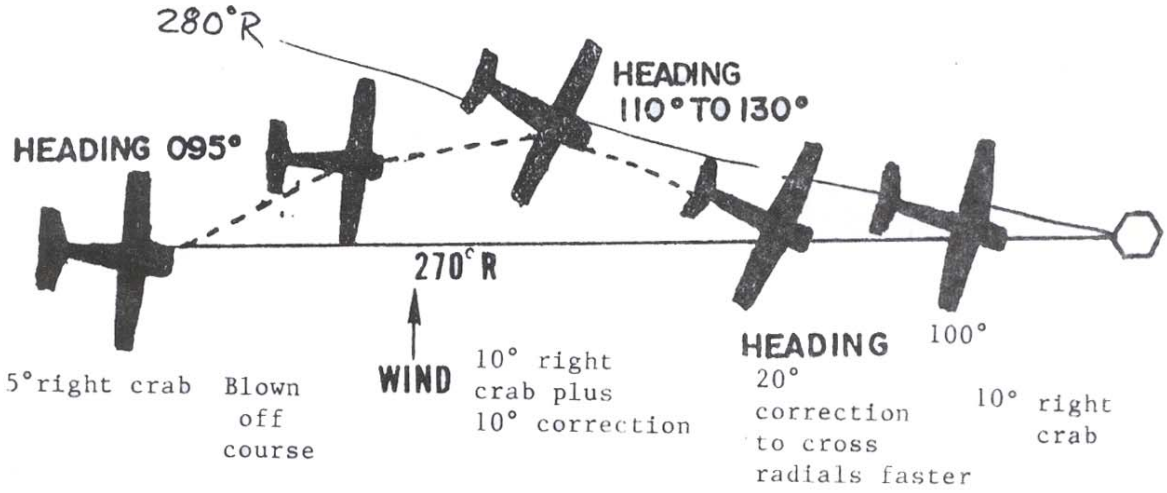


Figure 33

If the crab is too large, the aircraft will cross the radial and continue off in the opposite direction. (Figure 34)

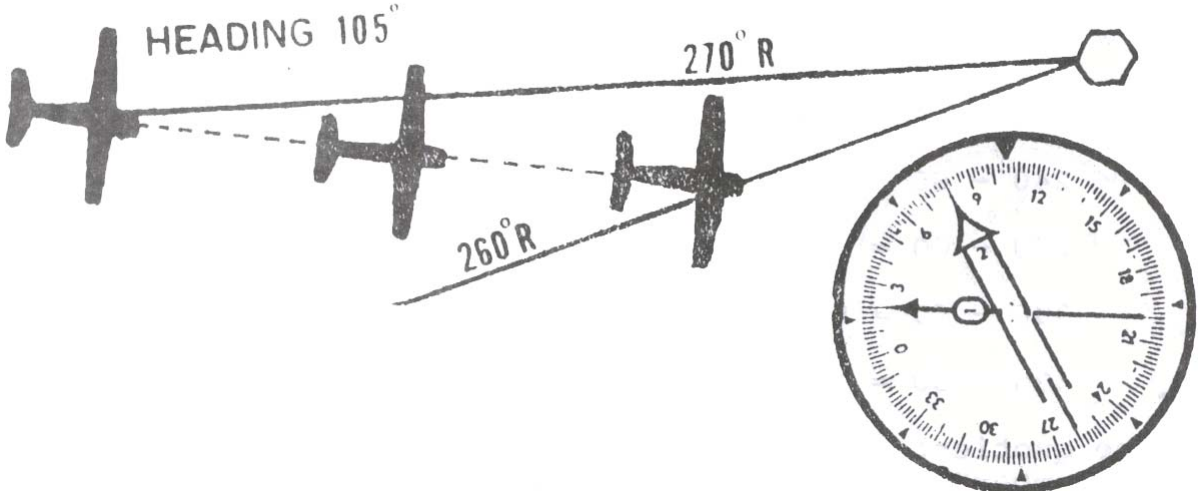


Figure 34

In Figure 35, the aircraft is crabbing 5° into the wind (095° heading) to maintain its present radial, 270° and its course of 090°.

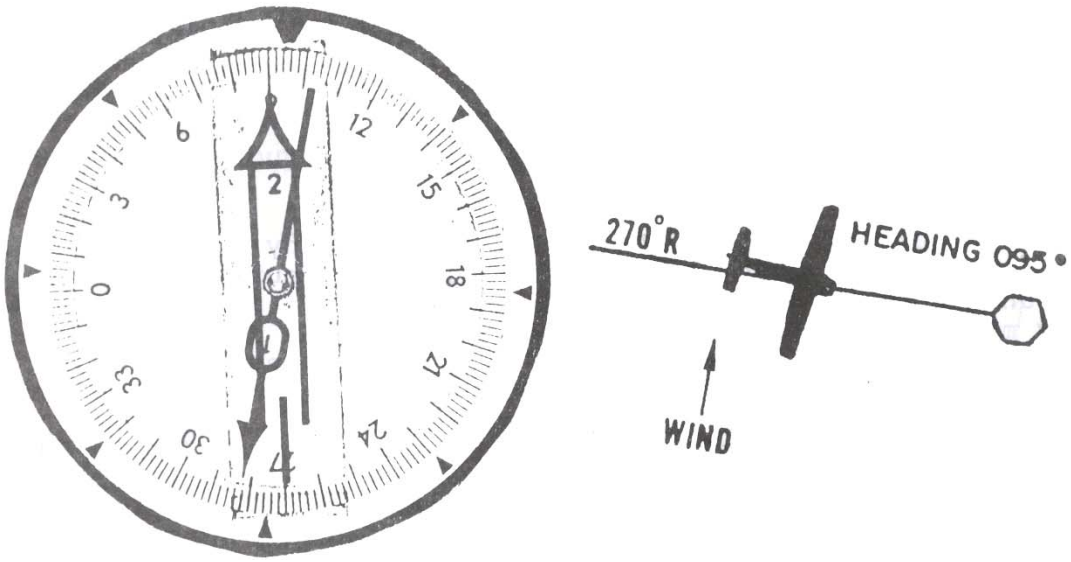


Figure 35

In addition to the method previously learned using the CR-2 computer, we can determine how much actual crosswind is acting on this aircraft. It will be a function of the aircraft's true air speed (TAS) and crab angle. Here is the procedure:

1. Take the aircraft's TAS and divide it by 60 minutes:

   For example:

   180 - 60 = 3 NM/MIN

   240 - 60 = 4 NM/MIN

   300 - 60 = 5 NM/MIN

   330 - 60 = 5.5 NM/MIN

   420 - 60 = 7 NM/MIN, etc.

The quotient is your TAS in NM/MIN which we will call your "guide number".

2. Now multiply your crab angle by the guide number. The product of that calculation will be a rough estimation of your crosswind component.

Therefore, if our aircraft is crabbing 5° and our TAS is 360, then our guide number is 6 and our crosswind component of the wind is 30 knots. This procedure can also be used in reverse to solve for a crab with a known crosswind. Simply divide your crosswind component by your guide number. The quotient is your crab angle.

For purposes of wind calculation and for many other reasons, it is important that you be able to calculate your aircraft's ground speed. It is a simple task but there are a few guidelines you must follow. You will determine your ground speed by computing the change of your TACAN DME. Recall now that DME gives you slant range to a TACAN station; as we get further away from TACAN stations, the difference between DME (slant range) and ground range decreases. To ensure that the mileage figures we use to compute our ground speeds are as close as possible to actual ground miles do not utilize the DME within a radius of a TACAN which is equal to your altitude in thousands of feet. For example, if you were on J-2 (Figure 36), flying from MSY to SJI at FL 370, you would not commence a ground speed check until at least 37 DME from MSY and stop it by 37 DME of SJI.

Remembering that restriction, here is the procedure for conducting a ground speed check.

1. Watch your DME. As it passes through a whole mile, start your clock.
2. Run your clock for three minutes.
3. At the end of three minutes note the new DME. 3-28

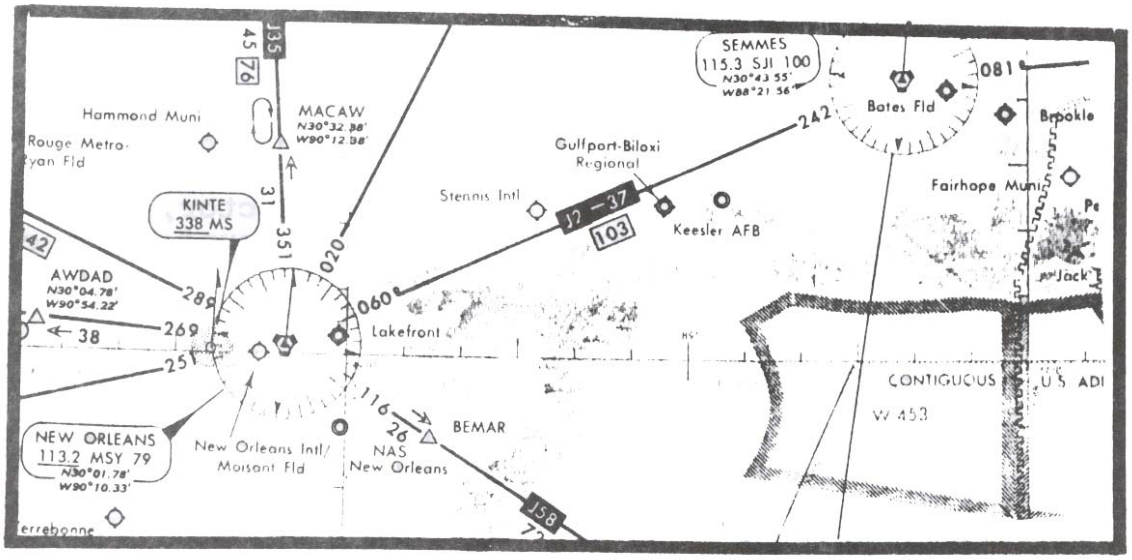


Figure 36

4. Subtract the two numbers, divide by 3 (for three minutes) and you will have your ground speed in nm per minute.
5. To change this to nautical miles/hour (knots), simply multiply this number by 60.

NOTE: A more convenient approach might be to double the DME difference and add a ZERO to the end of your product (same as multiplying by 20).

e.g. Ground speed check commenced at 38 DME: time 0 + 00
Ground speed check terminated at 54 DME: time 0 + 03

Difference = 16. 16 = 5 1/3 NM per MIN (5 1/3 x 60 = 320 kts).

Ground speed checks may be taken for any length of time. The longer the time, the more accurate the check. Whenever possible, 3 minutes is the recommended timing you should try for.

Another method of computing ground speed is give below:

GS check commenced at 40 DME: time 0 + 00
GS check terminated at 57 DME: time 0 + 03
57 - 40 = 17 DME

Since 3 minutes goes into 60 minutes (1 hour) 20 times, simply multiply 17 x 20. Your GS in this case is 340. This method nets the same answer as the previous method of calculation.

Now look at J-2 (Figure 36). Note that you should switch your TACAN to SJI at 51 ½ nm. If doing so conflicts with your ability to take an accurate ground speed check, use your discretion and with the permission of your instructor, you may be permitted to change the TACAN later after your ground speed check has been completed. Remember a ground speed must be attempted at least once per leg.

We have just talked about ground speeds and crab angles. These variables are needed to determine the actual direction and velocity of the wind. You already know how to calculate wind on the CR-2. Here you will learn a method of getting a rough wind, which can approach the accuracy of the wind you determined from your CR-2.

Given TAS: 300
G/S: 320
MC: 270°
MH: (to hold MC) 274°

First, it should be apparent that the aircraft has a 20 kts tailwind component. The crosswind component guide number is 5 (300/60). The crab angle is 4° (274-270=4°). It follows that 5 (Guide Number) times 4 (crab angle) equals 20 kts, your crosswind component.

Now simple geometry comes into play. Using Figure 37 and the theory of a right triangle, draw a line which equates to your course and your head or tail wind component: (A).

Next, at the beginning of that segment; i.e. where it commences, draw a line representing your crosswind component. We determined that since we were crabbing four degrees to the right, that our crosswind component consists of 20 kts off the right wing: (B).

Now simply connect the end points of the two segments. That line represents your wind velocity and direction.

Reviewing: If Segment A represents a course of 270°, then the origination of segment C (your wind) is from 045°. And if the lengths of both lines (A and B) represent 20 kts, then the length of line C, which is somewhat longer, represents about 28 knots.

If you were to work this out geometrically you would find that here we used a simplified example utilizing a right isosceles triangle. If you check your answer with the CR-2, it will be very close.

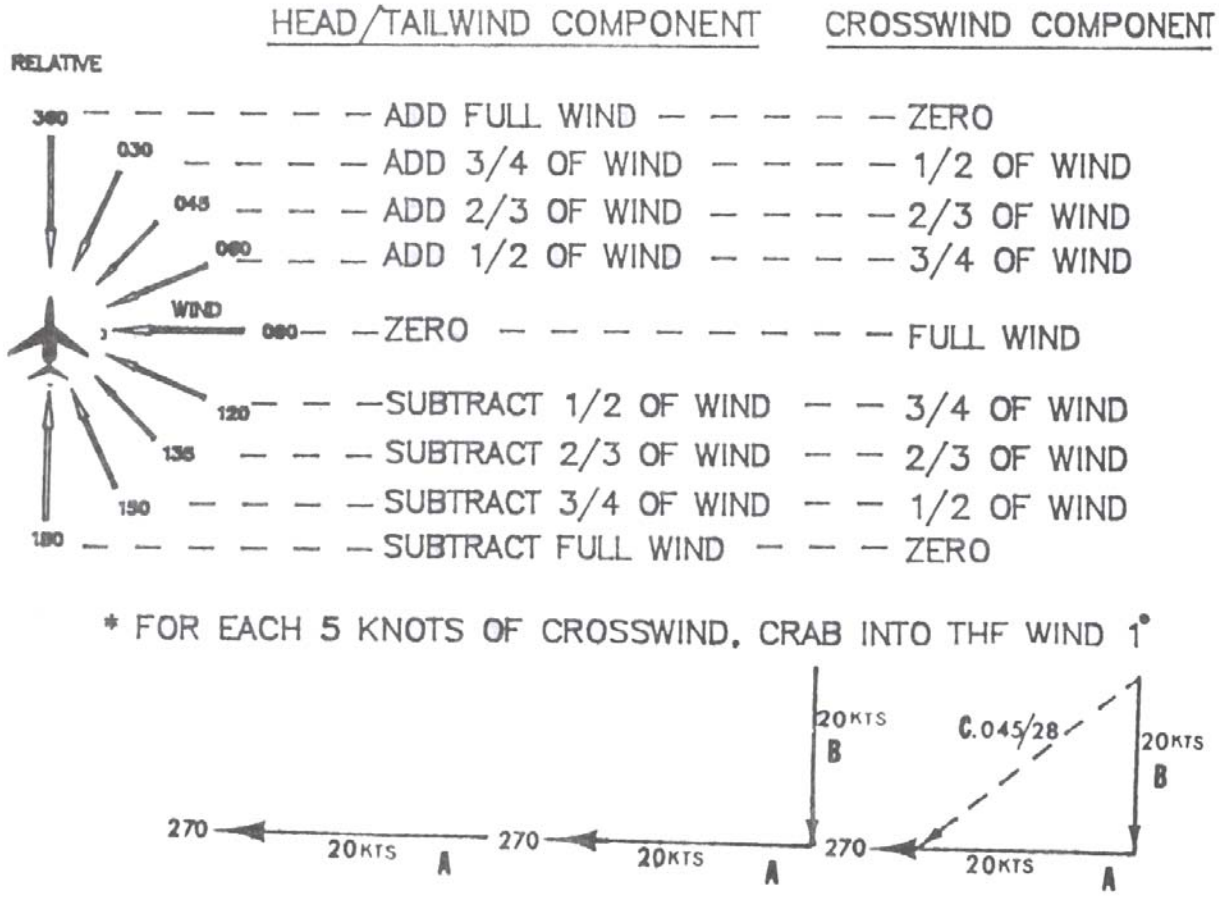


Figure 37

Another approach to wind analysis can be applied just by knowing the respective Head/Tail Wind Components and the Left/Right Crosswind Component. Based on your aircraft's magnetic course, determine the quadrant which coincides with your respective wind components. Once the quadrant is determined, further subdivide this into eights. If both components are of equal valve, the wind direction will correspond with a heading 45° from the aircraft's course; otherwise the wind direction will be from the eighth segment (sector) which has the larger component. If one component is twice as large as the other, then the wind direction will subdivide the sector of the larger component, etc. A relatively simple yet effective manner of calculating the velocity vector can be accomplished by utilizing the following formula:

Larger Component Plus ½ Smaller Component = Total Wind Velocity

In Figure 37, this formula yields a wind velocity of 20+(½x20) 30 knots.

Wind solutions may sometimes be difficult, however the direction and velocity will be helpful. The wind itself is never constant in either direction or velocity; therefore, pinpoint accuracy is never possible.

In addition to applying the wind to your enroute navigation, it will affect turn radius. In Figure 38, if you were proceeding west on J-36 and intended to join J-7 at Great Falls, you would have to intercept an outbound course of 023º.

If you turn to a heading of 023° on top GTF, you will probably parallel the left side of J-7 because your aircraft's turn radius would be too wide to intercept the 023ºR.

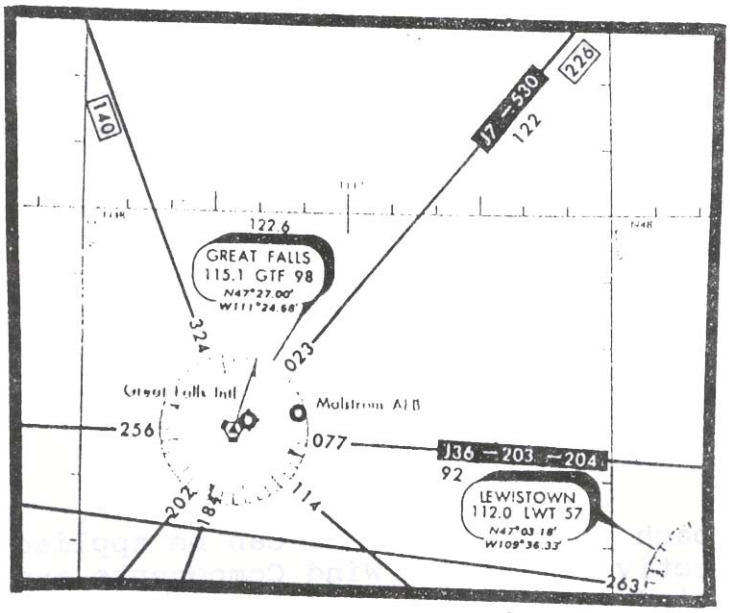


Figure 38

A tailwind in the previous situation would tend to increase the displacement between aircraft position and desired track; whereas, a headwind could negate some of the effects of the turn radius. Recall that the formula for leading turns is ½ of 1% of ground speed.

Once you know the wind, much of the guess war}: will be taken out of course control. The wind will affect you in flight. t may cause you to drift left or right or it may slow you down or speed you up. By applying the procedures you have learned in this chapter you will be able to compensate for it and you will be in control.

USE OF A CDI

General

Almost without exception, all military aircraft make use of a radio compass system as the primary navigation instrument. In the T-34C, this system',s cockpit display is the radio magnetic indicator or RMI. In its role as a compass, you have used this instrument since the Familiarization stage. In the Radio Instrument stage, you will combine this usage with the interception of aircraft position as depicted on the RMI's VOR and TACAN needles.

The RMI's principal shortcoming is its small size. Just as it is difficult to resolve small heading differences on the face of this instrument, it is also difficult to recognize small deviations from your desired course as depicted on the VOR and TACAN needles, hence the IND-350.

The course deviation indicator (CDI) is the major component of the IND-350; its other components are the omni bearing selector (OBS) and TO-FROM indicator (also known as the "ambiguity" indicator).

It is important to re-emphasize here that, in the event of a discrepancy between RMI and CDI, the RMI is to be relied upon for course information.

To properly use the IND-350 you must first twist the desired course with the OBS. Then set the VOR-TACAN switch to the appropriate position. The TO-FROM indicator will then show whether the course selected will take you TO or FROM the navigational facility tuned. If you are within ten degrees of the course selected, the course deviation indicator will provide a picture of relative position.

Figure 39 presents a typical situation. The selected course inbound to the station is 360 degrees and the aircraft is 5 degrees left of course (imagine your aircraft on the tail of the VOR needle, and at the center of the CDI). You must therefore, turn right (toward the CDI bar) to establish the aircraft on the desired course. Note that the CDI provides an easily interpreted picture of course deviation and correction, but actual aircraft position (185 degree radial) is more easily seen on the RMI.

Thus, as a general. rule, you will use the RMI for orientation, and the CDI as an initial indication of approaching the assigned course (specifically within 10 degrees of course) and fine tuning once established on course. Keep this dictum in mind and you should have few problems with disorientation.

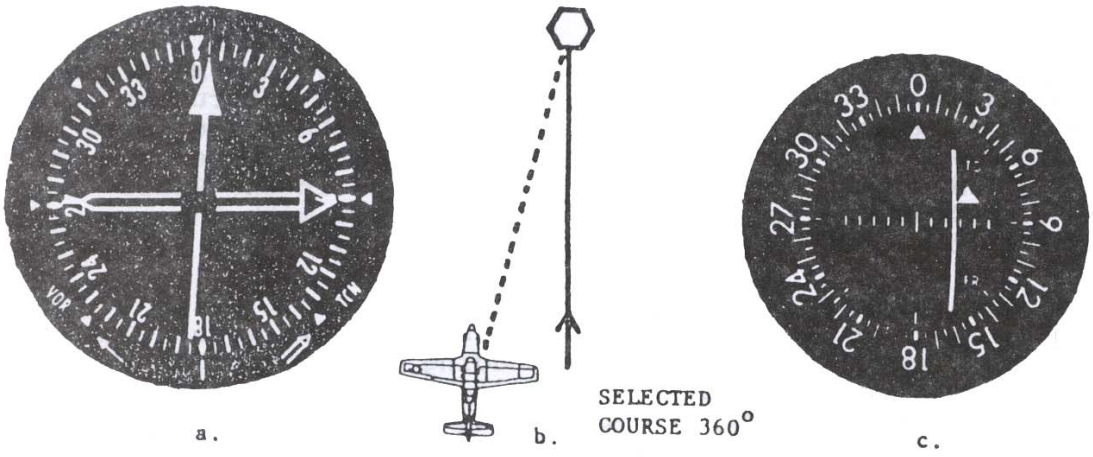


Figure 39

REVERSE SENSING

We have just covered the normal use of the IND-350. Now we will discuss a possible misuse of the course deviation indicator (CDI) portion of this instrument.

The CDI will be centered whenever the aircraft is on the radial selected by the OBS, or on the reciprocal of that radial. Keeping the above in mind, examine Figure 40 a and b, noting the absence of a TO-FROM indication. Can you determine the position of the aircaft?

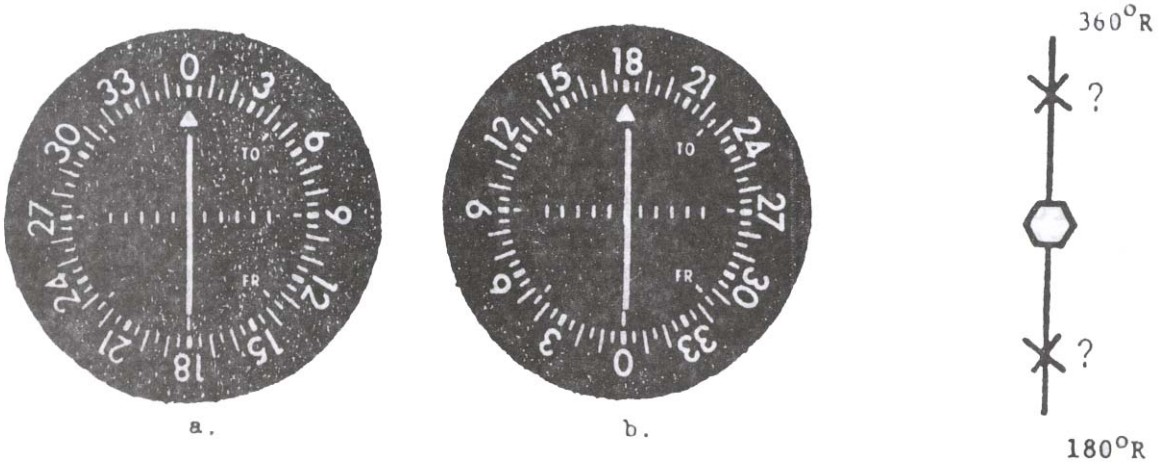


Figure 40

The answer, of course, is no! In both Figures 40a and 40b the aircraft could be either north or south of the station.

Until we know whether the course selected will take us TO or FROM that station, we cannot orient ourselves. Consider the same situation with an operational TO-FROM indicator.

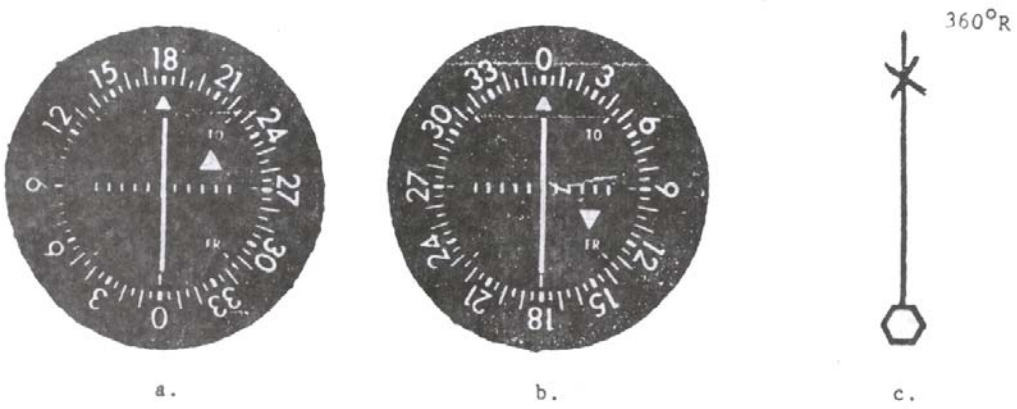


Figure 41

In Figure 41, the TO indicator is showing. This means that if you fly 180 degrees (course selected by OBS) you will go to the navaid. This could only be possible if you were north of the station as in Figure 41c. Figure 41b shows the FROM indicator with a course of 360 degrees set, meaning that if you fly 360 degrees you will go FROM the station. Again only the situation illustrated in Figure 41c satisfies these conditions.

Now we know that, in both the above depictions, the aircraft is located on the 360 degree radial; i.e, due north of the station. This is so because a course of 360 degrees will take us FROM the station and a course of 180 degrees will take us TO the station.

A problem remains, however, we have not yet discussed the aircraft's heading which is completely independent of its momentary position. Let us continue with the above example. Figure 42 shows one possible combination of aircraft heading and position.

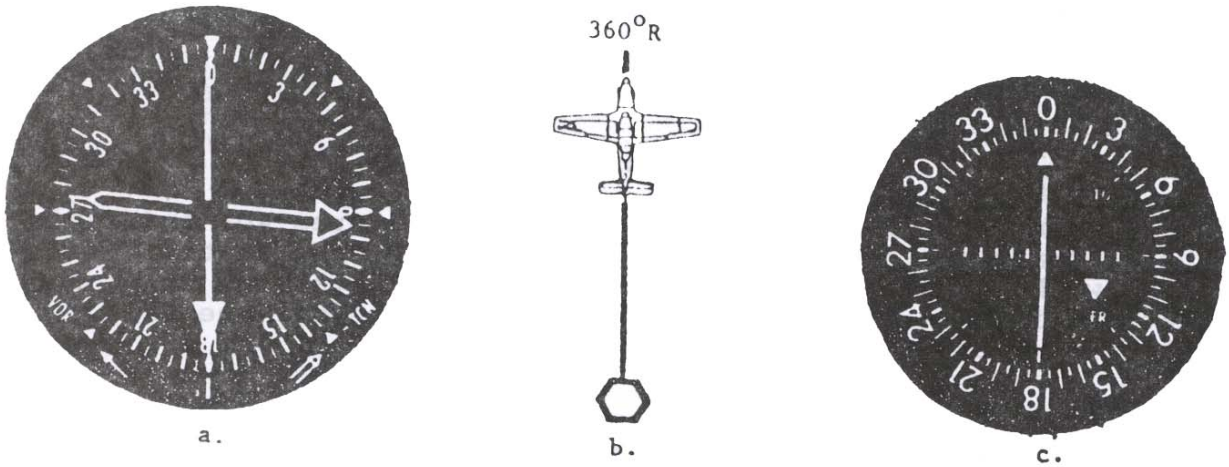


Figure 42

Now, suppose that we drift off of our desired course to the east. (A wind from the west or poor heading control could do this.) Our indications will be as in Figure 43.

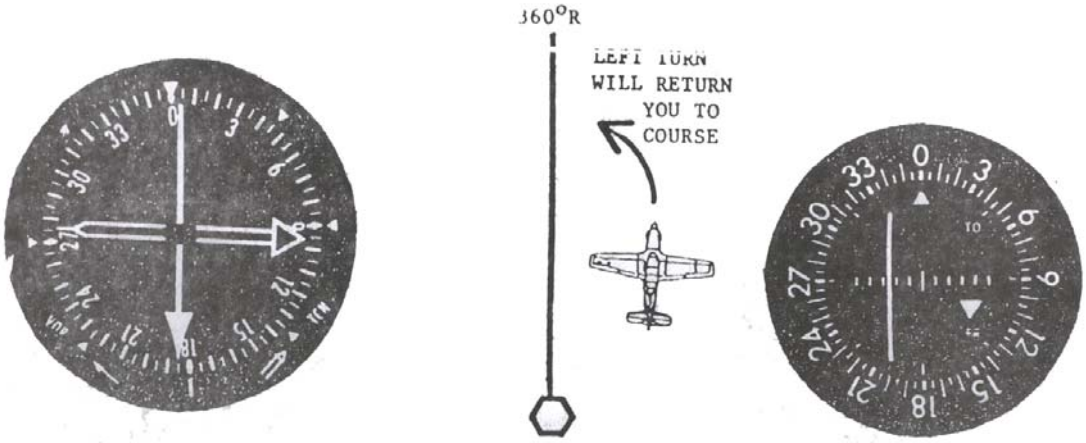


Figure 43

In Figure 43c the CDI is to the left of center indicating a left turn to get back on course. In Figure 43a, a left turn will place the tail of the needle in a position to rise to the course of 360.

In Figure 44 the aircraft is north of the station with 360 in the OBS. However in the case a heading of 180 is being flown.

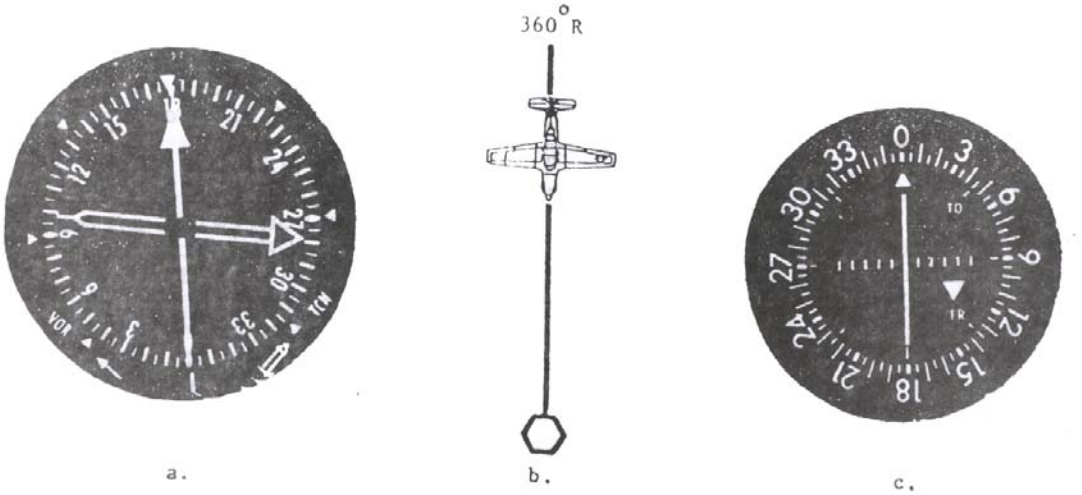


Figure 44

Again, consider the aircraft drifting off course to the east (Figure 45).

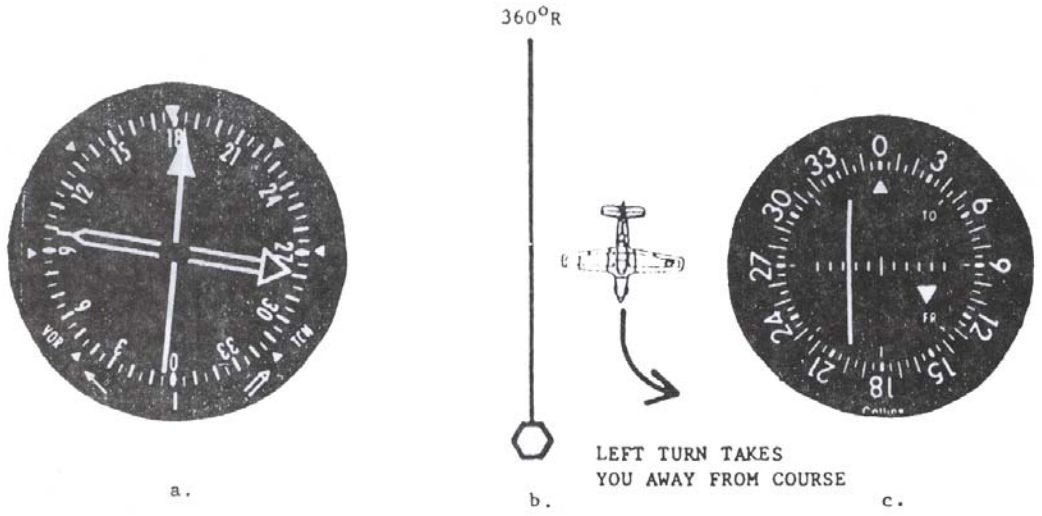


Figure 45

In Figure 45c the CDI is displaced to the left of center. This would suggest a left turn to return to the desired course. However, examination of Figures 45a and 45b indicates a right turn is necessary.

We can see that we appear to be getting conflicting information. The RMI shows a right turn necessary to return to course - the CDI indicates a left turn.

This is a condition of the IND-350 known as "reverse sensing". Reverse sensing will occur any time you twist a course with the OBS which lies in the lower half of the RMI, the case illustrated in Figure 45. In some cases, this may be done deliberately with the intention of immediately turning to a heading on which the IND-350 will provide proper sensing. In most cases, however, reverse sensing will be the result of setting an improper course (probably 180 degrees off) with the OBS, which is the case in Figure 45.

To avoid reverse sensing make it a habit to orient yourself on the RMI and use the IND-350 in its proper secondary role. Make sure you have the proper course selected with the OBS, remembering that if you track inbound to a station the course will be the reciprocal of the radial. If you always remember to set the proper course with the OBS, the vertical bar (CDI) will always tell you the direction to turn to return to course (i.e. if the bar is displayed to the left, turn left!)

SUMMARY

We have discussed the methods and procedures for determining courses, corrections to courses and radials, and for maintaining these courses. We have also discussed drift, crab angle and wind computations in relation to course control. Radial tracking is not limited to airways navigation. All Standard Instrument Departures (SIDS) and instrument approaches involve some form of radial tracking. You will find airways navigation will provide good practice and discipline for these critical areas of flight.

UNIT REVIEW

INAV 3: RADIAL TRACKING AND COURSE CONTROL

1. A radial is a (true/magnetic) bearing extending (to/from) a VOR, TACAN, or VORTAC station.

2. A course is a magnetic track flown only to a VOR, TACAN, or VORTAC station. (True/False).

3. TACAN/VOR information is displayed inside the T-34C on what instrument?

4. Established routes defined by radials between two navaids are referred to as what?

5. In the example shown below (Figure 46), is the aircraft heading to or <u>from</u> the navaid?

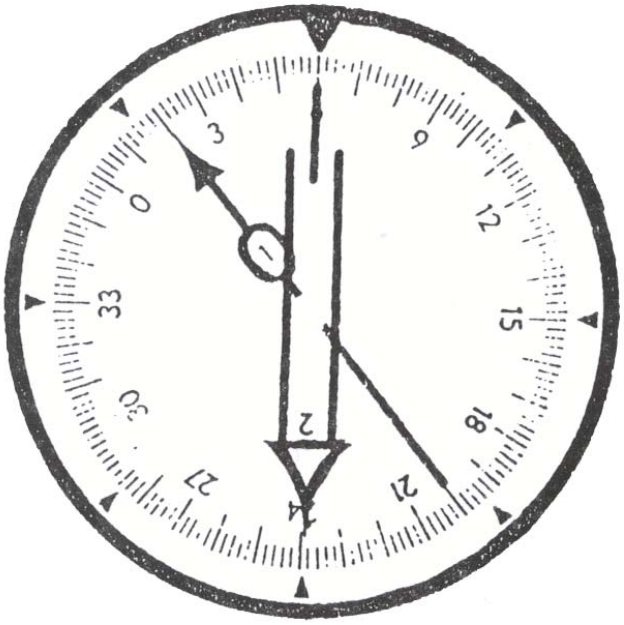


Figure 46

6. Which aircraft in Figure 47 is on the 240°R heading 060°?

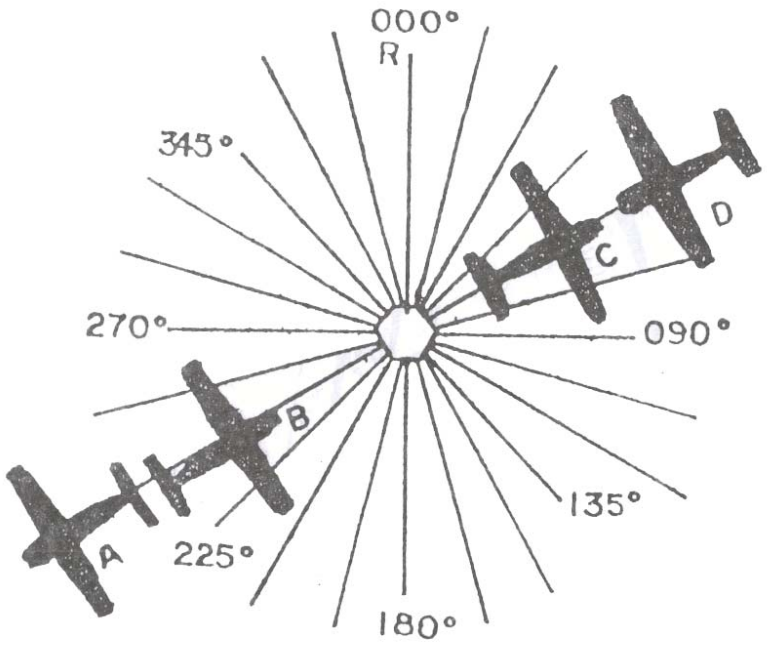


Figure 47

7. AT FL 240, the DME will indicate_____at station passage.

8. You are inbound on the 210°R at 36,000', TAS 330 kts. The next leg of your route of flight is outbound on the 330°R. If you lead turn, at what DME should you initiate the turn and to what heading?_____.

9. You make the turn overhead the navaid to head outbound on the 330°R. After steadying up on a heading of 330°, you note that you are on the 340°R. What direction and to what heading would you turn in order to intercept the 330°R?_____.

10. Given the following situation, Figure 48, in what direction and to what heading should you turn in order to intercept an inbound course of 180° to the TACAN station?

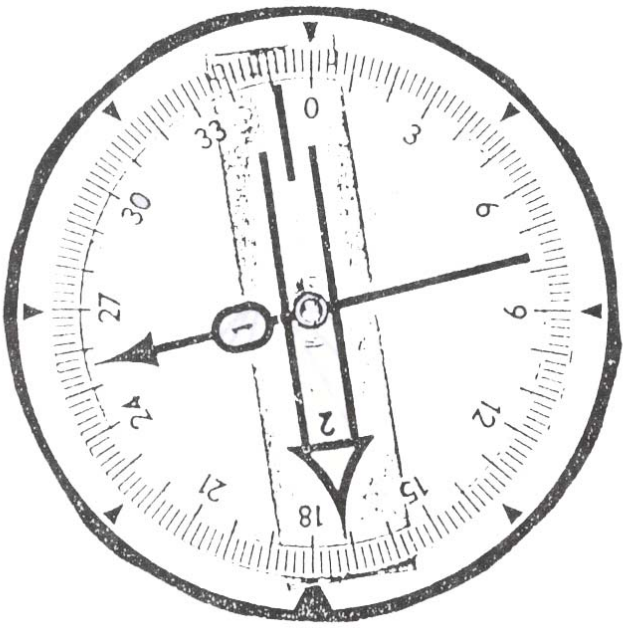


Figure 48

11. When approaching a desired radial, you begin the turn back to course (sooner/later) when you are 20 nm from the navaid than when you are 40 nm from it. Why?_____.

12. You are established outbound on the 090ºR. Noting a slow drift to the 093ºR, you take corrective action, reestablish yourself on the 090ºR, and leave in a crab angle. A short while later you note you are on the 092°R. Do you need to increase or decrease your crab angle into the wind?

13. On the RMI (Figure 49) the aircraft is heading 266° to maintain a course of 270. From which quadrant is the wind blowing?

TAS: 360
G/S CHECK COMMENCED AT 1400 - 36 DME
G/S CHECK TERMINATED AT 1403 - 56 DME

a. NE
b. SE
c. SW
d. NW

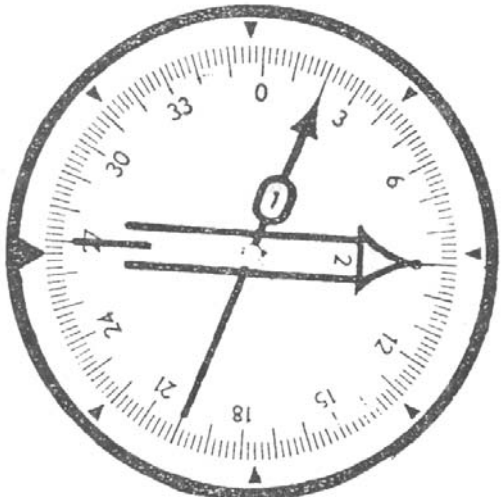


Figure 49

14. When flying on J-70 from DIK to ABR (Figure 50), when should you switch the TACAN to ABR?

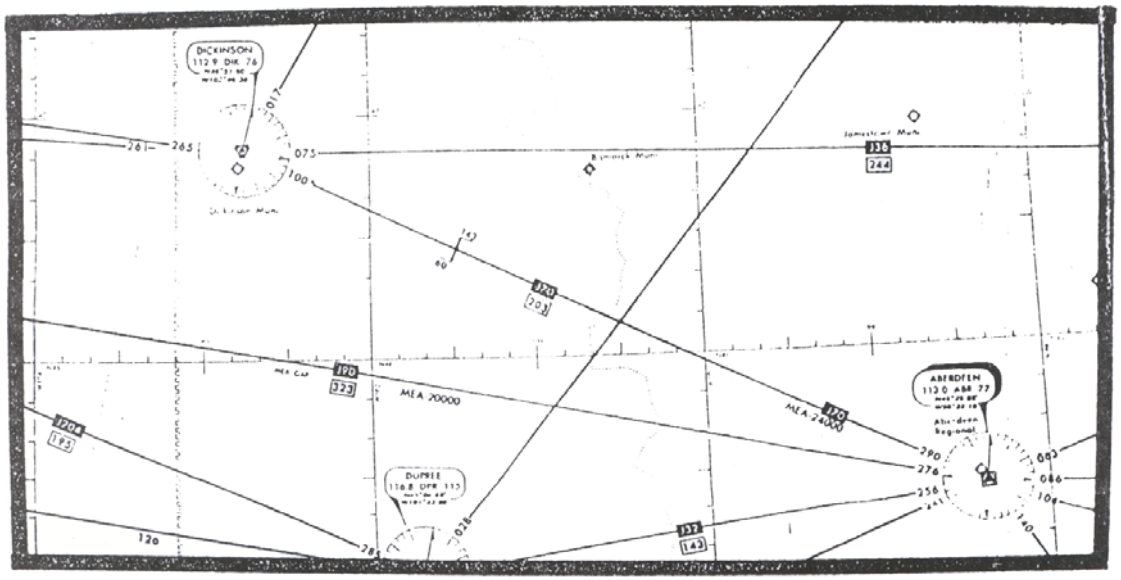


Figure 50

15. From question 14, you switch the TACAN and note the following:

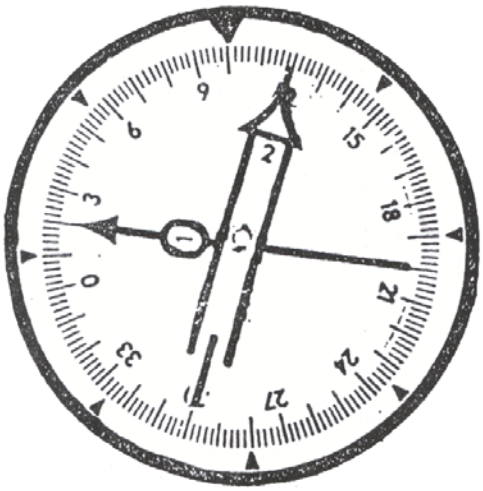


Figure 51

In which direction and to what heading would you tell the pilot to turn to get back on course?

