NAVAL AIR TRAINING COMMAND

NAS CORPUS CHRISTI, TEXAS CNATRA P-403 (Rev. 9-14)

INSTRUMENT NAVIGATION WORKBOOK

ADVANCED HELICOPTER TH-57C

2014

DEPARTMENT OF THE NAVY
CHIEF OF NAVAL AIR TRAINING
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Subj: INSTRUMENT NAVIGATION WORKBOOK, ADVANCED HELICOPTER, TH-57C

1. CNATRA P-403 (Rev. 09-14) PAT, "Instrument Navigation Workbook, Advanced Helicopter, TH-57C" is issued for information, standardization of instruction, and guidance to all flight instructors and student military aviators in the Naval Air Training Command.

2. This publication is an explanatory aid to the Helicopter curriculum and shall be the authority for the execution of all flight procedures and maneuvers herein contained.

3. Recommendations for changes shall be submitted via CNATRA TCR form 1550/19 in accordance with CNATRAINST 1550.6 series.

4. CNATRA P-403 (Rev. 12-09) PAT is hereby cancelled and superseded.

M. B. TATSCH
By direction

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STUDENT GUIDE

FOR

ADVANCED INSTRUMENT NAVIGATION WORKBOOK

TH-57C

P-403

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LIST OF EFFECTIVE PAGES

Dates of issue for original and changed pages are:
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INTERIM CHANGE SUMMARY

The following Changes have been previously incorporated in this manual:

CHANGE NUMBER	REMARKS/PURPOSE

The following interim Changes have been incorporated in this Change/Revision:

INTERIM CHANGE NUMBER	REMARKS/PURPOSE	ENTERED BY	DATE

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ADVANCED PHASE

DISCIPLINE: Instrument Navigation Advanced Helicopter

COURSE TITLE: Instrument Navigation

UNIT: Instrument Navigation Advanced Helicopter Workbook

WORKBOOK SCOPE

Upon completion of this workbook, student naval aviators will interpret all elements involved in planning, filing, and flying on an instrument flight plan and respond to questions on the criterion test with a minimum score of 80%.

TERMINAL OBJECTIVES

1. Recall OPNAVINST 3710.7, FAA Flight Rules and Regulations, and FLIP procedures.

2. Recall approach procedures, approach clearances, ATIS, terminal radar control and other related information.

3 Recall elements of the airways route system and techniques for the proper utilization of navigational aids, specifically the VOR, TACAN, and VORTAC.

4. Interpret the functions of the TACAN and VOR navigation by solving given problems and answering related questions.

5. Interpret the functions of the instrument landing system as it applies to the TH-57C.

6. State the use of nondirectional radio beacons, ADF procedures, and the TH-57C helicopter direction finding equipment.

7. Recall elements of the Global Positioning System (GPS) and state techniques and procedures as they apply to the TH-57C.

8. Recall facts about the development, uses, and operation of the KT-79 Transponder.

9. Recall procedures and general information for executing Ground Controlled Approaches.

10. Recall IFR holding procedures.

11. Write voice reports in the correct format using the correct phraseology.

12 Resolve the correct procedure to follow in the event of two-way communication failure during IFR flight on the federal airways.

INTRODUCTION TO INSTRUMENT NAVIGATION ADVANCED HELICOPTER WORKBOOK

The purpose of this unit is to introduce and review procedures and concepts related to instrument navigation. Special emphasis will be given to the advanced procedures needed by helicopter aviation students. Many of the specific details will pertain to a single-piloted TH-57C.

There is a multitude of publication instructions, regulations, and various other information sources that a pilot must be aware of before attempting a flight, especially in IFR conditions. This book will highlight some of the more important points and the ones that are most commonly misinterpreted or incorrectly applied. Source documents for this workbook are located on page C-1. All the information presented therein was current at the time of publication, but is subject to change upon update and revision of the source documents. From time to time, various elements in these publications are either deleted, moved to another publication, or added. Thus, it is imperative the naval aviator stay abreast of all of the changes. ***The reason a thorough knowledge is important is that not only can ignorance of the proper procedures lead to a flight violation, but it may also lead to loss of an aircraft or even a life.***

Two of the most important publications involving naval aviators are the Federal Aviation Regulations (FAR) and the NATOPS General Flight and Operating Instructions (OPNAVINST 3710.7). The Federal Aviation Administration publishes the section which most concerns the military pilot; FAR Part 91. This section deals primarily with the rules of the road. The Chief of Naval Operations has set forth rules governing the operations of naval aircraft. These rules are found in the OPNAVINST 3710.7 (series).

HOW TO USE THIS WORKBOOK

1. Read and become familiar with these objectives. These objectives state the purpose of each chapter of instruction in terms of WHAT YOU WILL BE ABLE TO DO after you complete the unit. Most importantly, your end-of-course examination is developed directly from these instructional objectives. Therefore, it is to your benefit to know all information the objectives are asking you to comprehend.

2. Read and comprehend the information in each chapter. Each chapter consists of a set of facts and explanations. After comprehending all facts and information indicated by the objectives, complete the post test and check your answers. If you answer the questions correctly, continue to the next chapter. If you incorrectly answer a question(s), review the objective and information covering that subject area.

CHAPTER ONE
OPNAVINST 3710.7/FAR PART 91

100. INTRODUCTION

OPNAVINST 3710.7 paragraph 1.2.3 states that "naval aircraft shall be operated in accordance with applicable provisions of FAR Part 91 except where this instruction prescribes more stringent requirements." However, there are a few areas in which FAA has permitted the Navy to deviate from FAR Part 91. In certain areas dealing with aircraft speed, alternate airport weather requirements, and special low level missions, the Navy ***is less*** stringent than the corresponding regulation in the FAR Part 91.

101. LESSON TOPIC LEARNING OBJECTIVES

Terminal Objective

The specific purpose of this chapter is to recall OPNAVINST 3710.7, FAA Flight Rules and Regulations, and FLIP procedures. Using the listed publications, the student should answer all questions on the criterion test.

Enabling Objectives

1. List the services of Flight Service Stations (FSS) and their standard operating frequencies.

2. State VFR/IFR semicircular cruising rules.

3. List FAR/OPNAV cloud clearances and visibility requirements to operate in controlled airspace and uncontrolled airspace and special rules for helicopters (if any).

4. State the OPNAV rules for operating helicopters in Class B, C, and D airspace and special rules for helicopters (if any).

5. List OPNAV restrictions for operating aircraft near persons, vessels, vehicles, structures, disaster areas, resorts, cities, villages, and beaches.

6. State the responsibilities of an aircraft commander.

7. State the requirements for annual instrument evaluations.

8. List personnel authorized to start helicopter engines.

9. List personnel authorized to engage the rotors of helicopters.

10. State the OPNAV requirements for the use of life rafts, life jackets, and parachutes, and special requirements for their use which apply to helicopters.

11. State the OPNAV restrictions for the operation of aircraft near commercial and civil aircraft.

12. List OPNAV standard card takeoff weather minimums.

13. State the OPNAV definition of a multi-piloted aircraft.

14. State OPNAV approach minimums for single-piloted and multi-piloted aircraft and special rules for helicopters (if any).

15. State OPNAV requirements for selection of alternate airports on IFR flight plans.

16. Apply OPNAV flight planning approach minimums at the destination airport for the approach being made.

17. Apply OPNAV requirements for selection of an alternate airport.

18. Complete minimum fuel reserve as required by OPNAV for turbine-powered aircraft (and helicopters).

102. SPECIFIC TOPIC AREAS

The following contains specific topic areas covered by either the FAR or OPNAVINST 3710.7 or both. It is imperative the naval aviator thoroughly understand each concept.

Emergencies

The FAA, realizing there are situations when a pilot may not be able to follow FAR, makes provisions for deviations from FAR. FAR Part 91.3 states, "In an emergency requiring immediate action, the pilot in command may deviate from any rule...to the extent required to meet that emergency."

Preflight Planning

FAR states a pilot in command shall, before beginning every flight, familiarize himself/herself with all available information concerning that flight. This information gathering is called "preflight planning" and should include (but is not limited to) information concerning weather, NOTAMs, fuel requirements, possible alternate or emergency airfields enroute, and anticipated delays.

Pilot in Command

FAR Part 91 states the "pilot in command" of an aircraft is the pilot responsible for the operation and safety of an aircraft. OPNAVINST 3710.7 paragraph 3.7.1 further defines the pilot in command as the pilot who is assigned the responsibility for the safe and orderly conduct of a flight and for the well-being of the crew. The authority and responsibility of the pilot in command shall not be transferred during flight.

OPNAVINST 3710.7 paragraph 3.7.1 additionally states the authority and responsibility of a pilot in command is independent of rank or seniority in relation to other participants in the flight ***except*** in the following situations:

1. OFFICER IN TACTICAL COMMAND EMBARKED. Wing, group, or squadron commanders, if embarked on a mission involving aircraft of their command retain full authority and responsibility regarding command, including the mission in which participating.

2. FLAG OR GENERAL OFFICER EMBARKED. A flag or general officer eligible for command at sea or in the field embarked aboard an aircraft as a passenger, may elect to exercise his authority to command the aircraft, thereby assuming full responsibility for the safe orderly conduct of the flight.

103. REQUIREMENTS FOR INSTRUMENT RATINGS AND QUALIFICATIONS

OPNAVINST 3710.7, Chapter 13 gives guidelines on the requirements for a standard or special instrument rating, as well as annual requirements for qualification. The instrument check ride you will fly at the end of the radio instrument syllabus constitutes your initial qualification, which expires one year after the last day of the month in which the evaluation was completed. Renewal of instrument ratings shall be accomplished annually.

Within the six months preceding the date of the instrument evaluation flight, each pilot must have completed a minimum of:

1. Six hours of instrument flight, either actual or simulated;

2. Twelve approaches (six precision and six non-precision), either actual or simulated.

Within 12 months, a minimum of:

1. Twelve hours of instrument flight, either actual or simulated.

2. Eighteen approaches (twelve precision and six non-precision), either actual or simulated.

Furthermore, a formal instrument ground syllabus with a written examination must be completed within 60 days prior to the evaluation flight. If such a syllabus is not available, the command to which the pilot is assigned shall ensure the completion of an examination.

Standard ratings are assigned with 50 hours of instrument flight and successful completion of an instrument flight evaluation. Special ratings require:

1. Five years of military and nonmilitary flying experience.

2. Two thousand hours flight time.

3. One hundred hours of military actual instrument time.

Instrument evaluation flights are conducted in accordance with the NATOPS Instrument Flight Manual (NIFM). The instrument flight evaluation consists of two parts; one part covers basic instrument flying and the other covers the planning and conduct of a flight under actual or simulated instrument conditions in control areas. Specific maneuvers to be evaluated and their grading criteria are listed in NIFM. An unsatisfactory grade in any area shall result in an unsatisfactory grade for the flight.

104. INSTRUMENT FLIGHT REQUIREMENTS

NATOPS INSTRUMENT RATING REQUEST
OPNAV 3710/2 (REV. 1-74) S/N 0107-728-2903

REF: OPNAVINST 3710.7 SERIES
OPNAVINST 3510.9 SERIES
NATOPS INSTRUMENT FLIGHT MANUAL

NAME *(Last, first, middle initial)*	GRADE	SSN	DATE

UNIT

APPLICATION IS HEREBY MADE FOR AN INSTRUMENT RATING *(Check one)*
☐ STANDARD ☐ SPECIAL

EXPERIENCE SUMMARY

MISCELLANEOUS SUMMARY

ITEM	LAST 6 MO.	LAST 12 MO.
PRECISION APPROACHES		
NON-PRECISION APPROACHES		
TOTAL PILOT TIME		

INSTRUMENT PILOT TIME

ITEM	PAST 12 MO.	LAST 6 MO.	TOTAL ALL YEARS
ACTUAL			
SIMULATED			
INSTRUMENT PILOT TIME TOTAL			
TOTAL YEARS FLYING EXPERIENCE *(Military and Commercial)*			

AIRCRAFT QUALIFICATIONS

CURRENT RATING

PILOT'S BIRTHDAY

SIGNATURE OF APPLICANT

WRITTEN EXAMINATION

THIS IS TO CERTIFY THAT THE APPLICANT HAS . . .
☐ SATISFACTORILY ☐ UNSATISFACTORILY
. . . COMPLETED THE WRITTEN EXAMINATION FOR AN INSTRUMENT RATING AS REQUIRED BY THE NATOPS INSTRUMENT FLIGHT MANUAL

1ST EXAM *(Grade)*	2ND EXAM *(Grade)*	3RD EXAM *(Grade)*

SIGNATURE OF EXAMINING OFFICER	*(Grade)*
	DATE

FLIGHT EVALUATION

	PART ONE *(Basic Instruments)*	QUAL	UNQUAL
1	INSTRUMENT TAKEOFF *(Optional)*		
*2	CLIMBING, DESCENDING AND TIMED TURNS		
*3	STEEP TURNS		
*4	RECOVERY FROM UNUSUAL ALTITUDES		
5	VOR/TACAN POSITIONING		
*6	PARTIAL PANEL AIRWORK		
7	ADF/MDF ORIENTATION		

	PART TWO *(Instrument Flight within control areas with emphasis on VOR, TACAN where feasible.)*	QUAL	UNQUAL
1	FLIGHT PLANNING		
2	CLEARANCE COMPLIANCE		
3	INSTRUMENT APPROACHES		
4	COMMUNICATIONS AND NAVIGATION EQUIPMENT		
5	EMERGENCY PROCEDURES		
6	VOICE PROCEDURES		

*Not required when evaluation is conducted under actual instrument conditions.

REMARKS

DATE OF FLIGHT CHECK	AIRCRAFT MODEL	BUNO	INSTRUMENT RATING ISSUED ☐ STANDARD ☐ SPECIAL	*(Expires)*

SIGNATURE OF FLIGHT EXAMINER *(Grade and title)*	SIGNATURE OF OFFICER ISSUING CARD *(Grade and title)*

Figure 1-1 NATOPS Instrument Rating Request (OPNAV 3710/2)

105. OPNAVINST 3710.7 READING REQUIREMENTS

OPNAVINST 3710.7 prescribes general flight and operation instructions and procedures applicable to all naval aircraft. Therefore, all designated Naval Aviators should be familiar with its contents.

For the purposes of this course of instruction and the examination, chapters 4, 5 (excluding ACM), 6 and 9 are testable along with the Glossary and Abbreviations appendices. Chapters 1, 3, 7, 8 and 13 have information you should be familiar with prior to your instrument check flight and receiving your wings.

REVIEW QUESTIONS

The following publications may be used with this review.

OPNAVINST 3710.7 series

General Planning (GP)

Area Planning (AP-1)

IFR Supplement

Low Altitude Approach Procedures, Volumes 14, 16, 17, 18, and 19, dated 27 Oct 2005

Aeronautical Information Manual

IFR Enroute Low Altitude Chart, dated 27 Oct 2005

1. Which sub-agency of the FAA is responsible for providing all aircraft with in-flight radio assistance such as weather broadcasts, VFR position reports and accepting amended flight plans?

a. "Pensacola Metro"
b. "Jacksonville Center"
c. "Orlando Approach Control"
d. "Dothan Radio"

2. In the absence of direct orders from higher authority, the responsibility for starting or continuing a mission with respect to weather or any other condition affecting safety of the aircraft rests with the pilot in command.

a. True
b. False

3. When the engine of a helicopter is started, the controls should be manned by a qualified ____________. Commanding Officers may authorize certain specifically qualified personnel, other than pilots, to ground test helicopters when a pilot is not available. Rotors shall not be engaged except by a qualified ____________.

a. Pilot . . . Pilot
b. Helicopter pilot . . . Helicopter pilot
c. Pilot . . . Mechanic
d. Mechanic . . . Pilot

4. Inflatable life preservers shall be worn during all flights originating from or terminating on ships or landing platforms and should be readily available when operating from aerodromes in the vicinity of coastal waters or when operating from inland aerodromes where takeoff, route of flight, or approach path is over water.

a. True
b. False

5. For the execution of a straight-in landing, the visibility required for helicopters may be reduced by one-half that of Category-A aircraft, but in no case may it be reduced to less than one-fourth mile or 1200 feet RVR for single-piloted aircraft.

a. True b. False

6. In the case of major accidents, natural disasters, or events of high public interest, temporary flight restrictions may be placed in effect. Normally, the exact dimensions of this airspace will be included in the

a. VFR Supplement. b. IFR Supplement
c. NOTAMs. d. AP-1A/2A/3A.

7. According to OPNAVINST 3710.7, commercial and civil aircraft shall be avoided by at least ______ feet vertically or ______ mile(s) laterally.

a. 500 . . . 1 b. 500 . . . 2
c. 1000 . . . 1 d. 1000 . . . 2

8. Generally Class "D" Airspace is composed of a ____________ and controls aircraft up to ___________ with horizontal limits as needed.

a. Control Tower . . . 2500 AGL b. Control Tower . . . 2500 MSL
c. Control Tower . . . 3000 AGL d. Control Tower . . . 3000 MSL

9. Helicopter flights within Class "D" airspace shall be in accordance with the local flight rules. Where no guidance is provided, pilots shall not exceed ______ AGL unless specifically cleared by the tower or other control agency.

a. 200 b. 500
c. 1000 d. 1200

10. No person may operate an aircraft within Class "B" Airspace unless that person has received ____________ from Air Traffic Control (ATC) prior to operation.

11. For a turbine-powered helicopter, OPNAVINST 3710.7 states that the planned reserve fuel after final landing at the destination or alternate, if required, shall not be less than that fuel required for 20 minutes of flight at a fuel consumption based on

a. Maximum endurance operation at normal cruise altitude.
b. Maximum endurance operation at 10,000 feet.
c. Operation at planned flight altitude.
d. Reserve fuel not required for a VFR flight.

12. For a standard card pilot departing North Myrtle Beach Rwy 23 and all equipment is up and operating, the absolute lowest takeoff weather minimums are

a. 200 . . . ¼ b. 200 . . . ½
c. 300 . . . ¾ d. 300 . . . 1

13. According to OPNAVINST 3710.7, the TH-57C meets the requirements of a multi-piloted aircraft when being flown by two pilots, both meeting the requirements of the TH-57C NATOPS Manual.

a. True b. False

14. With reported weather of 200 feet broken and 3 miles visibility, may a single-piloted helicopter depart NAS Meridian, Mississippi, on duty runway 19? If yes, could the departure be VFR?

a. No . . . No b. Yes . . . Yes
c. No . . . Yes d. Yes . . . No

15. What is the absolute lowest weather minimum for a single-piloted helicopter executing a precision (PAR, ILS) approach?

a. 200 . . . ¼ or 1200 RVR
b. 200 . . . ½ or 2400 RVR
c. Both a and b above, whichever is higher
d. 33 . . . 1

16. When selecting a suitable alternate, radar (PAR/ASR) approach minimums at the alternate may NOT be used by pilots flying

a. single-piloted aircraft.
b. multi-piloted aircraft.
c. aircraft with one operable UHF/VHF transceiver.
d. both a and c.

17. Alternate weather requirements are based on the pilot's best judgment as to the runway that will be in use upon arrival at the destination and alternate.

a. True b. False

18. Assume that you are flying in a single-piloted TH-57C and your destination is Dobbins ARB, Georgia. The forecast winds at Dobbins at your planned ETA are 27015KT. What are your lowest approach minimums for the execution of an approach at Dobbins ARB?

a. 100 . . . ¾
b. 300 . . . ½
c. 200 . . . ½
d. 200 . . . ¼

19. In reference to question 18, Dobbins ARB forecast weather at your planned ETA (±1 hour) is KMGE BCMG 0350 14008KT 1600 +RA BKN004 OVC010 QNH 2992INS. To file an IFR flight plan to Dobbins, you must select a suitable alternate whose forecast is at least

a. 3000 ... 3.
b. Non-precision approach published minimums plus 300 . . . 1.
c PAR approach published minimums plus 200 . . . ½.
d. 1000 . . . 1.

20. You are planning an IFR flight to NAS Pensacola in a single-piloted helicopter. Pensacola's forecast weather at your planned ETA (±1 hour) is KNPA FM1200 20015KT 1600 FG BKN003 OVC010 QNH 2998INS. For flight planning purposes, what are your lowest approach minimums at NAS Pensacola?

a. 200 . . . ¼
b. 200 . . . ½
c. 400 . . . ¼
d. 400 . . . ½

21. In reference to question 20, and in accordance with OPNAVINST 3710.7, if NAS South Whiting is your planned alternate, what must NAS Whiting Field be forecasting before you can file an IFR flight to NAS Pensacola?

a. 300 . . . ¼
b. 300 . . . ½
c. 600 . . . 1
d. 400 . . . 1

22. Your destination is Tyndall AFB, Florida, and you are flying a single-piloted helicopter. The weather at Tyndall at your planned ETA (±1 hour) is KPAM TAF FM1400 03016KT 3200 RA BKN003 OVC010 QNH 3013INS. If Moody AFB, Georgia, is the only available alternate, what is the minimum weather Moody may be forecasting for you to file an IFR flight plan to Tyndall AFB?

a. 400 . . . ½
b. 400 . . . 1
c. 700 . . . 1½
d. 3000 . . . 3

23. Assume you are planning a flight to NAS Whiting Field North in a TH-57 from NAS New Orleans with an ETE of 1+45 minutes and your TH-57 has 2+30 minutes of fuel on board. If Whiting is forecasting KNSE TAF BCMG 1819 12010KT 3200 RA BKN002 OVC010 QNH 2992INS at your planned ETA (±1 hour) and all the suitable alternates within 100 NM of Whiting are lower, can you file an IFR flight plan to Whiting Field?

a. Yes b. No

24. Assume you are flying a TH-57C and your final destination is NAS North Whiting Field. Pensacola Approach Control has cleared you for North Whiting TACAN Rwy 14 approach and reports Whiting weather is KNSE FM1900 03006KT 4800 HZ BKN002 QNH 3016INS. May you accept the approach clearance and commence the approach?

a. Yes b. No

25. Outside of controlled airspace, a helicopter may be operated below 1200 feet AGL when the visibility is less than 1 statute mile.

a. True b. False

26. A helicopter is operating under special VFR clearance in Class "E" Airspace. Which of the following requirements does not apply?

a. Pilot and aircraft must be certified for instrument flight.
b. Remain 500 feet below clouds.
c. Authorization from ATC in Class "E" Airspace
d. Maintain 1 mile visibility unless waived for operational necessity.

27. VFR semicircular cruising rules begin at

a. 1000 feet MSL.
b. 2000 feet AGL.
c. 3000 feet MSL.
d. 3000 feet AGL.

28. What are FSS's two standard frequencies?

a. 255.4 . . . 272.2 b. 122.2 . . . 255.4
c. 243.0 . . . 255.2 d. 121.5 . . . 122.1

29. A TH-57C must have an operable clock with a sweep second hand for instrument flight.

a. True b. False

30. You are flying a TH-57C single-piloted, and your destination is forecasting at or above your lowest approach mins but below 3000 feet/3 mile visibility. With Keesler AFB as your alternate, what are the lowest acceptable weather mins for filing purposes?

a. 700 . . . 1¾
b. 800 . . . 2
c. 400 . . . 1
d. 300 . . . ¾

31. Within 12 months of an instrument evaluation, a pilot is required to have a minimum of ______ hours of instrument flight and ______ approaches, (______ precision and ______ non-precision).

32. Helicopters may reduce Category A visibility on non-copter procedures to ______ of published minima, but no lower than ____________ when executing an approach. This is based on airspeeds not exceeding 90 knots on final approach.

SINGLE-PILOTED MINIMUMS

(___) = mins taken from approach plates
<___> = your mins derived using criteria in OPNAV 3710

I. FLIGHT PLANNING: Forecast weather for ETA + 1 hour.

Destination: ________ name/ID	Alternate: ________ name/ID	
CIG/VIS ____ WIND ___/___	CIG/VIS ____ WIND ___/___	
3000/3	<Not Required>	
(/) up to 3000/3	Non-Prec	Precision
Expected approaches TYPE RWY MINS	(/)	(/)
______(___)	+ 300/1	+ 200/ 1/2
______(___)	< >	< >
______(___)		
0/0 up to (___/___)	<3000/3>	
Radar mins MAY be used for dest.	NO radar mins for alt.	

II. TAKEOFF CRITERIA: Observed weather at actual time of takeoff.

Takeoff from: __________ Wind ______ Rwy ___

Non-precision	Precision
(/)	(/)
or	or
300/1	200/1
< >	< >

III. ENROUTE: Observed and forecast weather for entire route. Practice approaches at fields other than destination may be executed with no weather mins.

IV. APPROACH CRITERIA: Observed weather at the time of the approach.

	TYPE	RWY	(PUB MINS)	<HELO MINS>
1.	______		(____)	<____>
2.	______		(____)	<____>
3.	______		(____)	<____>

Figure 1-2 Single-Piloted Minimums

REVIEW ANSWERS

1.	d.	GP	17.	a.	3710
2.	a.	3710	18.	d.	3710/APP VOLS
3.	b.	3710	19.	b.	3710
4.	a.	3710	20.	a.	3710
5.	a.	3710	21.	d.	APP VOLS
6.	c.	FAR 91	22.	b.	APP VOLS
7.	a.	3710	23.	b.	3710
8.	a.	(GP)	24.	b.	3710
9.	b.	3710	25.	a.	3710
10.	clearance	(AP-1)	26.	b.	3710/FAR
11.	c.	3710	27.	d.	FAR
12.	b.	3710	28.	b.	IFR Low Alt Chart
13.	a.	3710	29.	b.	3710
14.	d.	APP VOLS/3710	30.	c.	APP VOLS
15.	a.	3710	31.	12, 18, 12, 6	3710
16.	d.	3710	32.	½, ¼ mile or 1200 RVR	3710

CHAPTER TWO
IFR FLIGHT

200. INTRODUCTION

This chapter is intended to review the important concepts of filing and flying an IFR flight plan. Additionally, it touches upon the organization of ATC and how it affects your flight.

201. LESSON TOPIC LEARNING OBJECTIVES

Terminal Objective

Upon completion of this chapter, and in response to questions and examples given on the post test, the student will recall approach procedures, approach clearances, ATIS, terminal radar control and other related information with a minimum score of 80%.

Enabling Objectives

1. List the uses of each of the four FLIP publications.

2. List the information and services provided by ATIS.

3. State the two major responsibilities of Approach Control.

4. State the relationship between the ATRCC and Departure/Approach Controls.

5. State takeoff minimums for standard card pilots and special card pilots.

6. State the ceiling and visibility minimums for various approaches.

7. State specific ceiling and visibility minimums for the type of approach to be executed.

8. Label approach diagrams with correct approach procedures.

9. List the differences between a visual approach and a contact approach.

10. Define "Sidestep Maneuver."

11. State missed approach procedures.

12. Select the correct procedure by translating approach clearances issued by Approach Control.

13. Select the correct requested information provided by approach plates.

14. Determine when to use straight-in landing minimums or circling landing minimums.

15. Apply OPNAV Instructions minimums for takeoff to various given situations.

16. Apply OPNAV Instructions for approach minimums to various given situations.

17. Apply OPNAV Instructions for selecting alternate airports in various given situations.

18. State which Navy/Marine flights require a flight plan.

19. List two acceptable types of flight plans as defined by OPNAVINST 3710.7.

20. State the type of flight plan used by the Training Command for syllabus flights within the local training area.

21. State what actions the pilot in command must take to close out the flight plan upon landing at a military or civilian airfield.

22. State what actions are required of the pilot in command to receive an IFR clearance from a military or civilian airfield, under the circumstances listed in this unit.

23. State which agency of the FAA handles flight following for the U.S. Navy.

24. State which personnel aboard the aircraft must be listed on the manifest.

25. State where the passenger manifest must be deposited before takeoff from a civilian airport.

26. State when a copy of the flight plan must be left with the passenger manifest.

27. State the reason for closing out a flight plan.

28. State the difference between closing out and canceling a flight plan.

29. State who is responsible for closing out a flight plan under all conditions.

30. State where a pilot can obtain a weather brief at a civilian airport.

31. State what is meant when a control tower says that a clearance is on request.

32. State what happens to a request for an ATC clearance from the time it is turned in to base operations at a military airfield until it is read to the pilot.

33. Define an ATC approved "visual approach."

34. Define an ATC approved "contact approach."

35. State the procedures for a charted visual approach.

202. FLIGHT PLANS

Due to OPNAVINST 3710.7 (series), you will be required to file a flight plan anytime you fly while in the Navy or Marine Corps. This workbook text will describe the reasons for this, the general procedures to be used, and some of the variables that may be encountered.

A few quotes from OPNAVINST 3710.7, with explanations, are in order. OPNAV says the following about the requirements for filing a flight plan:

A flight plan appropriate for the intended operation shall be submitted to the local air traffic control facility for all flights of naval aircraft except the following:

1. Flights of operational necessity.

2. Student training flights under the cognizance of the Naval Air Training Command conducted within authorized training areas. The Chief of Naval Air Training shall institute measures to provide adequate flight following service.

In other words, unless you are one of the exceptions listed, you ***will*** file a flight plan for ***all*** flights. Note, Training Command flights are excepted only when remaining within the local training area.

The following items constitute a flight plan, as defined by OPNAVINST 3710.7:

1. DD 175 Military Flight Plan used from airfields at which a military operations department is located.

2. Daily flight schedule when the flight will be conducted within the local training area,

3. FAA Flight Plan at airfields in the United States which do not have military installations,

4. An ICAO Flight Plan, or military version thereof, for flights conducted in international airspace, and,

5. The flight plan specified by the local authorities shall be used for flights originating at points of departure outside the United States.

As you can see, the daily flight schedule constitutes a flight plan, as long as you stay within the local training area. Thus, you are on a flight plan for all Training Command flights. When you land at the end of your flight and Ground Control tells you they have "closed you out," it means they have closed out your flight plan.

Now we know we must file a flight plan, we need to know which type (IFR or VFR) to file. OPNAVINST 3710.7 has two paragraphs to cover this topic:

“Meteorological conditions notwithstanding, IFR flight plans shall be filed and flown whenever practicable as a means to reduce midair collision potential.”

“To decrease the probability of midair collisions, all flights in naval aircraft shall be conducted in accordance with IFR to the maximum extent practicable. This shall be construed to include all point-to-point and "round robin" flights using the federal airways, and other flights or portions thereof, such as flights to and from targets or operating areas that may be amenable to IFR filing. All other portions of the flights shall be conducted under positive control to the maximum extent possible.”

These quotes are self-explanatory. With a few exceptions, such as urgent military necessity, all flights will be filed on IFR flight plans.