16. You are on a course of 330° heading 330°. The tail of the 12 needle begins to move to the right. What type of wind is acting on the aircraft (LT crosswind, RT crosswind, head wind, or tail wind)?_____.

17. When traveling on J-50 from SSO to ELP, when should you switch the TACAN to ELP? (Figure 52)

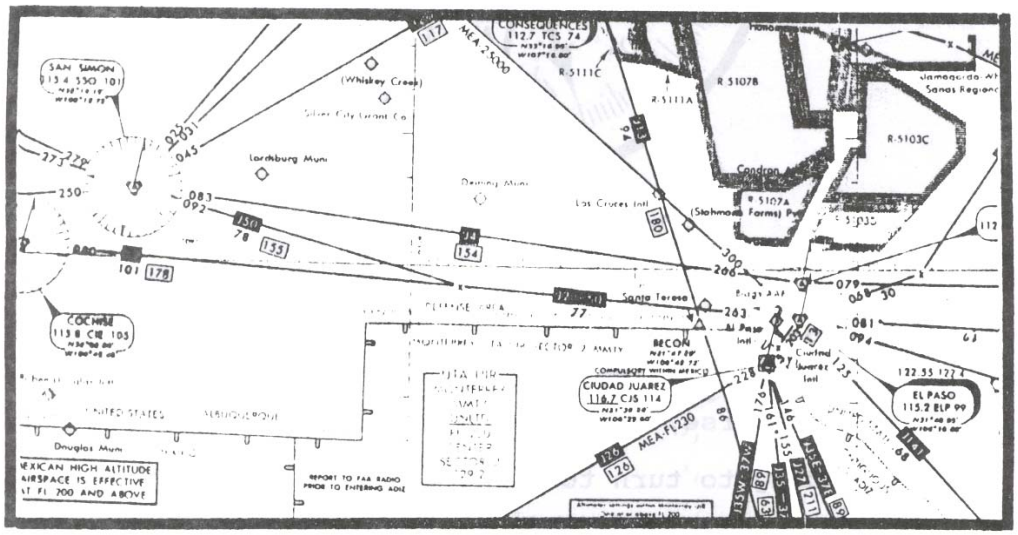


Figure 52

18. You switch the TACAN and note the following:

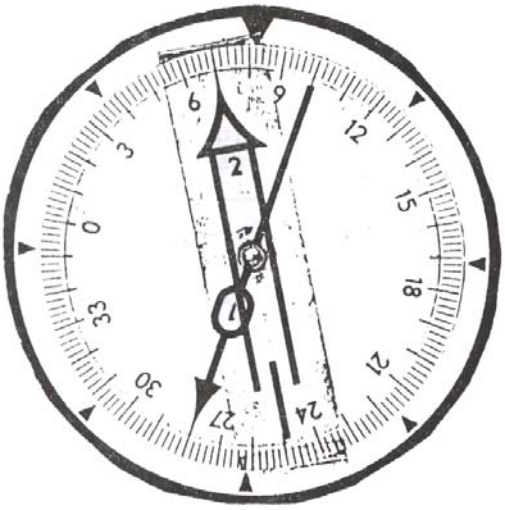


Figure 53

You are:

a. Right of course, correcting

b. Right of course, not correcting

c. Left of course, correcting

d. Left of course, not correcting

The proper heading to turn to is: _____.

19. From ELP you are proceeding on J-2 FST. After steadying up on a heading of 094º you note that you are on the 105º radial/50 DME. What direction of turn and heading should you tell the pilot to come to in order to get back on course?

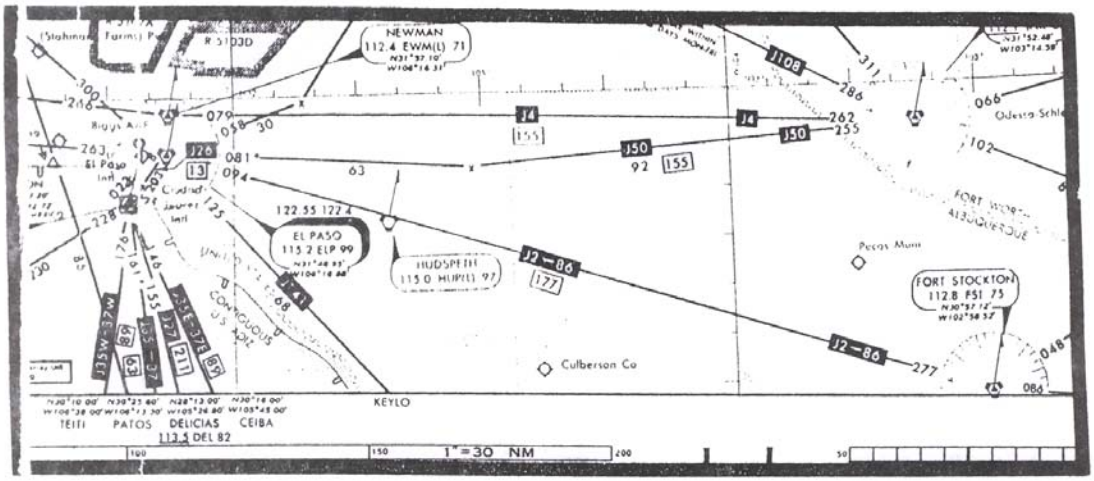


Figure 54

ANSWER SHEET

1. Magnetic from
2. False
3. RMI (T-34)
4. Airways/Jet Routes
5. From
6. B
7. Approximately 4 nm
8. 7.6 DME, HDG 330
9. Left to 320°
10. Left to 164^0
11. Sooner. Because the radials are spaced more closely together at 20 nm.
12. Increase
13. b. SE
14. DIK 100/60
15. Right to 130"
16. Left crosswind
17. SSO 092°/78
18. b, Left to 057° 19. Left to 083^0

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INAV 4: TACAN ARCING

Terminal Objectives, Enabling Objectives, and Enabling Steps are established by CNATRAINST 1542.54.

TERMINAL OBJECTIVE:

C. Navigate an aircraft via visual references and navigation instruments with the assistance of a flight instructor.

ENABLING OBJECTIVE:

C.1.1 Identify aircraft position relative to an operable TACAN/VOR station, given a Tactical Air Navigation (TACAN)/VHF Omnidirectional Range (VOR) and FLIP, without error.

C.5 Fly a standard instrument departure, given a specified route and a 1D23 trainer, without error.

SKILLS DEVELOPMENT UNIT: This academic unit of instruction interfaces with flights FAM 2-8 and VNAV 1-3.

MODE OF INSTRUCTION: This unit is a classroom lecture and demonstration presentation. The method used to fly an arc will be demonstrated. At the end of the unit the student will receive a quiz.

INSTRUCTIONAL AIDS:

1. RMI facsimile

REFERENCES:

1. Airman's Information Manual
2. NATOPS Instrument Flight Manual

INTRODUCTION

TACAN arcs are used most frequently during SID's (Standard Instrument Departures) and instrument approaches. Arcing is simply flying around a navaid while maintaining a constant distance from it.

DETERMINING LEAD TO ENTER AN ARC

To establish yourself on an arc, either tracking inbound or outbound on a radial, a lead must be determined. When using 30 degrees of bank, an approximate lead point for the arc may be determined from the aircraft ground speed.

The lead point should be ½% of your ground speed. The resultant number will be the distance by which you will lead your turns into an arc. For example:

GS 180 Lead Turn by 0.9 nm
GS 250 Lead Turn by 1.2 – 1.3 nm
GS 380 Lead Turn by 1.9 nm

These lead points are necessary because aircraft turn radius is a function of speed. If an aircraft traveling at 180 kts ground speed inbound on a radial should turn off that radial (using a standard rate turn of 3° per sec) at 10 nm, when it rolls out wings level, it will not be at 10 nm but approximately 9.1 nm. That's why at the airspeed given above, you should lead the turn by .9 nm (i.e. turn at 10.9 nm.) so that you will end up on the 10 nm arc as desired.

When in a climb or descent, true airspeed and ground speed will be changing due to winds at different altitudes, differing pressure altitudes, and temperatures. Lead points for arcing should be based on your aircraft speed over the ground. Practically speaking, however, there is very little time available to you during the departure and approach phases of flight to figure out your ground speed. The next best speed to use in calculating lead points would be true airspeed which would equal ground speed under no-wind conditions. Because of the time restriction again on departures and approaches and the fact that TAS is changing in a climb or descent it would be difficult to estimate an exact TAS to use in determining arc lead points. While actually flying departures and approaches use your Indicated Airspeed to determine your lead point.

If you have a headwind or tailwind prior to transitioning to an arc, you must consider altering your lead point or varying your angle of bank. Altering your lead point is the preferred method entering the clouds suddenly at a severe angle of bank may lead to disorientation.

Example: You are proceeding outbound on the 090 radial and desire to establish yourself on the 15 nm arc (Indicated Airspeed = 180).

You correctly determine that a lead of 0.9 nm is necessary, and that you would turn at 14.1 DME. (Figure 1)

No wind flight path
turn at proper lead

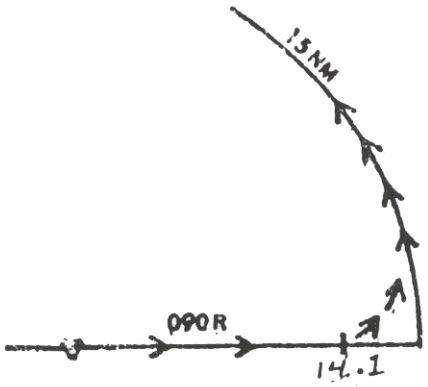


Figure 1

In Figure 2, you would not want to turn at 14.1 DME. You might wait and turn at 14.3 to 14.5 nm to offset the effects of your headwind. The opposite would be true when experiencing a tailwind. That is, instead of turning at 14.1 you might turn at 13.7 to 13.9 DME. (Figure 3)

Headwind shortens
turn radius.
Adjust your turn
point. Lead point
will be less.

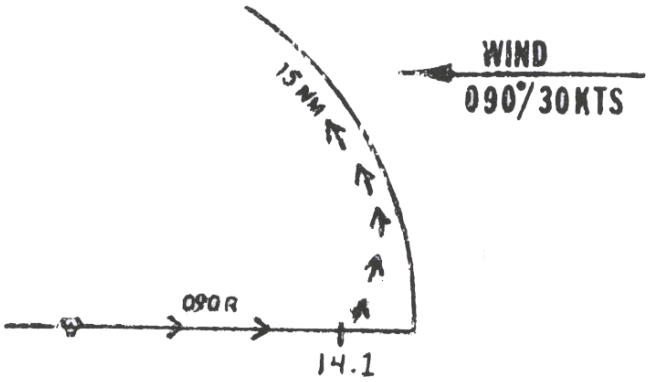


Figure 2

Another alternative to the situation would be to turn at 14.1 DME, but use a shallower or steeper angle of bank as necessary to offset any wind. With a headwind, you would require a shallower angle of bank than normal. With a tailwind, a steeper angle would be necessary. Tailwind increases turn radius. Start your turn earlier. Lead point will be earlier.

Tailwind increases
turn radius.
Start your turn
earlier. Lead point
will be earlier.

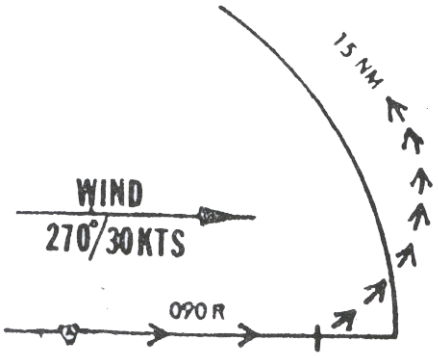


Figure 3

There are not exact formulae to apply for the effects of wind and determining a lead point. Just be aware of how wind will affect your aircraft movement when turning on an arc and decide which method will be your course of action.

When entering an arc from a radial while tracking inbound the same general rules apply (Figures 4A, 4B, 4C).

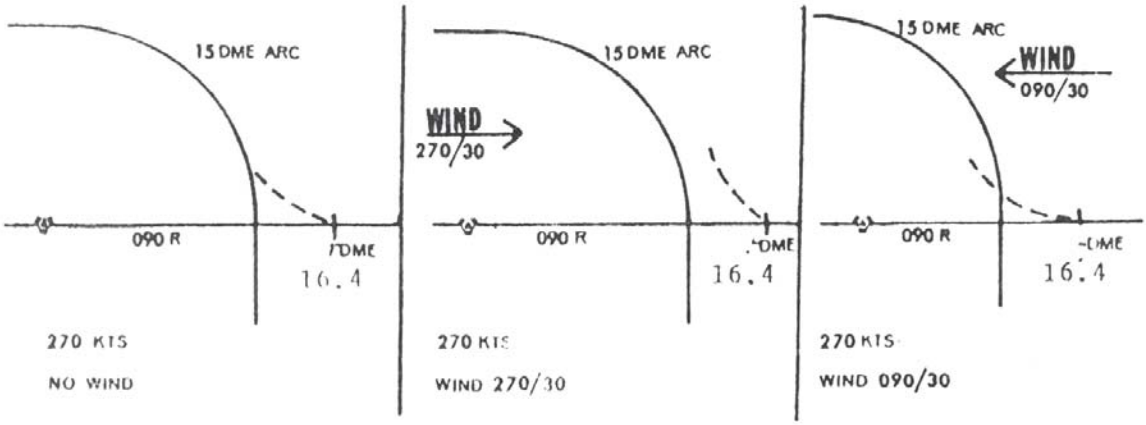


Figure 4A **Figure 4B** **Figure3 4C**

ARC INTERCEPTIONS

In the cases pictured above, we entered an arc from a radial. When a radial crosses an arc, a 90º angle is formed. Therefore, the heading on which you choose to enter an arc should differ 90º from the heading you maintained on the radial (Figure 5),

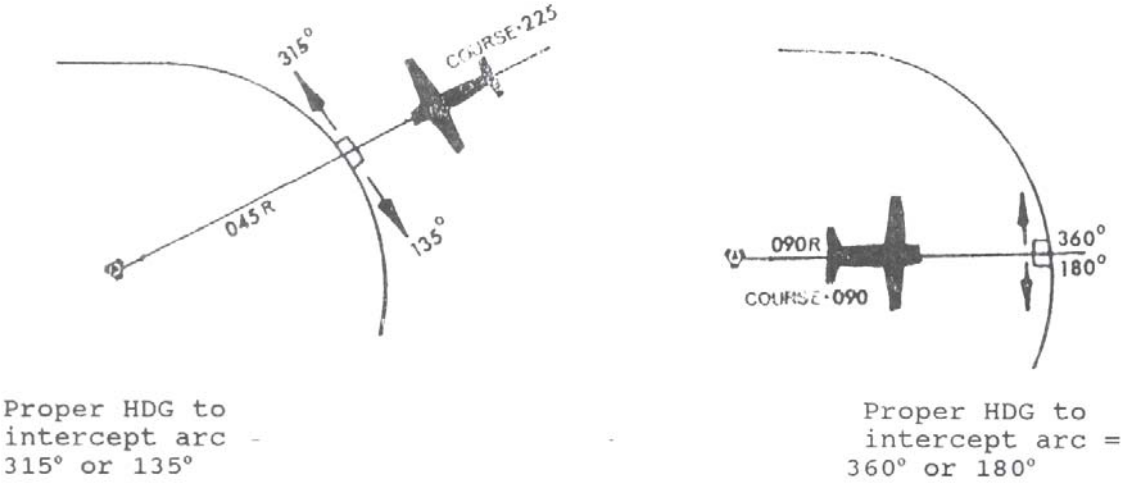


Figure 5

There will be times when you will transition to an arc requiring a turn of less or more than 90°. If your initial turn onto an arc requires a turn of less than 90°, your lead point will have to be decreased. If your turn to transition on an arc is going to require a turn of approximately 45°, your lead would be approximately one-half of your normal lead. (Figure 6)

"0F 21 FLY HEADING OF 340° UNTIL INTERCEPTING THE PENSACOLA 15 NM ARC. ARC EAST.....

INTERCEPTING AN ARC WITH A TURN OF LESS THAN 90° REQUIRES LESS OF A LEAD POINT.

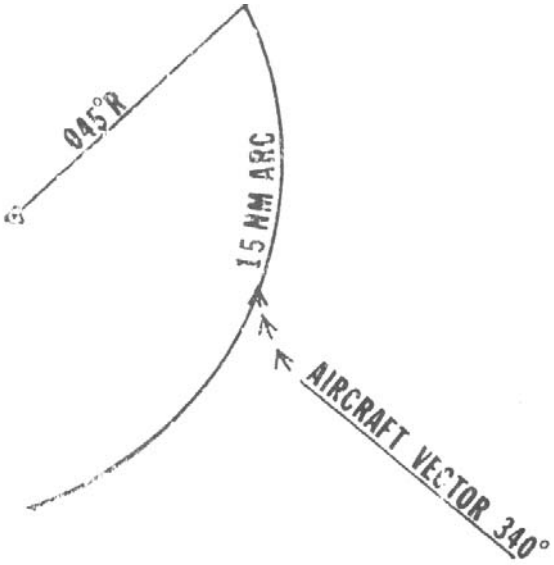


Figure 6

The same is true for a required turn of more than 90°. You would increase your lead by a relative factor. Again, wind and ground speed would be factors in your analysis. You may experience this situation when flying a vector assigned to you by a controlling agency. (Figure 7)

"CAT 84, TURN RIGHT TO 180° UNTIL INTERCEPTING THE 15 NM ARC. ARC EAST UNTIL INTERCEPTING THE 090°R".

INTERCEPTING AN ARC WITH A TURN OF MORE THAN 90° REQUIRES AN INCREASED LEAD POINT.

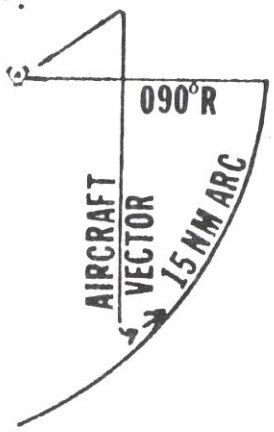


Figure 7

To intercept an arc from a radial, a turn of approximately 90º is required to place the head of the #2 needle on the wing tip with a DME indication equal to the desired arc. Determine the direction to turn and the desired lead point. Initiate the turn when the DME is equal to the radius of the arc plus or minus the desired lead. During the last 30º of turn, monitor the head of the #2

needle and range to determine when to roll out. If the aircraft will be inside or outside the arc, increase or decrease the angle of bank as necessary to roll out on the arc. (Figure 8)

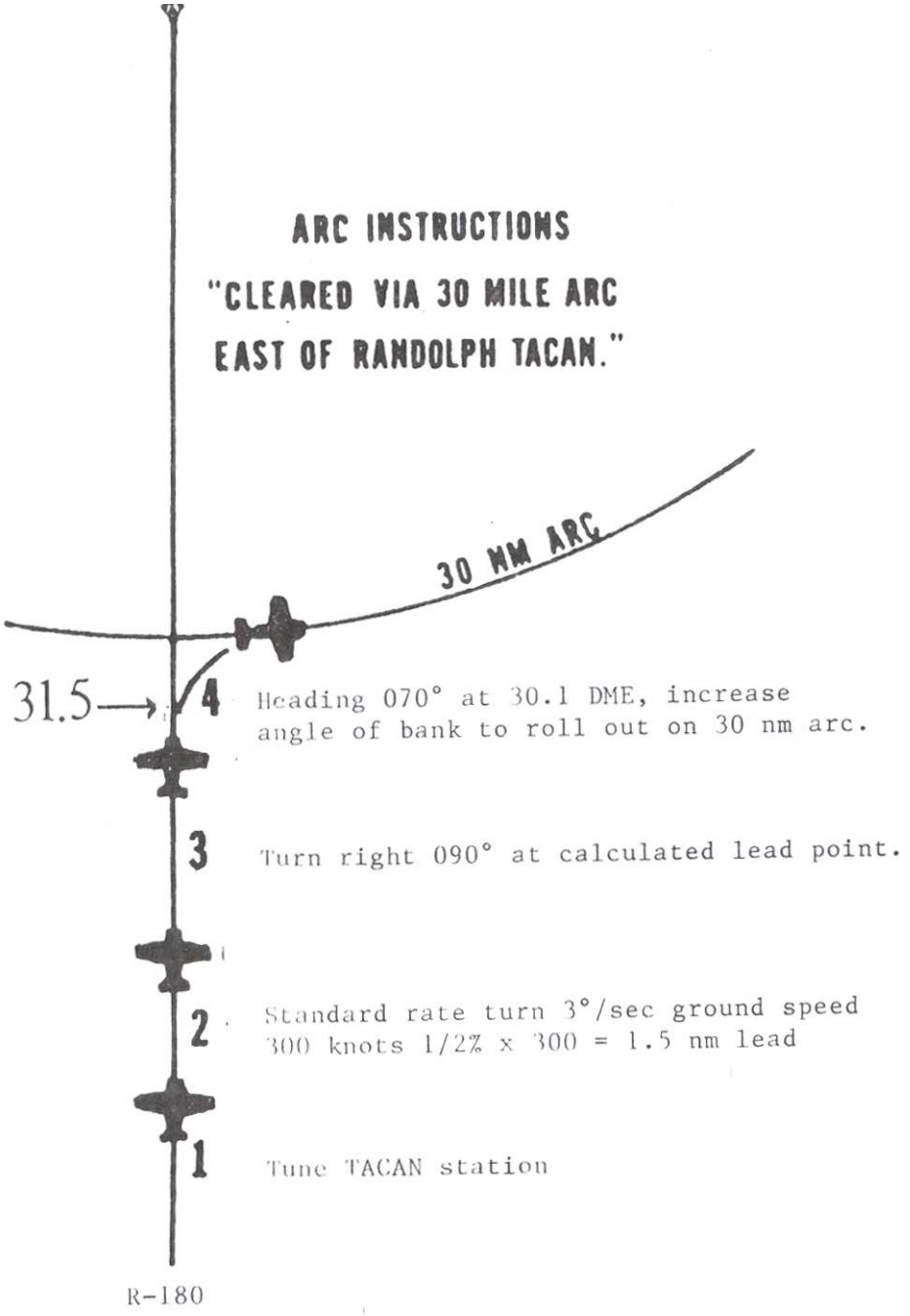


Figure 8

MAINTAINING ARCS

In theory, it is a simple matter to maintain an arc. The aircraft will fly in an exact circle around the station if you maintain a relative bearing of 090° or 270° to the station at all times. In practice, this would require a constant angle of bank throughout the whole arc.

Another method for maintaining an arc is to fly a series of short legs, keeping the head of the #2 needle on or near the wingtip position (i.e., 9 or 3 o'clock) while maintaining the desired range. This is sometimes known as the "Chord" method, for the aircraft will be tracing a series of chords to the arc as it progresses along the arc.

Always remember the relationship between the head of the needle and DME. If the head of the needle is above the "wingline" (90° fiducial marker on BDHI/RMI) the DME will decrease. If the head of the needle is below the wingline DME will increase. These are no wind rules.

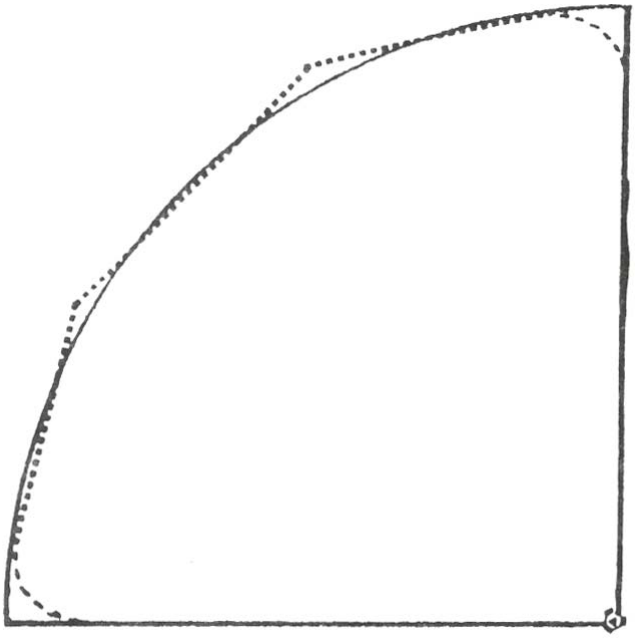


Figure 9

The flight path of an aircraft employing the Chord Method might look like the path depicted by the dotted line. (Figure 9)

The steps to follow when usinq the chord method are:

1. Start with the head of the #2 needle on the wing tip and the aircraft at the desired range.
2. Maintain heading and allow the head of the needle to move 10 degrees behind the wingtip position. (This will cause the range to increase slightly.)
3. Turn toward the station to place the head of the needle 10 degrees ahead of the wing tip.
4. Maintain this heading until the head of the needle again falls behind the wing tip.

NOTE: This method is to be used when flying an arc close to the station ($\leq$ 20 nm). However, when flying arcs farther from the navaid, the bearing pointer should be kept on or within 2° to 3° of the wingtip position.

For example, if you allow the bearing pointer to move 10° behind the wingtip position on a 50 nm arc, your distance from the station would increase faster than you would cross radials. Therefore, a 50 nm arc would be impossible to maintain using the same methods for flying an arc close to the station because of the greater distance between radials.

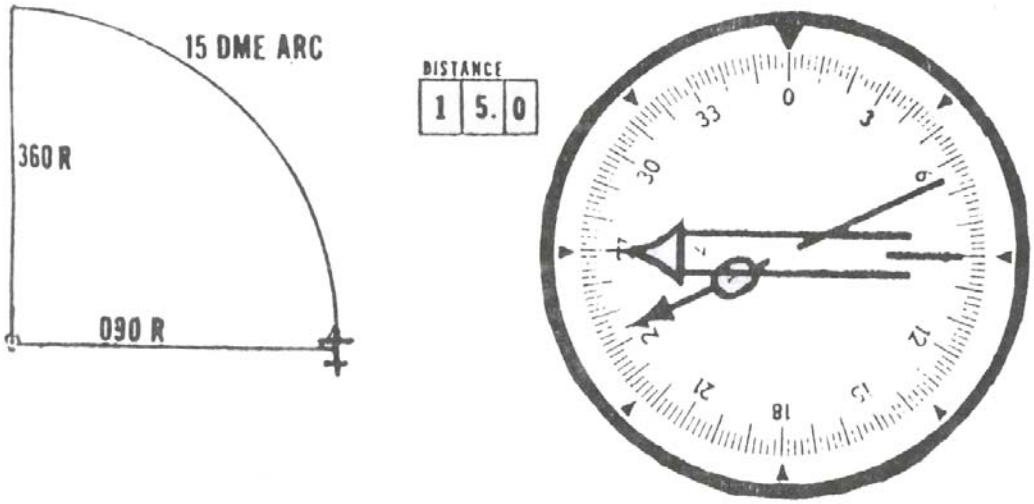


Figure 10

Now, if the aircraft depicted in the above illustration (Figure 10) continues on a heading of 360°, it will eventually increase its DME, and its radial will have changed as shown in the following illustration.

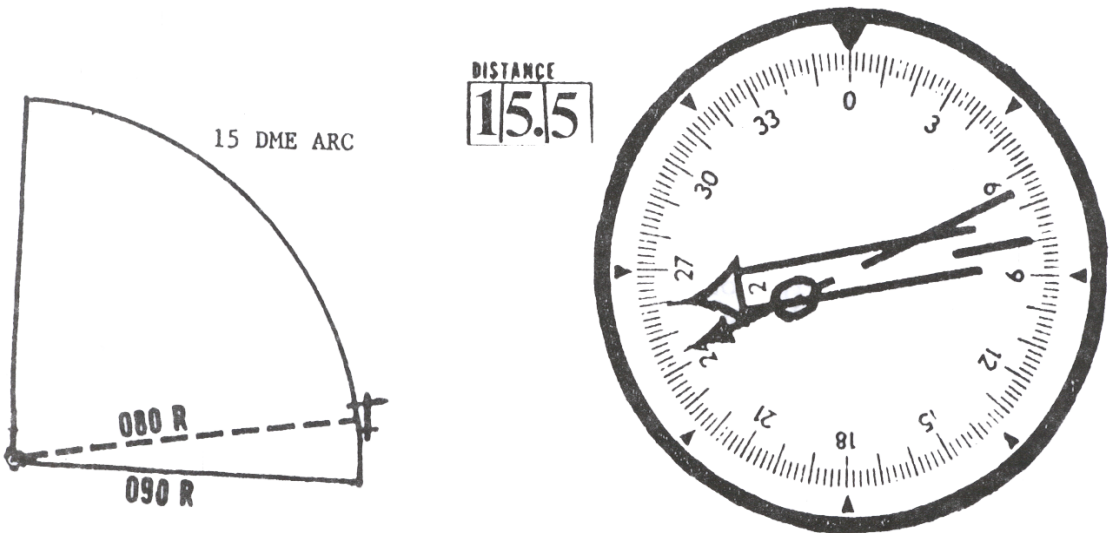


Figure 11

CORRECTTRG HACK TO THE ARC

As a guide, correct approximately 10 to 20 degrees for each 1/2 mile of deviation from the desired arc. For example, under no-wind conditions, if the aircraft is 1/2 mile outside the arc and the bearing pointer is 10° below the wing tip, the aircraft should be turned approximately 20 degrees toward the station to return to the arc. The actual amount of correction required for a given error varies. Factors to consider are the size of the arc, ground speed of the aircraft whether the aircraft is inside or outside the arc, etc. These factors affect the rate of deviation from an arc and type of correction necessary to return to the arc. Remember that the curve of small arcs is relatively "sharp," and corrections from the inside are assisted by the arc curving toward the aircraft. Conversely, the aircraft outside a small arc requires larger corrections because of the curvature away from the aircraft. Large arcs are easier to fly because of their "flatter" curves. High speeds require more attention to maintain an arc because of higher rates of deviation and correction.

So, in order to stay on the 15 nm arc in the previous illustration (Figure 11) you'd turn left. Since the head of the 02 needle had fallen 10° below the wingtip, you must turn the aircraft 20° left, so that the needle will be 10° above the wingtip. As you progress on your new heading, the needle will continue to fall. When it does, you will simply turn 20° to ensure that it stays within 10° either side of the wingtip.

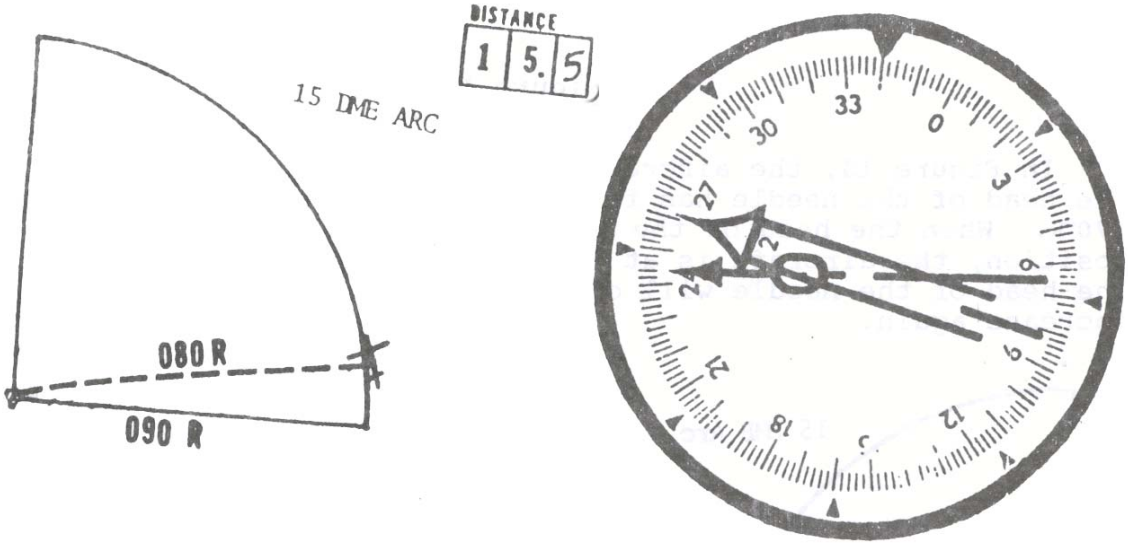


Figure 12

In the example above (Figure 12), the aircraft has just made its turn 20° to the left. It is still on the 080° R but its flight path will bring it closer to the station, thus decreasing the DME. The aircraft's path will cross radials, causing the head of the needle to fall.

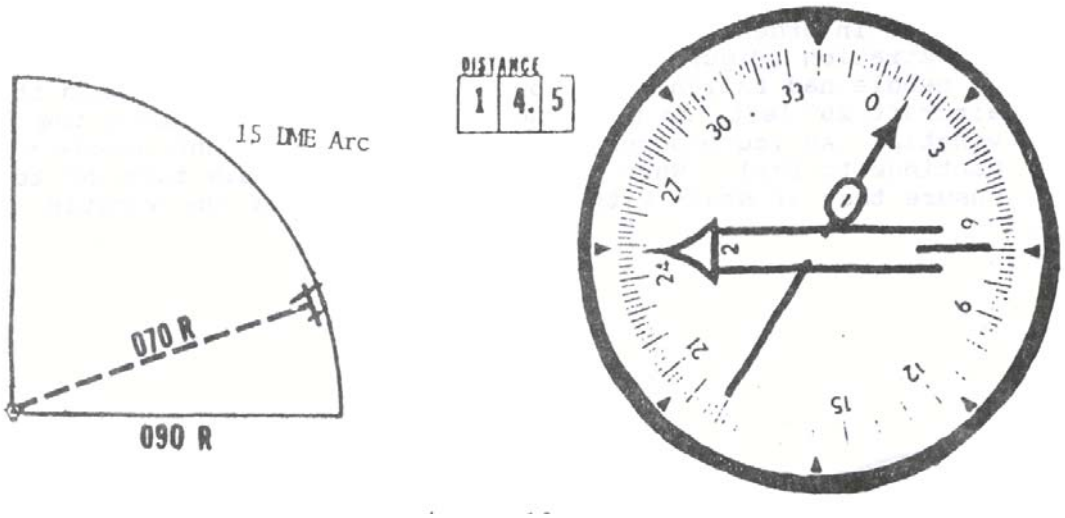


Figure 13

In Figure 13, the aircraft is still heading 340°; however, the head of the needle has fallen. The aircraft is now on the 070°R. When the head of the needle is at the *3* or 9 o'clock position, the aircraft is at its closest point to the station. The head of the needle will continue to fall and the DME will increase again.

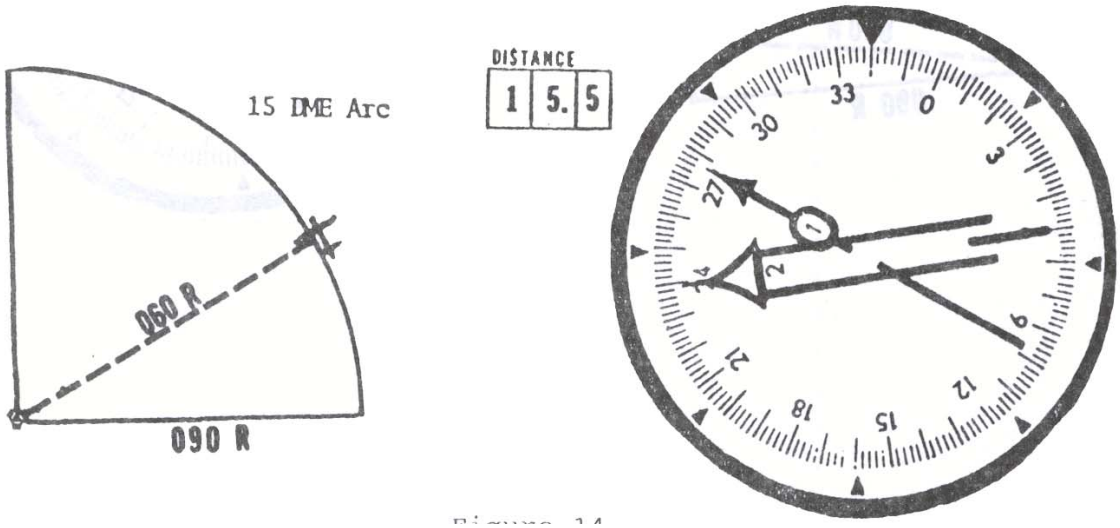


Figure 14

In Figure 14, the head of the needle has fallen 20° and we now find ourselves on the 060° radial, and at a DME of 15.5. Our flight path has caused us to cross the arc, go inside of it and then outside of it to 15.5 DME. The simultaneous occurrence of the needle's falling 10° below the wingtip and the DME's increase to figure greater than that of the arc signals us to turn the aircraft once again. (Figures 15, 16, 17)

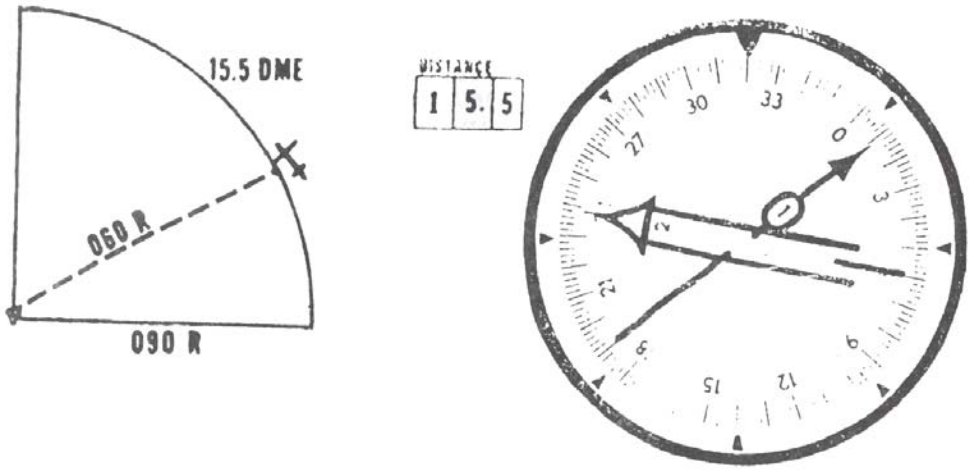


Figure 15

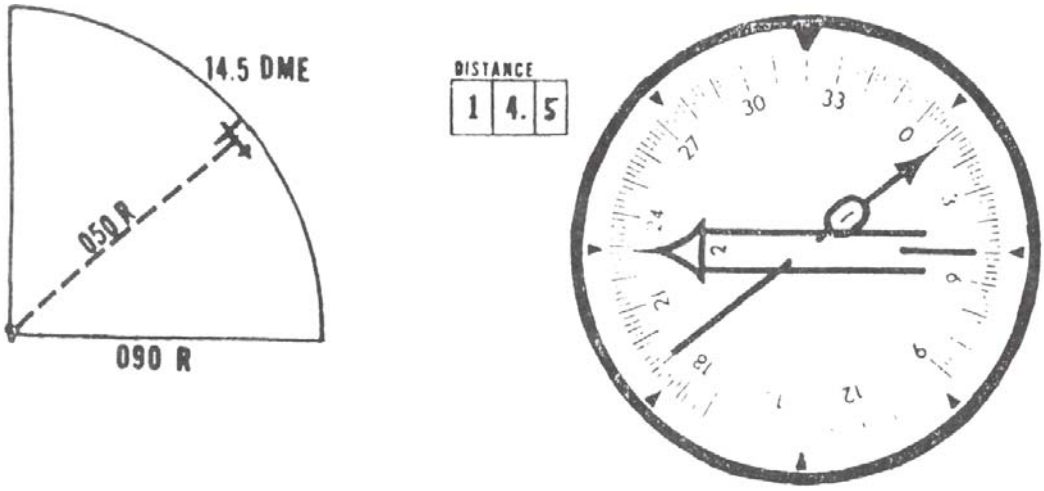


Figure 16

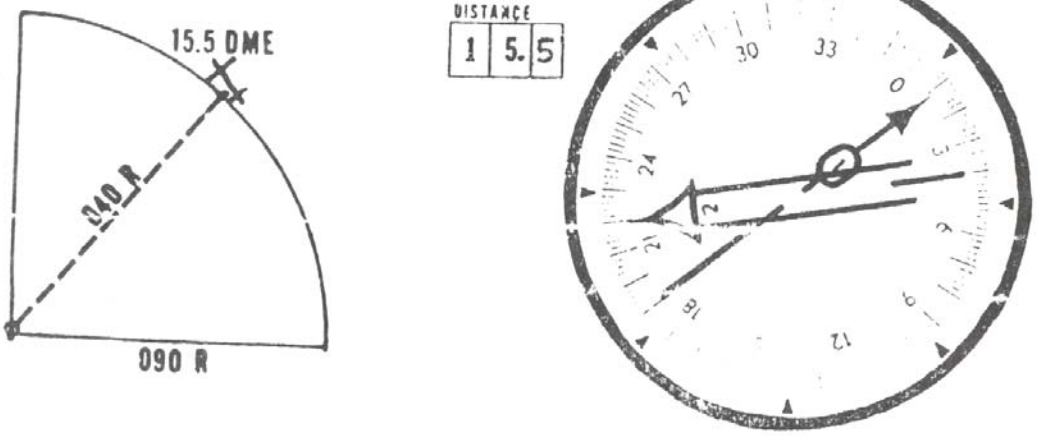


Figure 17

The same sequence of events continues to occur. The aircraft turns 20° to the left, eventually crosses inside the arc and then outside again. On the RMI, the needle shifted to 10° above the wingline as the aircraft turned. As the aircraft progressed, you cut radials, going from the 060° past to 050° to 040°. When your needle is 10° below the wingtip and the DME is greater than that of the arc, you must turn once again. (Figure 18, 19, 20)

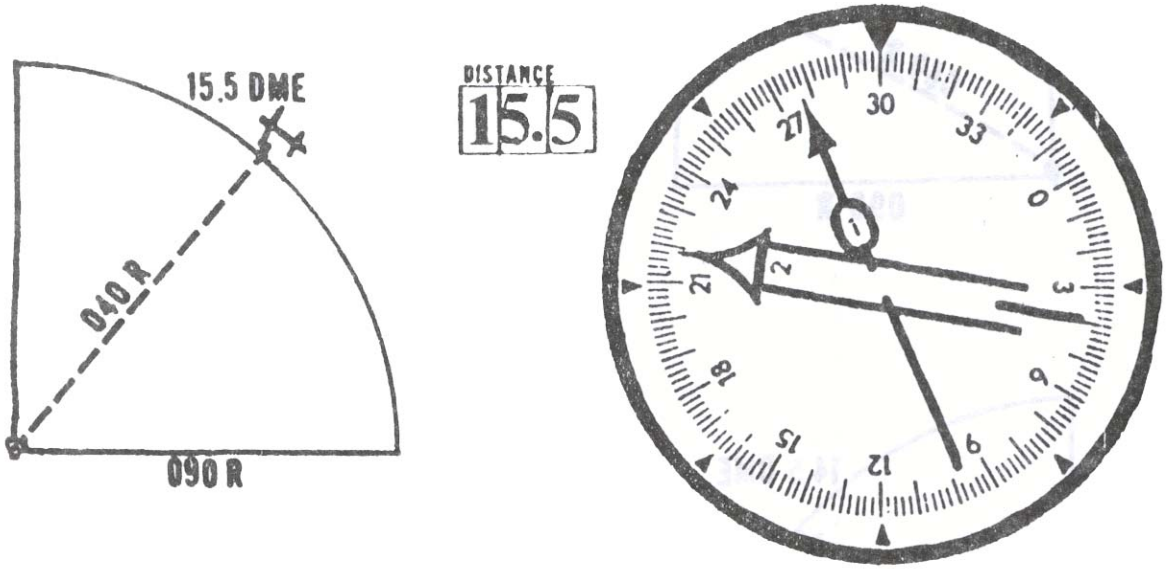


Figure 18

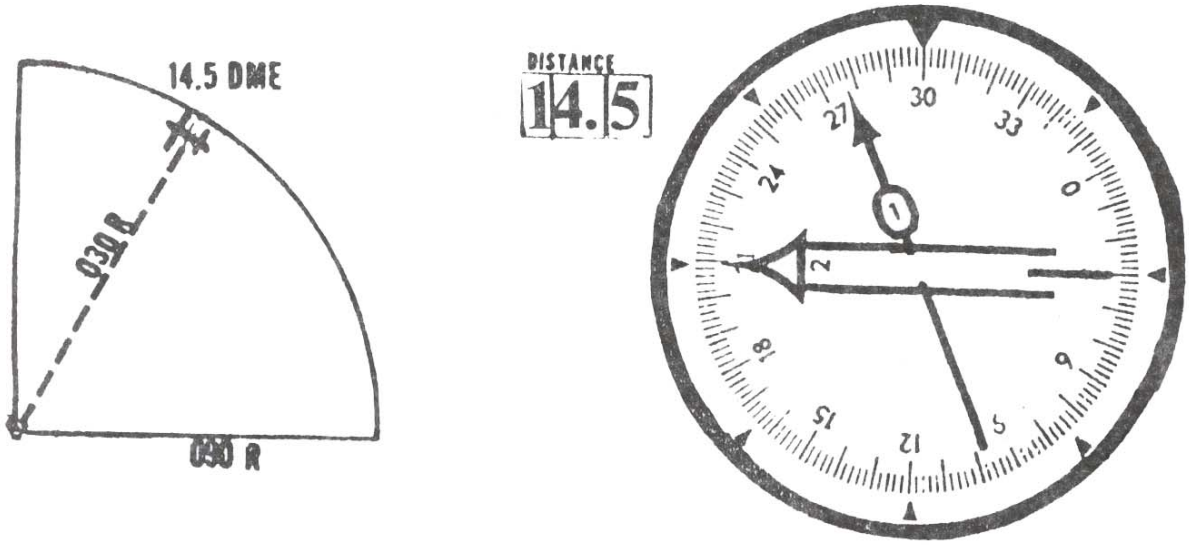


Figure 19

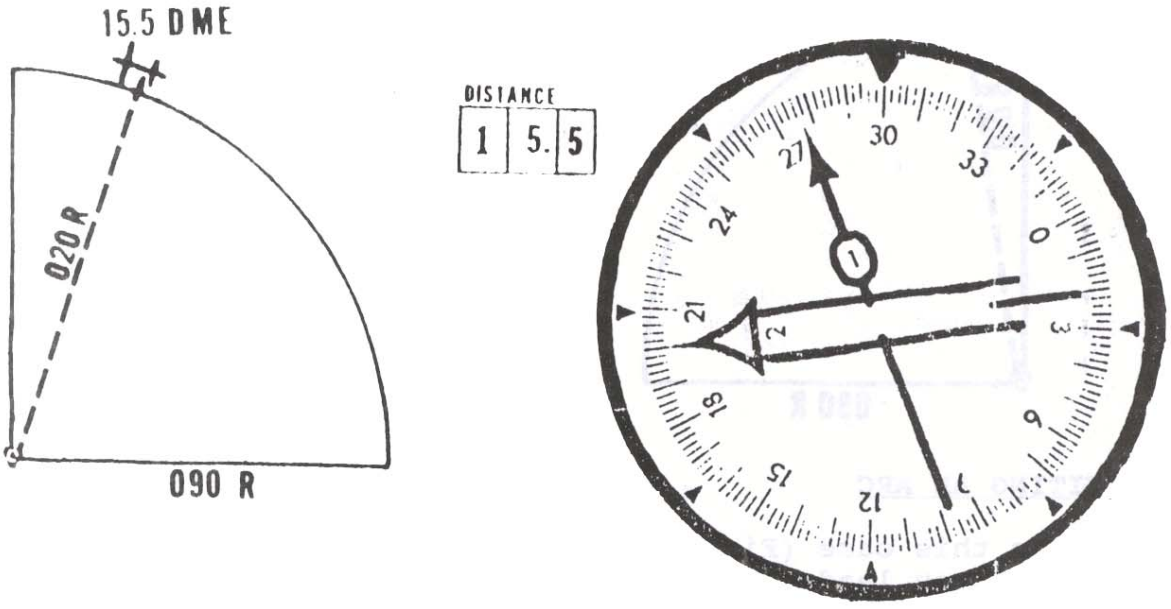


Figure 20

As the sequence continues, the aircraft is approaching the 360ºR (the radial on which it will exit). (Figure 21)

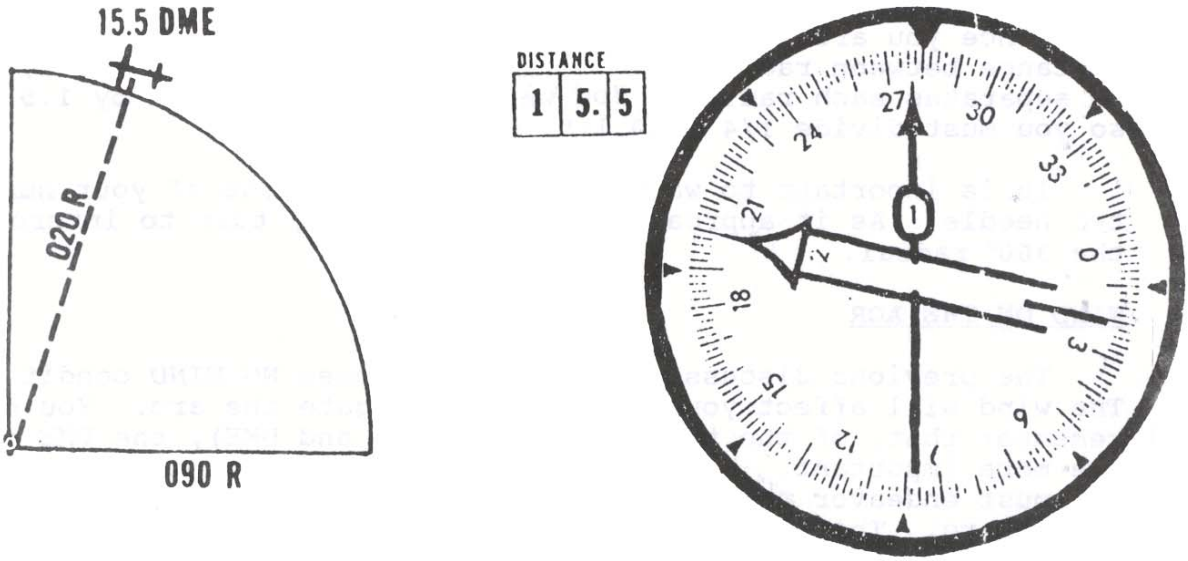


Figure 21

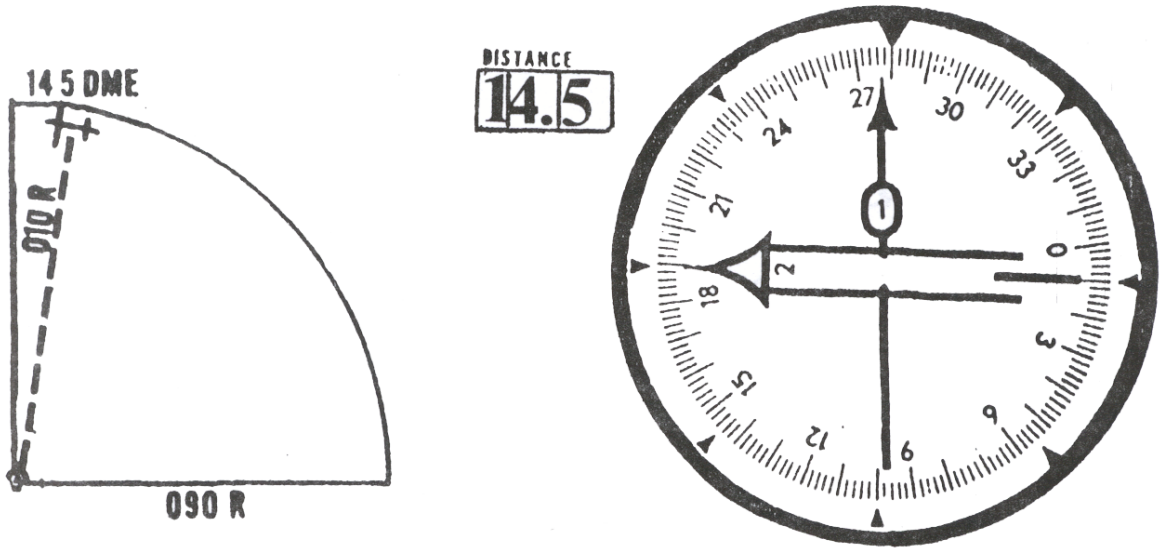


Figure 22

EXITING AN ARC

In this case (Figure 22), you are to intercept the 360ºR. Just as you lead your turns on an arc, you must lead them off of the arc. The lead point is calculated in exactly the same manner as it was to enter an arc.

Let's assume your ground speed is 300 kts. In this case, you would exit the arc 1.5 nm prior to the 360° R. The question now arises, how do you determine 1.5 nm? After all, the DME has been almost constant (15 ± .5) for the past few minutes. To determine mileage you must refer back to the old principle of distance between radials.

Since you are flying the 15 nm arc, you must determine the distance between radials at 15 nm: 15/60 = 1/4. Therefore, 1/4 nm separates each radial. You want to lead your turn by 1.5 nm, so you must divide 1/4 into 1.5, which equals 6.

It is important to watch the rate of movement of your number two needle. As it approaches the 006° radial, turn to intercept the 360° radial.

WIND ON THE ACR

The previous discussion of arcing assumed NO WIND conditions. The wind will affect your ability to navigate the arc. You must remember that, of the two aids (#2 needle and DME), the DME is the more important. Regardless of the position of the #2 needle, you must endeavor to keep the DME as close as possible to the DME of the arc. Therefore, if you were attempting to fly the 15 DME arc and found yourself at 19 DME, you would turn toward the station until you were at 15 DME. To ensure that you stay at 15 DME, you must crab. Also remember, as you're turning your aircraft around the arc, the relative position of the wind will Change. A wind that

was on the nose, may now be on your wing. Wind on the arc becomes much more critical at slower airspeeds.

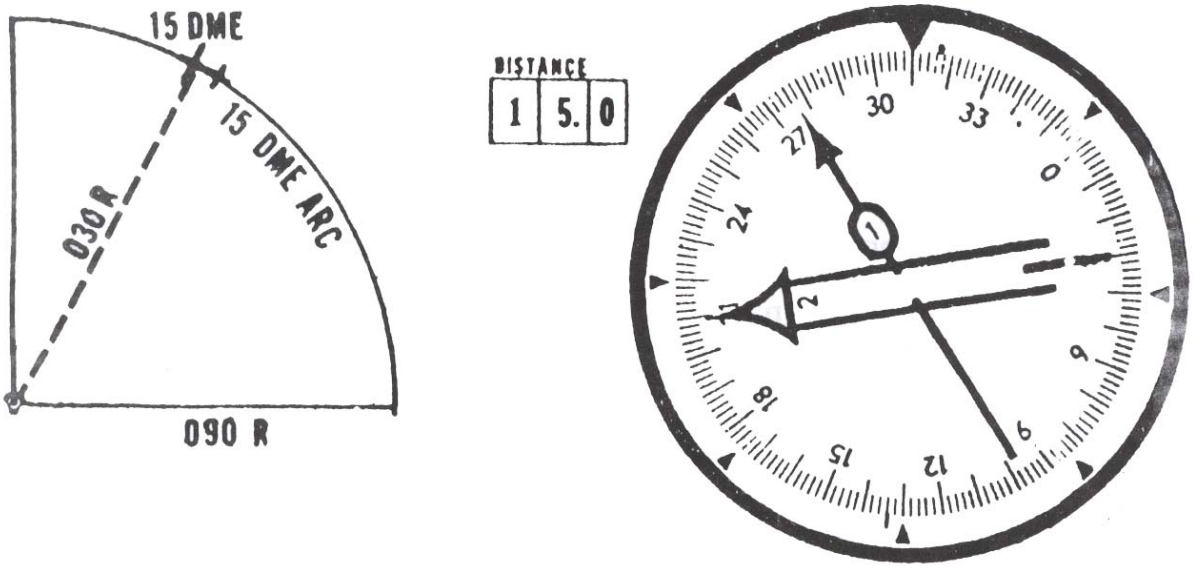


Figure 23

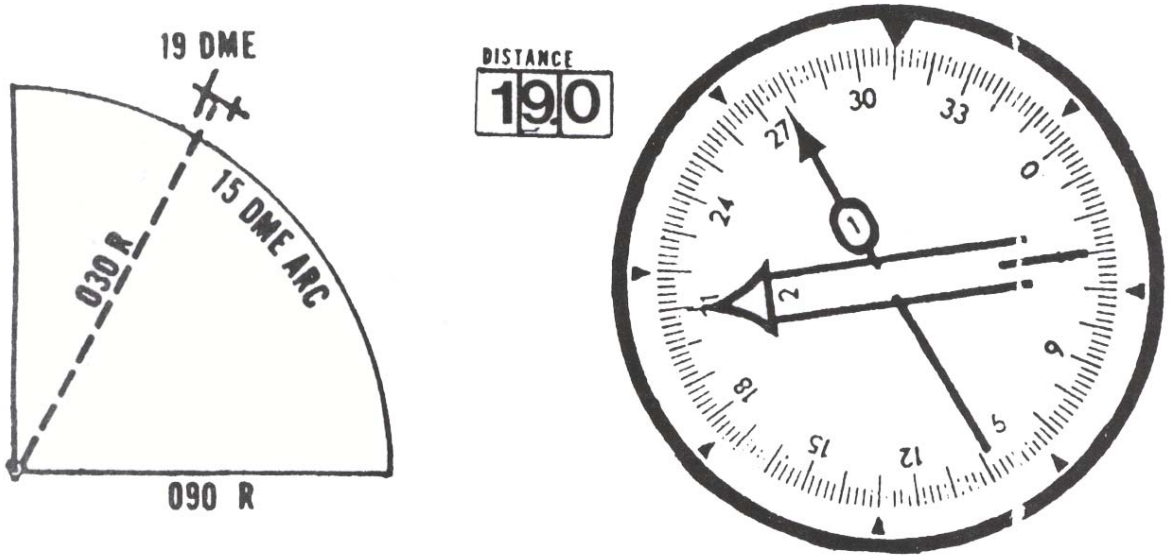


Figure 24

Note that each RMI is identical with the exception of the DME (Figures 23, 24). If you attempted to determine your position relative to the arc by use of the #2 needle alone, you would face an impossible task.

SUMMARY

In this unit of instruction, you have been taught the procedures to be used when flying an arc. You have learned that when intercepting an arc from a radial, you must lead the turn by a distance equal to ½ % of your ground speed. You must convert that distance to radials to determine your lead point for exiting the arc. You have also learned how to fly an arc by applying heading corrections to maintain a relative bearing of 90° or 270° to the selected TACAN. Wind and degrees to turn play an important factor in transitioning to, maintaining, and exiting arcs. These factors must be considered on all your instrument flights.

UNIT REVIEW

INSTRUCTIONS

For each of the following situations, you must determine two things: (1) the lead point to intercept the arc from a radial and (2) the lead radial to exit the arc. Ground speed (G/S) is given in each situation and the bank angle for each will be 30º. No wind. Turn the shortest direction.

1. While flying inbound (G/S 360 kts) on the 030º radial, you are told to intercept the 30 DME arc and fly that arc to intercept the 107° radial.

a._____ b._____

2. While flying outbound (G/S 260 kts) on the 317º radial, you are told to intercept the 45 DME arc and fly that arc northeast to intercept the 134º radial.

a._____ b._____

3. While flying inbound to a TACAN station (G/S 320 kts) on a course of 090º you are told to intercept the 35 DME arc and fly that arc to intercept the 354° radial.

a._____ b._____

4. While flying outbound (G/S 200) on the 145° radial, you are told to intercept the 20 DME arc and fly that arc to intercept the 010° radial.

a._____ b._____

5. While flying *inbound* (G/S 180) on the 179° radial, you are told to intercept the 15 DME arc and fly that arc to intercept the 352° radial.

a._____ b._____

ANSWER SHEET

1. a. 31.8 DME b. 103 or 104ºR
2. a. 43.7 DME b. 132ºR
3. a. 36.6 DME b. 351ºR
4. a. 19 DME b. 013ºR
5. a. 15.9 DME b. 348ºR

INAV 5: TACAN POINT-TO-POINT

Terminal Objectives, Enabling objectives, and Enabling Steps are established by CNATRAINST 1542.54.

TERMINAL OBJECTIVE:

C. Navigate an aircraft via visual references and navigation l/„ instruments with the assistance of a flight instructor.

ENABLING OBJECTIVE:

C.4. Execute TACAN point-to-point navigation, given a specified route, with instructor assistance as required, within 4 NM.

SKILLS DEVELOPMENT UNIT: This academic unit of instruction interfaces with flights B-1 through B-5.

MODE OF INSTRUCTION: This unit is a classroom lecture presentation designed to acquaint you with flying the TACAN Point-to-Point.

INSTRUCTIONAL AIDS:

1. RMI Model
2. Chalkboard
3. CR-2

REFERENCES:

NATOPS Instrument Flight Manual

INTRODUCTION

In Chapter Three of this text you were introduced to the Tactical Air Navigation system (TACAN). That lesson restricted its scope to the use of a TACAN for tracking inbound and outbound on predetermined radials. However, in this lesson, we will explore another utilization of the TACAN which will permit us to fly from one point to another without radial tracking.

USES OF TACAN

The TACAN is a very versatile navaid, and in this chapter, your understanding of its possible uses will be expanded. TACAN Point-to-Point navigation consists of flying from one TACAN position (or point) to another TACAN point, as defined from the same TACAN station. Because point-to-point navigation simply connects two known positions with a straight line, it is both expeditious and economical with respect to fuel.

Point-to-Point navigation employs principles previously taught to you, especially distance between radials, minimum DME, wind determination and course control. It is a good exercise in your understanding of navigation and will be used in almost every one of your flights here in VT-10 and in the fleet.

You will be introduced to three methods of point-to-point determination. These are not the only methods, nor should they be viewed as completely distinct from one another; however, they are the most appropriate for you at your stage of training and will provide you with the principles needed to practice the procedures in flight.

METHODS OF COMPUTATION

Logic

Your ability to logically determine where you are, where you are going, and how to get there should always play a large role in your navigational calculations. Mechanical, analytical, and "gouge" methods are all subject to some equipment error which can only be countered by human logic. Therefore, employing logic from the beginning should be your primary method of solving problems.

If you are on the NPA 180025 and you desire to go to the NPA 090050, you will have to determine a heading and course to get you there. Mentally picture your present position from the TACAN. Next, picture the destination and connect them with an . imaginary line. Your estimation of the direction and length of that line will provide you with a good basis on which to commence your point-to-point navigation.

A means of further confirming the mental picture is simply to draw it out. (Figure 1)

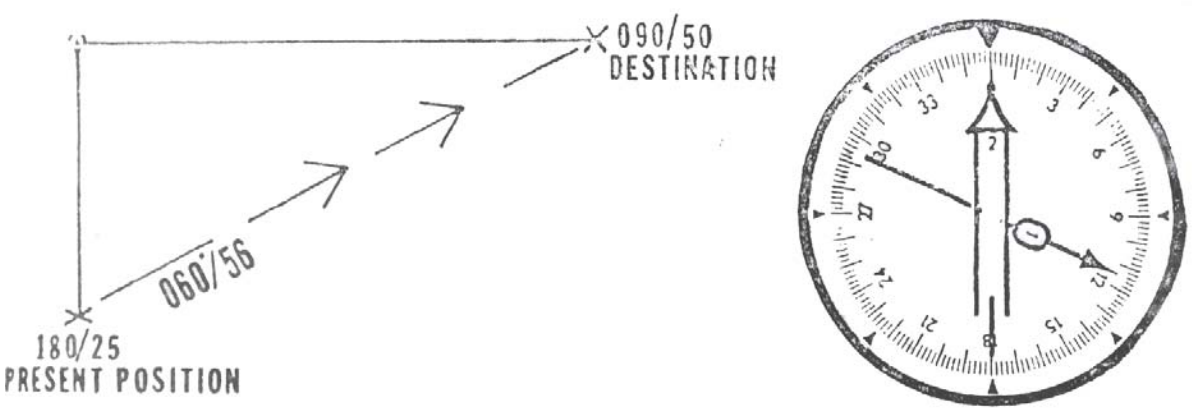


Figure 1

If you mentally estimated a heading of 060° for 56 NM, you are well on your way to a good understanding of point-to-point navigation. The diagram should help those who have trouble with the mental picture. To interpret the diagram, you must estimate the direction of the dotted line. You have references to work with, however. Notice that the dotted line is canted somewhat (about 30°) north of the 090° radial. If that is the case, then the line must represent a course of 060°. As for distance, notice the length of the segment connecting the TACAN with 090/50. It is obviously 50 NM. If that line is 50 NM, then the dotted line is certainly longer (about 5 NM longer) than 50 NM. These rough estimations will help prevent your making erroneous decisions concerning your point-to-point navigation, and they will help you build confidence in your navigation abilities.

Computer Method

So that the principles of point-to-point navigation might be more clearly understood, it is convenient for us to use the CR-2 navigation computer; specifically, the wind side. When using the CR-2, the center or grommet on the wind side is equated to the location of the TACAN station, common to both your present location and the point to which you wish to proceed.

To plot your position on the computer, utilize the methods you have learned for plotting winds, i.e., substituting TACAN radials for wind directions and TACAN DME for wind velocity. It is very important that you distinguish between your position and the point to which you are proceeding. One method is to use a triangle (or target) as your desired destination and a circle as your own position.

Figure 2 illustrates an aircraft presently on the 360°R/40 DME. Your desired position is in the 270°R/30 DME. Note the plotting of the two positions.

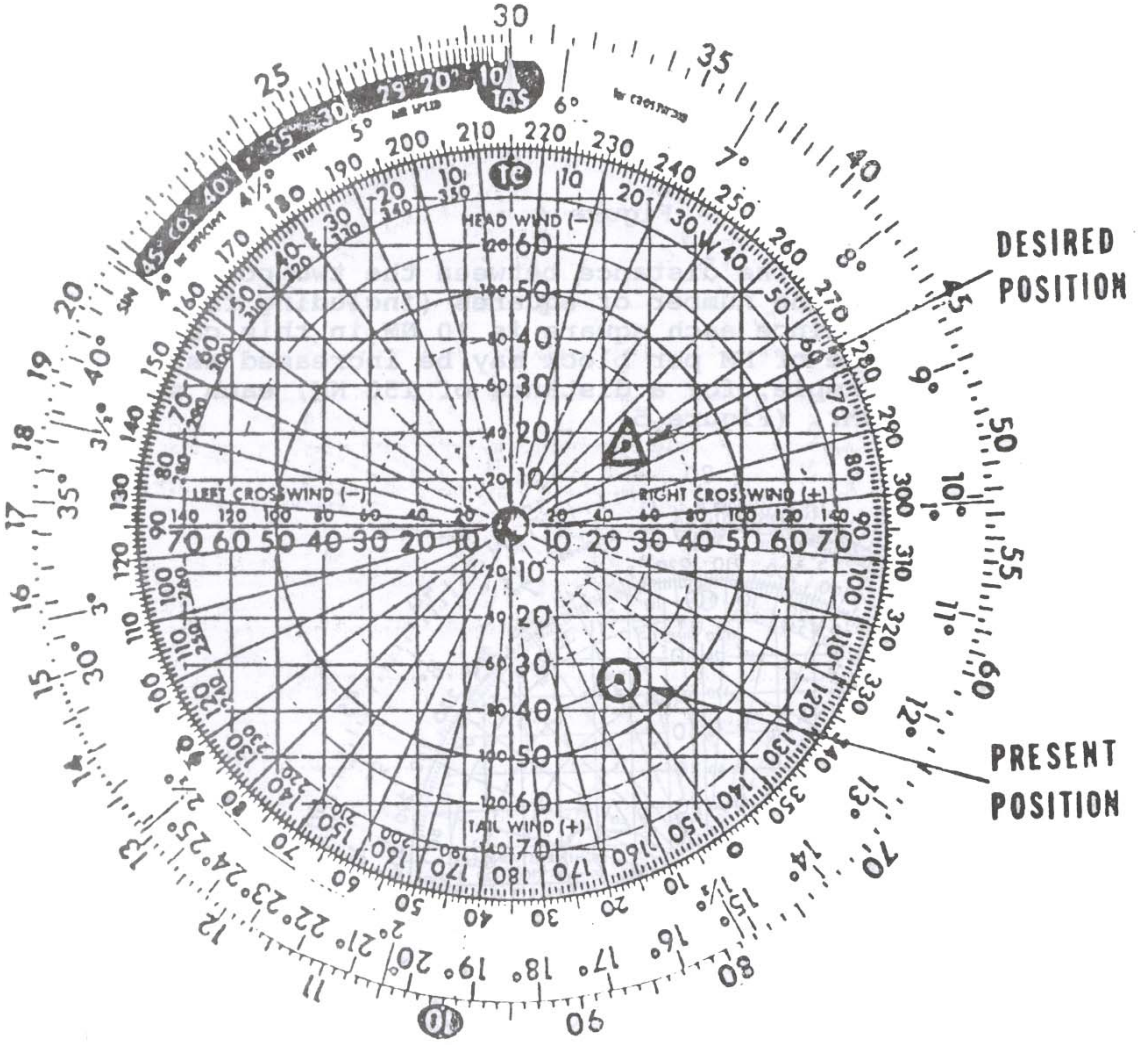


Figure 2

To determine what heading you will take from your present position (360ºR/40 NM) to your next point (270ºR/30 NM), rotate the top disk so that the desired position (triangle) is directly vertical above your present position (circle). Your heading is read off the TC index. This is in fact a magnetic course. Remember: Under a no-wind situation, magnetic course = magnetic heading. The computed heading/course = 216°. See the following figure.

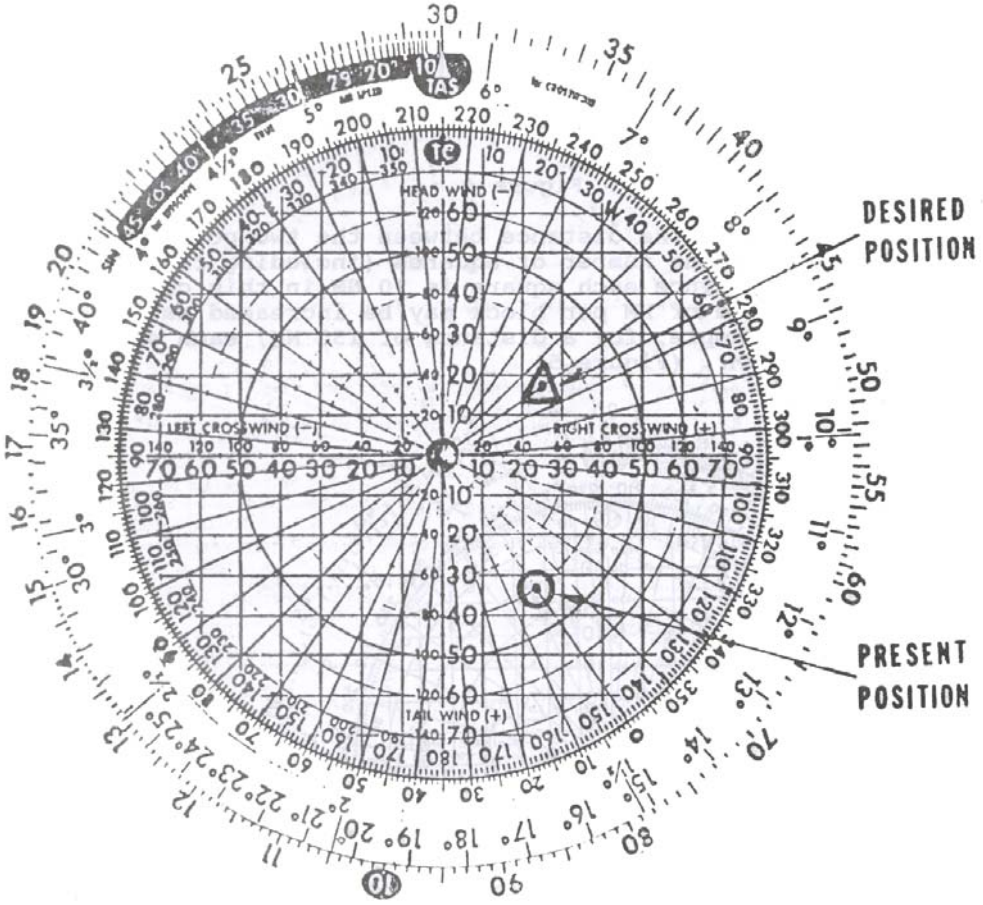


Figure 3

Always read the computed heading/course FROM your present position TO your desired point (Figure 3). Failure to do so will result in a reciprocal heading which is an incorrect solution. This can be avoided by always placing the under the on the CR-2.

By relying exclusively on the computer, without employing logic in the solution, a reciprocal heading may seem feasible. Such reliance will sometimes cause significant navigational errors. Do not let it happen to you. THINK!

Note in Figure 4 how your CR-2 calculations agree with your mental picture.

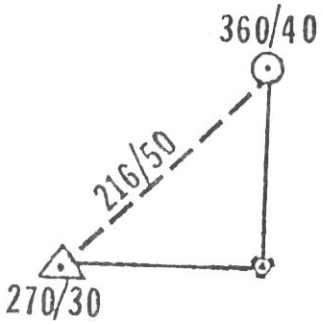


Figure 4

Now, to determine the distance between the two points in the example, just count the number of squares (including fractions) and multiply by 10 since each square is 10 NM in this case. See Figure 5. The scale of NM per block may be increased as necessary. For example, for a distance of 150 NM, each square may represent 20 NM. (Figure 5)

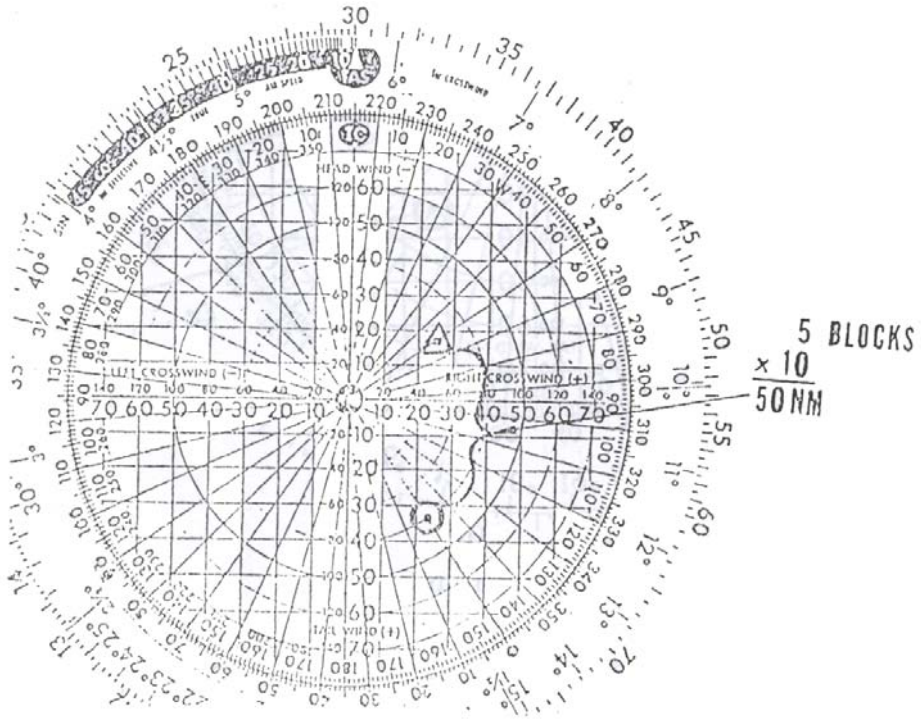


Figure 5

Pencil/Eyeball Method

Utilizing the same principles we learned on the CR-2, we can work point-to-point navigation by the pencil/eyeball method. The big drawback to the CR-2 method is that it consumes too much time. The pencil method, though not as accurate, is much quicker and shall be used on your training flights here in VT-10.

In working this method, we equate the center of the RMI to the TACAN station. The compass card then becomes the surrounding airspace. The tail of your #2 needle corresponds to your radial, and your aircraft position will be somewhere along its length (between the center and the end of the tail) (Figure 6)

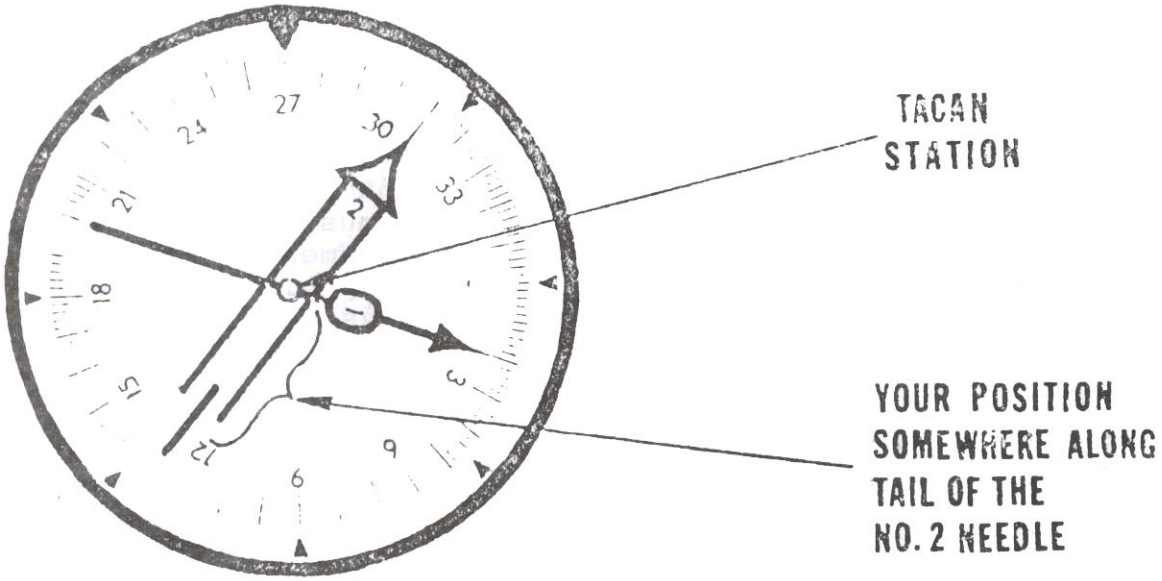


Figure 6

We now equate the larger of the two DME's with which we are working to the outer radius of the RMI card. The other, or smaller DME, will be somewhere proportionally between the outer edge of the RMI card and the center (TACAN station).

Example: Your position: 130º R/20 DME
Desired position: 200º R/40 DME

Remember now, your position is on the 130°R; therefore, it lies somewhere along the tail of the #2 needle. Now note which of the two DME's is largest--40. Therefore, 40 DME is the value assigned to the outer edge of the card. Our DME is 20, so it must be halfway between the compass edge and the RMI center.

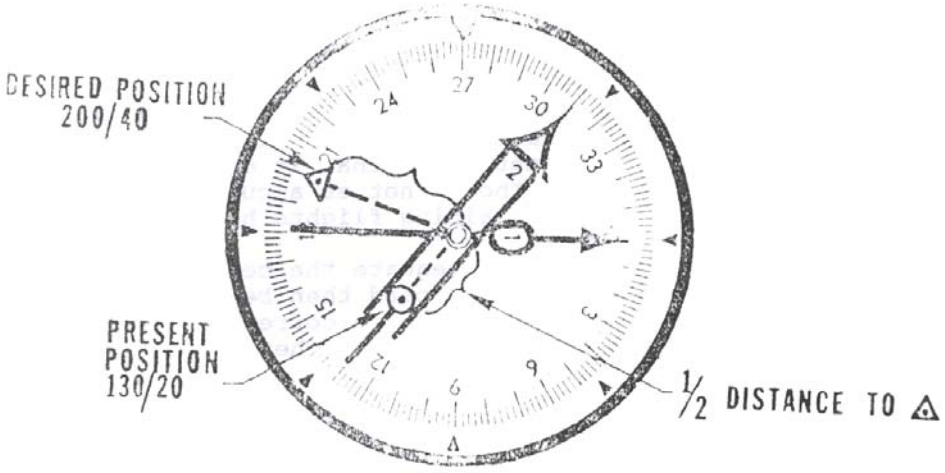


Figure 7

Now that we have established our present position and desired position relative to the TACAN station, we must connect them to determine what our course will be. The implement with which you will be connecting them will be a pencil or pen. Why a pencil or pen? Because, as an aviator, you will always have one handy and because either one will approximate a straight line (or course) fairly well.

To perform the pencil method, simply connect the two points by placing the tip of the pencil on the desired position and the butt of the pencil on the present position. Then carefully slide your pencil in a parallel manner to the center of the RMI and where your pencil intercepts the numerical values on the compass rose, read off your course (Figures 7,8,9).

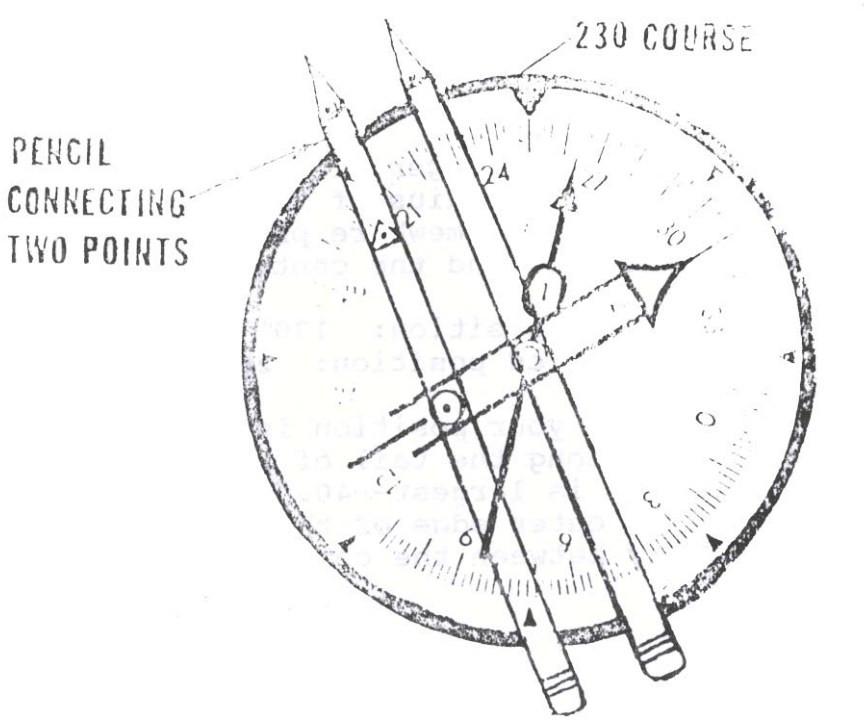


Figure 5-8

Upon turning to the heading determined by this method, the fixes should be vertical and parallel to the "top-to-bottom" line through the center of the compass card. In Figure 9 note that the course is 230°. When you turn to 230°, the pencil that connects the points becomes vertical.

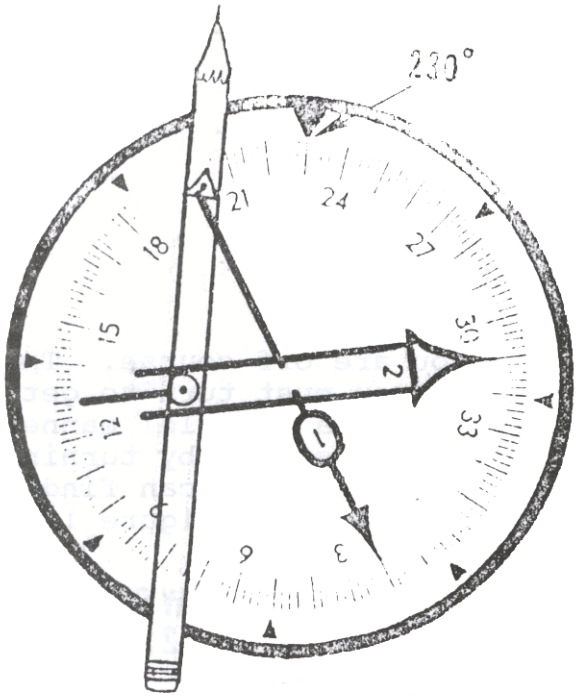


Figure 9

If we see the pencil move from the vertical position, 230° is no longer the course from your present position to your desired position.

Note in Figure 10 that the dotted line represents our original course. Ideally, the flight path of our aircraft should fall on it at all times.

As our aircraft progresses along the course, we should be able, at any time, to connect our new position and our desired position and find that our course remains 230°. If we find ourselves at the point indicated by the arrow, our course can no longer be 230°, it is instead about 220° as is indicated by the solid line. (Figure 10)

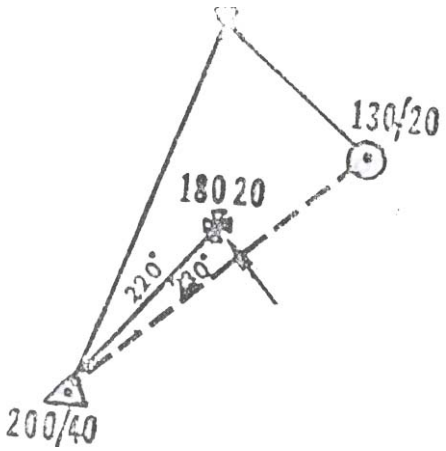


Figure 10

Whenever this happens you are off course. The pencil will be canted in the direction that you must turn to get back on course. By either bringing the pencil in a parallel manner to the grommet and turning to the indicated course, or by turning the aircraft until the pencil is again vertical, you can find the new course from your present to desired position (Figure 11).

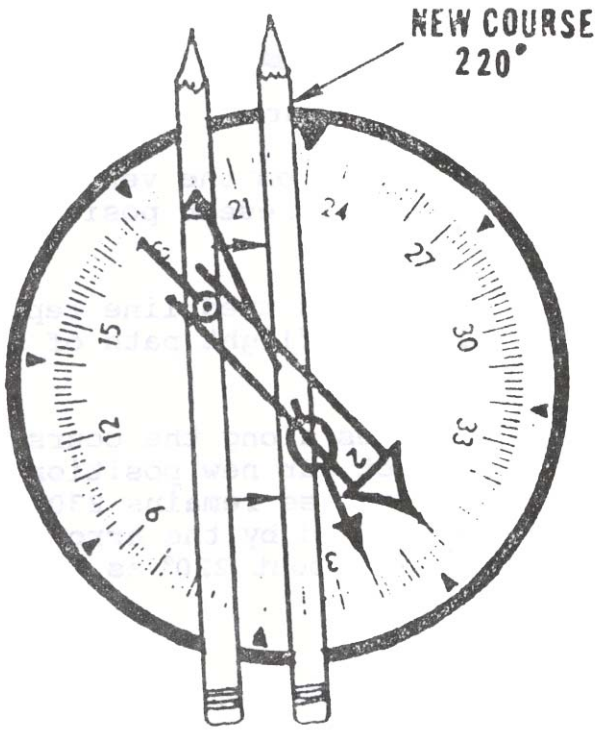


Figure 11

If you continually fly your aircraft in this manner, note that your track will look like the one depicted in Figure 12 below.

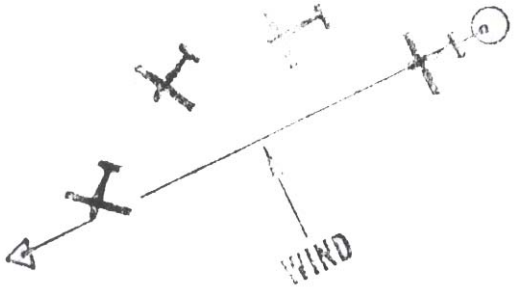


Figure 12

This type of flight path occurs because you have not yet corrected for the reason you get off course in the first place, namely wind. If you will reexamine Figure 12, you should notice that our aircraft has been blown NW of course; therefore, it probably is being subjected to a SE wind. If the aircraft turns to the new heading of 220° it will continue to drift NW because of that continuing SE wind. What it must do is attempt to actually fly along the solid. line representing a course of 220º by using a heading that crabs sufficiently into the wind to neutralize it, perhaps 215º. See Figure 13 below.

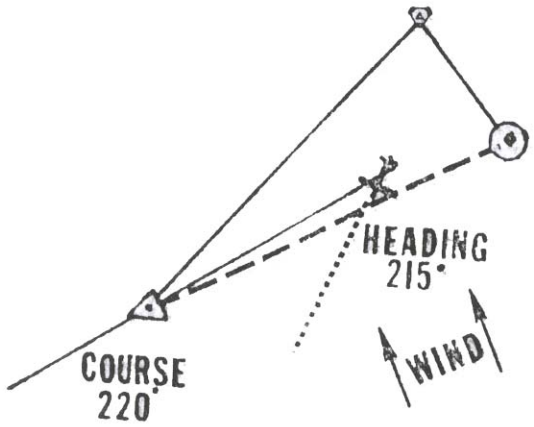


Figure 13

CO-DME SOLUTION

A logical extension of what we've been doing for the last few pages is the co-DME solution. When an aircraft is in transit to a certain point, it is likely to pass many radial/DME combinations. If one of the positions that it passes has a DME which is equal to the DME of the point to which it is flying, a co-DME situation exists. At this point the aircraft has an equal number of radials above and below its wingline.