In addition to the flight plan, the Navy has an agreement with the FAA to provide flight following. Under this agreement, the FSS in the local area is notified when you take off from a military field by the tower. FSS has your flight plan and knows your destination. Using the ETE on the flight plan and the takeoff time, an ETA is derived and passed on to the FSS near your destination. When you land, the FSS at the destination is notified. If the destination FSS is not notified of your landing within 30 minutes of the ETA (15 minutes for jets), they begin a systematic search for your aircraft. This flight following service is provided to all military aircraft, and is available on request to civilian aircraft.

With the protection provided by flight following goes a responsibility to notify FSS of your takeoff and safe arrival. In the case of local flights within the local training area, the control tower handles flight following and logs you in and out. On flights where a DD-175 is filed, the tower at a military airfield notifies FSS of your departure, and if you land at a military airfield, the tower then notifies FSS of your arrival. However, it is the pilot's responsibility to see this is accomplished.

The procedures to follow in filing a flight plan vary with the type of airport and the proximity of the FSS. We will cover each situation individually for both departure and arrival. The five basic situations to be covered are:

1. Military installations.

2. Civilian field, operating tower, FSS at the field.

3. Civilian field, operating tower, FSS not at the field.

4. Civilian field, no operating tower, FSS at the field.

5. Civilian field, no operating tower, FSS not at the field.

NOTE

The mere presence of a control tower does not mean it will be operating when you takeoff or land.

203. MILITARY INSTALLATIONS

Here you get a weather brief from the Naval Meteorology and Oceanography Command (NAVMETOCCOM) or their equivalent, fill out a DD-175 and then submit a copy of each to Base Operations. Base Operations usually has a flight planning branch to handle this. In the event there is no military weather forecaster available, you may call the nearest military weather briefing facility as listed in the Flight Information Handbook. OPNAVINST 3710.7 requires a weather briefing for all flights, and a DD-175-1 written briefing for IFR flights. Chapter 4.8.3.1 addresses how to obtain a brief if military forecasters are not available. This briefing is good for up to 30 minutes after the estimated time of departure.

The Operations Department passes your flight plan to FSS, and inserts it into the ATC computers. When you are in your aircraft and ready to taxi, call the tower (on ground control or clearance delivery frequency) and ask them to place your clearance on request. At this time, the tower will request your clearance from ATC via phone or computer. When they have it, they will ask you if you are ready to copy it. They will then read the ATC clearance to you. When you takeoff, the tower notifies FSS to activate the flight plan, and you contact Departure Control for positive control/IFR flight following to your enroute airway. When you arrive at your destination (a military airfield), tower closes out your flight plan by notifying FSS of your arrival. Anytime your destination is a military airport, FSS notifies the destination of your impending arrival and ETA so your destination can prepare to receive you.

A few more quotes from OPNAV are again in order:

Delivery of a properly prepared flight plan form to duty personnel at an established Base Operations Office at the point of departure assures the appropriate ARTCC/FSS will be furnished with the following:

1. Essential elements of the flight plan as initially approved, and

2. A takeoff report

It is the responsibility of the pilot in command/formation leader to ensure the proper agency is notified of flight termination. At military installations, the pilot shall either verbally confirm the closing of the flight plan with tower or Base Operations personnel or deliver a copy of the flight plan form to Base Operations.

The pilot in command may cancel an IFR flight plan at any time. However, a flight plan cannot be closed out (to terminate flight following) until you land.

Cancellation of an instrument flight plan in no way meets the requirement for "closing out" the flight plan. If you cancel your IFR flight plan, then you must file either an IFR or VFR flight plan in the air to cover the remainder of the flight. Only when a landing report has been properly delivered to the nearest FSS can a flight plan be considered to be closed out.

To depart a civilian field with an FSS at the field, you may get your weather brief either in person or over the phone from the FSS at the same time you file your flight plan with FSS. They will insert it into the ATC computers and you can place the clearance "on request" through the tower just like a military facility. However, the civilian tower will not notify FSS of your takeoff time (to activate the flight plan), so you must do this yourself when you are airborne.
The DD-175 flight plan form shows the persons on board your aircraft. However, you will not use this form at a civilian airport. Therefore, you must make up a list to leave with a responsible person. The airport manager or FSS are responsible persons, and would be easy for anyone to contact. OPNAVINST 3710.7 has the following to say about your manifest:

The pilot in command of a naval aircraft flight shall ensure a copy of the manifest is on file with a responsible agency at the point of departure before takeoff. The manifest shall include an accurate list of personnel aboard the aircraft, showing names, serial numbers, grade and service if military, duty station and status aboard the aircraft (passenger or crew). All persons aboard other than flight personnel are "passengers" and shall be manifested as such. When initial transmission of a flight plan by radio is permitted after takeoff in accordance with this instruction, the depositing of such a personnel list continues to be a mandatory pre-takeoff requirement of the pilot in command of the flight. The pilot shall state the location of the required personnel list when filing by radio or telephone. Helicopter pilots engaged in search and rescue (SAR) missions, lifting reconnaissance parties, patrols, and outposts during field problems are released from manifest responsibilities when there is no proper agency available with whom a passenger manifest could be deposited.

204. CIVILIAN FIELDS

Civilian Field, Operating Tower, FSS At The Field

Upon arriving at this type of airport, you may close out your flight plan with FSS by calling them on the radio as soon as you are on the ground, by stopping in at the FSS, or calling them on the phone. At a civilian field, you must do one of these yourself.

Civilian Field, Operating Tower, FSS Not At The Field

Since the FSS is not located at the field, you must call them on the telephone to get your weather brief and deliver your flight plan. Leave a manifest with the airport manager. When you call for taxi, the tower will place your clearance on request, and later read it to you. ***After takeoff, you are responsible for calling FSS to activate your flight following,*** then switch to Departure Control for further instructions to establish you on your route of flight.

Civilian Field, No Operating Tower, FSS at the Field

This could be a case where the tower doesn't open until 0900, but you want to takeoff at 0800. Although there is a tower at the field, it isn't operating when you takeoff. As before, you get a weather brief form and file your flight plan with FSS, either in person or by phone. Be sure to leave a manifest with the manager or FSS. When you are ready to taxi, call the FSS to get your clearance. When airborne, let FSS know and switch to Departure Control.

Civilian Field, No Operating Tower, FSS Not at the Field

There are two methods to choose from in this situation. OPNAVINST 3710.7 paragraph 4.5.3 explains it like this:

If no communication link exists between the point of departure and the ARTCC/FSS, the pilot may relay the flight plan to an appropriate FSS by commercial telephone. When unable to file in person or by telephone, the flight plan may be filed as soon as possible by radio after takeoff. ***Flight in controlled airspace in instrument meteorological conditions (IMC) without ATC clearance is prohibited. Filing by radio after takeoff is not permitted when it will involve unauthorized IMC flight.*** In any case, the pilot's responsibility is not fulfilled until a completed flight plan and passenger manifest has been deposited with the airport manager or other suitable person.

The flight plan is left in case you crash before contacting FSS for a clearance. The weather briefing would also be obtained by radio from FSS or possibly a Pilot-to-Metro Service (PMSV) site, by commercial telephone.

The second method is used when you can phone FSS, but have no way to receive your clearance from them before takeoff. In this case, you phone in the flight plan, get a weather briefing, and deposit a manifest as necessary; then you can hold the telephone line open while FSS runs your flight plan through the computers, or you can call them back later to get your clearance. In these instances, the clearance will have a specific takeoff time assigned. You must meet this takeoff time within the block of time stated or the clearance is canceled. Takeoff into IMC is now authorized and switch to departure control.

If operating on an IFR flight plan to an airport where there is no functioning control tower, the pilot must initiate cancellation of the IFR flight plan. OPNAVINST 3710.7 paragraph 4.9.2 says:

At nonmilitary installations, the pilot shall close the flight plan with flight service through any means of communication available. Collect, long distance telephone service may be used if required. When appropriate communication links are known or suspected not to exist at the point of intended landing, a predicted landing time in lieu of the actual landing shall be reported to an appropriate aeronautical facility while airborne.

NOTE

> Cancellation of an instrument flight plan does not meet the requirement for "closing out" the flight plan. When a landing report has been properly delivered, the flight plan will be considered closed out.

You may have noticed considerable time was spent covering the closing out of your flight plan. To show you why it is so important, let us take a hypothetical case where you departed from a military base, enroute to another military base.

The tower notifies FSS of your departure, and FSS passes your ETA to your destination. About halfway to the destination, you encounter a severe cold front with extensive thunderstorm development and decide to cancel your IFR clearance and land at a nearby civilian field to wait out the storm. It is likely you would not tell ARTCC your intentions, but merely cancel your clearance. Upon landing at the civilian field, you forget to call FSS to close out your flight plan. Thirty minutes after your ETA, FSS calls the destination to see if you have arrived. Since you haven't, the next step is to contact Approach Control to see if you are under their control. They haven't heard from you, so ARTCC is contacted, and they say you canceled your IFR clearance but gave no further intentions. The local FSS has no record of a VFR flight plan, and you don't answer any radio calls. Since there is no record of your landing, there is a strong possibility you may have crashed, and a SAR effort is launched.

Situations as described could have been avoided by contacting FSS after landing. As per OPNAVINST 3710.7, you are responsible for accomplishing this or having it done. At a military field, a call to Ground Control is sufficient as you clear the duty. At a civilian field, a phone call or personal visit is required. Failure to do so may result in a flight violation.

205. AIR TRAFFIC CONTROL (ATC)

ATC issues all IFR flight plans and controls all air traffic in the United States with help from its subagencies:

Control Tower

The Control Tower is responsible for the safe, orderly, and expeditious movement of all known aircraft operating on and in the vicinity of an airport/airport traffic area (this includes permission to taxi, take off, and land). In addition, the tower will also provide for the safe separation of IFR aircraft in the terminal area. In certain metropolitan areas where there is continuous terminal service between airports existing, tower will also provide Tower Enroute Control (TEC). It provides ATC services for non-turbojet aircraft below 10,000 feet MSL between terminal areas.

TRACON

TRACON (Terminal Radar Approach Control) is a terminal air traffic control facility providing approach and departure control services to all terminal and departing instrument air traffic ***as well as IFR aircraft transiting through their airspace. TRACONs will also provide radar flight following for VFR traffic on a workload permitting basis. TRACON is often referred to as Approach Control (APC) or Departure Control.***

Approach Control

The purpose of Approach Control is to control IFR flights which are arriving at (or departing from) airports which are located in controlled airspace during IFR conditions. Approach Control personnel are located in the tower (not necessarily in the tower of the departure/destination airport) or other ATC facilities in the vicinity of an airport.

IFR arrivals are requested not to initiate contact with Approach Control. The ARTCC will direct the pilot to contact Approach Control at a specified time or enroute point.

Pilots instructed to hold in the terminal area will be given an Expected Further Clearance Time, which is normally assigned by the center before reaching the holding fix and currently revised by Approach Control.

Departure Control

Departure Control is an approach control function responsible for ensuring separation between departures. To expedite the handling of departures, Departure Control may suggest a takeoff direction other than that which may normally have been used under VFR handling. Many times it is preferred to offer the pilot a runway that will require the fewest turns after takeoff to place the pilot on his filed course or selected departure route as quickly as possible. At many locations particular attention is paid to the use of preferential runways for local noise abatement programs and route departures away from congested areas.

Departure Control, utilizing radar, will normally clear aircraft out of the terminal area using standard instrument departures via radio navigation aids. When a departure is to be vectored immediately following takeoff, the pilot will be advised before takeoff of the initial heading to be flown. When given a vector taking his aircraft off a previously assigned nonradar route, the pilot will be advised briefly what the vector is to achieve. Thereafter, radar service will be provided until the aircraft has been reestablished “on-course” using the appropriate navigation aid and the pilot has been advised of his position; or, a handoff is made to another radar controller with further surveillance capabilities.

Tower will inform pilots of the Departure Control frequencies and, if appropriate, the transponder code before takeoff. Pilots should not operate their transponders until ready to start the takeoff roll; or change to the Departure Control frequency until directed.

Air Route Traffic Control Center

ARTCC is responsible ***for all instrument enroute*** air traffic between terminal areas in controlled airspaces and ***will also provide radar flight following for VFR traffic on a workload permitting basis.*** (Controlled airspace is discussed in Chapter 2.)

ARTCCs (commonly referred to as "Center") are capable of direct communications with IFR traffic on multiple frequencies. Maximum communication coverage is possible through the use of Remote Communications Air/Ground (RCAG) Facilities - unmanned VHF/UHF transmitter/receiver sites which are used to expand ARTCC air/ground communications coverage and to facilitate direct contact between pilots and controllers. Although some sites may be several hundred miles distance from the ARTCC, they are remoted to the various Centers by land lines or microwave links. Pilots should normally use these frequencies strictly for communications pertinent to the control of IFR aircraft. Flight plan filing, weather forecasts and similar data should normally be requested through FSS or appropriate military facilities capable of performing these services.

An ARTCC area is divided into sectors. Each sector is handled by one or a team of controllers and has its own sector discrete frequency. As a flight progresses from one sector to another, the pilot is directed to change to the appropriate sector discrete frequency.

RCAG facilities usually are **not** equipped with emergency frequencies 121.5 and 243.0.

When directed to change frequencies, if communications cannot be established, the pilot should first attempt to recontact the transferring controller for the assignment of an alternate frequency or other instructions.

When an ARTCC frequency failure occurs after two-way communications have been established, the pilot should attempt to reestablish contact with the center on any other known ARTCC frequency, preferably that of the next responsible sector when practicable. However, when the next normal frequency change along the route is known to involve another ATC facility, the pilot should contact that facility, if feasible. If communications cannot be re-established by either method, the pilot is expected to request communications instructions from the FSS (usually the nearest on 255.4) appropriate to the route of flight.

There are 20 ARTCCs in the conterminous United States. Additional centers are located outside the conterminous U.S.; e.g., Honolulu, Anchorage, and San Juan. Names of the centers and frequencies are located in the IFR Supplement. The areas over which each center has jurisdiction are depicted on the Enroute Charts.

A listing of the ARTCCs in the conterminous United States is as follows:

1. Albuquerque
2. Atlanta
3. Boston
4. Chicago
5. Cleveland
6. Denver
7. Ft. Worth
8. Houston
9. Indianapolis
10. Jacksonville
11. Kansas City
12. Los Angeles
13. Memphis
14. Miami
15. Minneapolis
16. New York
17. Oakland
18. Salt Lake City
19. Seattle
20. Washington

All aircraft proposing IFR flights along the nation's airways are subject to control of these centers. Pilots must file a flight plan and must obtain an ATC clearance to fly airways in IFR conditions.

ATC clearances for aircraft proposing IFR flights departing NAS Corpus Christi originate in the Houston ARTCC.

Information regarding the aircraft is forwarded from one center to the next adjoining center at least 30 minutes before the aircraft is estimated to enter the receiving center's area of jurisdiction. Controllers will direct pilots to contact the next sector within the same center area, or a sector within an adjoining center area at a given time or point on a specified frequency.

Examples:

1. "NAVY DELTA EIGHT FIVE TWO, CONTACT WASHINGTON CENTER ON THREE EIGHT FIVE POINT FOUR AFTER PASSING DONCASTER."

2. "AIR FORCE FIVE FOUR THREE TWO ONE, CONTACT DENVER CENTER ON THREE FIVE THREE POINT SEVEN AT ONE SIX THREE NINER."

3. "NAVY DELTA ONE FIVE NINER, CONTACT HOUSTON CENTER ON THREE ZERO SIX POINT NINER."

After acknowledging such a clearance, there is no requirement to tell the transferring controller when you actually switch frequencies.

As mentioned previously, aircraft shall not enter, cross, or operate within controlled airspace without first obtaining an ATC clearance whenever conditions are less than VFR. However, VFR traffic, including aircraft operating between cloud layers or above an overcast, may be flying on airways without the knowledge of ATC. Therefore, pilots should be extremely alert when "in the clear," even though flying at an assigned "hard" altitude on an IFR flight plan. Remember, “See and Avoid” applies anytime you are in VMC conditions.

Flight Service Station

FSS is responsible for providing aircraft with numerous services including in-flight radio assistance such as weather broadcasts, communication relay, and flight following services. Their standard operating frequencies include UHF 255.4 243.0 (emergency); VHF 122.2 121.5 (emergency); 123.6 (airport advisory) or as published in the Enroute Supplement or Low Altitude Charts.

Flight Service Stations are the Air Traffic Service facilities within the National Airspace System which provide pilot briefing, enroute communications and VFR search and rescue services, assist lost aircraft and aircraft in emergency situations, relay ATC clearances, originate Notices to Airmen, broadcast special weather and other information, receive and process IFR flight plans and monitor NAVAIDs. In addition, at selected locations, FSSs provide Enroute Flight Advisory Service (Flight Watch), take weather observations, issue airport advisories, and advise Customs and Immigration of transborder flights.

206. ATC CLEARANCES

The FAA defines an ATC clearance as an authorization by Air Traffic Control, for preventing collision between known aircraft, for an aircraft to proceed under specified traffic conditions within controlled airspace.

It should be noted that ATC clearances will only provide standard separation between IFR flights (exception: those aircraft assigned "VFR Conditions on Top"). During the time an IFR flight is operating in VFR weather conditions, it is the direct responsibility of the pilot to avoid other aircraft since VFR flights may be operating in the same area without the knowledge of ATC. ("ATC" will be used throughout this program to signify any of the agencies involved in air traffic control; ARTCCs, Approach Controls, Towers, etc. Remember enroute control of air traffic is the responsibility of ARTCC.)

Clearance Compliance

An ATC clearance does not constitute authority to violate any of the provisions of the FAR or OPNAV Instructions. If ATC issues a clearance that would cause a pilot to violate a rule or regulation, or, if in the pilot's opinion, would place the aircraft in jeopardy, it is the pilot's responsibility to request an amended clearance. In other words, the pilot has the privilege of requesting a different clearance from that which has been issued by ATC if he feels that he has information which would make another course of action more practical or if equipment limitations or Navy policy forbids compliance with the clearance issued. Of course, once a pilot accepts an ATC clearance, he is expected to comply with its provisions. Normally, when ATC issues an instruction, pilots are expected to comply with its provisions, ***upon receipt.***

In certain situations, ATC will include the word "IMMEDIATELY" in an instruction only when expeditious compliance is required to avoid an imminent situation. If time permits, ATC will include the reason for this action.

In other situations, ATC will include the phrase "AT PILOT DISCRETION" to indicate that ATC has offered the pilot the option to initiate the terms of the clearance whenever and however he wishes.

If the altitude information of an air traffic control DESCENT clearance includes a provision to "CROSS (fix) AT/AT OR ABOVE/BELOW (altitude)," the manner in which the descent is executed to comply with the crossing altitude is at the pilot's discretion. This authorization to descend at pilot's discretion is only applicable to that portion of the flight to which the crossing altitude restriction applies, and the pilot is expected to comply with the crossing altitude as a provision of the clearance. Any other clearance in which pilot execution is optional will so state: "AT PILOT'S DISCRETION."

Examples:

1. "NAVY ONE SIX ONE, DESCEND AND MAINTAIN SIX THOUSAND."

The pilot is expected to commence descent upon receipt of the clearance, and to descend until reaching the assigned altitude of 6000 feet.

2. "NAVY ONE SIX ONE, DESCEND AT PILOT'S DISCRETION, MAINTAIN SIX THOUSAND."

The pilot is authorized to conduct descent within the context of the term AT PILOT'S DISCRETION as described above.

3. "NAVY ONE SIX ONE, CROSS LAKEVIEW VOR AT OR ABOVE FLIGHT LEVEL TWO ZERO ZERO, DESCEND AND MAINTAIN SIX THOUSAND."

The pilot is authorized to conduct descent AT PILOT'S DISCRETION until reaching Lakeview VOR. He must comply with the clearance provision to cross the Lakeview VOR at or above FL 200. After passing Lakeview VOR, he is expected to descend until reaching the assigned altitude of 6000 feet.

4. "NAVY ONE SIX ONE, CROSS LAKEVIEW VOR AT SIX THOUSAND, MAINTAIN SIX THOUSAND."

The pilot is authorized to conduct descent AT PILOT'S DISCRETION; however, he must comply with the clearance provision to cross the Lakeview VOR at 6000 feet.

5. "NAVY ONE SIX ONE, DESCEND NOW TO FLIGHT LEVEL TWO SEVEN ZERO, CROSS LAKEVIEW VOR AT OR BELOW ONE ZERO THOUSAND, DESCEND AND MAINTAIN SIX THOUSAND."

The pilot should immediately begin a descent to flight level 270, then descend to 10,000 feet or below before crossing Lakeview VOR and finally continue down to 6000 feet.

Clearance Delivery

At airports where a control tower is in operation, ATC clearances normally are relayed to pilots of departing aircraft by the tower "Ground Control" position. At many busy airports, a tower "Clearance Delivery" position has been established and a separate voice frequency has been designated for this purpose. No visual surveillance or control over the movement of traffic is exercised by the tower "Clearance Delivery" position of operation.

Readback of Clearance

Readback of a clearance is not required by FAA except that the pilot of an airborne aircraft shall read back those parts of ATC clearance containing altitudes and/or vectors. However, the pilot is expected to request clarification if he does not understand other parts of the clearance. Moreover, the pilot should read back any portion of the clearance if he feels the need for confirmation.

Pilots shall read back clearances differing from the filed flight plan.

Adherence to Clearances

When an ATC clearance has been obtained, the pilot shall not deviate from the provisions thereof (except in an emergency) unless an amended clearance is obtained. The addition of a VFR or other restriction, (i.e., climb/descent at a particular point of time, crossing altitude, etc.), does not authorize a pilot to deviate from the route of flight or any other provision of the ATC clearance.

The most important and guiding principle to remember is that the last ATC clearance has precedence over related portions of the previous ATC clearance. When the route or altitude in a previously issued clearance is amended, the controller will restate applicable altitude restrictions. If altitude to maintain is changed or restated, whether before departure or while airborne, and previously issued altitude restrictions are omitted, those altitude restrictions are canceled, including departure procedure (DP) altitude restrictions. Pilots should always request route/altitude verification from ATC if any portion of a clearance is not understood.

When an aircraft is vectored off a previously assigned route, the controller is required to tell the pilot the airway, route or point to which the aircraft is being vectored.

If a pilot, for any reason, is incapable of complying with any provision of an issued ATC clearance or restriction added thereto, he is expected to immediately advise ATC. A brief reason, such as, "UNABLE, ACCOUNT OF LOAD," may be included if considered necessary. He may then expect an amended ATC clearance.

If thunderstorm conditions encountered are so severe that an immediate deviation from course and/or altitude is necessary and time will not permit approval by ATC, the pilot's emergency authority may be exercised.

The following information shall be furnished ATC when requesting clearance to detour thunderstorm activity:

1. Proposed point at which detour will commence

2. Proposed route and extent of detour (direction and distance)

3. Altitude(s)

4. Point and estimated time where original route will be resumed

5. Flight conditions (IFR or VFR)

6. Any further deviation that may become necessary as the flight progresses

7. Advise if the aircraft is equipped with functioning airborne radar

Clearance Limit

Initial clearances issued to departing aircraft will include, whenever practicable, the destination airport as the clearance limit. ATC may, however, use short-range clearance procedures instead of clearance to destination airport. When any part of the route beyond the short-range clearance limit differs from that specified in the original flight plan, clearance will include the proposed routing beyond said clearance limit.

When a flight has been cleared to a fix short of its destination airport, additional clearance to proceed beyond or instructions to hold at such fix, whichever is appropriate, will be issued at least five minutes before aircraft is estimated to reach the fix. If further clearance has not been received, hold in accordance with the charted holding pattern (FLIP Enroute Charts), or (if no pattern is charted at the clearance limit fix) hold in a standard pattern on the course on which the aircraft approached the fix.

Flights which are conducted in accordance with IFR for the initial part of the flight and VFR for subsequent portions will be cleared to the fix at which the IFR portion of the flight terminates.

Cruise Clearance

"CRUISE" is normally used only for relatively short flights in uncongested areas. The term "CRUISE" (instead of "MAINTAIN") is used in an ATC clearance to authorize a pilot to conduct flight at any altitude from the minimum IFR altitude up to and including the altitude specified in the clearance. The pilot may level off at any intermediary altitude within this block of airspace. Climb/descent within the block is to be made at the discretion of the pilot; however, once the pilot starts a descent and reports leaving an altitude in the block, he may not return to that altitude without additional ATC clearance. Further, it is approval for the pilot to proceed to and make an approach at the destination airport.

Maintain Clearance

The altitude instructions in an ATC clearance normally require that a pilot "MAINTAIN" the altitude at which the flight will operate when in controlled airspace. The pilot may not deviate from the assigned altitude until further instructed or, should the pilot desire a change while enroute, it will be requested at the time the change is desired.

The preponderance of IFR flights (below FL 290) will be assigned in conformance with the following: odd thousands for eastbound flights and even thousands for westbound flights. Therefore, pilots shall initially request altitude assignments accordingly. However, the center can and will deviate from this general concept.

Altitude Data - "VFR Conditions On Top"

Clearances may be issued specifying that flights maintain "VFR CONDITIONS ON TOP" of a cloud, haze, smoke, or other meteorological formation provided:

1. The flight is conducted according to proper flight visibilities (3 miles if operating below 10,000 feet MSL and 5 miles if operating at or above 10,000 feet MSL).

2. The flight is conducted according to proper cloud clearances (at least 1000 feet vertically over clouds, etc.).

3. The pilot is advised of the reported height of the tops of the clouds/formation (or that no such reports have been received).

4. The flight is conducted according to the "see and avoid" principles applicable to VFR flights. In other words, although on an IFR flight plan, pilots will not be provided with an assigned altitude of "VFR CONDITIONS ON TOP." The responsibility for avoidance of collision rests with the pilot.

5. The flight is conducted at a VFR semicircular cruising altitude. (Over 3000 AGL; odd + 500 feet eastbound, even + 500 feet westbound.)

NOTE

> The same position reporting procedures apply whether a pilot is assigned "VFR CONDITIONS ON TOP" or a "hard" altitude.

Pilots must specifically request such clearances (on the ground or in the air). In other words, ATC will not ***initiate*** the issuance of "VFR CONDITIONS ON TOP" altitude assignments (or VFR climbs/descents, for that matter). The phrase by the pilot "WILL ACCEPT VFR CLIMB (VFR ON TOP, etc.,)" does not suffice for this purpose.

Combination Clearances (Composite IFR/VFR)

Clearances issued when a flight plan indicates IFR for the first portion of flight and VFR for the latter portion will normally clear an aircraft to the point at which the change is proposed. Once the pilot has reported over the clearance limit and does not desire further IFR clearance, he shall advise ATC to cancel the IFR portion of his flight plan. Further clearance will not be necessary for VFR flight beyond that point. If the pilot desires to continue his IFR flight plan beyond the clearance limit, he shall contact ATC before reaching the clearance limit and request further IFR clearance.

If the requested clearance is not received before reaching the clearance limit fix, the pilot will be expected to hold as explained previously.

Amended Clearances

Amendments to the initial clearance will be issued at any time a controller deems such action necessary to avoid possible confliction between aircraft. Clearances will require that a flight "hold" or change altitude prior to reaching the point where standard separation from other IFR traffic would no longer exist. Some pilots have questioned this action and requested "traffic information" and were at a loss when the reply indicated "no traffic reported." In such cases, the controller has taken action to prevent a traffic confliction which would have occurred at a distant point.

A pilot may wish an explanation of the handling of his flight at the time of occurrence; however, controllers are not able to take time from their immediate control duties nor can they afford to overload the ATC communications channels to furnish explanations. Pilots may obtain an explanation by directing a letter or telephone call to the chief controller of the facility involved.

The pilot has the privilege of requesting a different clearance from that which has been issued by ATC if he feels that he has information which would make another course of action more practicable or if aircraft equipment limitations or military regulations forbid compliance with the clearance issued.

Pilots should pay particular attention to the clearance and not assume that the route and altitude are the same as requested in the flight plan. It is suggested that pilots make a written record of clearances at the time they are received, and verify by repeating any portions that are complex or about which a doubt exists. It will be the responsibility of each pilot to accept or refuse the clearance issued.

Flight through Restricted Areas

When an aircraft is operating on an IFR flight plan (including those cleared by ATC to maintain "VFR CONDITIONS ON TOP") ATC is responsible for obtaining clearance through the restricted area while it is "live." If this is not possible, the flight will be routed to avoid the restricted area.

When an aircraft is operating on a VFR flight plan, the pilot is responsible for obtaining approval from the using or controlling agency before penetration and transit through the restricted area.

IFR Enroute Aircraft Separation

Air traffic control effects separation of aircraft vertically by assigning different altitudes: longitudinally by providing an interval expressed in time or distance between aircraft on the same, converging, or crossing courses; and laterally by assigning different flight paths. When radar is employed in the separation of aircraft at the same altitude, a minimum of 3 miles separation is provided between aircraft operating within 40 miles of the radar antenna site, and 5 miles between aircraft operating beyond 40 miles from the antenna site. These minima may be increased or decreased in certain specific situations.