Example: Desired position 360 /50
Present position 090 /50

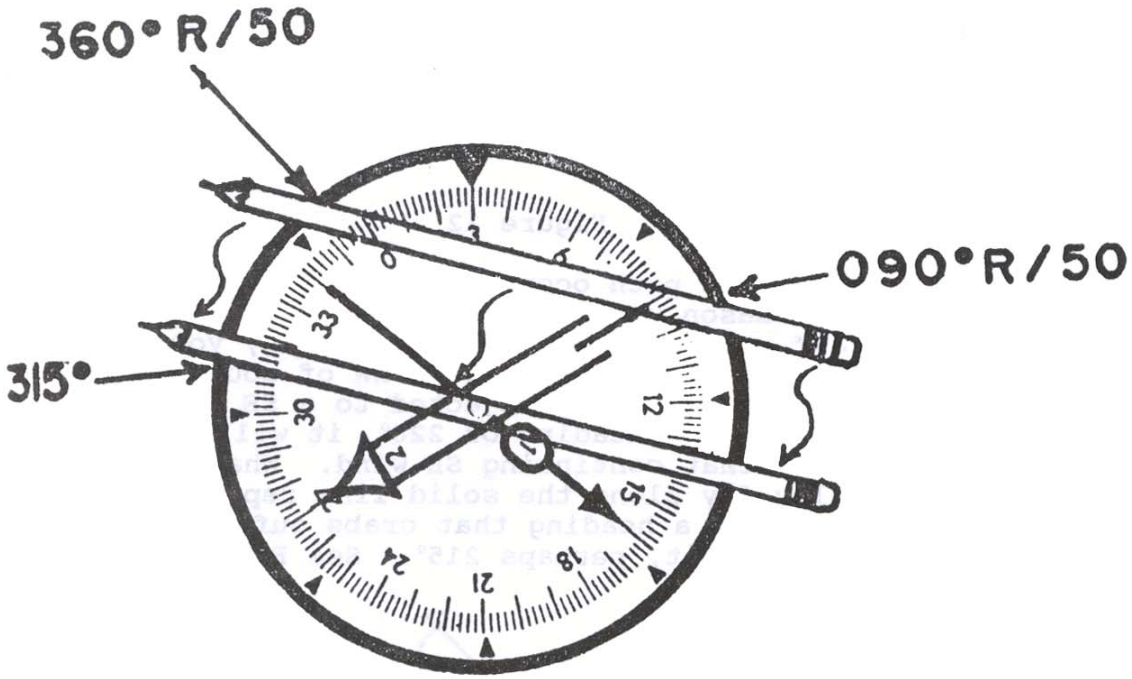


Figure 14

Plotting on the BDHI and using the pencil method we find that 315° is the correct course to fly from present position to the desired position. (Figure 14)

When a co-DME situation exists, we can forego the pencil method and substitute numerical computations. Here is the procedure to use:

1. On the BDHI, locate the head of the #2 needle and the numerical value of the radial you want to intercept.
2. Turn to the heading that is exactly equidistant between the two.
3. Apply crab.

Note that the aircraft is heading 315°: equal to the solution of the pencil method (Figure 15).

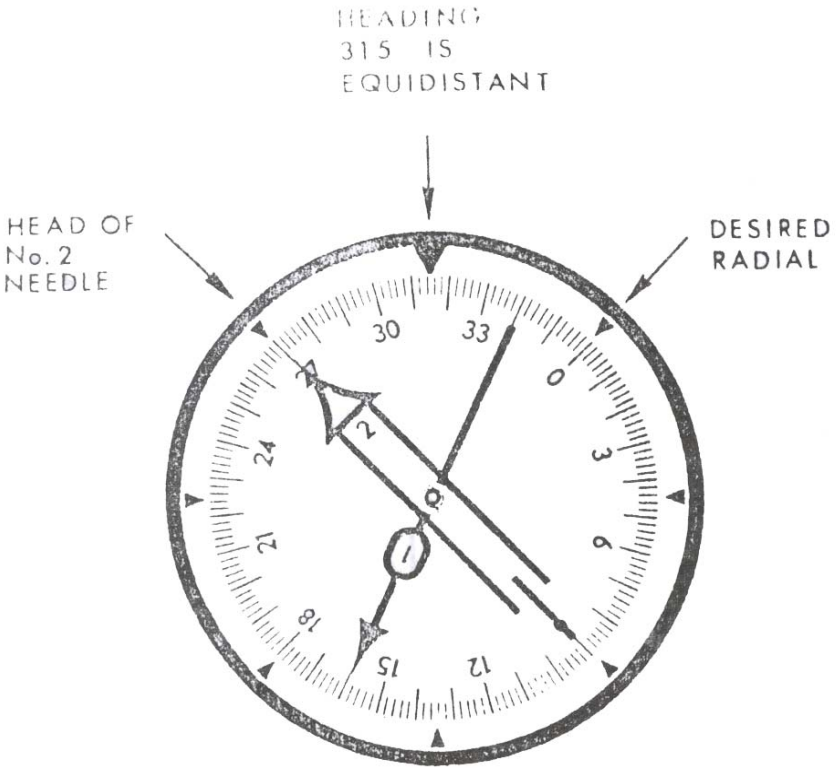


Figure 15

There may be a tendency to wait for a co-DME situation to occur rather than to take immediate action on a point-to-point. Never let this happen. Always aggressively pursue course control.

COURSE CORRECTION

As you know, by introducing a wind, heading, and course will obviously differ from each other unless the wind is strictly a headwind or tailwind.

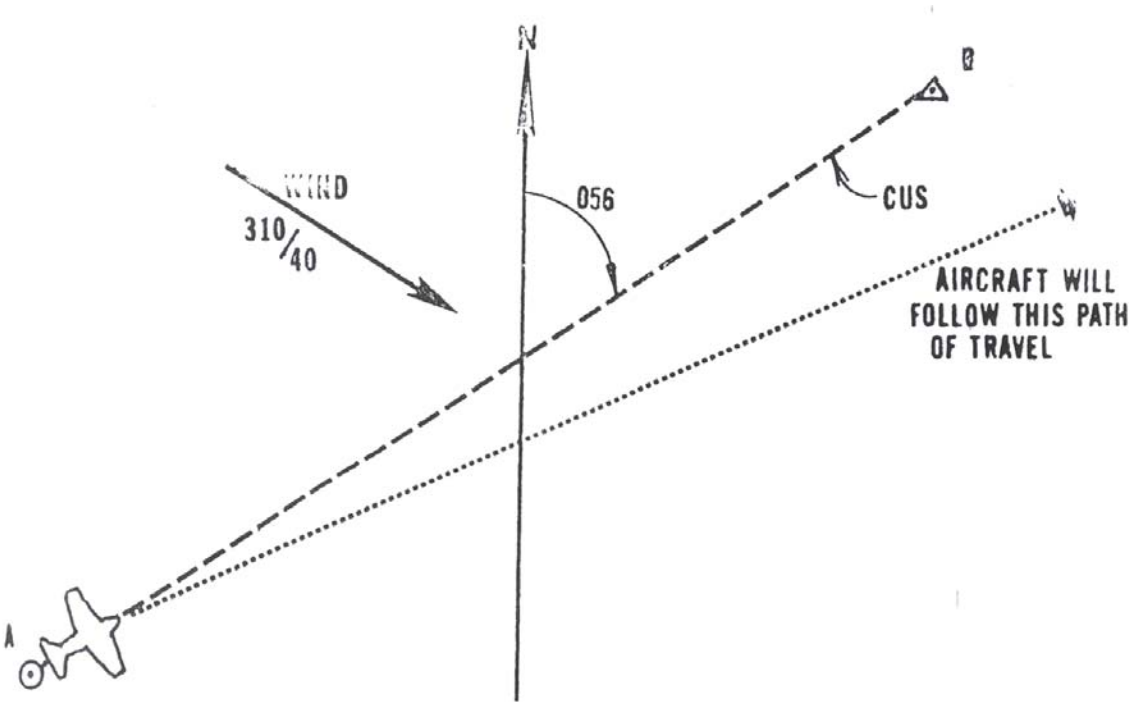


Figure 16

Thus, if you want to maintain a certain course, you must adjust your heading. °In Figure 16, we want to maintain a course of 056°. If we head 056° and do not compensate for the wind, our aircraft will be blown to the right and our track will be different than a 056°.

By not crabbing into the wind, but instead periodically turning to update your point-to-point, you end up flying a curved path instead of a straight one as shown in Figure 17.

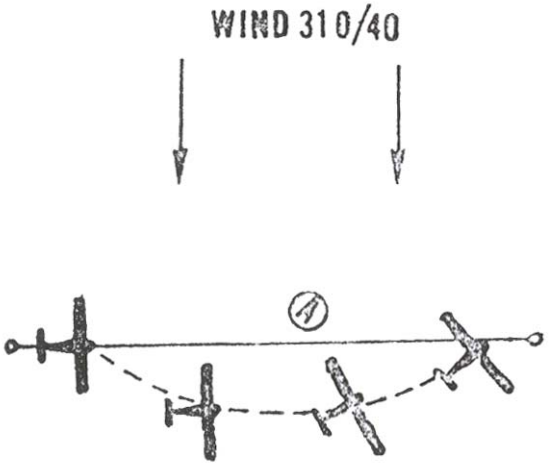


Figure 17

Once airborne, you can roughly determine the existing crosswind by noting the trend in heading changes needed to keep on course.

Example: In order to maintain a course of 090", you start heading 090°, but soon must come to 094°, and finally to 096°. Therefore, a right crosswind exists.

WIND COMPUTATION

By putting two concepts together (headings and ground speed differences) you can determine the specific quadrant, (NE, SE, SW or NW) from which the wind is blowing.

Let's assume we're on the 105°R/40 DME and want to go to the 025° R/60 DME and your TAS is 420. The course is 350°. (Figure 18)

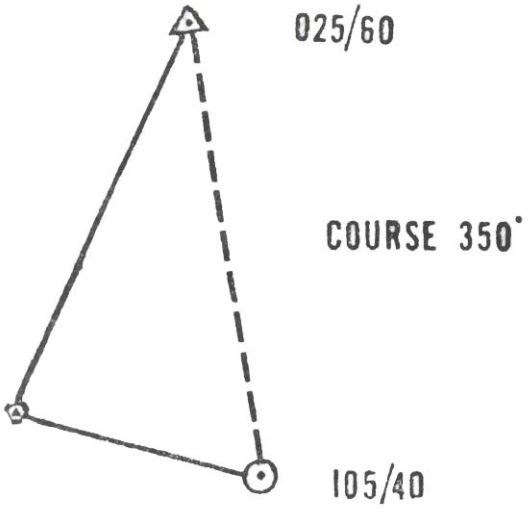


Figure 18

Now let's assume that you find that your progress toward your desired point is slower than you expected and that you constantly have to turn left to maintain your track. The combination of these two factors indicates that you have a wind from the Northwest.

Note how this situation would look on the CR-2

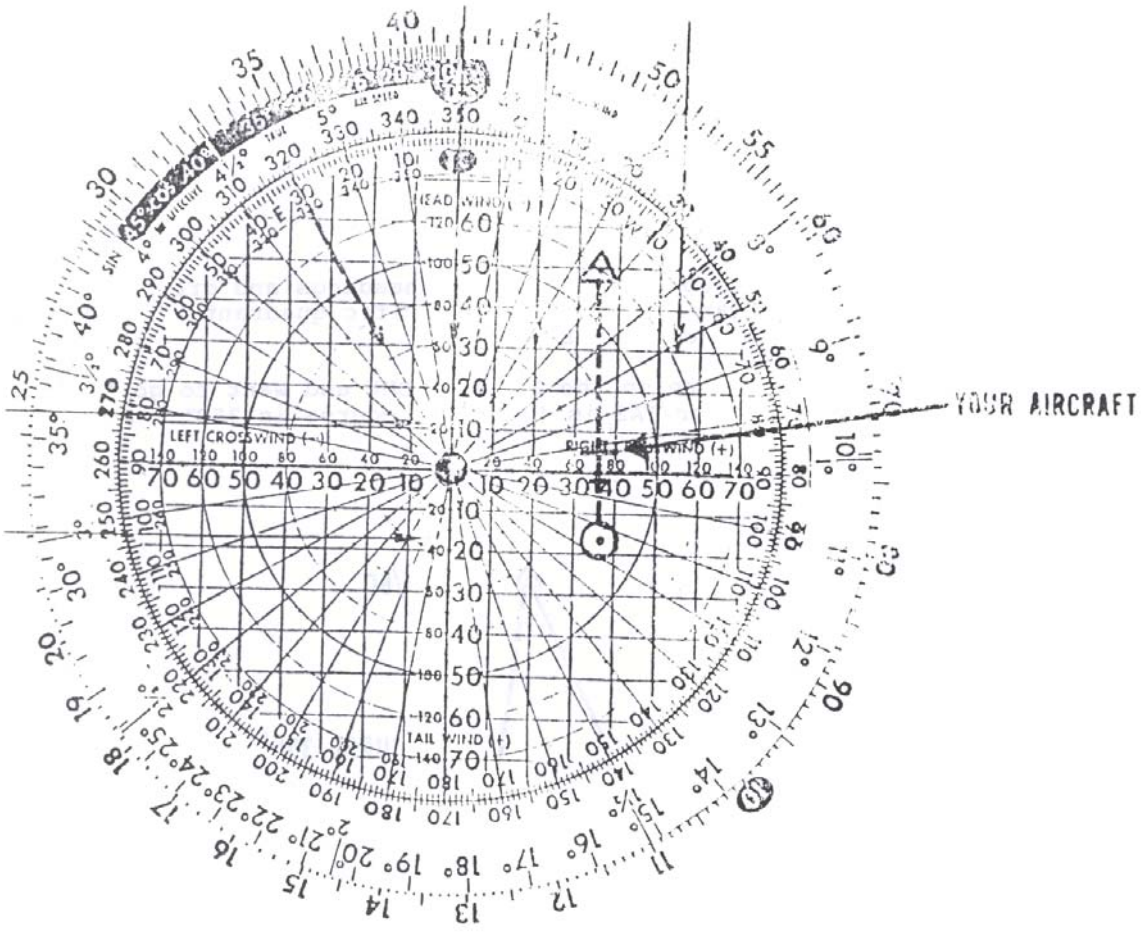


Figure 19

Note the solid arrows (Figure 19) which portray a headwind and a left crosswind. The sum of those arrows is represented by the dotted arrow in the Northwest quadrant.

In a no-wind situation, your track should be directly along the line that connects the two points, a course of 350°. If you were to take up a heading of 350°, however, and you still had that northwesterly wind, you would soon find yourself off course, and behind schedule.

In order to maintain a track of 350°', you must crab into the wind; and in order to determine your time of arrival at the desired point, you must be aware of your ground speed.

Ground speed calculations during point-to-point navigation are more difficult than in radial tracking because we can not directly utilize our changing DME. In order to compute a ground speed, we must somehow measure our actual forward movement relative to a constant source. For our purposes, we will use the CR-2 and the pencil.

To get a ground speed from the CR-2, simply note the distance you move from one TACAN fix to another over a set period of time (Figure 20).

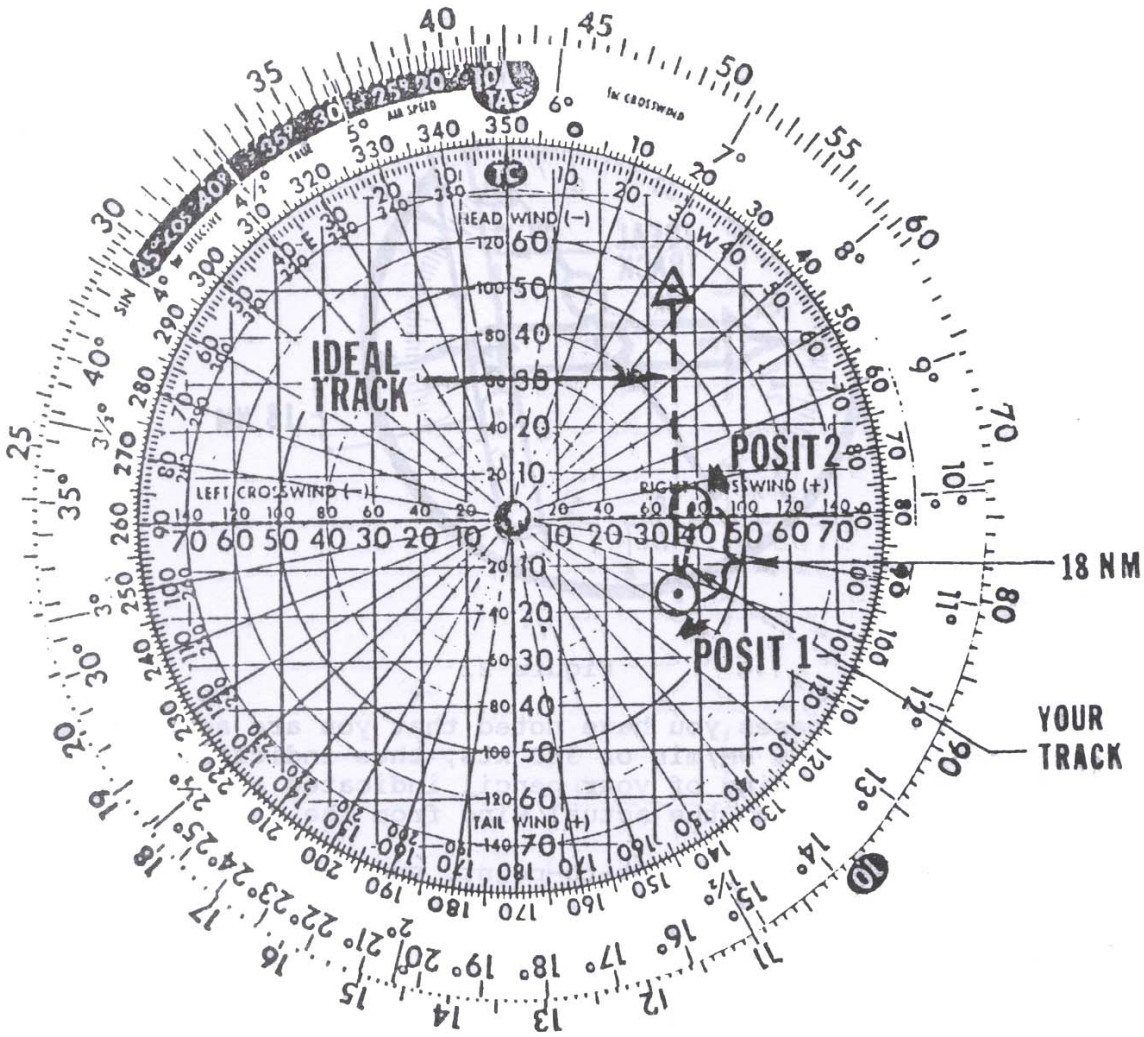


Figure 20

Continuing with our previous example, if we had commenced a ground speed check at our start point, the 105°R/40 DME, and 3 minutes later we found ourselves at the 078°R/38 DME (position number 2), our track would have been that of the dotted line. Our distance covered, the actual length of that line, is 18 NM. Since our G/S check was for 3 minutes, we have covered 6 nm/Min, or 360 Kts G/S. Since our TAS is 420, we have a headwind component of 60 Kts.

To determine a G/S utilizing the pencil method, we employ a similar principle by connecting the start point of our ground speed check to the stop point. Now compare the distance which you have noted by the length of the pencil segment, to the radius of the BDHI. If you have done it carefully, the proportion you determine should come out to 18 NM (Figure 21)

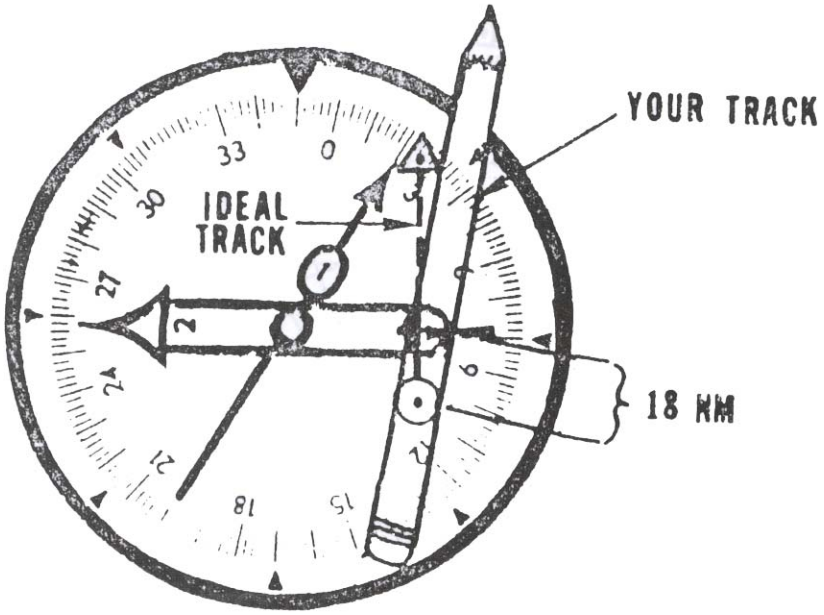


Figure 21

So, in both cases you have noted that you are actually flying a ground speed of 6 NM/min or 360 kts, thus indicating a headwind. The canting of your pencil indicates a crosswind; therefore, confirming the actual wind from the northwest.

To complete a good point-to-point, you must now apply your knowledge of the wind and turn from your current position (078°R/38) to a new course and the desired point of 025°R/60, remembering to crab to hold yourself on that new course. You can then determine your estimated time of arrival by recalling that you have done 6 nm/min, and applying that knowledge to the distance you measure from the 078° R/38 to the 025°R/60. The distance is about 48 NM, so you would arrive in 8 minutes.

SUMMMY

You have learned three methods of point-to-point navigation. The pencil/eyeball method is the method to utilize in the air. Although initially not as accurate as the CR-2 method, it saves time and will become accurate as your proficiency develops. Your eventual goal is to involve logic as much as possible to solve your point-to-point problems. Until that time, the pencil/eyeball method and, to a lesser extent, the CR-2 will be utilized to help your comprehension.

In addition to the TACAN and VOR, the T-34 can utilize its Area Navigation System (RNAV) and accurately solve for point-to-points through its remote navigation computer. Waypoint (point-to-point) bearing, distance and angular crosstrack deviation are continuously supplied by the RNAV computer. Utilization of this system will be further examined in your Flight Preparation Classes.

UNIT REVIEW

INSTRUCTIONS

The attached problems deal with TACAN point-to-point. Given data are presented. Using these data and your RNI facsimile, fill in the blanks with the requested information.

I. Ground speed is 360.

Problems

Position	Present Position	Desired
1.	140/60	110/10
2.	180/100	140/20
3.	200/50	090/50
4.	290/25	010/30
5.	270/120	050/30
6.	120/40	180/50
7.	360/60	220/50
8.	010/25	070/50
9.	175/55	330/50
10.	165/35	010/15

ANSWERS

	Heading	Distance	ETE
1.	_____	_____	_____
2	_____	_____	_____
3.	_____	_____	_____
4.	_____	_____	_____
5.	_____	_____	_____
6.	_____	_____	_____
7.	_____	_____	_____
8.	_____	_____	_____
9.	_____	_____	_____
10.	_____	_____	_____

ANSWER SHEET

	Heading	Distance	ETE
1.	323°	53	8 MIN, 50 SEC
2.	007°	86	14 MIN, 20 SEC
3.	055°	82	13 MIN, 40 SEC
4.	053°	34	5 MIN, 40 SEC
5.	083°	147	24 MIN, 30 SEC
6.	229°	45	7 MIN, 30 SEC
7.	198°	104	17 MIN, 20 SEC
8.	100°	44	7 MIN, 20 SEC
9.	343°	103	17 MIN, 10 SEC
10	353°	49	8 MIN, 10 SEC

INAV 6: HOLDING

Terminal Objectives, Enabling Objectives, and Enabling Steps are established by CNATRAINST 1542.54.

TERMINAL OBJECTIVES:

C. Navigate an aircraft via visual reference and navigation instruments with the assistance of a flight instructor.

ENABLING OBJECTIVES:

C.7. Fly entry and holding pattern procedures, given radio aids to navigation and flight information publications (FLIP), with instructor assistance as\required.

ENABLING STEPS:

C.7.1. Select entry pattern.

C.7.2. Comply with holding airspeed restrictions

C.7.3 Turn aircraft to enter and maintain the pattern.

SKILLS DEVELOPMENT UNIT: This academic unit of instruction interfaces with flights B-1 through B-5.

MODE OF INSTRUCTION: This unit is a classroom lecture and demonstration presentation. The method used to execute holding procedures will be demonstrated.

INSTRUCTIONAL AIDS:

1. RMI facsimile 2. Visual Aids

REFERENCES:
1. Airman's Information Manual

2. NATOPS Instrument Flight Manual

INTRODUCTION

The holding pattern is a defined area of space where aircraft are required to hold while enroute or awaiting their clearance for approach to an airfield. All aircraft given the same holding instructions must fly the same pattern separated only by altitude. Holding is most often required when weather conditions are such that you cannot maintain visual separation. Therefore, it is essential that you understand holding entry and pattern procedures to avoid midair collisions. Any flight terminating at the carrier at night will be required to hold until their assigned push time (approach time) arrives.

Holding is the maneuvering of an aircraft in relation to ’a navigational fix while awaiting further clearance. The STANDARD no-wind holding pattern is flown by following a specified holding course (along a radial) inbound to the holding fix, making a 180° turn to the right, flying a heading outbound to parallel the holding course (radial) and making another 180° turn to the right to intercept and follow the holding course (radial) inbound to the fix. The holding pattern is NONSTANDARD when the turns are made to the left. Unless published or otherwise instructed by Air Route Traffic Control Center (ARTCC), aircrews are expected to hold in a standard pattern. Because the primary navigation aid in the T-34 and T-39 is the TACAN, most of your holding will be in relation to a TACAN radial and DME fix.

TACAN HOLDING

When you are assigned to hold in relation to a TACAN, the radial and DME of the holding fix will be published (as on an approach plate) or will be assigned by ATC.

ATC clearances to holding generally consist of the following instructions if published holding instructions are not available:

1. Direction of holding (compass point, relative to the fix)
2. Holding navaid
3. Radial and DME of the holding fix
4. Outbound leg lengths in NM, or the two outer limits (in NM) of the holding pattern
5. Altitude
6. Direction of turns
7. Expected Further Clearance

An example of holding instructions follows:

"1F51, hold on the Navy Oceana 120°R/29 DME, from 29 to 39 miles, left turns. Maintain 15,000. Expect further clearance 2120Z."

Note that in this holding instruction the direction of holding is not stated, for it is implied in the location of the holding fix and its relation to the outer limit of the holding pattern (Figure 1).

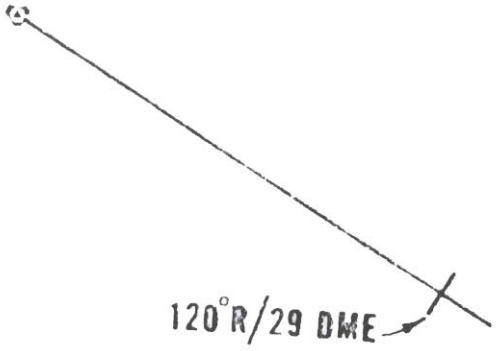


Figure 1

At any radial/DME holding fix, four holding patterns can be drawn. It is your responsibility to choose the correct one (Figure 2).

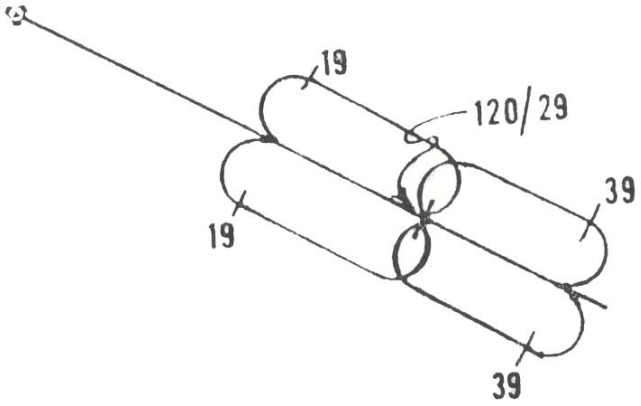


Figure 2

Now, if you read your holding instructions, you can start eliminating each of the incorrect racetrack patterns, one by one. Because the instructions state "hold from 29 to 39 miles...", you can eliminate the two patterns to the NW of the holding fix. , (Figure 3)

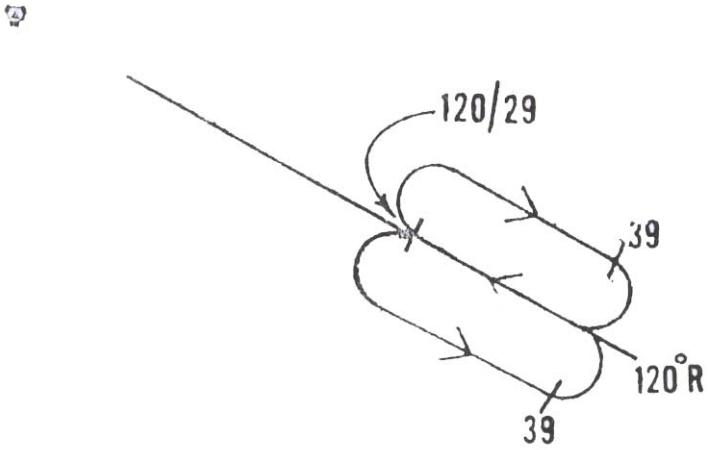


Figure 3

The instructions also state "left turns". Recall that you hold by radial tracking to the fix. The fix is the 120°R/29 DME. To hold into the fix, you would have to be flying from SE to NW along the radial until reaching the fix. Of the remaining two holding patterns, one denotes right turns; the other, left turns. It is obvious that you should choose the one on the bottom (Figure 4).

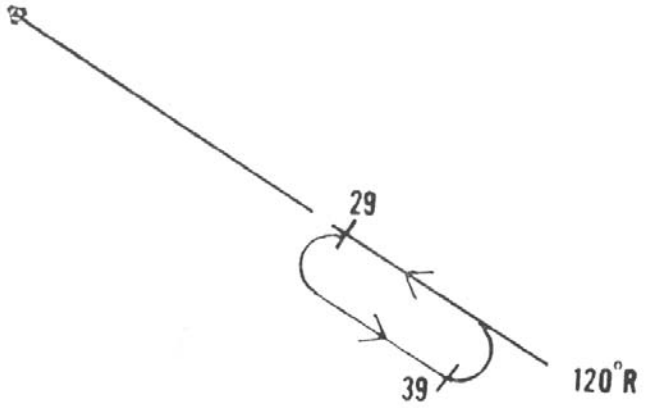


Figure 4

Note that the arrow on the radial indicates travel toward the holding fix. Also note that any aircraft flying this holding pattern would be making left turns.

Here is another example of a holding clearance:

"OF42, holding Southwest of the Marine Cherry Point 260°R/25 miles, 10 mile legs. Maintain 15,000'. Expect further clearance 2340Z.

In this clearance, you have not been given the outer limits of the holding pattern; however, you have been given the direction of holding and the leg length. You know the fix is 25 DME, so the legs will be either from 25-35 DME or 15-25 DME. To determine where your pattern will be, you must analyze further.

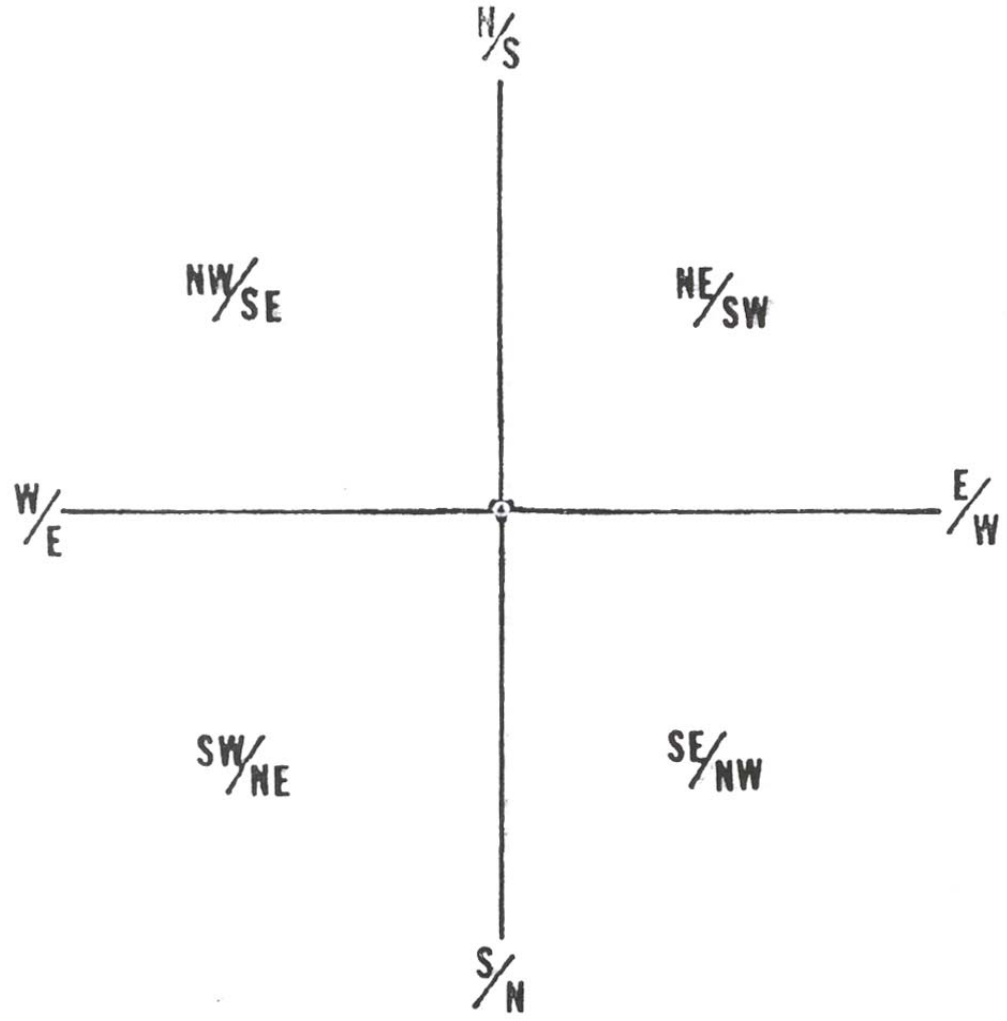


Figure 5

The illustration above (Figure 5) sets off the airspace around the TACAN station into four quadrants: NE, SE, SW, NW. Next to the name of each one of these quadrants is the name of the quadrant that is its opposite (e.g., NE is opposite SW). In addition, each one of the cardinal headings is named (i.e., N, E, S, W), along with its opposite.

The quadrants contain the following radials:

Northeast	001° - 089°
Southeast	091° - 179°
Southwest	181° - 269°
Northwest	271° - 359°

While;

N = 360°
E = 090°
S = 269°
W = 270°

If an aircraft is assigned a direction of holding (i.e., NW or SE, etc.) as OF42 was, the direction of holding is in relation to the holding fix. (Figure 6)



Figure 6

Since the 260°R is in the SW quadrant, you can only hold SW or NE of the fix (See Figure 5).

Example:

Assigned Holding Radial	Possible Holding Directions
010°	NE or SW
2710	NW or SE
090°	E or W
1790	SE or NW

Therefore, since you were told to hold SW, your possible holding patterns are limited to the two on the southwest portion of the 260 radial (Figure 7, 8).

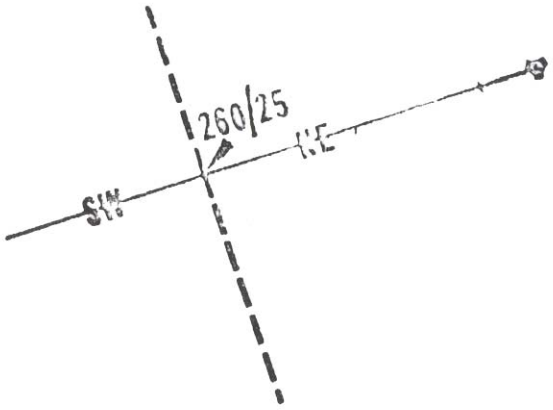


Figure 7

So, these are our two possible holding patterns:

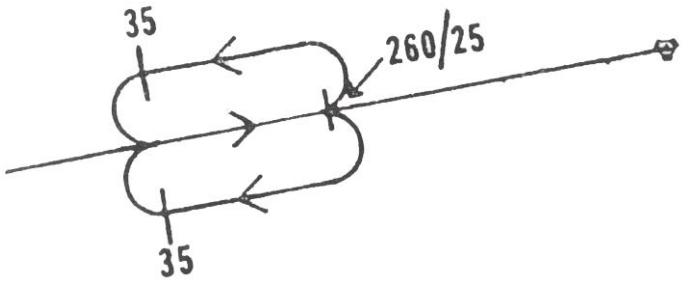


Figure 8

Next, you can analyze your end points. Since you're working with 10 NM legs, your end points must be at 35 DME. Recalling that travel must always be toward the fix, you know now that you will be flying from SW to NE toward 25 DME.

Finally, because no direction of turns are given, you assume that standard, or right turns are appropriate.

Of the two remaining patterns, only one satisfies all of the conditions: the one on the bottom (Figure 9).

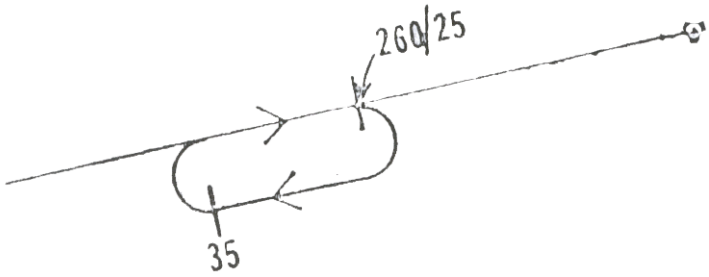


Figure 9

One more example:

"0F23, hold Southeast of the Navy Glenview 330°R/30 miles, 10 mile legs. Maintain 17,000'. Expect further clearance 1740Z (Figure 10).

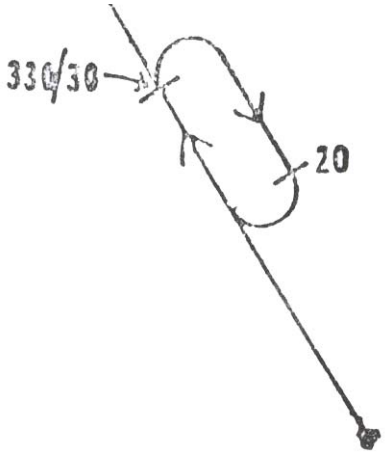


Figure 10

Another method for depicting this holding clearance is:

1. Draw a wind arrow represents the direction of holding (e.g. hold SE)
2. At the arrowhead, draw your holding fix.
3. Label the arrow with the appropriate radial.
4. Annotate the outer and inner limits of the holding pattern.

5. Draw your turn directions such that your track along the radial is toward the arrowhead (holding fix).

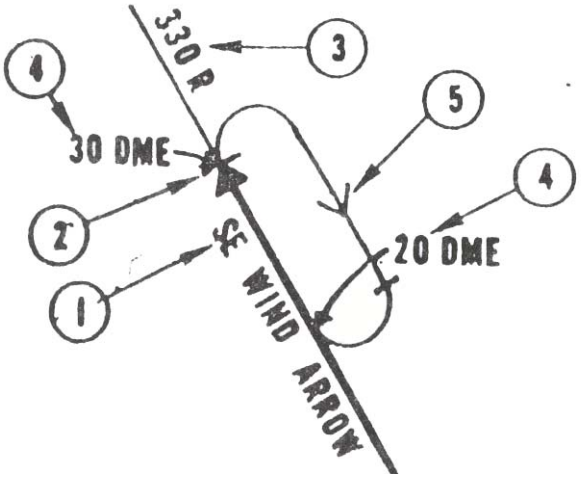


Figure 11

Notice in Figure 11 that the aircraft is holding SE of the fix. Note that it's making right turns (no direction was specified) and that its leg lengths are 10 miles (30-20).

REMEMBER: The direction of TACAN holding is relative to the holding fix, <u>not</u> the station (Figure 12).

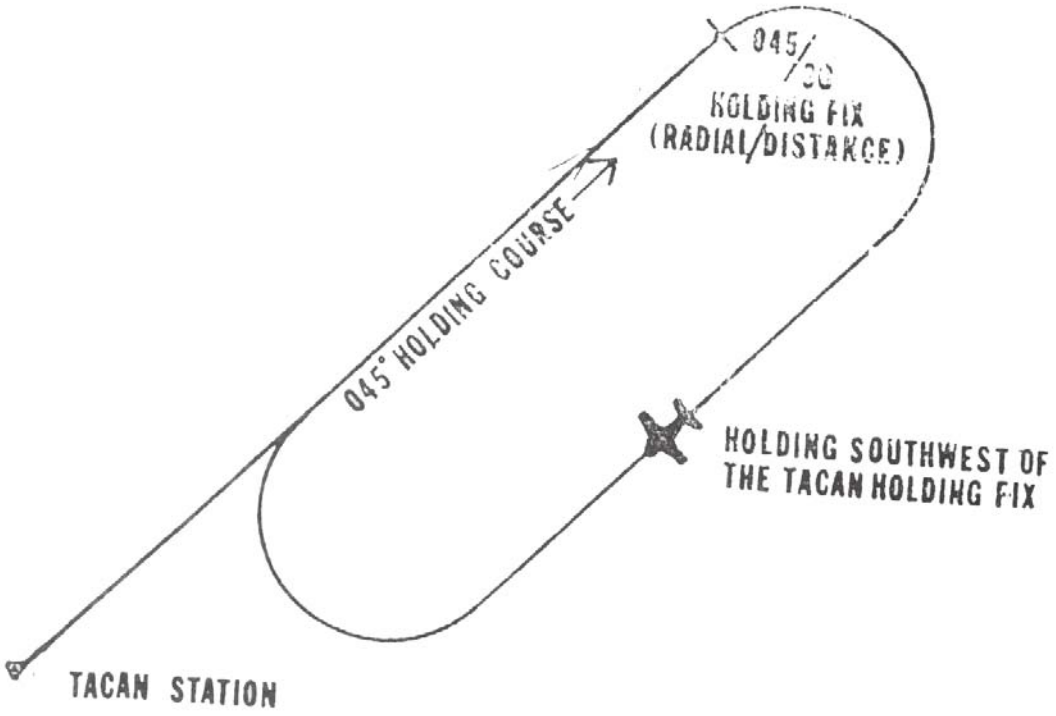


Figure 12

HOLDING AIRSPEEDS

You should slow to holding airspeed within three minutes of reaching the holding fix. The maximum holding airspeed for all aircraft is found in FLIP General Planning, Chapter 5. The T-39 maximum holding airspeed is 230 kts. The T-34 maximum holding airspeed is 175 kts. Recommended holding airspeed for the T-34 is 120 KIAS. The recommended holding airspeed for the T-39 is 200 KIAS.

ENTRY PROCEDURES

Holding pattern entry turns depicted on high altitude approach charts are provided for aircrew convenience and are recommended procedures only.

These entry procedures are referred to and depicted on approach plates as a left turn (LT), right turn (RT), and teardrop (TD), (Figure 13); however, they are commonly referred to as Direct Entry, Teardrop, and Outbound Parallel. The angular difference between the holding course and the aircraft heading when you cross the holding fix determines the type of entry procedures you will use. You must navigate to the holding fix prior to executing any of the holding entry procedures. For all procedures, once you cross the holding fix you are considered to be "in holding."

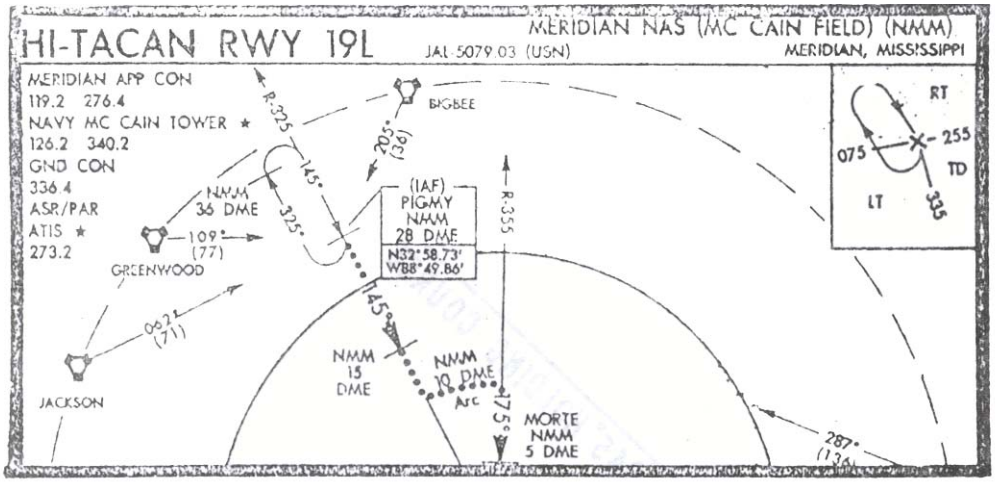


Figure 13

The following explanations refer to the recommended entry section of the approach plate depicted in Figure 13.

TEARDROP

Generally, the smallest quadrant depicted on the recommended entry section of the approach plate is labeled TD (Teardrop). If your heading to the holding fix falls within the ranges provided for TD quadrant, then you'll perform a teardrop entry. Upon reaching the holding fix, you turn the aircraft 30° from the published outbound leg heading, to fly into the holding pattern. Proceed on this heading until reaching the outer DME limit of the pattern, and then turn to fly the inbound course to the holding fix. In Figure 14, the outbound leg has published heading of 180°, so you would turn 210° or 150°, as appropriate, to fly through the holding pattern to 18 DME.