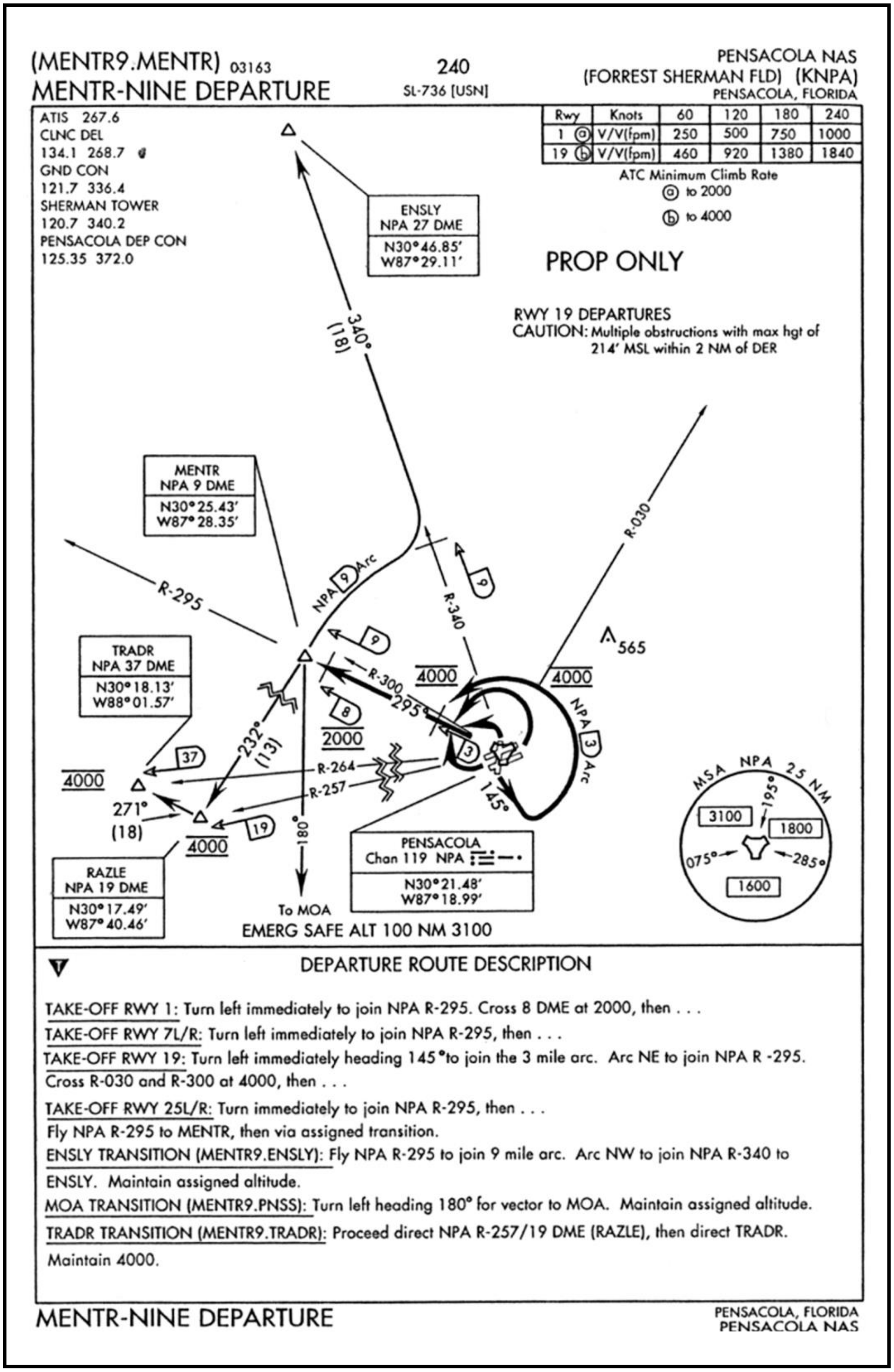

Figure 2-1 Departure Procedure (DP)

207. INSTRUMENT DEPARTURES

Standard Instrument Departures and textual IFR departure control procedures have been combined into a single entity called an instrument DP (departure procedure). These are published in text form, or in charted graphic form (Figure 2-1). Each DP provides the pilot with a way to depart the airport and transition to the enroute structure safely. They are available at most military and joint civil/military aerodromes and provide obstacle clearance protection to aircraft in IMC, increase efficiency and reduce communications and departure delays. Military pilots are encouraged to use DPs provided no flight degradation will result. If, for any reason, a pilot does not wish to use a DP issued in an ATC clearance or any other DP published for that location, he is expected to advise ATC. DPs/SIDs are published in the FLIP approach plates or locally available from base operations departments.

The controller will specify particular altitudes when they are not included in the published DP.

Example: "STROUDSBURG ONE DEPARTURE, CROSS JERSEY INTERSECTION AT FOUR THOUSAND, CROSS ORANGE INTERSECTION AT SIX THOUSAND."

If it is necessary to assign a crossing altitude which differs from the DP altitude, the controller will repeat the changed altitude to the pilot for emphasis.

Example: "STROUDSBURG ONE DEPARTURE, EXCEPT CROSS QUAKER AT FIVE THOUSAND. I SAY AGAIN, CROSS QUAKER AT FIVE THOUSAND."

When an instrument approach is initially developed for an airport, the procedure designer also does an assessment for departures. All departures are based on an aircraft taking off, crossing the end of the runway at 35 feet and then climbing up at 200 feet per nautical mile on runway heading up to 400 feet before being able to turn. If the aircraft can then turn in any direction without any obstructions, then that runway meets what is called ***diverse departure*** criteria. If any obstructions exist based on an obstacle clearance surface (OCS) gradient of 40:1 (40 feet of distance for every one foot of climb or 152-ft/NM) beginning at 35 feet over the end of the runway, then a specific obstacle DP is required for that airfield. This DP will require the pilot to adhere to an increase in climb gradient, increase standard takeoff minima to allow the pilot to visually clear the obstacle (see below), and/or assign a specific departure route. When an obstacle departure procedure is published for an aerodrome, it will be indicated on a given approach plate.

208. TAKEOFF/ALTERNATE MINIMUMS

FAR 91 prescribes takeoff rules and establishes standard takeoff minimums. Moreover, FAR 91 establishes standard alternate minimums. These will not be discussed in this unit, since Navy pilots are specifically exempted from the takeoff/alternate minimums contained in FAR 91. The Navy directive containing the takeoff and alternate minimums is OPNAV Instruction 3710.7. OPNAV Instruction 3710.7 takeoff minimums are as follows:

1. Special instrument rating - no takeoff ceiling or visibility minimums apply. Takeoff shall depend on the judgment of the pilot and urgency of flight.

2. Standard instrument rating - Published minimums for the available non-precision approach, but not less than 300-foot ceiling and 1 statute mile visibility. When a precision approach compatible with installed and operable aircraft equipment is available with published minimums less than 300/1, takeoff is authorized, provided the weather is at least equal to the precision approach minimums for the landing runway in use, but never when the weather is less than 200 feet ceiling and one-half statute mile visibility/2400 feet RVR.

Certain aerodromes require that takeoff minimums or alternate minimums other than standard be specified. In such cases, the approach plate may depict one or more of the following symbols:

indicates takeoff minimums are not standard (for civil pilots - naval aviators should comply with them, but are only required to comply with OPNAV takeoff minimums).

also indicates the airport may have an obstacle departure procedure published to assist pilots conducting IFR flight avoiding obstructions during climb to the minimum enroute altitude. The published departure procedure applies to all pilots, including naval aviators and are contained in the front of the approach plates.

The example depicted in figures 2-2 and 2-3 demonstrates the need for obstacle avoidance procedures when departing RWYs 8 and 9 from Fulton County Airport.

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▽ IFR TAKE-OFF MINIMUMS AND (OBSTACLE) DEPARTURE PROCEDURES

Military Airports and Selected Civilian Airports

ALL USERS: Airports that have Departure Procedures (DPs) designed specifically to assist pilots in avoiding obstacles during the climb to the minimum enroute altitude, and/or airports that have IFR take-off minimums other than standard, are listed below. Take-off Minimums and Departure Procedures apply to all runways unless otherwise specified. Altitudes, unless otherwise indicated, are minimum altitudes in feet MSL.

DPs specifically designed for obstacle avoidance are described below in text, or published separately as a graphic procedure. If the (Obstacle) DP is published as a graphic procedure, its name will be listed below, and it can be found in either this volume (military), or the Civil Departure Procedures volume (civil), as appropriate. Users will recognize (Obstacle) graphic DPs referenced below by the following note printed on the charted procedure: "If not assigned a Departure Procedure by ATC, this procedure may be flown to provide obstacle clearance". The term "(OBSTACLE)" will also be printed on the charted procedure.

(Note: Graphic Departure Procedures that have been designed primarily to assist Air Traffic Control in providing air traffic separation (as well as providing obstacle clearance) are usually assigned by name in an ATC clearance and are not listed by name in this section.)

MILITARY USERS: IFR departure procedures not published as graphic Departure Procedures and take-off minima are included below and are established to assist pilots in obstacle avoidance. Refer to appropriate service directives for take-off minimums.

CIVIL USERS: FAR 91 prescribes standard take-off rules and establishes take-off minimums for certain operators as follows: (1) Aircraft having two engines or less-one statute mile. (2) Aircraft having more than two engines-one-half statute mile. These standard minima apply in the absence of any different minima listed below.

AIRPORT NAME TAKE–OFF MINIMUMS

ATHENS/BEN EPPS (KAHN), GA . Rwy 20, 200–1
Rwy 2, 9 and 27, climb rwy hdg to 1100 before turning.

ATLANTA, GA
DELKAB-PEACHTREE (KPDK)
. Rwy 20L, 20R, 1100-2*
Rwy 34, 900-2**
* Or stahdard with minimum climb of 300/NM to 2300.
** Or standard with minimum climb of 280/NM to 2100.
Rwy 2L, 2R, 9, 16, 27 climb rwy hdg to 2300 before proceeding on course. Rwy 20L, 20R start left turn within 1 NM of airport, climb on hdg 150° to 3100 before proceeding on course. Departure procedures not required for aircraft with minimum climb of 310/NM to 3100.
TAKE-OFF OBSTACLES; Rwy 2L, 2R: 100' AGL trees 2100' from departure end of rwy. Rwy 9: 100' AGL trees 2750' from departure end of rwy. Rwy 27: 80' AGL trees 340' from departure end of rwy, 420' left of centerline.

FULTON COUNTY AIRPORT-BROWN FIELD (KFTY) .... Rwys 8, 9, 14, 400-1*
Rwy 32, 700-3*
Rwys 26, 27, 500-1**
* Or standard with a minimum climb of 290/NM to 1600.
** Or standard with a minimum climb of 260/NM to 1300.
Rwy 8, 9, left turn, climb on 060° on hdg to 3100 before proceeding on course. Rwy 14, climb rwy hdg to 1400 at minimum climb of 220/NM before proceeding on course. Rwy 26, 27, 32 climb rwy hdg to 1400 before turning. Departure procedure not required for aircraft with minimum climb of 300/NM to 3100 or when weather is 1300-2 or better.

AUGUSTA, GA
DANIEL FIELD(DNL) Amdt. 4, 02276
Rwy 23, minimum climb of 360/NM to 1400.

AUGUSTA REGIONAL AT BUSH FIELD(KAGS)
Amdt. 10. 02276
Rwy 8, climb via heading 097 to 2300' before turning northbound. Rwy 17, 26 and 35, climb rwy heading to 2300' before turning northeastbound.
TAKE-OFF OBSTACLES: Rwy 8: trees 560' from DER, 525' left of centerline, 70' AGL/208' MSL. Rwy 17, trees 1700' from DER, 650' right of centerline, 82' AGL/216' MSL. Rwy 26, trees 2050' from DER, 340' left of centerline, 88' AGL/233' MSL. Trees 5100' from DER 1200' left of centerline, 90' AGL/223' MSL.

BONIFAY, FL
TRI CO (1J0)
Rwys 1 and 19 climb rwy hdg to 2000 before turning West.

Figure 2-2 Obstacles Departure Procedures

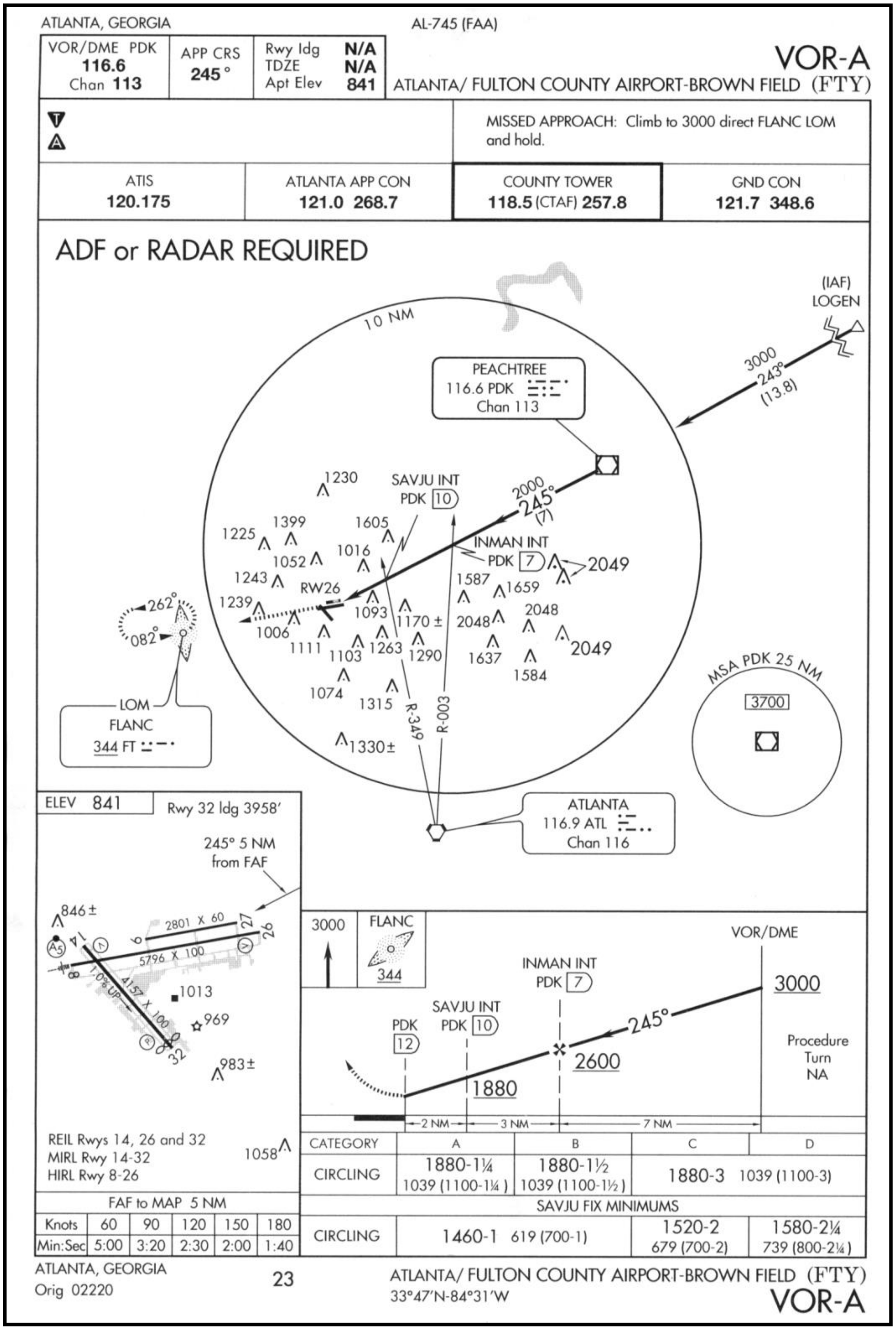

Figure 2-3 VOR-A

The symbol (Figures 2-4 and 2-5) on an approach plate directs pilots to the "IFR Alternate Minimums" section in the front of each approach plate book and indicates that **other than** standard alternate minimums apply. The published minimums in this section (Figure 2-4) do not apply to Naval Aviators who shall use OPNAVINST 3710.7 alternate minimums.

The following are exceptions to this rule. The **NA** symbol on the IAP, indicates IFR minimums are not authorized for alternate use, due to unmonitored facility or absence of weather reporting service. In addition, **NA** may be indicated on the alternate mins page for special circumstances. This rule applies to all pilots including Naval aviators.

ALTERNATE MINS
03023

INSTRUMENT APPROACH PROCEDURE CHARTS

IFR ALTERNATE MINIMUMS

CEILING AND VISIBILITY MINIMUMS NOT APPLICABLE TO USA/USN/USAF. PILOTS MUST REVIEW THE IFR ALTERNATE MINIMUMS NOTES FOR ALTERNATE AIRFIELD SUITABILITY.

Standard alternate minimums for non precision approaches are 800-2 (NDB, VOR, LOC, TACAN, LDA, VORTAC,VOR/DME or ASR); for precision approaches 600-2 (ILS or PAR). Airports within this geographical area that require alternate minimums other than standard or alternate minimums with restrictions are listed below. NA - means alternate minimums are not authorized due to unmonitored facility or absence of weather reporting service. Civil pilots see FAR 91. USA/USN/USAF pilots refer to appropriate regulations.

NAME	ALTERNATE MINIMUMS
ALBANY, GA	
SOUTHWEST GA. REGIONAL (KABY)	**ILS Rwy 4**
	LOC BC Rwy 22
	NDB or GPS Rwy 4
	VOR or TACAN or GPS Rwy 16
Category D, 800-2½.	
ATLANTA, GA	
DEKALB-PEACHTREE (KPDK)	**ILS Rwy 20L**
NA when control zone not in effect.	
FULTON COUNTY AIRPORT-BROWN FIELD (KFTY)	**ILS Rwy 8①②**
	NDB or GPS Rwy 8③
	VOR-A④
①ILS, NA when control tower closed. ②ILS, Categories A,B, 800-2; Category C, 800-2¼; Category D, 800-2½. LOC, Category C, 800-2¼; Category D, 800-2½. ③Category C, 800-2¼; Category D, 800-2½. ④Categories A,B, 1100-2; Categories C,D, 1100-3.	
AUGUSTA, GA	
AUGUSTA REGIONAL AT BUSH FIELD (KAGS)	**ILS Rwy 17①**
	ILS Rwy 35①
	NDB or GPS Rwy 17
	NDB or GPS Rwy 35
	VOR/DME Rwy 17
NA when control tower closed. ①ILS, 700-2.	
COLUMBUS, GA	
COLUMBUS METROPOLITAN (KCSG)	**ILS Rwy 6**
	NDB or GPS Rwy 6
NA when control tower closed.	
CRESTVIEW, FL	
BOB SIKES (KCEW)	**ILS Rwy 17**
ILS, Category D, 700-2.	
FORT LAUDERDALE, FL	
FORT LAUDERDALE EXECUTIVE (FXE)	**ILS Rwy 8**
ILS, Category D, 700-2.	
FORT LAUDERDALE-HOLLYWOOD INTL (KFLL)	**ILS Rwy 9L①**
	ILS Rwy 27R①
	NDB Rwy 13②
	RADAR②
	VOR Rwy 27R②
①ILS, Categories A,B,C, 700-2; Category D, 700-2¼. LOC, Category D, 800-2¼. ②Category D, 800-2¼.	
FORT MEYERS, FL	
PAGE FIELD (FMY)	**ILS Rwy 5**
NA when FMY tower closed.	
SOUTHWEST FLORIDA INTL (KRSW)	**ILS Rwy 6**
NA when control tower closed. ILS, Category E, 700-2½. LOC, Category E, 800-2½.	

ALTERNATE MINS XLIII

Figure 2-4 Alternate Minimums

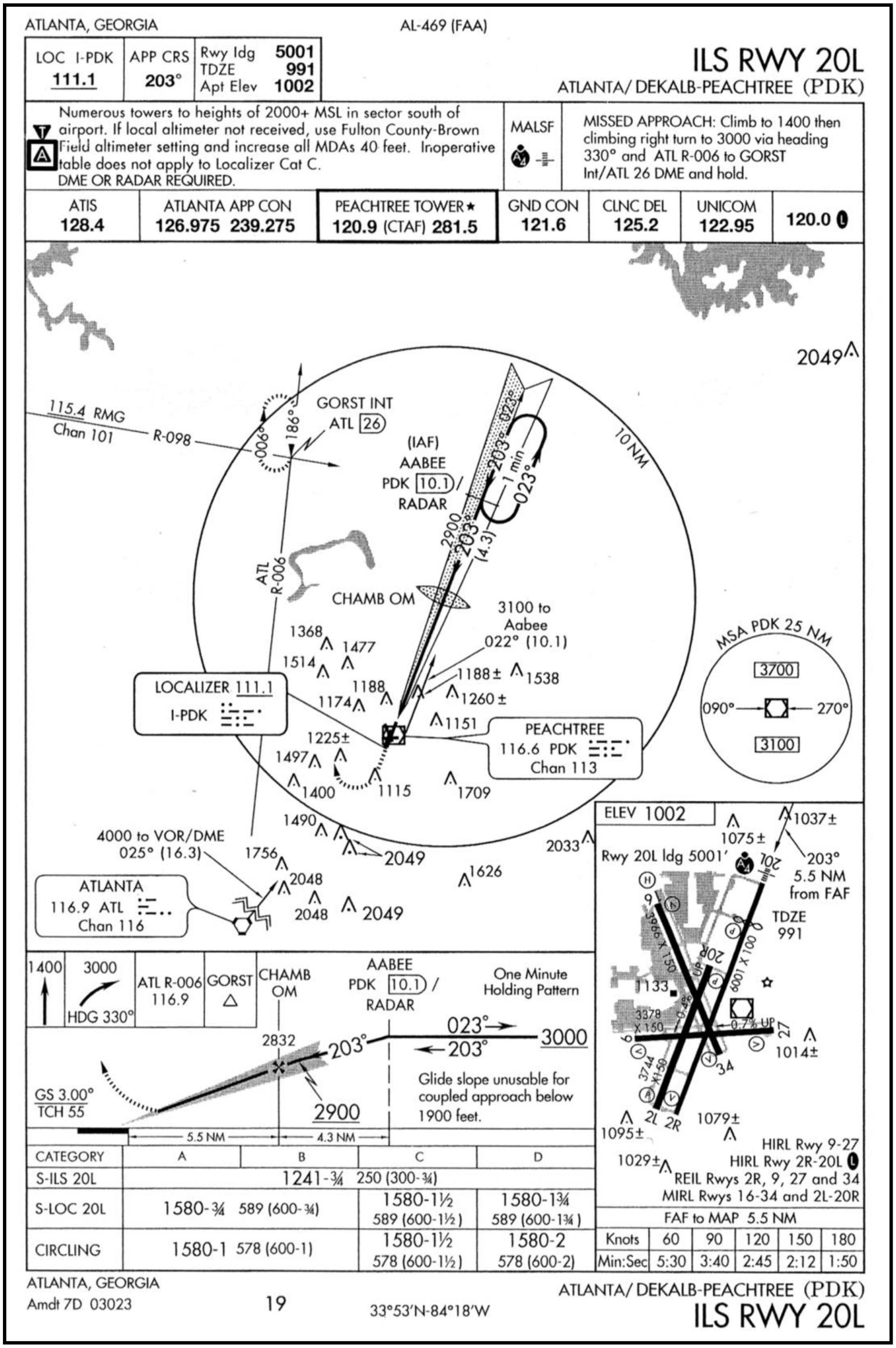

Figure 2-5 ILS RWY 20L

Traffic Advisories

Information may be issued to pilots of IFR aircraft whenever less than the applicable minimum longitudinal separation between such aircraft will exist, or one aircraft is cleared to climb/descend in accordance with VFR through the altitude of another. Traffic information may also be issued at other times when deemed necessary by the controller or requested by the pilot. It should be understood the issuance of traffic information by a controller is not mandatory. Many factors (such as limitations of the radar, volume of traffic, communications frequency congestion and workload) could prevent the controller from providing it.

Traffic Information/Flight Following

VFR radar flight following or VFR radar advisory service (often referred to as flight following) is essentially traffic advisories provided to VFR traffic upon request to ATC. As Naval Aviators, we are required by OPNAV to request radar advisories where available, provided no degradation of the assigned mission will result. Flight following is essential when flying VFR through high-density traffic areas. This serves as an additional precaution to the VFR see-and-avoid concept. ***Radar flight following with TRACON or ARTCC should not be confused with VFR flight following with FSS, which is tracking aircraft through pilot provided position reports.***

Traffic will be called out based on radar and non-radar identification using the clock system. It should be noted that all traffic calls might have a certain amount of induced error. The pilot must take into account his drift correction as traffic calls are relative to the aircraft's track, and not its current heading.

Examples: “TRAFFIC TWELVE O'CLOCK, ONE ZERO MILES, SOUTHBOUND, DC-EIGHT, ONE ZERO THOUSAND. "

"TRAFFIC TWELVE O'CLOCK, FIVE MILES WEST OF ALICE VOR, NORTHBOUND C-ONE THIRTY, FIVE THOUSAND."

"TRAFFIC, NUMEROUS TARGETS VICINITY OF RANDOLPH AIRPORT." ARRIVAL PROCEDURES

209. ARRIVAL PROCEDURES

Approach Clearance

All instrument approach procedures such as TACAN, VOR, GPS, ADF, ILS, ASR, SDF, RNAV, and PAR are depicted in the publication ***Low Altitude Instrument Approach Procedures.*** On the initial voice contact with Approach Control, the pilot may indicate the ***type of instrument approach*** he desires to make. However, controllers will normally clear the pilot for the instrument approach procedure ***that will expedite traffic*** the most. This is usually accomplished by issuing a clearance for a specific approach procedure. If the pilot does not want such approach, he may request a different type of approach. However, it may be necessary to withhold a clearance for the different approach until traffic conditions permit. Under such circumstances, the pilot may accept the suggested approach or wait for a different approach. If the pilot is involved in an emergency situation, he will be given ***priority*** over other air traffic and in the type of approach that may be necessary under the circumstances.

A clearance for a specific type of approach (VOR, ADF, etc.) to a pilot operating on an IFR flight plan does **not** mean that ***landing priority*** will be given over ***VFR*** traffic. ***Tower*** controllers handle all ***landing*** traffic, regardless of the type of flight plan, on a first-come-first-served basis. Because of local traffic or runway in use, it may be necessary for the controller, in the interest of safety, to provide a particular landing sequence. In any case, a landing sequence will be issued as soon as possible to enable the "IFR" pilot to adjust the flight path.

Anticipated Delay

1. If a delay is anticipated, center controllers will issue a holding clearance with an expected further clearance time at least five minutes before the aircraft is expected to reach the clearance limit.

2. If a delay is not anticipated, center controllers clear the pilot beyond the clearance limit before the aircraft reaches it by ***issuing an approach clearance or instructions to contact the terminal control facility*** (e.g., Approach Control).

The expected further clearance time is normally assigned by the ***center*** before the aircraft reaching the clearance limit and is later revised, if necessary, by Approach Control. (Close coordination is maintained between the center and Approach Control regarding expected further clearance times issued, highest holding altitude assigned, etc.)

Transfer of Control - (No Delay Anticipated)

1. If Approach Control services are **not** provided at the destination airport, the center controller will issue an approach clearance (with instructions to contact the Tower or Flight Service Station, usually upon commencing the approach).

2. If Approach Control services ***are*** provided at the destination airport, the center controller will issue a ***clearance to contact Approach Control*** at a specified ***time or place.***

Example: CONTACT (location name) - (terminal control function)

ON (frequency)

or

AT/WHEN (time, fix, or altitude)

Advance Approach Information

When a pilot intends to land at an airport where ***Approach Control services*** are provided and two or more instrument approach procedures are published, the facility (Center or Approach Control) controlling the aircraft immediately before entry into the Approach Center area shall inform the pilot of the type of approach to expect or that it will be ***vectored to the traffic pattern.***

Example: EXPECT (type) APPROACH

EXPECT VECTOR TO THE TRAFFIC PATTERN

The purpose of advance approach information is to aid the pilot in planning arrival actions; however, it is neither an ATC clearance nor a commitment and is subject to change. Pilots should bear in mind that fluctuating weather, shifting winds, blocked runways, etc., are conditions which may result in changes to approach information previously received.

Do not confuse Advance Approach Information with ATIS. Advance Approach Information will **not** be furnished when ATIS is provided for the airport or when the visibility is three miles (or better) and the ceiling is at or above the highest initial approach altitude established for any approach procedures to the airport.

Automatic Terminal Information Service (ATIS)

ATIS is the continuous broadcast of recorded noncontrol information in selected high-activity terminal areas. Its purpose is to improve controller effectiveness and to relieve frequency congestion by automating the repetitive transmission, with audio tape, of essential but routine information.

Information such as ceiling, visibility, wind, altimeter, instrument approach, and runways in use is continuously broadcast on the voice feature of a TVOR/VOR/VORTAC (VOR portion only) located on or near the airport, or on a discrete VHF/UHF tower frequency. Pilots of aircraft arriving or departing the terminal area can receive the continuous ATIS broadcasts at times when cockpit duties are least pressing, and listen to as many repeats as desired.

Pilots will be expected to listen to the ATIS broadcasts (where in operation) to obtain essential, but routine terminal information. Controllers will automatically issue the pertinent information to all pilots not acknowledging the receipt of the ATIS broadcasts.

Sample broadcast:

> "THIS IS SOUTH WHITING FIELD INFORMATION BRAVO. ACTIVE RUNWAY 32. CEILING MEASURED THREE HUNDRED OVERCAST, VISIBILITY ONE MILE, HAZE. WIND THREE SIX ZERO AT FIVE. ALTIMETER TWO NINER NINER TWO. ILS 32 APPROACH IN USE. ADVISE ON INITIAL CONTACT YOU HAVE INFORMATION BRAVO."

If the pilot relays correct ATIS code, controllers will not issue the following if current information on these items is contained in the ATIS broadcast. Ceiling and visibility may be omitted when the reported ceiling is at or above 5000 feet and the visibility is five miles in the ATIS broadcast.

TO ARRIVING AIRCRAFT

1. Specific traffic pattern information
2. Type of instrument approach to be expected
3. Runway in use
4. Surface wind
5. Ceiling and visibility
6. Altimeter setting
7. Temperature

TO DEPARTING AIRCRAFT

1. Runway in use
2. Surface wind
3. Altimeter setting

To reduce frequency congestion, pilots are expected to inform controllers of receipt of ATIS information.

ATIS broadcasts will be updated when there is a significant change in information contained therein. Each time an ATIS message is updated, the control facility will make a one-time announcement on appropriate control frequencies.

Example: "ATTENTION. NAVY WHITING AIRPORT INFORMATION HAS BEEN CHANGED TO INFORMATION ECHO."

The differences between ATIS information and Advance Approach Information should now be evident. You will recall that advance approach information will be provided to a pilot intending to land at an airport where Approach Control services are provided and where two or more instrument approach procedures are published. Remember, advance approach information will be in the form of the type of approach to expect or whether the aircraft will be vectored to the traffic pattern.

Commencing Approach – Reported Weather below Minimums

Controllers will normally clear military pilots for an approach with weather reported below mins. The Navy’s policy regarding the situation is quoted from OPNAVINST 3710.7 (Chapter 5) as follows:

In a ***single-piloted*** aircraft:

An instrument approach shall not be commended if this reported weather is below published minima for the type of approach being conducted.

In a ***multi-piloted*** aircraft:

When reported weather is at or below published landing minima for the approach to be conducted, an approach shall not be commenced in multi-piloted aircraft unless the aircraft has the capability to proceed to a suitable alternate in the event of a missed approach.

These provisions are not intended to preclude single-piloted aircraft from executing practice approaches (no landing intended) at a facility where weather is reported below published minima when operating with an appropriate ATC clearance. However, the facility in question must **not** be the filed destination or alternate, and the weather at the filed destination must meet the filing criteria for an instrument clearance. It should be noted that FAA controllers are not required to inform Navy pilots that the weather is below approach minimums. In many instances, **you** make this determination.

Can a navy pilot of a ***multi-piloted*** aircraft request and receive an approach clearance from a controller when the reported weather is below approved published landing minimums? Yes.