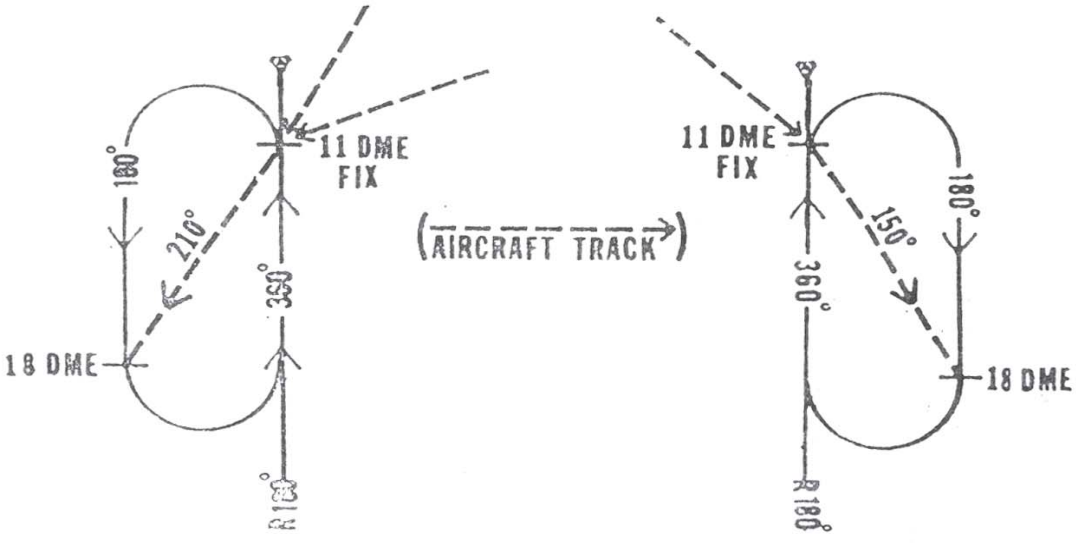


Figure 14

DIRECT ENTRY

The largest of the quadrants represents a Direct Entry, and it will be labeled RT or LT correspond with the DIRECTION of turns in holding. After reaching the holding fix, simply turn the aircraft left or right to approximate the racetrack pattern of the depicted holding pattern (see Figure 15).

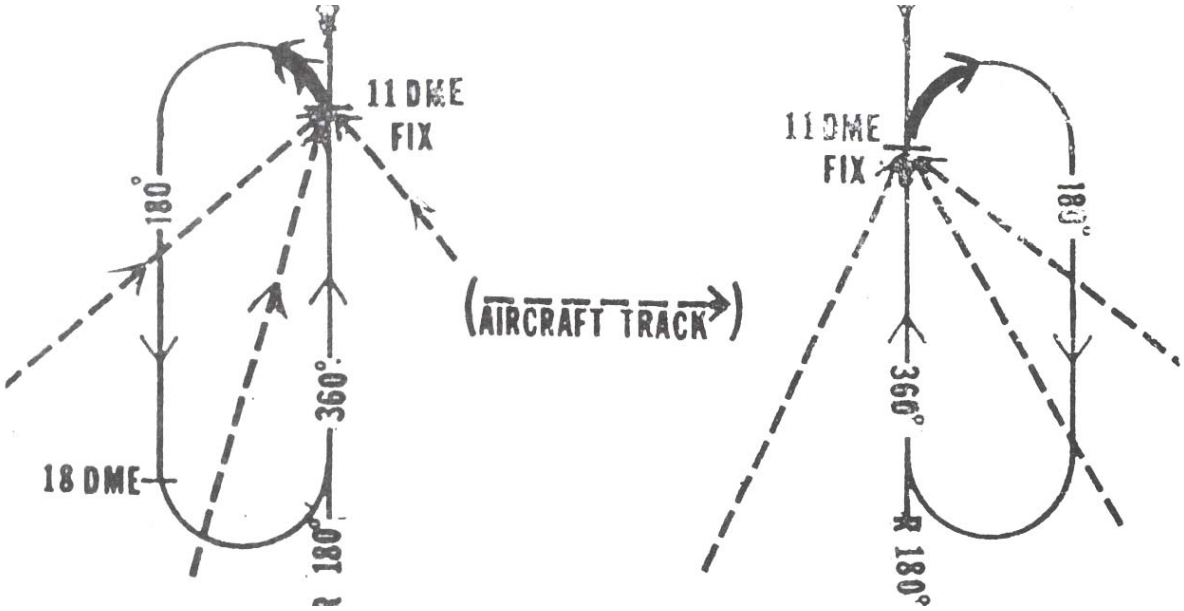


Figure 15

OUTBOUND PARALLEL

The final quadrant (which is generally larger than the teardrop and smaller than the direct entry) refers to an Outbound Parallel entry and is labeled either RT or LT, opposite to the direction of turns in holding.

Once you have crossed the fix, turn your aircraft to published heading for the outbound leg. Fly this heading out to the outer OME limit, then turn toward the holding pattern and fly the inbound radial (see Figure 16).

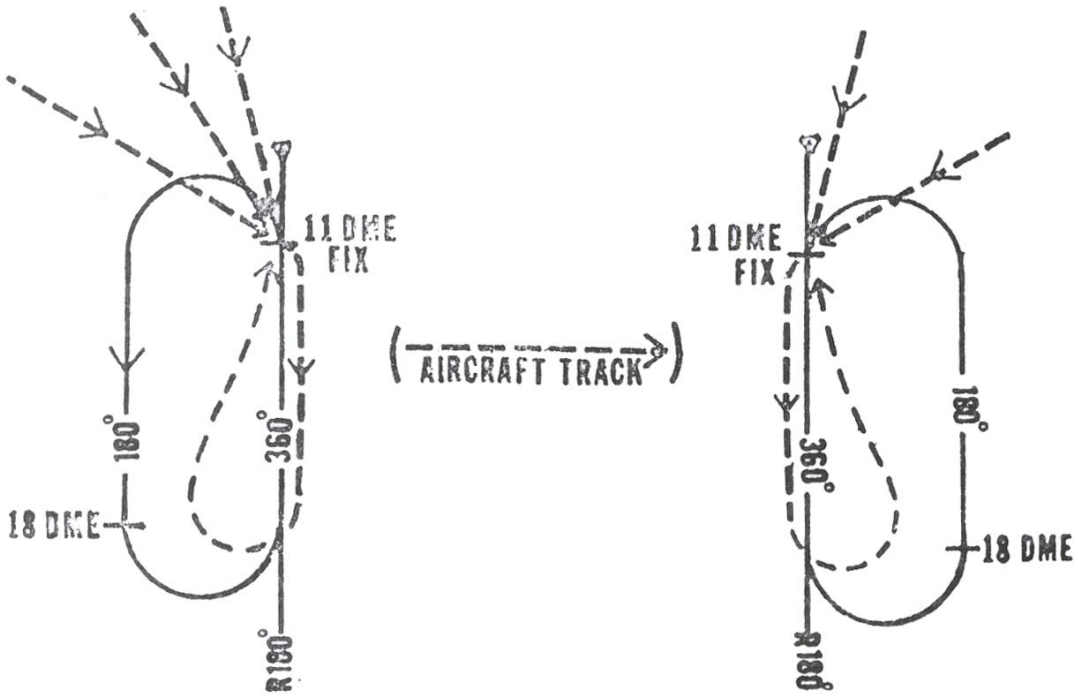


Figure 16

NOTE: Upon reaching the holding fix, your turn to parallel will provide lateral displacement of your aircraft from the holding radial.

Crosswind components may cause you to modify the headings in these entry procedures to maintain the integrity of your holding patterns. If a crosswind component causes you to drift away from the holding radial, you must compensate for it or you might drift out of protected airspace. Protected airspace is the area around a holding fix that air traffic controllers will keep clear of non-holding traffic. It is a completely arbitrary area. Its size will depend on the nature of the holding fix, type of approach and airport procedures.

NO DEPICTED PATTERN

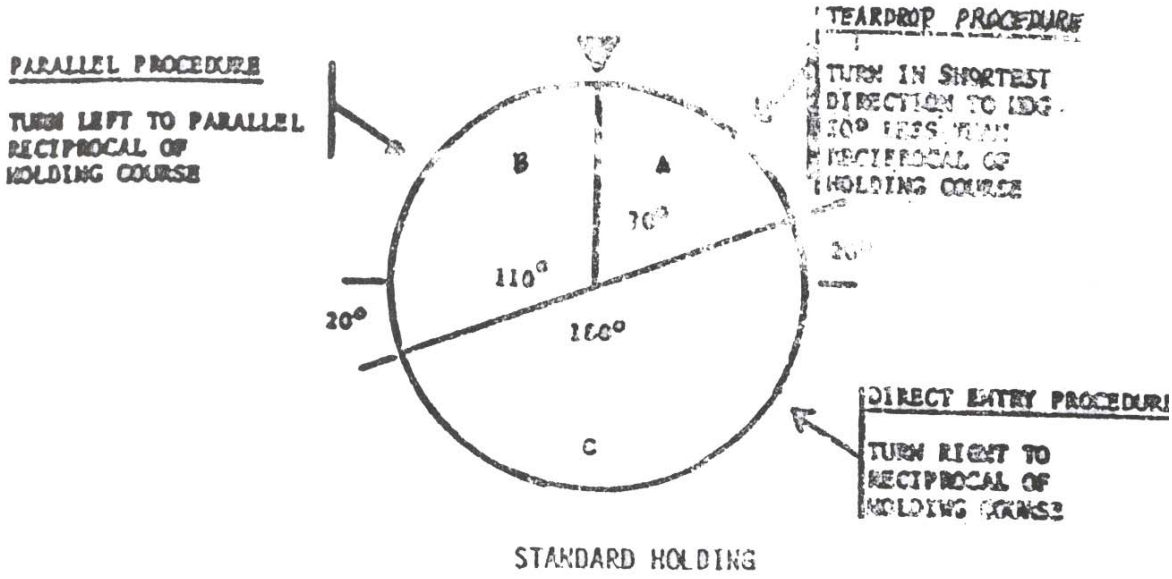
There are three types of entry procedures used to enter holding. The type entry is predicated on the reciprocal of the course you would fly while holding inbound to the holding fix. In most cases the reciprocal will be the same as the holding radial. There will be certain cases where the reciprocal will fall on, or very close to, a sector boundary. If the reciprocal is within 5° of a boundary, the entry procedure for either sector will be acceptable.

<u>Standard Holding, (Right Turns)</u> Figure 17A

1) Sector A (Teardrop): If the reciprocal is between the heading index and 70° to the right of the heading index, make a. teardrop entry. This is accomplished by turning the aircraft 30° into the depicted holding pattern.

2) Section B (Outbound Parallel): If the reciprocal is between the heading index and 110° to the left of the heading index, make a left turn to parallel the holding radial.

3) Section C (Direct Entry): If the reciprocal does not meet the criteria listed in 1 or 2 above, turn the aircraft right to the reciprocal of the holding course and enter holding outbound from fix.



STANDARD HOLDING

Figure 17A

<u>Non-standard Holding, (Left Turns)</u> Figure 17B

1) Sector A (Teardrop): If the reciprocal is between the heading index and 70° to the left of the heading index, make a teardrop entry. This is accomplished by turning the aircraft 30° into the depicted holding pattern to a point 2nm offset from the turn point.

2) Sector B (Outbound Parallel): If the reciprocal is between the heading index and 110° to the right of the heading index, make a right turn to parallel the holding radial. At the turn point, turn the aircraft right to intercept the holding course with a 30° extra correction cut.

3) Sector C (Direct Entry): If the reciprocal does not meet the criteria listed in 1 or 2 above, turn the aircraft left to the reciprocal of the holding course and enter holding outbound from fix. In all cases, depicted and nondepicted holding, after reaching the holding fix, you must turn your aircraft to enter holding. For the nonstandard pattern, the slope of the 70° line is reversed and oriented on the holding side just as in the standard pattern.

COMPENSATION FACTORS

There will be situations in which an entry procedure has be modified in order to establish the aircraft in holding in safe but expeditious manner. There are several factors that cause these last minute changes. The most common factors are wind and navigational error. Let's examine a few situations that may arise. Wind correction techniques will be examined in a later paragraph.

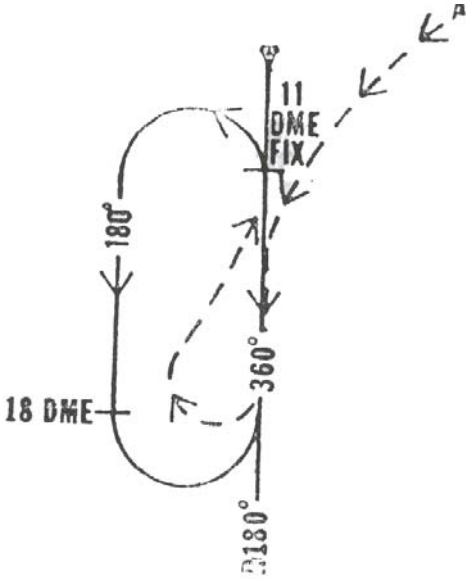


Figure 18

Aircraft A is inbound to the NPA holding fix from Crestview. It is to make one turn in holding. The student, ENS S. HOT, has correctly decided to utilize a teardrop ,entry. However, after a brief thought about his girlfriend, he let his navigation slip. The pilot is just waking up from his nap as ENS HOT quickly sizes up the situation: he is going to miss the holding fix. Being the flexible aviator that he is, ENS HOT tells the pilot to come to a heading of 180° for a modified outbound parallel entry, a perfectly acceptable Maneuver for this situation (Figure 18).

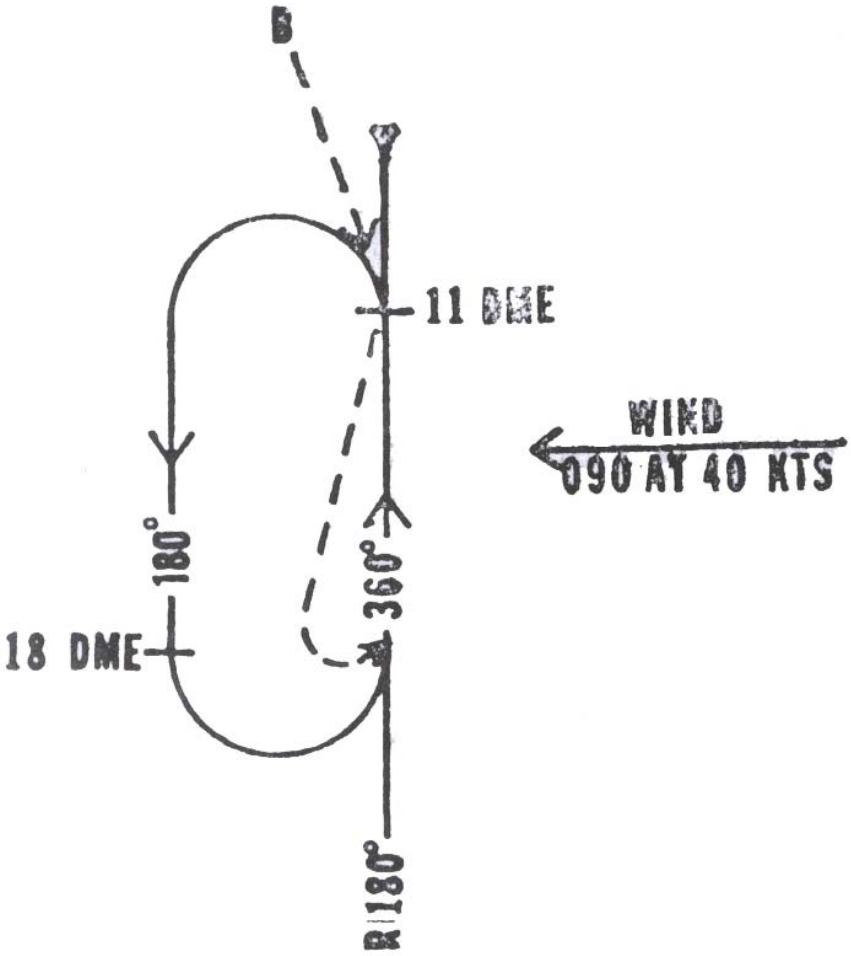


Figure 19

Aircraft B is to make one turn in holding. 2LT SHURE has called for an outbound parallel entry. After his initial turn to 180°, he notes a crosswind. He looks at his 12 needle and determines that his outbound parallel turn to the right will get him into trouble because he will drift to the right rather than parallelling the outbound course. He quickly analyzes his situation and calls for a left turn to offset his drift and to return to the holding course of 360°. He has saved the day by utilizing a modified teardrop turn.(Figure 19)

Keep these illustrations in mind for they are typical of the situations you may encounter. Be flexible and be ready to modify entry procedure if the need arises. However, it is more desirable that the wind be compensated for before modifications become necessary.

EXPECTED FURTHER CLEARANCE _(EFC)

An EFC is a time issued to you by an Air Traffic Controller. The time he gives you is the time that he expects to issue further clearance (i.e., another EFC or immediate clearance for your approach). If, after receiving an EFC, you should lose your radios, you are to hold until

your EFC expires. When it expires, leave holding, proceed to the IAF, and commence your approach.

Frequently, you will be cleared for a specific number of turns in holding in lieu of being given an EFC time. If, after receiving these instructions and clearance to commence the approach, you should lose your radios, execute the prescribed number of turns, proceed to the IAF and commence your approach.

Meeting An EFC Time

For example, if you have four minutes to the expiration of your EFC, you could fly a pattern in which each 180° turn takes one minute (3° of turn/second), and in which each of the legs requires one minute, making a total of four minutes. Any combination is acceptable, as long as you stay on the holding side of the radial, do not exceed the outer DME limit of the pattern, and fly the inbound course along the holding radial.

NON-DME HOLDING

When utilizing a navaid other than TACAN, or other DME equipped navaid, the procedures will vary somewhat. Because no distance reference is available without DME, you will have to time your legs.

The rules regarding timing legs are:

14,000' MSL and below	= 1 minute
Above 14,000' MSL	= 1 1/2 minutes

In the case of non-DME holding, the navaid, itself, is the holding fix. So, if you were told to hold utilizing a VOR or NDB station, you would hold directly over the navaid itself, and your inbound leg would be timed appropriately according to your altitude.

The holding clearance would retain the essential elements and might sound like this:

"1F47 hold east of Saufley VOR, 12,000'; left turns, EFC 1930Z." And the pattern would look like this:

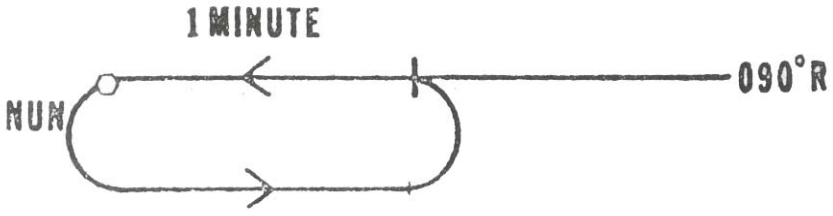


Figure 20

Headwind or Tailwind Corrections in a Timed Holding Pattern

After completing the first circuit of the holding pattern, adjust the time for the second outbound as necessary to achieve the desired inbound limit. For example, if the inbound leg were 30 seconds too long, subtract 30 seconds from the outbound leg. Say you're in holding at 12,000 feet, and you begin timing you outbound leg. At the expiration of your one minute timed leg, you make your turn to track inbound to the station. (You begin timing legs when the turns are complete, wings are level, and you are proceedings inbound or outbound on the desired track.) If it takes you one minute and thirty seconds to track inbound to your fix in this situation, you must subtract thirty seconds from your outbound leg to compensate for the wind factor.

For timed (non-DME) holding patterns, a method called the "6 T's" may help the student remember the procedures for entering and maintaining a holding pattern. They are:

1. TIME - Note the time and/or start the stopwatch when wings level or abeam the station (head of VCR needle passes 90 degree benchmark), whichever is last.

2. TURN - Turn in the appropriate direction to enter holding, or if already established in holding, turn when needed to fly the pattern.

3. TRANSITION - Slow to 120 KIAS. As the airspeed approaches 120 KIAS reset power as required to maintain 120 KIAS (approximately 450-500 FT-LBS). Retrim.

4. TWIST - Twist the holding course into the IND-350. This may be done any time after the initial turn, but must be completed prior to the inbound turn.

5. TALK - Give a voice report if required.

6. TRACK - Once established on the inbound leg, adjust heading as necessary to track the holding course (CDI bar should stay centered). If flying the outbound leg, simply maintain the outbound heading plus or minus the crab for wind (Note: the CDI bar will not be centered on the outbound leg).

We will see the "6 T's" again in Chapter 7 when timed approaches are covered.

SUMMARY

In this unit of instruction, you have learned the procedures to follow should you be required to hold during the approach or enroute phase of flight. You know that you must begin to slow to holding airspeed within three minutes or reaching the holding fix. Holding airspeed for the T-34 is 120 KIAS. For the T-39 it is 200 KIAS. You have learned that there are two types of holding patterns: standard (right hand turns) and nonstandard (left hand turns). You have also learned that there are three recommended ways to enter these patterns: direct entry, outbound parallel, and teardrop. These entry procedures may be modified if the need arises.

UNIT REVIEW

1. Holding is accomplished inbound to the_____.

   a. holding fix
   b. navaid

2. When established on the designated holding radial, should you be flying to the holding fix or away from holding fix?_____.

3. Unless otherwise published or instructed by ATC or any other controlling agency, all turns in holding will be_____turns.

4. List the times of the holding legs (in a non-DME holding pattern) for:

   a. 14,000 feet and below
   b. Above 14,000 feet

5. When do you slow to holding airspeed?_____.

6. Maximum holding airspeed for the T-39 aircraft is_____knots and_____knots for the T-34.

7. List three holding entry procedures.

   a._____.
   b._____.
   c._____.

8. Holding entries may be modified if necessary, but never lengthened._____.

   (True or False).

In questions 9-11, choose the proper holding pattern given the following clearances.

9. "OF21 HOLD NW OF THE NAVY PENSACOLA 097°R/35 DME, 10 MILE LEGS, FL 200. EXPECT FURTHER CLEARANCE AT 1710Z."

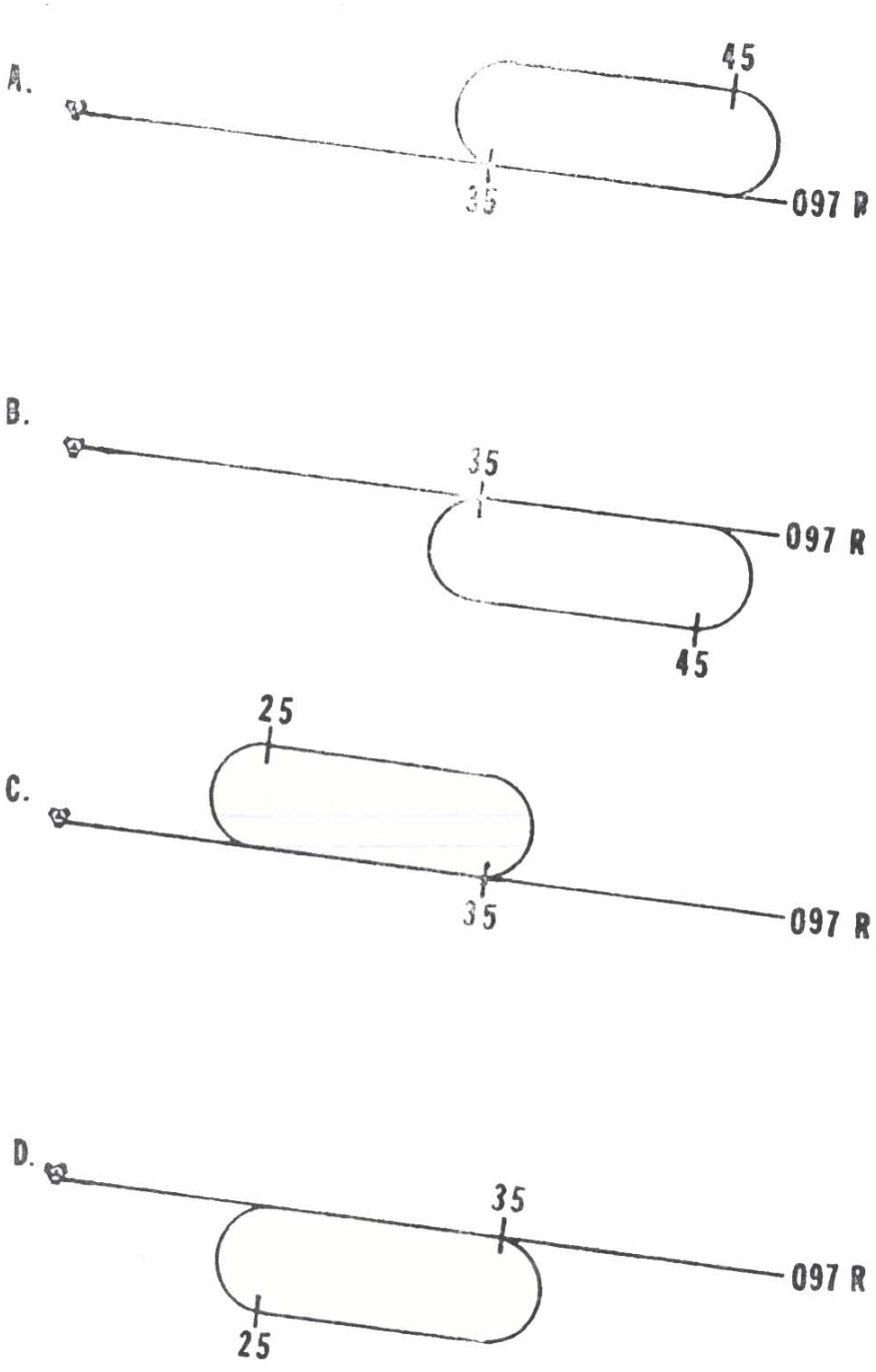


Figure 21

10. "1F53, HOLD ON THE NAVY PENSACOLA 280° R/30 NM, FROM 20 TO 30 MILES, NONSTANDARD TURNS, FL 190, EXPECT FURTHER CLEARANCE AT 0945Z." SKETCH THE DEPICTED HOLDING PATTERN.

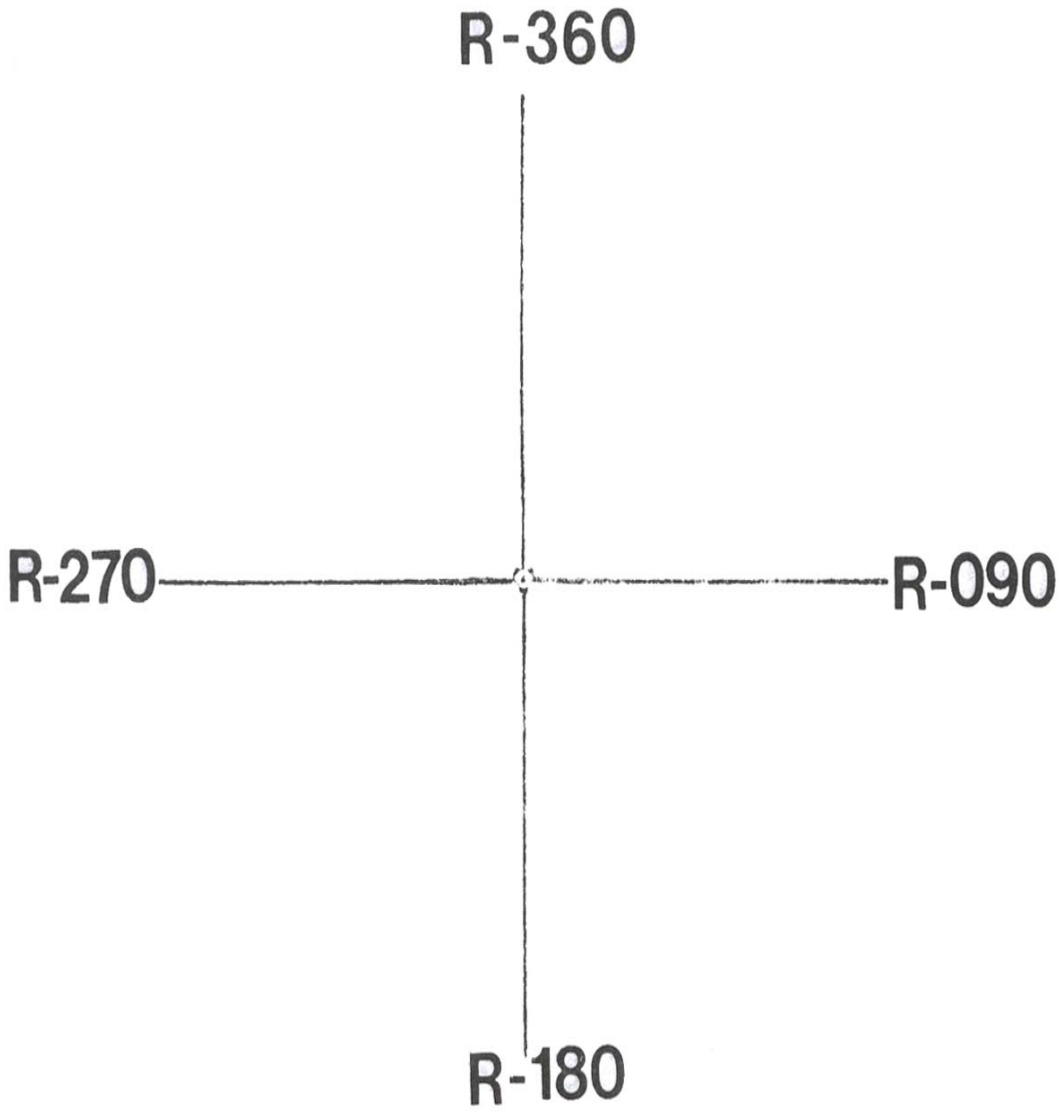


Figure 22

11. "NAVY 1F19, HOLD SE OF THE NAVY PENSACOLA 110°R/40 NM, 12 MILE LEGS, 13,000', NONSTANDARD TURNS. EXPECT FURTHER CLEARANCE AT 1500Z."

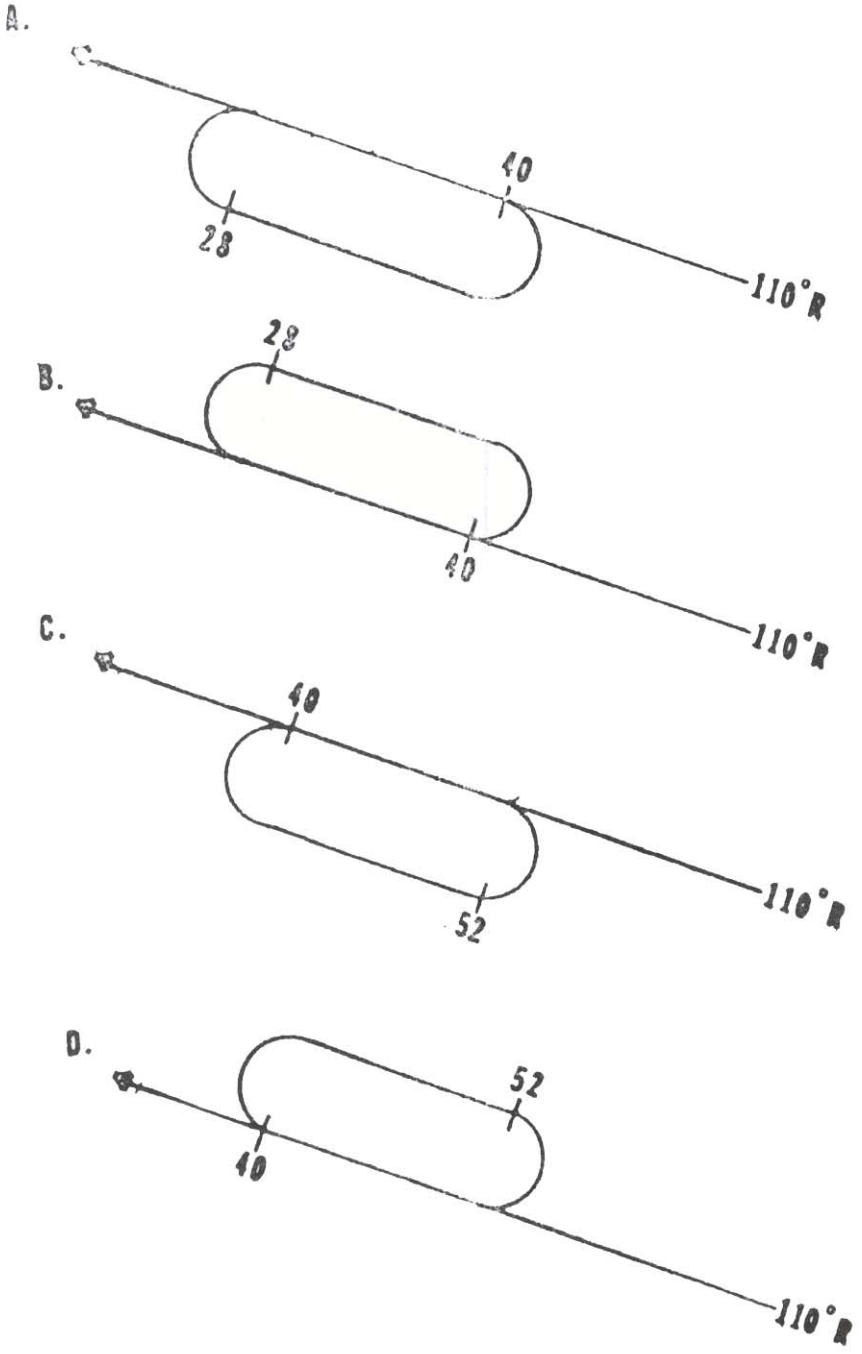


Figure 23

INSTRUCTIONS FOR PROBLEMS 12 THROUGH 15.

Each of the following pages presents a problem. For each problem you must determine two things: (1) the proper holding entry procedure and (2) the correct heading required to execute that procedure.

12. Refer to the approach plate below

Enter holding from Miami: a._____.
b._____.

Enter holding from Bimini:
c._____.
d._____.

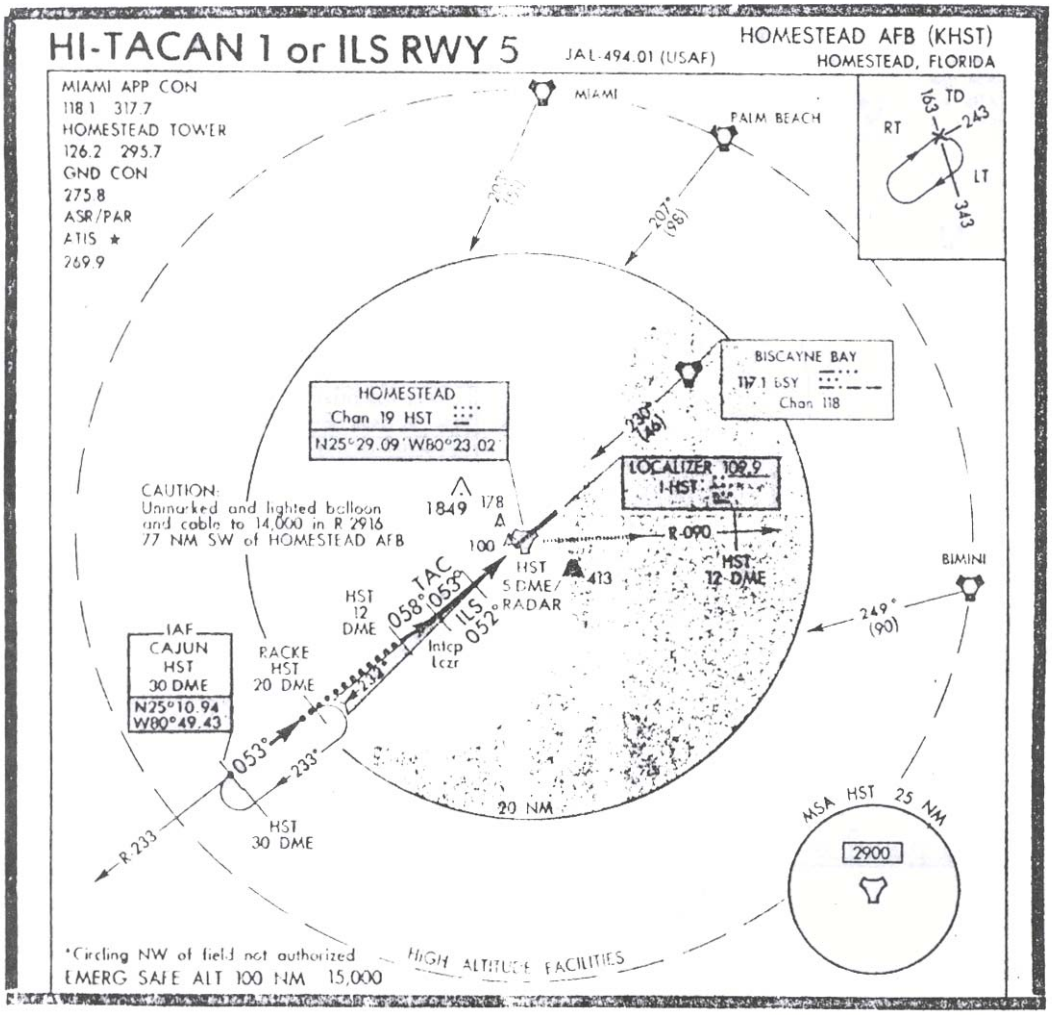


Figure 24

13. Refer to the approach plate below:

Enter holding from Montgomery: a._____.
b._____.

Enter holding from Jackson: c._____.
d._____.

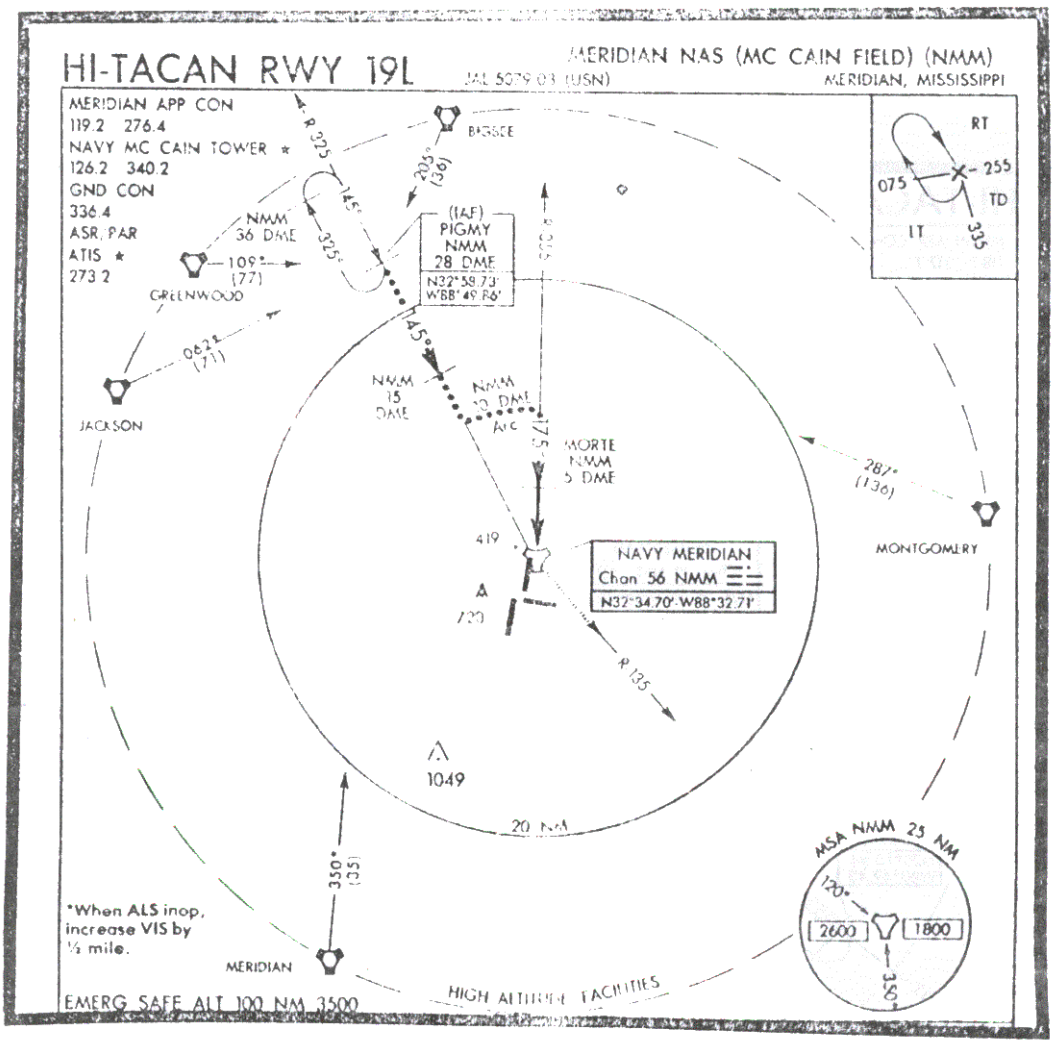


Figure 25

14. Refer to the approach plate below:

Enter holding from Macon: a._____.
b._____.

Enter holding from Tallahassee: c._____.
d._____.

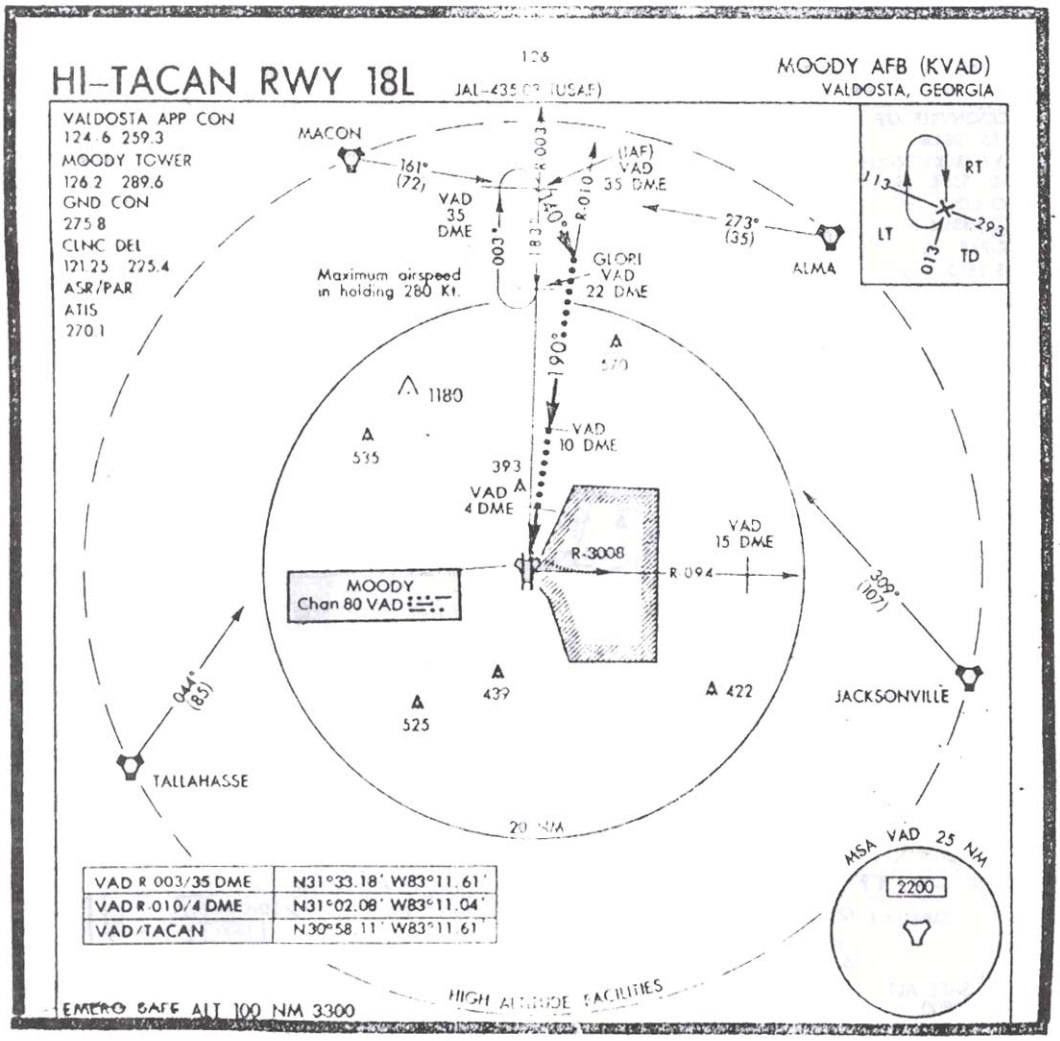


Figure 26

15. Refer to the approach plate below:

Enter holding from Taylor: a._____.
b._____.

Enter holding from Ormond Beach: c._____.
d._____.