210. INSTRUMENT APPROACH PROCEDURES

Controllers will issue one of two clearances to the pilot: "Cleared for approach" or "pilot is cleared for ____________." To require a pilot to execute a particular instrument approach procedure, controllers will specify in the approach clearance ***the name of the approach as published on the approach plate.***

Example: "CLEARED FOR VOR B APPROACH."
"CLEARED FOR VOR RUNWAY THREE SIX APPROACH."

Upon reaching the initial approach fix, the pilot should always turn in the shortest direction to intercept the approach course. Holding entry procedures concerning the initial entry turn are ***not*** necessarily applicable to the situation of commencing an approach.

When an approach involves a procedure turn, the turn will be executed within the ***specified distance*** from the fix - normally ten miles. However, to provide adequate separation from departing traffic, controllers may specify the point at which the turn shall be executed (expressed in minutes or miles outbound from the fix) which will be consistent with the limitations of the approach procedure plate.

The omission of a specific type of approach (e.g., TACAN, VOR, ADF, etc.) in the clearance, "CLEARED FOR APPROACH," indicates to the pilot that any published type of approach may be used at his/her discretion.

Normally, traffic conditions require controllers to issue a clearance specifying the ***type*** of approach. If the pilot is not familiar with the specified approach procedure, the ***controller should be advised*** and the clearance will include detailed information on the execution of the specified approach.

Example: "INITIAL APPROACH AT (altitude), PROCEDURE TURN AT (altitude) (number of) MINUTES/MILES (direction), FINAL APPROACH (name of NAVAID) (specified) COURSE/RADIAL."

Descent From Altitude – For Aircraft Operating On A Published Route

Before arriving at the initial approach fix, if an approach clearance is received which ***contains no altitude restrictions*** (e.g., "CLEARED FOR VOR RUNWAY THREE ONE APPROACH"), the pilot has the option of maintaining his last assigned altitude or he may descend to:

1. The published minimum enroute altitude (MEA) or the published minimum obstruction clearance altitude (MOCA) within 22 NM of the NAVAID depicted on the FLIP ***Enroute*** Chart if the flight is being conducted along an airway, or

2. ***The published initial approach altitude*** depicted on the FLIP ***Terminal*** chart, e.g., the flight is transitioning from an outer (feeder) fix to the initial approach fix. Initial approach information is portrayed in the plan view of instrument approach charts by course lines, with an arrow indicating the direction. Minimum altitude and distance between fixes is also shown with the magnetic course.

Descent from Altitude -- For Aircraft on Unpublished Routes

For aircraft operating on unpublished routes (a route for which no minimum altitude is published or charted for pilot use; it may include a direct route between NAVAIDs, a radial, radar vector, or a final approach course beyond the segments of an instrument approach procedure) a controller will issue an approach clearance only after the aircraft is:

1. Established on a segment of a published route or instrument approach procedure.

Example (Figure 2-6):

Aircraft 1: The aircraft is established on a segment of a published route at 6000 feet.

"CLEARED FOR VOR RUNWAY THREE FOUR APPROACH."
Aircraft may descend to 4000 feet.

2. Assigned an altitude to maintain until the aircraft is established on a segment of a published route or instrument approach procedure.

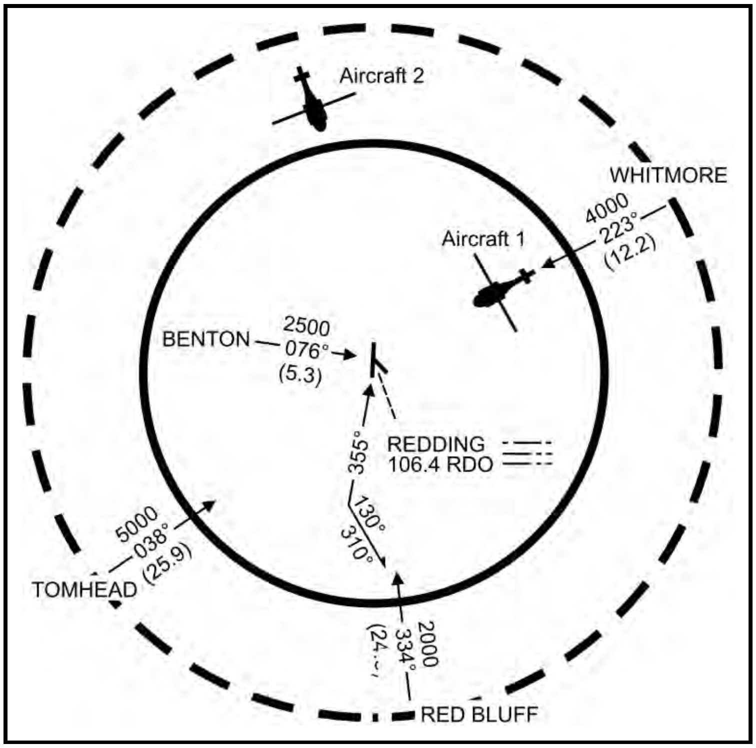

Figure 2-6 Instrument Approach Procedure

Example:

Aircraft 2: The aircraft is inbound to the VOR on an unpublished direct route at 7000 feet. The minimum IFR altitude for IFR operations (FAR 91.119) along this flight path to the VOR is 5000 feet, based on ATC clearance:

"CROSS THE REDDING VOR AT OR ABOVE FIVE THOUSAND, CLEARED FOR VOR RUNWAY THREE FOUR APPROACH."

NOTE

The altitude assigned must assure IFR obstruction clearance from the point at which the approach clearance is issued until established on a segment of a published route or instrument approach procedure.

When an approach clearance is received, before reaching the initial approach fix, which contains an altitude restriction in the clearance, the pilot should ensure strict compliance with the altitude restriction - usually, other air traffic is involved.

Example: "CLEARED FOR TACAN RUNWAY ONE FOUR APPROACH, DESCEND AND MAINTAIN FOUR THOUSAND UNTIL REACHING SHREVEPORT."

Example: "CLEARED FOR TACAN RUNWAY ONE FOUR APPROACH, DESCEND AND MAINTAIN FOUR THOUSAND, CROSS SHREVEPORT AT OR BELOW FIVE THOUSAND."

Example: "CLEARED FOR TACAN RUNWAY ONE FOUR APPROACH, MAINTAIN ONE ONE THOUSAND UNTIL REACHING SHREVEPORT."

Note that in the latest example, because of possible lower-altitude traffic, the pilot will arrive at the initial approach fix with excessive initial approach altitude. An accepted and standard technique for dissipating excessive initial approach altitude is to descend after arriving at the approach fix ***in a holding pattern*** established as depicted on the approach plate or if no pattern is depicted, in a holding pattern on the approach course (inbound to the fix), ***making*** turns on the ***procedure turn side of the approach course***. Altitude loss, in this maneuver, may be continued to as low as the procedure turn altitude depicted on the chart, if necessary.

If the approach procedures depicted on the chart looked like this --

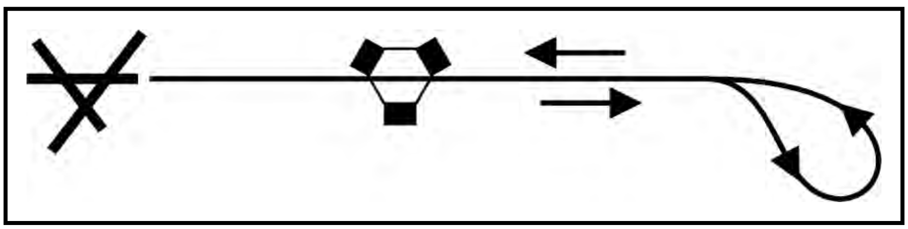

Figure 2-7 Approach Procedure

What would the holding pattern look like (to lose excessive initial approach altitude)?

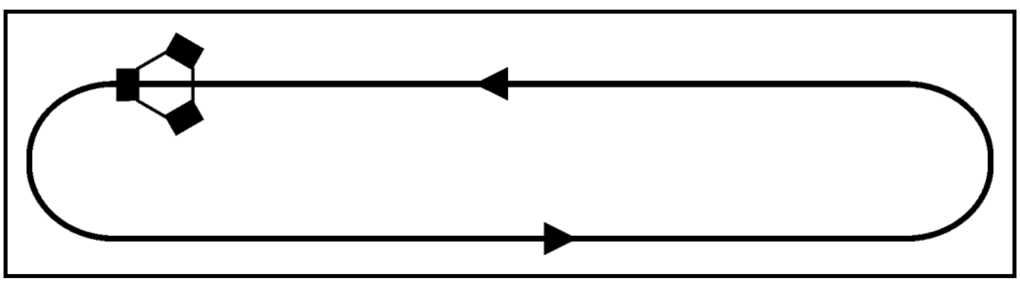

Figure 2-8 Holding Pattern

(Remember, be inbound to the fix and make turns on the procedure turn side of the approach course.)

Instrument Approach from Holding Pattern

When holding at a fix, usually an intersection, from which straight-in approaches are being conducted, clearances may specify the ***time of departure*** from the fix. Example: "DEPART XRAY INBOUND AT TWO SIX." This clearance does ***not*** constitute authority to commence an approach. It simply authorizes the pilot to depart the fix inbound toward the final approach fix. The pilot should adjust the flight path to leave the fix as closely as possible to the designated time. He must report leaving the fix, if in nonradar environment.

Descent, under the above circumstances, may be commenced when leaving the fix only if the pilot ***received clearance for a straight-in approach and when established on the inbound course.*** Otherwise, the pilot should hold the last assigned altitude, while inbound until he receives clearance for the straight-in approach. If clearance for a straight-in approach is not received, the pilot will be expected to execute the entire approach as published.

When holding at a fix (usually a NAVAID such as a VOR or Radio Beacon) from which procedure turn type approaches are being conducted, clearances will **not** normally specify the time to depart the fix. True, the holding clearance will have included a time at which the pilot can expect an approach clearance (expected further clearance time), but the pilot is not authorized to commence an approach at this "time" except under two-way radio failure. Normally, an approach clearance will be issued at or before the expected further clearance time.

Descent from the last assigned altitude to the procedure turn minimum may be commenced upon receipt of the approach clearance. The pilot must report leaving the last assigned altitude.

Upon receipt of the approach clearance, the pilot may leave the holding pattern to intercept the final approach course inbound. In other words, ***a procedure turn is not required when an approach can be made from a properly aligned holding pattern***. Therefore, under these circumstances, a report departing the VOR outbound is unnecessary; simply acknowledge the approach clearance and report leaving the altitude.

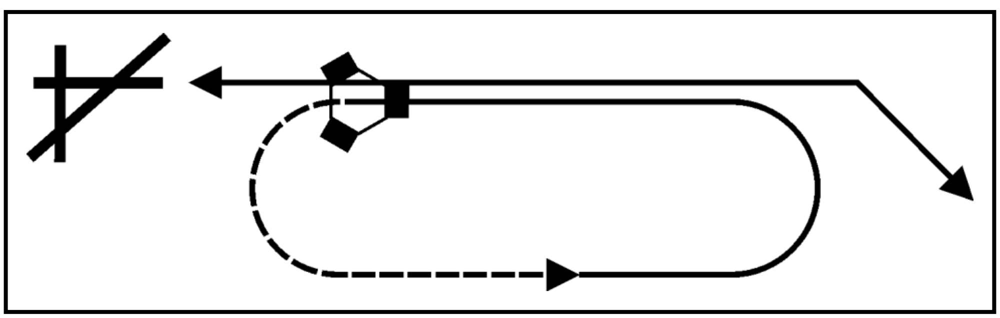

Figure 2-9 Leaving the Holding Pattern

Referring to Figure 2-9, assume approach clearance has been received on the outbound leg of the holding pattern. Additional circuits in the holding pattern are not required nor expected. Pilot should commence the approach with a turn toward the final approach course. If the pilots elect to make additional circuits to lose excessive altitude or to become better established on course, it is their responsibility to so advice ATC upon receipt of their approach clearance. Descent from published procedure turn altitude to final approach fix altitude will not commence until inbound on final approach course.

In this situation, the pilot should ensure such action will not allow the aircraft to exceed the maximum limiting distance for the execution of the procedure turn (usually ten miles).

Procedure Turns

"Procedure turn" means a maneuver prescribed when it is necessary to reverse direction to establish the aircraft on an intermediate or final approach course. The outbound course, direction of turn, distance within which the turn must be completed, and minimum altitude are specified in the published procedure. However, for the “45 degree procedure turn,” the point at which the turn may be commenced and the type and rate of turn (BARB, TEARDROP, HOLDING PATTERN) are left to the discretion of the pilot. Maneuvering must be done on the barbed side of the course line.

A type of procedure turn which is often used is the teardrop. The teardrop procedure turn consists of departure from an initial approach fix on an outbound course followed by a turn toward and intercepting the inbound course at or before the intermediate fix or point. When a teardrop type procedure turn is depicted and a course reversal is required, this type of turn must be executed.

The “holding-in-lieu of procedure turn” approach is also a procedure turn (despite the name) since it also provides for a course reversal to align the aircraft with the intermediate or final approach course. As with the teardrop approach, this approach must be executed as depicted.

A straight-in approach is an instrument approach procedure conducted by proceeding inbound to the final approach fix at the prescribed altitude and continuing inbound on the final approach course to the airport ***without making a procedure turn***. A straight-in approach is ***not necessarily completed with a straight-in landing*** or made to straight-in landing minimums.

A pilot shall not make a procedure turn (unless he so advises Approach Control and an appropriate clearance is received) when:

1. Issued a clearance for a straight-in approach (even though the published procedure depicts a procedure turn), or

2. The approach published on the FLIP Terminal Plate is designated "NoPT" (no procedure turn required), or

3. The aircraft is radar-vectored to a final approach position, or

4. The instrument approach procedure specifically prohibits use of a procedure turn.

Vectors to Final Approach Course

Where adequate radar coverage exists, radar facilities may vector aircraft to the final approach course for a straight-in approach.

Example: "DEPART (outer fix), HEADING (degrees), FOR VECTOR TO FINAL APPROACH COURSE FOR (approach name)."

Arriving aircraft are either cleared to an outer fix most appropriate to the route being flown (with holding instructions, if required), or, when radar hand-offs are effected between the Center and Approach Control, aircraft are cleared to a fix so located that the hand-off will be completed before the time the aircraft reaches the fix.

When radar hand-offs are used, after release to Approach Control, successive arriving flights are vectored to the appropriate final approach course (ILS, VOR, ADF, TACAN, etc.).

Radar vectors and altitudes will be issued as required for spacing and separating aircraft. Therefore, ***pilots must not deviate from the heading issued by Approach Control***. The radar vector issued for interception of the approach course will be such as to enable the pilot to establish his aircraft on the approach course before reaching the final approach fix. Aircraft will be cleared for a straight-in approach at the time the final heading for interception of the approach course is issued, or after the aircraft is established on the approach course before passing the final approach fix.

When established on the approach course, radar separation will be maintained and the pilot will be expected to complete the approach utilizing existing approach aids (ILS, VOR, ADF, etc.) as the primary means of navigation. After passing the final approach fix (outer marker, VOR, radio beacon, etc.), pilots are expected to proceed to the airport and complete the approach or effect the missed-approach procedure published for that airport.

211. EXPLANATION OF TERMS

Certain amendments to the FAR implemented new techniques and criteria associated with the manual titled U.S. Standard for Terminal Instrument Procedures (TERPS). This handbook contains criteria which are used to formulate, review, approve, and publish procedures for instrument approaches and departures of aircraft to and from civil and military airports. These procedures are promulgated in the Instrument Approach Procedures volume series. The minimums established for a particular airport shall be the lowest permitted by TERPS. Each procedure shall specify minimums for the various conditions stated in the procedure; i.e., straight-in, circling, alternate, and takeoff, as required.

Approach Categories - six approach categories (A,B,C,D,E, and COPTER) control the landing minima for different types of aircraft. Landing minimums for a particular type aircraft depend upon the approach category in which it is placed.

It should be noted that approach speeds are based upon a value 1.3 times the stalling speed of the aircraft in the landing configuration at maximum certified gross landing weight. Thus, they are computed values, not the speed at which an aircraft flies an approach nor the NATOPS listed approach speed. An aircraft can fit into only one category, that being the highest category in which it meets the specification. However, this does not preclude the aircraft commander from using higher approach minimums if the speed at which the aircraft actually flies an approach is in a higher category.

Approach Category	Calculated Approach Speed
A	Speeds less than 91 knots
B	Speeds 91-120 knots
C	Speeds 121-140 knots
D	Speeds 141-165 knots
E	Speeds over 165 knot

So if approach category is based on stall speed where do helicopters fit in? Helicopters have procedures designed specifically for them called COPTER procedures. COPTER procedures are designed for helicopter use only and therefore are restricted to airspeeds of 90 knots or less. A COPTER procedure has a final approach direction instead of a runway designation and provides ***no circling minimums***. See section 213 for Copter approaches.

In the absence of COPTER MINIMA, helicopters may use the CAT A minimums of other procedures. Due to unique maneuverability and handling characteristics, helicopters may reduce the required visibility of non-copter procedures to one-half the published visibility minimum for CAT A aircraft, but in no case may it be reduced to less than one-fourth mile or 1200 feet RVR. Visibility may not be reduced below published for COPTER procedures since the helicopter's maneuverability has already been factored in.

Minimum Decent Altitude (MDA) - An altitude, specified in feet above MSL, below which descent will not be made until visual reference has been established with the runway environment and the aircraft is in a position to execute a safe landing. MDAs apply to non-precision straight-in and circling approaches. After passing the final approach fix inbound, such as during a VOR approach, the pilot can now descend to the MDA value on the altimeter.

Decision Height (DH)/Decision Altitude (DA) - An altitude, specified in feet above MSL, at which a missed approach shall be initiated when either visual reference has not been established with the runway environment or the aircraft is not in position to execute a safe landing. In U.S. airspace, DH and DA are used interchangeably and apply to precision approaches (e.g., ILS and PAR) as well as RNAV (GPS) approaches with vertical guidance (LPA and LNAV/VNAV).

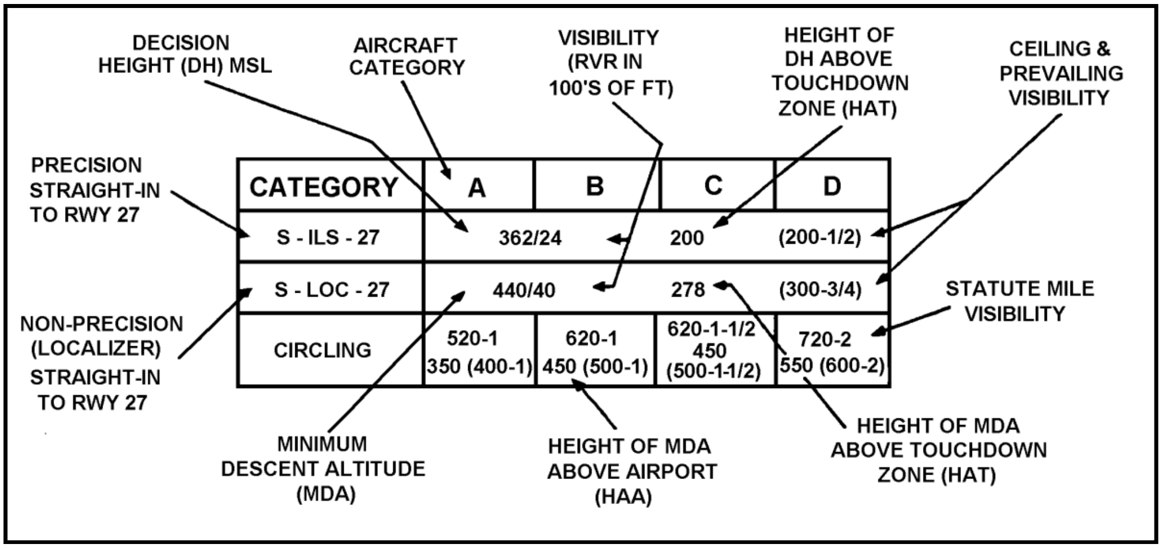

Figure 2-10 Sample Landing Minima Format

We have already defined MDA and DH in the preceding paragraphs. An explanation of the remaining terms used in the standard format above is as follows:

Height Above Airport - "Height Above Airport" (HAA) information indicates the height of the aircraft (when flying at the MDA) above the published airport elevation. The HAA will afford a minimum of 300 feet of obstruction clearance.

From the sample format on the previous page, it will be noted that when an aircraft of approach category B is flying at the MDA of 620 feet MSL, it is actually 450 feet above the published elevation of the airport. Therefore, the published elevation of the airport must be 170 feet. The published airport elevation is a measurement of the highest point of all the usable runway surfaces.

Height above touchdown - "Height above touchdown" (HAT) information indicates the height of the aircraft (when at the DH or MDA) above the highest runway elevation in the touchdown zone (first 3000 feet of runway). This is published in conjunction with straight-in minimums. From the sample format on the previous page, it will be noted that when an aircraft executing a straight-in ILS Runway 27 approach (all approach categories of aircraft have the same minimums) reaches the DH of 362 feet MSL, it is actually 200 feet above the highest runway (specifically, Runway 27) elevation in the touchdown zone. Therefore, the highest point in the first 3000 feet of Runway 27 is 162 feet.

It will be noted that in our sample format the published elevation of the airport (170 feet) and the highest runway elevation of the touchdown zone of Runway 27 (162 feet) are ***not*** the same.

Ceiling - Ceiling values, shown in parenthesis, are for the military pilot's use in accordance with the directives of each service. Ceiling values are stated in round hundreds of feet (e.g., 100, 200, 300, etc.) and are equal to or greater than the height of the MDA or DH above field elevation.

Ceiling values should be checked by the Navy pilot in the preflight phase of flight to determine if the airport's forecast weather meets OPNAVINST 3710.7 requirements for filing purposes to a destination (or an alternate).

Ceiling minimums are not prescribed by the FAA in TERPS procedure as a landing minimum. Controllers will allow approaches down to the prescribed MDA or DH without regard to the reported ceiling. (The published visibility will be the limiting condition for landing.) However, it should be stressed that OPNAVINST 3710.7 series still requires that ***ceiling and visibility*** be considered to determine whether or not the airport is above minimums.

Runway Visual Range (RVR) - RVR is an instrumentally derived value based on standard calibrations that represent the horizontal distance a pilot will see down the runway from the approach end. It is based on the sighting of either high-intensity runway lights or on the visual contrast of other targets - whichever yields the greatest visual range. RVR, in contrast to prevailing visibility, is based on what a pilot in a moving aircraft should see looking down the runway. RVR is horizontal, and not slant visual range. It is based on the measurement of a transmissometer made near the touchdown point of the instrument runway and will be shown in ***hundreds of feet***. (Example: 24 equals 2400 feet.)

The RVR value depicted immediately following the lowest altitude (DH, MDA) is of value to be used for determining if the field is above minimums for the type of approach contemplated. The visibility value shown in parenthesis is for military pilots to use for the type of approach contemplated when visibility values that follow the MDA/DH are not available.

It should be noted that the RVR values may be authorized for both precision and non-precision approaches when straight-in landing minimums to a specific runway are depicted. In other words, RVR values will **not** be specified in conjunction with circling landing minimums.

Prevailing Visibility - Prevailing Visibility is the greatest horizontal distance at which targets of known distance are visible over at least half of the horizon. Prevailing visibilities are used in conjunction with circling approaches and when RVR is not available. It is normally determined by an observer on or close to the ground viewing buildings or other similar objects during the day and ordinary city lights at night. Under low visibility conditions, the observations are usually made at the control tower. Prevailing visibility minimums will be shown in statute miles and fractions thereof. (Example: 1½ equals one and one-half miles.)

212. LANDING MINIMUMS

Straight-In Landing Minimums

The name of the instrument approach procedure is located in the upper and lower left-hand corner of the FLIP Instrument Approach Plates. One method used to name instrument approach procedures in the FLIP Approach Plates is to identify the type of facility which provides the final approach course guidance and the runway with which the facility is aligned (e.g., ILS Rwy 18, LOC (BC) Rwy 7, TACAN Rwy 36, LOC Rwy 4, GPS Rwy 32R, NDB (ADF) Rwy 21, VOR Rwy 15, VOR/DME Rwy 6, VORTAC Rwy 36, etc.). When operational requirements necessitate that more than one procedure be published to serve the same runway, using the same navigational aid, the procedures shall be numbered as follows: TACAN 2 Rwy 18, or lettered TACAN Y Rwy 18 and TACAN Z Rwy 18.

The above types of approach procedures will specify ***straight-in*** landing minimums (and possibly, circling landing minimums as well) on the approach plate. In other words, when a **runway reference** is included in the name of the approach procedure, you can expect to find straight-in landing minimums on the approach plate. It is not unusual to find two approaches depicted on one approach plate.

Straight-in landing minimums are shown on an instrument approach procedure chart when ***the final approach course*** of the instrument approach procedure ***is within 30º of the runway alignment and a normal descent can be made*** from minimum altitude at the final approach fix shown on the instrument approach procedure to the runway surface. When either the normal rate of descent or the runway alignment factor or 30º is exceeded, a straight-in landing minimum is not published and a circling minimum applies. The fact that a straight-in landing minimum is not published does ***not*** preclude the pilot from landing straight-in if he has the active runway in sight in sufficient time to make a normal approach for landing. Under such circumstances, and when cleared for landing on that runway, he is not expected to circle, although only circling minimums are published.

NOTE

> Do not confuse the term "straight-in ***approach***" with "straight-in ***landing minimums***." It is ***not*** necessarily true that because the pilot is cleared for a straight-in approach, he can descend to the straight-in landing minimum -- sometimes he will have to use the "circling" landing minimum, dependent upon several factors. As an example, controllers will include in the approach clearance instructions to circle to the runway in use ***if landing will be made on a runway other than that aligned with the direction of the instrument approach.***

Example: "CLEARED FOR STRAIGHT-IN VOR RUNWAY TWO TWO APPROACH, CIRCLE TO RUNWAY FOUR."

Note carefully, in the foregoing example, that the pilot is cleared for a straight-in approach, but he must use circling minimums. Conversely, it is possible to be cleared for an out-and-in procedure turn type of approach and descend to the straight-in landing minimums after passing the final approach fix.

Circling Landing Minimums

Whenever the criteria used to establish straight-in landing minimums cannot be met, only circling landing minimums will be shown on the chart. (Of course, many approach procedures depict both straight-in landing minimums and circling landing minimums.) When only circling minimums are possible, the method used to name the procedure is to identify the type of facility which provides final approach course guidance (runway reference is omitted). For example, TAC-A, TAC-B, NDB (ADF)-A, NDB (ADF)-B, etc. The first procedure shall be given the letter A, although there may be no intention to formulate additional "circling" approach procedures.

The circling landing minimums published on the instrument approach procedure chart provide adequate obstruction clearance - a minimum of 300 feet in the circling approach area (FAA Order 8260.3 TERPS) - and the pilot should not descend below the published MDA until the aircraft is in a position to make a descent for a normal landing. The "circling approach area" mentioned previously expands as the approach categories of aircraft go "up" from the letters "A" to "E." The larger the "circling approach area", the more likely that it will encompass a higher obstruction which will require a corresponding increase in circling minimums.

Maneuvering at the Circling Minimums

Sound judgment and knowledge of his and the aircraft's capabilities are the criteria for a pilot to determine the exact maneuver in each instance, since airport design and the aircraft position, altitude, and airspeed must all be considered. The following basic rules apply:

1. Maneuver the shortest path to the base or downwind leg, as appropriate, under minimum weather conditions. There is no restriction to passing over the airport or other runways. Advising the controller of your intentions is recommended.

2. Study the airport diagram and turn away from obstruction and/or high terrain.

3. At airports without a control tower, it may be desirable to fly over the airport to observe wind indicators and other traffic which may be on the runway or flying in the vicinity of the airport.

If visual reference is lost while maneuvering at the circling minimums, the ***missed approach specified for that particular procedure must be followed***.

Descent below MDA (or DH)

Visual Descent Points (VDPs) are being incorporated in nonprecision approach procedures. The VDP is a defined point on the final approach course of a nonprecision approach procedure (straight-in landing) from which normal descent from the MDA to the runway touchdown point may be commenced, provided visual reference required by 14 CFR Section 91.175(c)(3) is established (as outlined below). The VDP will normally be identified by DME on VOR and LOC procedures and by along-track distance to the next waypoint for RNAV procedures. The VDP is identified on the profile view of the approach chart by the symbol: **V**.

1. VDPs are intended to provide additional guidance where they are implemented. No special technique is required to fly a procedure with a VDP. The pilot should not descend below the MDA prior to reaching the VDP and acquiring the necessary visual reference.

2. Pilots not equipped to receive the VDP should fly the approach procedure as though no VDP had been provided.

FAR 91 specifically states that no person may operate aircraft below the prescribed minimum descent altitude (or continue an approach below the decision height) unless -

1. The aircraft is in a position from which a normal approach to the runway of intended landing can be made; and

2. The runway environment is clearly visible to the pilot. ("Runway environment" is defined as the runway approach threshold, or approach lights or other markings identifiable with the approach end of that runway.)

NOTE

DH indicates to the pilot the published descent profile is flown to the DH (MSL), where a missed approach will be initiated if visual references for landing are not established. Obstacle clearance is provided to allow a momentary descent below DH while transitioning from the final approach to the missed approach. (A.I.M. 5-4 – 5.J.4)

Sidestep Maneuver

A visual maneuver accomplished by a pilot in the completion of an instrument approach to permit a straight-in landing on a parallel runway not more than 1200 feet to either side of the runway to which the instrument approach was conducted. Aircraft will be cleared for a specified non-precision approach and landing on the adjacent parallel runway. The sidestep should be commenced as soon as possible after the runway or runway environment is in sight.

Example: "CLEARED TACAN 7 LEFT APPROACH, SIDESTEP 7 RIGHT APPROACH."

213. COPTER ONLY APPROACHES

Pilots flying Copter approach procedures, other than GPS, may use the published minima with no reductions in visibility allowed. The maximum airspeed is 90 KIAS on any segment of the approach or missed approach. (OPNAVINST 3710.7) (Figure 2-11).

Pilots flying Copter GPS or WAAS approaches at civilian fields must limit the speed to 90 KIAS on the initial and intermediate segment of the approach, and to no more than 70 KIAS on the final and missed approach segments (Figure 2-12). Copter GPS approaches at military fields are designed to be flown at 90 KIAS or less.