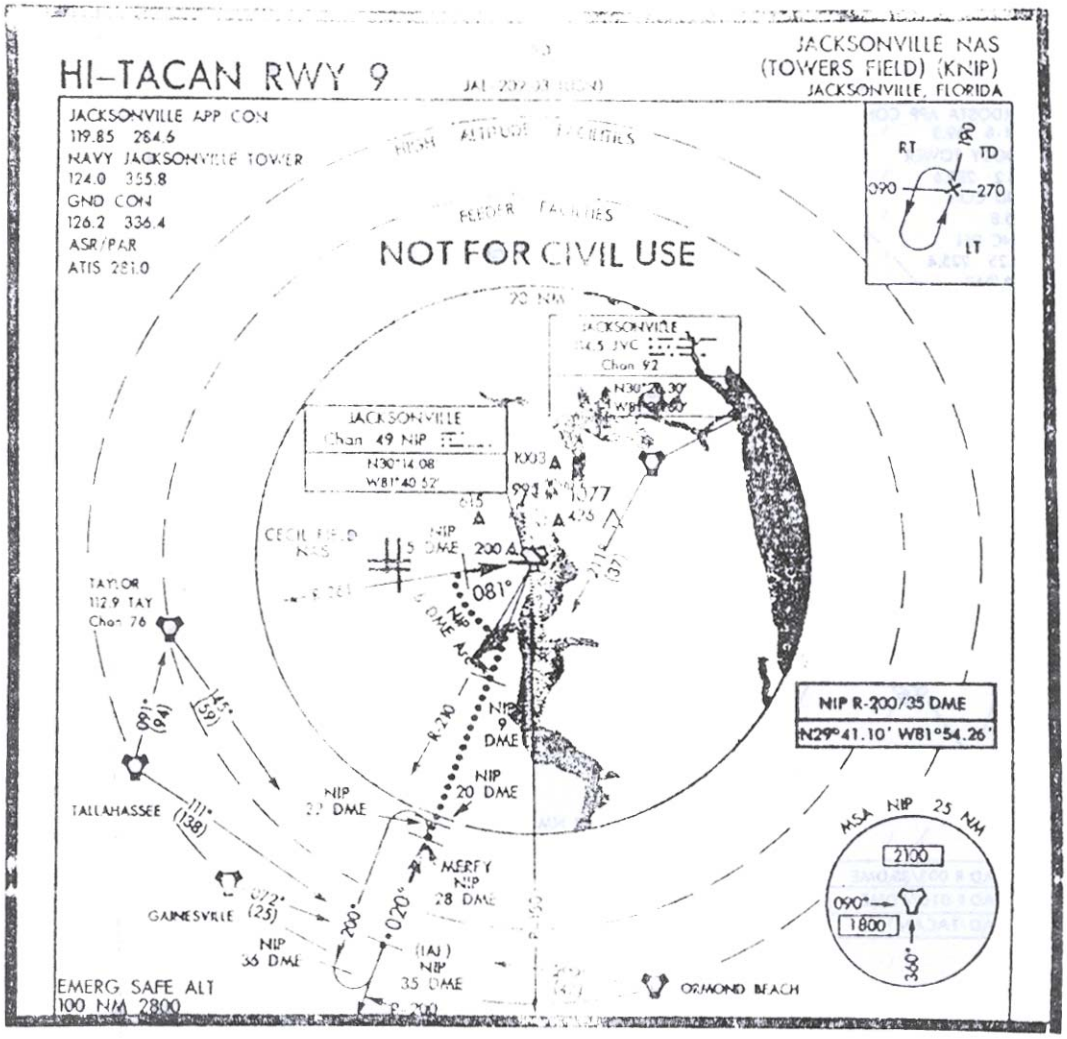


Figure 27

ANSWER SHEET

1. A

2. To the holding fix

3. Right

4. a. 1 minute
   b. 1 1/2 minute

5. Approximately 3 minutes prior to crossing the holding fix.

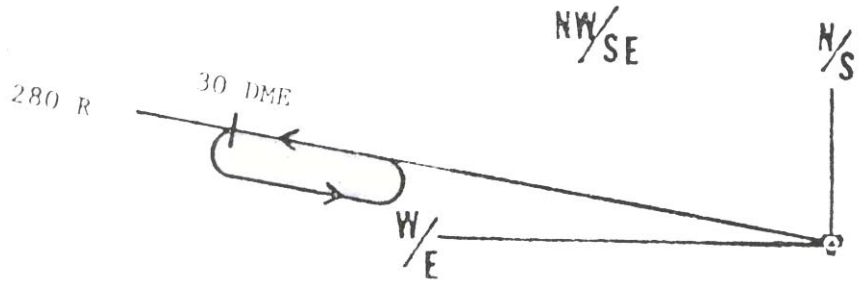
6. 230 knots; 175 KTS

7. a. Direct
   b. Teardrop
   c. Outbound Parallel

8. True

9. D

10.



11. C

12. a. Teardrop
    b. 203°
    c. Outbound Parallel
    d. 233°

13. a. Teardrop
    b. 295°
    c. Outbound Parallel
    d. 325°

14. a. Direct Entry
    b. 003
    c. Outbound Parallel
    d. 003

15. a. Outbound Parallel
    b. 200°
    c. Direct Entry
    d. 200°

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INAV 7: INSTRUMENT DEPARTURES AND APPROACHES

Terminal Objectives, Enabling Objectives and Enabling Steps are established by CNATRAINST 1542.54.

TERMINAL OBJECTIVE

C. Navigate an aircraft via visual references and navigation instruments with the assistance of a flight instructor.

ENABLING OBJECTIVES:

C.5. Fly a standard instrument departure, given radio aids to navigation and flight information publications (FLIP), with instructor assistance as required, within 8 degrees on 3 NM of course.

C.6. Fly a radio instrument and ground controlled approach, given radio aids to navigation and flight information publications (FLIP), with instructor assistance is required, within 8 degrees on 3 NM of course.

SKILLS DEVELOPMENT UNIT: This academic unit of instruction interfaces with flights B-3. through B-5.

MODE OF INSTRUCTION: This unit is a classroom lecture presentation designed to acquaint you with flying the TACAN Point-to-Point.

INSTRUCTIONAL AIDS

1. RMI Model
2. Chalkboard
3. CR-2

REFERENCES:

NATOPS Instrument Flight Manual

DEPARTURES

Introduction

A Standard Instrument Departure (SID) is a procedure to effect a safe climbout from an airport under instrument conditions and to provide safe separation between aircraft. The SID is a preplanned, IFR departure route. It provides the following advantages:

a. Graphic portrayal of departure route.

b. Reduce time delay and radio communications required to issue clearances.

c. Provides approved ATC departure route clearance in the event of radio failure.

d. Can be designed to support noise abatement programs.

Planning for the route of flight is an integral part of preflight preparation. Since, in most cases, ATC will issue clearance as filed, it is an advantage to file for a SID because it enables the NFO to anticipate the instructions. The departure plate must be studied thoroughly for headings, courses, and altitude restrictions. Figure 1 is an example of typical "Pilot NAV" SID, in which the aircrew is responsible for navigation. Other SIDS, labeled VECTOR, do not require aircrew navigation beyond an initial heading.

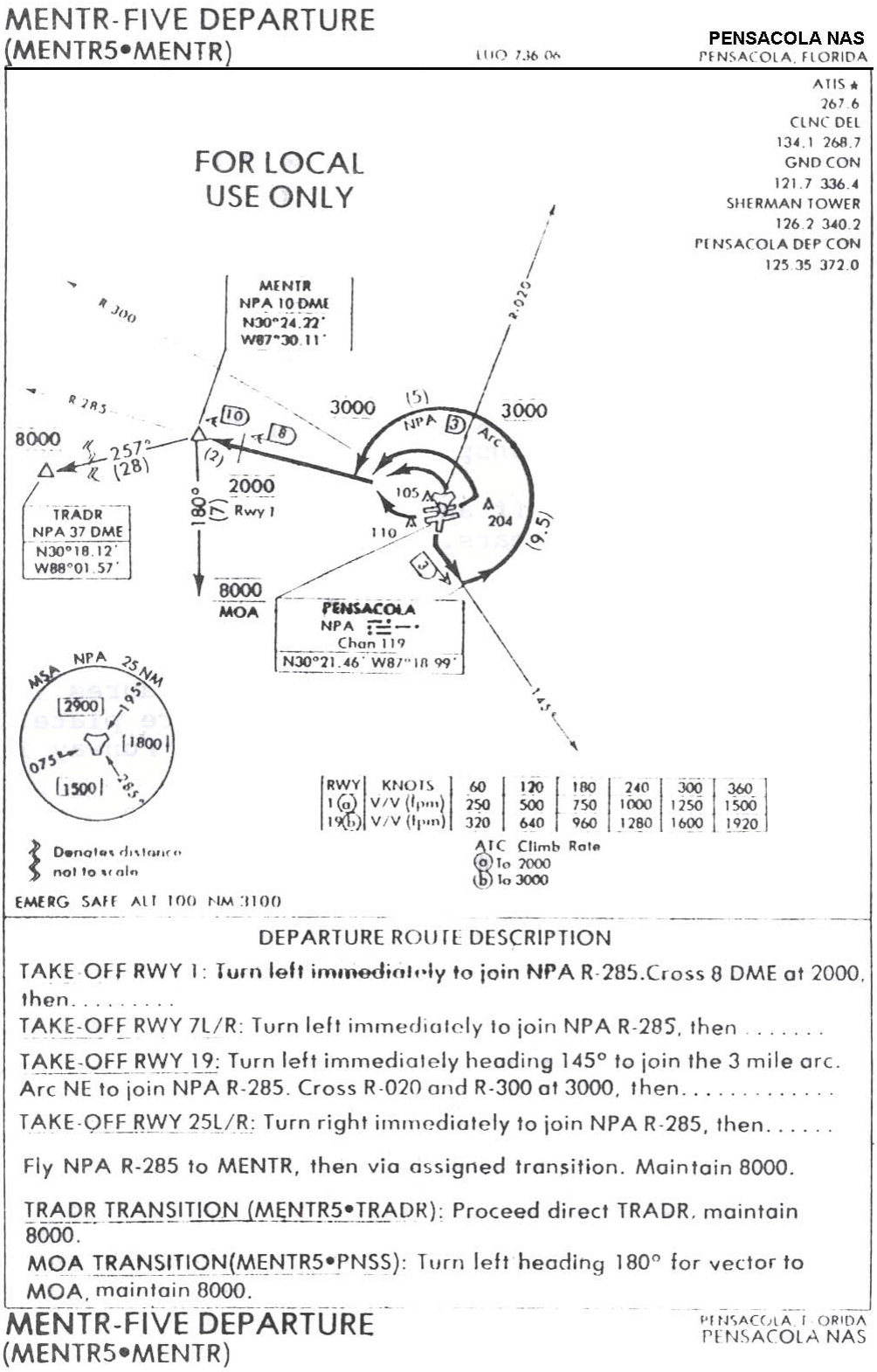

MENTR-FIVE DEPARTURE
(MENTR5•MENTR)
LUO 7.36 06
PENSACOLA NAS
PENSACOLA, FLORIDA
ATIS ★
267.6
CLNC DEL
134.1 268.7
GND CON
121.7 336.4
SHERMAN TOWER
126.2 340.2
PENSACOLA DEP CON
125.35 372.0
FOR LOCAL
USE ONLY
MENTR
NPA 10 DME
N30°24.22'
W87°30.11'
R 300
R 285
R 020
8000
257°
(28)
3000
(5)
NPA
3
Arc
3000
10
8
(2)
2000
180°
Rwy 1
105
204
110
(9.5)
TRADR
NPA 37 DME
N30°18.12'
W88°01.57'
8000
MOA
PENSACOLA
NPA
Chan 119
N30°21.46' W87°18.99'
145°
MSA NPA 25 NM
2900
1800
1500
195°
075°
285°
Denotes distance
not to scale
RWY | KNOTS | 60 | 120 | 180 | 240 | 300 | 360
1(a) | V/V (fpm) | 250 | 500 | 750 | 1000 | 1250 | 1500
19(b) | V/V (fpm) | 320 | 640 | 960 | 1280 | 1600 | 1920
ATC Climb Rate
(a) To 2000
(b) To 3000
EMERG SAFE ALT 100 NM 3100
DEPARTURE ROUTE DESCRIPTION
TAKE-OFF RWY 1: Turn left immediately to join NPA R-285.Cross 8 DME at 2000, then. . . . . .
TAKE-OFF RWY 7L/R: Turn left immediately to join NPA R-285, then . . . . . .
TAKE-OFF RWY 19: Turn left immediately heading 145° to join the 3 mile arc. Arc NE to join NPA R-285. Cross R-020 and R-300 at 3000, then. . . . . .
TAKE-OFF RWY 25L/R: Turn right immediately to join NPA R-285, then. . . . . .
Fly NPA R-285 to MENTR, then via assigned transition. Maintain 8000.
TRADR TRANSITION (MENTR5•TRADR): Proceed direct TRADR, maintain 8000.
MOA TRANSITION(MENTR5•PNSS): Turn left heading 180° for vector to MOA, maintain 8000.
MENTR-FIVE DEPARTURE
(MENTR5•MENTR)
PENSACOLA, FLORIDA
PENSACOLA NAS

Figure 1

PROCEDURE

1. Tune and identify the required radio facility (TACAN channel 119 for the MENTR-FIVE departure). VOR and TACAN stations are subject to line of sight limitations so you may be unable to receive them before takeoff. Therefore leave the navaid audio switch forward until you have received a good ident. If neither VOR nor TACAN are required by the assigned departure procedure, it is prudent to leave one tuned to the departure airfield station to expedite and emergency recovery.

2. Set the appropriate course in the IND-350 (285 in this case). Check that the VOR-TACAN switch is in the correct position (TACAN in this case).

3. Set assigned squawk into transponder. Approaching the hold short line, switch transponder to "ALTITUDE".

4. During the takeoff and climbout, observe that the NAv flag in the IND-350 disappears. Establish your scan.

5. Make initial contact with Departure Control once safely airborne.

6. Continue enroute following the procedures listed under the departure route description on the departure plate. In the specific case of the MENTR-FIVE departure from runway 19 you will proceed as follows:

   a. Turn left at a standard rate (approximately 25° AOB) to a heading of 145°. Continue climbing to 3000 feet MSL.

   b. Turn left to intercept the 3 DME arc (don't forget to turn at the proper lead point!)

   c. Arc at 3 DME as discussed in Chapter 4. Ensure you are level at 3000 feet MSL by the 020 radial.

   d. Passing the 300 radial, start a climb to 8000 feet MSL.

   e. Turn right (at the proper lead point) to join the 285 radial and track it outbound to MENTR.

Common Errors

1. Forgetting to set up radios and transponder for the departure prior to takeoff.
2. Not setting up navaids properly, i.e:

   a. Not twisting departure course in the IND-350, and not checking that the VOR-TACAN switch is in the proper position.

   b. Not switching to the T/R position on the TACAN. You must be in the T/R position to receive DME information.

   c. Not identifying the station you tune. You must always identify each station you tune by having the proper audio switch forward.

INSTRUMENT APPROACH PLATES

Each instrument approach plate consists of four sections: planview, profile view, landing minimum section (and notes), and airport sketch. Refer to Figures 2 and 3, the VOR RWY 19 approach at NAS Pensacola and the VOR-A or TACAN at Dothan.

FORMAT

1. Margin Identification - The approach name is derived from the type facility providing final approach course guidance. The runway number is included when the final approach course is within 30° of runway centerline (ex: VOR RWY 19) or a sequential letter code is included when the final approach course is more than 30° from the runway centerline (ex: VOR-A or TACAN).

a. VOR/DME in the margin means that both VOR and DME receivers and ground equipment are required to execute the approach. The procedure is not authorized when either VOR or DME is inoperative. TACAN azimuth is to authorized for course guidance.

b. VOR/DME or TACAN in the margin means the procedure may be executed using VOR or TACAN azimuth for course guidance and DME is required.

c. VOR OR TACAN in the margin means a VOR instrument approach using a VORTAC facility has been approved for use by TACAN equipped aircraft. In Figure 3 the procedure turn could be executed using either VOR or TACAN azimuth to position the aircraft on final approach or if DME equipped, an arcing maneuver could be used with VOR or TACAN azimuth on final approach.

2. Planview - This is a bird's eye view of the approach procedure, including procedure turn or another specified initial approach segment, minimum safe altitudes, courses for the final approach segment, obstructions, and navigation and communication frequencies. Data shown within the distance circle (normally 10 NM) is always shown to scale. Dashed circles are used to indicate needed information for the procedure which will not fit to scale within the plan view and include Enroute Facilities (low altitude airways navaids, fixes, and intersections shown in their relative position around the approach facility) and Feeder Facilities (navaids, fixes, and intersections used by ATC to direct aircraft to intervening fixes between the enroute structure and the initial approach fix, Figure 3).

"ASR" or "PAR" listed below the communications information indicates that radar approaches and radar vectors to final approach course are available. The term "Radar Vectoring" means that vectors to final approach course are available, but radar approaches are not.

3. Profile View - shows a side view of approach procedures (Figure 4). The profile contains:

a. Initial approach fix altitude (not specified for all approaches).

b. Procedure turn altitude.

c. Final Approach Fix altitude.

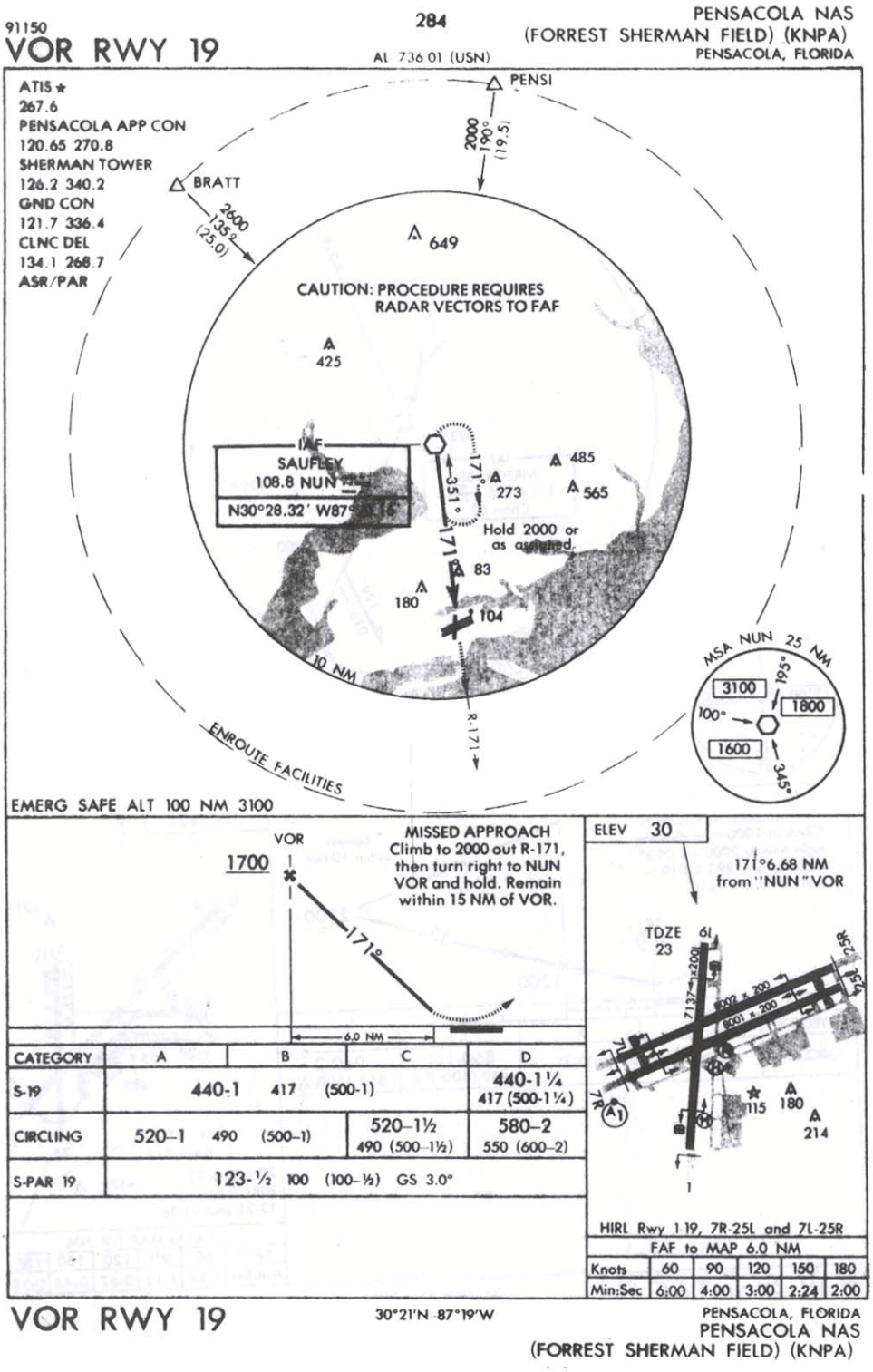

91150
VOR RWY 19
284
AL 736.01 (USN)
PENSACOLA NAS
(FORREST SHERMAN FIELD) (KNPA)
PENSACOLA, FLORIDA
ATIS ★
267.6
PENSACOLA APP CON
120.65 270.8
SHERMAN TOWER
126.2 340.2
GND CON
121.7 336.4
CLNC DEL
134.1 268.7
ASR/PAR
PENSI
BRATT
2000
190°
(19.5)
2600
135°
(25.0)
649
CAUTION: PROCEDURE REQUIRES
RADAR VECTORS TO FAF
425
IAF
SAUFLEY
108.8 NUN
N30°28.32' W87°
171°
351°
485
273
565
Hold 2000 or
as assigned.
83
180
104
10 NM
R-171
ENROUTE FACILITIES
MSA NUN 25 NM
195°
3100
1800
100°
1600
345°
EMERG SAFE ALT 100 NM 3100
VOR
1700
171°
MISSED APPROACH
Climb to 2000 out R-171,
then turn right to NUN
VOR and hold. Remain
within 15 NM of VOR.
6.0 NM
ELEV 30
171°6.68 NM
from "NUN" VOR
TDZE
23
61
25R
25L
7137 x 200
8001 x 200
7R
7L
115
180
214
HIRL Rwy 1-19, 7R-25L and 7L-25R
FAF to MAP 6.0 NM
Knots 60 90 120 150 180
Min:Sec 6:00 4:00 3:00 2:24 2:00
CATEGORY A B C D
S-19 440-1 417 (500-1) 440-1¼ 417 (500-1¼)
CIRCLING 520–1 490 (500–1) 520–1½ 490 (500–1½) 580–2 550 (600–2)
S-PAR 19 123-½ 100 (100–½) GS 3.0°
VOR RWY 19
30°21'N-87°19'W
PENSACOLA, FLORIDA
PENSACOLA NAS
(FORREST SHERMAN FIELD) (KNPA)

Figure 2

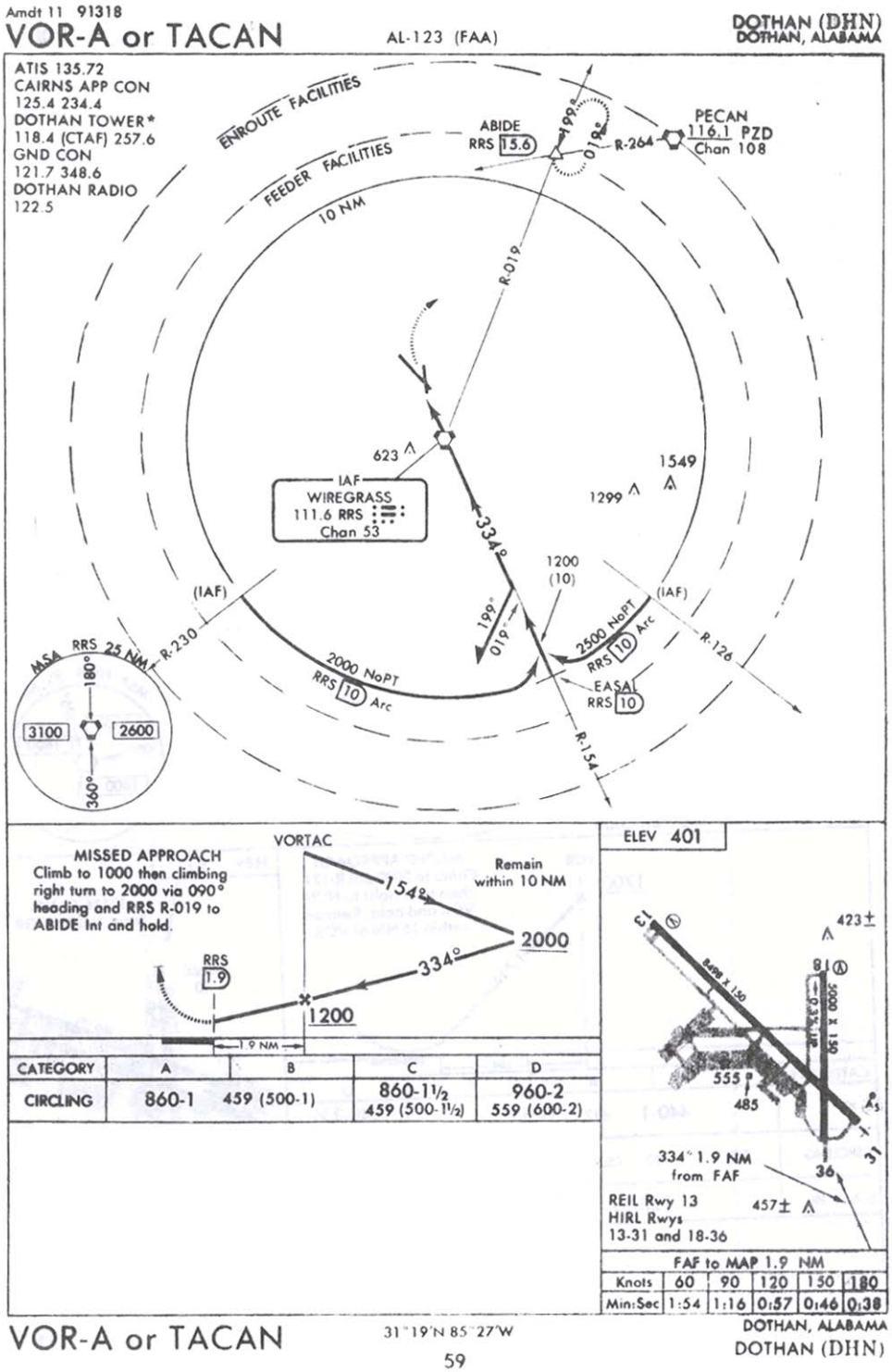

Amdt 11 91318
VOR-A or TACAN
AL-123 (FAA)
DOTHAN (DHN)
DOTHAN, ALABAMA
ATIS 135.72
CAIRNS APP CON
125.4 234.4
DOTHAN TOWER*
118.4 (CTAF) 257.6
GND CON
121.7 348.6
DOTHAN RADIO
122.5
ENROUTE FACILITIES
FEEDER FACILITIES
10 NM
ABIDE
RRS 15.6
PECAN
116.1 PZD
Chan 108
R-264
199°
019°
R-019
623
1549
1299
IAF
WIREGRASS
111.6 RRS
Chan 53
334°
1200
(10)
(IAF)
(IAF)
199°
019°
2500 NoPT
RRS 10 Arc
2000 NoPT
RRS 10 Arc
EASAL
RRS 10
R-126
R-154
R-230
MSA RRS 25 NM
180°
3100
2600
360°
MISSED APPROACH
Climb to 1000 then climbing right turn to 2000 via 090° heading and RRS R-019 to ABIDE Int and hold.
VORTAC
Remain within 10 NM
154°
2000
334°
RRS 1.9
1200
1.9 NM
ELEV 401
423±
8000 X 150
3500 X 150
555
485
334° 1.9 NM from FAF
36
31
REIL Rwy 13
HIRL Rwys 13-31 and 18-36
457±
FAF to MAP 1.9 NM
Knots 60 90 120 150 180
Min:Sec 1:54 1:16 0:57 0:46 0:38
CATEGORY A B C D
CIRCLING 860-1 459 (500-1) 860-1½ 459 (500-1½) 960-2 559 (600-2)
VOR-A or TACAN
31°19'N 85°27'W
DOTHAN, ALABAMA
DOTHAN (DHN)
59

Figure 3

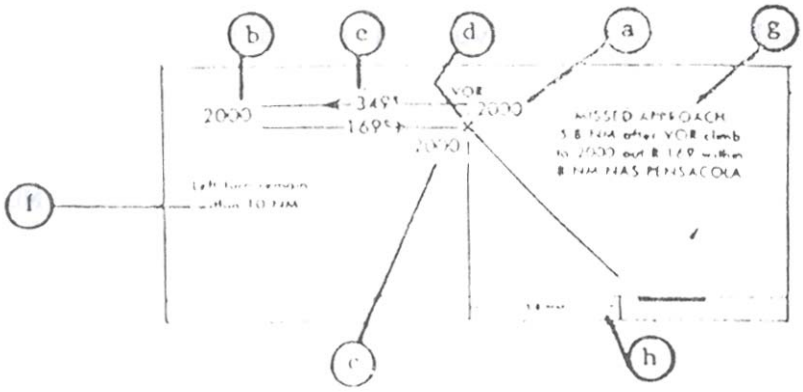


Figure 4

d. Final Approach Fix (FAF) symbol; denotes location of

e. Course information.

f. Procedure turn maneuvering area; procedure turn must be completed within this distance.

g. Missed approach procedures.

h. Missed approach. point.

4. Minimum section - found just below the profile view (Figure 5).

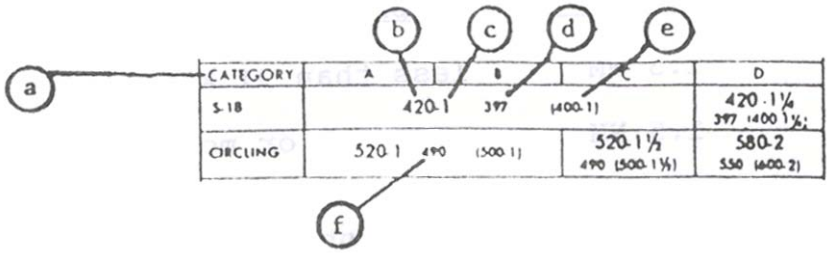


Figure 5

a. Aircraft Approach Category.

b. Minimum descent altitude (MDA); expressed as an MSL altitude. Descent below this altitude is unauthorized until the runway environment is in sight, the aircraft is past the Visual Descent Point (if required), and the pilot can maneuver safely to a landing.

c. Visibility required for the approach in statute miles. RVR in hundreds of feet may be given in place in visibility for an approach to a straight-in landing.

d. Height above touchdown (HAT): height of MDA (or DH) above the touchdown zone elevation (used with straight-in mins).

e. Ceilings - visibility: used for filing purposes and commencing an approach.

f. Height above Airport (HAA): height of MDA above published airport elevation (used for circling mins).

NOTE: In the landing mins section large type altitudes (b) are MSL: (d, e, etc.) are AGL.

NOTE: HAT is associated with straight-in approaches. HAA is associated with circling approaches. MDA is associated with non-precision (no glideslope) approaches.

5. Aircraft Approach Category - a grouping of aircraft based on an approach speed of 1.3 times to stall speed in a the landing configuration at maximum gross weight. Each category provides 300 feet of obstacle clearance at MDA within the circling radius (Figure 6).

Aircraft Category	Obstruction Clearance Radius	Approach Speed (KIAS)
A	1.3 NM	less than 91 knots
B	1.5 NM	91 knots or more but less than 121 knots
C	1.7 NM	121 knots or more but less than 141 knots
D	2.3 NM	141 knots or more but less than 166 knots
E	4.5 NM	166 knots or more (refer to FAR Parts 1 and 95)

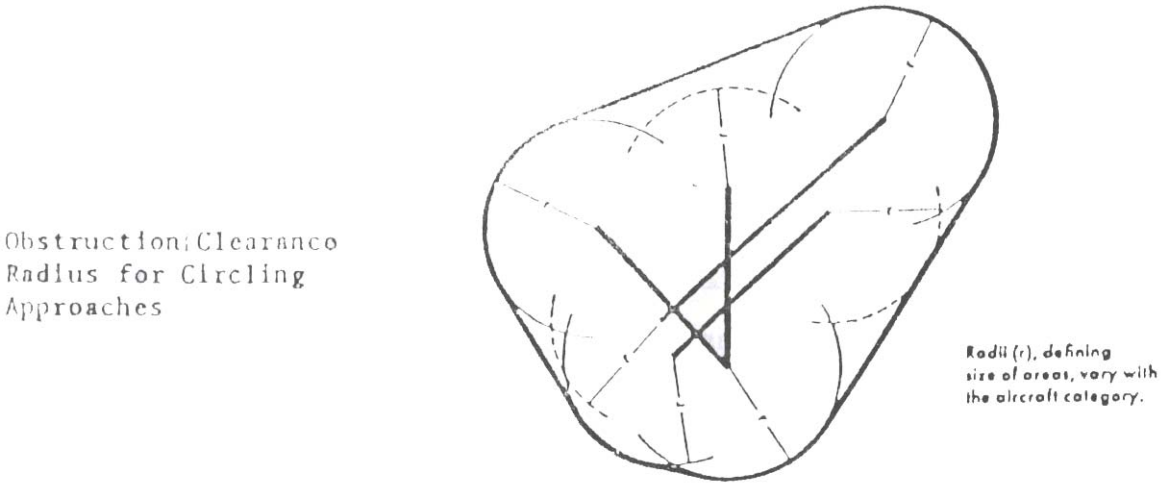


Figure 6

NOTE: The T-34C is an Approach Category B aircraft

6. An airport sketch (Figure 7) is provided on each approach plate in the bottom right-hand corner. It shows the runways, taxiways, control tower, vertical obstructions, and the field elevation. All elevations are in feet above Mean Sea Level (MSL). Note the arrow which depicts the aircraft track as it nears the field on Final Approach Course. It may include other information such as airport lighting, arresting gear, or displaced thresholds.

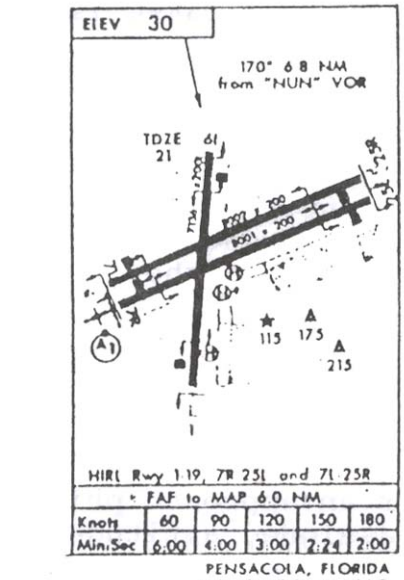


Figure 7

Note the "FAF to MAP" timing at the bottom of the airport sketch. This table is used to determine the time to the missed approach point from the Final Approach Fix at various ground speeds. Ground speed must be estimated. Example: With an approach speed of 120k and 15k of headwind, ground speed becomes 105k with timing (Figure 7) of 3:30.

LOW ALTITUDE INSTRUMENT APPROACHES

Introduction - An instrument approach enables an aircraft to transition from instrument flight conditions to a visual landing while providing terrain clearance and separation from other aircraft. There are a number of low altitude instrument approach procedures which may be executed with the navigation equipment in the T-34C. These include procedure turn, teardrop, holding pattern, straight-in, and arc and radial combination approaches which use VOR, DME, TACAN or a combination thereof to define the approach. Radar vectors to final approach course is an additional procedure which may be applied to any of the above approaches.

Procedure

1. Prior to departure familiarize yourself with the destination instrument approach procedures (IAP's) compatible with aircraft navigational aids. Check forecast weather conditions against weather minimums listed on the approach plate and choose a suitable alternate. Enroute, review the approach procedures and check the destination ATIS.

2. Determine whether the duty runway requires straight-in or circling minimums, then compare current weather and the weather minimums for the approach. The T34-C is considered a single-piloted aircraft. Therefore, you may not commence an instrument approach if either

ceiling or visibility is reported to be below minimums, but must request an approach with acceptable weather minimums or clearance to your alternate.

NOTE: At some point prior to reaching the missed approach point, the crew shall review the missed approach procedure.

3. Normally, ATC will switch you form Center frequencies to Approach frequencies in the vicinity of your destination. Initiate contact with Approach Control using the standard format.

4. When cleared for an approach prior to the IAF do not descend below the last assigned altitude unless:

a. A new altitude is assigned by ATC.

b. The aircraft is established on a segment of a published feeder route or instrument procedure. (For aircraft on an unpublished route or radar vectors, ATC should not issue approach clearance until the aircraft is so established unless they also give an altitude assignment.)

PROCEDURE TURN APPROACH

Introduction - A procedure turn approach is an instrument maneuver used to reverse direction to establish an aircraft inbound on the intermediate or final approach course. Procedure turns are depicted by a "barb" symbol on the approach plates which indicates on which side of the outbound course using to complete the turn (figure 8). Headings are provided to reverse course using a 45° type maneuver. However, the point at which the turn may be commenced, and the type and rate of turn, are left to the discretion of the pilot as long as the procedure turn is executed on the proper side of the outbound course and the "Remain Within" distance (normally 10 NM) is not exceeded. Some of the options are the 45° procedure turn, the racetrack pattern, the teardrop procedure turn, or the 80°-260° course reversal.

NOTE: When a teardrop procedure is depicted (figure 9) and a course is required, this type turn must be executed.

Do not execute a procedure turn when:

1. Radar vectors to the final approach course are provided.
2. A holding pattern is specified in lieu of a procedure turn (Figure 10).
3. Approach can be made from a properly aligned holding pattern (Figure 11).
4. The procedure specifies "No PT," no procedure turn.
5. The planview does not depict a procedure turn "barb" symbol.

Procedure - The following procedures assume clearance for the VOR RWY 5 approach at Greenwood (Figure 8) has been received and you are proceeding to GRW (the IAF) at 4000 ft.

1. At the IAF, indicated by station passage, execute the 6 T's:

   a. TIME - Start the clock's sweep second hand for two minutes of outbound timing when wings level or abeam the station whichever occurs last.

   b. TURN - Int the shortest direction to parallel the outbound course (256°).

   c. TRANSITION - Slow to 120 knots. Approaching 120 knots lower the nose and descend at 120 knots to the procedure turn a altitude (2500 ft).

   d. TWIST -

Set the outbound course (256°) in the IND-350.

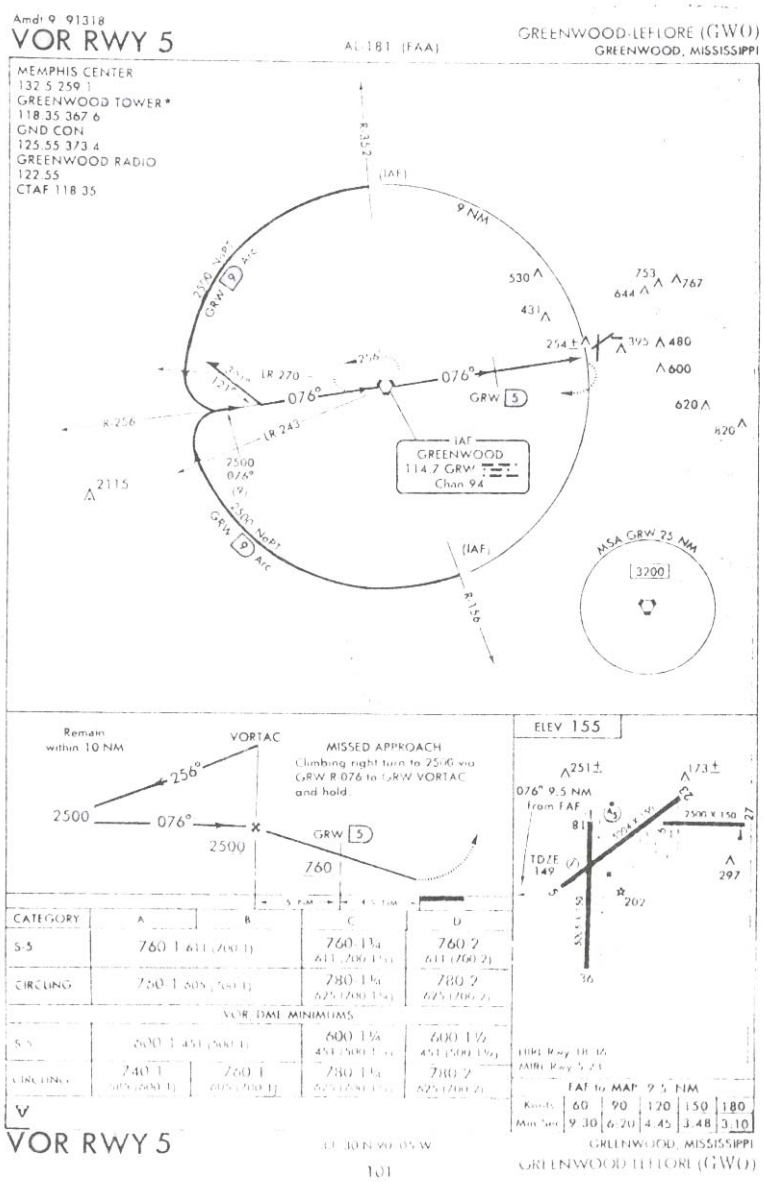


Figure 8

TEARDROP APPROACH

Introduction - A teardrop approach is a type of procedure turn which uses an outbound to inbound radial intercept maneuver to reverse course and establish the aircraft inbound on the intermediate and final approach course. Do not exceed the "Remain Within" distance. The teardrop approach is usually a timed approach.

Teardrop approaches are not very common in the low altitude approach plates, however in the FLIP High Altitude IAP's the teardrop maneuver is often used with non-DME penetrations.

Procedure - You have received clearance direct to the Cecil VOR, maintain 4000, cleared for the VOR-A approach to Navy Jacksonville (Figure 9).

1. At the IAF, indicated by station passage, execute the "6 T's":

   a. TIME - Start the clock's sweep second hand for three minutes outbound timing when wings level or abeam the station, whichever occurs last. (Three minutes, at 120 KIAS, will put your teardrop turn at six miles.)

   b. TURN - Turn in the shortest direction to parallel the outbound course (263°).

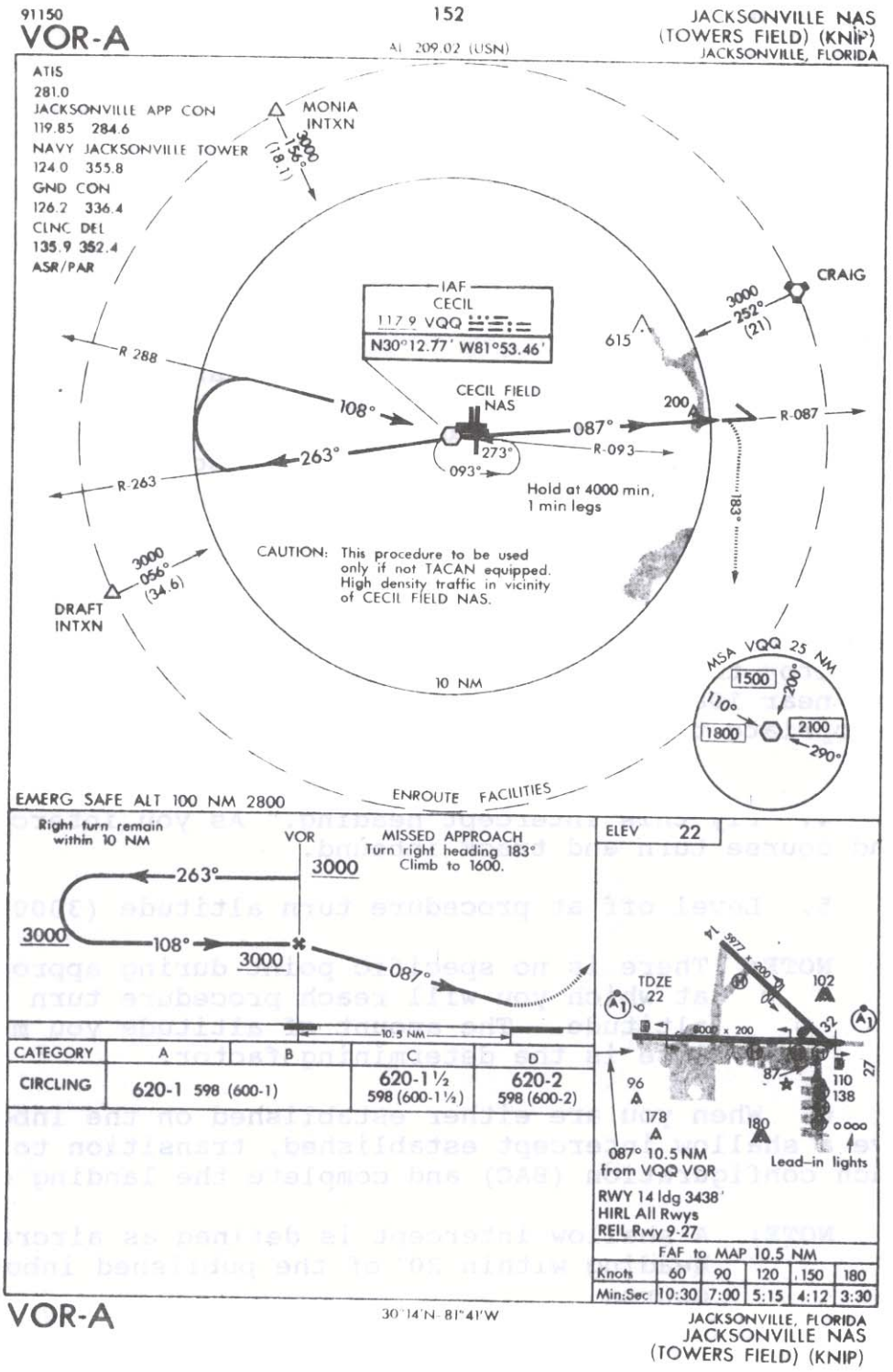

91150
VOR-A
152
AL 209.02 (USN)
JACKSONVILLE NAS
(TOWERS FIELD) (KNIP)
JACKSONVILLE, FLORIDA
ATIS
281.0
JACKSONVILLE APP CON
119.85 284.6
NAVY JACKSONVILLE TOWER
124.0 355.8
GND CON
126.2 336.4
CLNC DEL
135.9 352.4
ASR/PAR
MONIA
INTXN
3000
156°
(18.1)
IAF
CECIL
117.9 VQQ
N30°12.77' W81°53.46'
CRAIG
3000
252°
(21)
615
R 288
108°
CECIL FIELD
NAS
087°
200
R-087
263°
273°
R-093
093°
R-263
Hold at 4000 min,
1 min legs
183°
CAUTION: This procedure to be used
only if not TACAN equipped.
High density traffic in vicinity
of CECIL FIELD NAS.
3000
056°
(34.6)
DRAFT
INTXN
10 NM
MSA VQQ 25 NM
1500
200°
110°
1800
2100
290°
EMERG SAFE ALT 100 NM 2800
ENROUTE FACILITIES
Right turn remain
within 10 NM
VOR
MISSED APPROACH
Turn right heading 183°
Climb to 1600.
263°
3000
3000
108°
3000
087°
10.5 NM
CATEGORY
A
B
C
D
CIRCLING
620-1 598 (600-1)
620-1 ½
598 (600-1 ¼)
620-2
598 (600-2)
ELEV 22
TDZE
22
5977 x 200
14
8000 x 200
32
102
27
96
87
110
138
178
180
087° 10.5 NM
from VQQ VOR
Lead-in lights
RWY 14 ldg 3438'
HIRL All Rwys
REIL Rwy 9-27
FAF to MAP 10.5 NM
Knots 60 90 120 150 180
Min:Sec 10:30 7:00 5:15 4:12 3:30
VOR-A
30°14'N-81°41'W
JACKSONVILLE, FLORIDA
JACKSONVILLE NAS
(TOWERS FIELD) (KNIP)

Figure 9

c. TRANSITION - make a level speed change to 120 knots. Approaching 120 knots, lower the nose and descend at 120 knots to 3000’.

d. TWIST - Set the outbound course (263°) in the IND 350.

e. TALK - give the appropriate voice report:

SNFO: "Jax Approach, Turbo 11, VOR outbound, leaving 4000."