The missed approach segment TERPS criteria for all Copter approaches take advantage of the helicopter's climb capabilities at slow airspeeds, resulting in high climb gradients. The obstacle clearance surface (OCS) used to evaluate the missed approach is a 20:1 inclined plane. This surface is twice as steep for the helicopter as the OCS used to evaluate the airplane missed approach segment. The helicopter climb gradient is therefore required to be double that of the airplane's required missed approach climb gradient. A minimum climb gradient of at least ***400 feet per NM*** is required unless a higher gradient is published on the approach chart; e.g., a helicopter with a ground speed of 70 knots is required to climb at a rate of 467 feet per minute (FPM). The advantage of using the 20:1 OCS for the helicopter missed approach segment instead of the 40:1 OCS used for the airplane is that obstacles that penetrate the 40:1 missed approach segment may not have to be considered. The result is the DA/MDA may be lower for helicopters than for other aircraft. The minimum required climb gradient of 400 feet per NM for the helicopter in a missed approach will provide 96 feet of required obstacle clearance (ROC) for each NM of flight path.

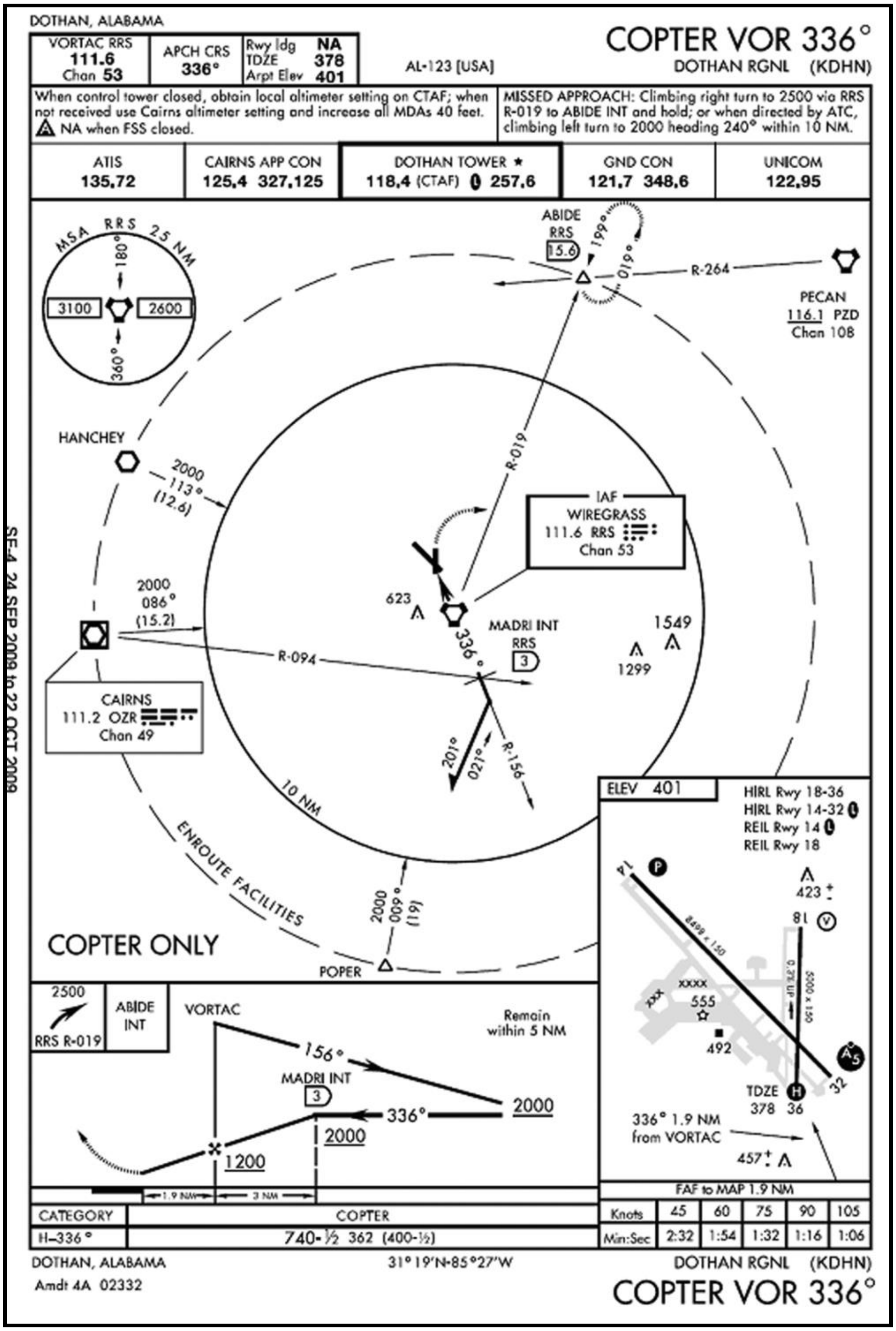

Figure 2-11 Copter Approach

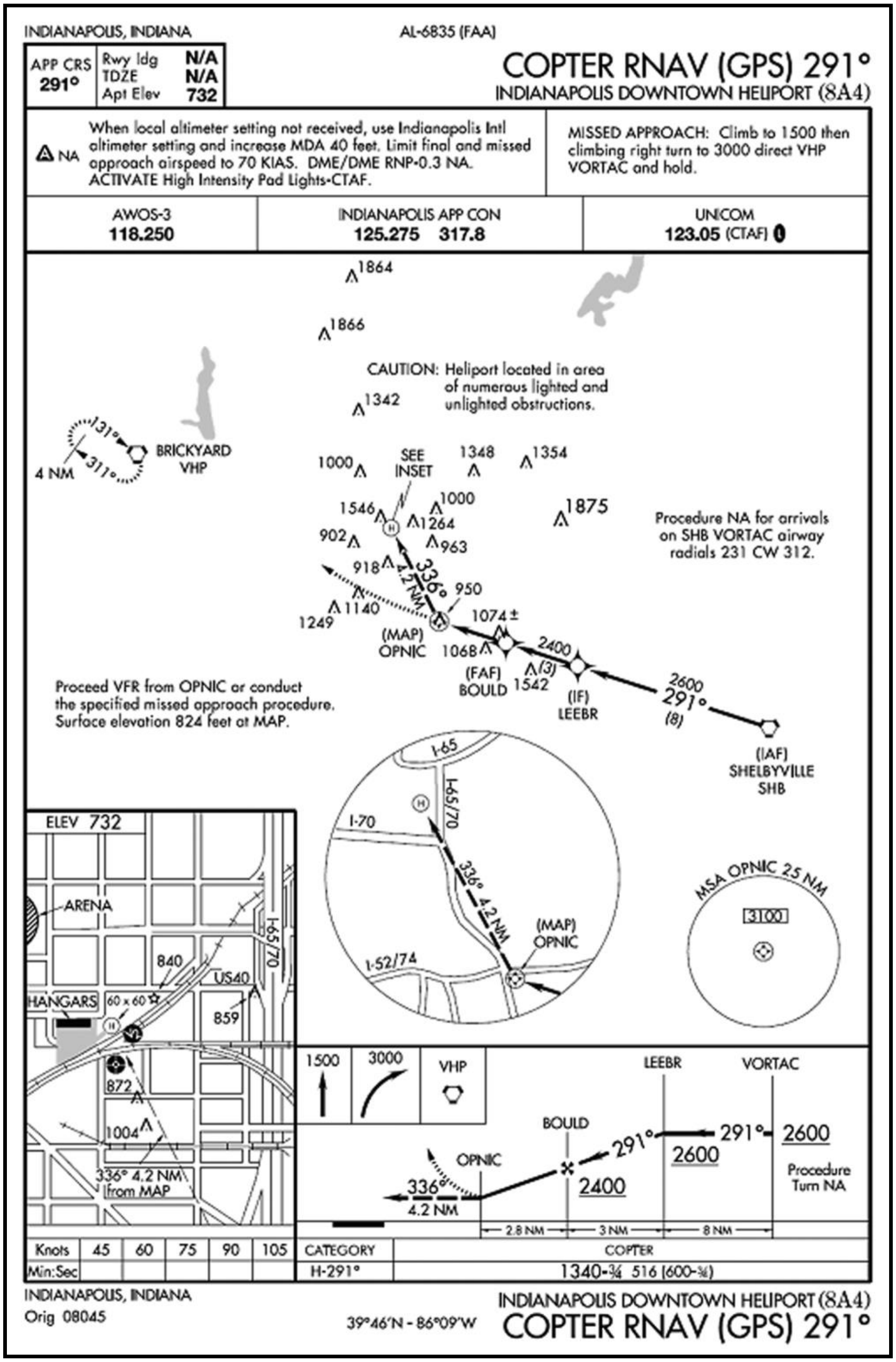

Figure 2-12 Copter RNAV Approach w/Visual Flight Path

214. VISUAL APPROACHES

Contact Approach

A contact approach is defined as an approach wherein the pilot of an aircraft on an IFR flight plan, operating clear of clouds with at least one mile flight visibility, has ***requested*** and ***received*** authorization, may deviate from the prescribed instrument approach procedure and proceed to the airport of destination by visual reference to the surface.

Example: "CLEARED FOR CONTACT APPROACH, MAINTAIN NOT ABOVE (altitude) (routing and/or reports as required), IF NOT POSSIBLE (alternate procedures) AND ADVISE."

In summary, controllers may authorize a contact approach provided:

1. The pilot so requests;

2. The reported ground visibility at the destination airport is at least one mile for military aircraft; and

3. Approved separation can be applied between aircraft so cleared and between those aircraft and other IFR aircraft.

However, the pilot must realize that he assumes the responsibility for obstruction clearance by electing to abandon the safeguards which are guaranteed by compliance with a published instrument approach. This procedure is intended primarily as an alternative for a prescribed instrument approach procedure and pilots should use discretion in conducting a contact approach.

Visual Approach

ATC may authorize a visual approach to any airport for which there is a standard or special instrument approach procedure. The ceiling and visibility at and in the vicinity of the destination airport must be such that the entire "visual approach" and landing can be accomplished in VFR conditions (1000 feet ceiling and 3 miles of visibility). When ATC is employed to separate and sequence air traffic, clearance for a "visual approach" may be issued only when the aircraft is either at the minimum vectoring altitude or able to descend to that altitude in VFR conditions. When operating to an airport with a functioning approach control tower, one or more aircraft may be authorized to conduct a "visual approach." The first aircraft must have the airport in sight. Any succeeding aircraft must maintain visual contact with the aircraft it is instructed to follow.

When operating to an airport with a functioning nonradar approach control tower, or a nonapproach control tower, or to an airport with no control tower, only one aircraft at a time may be cleared to conduct a "visual approach." That aircraft must be operating within the control zone of the destination airport, must have the airport in sight, and must be the number one IFR aircraft in the approach sequence. Additionally, since a clearance for a "visual approach" may be issued by a remote approach control facility, or by an air route traffic control center, it is important that pilots accomplish cancellation of their IFR flight plans consistent with their communications capability with the ATC facility with whom they are in contact.

IFR aircraft may be descended to the minimum vectoring altitudes, vectored to the airport traffic pattern (instead of the final approach course of a prescribed instrument approach), and cleared for a visual approach.

In a visual approach the following may apply:

The pilot:

1. If a visual approach is not desired, advises ATC.

2. Complies with controller's instructions for vectors toward the airport of intended landing or to a visual position behind a preceding aircraft.

3. The pilot must, at all times, have either the airport or the preceding aircraft in sight. After being cleared for a visual approach, proceed to the airport in a normal manner or follow the preceding aircraft. Remain clear of clouds while conducting a visual approach.

4. If the pilot accepts a visual approach clearance to visually follow a preceding aircraft, he is required to establish a safe landing interval behind the aircraft you were instructed to follow. You are responsible for wake turbulence separation.

5. Advise ATC immediately if you are unable to continue following the preceding aircraft, cannot remain clear of clouds, or lose sight of the airport.

6. Be aware that radar service is automatically terminated, without being advised by ATC, when the pilot is instructed to change to advisory frequency.

7. Be aware that there may be other traffic in the traffic pattern and the landing sequence may differ from the traffic sequence assigned by approach control or ARTCC.

The controller:

1. Do not clear an aircraft for a visual approach unless reported weather at the airport is ceiling at or above 1000 feet and visibility is 3 miles or greater. When weather is not available for the destination airport, inform the pilot and do not initiate a visual approach to that airport unless there is reasonable assurance that descent and flight to the airport can be made visually.

2. Issue visual approach clearance when the pilot reports sighting either the airport or a preceding aircraft which is to be followed.

3. Provide separation except when visual separation is being applied by the pilot.

4. Continue flight following the traffic information until the aircraft has landed or has been instructed to change to advisory frequency.

5. Inform the pilot when the preceding aircraft is a heavy.

6. When weather is available for the destination airport, do not initiate a vector for a visual approach unless the reported ceiling at the airport is 500 feet or more above the MVA and visibility is 3 miles or more. If vectoring weather minima are not available but weather at the airport is ceiling at or above 1000 feet and visibility of 3 miles or greater, visual approaches may still be conducted.

7. Informs the pilot conducting the visual approach of the aircraft class when pertinent traffic is known to be a heavy aircraft.

Charted Visual Flight Procedures

In addition to conventional visual approaches, some locations have developed charted visual flight procedures (CVFP) (Figure 2-13) to enhance noise abatement. They are used only in a radar environment at airports which are served by an operating control tower and have a weather reporting service.

CVFPs originate over or near a prominent landmark. If the landmark cannot be readily identified at night, the procedure will be annotated PROCEDURE NOT AUTHORIZED AT NIGHT. An aircraft following another aircraft on approach must report sighting the preceding aircraft unless ATC is providing standard separation. Acceptance of a CVFP clearance constitutes pilot acceptance of responsibility for maintaining a safe approach interval and adequate wake turbulence separation. When not following another aircraft, an aircraft may be cleared for a CVFP when it reports a charted visual landmark in sight.

A CVFP is not an instrument approach. Therefore, it does not have a missed approach segment. Aircraft unable to complete a CVFP will be handled as any go-around.

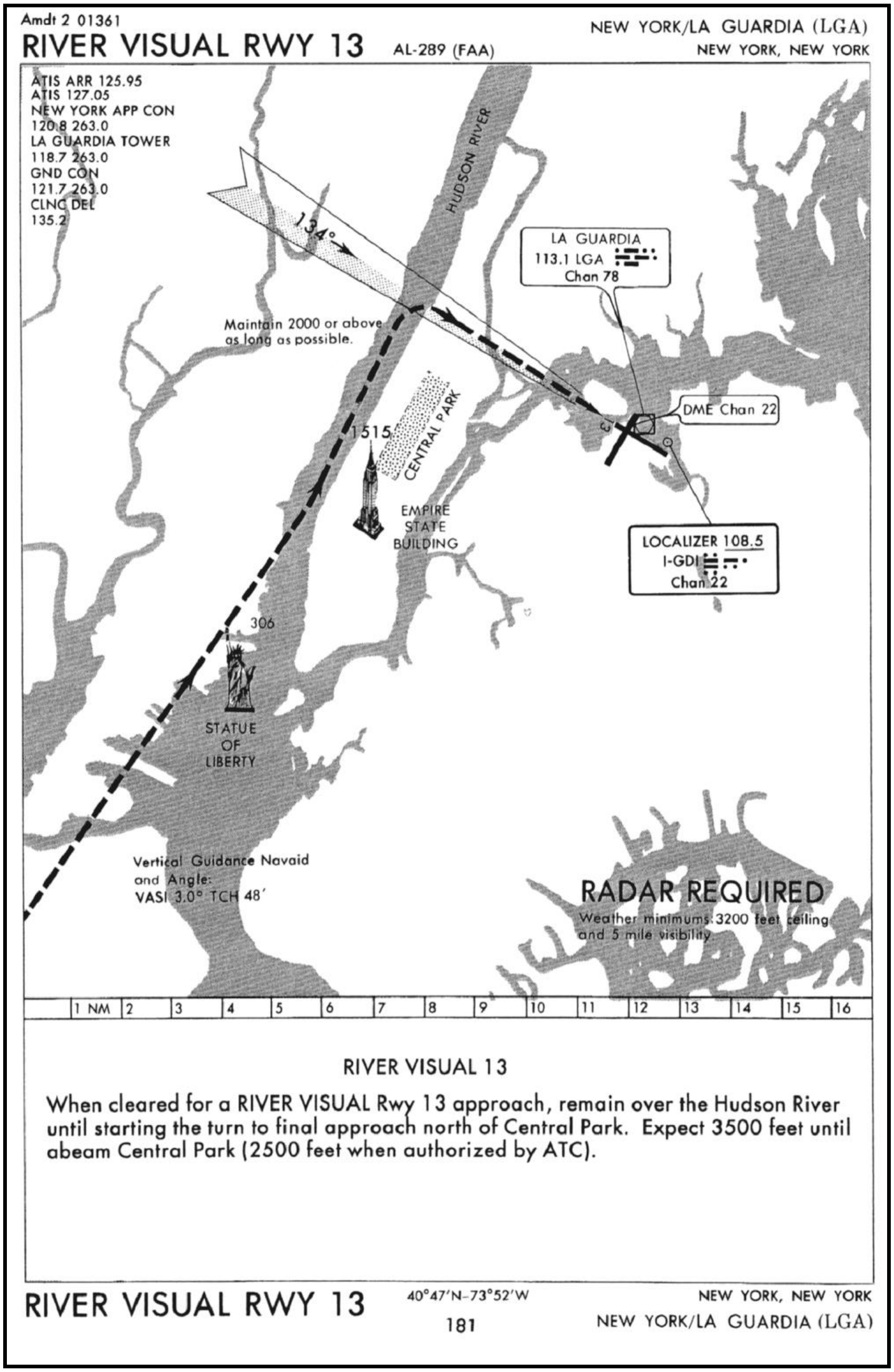

Figure 2-13 CVFP

215. MISSED APPROACH

When the required visual reference is not established upon reaching the missed-approach point, the pilot shall follow the prescribed missed-approach procedure (unless alternative missed-approach instructions have been issued) and obtain further clearance.

1. The pilot may request clearance for ***another approach***. Traffic permitting, an approach clearance may be issued immediately or the flight may be required to hold until clearance for an approach can be issued.

2. The pilot may request a ***holding clearance*** to await improvement in the weather if the fuel remaining is sufficient and the weather trend indicates improvement.

3. The pilot may, at any time, request clearance to an ***alternate airport***.

Protected obstacle clearance areas for missed approach are predicated on the assumption that the missed approach is initiated at the missed approach point not lower than the MDA. Reasonable buffers are provided for normal maneuvers; however, no consideration is given to an abnormally early turn. Therefore, when an early missed approach is executed, pilots should, unless otherwise cleared, fly the instrument approach procedure as specified on the approach plate to the missed approach point at or above the MDA ***before executing a turning maneuver***.

If visual reference is lost while circling to land from an instrument approach, the missed approach specified for that particular procedure must be followed (unless alternate missed approach instructions have been issued). To become established on the prescribed missed approach course, the pilot should make an initial climbing turn ***toward the landing runway*** and continue the turn until he is established on the missed approach course. Inasmuch as the circling maneuver may be accomplished in more than one direction, different patterns will be required to become established on the prescribed missed approach course, depending on the aircraft position at the time visual reference is lost. Adherence to the procedure will assure that an aircraft will remain within the circling and missed approach obstruction clearance areas.

Many instrument flights terminate at airports where weather conditions are well above the instrument approach minimums. Consequently, it is often unnecessary, impractical, or even inadvisable to make a complete standard instrument approach; it is more likely, under these circumstances, that pilots will

1. Cancel the IFR flight plan;

2. Request clearance for a CONTACT APPROACH;

3. Receive clearance for a VISUAL APPROACH.

After descending into VFR weather conditions, pilots often cancel their IFR flight plans because it may be beneficial to do so (especially at airports where no Approach Control is provided). After canceling, the pilot is no longer required to complete the full standard instrument approach and may expedite landing by shortening the approach path. Also, canceling the IFR flight plan allows the pilot more freedom to maneuver his aircraft for sequencing with VFR traffic. Retaining the IFR flight plan when operating in VFR weather conditions does ***not*** relieve the pilot of the responsibility of locating and avoiding other aircraft. Canceling an IFR flight plan is the pilot's prerogative. Controllers cannot disapprove such action. Recall that OPNAVINST 3710.7 requires all military flights use a flight plan.

This means you should file a VFR flight plan in the air, with the nearest flight service station, whenever you cancel your IFR clearance.

Canceling an IFR flight plan in the air ***does not*** relieve the pilot of the responsibility of ***closing* out** his flight plan after landing with the nearest FSS.

216. AIRPORT HOT SPOTS

An airport "hot spot" is defined as "A location on an airport movement area with a history of potential risk of collision or runway incursion, and where heightened attention by pilots and drivers is necessary." Hot spots are designated on airfield diagrams as shown in Figure 2-14. Each DoD Terminal FLIP contains a list of designated hot spots as the last section of "Supplementary Enclosures" before the approach procedure charts begin. The FAA Airport Facility Directories contain a more descriptive listing of hot spot information and you can also find them online at http://www.faa.gov/airports/runway_safety/hotspots/hotspots_list/, or contact the airfield operations department or ground control for additional information. Failure to notice a hot spot could possibly result in an FAA pilot deviation report or worse!

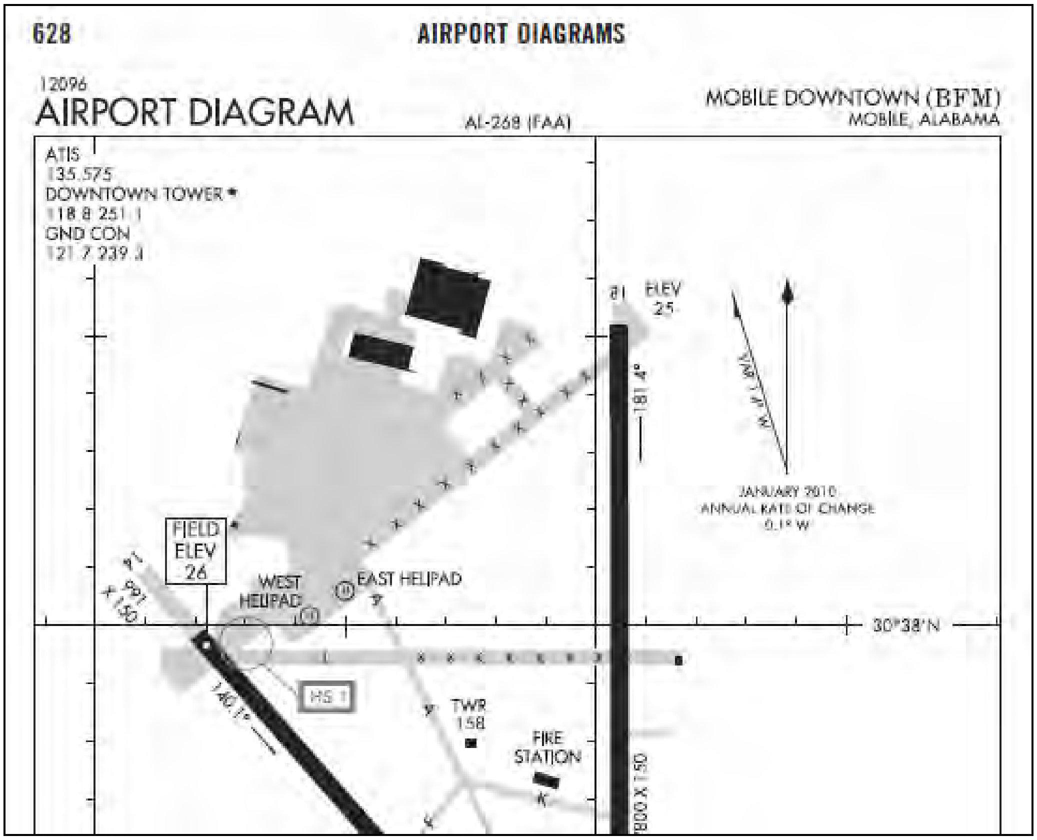

Figure 2-14 Airfield Hot Spots

REVIEW QUESTIONS

1. The FLIP that depicts instrument approach procedures such as VOR or TACAN approaches is

   a. IFR Supplement.
   b. VFR Supplement.
   c. General Planning (GP).
   d. Instrument Approach Procedures.

2. Radar approach minima information is contained in

   a. IFR Supplement.
   b. VFR Supplement.
   c. General Planning (GP).
   d. Instrument Approach Procedures.

3. ILS approaches are depicted in

   a. Instrument Approach Procedures.
   b. IFR Supplement.
   c. VFR Supplement.
   d. Area Planning (AP).

4. An ATIS broadcast will include weather and visibility whenever the reported ceiling is below ________ feet and visibility less than ________ miles.

   a. 5000 . . . 5
   b. 4000 . . . 4
   c. 3000 . . . 3
   d. 1000 . . . 3

5. To relieve frequency congestion, pilots are expected to inform the controller of receipt of ATIS information.

   a. True b. False

6. An Approach Control can serve more than one airfield.

   a. True b. False

7. If Approach Control services are not provided at the destination airport, the _______________ controller will issue an approach clearance.

   a. Tower
   b. ARTCC
   c. FSS
   d. Ground Control

8. If Approach Control services are provided at the destination airport, the Center controller will issue a clearance to

   a. Land.
   b. Commence the approach, and contact FSS.
   c. Contact Approach Control.
   d. Contact tower.

9. Advance approach information will not be provided when ATIS is in operation.

   a. True b. False

10. When the controller says "CLEARED FOR APPROACH," the pilot may select any approach (VOR, GPS, TACAN, ILS, ADF) published for that location.

   a. True b. False

11. Military pilots may ignore  on approach plates

   a. True b. False

12. The pilot may leave a properly aligned holding pattern to intercept the final approach course, upon receipt of the approach clearance.

   a. True b. False

13. When holding at an intersection fix from which straight-in approaches are being conducted, clearances will usually specify the time of departure from the fix (EFC).

   a. True b. False

14. The holding pattern, to lose excessive initial approach course altitude, if none is depicted, should be established on the approach course, making turns on the _______________ side of the approach course.

a. Holding pattern.
b. Procedure turn.
c. Final approach fix.
d. Airfield.

15. After radar vectors have established the aircraft inbound on the approach course, the pilot can expect a clearance for a straight-in approach.

a. True b. False

16. When the aircraft has been radar vectored to a final approach course, the pilot shall not execute a procedure turn.

a. True b. False

17. The term "Decision Height" applies only to precision approaches.

a. True b. False

18. In the minimum section of the approach plate, S-ILS-27 means

a. Precision approach to ILS, descend from 2700 feet.
b. Precision straight-in to runway 27.
c. Non-precision straight-in to runway 27.
d. Precision straight-in to runway 9.

19. Visibility (RVR) minimums are always identical for precision and non-precision approaches.

a. True b. False

20. The published airport elevation is a measurement of

a. Tower height.
b. Lowest point of usable runway.
c. Highest point of usable runway.
d. Mean height of usable runway.

21. An RVR value of 40 depicted on a FLIP terminal plate represents

a. 400 feet.
b. 4000 feet.
c. 40 miles.
d. None of the above

22. When both an RVR value and a prevailing visibility value (in parenthesis) is shown, the one to be used for determining if the field is above the minimums for an approach to a straight-in landing is

a. RVR.
b. prevailing visibility.
c. either one.
d. Neither of these factors should be used.

23. Runway Visual Range is

a. Slant range.
b. Horizontal range.
c. Distance from threshold to point of intended touchdown.
d. Distance from which the runway is visible.

24. A Navy pilot of a multi-piloted aircraft may request and receive an approach clearance from a controller when the weather is below published minimums.

a. True b. False

25. FAA controllers are NOT required to inform Navy pilots that the weather is below approach minimums.

a. True b. False

26. After reported weather is below published landing minimums for the approach to be conducted, an approach shall not be commenced in multi-piloted aircraft unless

a. The FAA supervisor approves it.
b. The aircraft has the capability to proceed to alternate.
c. The Navy pilot specifically requests it.
d. There are no exceptions.

27. Whenever the criteria used to establish straight-in landing minimums cannot be met, only circling landing minimums will be shown on the chart.

a. True. b. False

28. When only circling minimums are possible, the name of the approach procedures will not include a runway reference.

a. True b. False

29. When you are maneuvering at the circling minimums, you need NOT be in constant visual reference with the surface.

a. True b. False

30. When a runway reference is included in the name of an approach procedure, you can expect to find straight-in landing minimums on the approach plate.

a. True b. False

31. Straight-in landing minimums are shown on the FLIP approach plate when the final approach course of the approach procedure is within ______ degrees of the runway alignment.

a. 15
b. 20
c. 25
d. 30

32. When cleared for a straight-in approach, you should always use straight-in landing minimums.

a. True b. False

33. Whether you are departing a civil or a military airport a  symbol indicates your takeoff minimums are published in the IFR Takeoff Minimums Section of the Instrument Approach Procedures.

a. True b. False

34. Circling landing minimums provide a minimum of ________ feet obstruction clearance in the "circling approach area."

a. 200
b. 300
c. 350
d. 400

35. Controllers may clear an aircraft for a _______________ approach whether or not the pilot requests it.

a. contact
b. visual
c. blind
d. Special VFR

36. Controllers may clear an aircraft for a contact approach whether or not the pilot requests it.

a. True b. False

37. In order to request a contact approach on an IFR flight plan, pilots must be clear of clouds and have ________ flight visibility.

a. 2000 feet
b. 1 mile
c. 1000 feet
d. 3 miles

38. A single-piloted aircraft may request a practice approach at his destination if the weather is above his lowest approach minimums.

a. True b. False

39. VFR Radar Traffic Advisory Services (radar flight following) is provided by who?

40. How long is your weather briefing good?

41. What flights require a weather briefing?

42. Who is responsible for closing your flight plan?

43. If you cancel your IFR flight plan in route, what should you do?

44. Who would you contact for a weather briefing if departing a civilian airfield where a military briefer is not locally available?

45. How could you file your flight plan at a civilian airport with no tower and the FSS not at the field?

46. With whom would you leave a copy of your clearance and manifest at a civilian airport?

47. If you don't close out your flight plan, what could happen?

48. What penalty could you receive if you don't close out your flight plan?

49. Which publication lists requirements for flight plan filing?

50. According to OPNAVINST 3710.7 name one case in which you are not required to file a flight plan.

51. Name the five (5) items that constitute a flight plan as defined by OPNAVINST 3710.7.

52. What does OPNAVINST 3710.7 say about filing of flight plans?

53. A charted visual flight procedure is an instrument approach.

a. True b. False

REVIEW ANSWERS

1. d.
2. d.
3. a.
4. a.
5. a.
6. a.
7. b.
8. c.
9. a.
10. a.
11. b.
12. a.
13. a.
14. b.
15. a.
16. a.
17. a.
18. b.
19. b.
20. c.
21. b.
22. a.
23. b.
24. a.
25. a.
26. b.
27. a.
28. a.
29. b.
30. a.
31. d.
32. b.
33. b.
34. b.
35. b.
36. b.
37. b.
38. a.
39. TRACON or ARTCC controllers (radar controllers) depending on whose airspace you are flying through.
40. 30 minutes after ETD
41. All
42. Pilot in command or formation leader
43. Contact FSS and file a VFR flight plan.
44. Contact NAVMETOCCOM, PMSV (FIH) or FSS by phone
45. Call FSS by phone or radio
46. FSS or airport manager
47. Launch SAR
48. Flight violation
49. OPNAVINST 3710.7
50. Student training (CNATRA); urgent military necessity.
51. DD-175, Daily Flight Schedule, FAA Flight Plan, ICAO Flight Plan, flight plan specified by local authorities when departing from points outside CONUS
52. IFR flight plans shall be filed to the maximum extent possible.
53. b.

CHAPTER THREE
NAVIGATIONAL AIDS

300. INTRODUCTION

Various types of NAVAIDs are in use today, each serving a special purpose in our system of air navigation. These aids have varied owners and operators; namely, the Federal Aviation Agency (FAA), the military services, the individual states, and private organizations. The FAA has statutory responsibility to authorize the operation of all NAVAIDs. Moreover, the FAA maintains the NAVAIDs, including military, private, etc., used by the general public for air navigation in federally controlled airspace.

Practically all NAVAIDs transmit an identification signal, usually in Morse code. However, during periods of routine or emergency maintenance, the coded identifier (including the voice identifier, where applicable) will be removed from certain NAVAIDs, namely, TACAN, ILS, localizers, VORs and LF ranges. The removal of the identifier serves as a warning to pilots that the particular NAVAIDs have been officially taken over by "Maintenance" for tune up or repair and may be unreliable, even though on the air intermittently or constantly.

Except during shutdowns for maintenance purposes or unless otherwise noted on the FLIP-Enroute Supplement, all NAVAIDs operate continuously; i.e., 24 hours a day, 7 days a week, during VFR or IFR weather conditions.

A periodic check of the various NAVAIDs is conducted by FAA. If IFR conditions exist, a NOTAM may be issued advising that the NAVAID is shut down when undergoing maintenance. Therefore, pilots should check the NOTAMs before flight, regarding operation and use of the NAVAIDs.

The coded NOTAM messages can be decoded using the information found in the Flight Information Handbook.

Selected FSSs having voice capability on NAVAID frequencies, broadcast continuous automatic transcribed weather reports and other airway information such as current NOTAMs of NAVAIDs within 150 NM radius of the transmitting station. The "Radio Class Code" symbol AB denotes the transcribed weather broadcast and is found in the IFR Supplement. In each of the following examples of Radio Class Code symbols, transcribed weather broadcasts are transmitted on the NAVAID frequency: ABVOR, ABVORTAC, NDB (AB), etc.

Many NAVAIDs do not have voice capability. The Radio Class Code symbol W denotes unavailability of voice on the NAVAID frequency and is found in the FLIP Enroute Supplement. For example, MHW means that no voice is available on the low power NDB frequency. Certain NAVAIDs, such as TACANs and marker beacons, never have voice and although the Radio Class Code symbols do not include the letter W, it is understood that these NAVAIDs are always without voice. Voice capability indicates that the station is remotely linked to ATC for voice transmission. Not all TWEB/HIWAS capable stations have voice capability.

In the case of a VORTAC with transcribed weather broadcasts (ABVORTAC), the broadcast is transmitted on the VOR frequency only and **not** on the TACAN portion.

301. LESSON TOPIC LEARNING OBJECTIVES

Terminal Objective

Upon completion of this chapter, the student will recall elements of the airways route system, GPS and techniques for the proper use of navigational aids, specifically the VOR, TACAN, VORTAC and GPS. To successfully complete the unit post test, the student should achieve a minimum score of 80%.

Enabling Objectives

In response to questions and examples given in the text, the student will do the following:

1. List the three goals of the airway route system.

2. List the three navigational layers of the airways systems over the Continental United States as defined by the FAA.

3. Define the Low Altitude Airways system and list its limitations.

4. List the uses of alternate airways and how they are identified.

5. List the limitations of NAVAIDs established by the "Radio Class Code."

6. List the navigational distance limitations in the low and high altitude route structure.

7. State how VOR/TACAN NAVAID frequency interference has been eliminated.

8. State the means by which pilots are notified that NAVAIDs are out of service.

9. State the primary indication to a pilot when a NAVAID is unreliable for use.

10. List the two major components of the TACAN system.

11. List the advantages of the TACAN system.

12. List the limitations of the TACAN system.

13. State how the frequencies of a TACAN station are identified.

14. State the indications of the #2 needle when the RMI malfunctions.

15. State the components of a VORTAC station.

16. State the information received from a VORTAC.

17. State how a VORTAC station is identified.

18. State the difference between a VORTAC station and a VOR/DME station.

19. State the meaning of the acronym TACAN.

20. State the number of X-band and Y-band TACAN channels.

21. State the normal anticipated interference-free reception range and number of channels of TACAN.

22. Describe the TACAN cone of confusion.

23. State the methods and procedures for VOR and TACAN receiver checks.

302. AIRWAY ROUTE SYSTEM

The airway route system has three goals - simplification, user needs, and the best use of a limited number of NAVAID frequencies. The airspace over the U.S. is currently structured into three layers:

1. **Low-altitude airways** which extend up to 18,000 feet MSL,

2. **Jet airways**, from Flight Level 180 (beginning at 18,000 feet, altitudes are called Flight Levels and are expressed in three-digit numbers representing hundreds of feet) to Flight Level 450, and

3. **Area Navigation (RNAV) Routes.** Published RNAV routes, including Q-Routes and T-Routes, can be flight planned for use by aircraft with RNAV capability. T-Routes are available between 1,200 feet above the surface up to but not including 18,000 feet MSL (some instances higher). Q-Routes are available between 18,000 feet MSL and FL 450 inclusive.

In the early stages of system development, all VORs were assigned different frequencies. As more VORs (and VORTACs) were added to the system an interference problem developed, as the same frequency had to be assigned to more than one NAVAID. For example, as many as 20 VORs use the same frequency. The interference problem was only partly solved by ensuring that those NAVAIDs assigned the same frequency were spaced far apart. The airway system is line-of-sight and aircraft at high altitudes could still experience frequency interference - the stronger of the two signals would take over and it may result in the pilot following the wrong signal. The interference problem was completely eliminated by establishing an operational limitation directive (a maximum distance up to the certain altitude) for navigational guidance on a NAVAID (Figure 3-1).

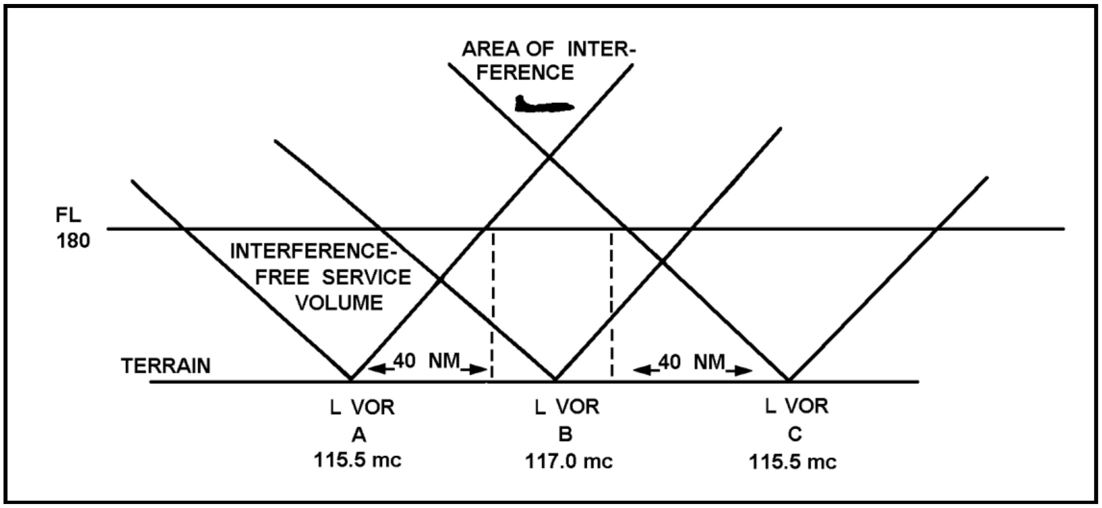

Figure 3-1 NAVAID

For the low-altitude structure, the operational limitations established are 40 nautical miles (NM) from the station up to FL 180, which provide interference-free service. These NAVAIDs are given a Radio Class designation L, which indicates the operational limitations free from another NAVAIDs interference. In Figure 3-1, although stations A and C are using the same frequency, aircraft flying in the low-altitude structure will not experience frequency interference.

Jet routes are supported by NAVAIDs classed as HA, which allow navigational guidance up to FL 450 to a distance of 130 NM from the NAVAID. Both classes of NAVAIDs, L and HA, have the same power and equipment and can be used at higher altitudes by aircraft closer to the NAVAID. Use of these facilities outside the service volume is not intended and may result in undependable or unreliable indications in the aircraft. However, all published routes and instrument approach procedures are frequency-protected; i.e., if the pilot follows proper enroute procedures, he will not experience frequency interference.

Another class of NAVAIDs, (T), which are not used in the airway route system, are installed for departure and arrival procedures. (T) NAVAIDs are protected from interference for 25 NM up to 12,000 feet MSL.

When specifying a route other than an established airway, pilots should not plan to exceed the operational limitations imposed on the various NAVAIDs because of the interference problem which may be encountered.

In the low-altitude structure, FARs prescribe that altitude shall be in feet ***above*** mean sea level. Accordingly, the current reported altimeter setting of a station along the route and within 100 nautical miles of the aircraft shall be used. The pilot is not expected to compensate for temperature or pressure variances from the normal gradients.

When in the enroute phase of flight, pilots are not required to read back altimeter settings. However, pilots shall read back all altimeter settings received from approach control agencies when in the terminal phase of flight (during instrument approaches, arriving or departing holding fixes, etc.). (Exception: When under the control of the final controller on a GCA approach and the pilot has been released from further transmission requirements.)

Low-Altitude Airway System

The low-altitude airways extend from a "floor" of 1200 feet above the surface (except where designated at higher altitudes) up to, but not including, 18,000 feet mean sea level. The normal NAVAID spacing is 80 nautical miles (NM). The airspace area has a width of 8 NM, 4 NM each side of centerline, within 51 NM of the facility. Beyond 51 NM, the airways expand approximately 2 NM in total width every 13 NM. Additional airspace will be protected for aircraft executing turns at high airspeeds or when the airway course changes by 15° or more. Aircraft will fly the centerline of the airway when operating IFR.

The low-altitude airways are predicated solely on VOR/VORTAC NAVAIDs and are depicted on aeronautical charts by a "V" (Victor) followed by the airway number, e.g., V20. These airways are numbered similarly to U.S. highways; airways which generally run east and west have even numbers. As in the highway numbering system, a segment of an airway which is common to two or more routes carries the numbers of all the airways which coincide for that segment. When such is the case, a pilot in filing a flight plan needs to indicate only that airway number of the route which he plans to use.

Area Navigation (RNAV) Routes

Published RNAV routes, (T-routes (low altitude) and Q-routes (high altitude)), are depicted in blue and can be flight planned for use by aircraft with RNAV capability, subject to any limitations or requirements noted on enroute charts or by NOTAM.

VORs and TACANs

The FAA operates approximately 60 VOR, 405 VOR/DME, and 590 VORTAC stations, plus another 30 DMEs collocated with NDBs. The FAA owns approximately 900 of these facilities; other Federal agencies, states, local governments, and private entities own the rest. Additionally, the DoD operates approximately 15 VOR, 18 VOR/DME, and 24 VORTAC stations, located predominately on military installations on the U.S. and overseas, which are available to all users. TACAN is a tactical air navigation system for the military services ashore, afloat, and airborne. It is the military counterpart of civil VOR/DME. TACAN provides bearing and distance information through collocated azimuth and DME antennas. TACAN is primarily collocated with the civil VOR stations (VORTAC facilities) to enable military aircraft to operate in the NAS and to provide DME information to civil users. The FAA and DoD currently operate approximately 114 “stand-alone” TACAN stations in support of military flight operations within the NAS. A reduction in the VOR population (only) is expected to begin in 2010. The proposed reduction will transition from today’s VOR services to a minimum operational network (MON). The MON will support IFR operations at the busiest airports and serve as an independent civilian backup navigation source to GPS and GPS/WAAS in the NAS. (2005 Federal Radionavigation Plan).

VHF Omnidirectional Range (VOR)

VOR was developed in the late 1940s to meet the demand for a reliable NAVAID in the growing world of civilian aviation. The transmission principle of the VOR is based upon the creation of a phase difference between two signals (Figure 3-2). One signal, the reference phase, is omnidirectional and radiates from the station in a circular pattern. The phase of this signal is constant throughout 360°. The other signal, the variable phase, rotating at 1800 rpm, causes its phase to vary at a constant rate. Magnetic north is used as the baseline for electronically measuring the phase relationships. At magnetic north, the signals are exactly in phase. A phase difference exists at any other point around the station. The aircraft receiver measures this difference and displays it on the RMI and CDI (or HSI). The VOR frequency range is 108.0 to 117.95 MHz. This range overlaps the VHF communications frequency band, therefore, the VOR receiver may be used as a secondary VHF communication receiver.

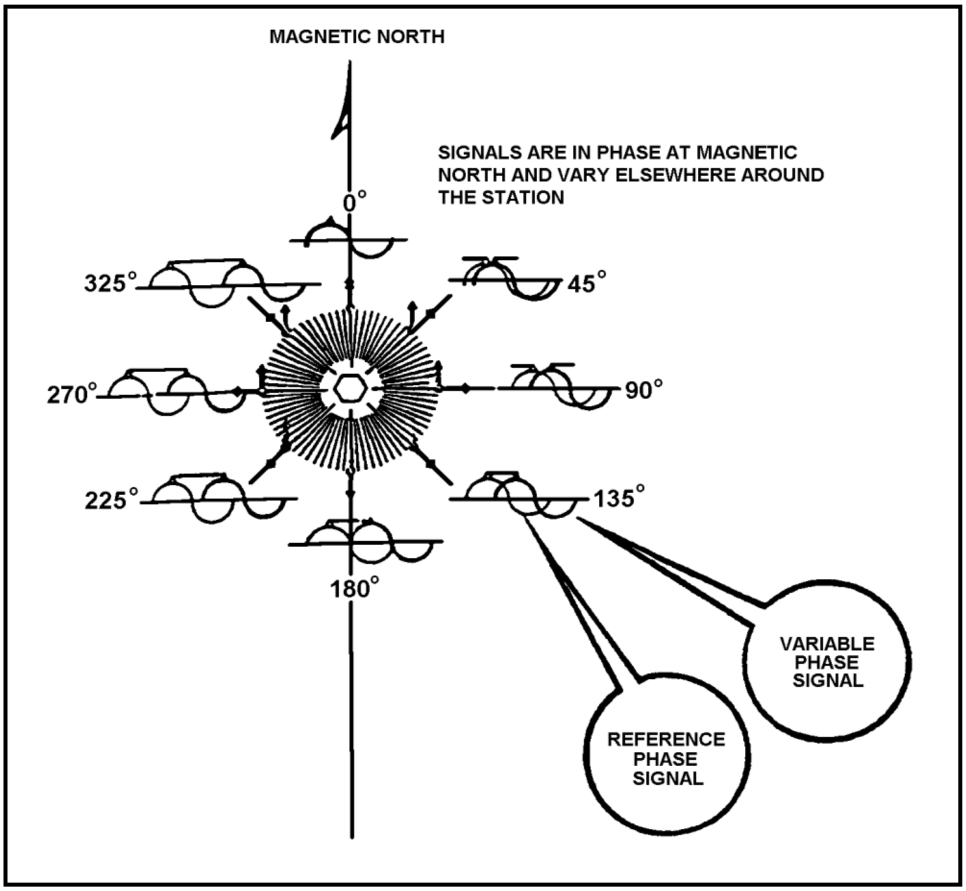

Figure 3-2 Phase Difference Between Two Signals

With the rapid increase in the late 1940s and early 1950s of civilian air traffic, a system was needed to help air traffic controllers in maintaining enroute air traffic separation. "Highways in the sky" or Victor Airways were created to ensure air traffic followed specific routes as opposed to haphazard, random routing. This system of Victor Airways was, and still is, predicated on VOR radials. The FAA is in the process of converting all VOR stations to VORTAC (a combination of VOR and TACAN) stations. This will allow enroute navigation on all airways using either VOR or TACAN (or both).

The TACAN channel at a VORTAC is paired to the VOR frequency; therefore, when a TH-57C pilot selects a VOR frequency at a VORTAC station using NAV-1, he will receive VOR radial information and distance, groundspeed, and time-to-station information if NAV-1 is selected on the KDI-572. Should the pilot change the NAV-1 mode from VOR to TAC, further "tuning" of the TACAN is not required. The frequency (FRQ) readout on the NAV-1 would show the paired TACAN channel. If a pilot is using a VOR/DME station to navigate, and switches to TAC mode on the NAV-1, there will be no radial information available and the FRQ display will be dashed. While in the VOR mode, the radial and distance displays on the NAV-1 will be blank. If the pilot depresses the Chk button on the NAV-1, radial and distance from the station will be displayed if using a VOR/DME or VORTAC station.

Refer to "Instrument Navigation, Primary T-34C" course materials for a review of specific VOR procedures.

TACAN

TACAN was developed in the early 1950s to meet the military requirement for a portable aircraft navigation system for tactical use. It is considered superior to the VOR system in that it provides distance information in addition to bearing. The TACAN system enables the pilot to fix his position over the ground through the use of only one NAVAID. TACAN operates in the UHF range of 962-1213 MHz. All TACAN stations are assigned a channel that corresponds to a specific UHF frequency. There are 126 "X-band" channels currently in use in the TACAN system and 126 "Y-band" channels available for future use. To determine the TACAN channel of a NAVAID, consult appropriate FLIP publications.

The TACAN system provides the pilot with relative bearing and slant-range distance information with respect to selected TACAN or VORTAC ground station. The effective range of TACAN is limited to line of sight. Actual operating range depends on the altitude of the aircraft, weather, type of terrain, location and elevation of the ground transmitter and the transmitter power. The ground equipment provides radial information with two special rotating antennae, which rotate around a central, stationary antenna at 15 cps (revolutions or cycles per second). One main reference pulse and 8 auxiliary pulses occur on each cycle; therefore, a reference pulse occurs each 40° of rotation. The electronic equipment electronically measures the time lapse between the main reference pulse and the maximum signal strength of the rotating signal pattern. This determines the aircraft's bearing from the station within a 40-degree sector. Then, the time lapse between the auxiliary pulses and the maximum signal strength of the combined inner and outer antennae rotation of 135 cps is measured to determine the aircraft's position within the 40-degree sector.

Bearing information is accurate to plus or minus 1º of the designated radial and distance information is accurate to within one-half mile or 3% of the distance to the facility, whichever is greater. This means that at about 100 miles from the transmitter, you can be sure of your position within 2 miles either side of the indicated bearing and within 3 miles of the distance reading.

Distance is determined with TACAN equipment by measuring the elapsed time between transmission of interrogating pulses of the airborne set and reception of corresponding reply pulses of the ground station. The aircraft transmitter starts the process by sending out the interrogation pulses on an irregular, random basis. The ground station receiver then triggers its transmitter, which sends out the distance reply pulses in the same pattern in which they were received. This allows several aircraft to interrogate a station simultaneously. The aircraft equipment essentially divides the number of microseconds it took for an interrogation pulse to travel round trip by 12 to give distance from the station in nautical miles. Reliable signals may be received at distances up to 199 NM at line-of-sight altitude. When equipped, further processing of this information by the aircraft's equipment can produce groundspeed and time-to-station information for display to the pilot.

A "cone of confusion" up to 100° wide exists above the TACAN station, and in this cone no bearing information will be received. However, the identifier signal and distance information will continue to be received in the "cone." Although narrow at low altitudes, this "cone" expands to about 15 miles across at 40,000 feet and requires that holding patterns be located some distance from the station.

The station identifies itself about every 35 seconds with a three-letter identifier in Morse Code. It will be remembered that TACAN stations are without voice on the NAVAID frequency. TACAN stations cannot provide scheduled weather broadcasts. TACAN installations are usually found only on military airports. However, many civilian fields have VORTAC stations.
When the compass card is known or suspected to be malfunctioning, the selected TACAN needle must be considered unreliable until verified by other means. In this situation, the TACAN needle will **not** point toward the TACAN facility (relative bearing), but **may** still indicate proper magnetic bearing information. The TACAN needle will provide bearing information in relation to the compass card, not the aircraft's heading. Additional information regarding the TACAN may be found in Appendix B.

VORTAC

The FAA has been in the process of integrating TACAN facilities with VOR facilities. These integrated facilities are called VORTACs. VORTAC, therefore, consists of two coaxially collocated components, VOR and TACAN, which provide three individual services: VOR azimuth on VHF (108.0 - 117.95 MHz), TACAN azimuth and TACAN distance (DME) on UHF TACAN channels. Although consisting of more than one component, incorporating more than one operating frequency, and using more than one antenna system, a VORTAC is considered to be a unified NAVAID. Both components of a VORTAC can be envisioned as operating simultaneously and providing the three services at all times.

When tuned to a VORTAC, aircraft equipped with TACAN equipment only will receive TACAN bearing information, TACAN distance information, and the station identifier about every 35 seconds.

When tuned to a VORTAC, aircraft equipped with VOR equipment only will receive VOR bearing information and the station identifier signal, received simultaneously.

When tuned to a VORTAC, aircraft equipped with **both** VOR and TACAN equipment will receive both TACAN and VOR bearing information (readings should be about the same) as well as TACAN distance information and the station identifier signal (received continuously if monitoring the VOR receiver, etc.).

Some civil aircraft are equipped with a separate DME airborne unit as well as a VOR receiver. In this situation, when tuned to a VORTAC, the aircraft will receive VOR bearing information, TACAN distance information, and the station identifier signal (received continuously if monitoring the VOR receiver, etc.).

Concerning a VORTAC, the transmitted signals of VOR and TACAN are each identified by a three-letter code transmission and are interlocked so that pilots using VOR azimuth with TACAN distance can be assured that both signals being received are definitely from the same ground station. The code for the VOR is transmitted continuously, except that about each half-minute, the VOR identification is omitted to allow an identification of the TACAN signal. A supplementary automatic voice identification has been added to the **VOR** portion of many VORTACs. An example of a combination code and voice identifier is as follows:

115.9 CEW = "— • — • • • — — CRESTVIEW VORTAC"

A limited number of VOR/DME facilities are included in the federal airway system. It should be recognized that a VOR/DME facility is **not** quite the same as a VORTAC facility. A VOR/DME facility is simply a VOR component collocated with a DME TRANSPONDER. However, the identifier signals are synchronized on timeshare basis as with VORTAC facilities.

When tuned to a VOR/DME, aircraft equipped with TACAN equipment will receive TACAN distance information and the station identifier (about every 35 seconds).

When tuned to a VOR/DME, aircraft equipped with only VOR equipment (no DME unit) will receive VOR bearing information and the station identifier.

Continuous automatic transcribed weather broadcasts and other information may be available on the VOR frequency of a VORTAC. Remember that voice is **not** available on TACAN frequency. Therefore, after once identifying the TACAN signal of a VORTAC, pilots of aircraft using both VOR and TACAN should monitor the VOR frequency and not the TACAN frequency. When flying on an IFR flight plan, the pilot can make his job safer and much easier through the proper selection and setup of his navigation radios. He must ensure the NAVAIDs have been identified and are receiving accurate information. When flying on airways, the pilot should tune the next station on his VOR/TACAN receiver at the halfway point between the NAVAIDs that define the airway or at the designated changeover point as found on the low altitude charts. Otherwise, he may stray off the airway. The following chapters will deal with specific navigation systems.

303. NAVIGATION RECEIVER CHECKS

To meet requirements for VOR equipment accuracy checks before flight under IFR conditions and to ensure satisfactory operation of the airborne system, the FAA has provided pilots with the following means of checking VOR receiver accuracy:

1. VOR test facilities (VOTs);
2. Certified airborne checkpoints;
3. Certified checkpoints on the airport surface.

A safe practice is to make an operational accuracy check before each IFR flight. An operational check consists of:

1. An accuracy check of the CDI and HSI course deviation bar and RMI needles;
2. A check to ensure proper sensing of the TO/FROM indicator;
3. A check to ensure 10° CDI/HSI deviation needle swing from center to each side.

VOT

FAA VOR test facilities (VOTs) transmit test signals which provide users a convenient means to determine the operational status and accuracy of a VOR receiver on the ground where a VOT is located. VOT facilities are identified in the IFR Enroute Supplement Airport/Facility Directory in the NAVAIDs section.

To use the VOT, tune in the VOT frequency on your VOR receiver and identify it. VOT signals are identified by either a continuous series of dots or a continuous 1020 Hz tone. Rotate the HSI and CDI pointers to 0°. The HSI and CDI course deviation bars should center and the TO/FROM indicator should show "FROM." The RMI needle for the selected NAV receiver will indicate 180° on any OBS setting. The maximum permissible bearing error is 4°.

Certified Airborne and Ground Checkpoints

Ground checkpoints are available in airport operations offices and are identified in the NOAA Airport/Facility Directory. Airborne checkpoints are published in the AP/1. They consist of certified radials received at specific points on the airport surface or over specific landmarks while airborne in the immediate vicinity of the airport.

Should an error more than ± 4° be indicated through use of a ground check, or ± 6° using the airborne check, IFR flight shall not be attempted without first correcting the source of the error.

Dual System Checks

If a dual system VOR (units independent of each other except the antenna) is installed in the aircraft, one system may be checked against the other. Turn both systems to the same VOR facility and note the indicated bearing to that station. The maximum permissible variation between the two indicated bearings is 4°.

In-Flight Systems Check

If no check signal or point is available, VOR receivers may be checked using the following procedures:

1. Select a VOR radial that lies along the centerline of an established VOR airway;

2. Select a prominent ground point depicted along the selected radial, preferably more than 20 miles from the VOR ground facility and maneuver the aircraft directly over the point at a reasonably low altitude;

3. Note the VOR bearing indicated by the receiver when over the ground point.

The maximum permissible variation between the published radial and the indicated bearing is 6°.

For TACAN receivers, military bases normally designate a specific ground point for checking their accuracy. The tolerances are similar to the VOR: within ±4° of the designated radial and within one-half mile or 3 % of the distance to the facility, whichever is greater.

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REVIEW QUESTIONS

1. When a pilot is unable to receive the identifier (either code or voice) from a NAVAID, he can assume

   a. Normal VOR operations, if his instruments are reacting normally to the signal.
   b. Normal VOR operations unless the alarm flag is showing on his deviation indicator.
   c. Abnormal VOR operation -- a warning that the signal may be unreliable.
   d. That the Flight Service Station is transmitting voice on UHF frequency.

2. A station classed as a BVORTAC means that scheduled weather broadcasts are made on both the VOR and TACAN portions of the VORTAC.

   a. True b. False

3. A station classed as VORTACW means that no voice is available on the VOR portion of the VORTAC.

   a. True b. False

4. NAVAIDs are normally operated only when weather conditions are less than VFR.

   a. True b. False

5. The "floor" of a low-altitude airway is usually 1200 feet above the surface.

   a. True b. False

6. Low-altitude airways extend up to, but do not include 18,000 feet MSL.

   a. True b. False

7. Jet airways extend from Flight Level 180 to Flight Level 450.

   a. True b. False

8. Jet airways are supported by NAVAIDs classed as L such as L VORTAC.

   a. True b. False

9. While in the enroute phase of flight, pilots are required to read back all altimeter settings.

   a. True b. False

10. While in the terminal phase of flight, pilots are NOT required to read altimeter settings received from Approach Control.

a. True b. False

11. Use of a NAVAID outside the intended service (volume) may result in unreliable indications in the aircraft.

a. True b. False

12. An NDB classed as MH has a greater power output than an NDB classed as H.

a. True b. False

13. The operational limitations established on an L VORTAC are 40 NM up to FL180.

a. True b. False

14. A pilot is proceeding on airways from "A" to "B." He should tune the next station, "B," on his VOR receiver

a. immediately after passing "A."
b. as soon as the alarm flag on his deviation indicator comes into view (receiver tuned to "A").
c. anywhere between "A" and "B."
d. at the VOR/VORTAC changeover symbol; if one is not indicated, at the halfway point between "A" and "B."

15. A radial is defined as a

a. true course from a TACAN/VOR.
b. true course to a TACAN/VOR.
c. magnetic bearing from a TACAN/VOR.
d. magnetic course to a TACAN/VOR.

16. TACAN stations transmit a three-letter identifier in Morse code approximately once every

a. two minutes.
b. 35 seconds.
c. 15 seconds.
d. few seconds (continuously).

17. Assuming that an aircraft has ample altitude and an unobstructed line-of-sight to a TACAN station, the maximum range for DME is how many miles?

a. 95
b. 155
c. 199
d. 295

18. When an aircraft is within the TACAN cone of confusion, which of the following is FALSE?

a. Bearing information will be received.
b. Distance information will be received.
c. The identifier signal will be received.
d. Both the identifier signal and distance information will be received.

19. TACAN installations are usually located on civil airports rather than military airports.

a. True b. False

20. When directly over a TACAN station at all altitudes, the DME should read "ZERO."

a. True b. False

21. To receive a DME reading, the airborne equipment must be transmitting.

a. True b. False

22. TACAN stations do NOT provide scheduled weather broadcasts.

a. True b. False

23. TACAN holding patterns are located some distance from the station because of the wide "cone of confusion."

a. True b. False

24. The scheduled weather broadcast, if available, is made on both the VOR and TACAN portions of a VORTAC.

a. True b. False

25. The identifier signal for the TACAN portion of a VORTAC is continuously transmitted.

a. True b. False

26. Which of the following may be received from a VORTAC station by an aircraft equipped with both VOR and TACAN equipment?

a. TACAN bearing, DME, VOR bearing
b. DME only
c. VOR bearing, DME only
d. DME, VOR bearing only

27. Which of the following services may be received from a VORTAC station by an aircraft equipped with TACAN equipment only?

a. TACAN bearing
b. HIWAS
c. Transcribed weather brief
d. VOR bearing

28. Which of the following services may be received from a VOR/DME installation by an aircraft equipped with TACAN equipment only?

a. TACAN bearing
b. DME
c. VOR bearing
d. VOR course

29. VOR stands for ____.

30. The frequency range of the VOR is ______ to ______ MHz.

31. The low altitude airway system is based upon __________ radials.

32. Maximum error for a certified VOR ground check is plus or minus ______ degrees, and plus or minus ______ degrees for an airborne check.