APP CONT: "Navy Turbo 11, Jax Approach, roger report turn inbound."

SNFO: "Turbo 11, wilco."

f. TRACK - If you are not established on the outbound course (CDI centered and tail of the needle on 263°) turn to get there and track outbound on the 263° radial. It is important to get established on course as soon as possible.

2. After 2 1/2 minutes of outbound timing, twist the inbound course into the IND-350. (108°).

3. At three minutes of outbound timing, execute a turn in the direction depicted (right). During the last 20 degrees of turn monitor the head of the needle. If it is not going to be on or very near 108, roll out early or continue the turn, whichever is appropriate to establish a correction to the 108 course inbound.

4. Fly this intercept heading. As you intercept the inbound course turn and track inbound.

5. Level off at procedure turn altitude (3000).

NOTE: There is no specific point during approach at which you will reach procedure turn altitude. The amount of altitude you must lose is the determining factor.

6. When you are either established on the inbound course or have a shallow intercept established, transition to the basic approach configuration (BAC) and complete the landing checklist.

NOTE: A shallow intercept is defined as aircraft heading within 20" of the published inbound course

7. Report procedure turn inbound after the transition to BAC. This report is given only when requested by the controller.

a. Procedure turn inbound report where radio facility is not located at the field:

SNFO: "Approach, Turbo 11, turning around".

APP CONT: "Navy Turbo 11, Jax Approach, roger, contact Tower 355.8 at VOR inbound".

SNFO: "Turbo 11, tower on 355.8, when inbound".

b. Procedure turn inbound report where radio facility is located at the field:

SNFO:	"Approach, Turbo 11, procedure turn inbound."
APP CONT:	"Turbo 11, Jax Approach, roger, contact Navy Jax Tower 355.8."
SNFO:	"Turbo 11, roger, tower on 355.8."
SNFO:	(After switching to 355.8) "Tower, Turbo 11, procedure turn inbound, gear down, full stop."
TOWER:	"Turbo 11, Navy Jax tower, cleared to land runway 09"
SNFO:	"Turbo 11, roger, cleared to land runway 09"

8. Maintain the aircraft on the inbound course to the station at the minimum altitude, 3000 feet. (If the station is located at the field, you will descend to MDA out of the teardrop turn.)

9. The procedures at the final approach fix (or at the inbound turn if the radio facility is at the field) are designed to allow the aircraft to be flown safely to the field at the lowest possible altitude until further descent to landing can be made.

a. Procedures at the PAP. You must fly from the station (final approach fix) inbound to the field for a specific length of time. The length of time you fly depends upon your ground speed and plate. You will also descend to the minimum descent altitude (MDA) at this time.

(1) At the final approach fix (FAF) perform the following procedures (6 T's):

(a) TIME - start the clock sweep second hand.

(b) TURN - to parallel inbound course (087°).

(c) TRANSITION - start a descent to the minimum descent altitude (MDA). 7-17

NOTE: Be sure you are using the correct minimums for the duty runway.

(d) TWIST - the final approach course (087°) in the IND-350. Turn to intercept the final approach course.

(e) TALK - give the required voice report.

SNFO:	"Tower, Navy Turbo 11, Final Approach Fix, gear down, full stop."
TOWER:	"Navy Turbo 11, Navy Jax Tower, cleared to land runway 09."
SNFO:	"Turbo 11, cleared to land runway 09."

(f) TRACK - outbound on the 087° radial.

(2) Level off at the minimum descent altitude (620' MSL).

(3) At the end of FAF-to-MAP timing, if the field is in sight and the aircraft is in a position to make a safe landing, descent below the MDA is authorized. If both conditions are not met, execute a missed approach.

HOLDING PATTERN APPROACH

Introduction - A holding pattern approach uses a published holding pattern to reverse course and establish the aircraft inbound on the intermediate or final approach course. Holding pattern approaches are printed using a normal holding pattern track with a heavy line indicating it is to be done "in lieu of procedure turn". The entry turn and maneuvering in holding both utilize normal holding procedures. Only one circuit of the holding pattern is expected unless more are necessary to lose excessive altitude or to become better established on course, in which case ATC must be advised. Descent from the minimum holding altitude may be commenced at the holding fix (case I) or on the inbound leg (case II) when cleared for the approach.

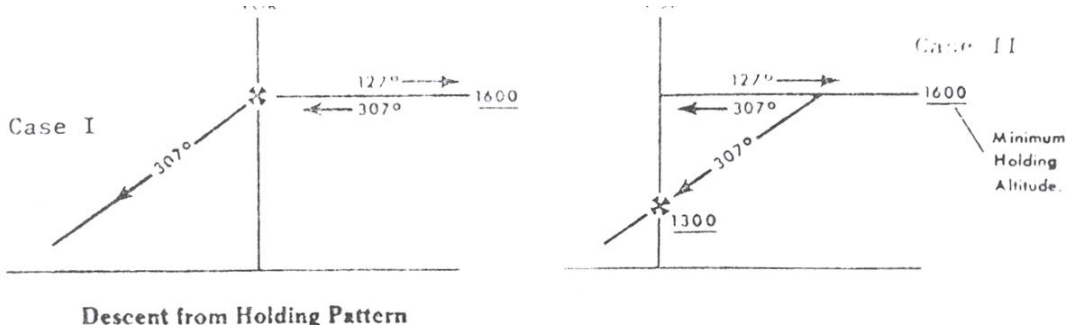


Figure 10

In the later case, the aircraft must be established on the inbound segment of the published approach course prior to beginning descent.

If established in a holding pattern as depicted in Figure 11 (thin blue line) and subsequently cleared for the approach do not execute the procedure turn. Use holding pattern approach procedures. If holding as depicted in Figure 12 and subsequently cleared for the approach, the procedure turn must be executed to allow sufficient time to intercept the final approach course, transition to BAC, and descend to MDA. Request clarification from ATC if unsure of correct-procedure.

Procedure - The following procedures assume clearance for the Marianna VOR-A approach (Figure 13) has been received and you are proceeding to the IAF at 3000'.

1. At the IAF, indicated by station passage, execute the6 T's.

   a. TIME - Start the depicted outbound timing (one minute) using the stop watch function of the clock when wings level or abeam the station whichever occurs last. (If no timing is depicted use one minute below 4000'.)

   b. TURN - Use the holding pattern entry procedures described in Chapter 6 to determine heading and turn direction.

   c. TRANSITION - Make a level speed change to 120 knots. Descend at 120 knots to the published minimum holding altitude (2000').

   d. TWIST - Twist the depicted inbound course (315°) with the OBS. In a holding pattern approach fly a hading on the outbound leg.

e. TALK - Give the appropriate voice report.

SNFO: "Cairns Approach, Turbo 11, VOR outbound, leaving 3000".

It is not necessary to state the altitude to which descending, because it is depicted on the approach plate and not assigned verbally.

CONTROLLER: "Turbo 11, Cairns Approach, roger, report VOR inbound.

f. TRACK - hold a heading outbound.

2. Approaching completion of your outbound timing determine the correct direction of turn to intercept the inbound course (315°) in accordance with holding procedures. Start the turn at the completion of you outbound timing (one minute in this example). Intercept the inbound altitude.

3. Level off at the holding altitude.

NOTE: The level-off may occur at any time during the holding orbit depending on how much altitude you have to lose.

4. Transition to BAC. When established on the inbound course or when you shallow intercept transition to BAC and complete the Landing checklist.

5. Fly the inbound course to the station. When established inbound, descend to the Final Approach Fix altitude (17000')

6. Procedures at and after the final approach fix are identical to those for the procedure turn and teardrop approaches.

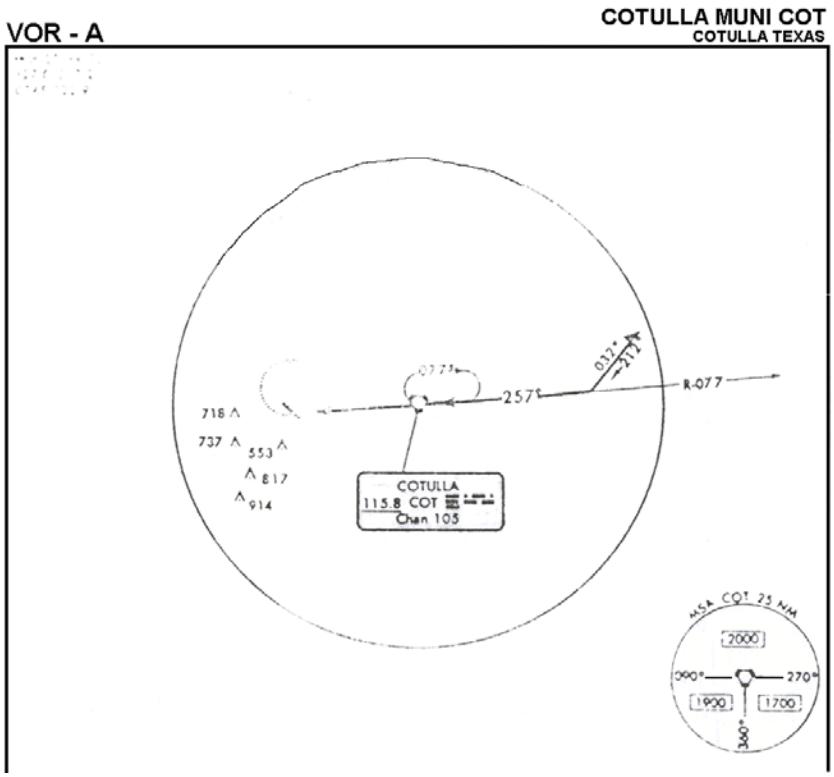


Figure 11

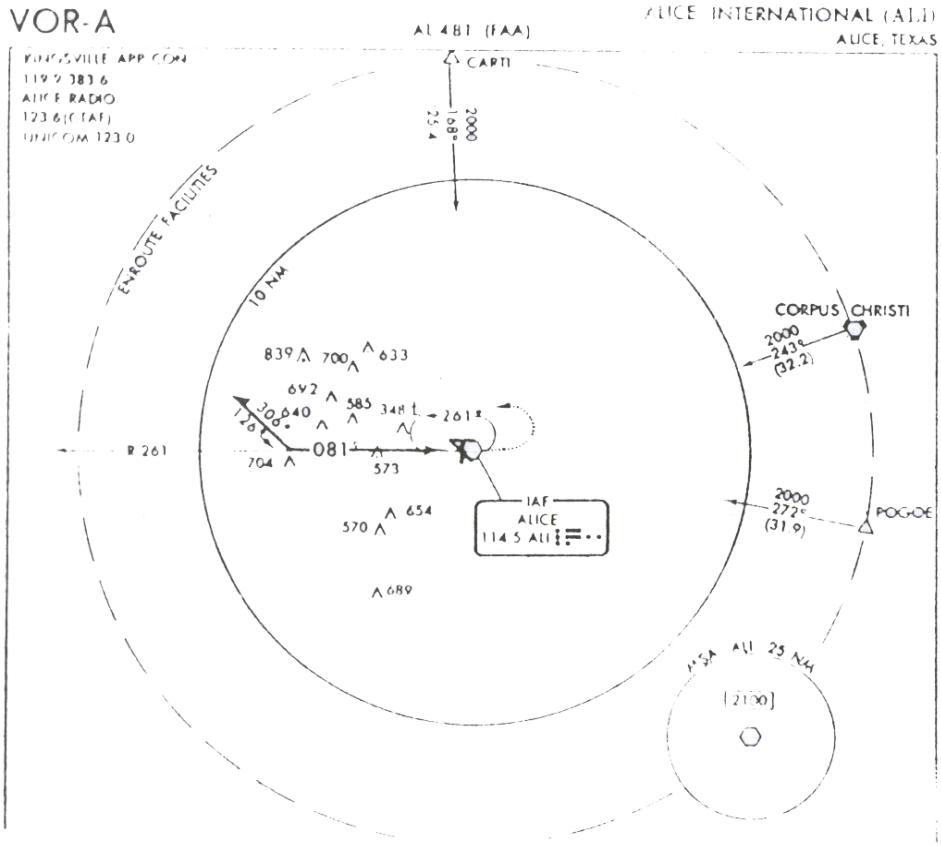


Figure 12

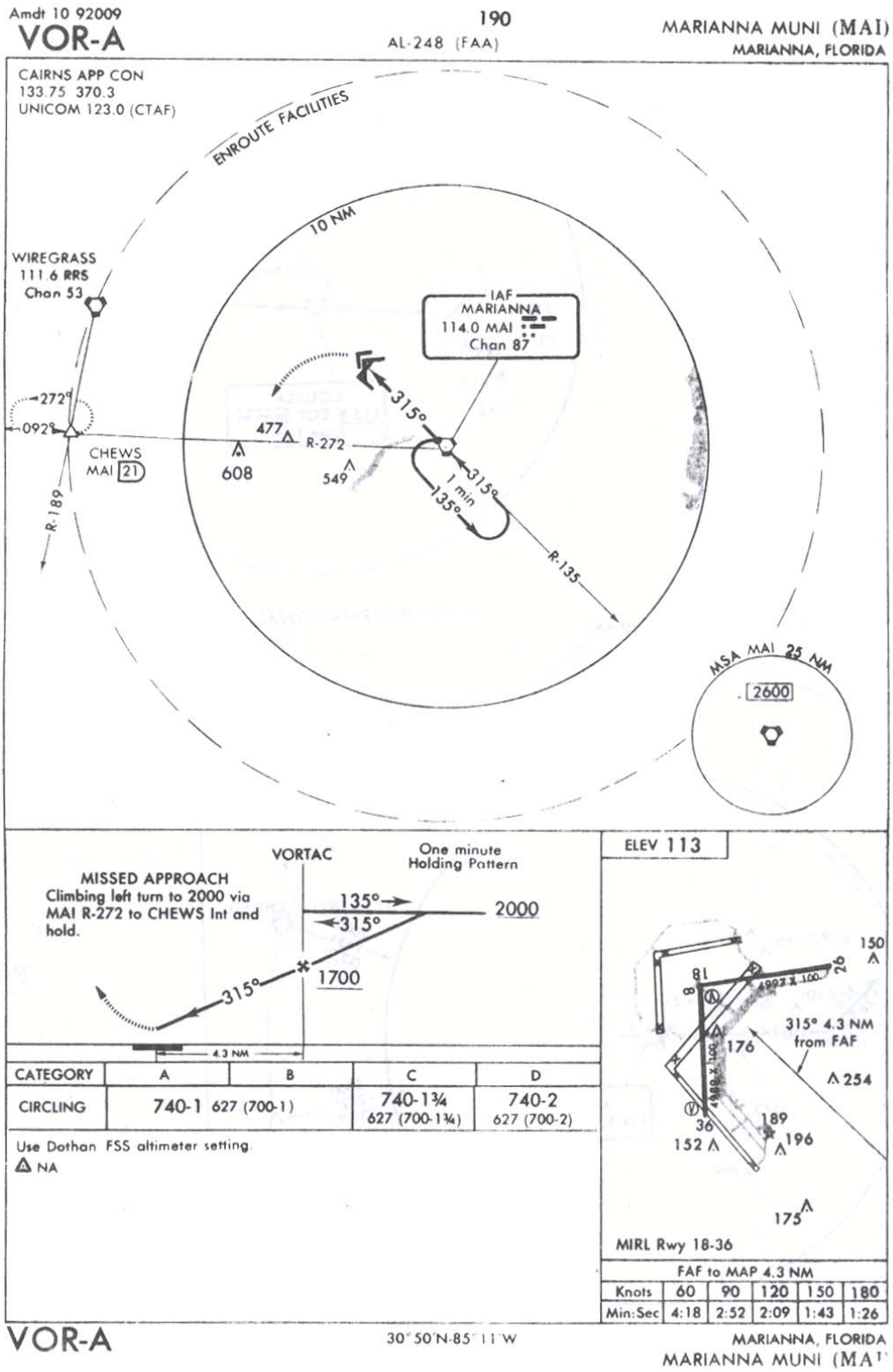

Amdt 10 92009
VOR-A
190
AL-248 (FAA)
MARIANNA MUNI (MAI)
MARIANNA, FLORIDA
CAIRNS APP CON
133.75 370.3
UNICOM 123.0 (CTAF)
ENROUTE FACILITIES
10 NM
WIREGRASS
111.6 RRS
Chan 53
IAF
MARIANNA
114.0 MAI
Chan 87
272°
092°
CHEWS
MAI 21
477
608
R-272
549
315°
1 min
135°
315°
R-135
R-189
MSA MAI 25 NM
2600
VORTAC
One minute
Holding Pattern
MISSED APPROACH
Climbing left turn to 2000 via
MAI R-272 to CHEWS Int and
hold.
135°
315°
2000
315°
1700
4.3 NM
ELEV 113
150
81
18
26
8
4997 X 100
315° 4.3 NM
from FAF
176
254
4998 X 100
36
189
152
196
175
MIRL Rwy 18-36
CATEGORY | A | B | C | D
CIRCLING | 740-1 627 (700-1) | | 740-1¾ 627 (700-1¾) | 740-2 627 (700-2)
Use Dothan FSS altimeter setting.
NA
FAF to MAP 4.3 NM
Knots | 60 | 90 | 120 | 150 | 180
Min:Sec | 4:18 | 2:52 | 2:09 | 1:43 | 1:26
VOR-A
30° 50' N-85° 11' W
MARIANNA, FLORIDA
MARIANNA MUNI (MAI)

Figure 13

ARCING APPROACH

Introduction - An arcing approach makes use of an arcing maneuver to position the aircraft inbound on the final approach course. Arcing approaches are normally identified by VOR/DME or TACAN in the approach plate margin meaning DME is required. The margin identification may not require DME if an arcing maneuver is depicted as an alternative to a procedure turn (Figure 14). However, when arcing to final, DME is required. If executing an arcing maneuver with the term "No PT" displayed along the arcing track, the procedure turn is not authorized.

DME provides more accurate fixing of an aircraft's position on final approach because it is not affected by wind, unlike the timing used on a pure VOR approach.

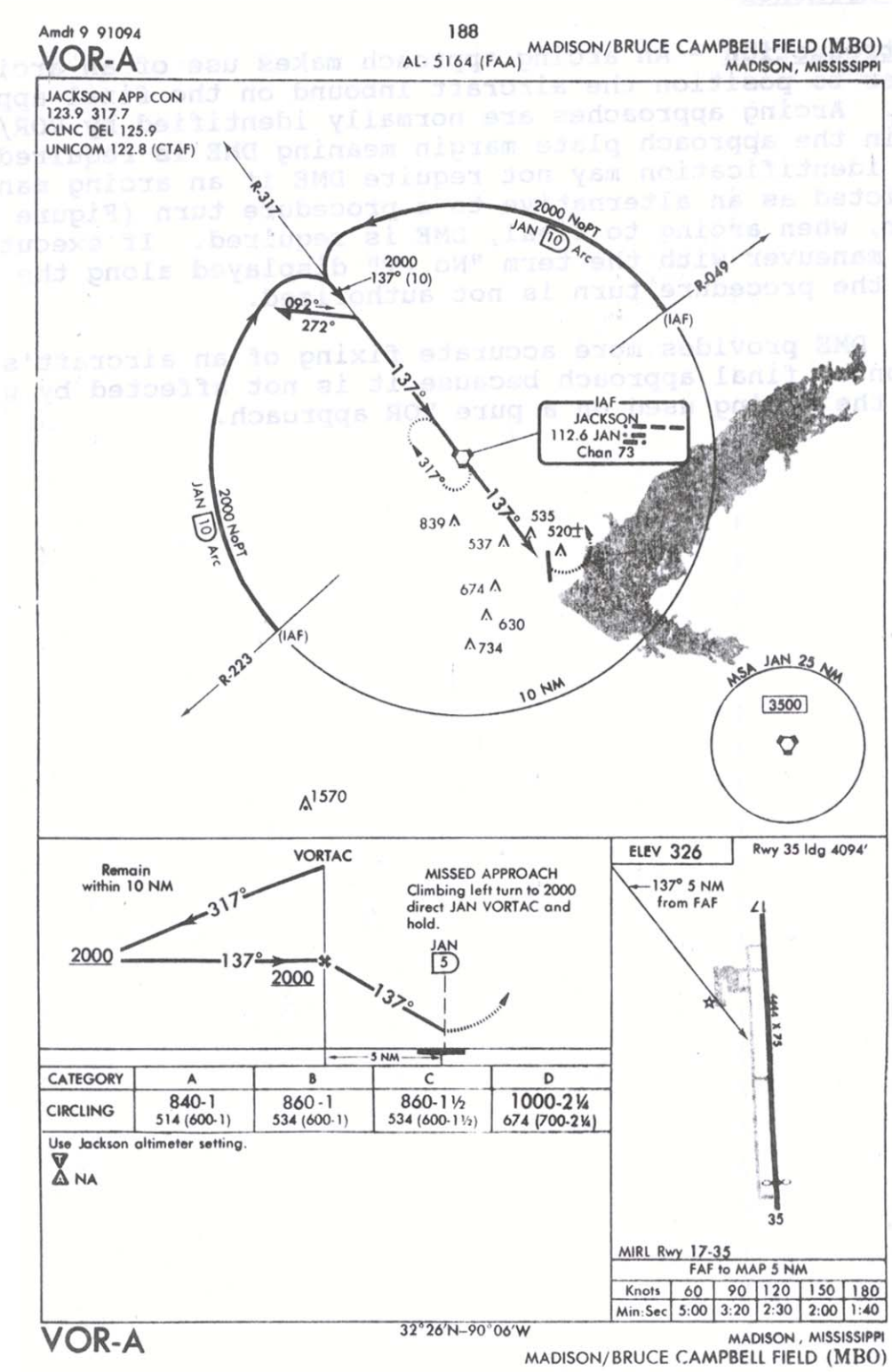

Amdt 9 91094
188
VOR-A
AL- 5164 (FAA)
MADISON/BRUCE CAMPBELL FIELD (MBO)
MADISON, MISSISSIPPI
JACKSON APP CON
123.9 317.7
CLNC DEL 125.9
UNICOM 122.8 (CTAF)
R-317
2000 NoPT
JAN 10 Arc
R-049
2000
137° (10)
092°
272°
(IAF)
137°
IAF
JACKSON
112.6 JAN
Chan 73
317°
137°
535
520±
839
537
674
630
734
JAN 10 Arc
2000 NoPT
(IAF)
R-223
10 NM
MSA JAN 25 NM
3500
1570
VORTAC
Remain within 10 NM
317°
2000
137°
2000
137°
MISSED APPROACH
Climbing left turn to 2000 direct JAN VORTAC and hold.
JAN
5
5 NM
ELEV 326
Rwy 35 ldg 4094'
137° 5 NM from FAF
4444 X 75
35
MIRL Rwy 17-35
FAF to MAP 5 NM
CATEGORY | A | B | C | D
CIRCLING | 840-1 514 (600-1) | 860-1 534 (600-1) | 860-1½ 534 (600-1½) | 1000-2¼ 674 (700-2¼)
Knots | 60 | 90 | 120 | 150 | 180
Min:Sec | 5:00 | 3:20 | 2:30 | 2:00 | 1:40
Use Jackson altimeter setting.
NA
VOR-A
32°26'N–90°06'W
MADISON, MISSISSIPPI
MADISON/BRUCE CAMPBELL FIELD (MBO)

Figure 14

Procedure – The following procedures assume clearance for the TACAN RWY 25L approach at NAS Pensacola (Figure 15) has been received and you are proceeding direct to the IAF at 3000'.

1. At the IAF:

    a. TIME - Not applicable

NOTE: If the turn to intercept the initial approach is more than 90°, a clearance may be requested from ATC to execute a teardrop type maneuver to avoid having an excessive angle of intercept. Clearance must be obtained from ATC. Clearance for the approach does not include clearance for use of holding or maneuver airspace.

NOTE: In this approach there is a short inbound leg, flown from the IAF, prior to intercepting the arc. In some approaches the IAF is already on the arc.

b. TURN - To intercept and track inbound to the arc on the depicted course (321°).

c. TRANSITION - Perform a terminal descent at 150 KIAS to the minimum altitude for this segment (1200').

NOTE: If holding was accomplished prior to the approach accelerate to 150 knots leaving the IAF.

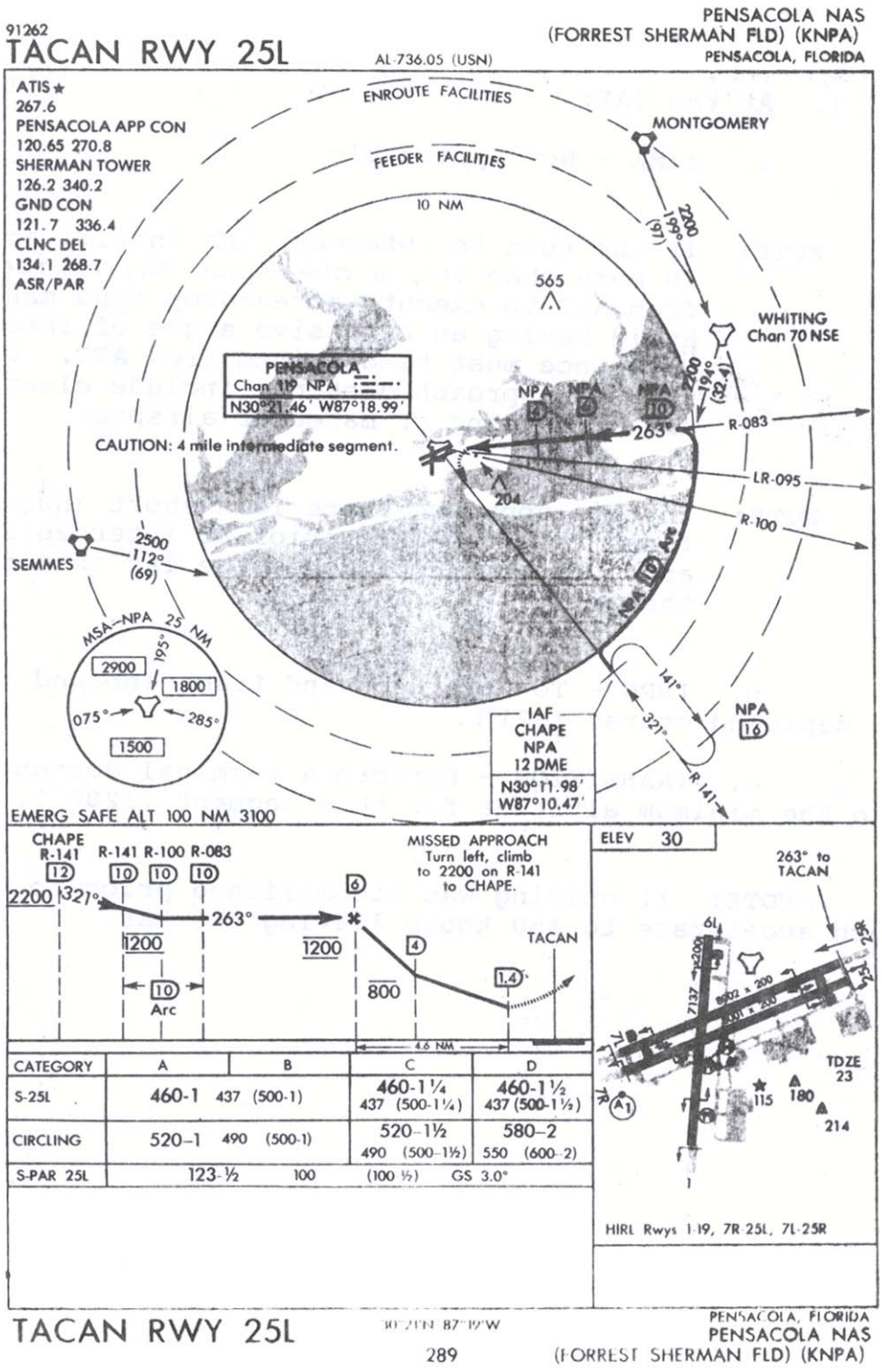

91262
TACAN RWY 25L
AL-736.05 (USN)
PENSACOLA NAS
(FORREST SHERMAN FLD) (KNPA)
PENSACOLA, FLORIDA
ATIS ★
267.6
PENSACOLA APP CON
120.65 270.8
SHERMAN TOWER
126.2 340.2
GND CON
121.7 336.4
CLNC DEL
134.1 268.7
ASR/PAR
ENROUTE FACILITIES
FEEDER FACILITIES
10 NM
MONTGOMERY
WHITING
Chan 70 NSE
PENSACOLA
Chan 119 NPA
N30°21.46' W87°18.99'
CAUTION: 4 mile intermediate segment.
565
204
263°
R-083
LR-095
R-100
SEMMES
MSA—NPA 25 NM
2900
1800
1500
075°
195°
285°
IAF
CHAPE
NPA
12 DME
N30°11.98'
W87°10.47'
NPA
16
141°
321°
R-141
EMERG SAFE ALT 100 NM 3100
CHAPE
R-141
R-141 R-100 R-083
2200
321°
263°
1200
Arc
MISSED APPROACH
Turn left, climb
to 2200 on R-141
to CHAPE.
TACAN
800
4.6 NM
ELEV 30
263° to
TACAN
TDZE
23
115
180
214
HIRL Rwys 1-19, 7R-25L, 7L-25R
CATEGORY
A
B
C
D
S-25L
460-1 437 (500-1)
460-1¼ 437 (500-1¼)
460-1½ 437 (500-1½)
CIRCLING
520-1 490 (500-1)
520-1½ 490 (500-1½)
580-2 550 (600-2)
S-PAR 25L
123-½ 100 (100 ½)
GS 3.0°
TACAN RWY 25L
PENSACOLA, FLORIDA
PENSACOLA NAS
(FORREST SHERMAN FLD) (KNPA)
289

Figure 15

d. TWIST - Ensure that the inbound course (321°) is set in the IND-350 intercept the course inbound.

e. TALK - report initial approach fix leaving altitude.

SNFO: "Pensacola Approach, Turbo 11, leaving 3000."

APP CONT: "Turbo 11, Pensacola Approach, roger."

f. TRACK - Inbound on the 321° course.

2. Intercept and maintain the arc. This step may occur before the above steps are completed. Remember to use the proper lead point (10.7 DME). Once established on the arc twist in the final approach course (263°).

NOTE: Some approaches have progressively lower minimum altitudes on various segments of the arc.
knots.

3. 30° prior to the Final Approach Course, slow to 120

4. Anticipate interception of the final approach course referencing the TACAN needle and the CDI while on the arc. Remember, this is almost a 90° intercept. Lead your turn by the proper amount. The published lead radial (LR-095) gives a 2 mile lead. Yours should be the R-088.

5. Once established inbound on the FAC, or with a shallow intercept, transition to the basic approach configuration.

NOTE: A shallow intercept is defined as aircraft heading within 20° of the published inbound course.

6. Complete the landing checklist.

Approach control will normally switch you to Tower 812 miles from the field. You need to be dirty in order to report the gear down at the FAF.

7. Maintain 120 knots while tracking inbound to the final approach fix.

8. At the final approach fix the procedures are the same as for previous approaches except no timing is involved. The MAP is defined by DME.

9. Upon reaching the missed approach point (1.0 DME prior to TACAN in this case), if the field is in sight and the aircraft is in a position to make a safe landing, descent below MDA is authorized. If both conditions are not met execute a missed approach. Some approaches may have a Visual Descent Point (VDP) prior to the MAP. If so, descent below MDA is not authorized until past the VDP and the field is in sight. At the VDP, a normal rate of descent (often coincident with VASI or OLS glideslope) may be used to touchdown.

Common Errors

1. Overshooting arc and FAC due to insufficient lead.

2. Failure to descend and meet altitude restrictions for the various approach segments. Remember to refer to the profile view.

STRAIGHT-IN- APPROACH

Introduction - A straight-in approach is an instrument approach where final approach is begun without having executed a procedure turn. A straight-in procedure does not mean the approach must be completed with a straight-in landing or made to straight-in landing minimums. Generally, there are two basic differences in straight-in approaches--approaches which have the IAF located on the final approach course and approaches which utilize intersections, TACAN fixes, and other NAVAIDS for an IAF.

1. APPROACHES WHICH HAVE THE IAF LOCATED ON THE FAC: These approaches do not normally depict a procedure turn. DME is often required to define the IAF, step-down fixes, FAF and MAP. The TACAN RWY 14 approach at North Whiting (Figure 16) is an example of this type of straight-in approach. A variation to this typical approach would be a VOR approach utilizing intersections formed by radial cuts from another facility to provide an IAF and FAF such as the VOR-C to Beaumont-Port Arthur/Jefferson Co. (Figure 17).

2. Procedure. The following procedures assume that you are at TROJN IAF, cleared for the TACAN RWY 14 approach and at 3000’.

3. At the IAF:

   a. TIME - Not applicable

NOTE: If the turn to intercept the final approach course is more than 90°, a clearance may be requested from ATC to execute an offset type maneuver to avoid having an excessive angle of intercept. Clearance must be obtained from ATC. Clearance for the approach does not include clearance for use of holding or maneuvering airspace.

   b. TURN - Turn in the shortest direction to intercept the final approach course (124°).

   c. TRANSITION

      (1) Descend to FAF altitude (1700')

      (2) Check speed below 150 KIAS and transition to basic approach configuration.

      (3) Complete the landing checklist. Normally you will want to perform your landing checks 4-5 DME prior to the FAF.

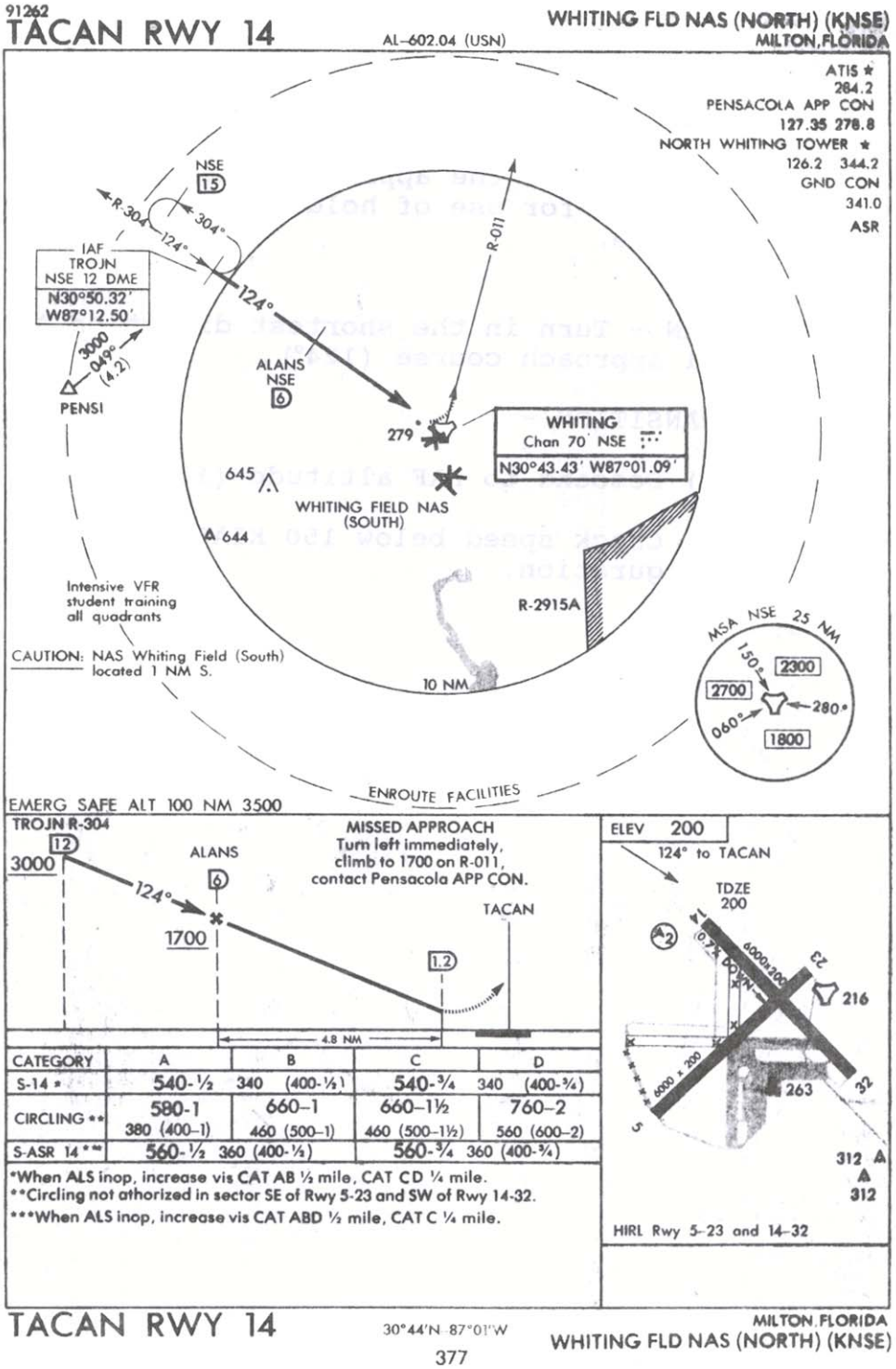

91262
TACAN RWY 14
AL-602.04 (USN)
WHITING FLD NAS (NORTH) (KNSE)
MILTON, FLORIDA
ATIS ★ 284.2
PENSACOLA APP CON 127.35 278.8
NORTH WHITING TOWER ★ 126.2 344.2
GND CON 341.0
ASR
NSE 15
R-304
304°
124°
IAF
TROJN
NSE 12 DME
N30°50.32'
W87°12.50'
3000
049°
(4.2)
PENSI
ALANS
NSE 6
R-011
279°
WHITING
Chan 70 NSE
N30°43.43' W87°01.09'
645
WHITING FIELD NAS
(SOUTH)
644
R-2915A
Intensive VFR
student training
all quadrants
CAUTION: NAS Whiting Field (South)
located 1 NM S.
10 NM
MSA NSE 25 NM
150°
2300
2700
280°
060°
1800
ENROUTE FACILITIES
EMERG SAFE ALT 100 NM 3500
TROJN R-304
12
3000
ALANS
6
124°
1700
MISSED APPROACH
Turn left immediately,
climb to 1700 on R-011,
contact Pensacola APP CON.
TACAN
1.2
4.8 NM
ELEV 200
124° to TACAN
TDZE
200
A2
(0.7%)
DOWN
6000 x 200
23
216
6000 x 200
263
32
5
312 A
A
312
HIRL Rwy 5-23 and 14-32
CATEGORY | A | B | C | D
S-14 * | 540-½ 340 (400-½) | | 540-¾ 340 (400-¾) |
CIRCLING ** | 580-1 380 (400-1) | 660-1 460 (500-1) | 660-1½ 460 (500-1½) | 760-2 560 (600-2)
S-ASR 14 *** | 560-½ 360 (400-½) | | 560-¾ 360 (400-¾) |
*When ALS inop, increase vis CAT AB ½ mile, CAT CD ¼ mile.
**Circling not athorized in sector SE of Rwy 5-23 and SW of Rwy 14-32.
***When ALS inop, increase vis CAT ABD ½ mile, CAT C ¼ mile.
TACAN RWY 14
30°44'N 87°01'W
MILTON, FLORIDA
WHITING FLD NAS (NORTH) (KNSE)
377

Figure 16

d. TWIST - Twist the FAC into the OBS (124°).

e. TALK - Report IAF, leaving altitude if appropriate.

SNFO: "Pensacola Approach, Turbo 11, leaving 3000".

APP CONT: "Turbo 11, Pensacola Approach, roger, contact North Whiting Tower frequency 344.2 at the final approach fix inbound."

SNFO: "Turbo 11, wilco"

f. TRACK - Inbound on a course of 124°.

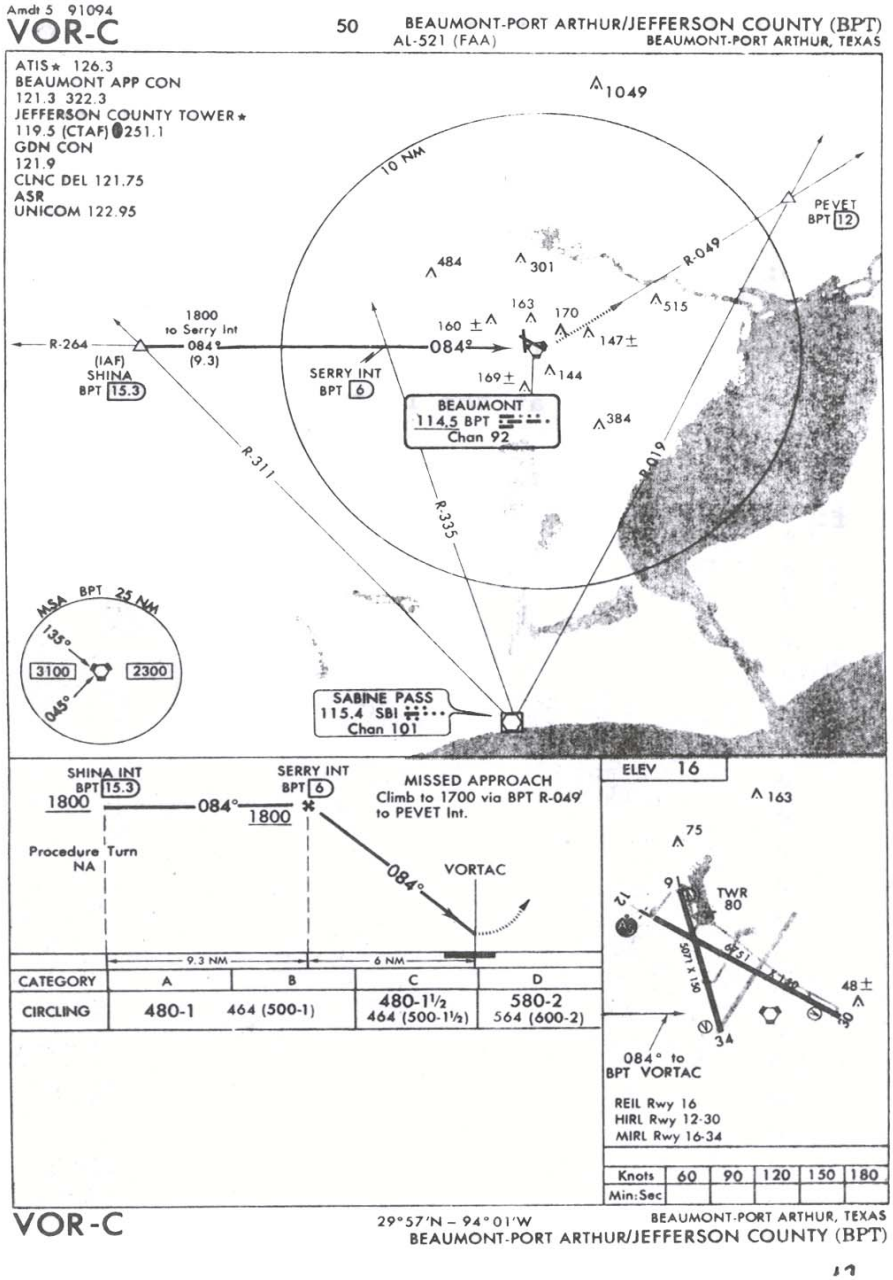


Figure 17

g. Once the BAC transition is complete and the descent to MDA established, the PAP procedures are identical to those on previously introduced approaches.