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REVIEW ANSWERS

1. c.
2. b.
3. a.
4. b.
5. a.
6. a.
7. a.
8. b.
9. b.
10. b. AP-1 pg. 3-63 8.d
11. a.
12. b.
13. a.
14. d.
15. c.
16. b.
17. c.
18. a.
19. b.
20. b.
21. a.
22. a.
23. a.
24. b.
25. b.
26. a.
27. a.
28. b.
29. VHF OMNI-DIRECTIONAL RANGE
30. 108.0 - 117.95
31. VOR
32. 4, 6

CHAPTER FOUR
TACAN AND VOR NAVIGATION

400. INTRODUCTION

TACAN is used for airways Flight and Instrument approaches and for tactical control of aircraft. TACAN is a navigational aid which provides azimuth and slant range distance (DME) information to the pilot, enabling precise fixing of geographical position at all times. TACAN stations operate in the UHF range (962 to 1213 MHz), are selected by dialing one of 252 "X" or "Y" channels, and are identified by an aural Morse Code repeating every 35 seconds. As with VOR, reception range is limited by line of sight and is not affected by weather.

The VOR is a navigation system which operates in the VHF frequency range (108.00 to 117.95 MHz). VOR course information is not affected by lightning or other types of severe weather; however, reception is limited by line of sight. Normal reception range is 40–45 NM at 1000 feet AGL and increases with altitude. VOR provides azimuth information only, with accuracy being generally plus or minus 1º.

Most airways in the United States are defined by combination VOR and TACAN stations (VORTAC), which provide VOR and TACAN azimuth and TACAN distance (DME) at one site. The VOR portion of the facility is identified by a coded tone modulated at 1020 MHz or a combination of tone and voice. The TACAN is identified by a coded tone modulated at 1350 MHz, transmitted one time for each three or four times that the VOR is transmitted. DME furnishes reliable, line of sight, SLANT RANGE information at distances up to 199 NM with an accuracy of ½ mile or 3% of the distance, whichever is greater.

401. LESSON TOPIC LEARNING OBJECTIVES

Terminal Objective

Upon completion of this chapter, the student will interpret the functions of the TACAN and VOR Navigation by solving given problems and answering related questions on the post test with a minimum score of 80%.

Enabling Objectives

1. Identify the TACAN/VOR equipment installed in the TH-57C.

2. State the function of the KNI-582 as it applies to TACAN navigation.

3. Describe the Distance Measuring displays installed in the TH-57C.

4. List the steps to tune a TACAN/VOR channel on the NAV-1 navigation equipment.

5. Define the term "slant range."

6. State the TACAN arcing procedures.

7. Transcribe TACAN holding patterns from ATC holding instructions.

8. Solve holding entry procedures for TACAN holding.

9. Compute TACAN point-to-point direct courses using the KNI-582 RMI or CR-2 computer.

402. VOR - TACAN PROCEDURES AND OPERATING INSTRUCTIONS

Navigation and NAVAIDS System in the TH-57C

The Navigation and NAVAIDS System consists of a NAV 1 and NAV 2 system, ADF system, Marker Beacon system, DME system, DME/TACAN system, GPS, and a Transponder and Altitude Encoder system. This system is coupled with the Compass/Heading system and Audio/ICS system.

The primary TH-57C navigation receivers are the KNS-81 (NAV-1) and the KLN-900. Using the mode selector on the NAV-1, the pilot would select either VOR, VOR/RNV, or VOR/RNV APR. In the VOR mode, the HSI (or CDI if using NAV-2) displays conventional cross track deviation information of +10°. In the VOR/RNV mode the HSI/CDI displays constant course width information with a full-scale deflection of +5 NM. In this mode, a DME "unlock" will cause an HSI/CDI flag. The VOR mode must be used for an approach, since the resolution of an off-course indication increases with decreasing distance to the station in standard VOR, but remains a constant in VOR/RNV mode. The VOR/RNV mode would be used when flying waypoints to ensure the aircraft is kept within 5 NM of the simulated airway. The VOR/RNV APR mode would be used for an RNV approach using VOR waypoints. The sensitivity in this mode is +1.25 NM/needle (CDI/HSI) deflection.

NAV-2, the KLN-900, controls the single needle on both RMIs, while NAV-1, the NAV-1 controls the double needle on both RMIs. It should be noted that, since the TH-57C is also equipped with an ADF and there are only two pointers on the RMIs, use of the ADF/VOR mode selector(s) on the RMI is required. For example, if the pilot selected an ADF station on the KR-87 (ADF) and a VOR station on the NAV-1, he may want to select VOR on the double needle and ADF on the single needle, using the mode selector on the RMI to do so.

The NAV 1 system is a VOR/LOC system, and a single TACAN system consisting of one KNS-81 receiver, a KDI-206 course deviation indicator (CDI), a KDI-525A horizontal situation indicator (HSI), and associated antennas.

Nav 1 Receiver

One KNS-81 receiver is installed in the radio console as NAV 1 (Figure 4-3). The NAV-1 consists of a VOR/Localizer receiver, an RNAV computer and a glideslope receiver, and control function for the KTU-709 TACAN is in a single unit. When combined with the CDI or HSI and DME Indicator the unit becomes a complete navigation system featuring three modes of VOR or TACAN OPERATION (VOR, VOR RNV, VOR RNV APR, TAC, TAC RNV, TAC RNV APR) and ILS. The unit also simultaneously displays waypoint parameters of frequency, radial and distance plus one of the ten waypoints. It can display TACAN or VOR radial and DME distance information when the CHK button is depressed. It also can display bearing from the VORTAC or waypoint in the DME indicators in place of groundspeed when the RAD button is depressed.

The TACAN equipment installed in the TH-57 consists of the remote-mounted KTU-709 transceiver and its associated antennae and the KDI-573 Distance Measuring display located on the copilot's instrument panel which is slaved to the KDI-572 located on the pilot's instrument panel.

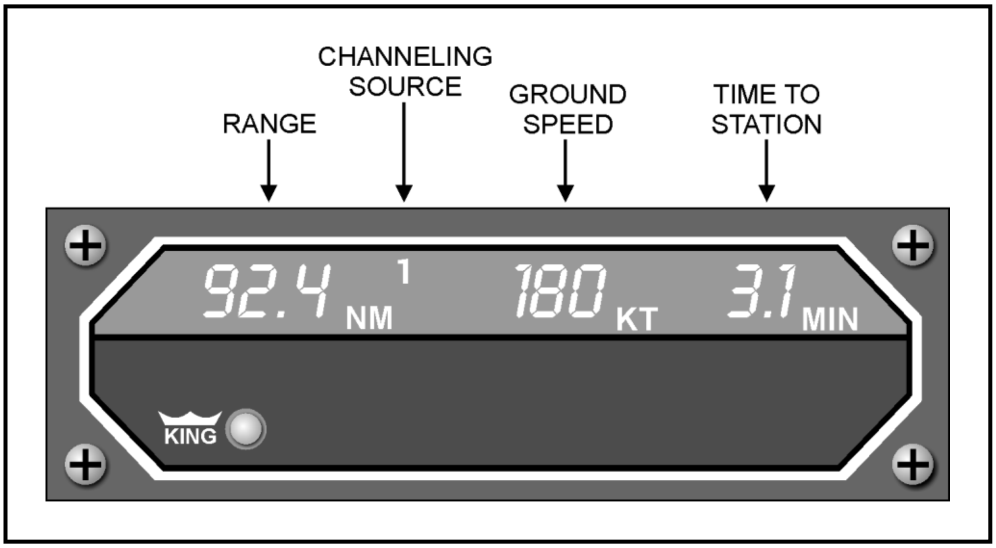

Figure 4-1 KDI-573

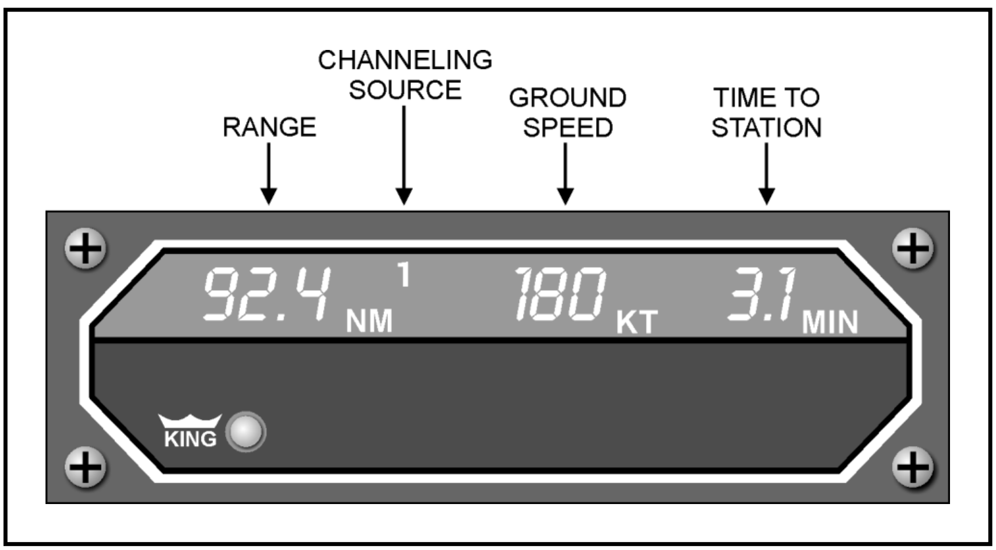

Figure 4-2 KDI-572

By design, the NAV-1 integrated navigation system used in the TH-57C is capable of displaying only VOR radial or ILS course information. This problem is easily solved by a converter located within the KTU-709 which converts the TACAN signal input into a "synthesized" VOR radial output, usable by the NAV-1. The NAV-1 sends this synthesized radial information to the KNI-582 Radio Magnetic displays (RMI) located on the instrument panel. The pilot will also use the HSI Pictorial Navigation Indicator to maintain the aircraft on the desired radial, while the copilot will use the conventional CDI for the same purpose.

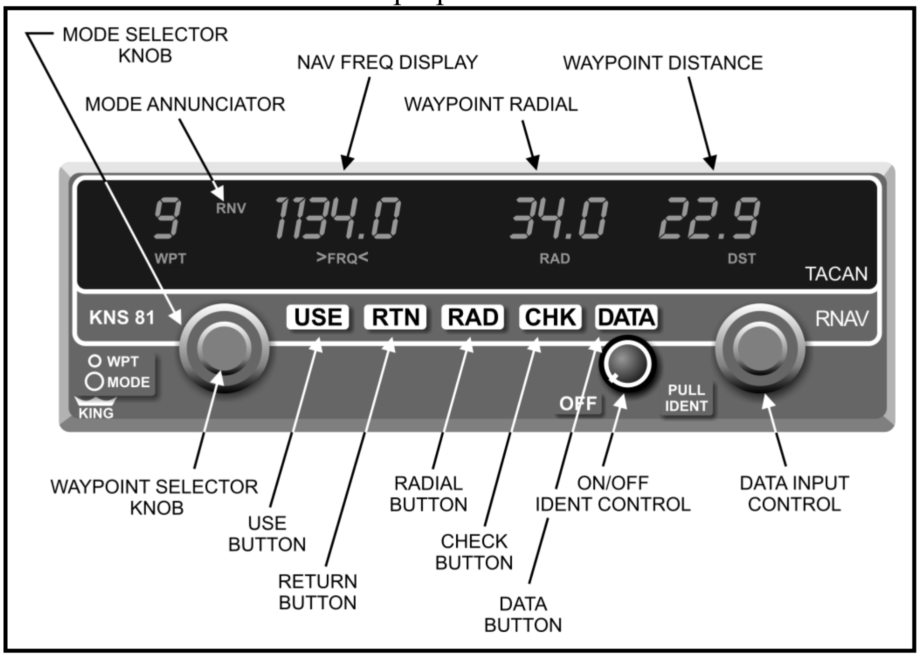

Figure 4-3 KNS-81 Control Functions

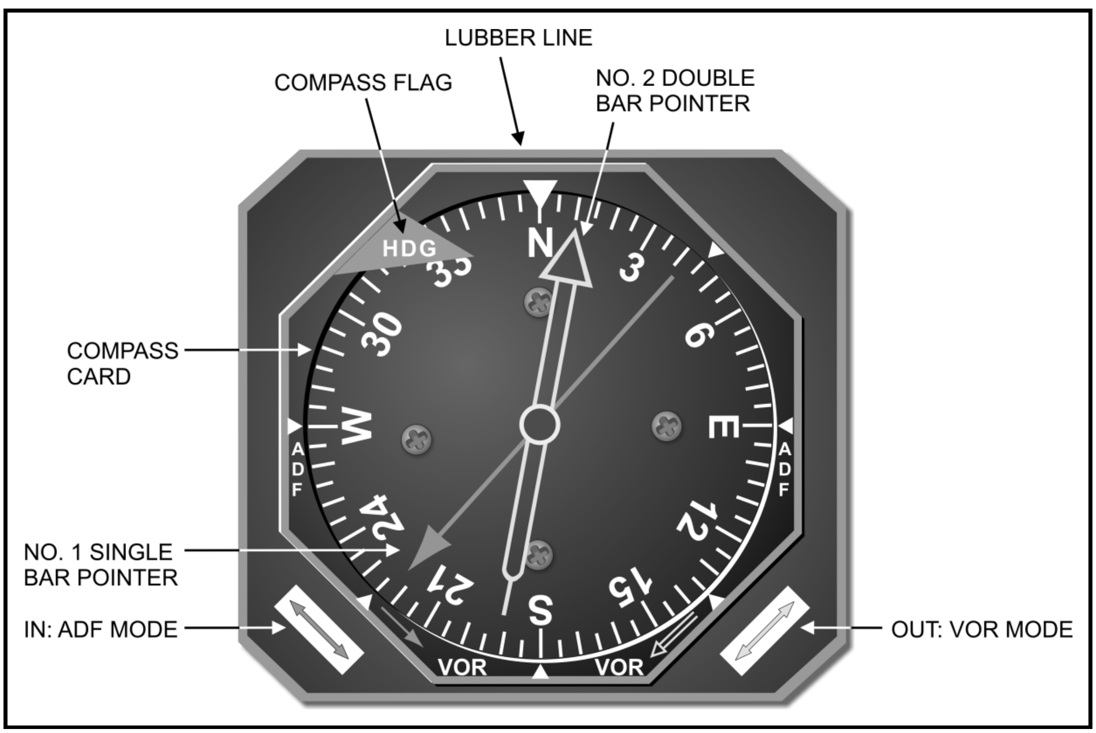

Figure 4-4 KNI-582 RMI

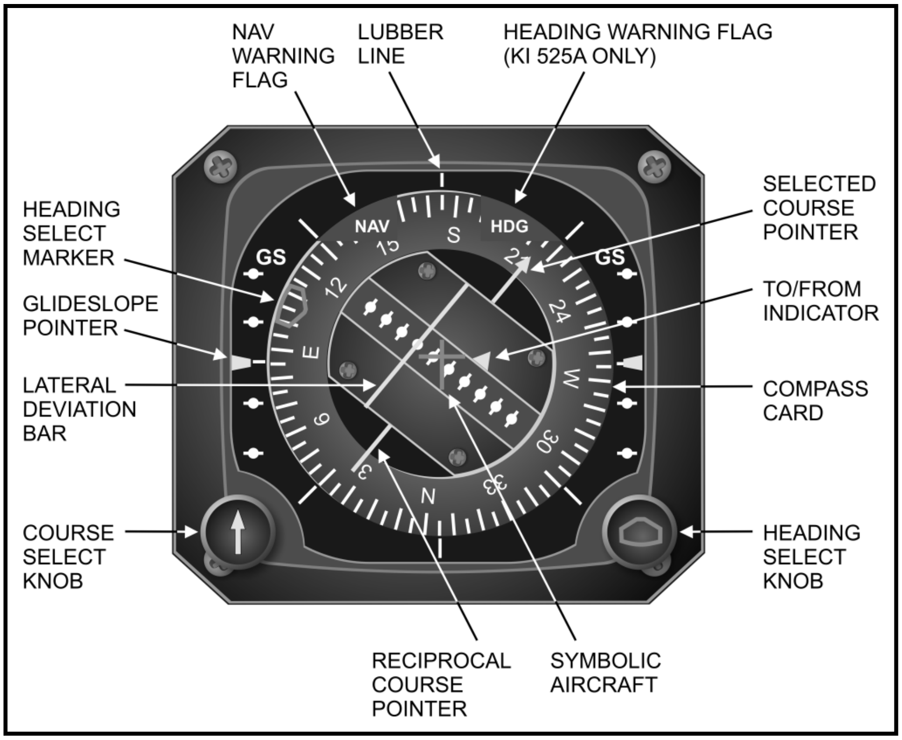

Figure 4-5 KDI-525A HSI

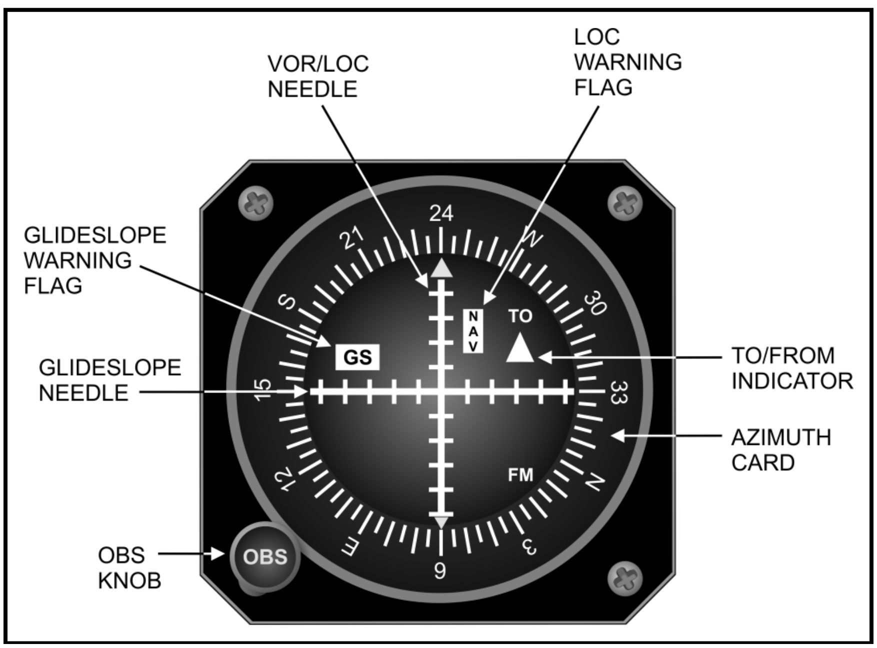

Figure 4-6 KDI-206 CDI

The pilot can select NAV-1 to navigate in the TACAN mode on the NAV-1. To tune the desired TACAN station on the NAV-1, follow these steps:

1. Turn power switch on and adjust volume as desired on the NAV-1.

2. Select TAC with mode select knob on NAV-1. This mode gives the CDI and HSI ± 10 degree needle deflection.

3. Select desired TACAN channel with DATA input control knobs on NAV-1. Momentarily press the USE button.

4. Pull the ON/OFF switch on NAV-1 to identify the station. (Ensure audio panel mixer switches are properly set.)

5. KDI-572/573 will indicate distance to the TACAN station, groundspeed and time to station.

6. The double needle on the RMIs will indicate radial information for NAV-1 and the single needle on the RMIs will indicate NAV-2 radial information.

NOTE

Manual selection of single or double needles on the RMI may be necessary if the pilot has selected a station on the KR-87 (ADF).

Distance measuring equipment (DME) in the aircraft provides distance to the station (slant-range), groundspeed and time-to-station as discussed previously in this text. Slant range is not equal to the aircraft's actual distance from the station over the ground. To understand why ***slant range*** is different from the actual distance you are from the station, you must remember that the aircraft is flying at some altitude above the ground. Thus, the slant range will be the hypotenuse of the triangle, while the actual distance to the station is equal to the adjacent side.

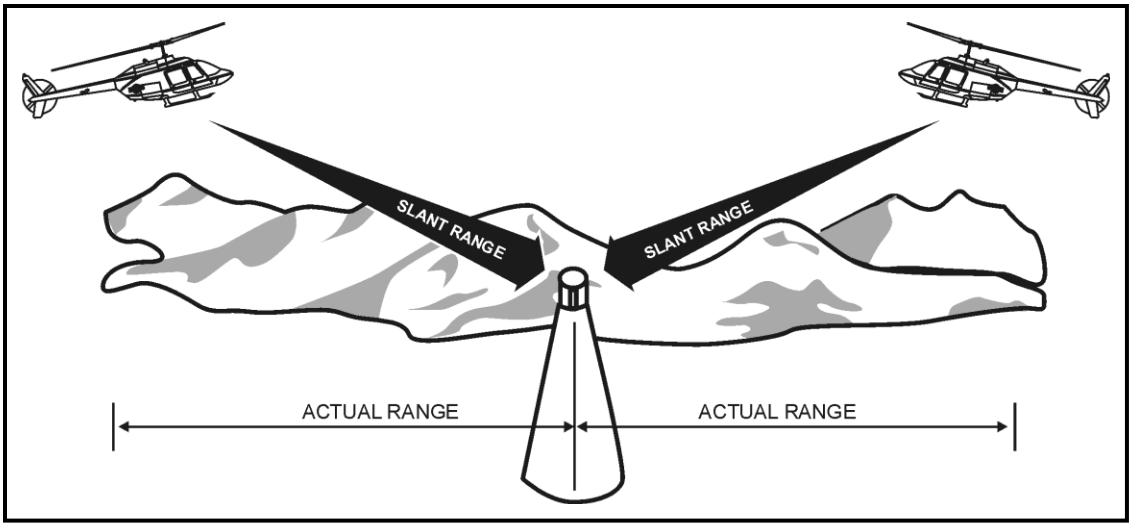

Figure 4-7 Slant Range

Since the hypotenuse is always the longest side of a right triangle, the slant range will always be greater than the distance along the ground.

Although the slant range must always be greater, the difference is usually small. For example, take an aircraft flying at an altitude of 6000 feet (1 NM) and indicating a slant range of 40 miles to the TACAN station. The pilot's actual distance to the station over the ground is 39.99 NM. There is only 1/100 of a mile difference between the slant range and the distance along the ground.

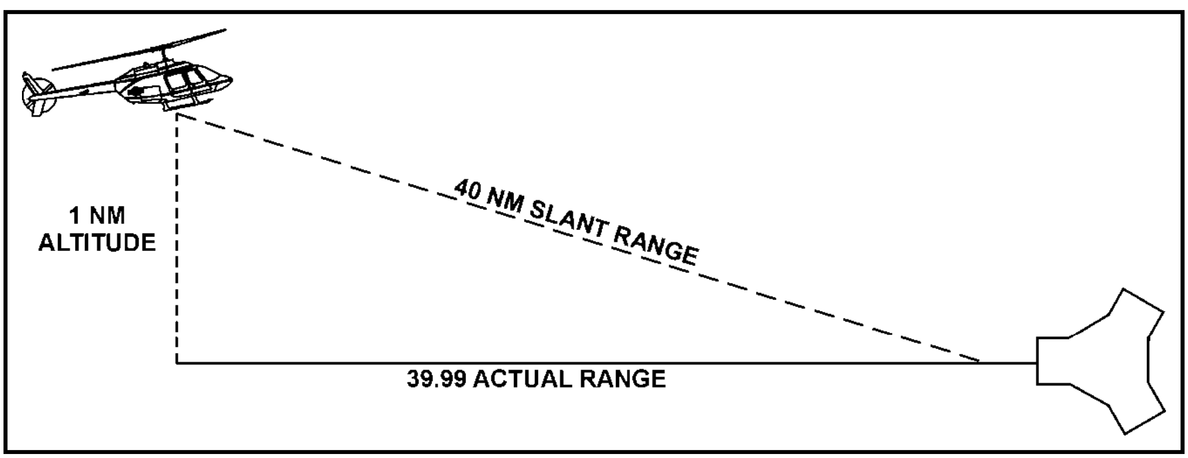

Figure 4-8 Slant Range vs. Actual Range

As you fly closer to the TACAN station, the difference between slant range and ground distance increases until you are directly over the station. At this point, the slant range equals the aircraft's altitude. Thus, if you were flying at an altitude of 6000 feet (1 NM), your slant range would decrease steadily until you were over the station.

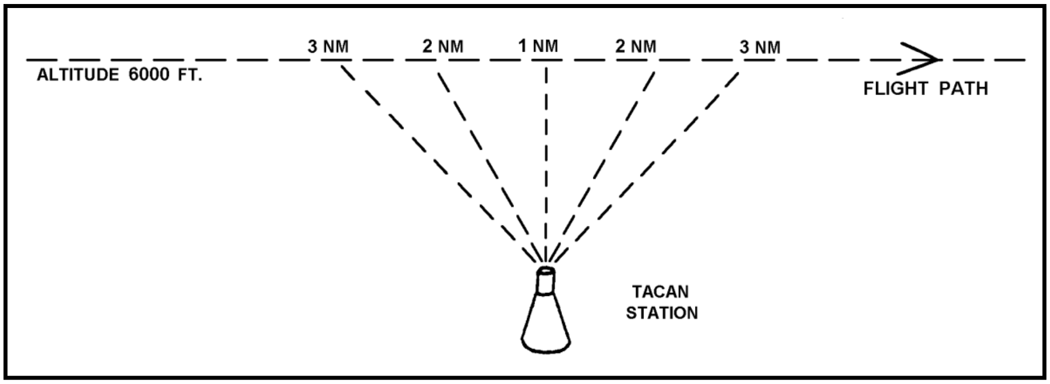

Figure 4-9 TACAN Station

As can be seen, the slant range is one mile when over the station, although the actual distance over the ground to the station is zero.

Another place where TACAN differs from VOR is in the cone of confusion. You may recall from previous texts and your flying experiences that VOR bearing information cannot be received when directly over the station. The VOR cone is 40-50 degrees wide and the area covered increases with altitude. TACAN stations also have a cone of confusion, but they are much larger. The TACAN cone is up to 100° wide. This works out to about 15 NM at 40,000 feet, and at an altitude of 5000 feet, it would be just under two miles wide or about one mile around the station.

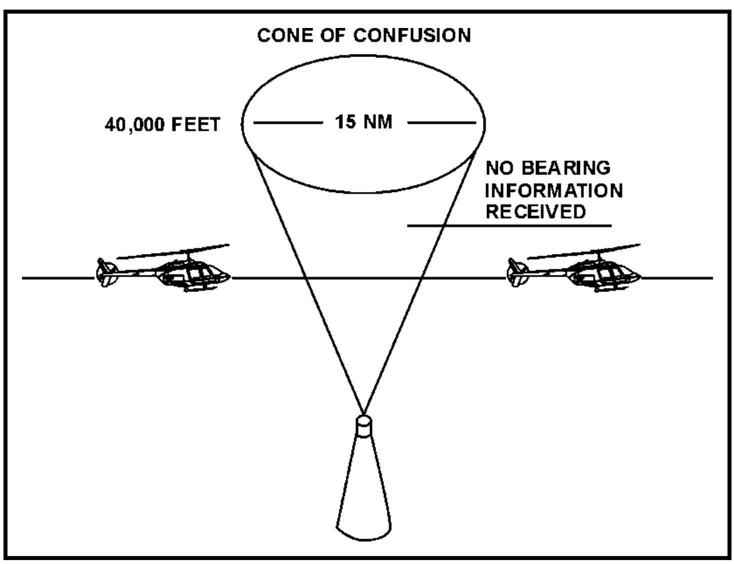

Figure 4-10 Cone of Confusion

Inside the TACAN cone, no bearing information can be received, but slant range information is still reliable. Because of the size of the TACAN cone, holding cannot be accomplished over a TACAN station. Instead, the holding pattern will be oriented at a holding fix at some specified range and bearing from the station. Station passage is also affected by the cone of confusion.

Since the slant range still functions, the minimum slant range or minimum DME will designate station passage. In other words, the range will decrease as you approach the station and will increase after you pass it. The point at which the slant range begins to increase again is station passage. Note that the range will probably not decrease to zero, unless you are flying extremely low.

403. HOLDING

As discussed previously, TACAN holding takes place at a specified fix outside the cone of confusion. The fix will be specified in the clearance as a radial and DME from the TACAN station. Example: "Hold west of the 10-mile DME on the 090 radial of the PODUNK TACAN, 2-mile legs, left turns . . . " This would be just like holding at an intersection except it would be easier to accomplish, since only one TACAN station is required to identify the fix as opposed to two VOR stations.

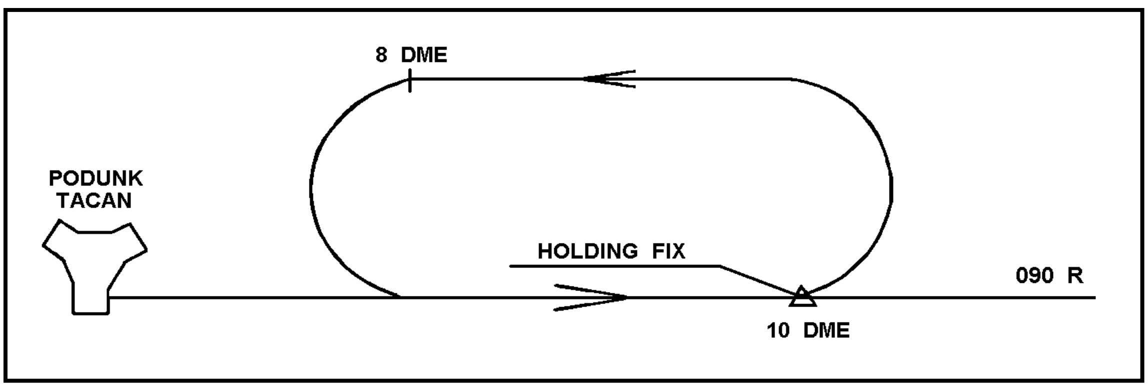

Figure 4-11 TACAN Holding

You will recall from VOR holding that the inbound leg had to be one minute. This sometimes required some quick computing to adjust the outbound leg to obtain one minute on the inbound leg. This is not necessary with TACAN holding, since you have slant range. In TACAN holding, the length of the legs are specified in the holding clearance, and turns are made after flying the specified distance. Thus, a clearance could read, "Hold east of the 5-mile DME on the 090 radial of the PODUNK TACAN, 2-mile legs . . ."