After switching to 344.2 and at the PAP:

SNFO: "North Whiting Tower, Turbo 11, final approach fix, three down and locked, full stop."

TOWER: "Turbo 11, North Whiting Tower, roger, cleared to land Runway 14."

SNFO: "Turbo 11, cleared to land 14."

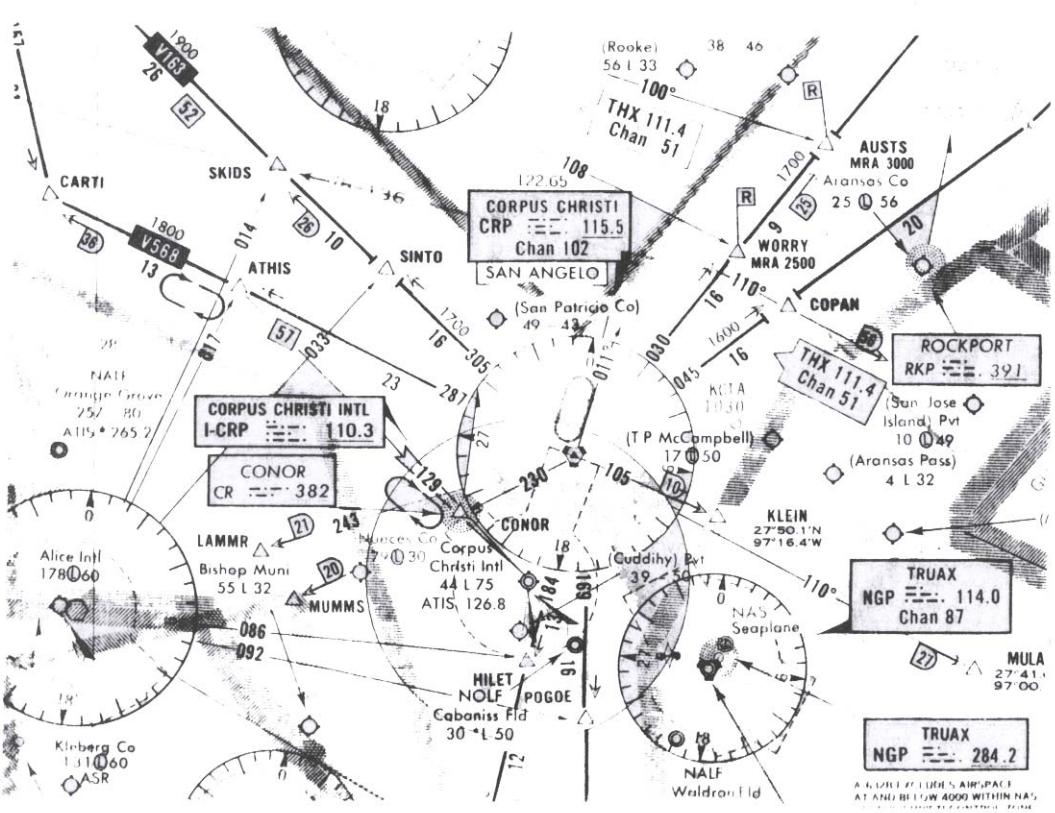


Figure 18

2. STRAIGHT IN APPROACHES WITHOUT THE IAF ON THE FAC

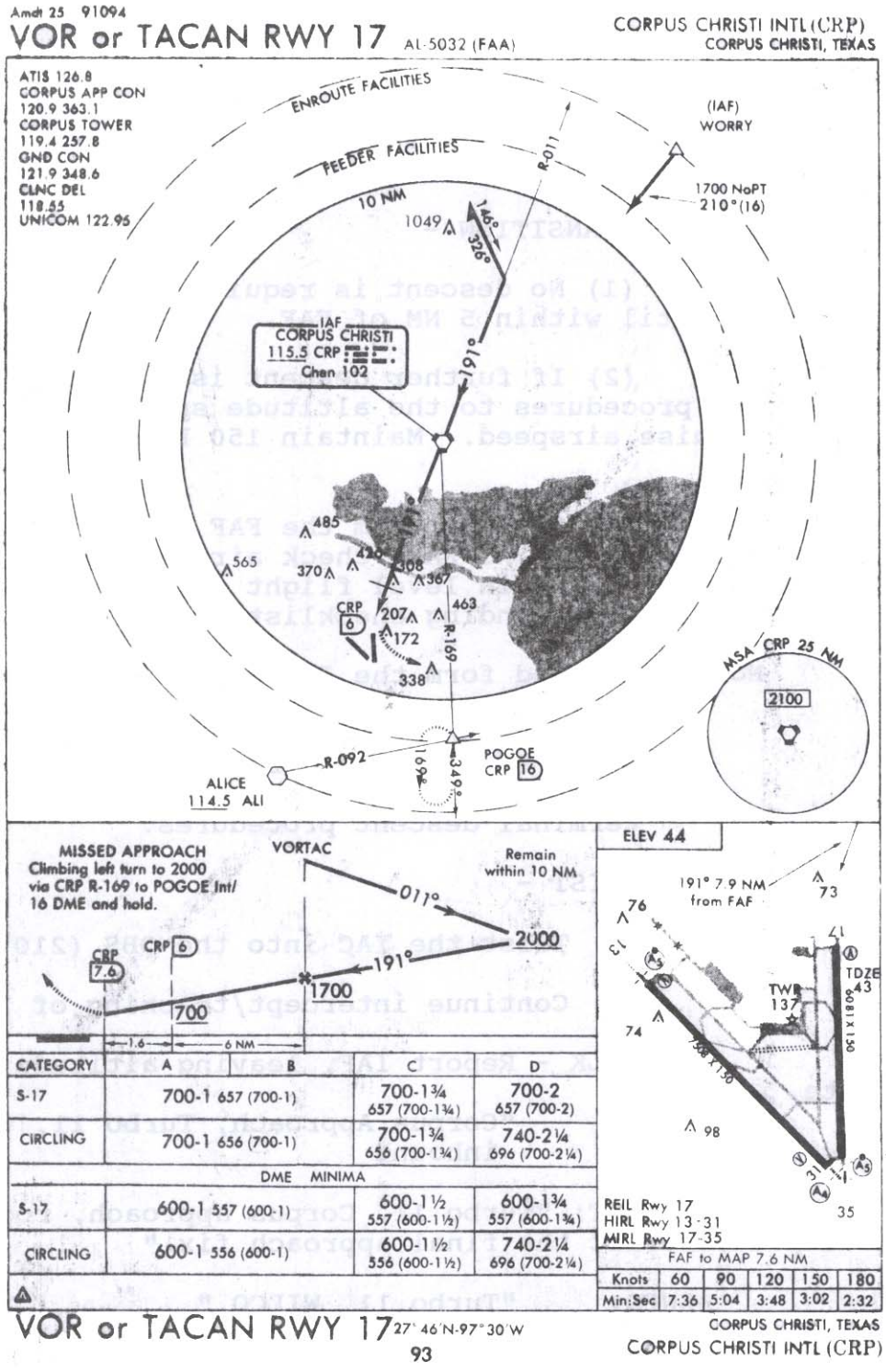
Introduction - These approaches utilize intersections, TACAN fixes and other navaids for an IAF. They expedite the flow of arriving aircraft at a destination by using IAFs which are favorably positioned to establish the aircraft inbound on the final approach course without having to execute a procedure turn. The term "No PT" is used on approach plates to designate straight-in procedures where a procedure turn is also printed on the approach plate (Figure 19). When distance from the IAF to the Final Approach Fix is excessive, i.e., more than 5 miles, normal cruise airspeed should be maintained and the BAC procedure delayed until within 4-5 nm. Note the initial approach fix is on the airway to simplify the transition from the enroute phase to the terminal phase of flight. Figure 18 displays the enroute low altitude (L-16) chart in the area of Corpus Christi.

Procedure. The following procedures assume you have just passed AUSTS southwest bound on V-13 at 6000, and have been instructed to contact Corpus Approach Control.

1. Contact Approach Control using standard format.

   After receiving clearance for the approach, begin descent to the MEA, of V-13 or the IAF altitude, whichever is higher. In this case, both are 1700'.

NOTE: This is permissible because you are established on a published route. If you were on vectors to worry you would remain at 6000'.



CATEGORY	A	B	C	D
S-17	700-1 657 (700-1)		700-1¾ 657 (700-1¾)	700-2 657 (700-2)
CIRCLING	700-1 656 (700-1)		700-1¾ 656 (700-1¾)	740-2¼ 696 (700-2¼)
DME MINIMA				
S-17	600-1 557 (600-1)		600-1½ 557 (600-1½)	600-1¾ 557 (600-1¾)
CIRCLING	600-1 556 (600-1)		600-1½ 556 (600-1½)	740-2¼ 696 (700-2¼)

Figure 19

2. Normal cruise airspeed is maintained to the IAF. 3. At the IAF:

a. TIME - Start the clock's sweep second hand - approximately 4 1/2 minutes are needed to reach a point 5nm from the PAP. (16.0 - 5= 11nm; 11 -2.5= 4.4 minutes). Timing is not required if DME IS available.

b. TURN - Turn in shortest direction to intercept the intermediate approach course (210°).

c. TRANSITION -

(1) No descent is required; maintain normal cruise airspeed until within 5 NM of PAP.

(2) If further descent is required, use terminal descent procedures to the altitude specified and level off at normal cruise airspeed. Maintain 150 KIAS until with 5 NM of the FAF.

(3) AT 5 NM from the PAP (10-15 NM from the field if the procedure has no PAP) check airspeed below 150 KIAS and lower the gear. Maintain level flight as the airspeed decreases. Complete the Landing checklist.

NOTE: Inbound form the IAF ATC may request you to maintain airspeed to expedite the approach. Transition to BAC as appropriate but adjust power to maintain airspeed requested by ATC, if possible. If a descentis required use terminal descent procedures.

d. TWIST -

(1) Twist the IAC into the OBS (210°).

(2) Continue intercept/tracking of IAC.

f. TALK - Report IAF, leaving altitude if appropriate.

SNFO: "Corpus Approach, Turbo 11, WORRY inbound

APP CONT: "Turbo 11, Corpus approach, roger, contact Corpus Tower at the final approach fix."

SNFO: "Turbo 11, WILCO."

4. Procedures at the PAP are identical to those used on all other approaches. Perform the six "T's." Remember that a turn to the PAC will be required.

RADAR VECTORS TO FINAL APPROACH COURSE

Introduction - Radar vectors to final approach course is a procedure used by Approach Control to increase the arrival rate of aircraft at airports and to establish aircraft on the final approach course through the most expeditious routes consistent with traffic situations. Previous discussions have emphasized aircrew navigation procedures to establish your aircraft on the inbound course to the final approach fix (FAF). However, approach control agencies with radar capability will, more often than not, vector you from your position on the airway directly to the final approach course, thereby eliminating the "procedure turn" portion of the approach.

Although this routing does indeed expedite arrival at your destination, it has one characteristic of which you should be aware - the lack of published minimum altitudes until joining a segment of published approach. Approach Control has the statutory responsibility for ensuring terrain clearance while vectoring you for the approach. This is done through the use of MVA (Minimum Vectoring Altitude) charts superimposed on its radar displays. However, the NFO who wishes to double check the controller must depend largely upon the minimum safe altitudes published on the approach plate and a constant awareness of his own position.

Good technique and good sense dictate that you never fully relinquish the responsibility for terrain clearance to outside agency. Never blindly follow vectors from a controller be aware of what lies ahead on your assigned heading. If in doubt as to the appropriateness of a given instruction, make an inquiry.

Procedure - A request for radar vectors to the final approach course may be initiated by the aircrew or may be issued by Approach Control with the aircrew's consent. In either event the crew must ensure the appropriate navaid is tuned and identified and the final approach course is set in the IND-350.

The pilot must then follow the radar vectors assigned by Approach Control to intercept the final approach course. If a descent is required, it is performed using terminal descent procedures. Usually Approach Control will have the aircraft descend to final approach course is set in the IND-350.

The crew will be advised of their position relative to the navaid on a VOR approach. Slow to 120 knots when the aircraft position is within ten NM of the field (five NM of FAF on a TACAN approach), 30 radials of the inbound course and 90 degrees heading of the FAC.

Once you are cleared for the approach and are established on the inbound course or a shallow intercept, transition to BAC and perform the landing checklist. Once the BAC transition is complete, the remaining procedures are identical to those used on previously introduced approaches.

1. Procedures for Radar Vectors to Final Approach Course (Figure 20)
   a. Initiate request for radar vectors to final approach course.

      SNFO: "Pensacola Approach, Turbo 11, 5500' information B, request vectors to TACAN final."

      APP CONT: "Navy Turbo 11, roger squawk_____."

      SNFO: "No verbal response is necessary.

      APP CONT: "Navy Turbo 11, Pensacola Approach, radar contact 20 miles west of Sherman field. Turn left heading 060, vectors to TACAN final approach course runway 25L at Navy Pensacola. Descend and maintain 3000; Sherman altimeter 30.06."

      SNFO: "Turbo 11, left 060, leaving 5500 for 3000, altimeter 30.06."

b. Tune and identify the appropriate navaid.

c. Check the VOR/TACAN switch in the proper position.

d. Twist the final approach course into the IND-350.

e. Follow radar vectors given by Approach Control.

f. If a lower altitude is assigned, perform a terminal descent.

g. When aircraft position is within ten NM of the field (five NM of FAF on TACAN approach), 30 radials and heading within 90 degrees of FAC, slow to 120 knots.

NOTE: If established in a terminal descent and heading within 90 degrees of FAC when within 10 NM and 30° continue descent at 150 knots until reaching assigned altitude then slow to 120 knots.

APP CONT: "Navy Turbo 11, Pensacola Approach, now 5 miles from the final approach fix, turn right heading 235°, maintain 2200 until established on final, cleared for the TACAN 25L approach to Navy Pensacola. Contact Sherman Tower local channel 4."

SNFO: "Turbo 11, right to 235, cleared for the approach, leaving 3000 for 2.2, switching tower."

Switch to 340.2 and contact tower as follows:

SNFO: "Sherman Tower, Turbo 11, 10 DME TACAN final."

TOWER: "Navy Turbo 11, Sherman Tower, roger, report the final approach fix runway 25L."

SNFO: "Turbo 11, WILCO"

h. Maintain assigned altitude and heading until you have intercepted the final approach course; i.e., established the aircraft on a segment at a published approach procedure.

i. Once cleared for the approach **and** established on either the inbound course or a shallow intercept, transition to BAC and perform the landing checklist.

j. Once the BAC transition is complete, the remaining procedures are identical to those on previously introduced approaches.

NOTE: If the controller vectors you through the final approach course without explanation, you should query him regarding the reason. Such a vector may at times be necessary but should be previously explained by the controller (e.g., "vectors across the final approach course for sequencing."

Common - Errors

1. Poor orientation. Be aware of your position. You must transition to 120 knots within 30° of the final approach course and ten NM of the field (5 NM of FAF on TACAN approaches).

2. Failing to intercept the final approach course once cleared to do so. Be alert for CDI movement and lead the turn sufficiently to roll out on course.

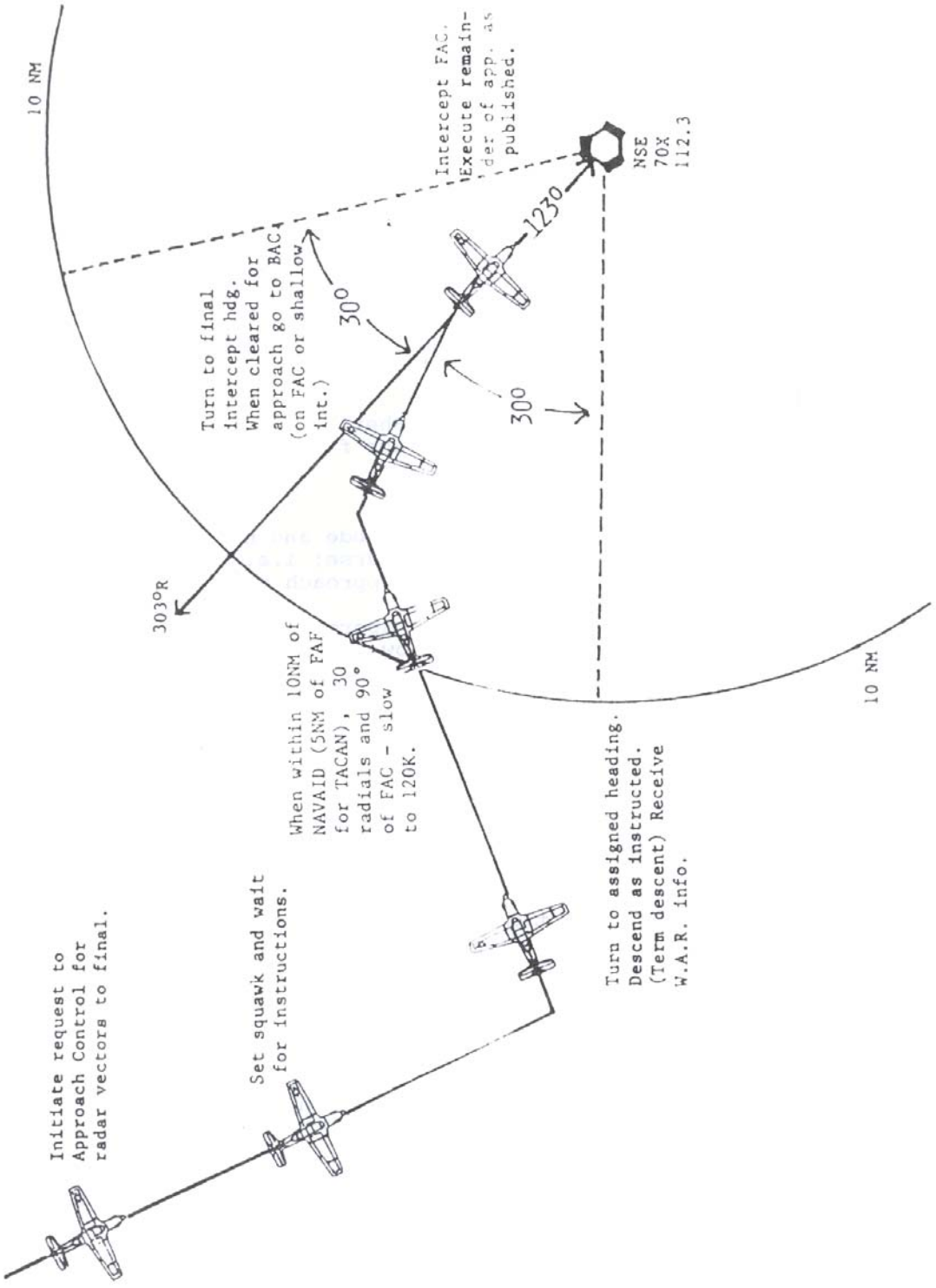

10 NM
Intercept FAC.
Execute remain-
der of app. as
published.
NSE
70X
112.3
123°
30°
300
Turn to final
intercept hdg.
When cleared for
approach go to BAC
(on FAC or shallow
int.)
303°R
When within 10NM of
NAVAID (5NM of FAF
for TACAN), 30
radials and 90°
of FAC - slow
to 120K.
10 NM
Turn to assigned heading.
Descend as instructed.
(Term descent) Receive
W.A.R. info.
Set squawk and wait
for instructions.
Initiate request to
Approach Control for
radar vectors to final.

Figure 20

PRECISION APPROACH RADAR_ APPROACH

Introduction - The precision approach radar (PAR) approach uses radar vice aircraft equipment to maneuver the aircraft to a position for landing during conditions of low ceiling and/or poor visibility. In the previous section, you were introduced to radar vectors to final approach course. During this procedure, the approach controller used his radar capability to direct your aircraft to a segment of a standard instrument approach procedure.

During a radar approach, the controller will direct your aircraft to a position from which you can safely land. Radar approaches fall into two classes: (1) airport surveillance radar (ASR) approaches which provide course and range information only and are thus non-precision approaches (these use an MDA), (2) precision approach radar (PAR) approaches which provide course, range and glideslope information and can thus be flown to lower minimums (using a Decision Height) than ASR's.

The balance of this chapter will address PAR's only. The procedures for ASR's are similar.

Procedure

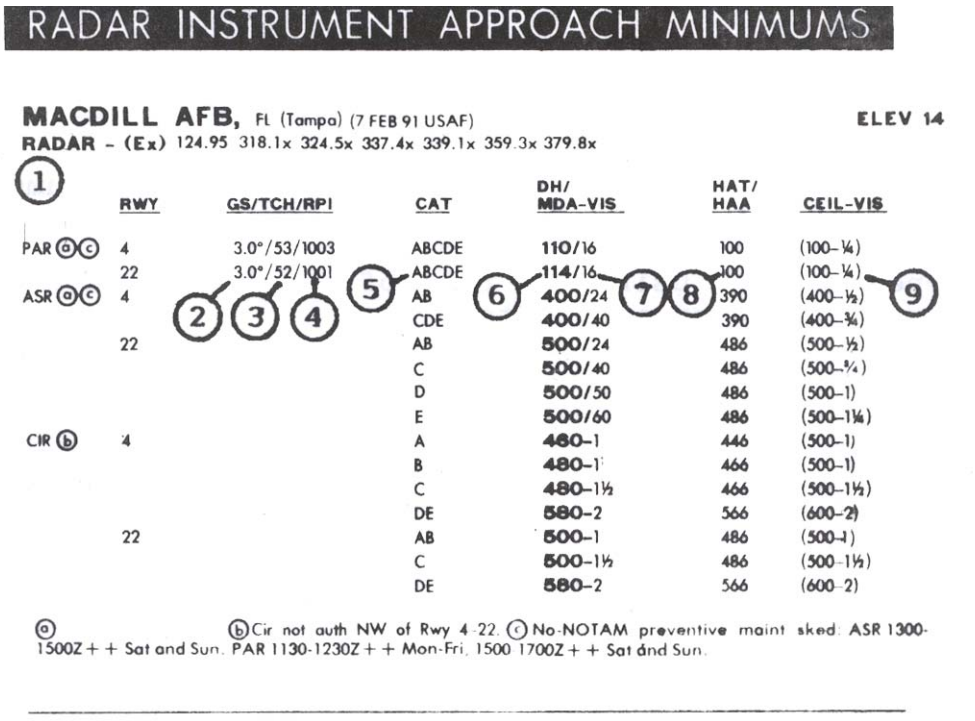
1. Preflight - Radar instrument approach minimums are published in tabular form in the front of FLIP terminal instrument approach procedures (approach plates), providing information regarding decision height, weather minimums, and glideslope angle. From glideslope angle and ground speed the pilot can determine the rate of descent required to maintain glideslope on final using the rate of descent table inside the backcover of the approach plates.

Familiarize yourself with this information as part of your preflight planning when a radar approach (PAR or ASR) is available at your destination or alternate. Additional information may be found in the ILS/RADAR section of the IFR Supplement entry.

Figure 21 is a sample of the section in the approach plates which contains information on radar approaches. For the purposes of illustration we will consider the PAR approach to runway 22 at MacDill AFB.

a. Under the heading of RADAR (1) is a list of frequencies on which your approach may be conducted. The X's following the frequencies indicate that the radar site has the capability to work on that frequency but does not monitor it continuously. The PAR approach to runway 22 has a glideslope, GS(2), of 3.0 degrees. The threshold crossing height, TCH (3), is 52 feet. This means that if you are on gileslope, as you cross the runway threshold you will be 52 feet above the runway surface. If you remain on glideslope until touchdown you will land 1001' down the runway point to interception, RPI (4).

b. The next column indicates that the published minimums for this approach apply to all categories, CAT (5), of aircraft. Decision height, DH (6), is 114 feet in this case. Required runway visual range, RVR (7), for the approach is 1600 Height above touchdown, HAT (8), is 100 feet. Ceiling and visibility, Ceil-Vis (9), for filing purposes and executing the approach is 100-1/4.



RADAR INSTRUMENT APPROACH MINIMUMS

MACDILL AFB, FL (Tampa) (7 FEB 91 USAF) ELEV 14

RADAR - (Ex) 124.95 318.1x 324.5x 337.4x 339.1x 359.3x 379.8x

	RWY	GS/TCH/RPI	CAT	DH/ MDA-VIS	HAT/ HAA	CEIL-VIS
PAR ⓞⓒ	4	3.0°/53/1003	ABCDE	110/16	100	(100-¼)
	22	3.0°/52/1001	ABCDE	114/16	100	(100-¼)
ASR ⓞⓒ	4		AB	400/24	390	(400-½)
			CDE	400/40	390	(400-¾)
	22		AB	500/24	486	(500-½)
			C	500/40	486	(500-¾)
			D	500/50	486	(500-1)
			E	500/60	486	(500-1¼)
CIR ⓑ	4		A	460-1	446	(500-1)
			B	480-1	466	(500-1)
			C	480-1½	466	(500-1½)
			DE	580-2	566	(600-2)
	22		AB	500-1	486	(500-1)
			C	500-1½	486	(500-1½)
			DE	580-2	566	(600-2)

ⓞ ⓑCir not auth NW of Rwy 4-22. ⓒNo-NOTAM preventive maint sked: ASR 1300-1500Z++ Sat and Sun. PAR 1130-1230Z++ Mon-Fri, 1500-1700Z++ Sat and Sun.

Figure 21

NOTE: The T-34 is considered a single-piloted aircraft. OPNAV indicates that single-piloted aircraft use 200' ceiling/HAT and 1/2 mile/2400' RVR as absolute minimums for instrument approaches. Consider the above example. When you reach the published decision height of 114' MSL you will be at an HAT of 100' AGL. In order not to break the 200' HAT absolute minimum you must increase the decision height of In this case and increase of 100' is necessary. This would result in a modified DH of 214' MSL resulting in a HAT of 200' AGL. In addition, the minimum visibility required to commence the approach would become 1/2 mile instead of the original 1/4 mile.

2. Initial contact with Approach Control. Make the request for PAR approaches upon initial contact with Approach Control. The following approach information will be provided by ATC:

a. Type of approach. "This will be a PAR approach to runway 22."

b. Altimeter setting.

c. Ceiling and visibility if below 1000 feet (or below highest circling minimum, whichever is greater or visibility less than 3 miles.

d. Special weather observations.

e. Airport conditions important to the safe operation of aircraft.

f. Lost communication procedures, when weather reports indicate that IFR weather conditions will likely be encountered during the approach. Lost communication instructions will typically include an altitude and a standard instrument approach procedure; e.g., "... if no transmissions received for 30 seconds (not more than one minute) in the pattern or 5 seconds on final, attempt contact on 258.3, and proceed VFR.

If unable, proceed with the TACAN 22 approach, maintain 2600 until over OZONA IAF." (See MacDill AFB TACAN Rwy 22 for illustration.)

3. Missed Approach. A missed approach procedure will be issued to an aircraft planning a full stop landing, if weather reports indicate that any portion of the final approach will be conducted in IFR conditions. For aircraft planning a low approach or touch and go, departure instructions will be issued; e.g., ". . . after completing low approach, climb and maintain 1600, turn left heading 090. . ."

When planning a full stop landing, low approach, or touch and go instructions should be issued by ATC prior to commencing final descent.

4. Vectors to the PAR Pattern. When the approach controller picks you up on his scope, his task is to vector your aircraft to a suitable position and altitude for handoff to the PAR final controller. Maintain normal cruise until a transition is appropriate. If a descent is required, report leaving present altitude and conduct a terminal descent to the assigned altitude. Turns should be performed at standard rate until established on PAR final. Monitor destination navaids as an aid in orientation as well as a means of preparation for the lost communication contingency. The controller will advise you of aircraft position at least once before starting final, e.g., ". . . downwind leg, 8 miles northeast of airport," and at least once each mile on final approach, e.g., ". . . 3 miles from touchdown."

On this approach you could be vectored to any one of four positions relative to the PAR final: downwind, base, semifinal or final itself. During subsequent approaches, vectors will follow the "box" pattern (figure 22).

a. Vectors to downwind. The downwind leg is flown in the clean configuration at 150 KIAS.

b. Vectors to base leg. There are two ways to reach base leg. One is to be vectored directly on to base leg from outside the pattern. The other is to be vectored on to base leg after having flown a downwind leg. The approach controller should advise you when you reach the base leg. Your TACAN position/heading relative to the field may be used as an indication of arrival on base leg if the controller fails to provide this advisory. You will dirty up on base leg. If on base inside 8 miles, lower gear and flaps as soon as practical. If 8-13 NM from the field on base leg, wait until you are within 30° of final, then dirty up.

Transition as follows:

(a) Check airspeed below 150 knots and lower the gear.

(b) Slow below 120 knots and lower full flaps.

(c) Perform the Landing checklist. Report gear down to final controller.

NOTE: Army and Navy controllers are required to advise the pilot to, "Perform landing check," at least once prior to final descent.

c. Vectors to semi-final. In some cases you will be vectored to a semi-final or a "dog-leg." Normally on this leg you will be approaching final at a 30-45° angle. If you enter this leg in normal cruise, transition to landing configuration as you would on base leg. In any case, the transition to landing configuration should be complete prior to handoff to the PAR final controller. This normally occurs approximately eight miles from the runway.

d. Vectors to final. For a straight-in PAR, transition to landing configuration when inside 13 NM.

e. PAR "box" pattern. The standard PAR "box" pattern consists of sequential vectors to the downwind, base, and semi-final/final legs. Perform the appropriate procedures on each leg as described above. See Figure 22.

5. PAR Final. All procedures described thus far have, as their end result, the establishment of the aircraft on PAR final. The crux of the entire approach is the ability of the pilot to accurately comply with the final controller's course and glidepath corrections until visually acquiring the runway environment or reaching decision height (DH).

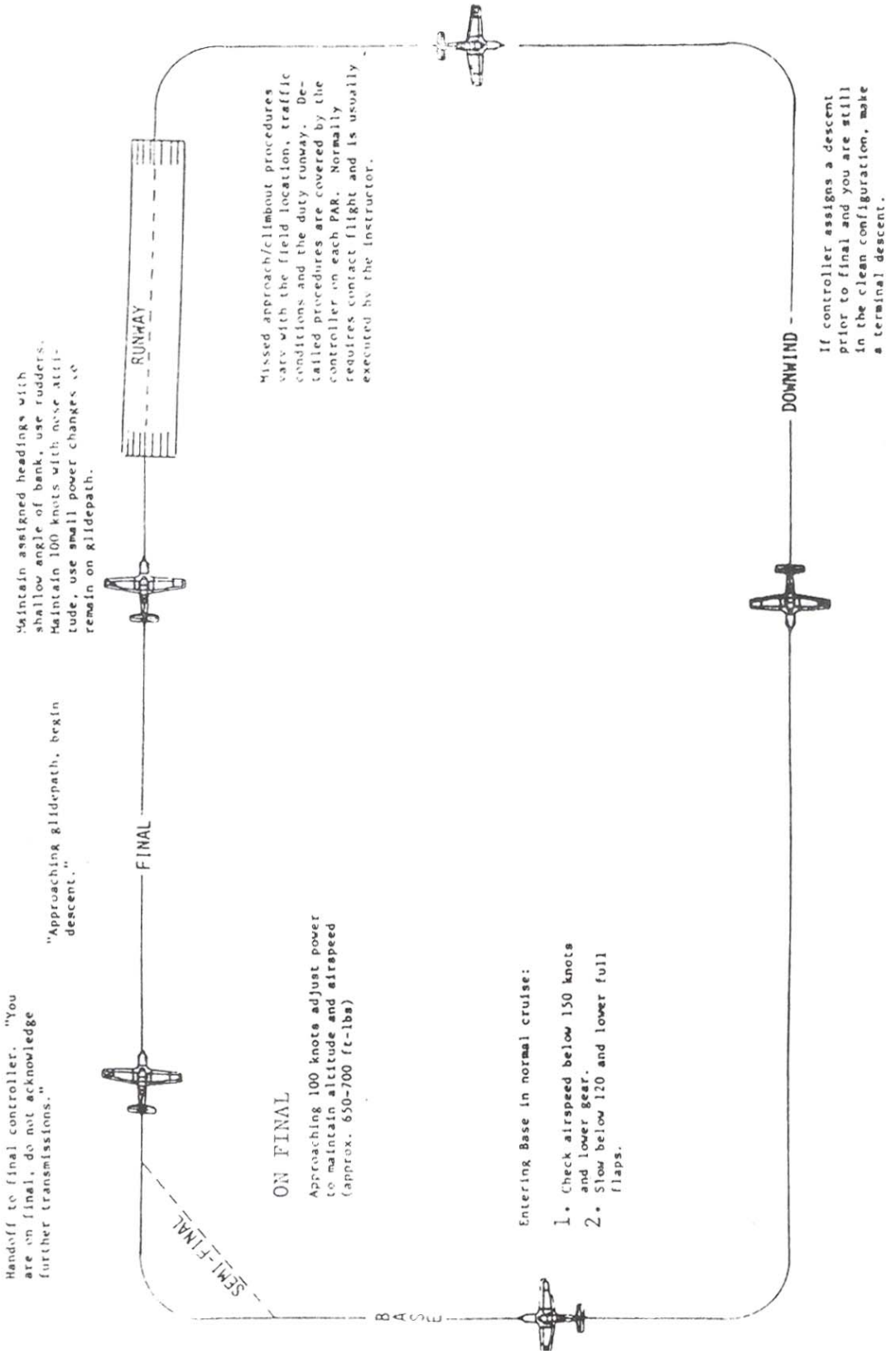

RUNWAY
FINAL
SEMI-FINAL
BASE
DOWNWIND
ON FINAL
Approaching 100 knots adjust power to maintain altitude and airspeed (approx. 650-700 ft-lbs)
Entering Base in normal cruise:
1. Check airspeed below 130 knots and lower gear.
2. Slow below 120 and lower full flaps.
"Approaching glidepath, begin descent."
Handoff to final controller. "You are on final, do not acknowledge further transmissions."
Maintain assigned headings with shallow angle of bank, use rudders. Maintain 100 knots with nose attitude, use small power changes to remain on glidepath.
Missed approach/climbout procedures vary with the field location, traffic conditions and the duty runway. Detailed procedures are covered by the controller on each PAR. Normally requires contact flight and is usually executed by the instructor.
If controller assigns a descent prior to final and you are still in the clean configuration, make a terminal descent.

Figure 22

a. Handoff to the Final Controller. Precision approach radar, though highly accurate, is quite limited in range and azimuth, thus it cannot be used to vector the aircraft downwind and base legs. You will generally be handed off to the final controller on final or semi-final. The final controller will first conduct a radio check, ask you to confirm your wheels are down, and then continue to assign heading changes to properly position the aircraft on PAR final.

b. Maintaining alidepath and course. Once the final controller has established your aircraft on final, he will say, "Do not acknowledge further transmissions." Further heading changes will be assigned as necessary and at approximately five-six miles from the runway, you will be told "approaching glidepath, begin descent." At this point, gradually reduce power to approximately 500 ft-lbs and lower the nose to maintain 100 knots. Check for the descent rate previously determined (approximately 400-500 FPM). The final controller will assign corrections to enable you to maintain glidepath and course.

If the aircraft is observed to deviate above or below the glidepath, the pilot is given the relative amount of deviation by use of terms "slightly" or "well" and needs to adjust his rate of descent to return to the glidepath. Correct these deviations with coordinated pitch and power changes. Maintain a constant airspeed during the approach. When power changes are required, avoid excessive PCL movements. Corrections should be made immediately after instructions are given or when deviations from established attitude or performance indications are desired to return the aircraft to the glidepath.

Accuracy of heading is important for runway alignment during the final approach phase. When instructed to make heading changes, make them immediately. Instructions to turn are preceded by the phrase "turn right" or "turn left." To prevent overshooting, the angle of bank should approximate the number of degrees to be turned, not to exceed a one-half standard rate turn. After a new heading is directed, the controller assumes it is being maintained. Additional heading corrections will be used based on the last assigned heading.

c. Suggested PAR techniques

(1) Due to the precision and quick reactions required during PAR final, the following abbreviated scan has been found to be helpful: Attitude Gyro, Airspeed, RMI and VSI.

(2) Small heading corrections (less than 5°) cause numerous problems. Continue to make coordinated turns using aileron and rudder but never use an angle of bank greater than the number of degrees off heading. This eliminates the tendency to overbank and miss the assigned heading.

(3) Generally the instructor will make all UHF transmissions and use of the ICS should be held at a minimum.

(4) Once established on glidepath with 100 knots, the "glidepath" rate of descent will be indicated on the VSI. Small nose attitude changes can be immediately detected on this instrument. If the VSI begins to indicate a rate of descent greater than the "glidepath" rate of descent, the nose is too low (and vice versa) and an adjustment is necessary to avoid deviating from glidepath. Maintain 100 knots with nose attitude and use small power corrections to adjust rate of descent.

NOTE: Instructor will discuss technique for initial reduction of power in the T-34 to initiate descent. This may vary from aircraft to aircraft.

6. Missed approach. A missed approach must be executed when you reach decision height (DH) if the runway environment is not in sight.

NOTE: After reaching Decision Height (DH), the precision final controller will continue to provide course and flight path information until the aircraft passes over the landing threshold. The information is strictly advisory in nature. Additionally, a missed approach must be executed when any of the following occur:

a. When instructedby the controller, due to aircraft outside safe limits of azimuth or elevation, unless the field is in sight.

NOTE: Decision Heights occurs on your barometric altimeter or when advised by the final controller, whichever occurs first. If published minimums show a 100'HAT, the controller may not call "at decision height" until the aircraft reaches this point. It is your responsibility to initiate the missed approach at the single piloted minimum of 200'HAT if the runway environment is not in sight.

MISSED APPROACH

Introduction. A missed approach is a procedure used to discontinue an instrument approach in the event visual contact has not been established or the aircraft is not in a position to make a safe landing. Your primary concern, if unable to land, is to climb,to a safe altitude. Therefore, establishing and maintaining a positive rate of climb should be your first reaction if a missed approach is commenced. Your second reaction should be to turn the aircraft (if required) to intercept the missed approach course or to the designated heading. (There may be a mountain dead ahead.)

The missed approach procedures are found in the profile view of the approach plate. Review the procedures briefly. Know what you have to do before it is required.

Procedure. At the missed approach point, if the field is not in sight, execute a missed approach as follows:

1. Increase power to maximum allowable.

2. Assume the climbing attitude of 6-8 degrees nose high.

3. Establish a positive rate of climb (check the altimeter and VSI).

4. Retract the gear (before airspeed reaches 120 knots). Turn landing lights off.

5. Maintain 120 knots (trimming as required) and start a standard-rate turn toward the missed approach course or heading. Stay on the attitude gyro and maintain the climbing attitude (6-8 degrees).

6. Establish an appropriate intercept to the missed approach course or continue the turn to the designated heading. The missed approach course may be twisted when comfortably established in the missed approach. Retract flaps passing 300 feet AGL.

7. Continue the 120 knot climb and report missed approach to tower:

SNFO: **"Bob Sikes Tower, Turbo 11, missed approach."**

NOTE: Include the reason for the missed approach unless initiated by ATC.

TOWER: "Navy Turbo 11, Bob Sikes Tower, roger, contact Crestview Approach, frequency 272.7."

SNFO: "Turbo 11, switching 272.7." 7-49

NOTE: You may delay contacting tower or approach control until comfortably established in a wings level climb, on assigned heading or with an intercept established for the missed approach course. "Aviate, navigate, communicate."

8. Level off at missed approach altitude.

NOTE: It is possible to intercept the missed approach course while still in the climb. Watch the tail of the needle and if it approaches the missed approach course, turn the aircraft and intercept while continuing the climb.

9. After the missed approach, ATC needs to know your intentions.

a. Request another approach, fuel permitting. If you flew a bad approach (off altitude or course), you might request clearance to fly the same approach again. If the weather is bad and the field has another approach with lower minimums (such as a GCA approach), you might request clearance to fly it. In the first case, the voice report would be: "Crestview Approach, Turbo 11, missed approach, request clearance for another VOR Bravo approach."

b. If weather and/or fuel considerations dictate proceeding to your alternate, request clearance using the DRAFT format (pestination, Route, Altitude, Fuel, Time enroute). The voice report using the DRAFT format would be: "Crestview Approach, Turbo 11, missed approach, request clearance to my alternate, Navy Whiting Field, via direct Crestview, direct Navy Whiting, request 4500, 1+30 fuel remaining, 0+20 enroute."

Common Errors

1. Scan: When you first execute the missed approach, stay on the attitude gyro exclusively until the aircraft is cleaned up and trimmed up. Raise the nose no more than 6-8° above the horizon and your airspeed won't get slow.

2. Letting the nose attitude drop when commencing the turn. This allows the airspeed to get fast and the climb rate to decay. Stay on the attitude gyro and maintain the climb attitude.

3. Not distinguishing between a depicted heading and a radial outbound type of missed approach.

4. Not trimming as the aircraft accelerates to normal cruise.

5. Trying to contact tower or approach control before comfortably established in the missed approach.

SUMMARY

Instrument departures and approaches are key elements of most flight in Naval aircraft. At a minimum it takes precise course control, a solid instrument scan and good airwork to successfully fly a SID or Approach. Often they require the combination of many instrument techniques such as arcing, holding and the 6 T's. It is obvious that the departure and approach phases are often the most challenging phases of a flight and must be mastered accordingly.

INAV 8: BASIC INAV

Purpose

The purpose of the Basic INAV course review is to provide experience through actual involvement with course materials, lessen the abstract aspects of learning and provide for an atmospheric of informal open discussion for the students.

Description

A comprehensive step-by-step overview of INAV lessons 1-7 will be conducted. Specific emphasis will be placed on addressing those concepts that are basic and germane to the Naval Flight Officer's job. All course learning objectives will be reviewed for understanding and clarity. An atmosphere of open discussion will serve as the review session format throughout the question and answer period.

Requirements

One hour has been allotted or the INAV Review. During the review, students will be permitted to use reference materials and training devices as each deems necessary.

Debrief

Upon completion of the question and answer period, the instructor will make subjective comments regarding overall class performance with emphasis placed on observed areas of weakness.

Critiqqes

At the back of this book, you will final a critique form. Constructive comments and criticisms are encouraged.

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INAV 9: BASIC INAV COURSE EXMINATION

Mastery of the Learning objectives listed at the beginning of each unit will ensure satisfactory completion of the INAV/Flight Planning Exam.

Description of examination

The Basic INAV end-of-course examination comprises approximately twenty-five of fifty total objective-type questions on the Flight Planning Exam.

Time allocation

Three hours (3+00) are allotted for the Flight Planning Exam.

Standards and grading criteria

In order to successfully complete the examination, you are required to correctly answer a minimum of 80% of the questions.

Materials required

The instructor will provide all test materials required for the examination. Text books, class notes or other study aids are prohibited. RMI's and CR-2's may be utilized on the examination.

Testing Procedures

The examination will begin "on time". Students late by less than ten minutes will be permitted to take the examination with their class; however, scheduled completion time remains in effect. Time extensions for late arrivals are prohibited. Students arriving in excess of ten minutes late will be referred to the Academic Training Officer for disposition. All international students will be given an additional 15 minutes to complete the examination.

The instructor will provide an examination, answer sheets, and pencil to each student.

After commencement of the examination, students who leave the room are not permitted re-entry until all students have completed and examination materials have been collected.

Should questions arise during the examination period, students should raise their hand for instructor assistance.

Writing in examination booklets is prohibited. 9-1

STUDENT EVALUATION OF COURSE AND INSTRUCTOR

Name (optional):_____ Class #_____
Course:_____ Instructor:_____
Exam version:_____ Date_____

Assign a grade to each of the evaluation categories for the course and the instructor according to the scale below. A space is provided for you to enter comments and constructive criticism.

UNSAT	POOR	FAIR	GOOD	EXCELLENT
1	2	3	4	5

I. COURSE EVALUATION

1. Learning objectives were clearly explained. ☐
2. Course was well planned with a logical sequence. ☐
3. Class presentation covered objectives. ☐
4. Training aids enhanced the lecture material. ☐
5. Course material (book, handouts, etc.) were well planned and organized. ☐
6. Assignments/readings increased understanding. ☐
7. Examination represented the material and learning objectives. ☐
8. Safety, relevant to the material, was emphasized. ☐

II. What sections or topics of the course were the most difficult to understand? Explain why?

III. How can we improve this course?

IV. INSTRUCTOR EVALUATION

1. Was prepared for class. ☐
2. Displayed enthusiasm toward subject. ☐
3. Demonstrated knowledge of subject material. ☐
4. Appropriate Presented material clearly, at an level for all students. ☐
5. Encouraged class participation. ☐
6. Invited questions. ☐
7. Answered questions adequately. ☐
8. Used training aids effectively. ☐
9. Made good use of allotted time. ☐
10. Displayed a professional attitude. ☐

V. In your opinion, what is the major strength of this instructor?

VI. In your opinion, what is the major weakness of this instructor and how can it be improved?

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