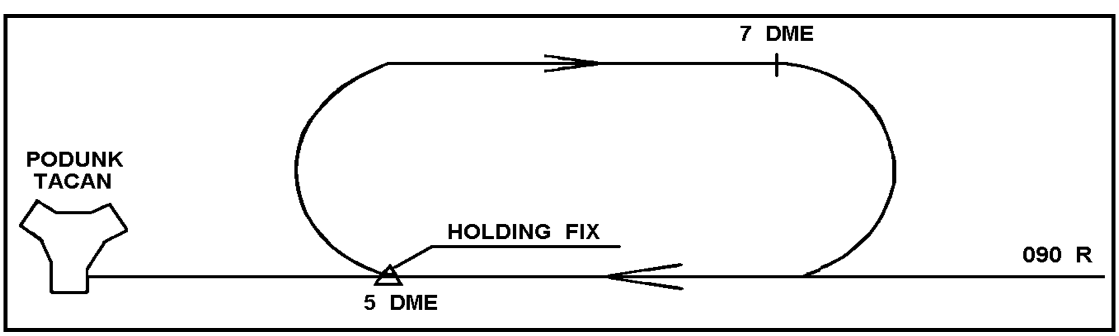

Figure 4-12 TACAN Holding

There are two standard and two nonstandard holding patterns that can be oriented about a TACAN radial/DME fix. A TACAN holding pattern can also be classified as either station-side or nonstation-side.

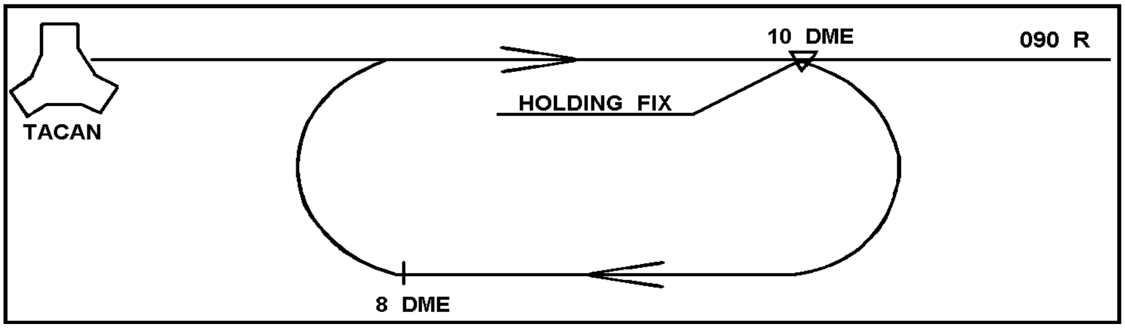

Figure 4-13 Station-side, Standard Holding Pattern

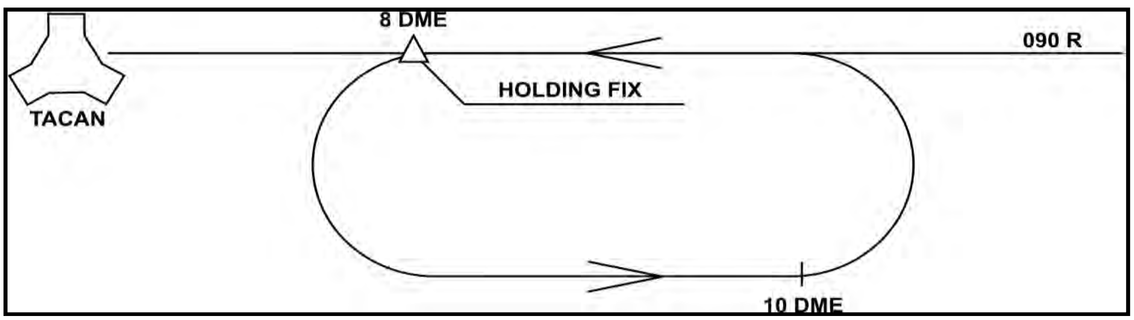

Figure 4-14 Nonstation-side, Nonstandard Holding Pattern

Figure 4-13 is an example of a station-side, standard holding pattern.

Figure 4-14 is an example of a nonstation-side, nonstandard holding pattern. Station-side holding occurs when the holding pattern is located between the holding fix and the station. An example would be as follows: "Hold west of the 7-mile DME on the 090 radial of the PODUNK TACAN, 2-mile legs . . ."

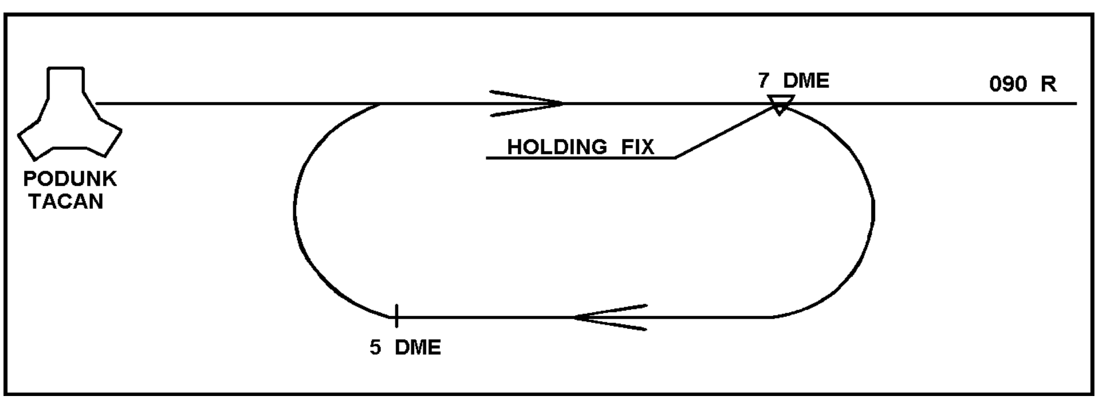

Figure 4-15 Station-Side Holding

Here the inbound holding course takes you away from the TACAN station. For this and other types of holding, the inbound course ***to the holding fix*** is inserted into the CDI or HSI as appropriate. For station-side holding, the inbound leg is actually outbound from the station.

Note that in the holding instructions "Hold west . . . ," the controller is telling the pilot the direction of the outbound holding course. Also, note that with station-side holding, the direction to hold "west" is 180° from the holding radial "090."

Holding entry procedures are the same for TACAN as they are for VOR. However, you must be careful to use the outbound holding course (as opposed to the holding radial) to determine the direction of turn. With VOR holding and TACAN nonstation-side holding, the outbound holding course and the holding radial are the same, but with TACAN station-side holding, the outbound holding course is the reciprocal of the holding radial. As long as you use the outbound holding course in all cases, you will have no difficulty in choosing the correct entry procedures. Remember, after initial holding fix passage, turn to the outbound holding course.

404. TACAN RANGE

The normal anticipated interference-free range of TACAN when below 18,000 feet MSL is 40 NM. This range increases with altitude up to a maximum of 130 NM in the jet airway structure; however, we will limit ourselves to discussing the low altitude airway structure. With a range limit of 40 NM, we could fly between any two TACAN stations within 80 NM of each other on an IFR flight plan. This would ensure that we could always receive one of the TACAN stations. A careful examination of a low altitude airways chart will show that some stations are considerably farther apart than 80 miles. For example, on V437, the distance from Ormond Beach VORTAC, FL to Savannah VORTAC, GA is 170 NM with an MEA of 8000. As long as you fly at or above the MEA on a designated airway, you can receive the appropriate NAVAIDs. To fly ***direct*** from one TACAN to another on an IFR flight plan, off airways, the maximum distance is 80 NM. To fly direct to or from a single TACAN station, the maximum distance is 40 NM.

It is possible a malfunction in either your TACAN set or the TACAN ground station will cause you to lose magnetic course information on your RMI. If this happens, you can still navigate to the station with the range indicator alone if it is operating properly.

To begin, you must turn the aircraft as necessary until the range stops decreasing. By definition, your course is now a tangent with respect to that particular range circle.

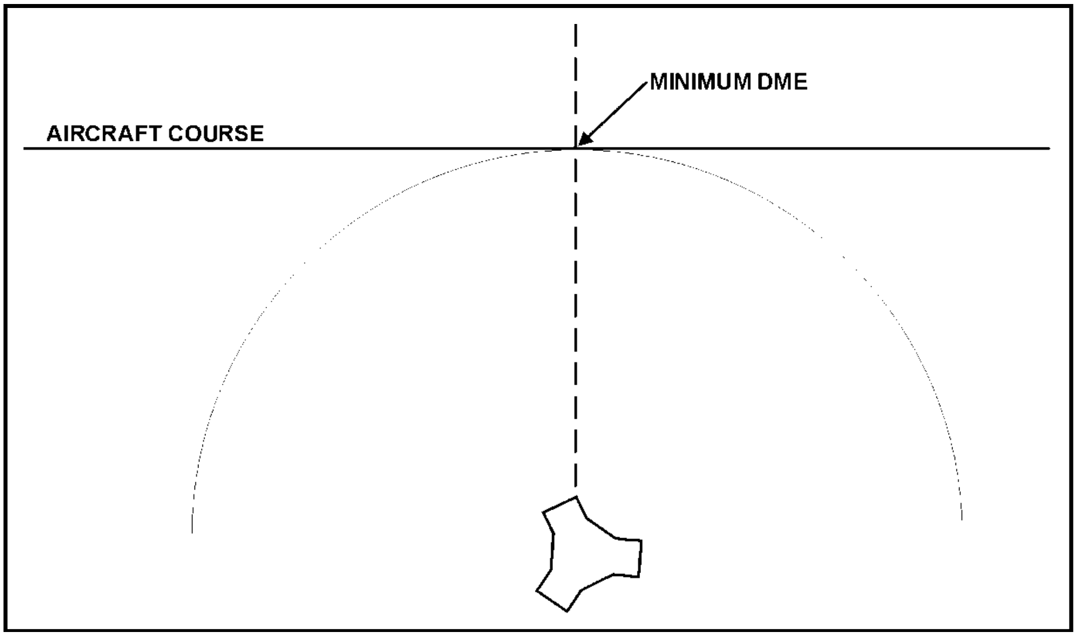

Figure 4-16 Course Tangent

Again, by definition, a line drawn through the tangent point and the center of the circle will be perpendicular to the course line. Therefore, turn 90º to the left or right and observe the range indicator. If it is decreasing, continue on that course to the station. If it is increasing, turn 180º and fly to the station. In a no-wind condition, this procedure will take you directly to the station. If a wind is encountered, you should still be able to fly to the station. If not, simply repeat the second half of the procedure when the range starts to increase again.

405. ARCING

Another procedure that is commonly used with TACAN or VOR/DME is ***arcing***. Arcing is a procedure most commonly used during a TACAN approach, but it can also be used in other portions of flight as well. In practice, the idea is to fly a portion of a circle (an arc) around a TACAN station, always remaining at a constant range. For example, you might have an initial approach fix at the point where 330 radial meets the 10 NM range circle and the final approach course is 090. To shoot the approach you must arc at 10 DME until you arrive at the 270 radial. At this point, you would turn to a course of 090º and fly inbound to the station, descending to the MDA (Figure 4-17).

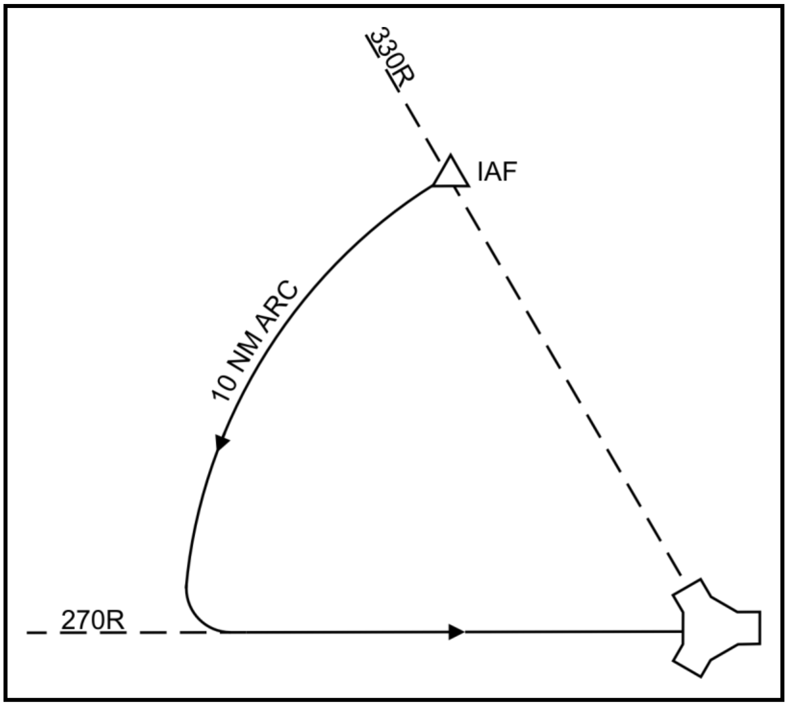

Figure 4-17 TACAN Approach

This is an example of a typical TACAN approach, so you can see the importance of being able to arc around the station.

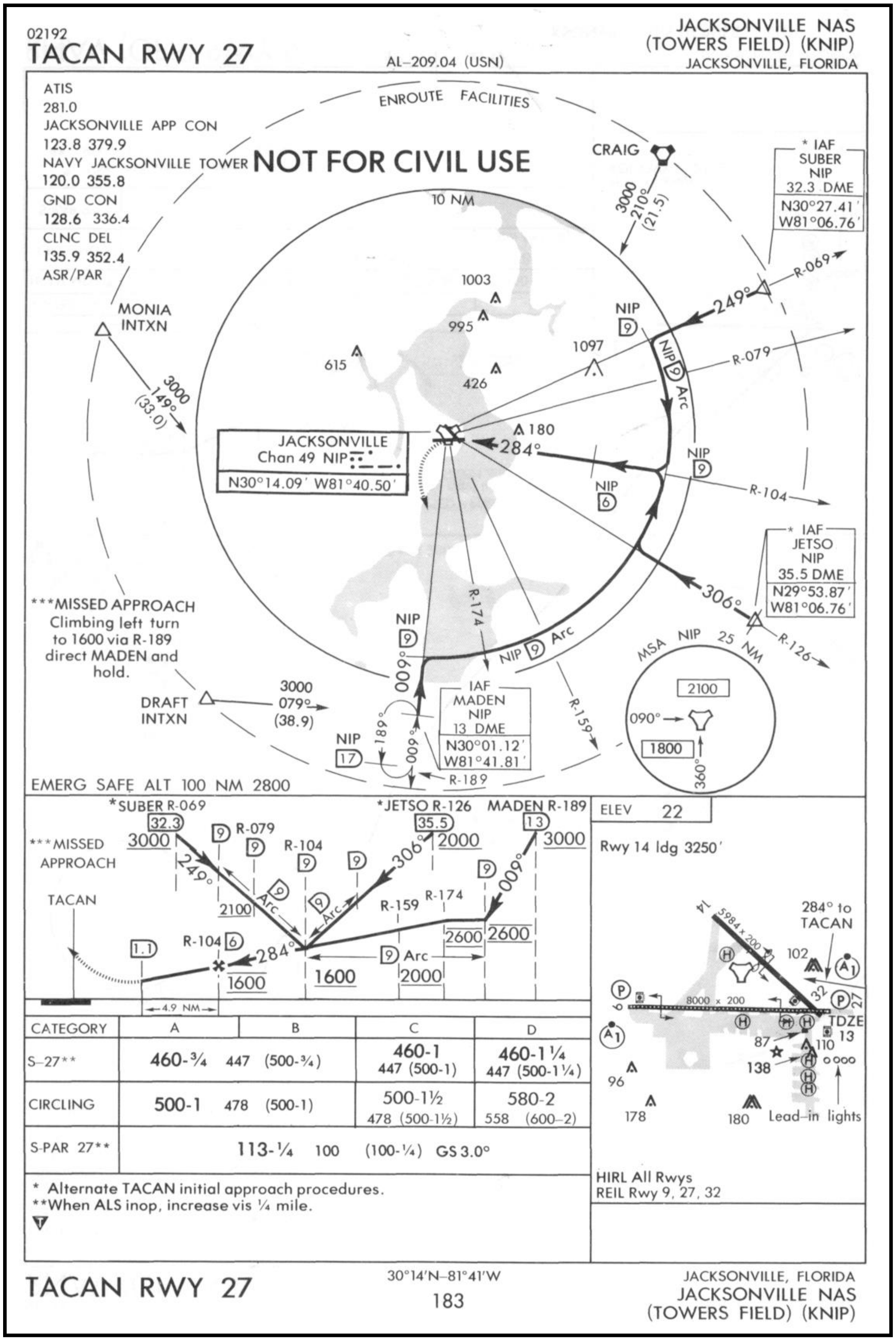

Figure 4-18 TACAN RWY 27

Consider the above approach (Figure 4-18). Assume the pilot has been instructed to hold at MADEN (189R/13DME) and then was cleared for the approach. The pilot, upon receiving approach clearance, would depart the holding pattern at any point and intercept the 189 radial inbound. The pilot would continue inbound on a course of 9º to the 9.5 DME and then turn right to intercept the 9 DME arc. To intercept an ***arc***, lead the arc by ***½ NM***.

Arcing itself is rather easy, and there are two methods of ***arcing***. The first method is to turn in the desired direction until the head of the appropriate RMI needle is exactly 90º from the aircraft's heading (at the 90º bench mark on the RMI). As long as you maintain the needle in this position, in a no-wind condition, you will fly a perfect ***arc*** around the station. The problem with this method is that you must be constantly changing your heading to keep the needle at the 90º position. This consumes much of your ***scan*** and attention that could be put to better use elsewhere in the cockpit.

A more simplified method of ***arcing*** is to break the ***arc*** up into a series of straight lines. To do this, turn the aircraft in the desired direction until the head of the RMI needle is 90º from the aircraft's heading, and then maintain that heading. Because you are flying a constant heading rather than an arc, the head of the RMI needle will fall. Allow the head to fall 5–10 degrees "below wingtip position," and then turn toward the station, raising the head of the RMI needle until it is in the 80–85 degree position. Maintain this heading until the head again drops to the 95–100 degree position. Then turn toward the station raising the head, and continue to repeat this procedure until arriving at the desired radial. To simplify this procedure a little, think of the 90º position as your wingtip. To arc left, intercept the arc and hold your heading until the RMI needle drops 5–10 degrees below the wingtip. Then turn toward the station until the RMI needle is 5–10 degrees above the wingtip and hold that heading until it drops again.

Figure 4-19 RMI

To correct for any crosswinds, such as a wind blowing you closer to or farther away from the station merely turn the aircraft as necessary to maintain the range indicator on the specified range. To determine which way to turn, just remember that you must turn away from the station to increase the range, and toward the station to decrease the range. In other words, if you are arcing on the 10 DME arc and you are presently 11 NM from the station, then turn toward the station. As you turn toward the station, the head of the appropriate RMI needle will raise. Continue the turn until the head is 10–20 degrees above the wingtip and then roll wings level. Fly the heading, noting the movement of the head of the RMI needle and the DME decreasing. If the DME does not decrease or is decreasing too slowly, turn toward the station and raise the head 5–10 degrees more.

When correcting for crosswinds, always remember that the DME should decrease when the head of the RMI needle is above the wingtip and increase when the head is below the wingtip. How many degrees should be above or below the wingtip depends on the crosswind and your distance from the arc. A good rule of thumb is, for every mile off the arc, fly an intercept of 10–20 degrees. For example, an aircraft arcing from the 240 radial to the 300 radial on the 10 DME arc is presently 12 NM from the station. To reintercept the arc, the pilot would turn right toward the station. As the pilot turned, the head of the RMI needle would raise above the wingtip. The pilot would continue the turn until the head was 20–40 degrees above the right wingtip. The wind is from the east and the pilot must correct for the wind.

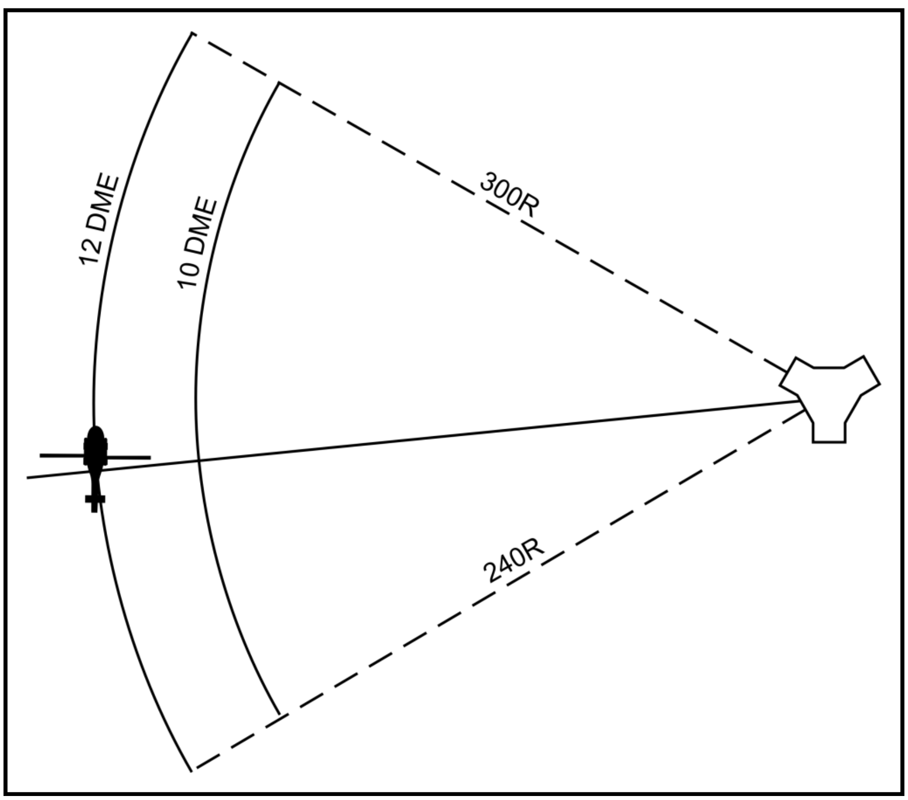

Figure 4-20 Correcting for Crosswinds

During flight planning, if you plan on shooting an arcing approach at your destination or alternate (if required), you will need to know the distance of an arc and your groundspeed to determine the total time and fuel required to fly the arc. To compute the distance of an arc, consider the following information: At a range of 60 NM from a TACAN station, one degree of arc constitutes one NM of distance of an arc. Thus, you can express the distance of an arc as a proportion of the 60 NM arc.

The formula for this is as follows:

$$\textbf{Distance of an arc} = \frac{\text{DME of an arc}}{\text{60 NM}} \text{ x number of radials of arc}$$

Thus, an arc on the 16 NM range for 90º would look like this:

$$D = \frac{16}{60} \text{x}\, 90 = 24$$

or

$$\textbf{CR-2 Computer Solution} = \frac{\text{DME}}{60} = \frac{\text{Distance of an arc}}{\text{Number of radials of arc}}$$

406. POINT TO POINT

Once you know the distance, it is time to compute groundspeed. This looks difficult at first glance (since your heading is always changing during the arc). To simplify matters, merely draw a straight line connecting the point where the arc begins, to the point where the arc ends. This line will constitute the "Average Course." You can now use this "Average Course," the forecast winds, and your true airspeed to compute a groundspeed. A technique for determining the average course using the CR-2 computer will be explained later in this workbook text under point-to-point navigation.

Another very significant difference between navigating with a VOR and TACAN is that with TACAN a pilot can navigate himself ***directly*** from one TACAN radial/DME fix to another without first flying to the TACAN station. This is called ***point-to-point navigation*** and can be accomplished with the CR-2 computer or with the RMI.

The RMI is the primary tool for establishing a point-to-point direct course in flight. Think of the RMI as a map with the TACAN station in the center of the gauge. The aircraft is located on the tail of the RMI needle, and the radial of the destination can be easily identified on the RMI. However, we still need a range scale to accurately plot both positions. Therefore, we take the greatest distance to be used in this computation and make the radius of the RMI equal to that range. Thus, if we are on the 135º/10 and want to go to the 045º/15, then 15 is the greatest range and the radius of the RMI equals 15 NM. Ten NM will now be 2/3 of the way from the center of the RMI, since 10 is 2/3 of 15. Using a pencil, we can imagine two dots on the clear face of the

RMI. Then lay a pencil across the two dots to connect them. Knowing that you want to go from your present position to the desired location, place the pointed end of your pencil on top of the destination, and the blunt end over your present location. Now think of the pencil as an arrow, showing the heading to fly. Maintaining that heading, slide the arrow to the center of the gauge and you now have a makeshift RMI needle indicating the magnetic bearing to the destination. This method should produce a course that is accurate within a 10º range, 5º either side.

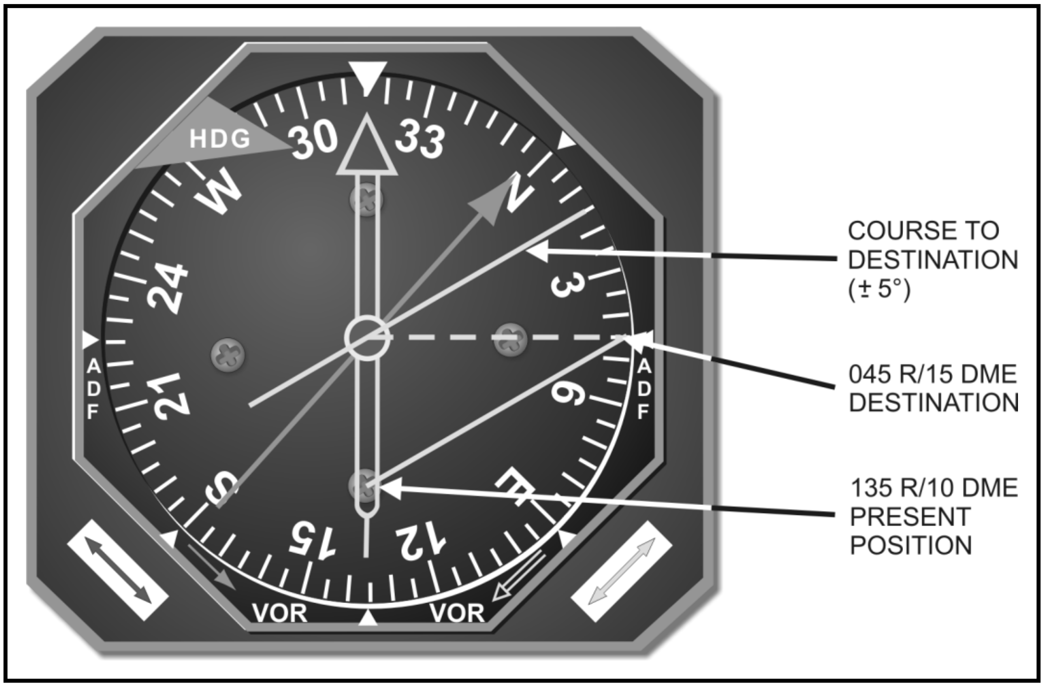

Figure 4-21 Point to Point Direct Course

When flying the intercept course during a point-to-point problem on the RMI, the destination point should be directly above your present position point. If it is not, turn the aircraft a few degrees as required so that a line connecting the two positions would be parallel to the aircraft's heading.

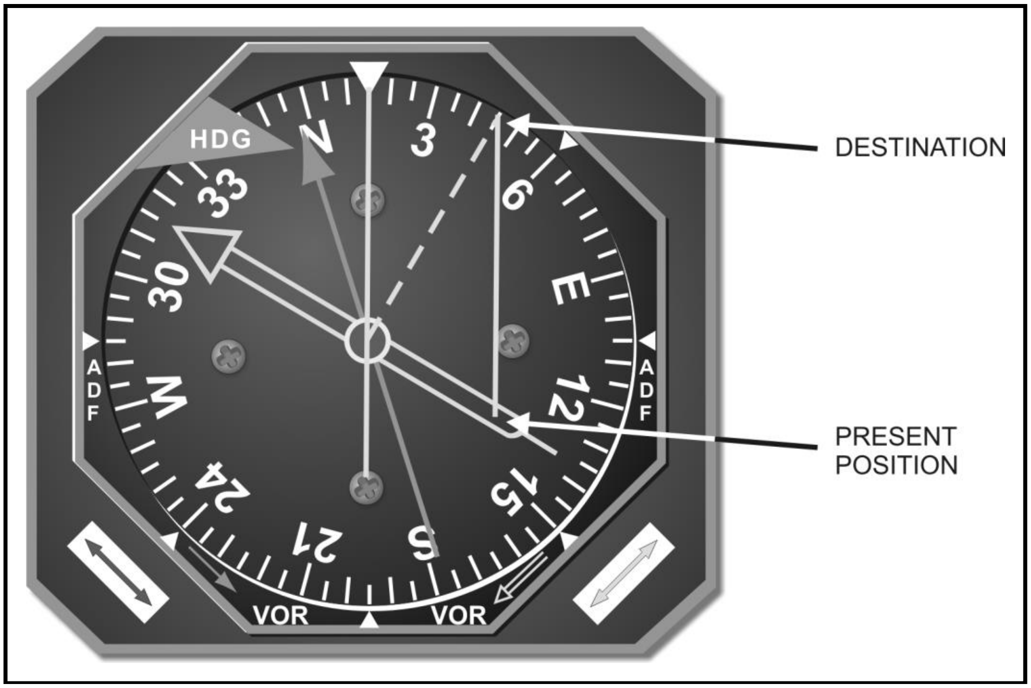

Figure 4-22 Intercept Point

To update your course using the RMI, you should completely recompute your course to your destination at several checkpoints. If there is a difference between the new course and the original one, you have a crosswind component affecting your track across the ground. To correct for this crosswind, turn to the new intercept heading and then turn even further to account for the crosswind. The extra amount will vary with the amount of crosswind, but 10° would be a reasonable starting point. This procedure is just like tracking on a radial, and as such, the amount of crab is variable.

NOTE

Use of the HSI/CDI, while not required for point-to-point, will assist in the intercept of the new radial.

There are several ways to determine groundspeed with a TACAN set. If you are on an airway, or are tracking along a radial, then just note how far you travel in six minutes and multiply that mileage by 10 to get the groundspeed.

When you are not navigating along a radial, or airway, you cannot use the range indicator as your sole indication of distance covered. In this situation, you must use the CR-2 computer or its equivalent. As in point-to-point navigation, mark your present position on the computer. Fly for six minutes and mark this position on the computer. Now, connect these two points with a line. This line can be measured to give us the distance traveled in six minutes. When multiplied by 10, the product is the groundspeed. We are simply using a different means of determining how far we have traveled in six minutes.

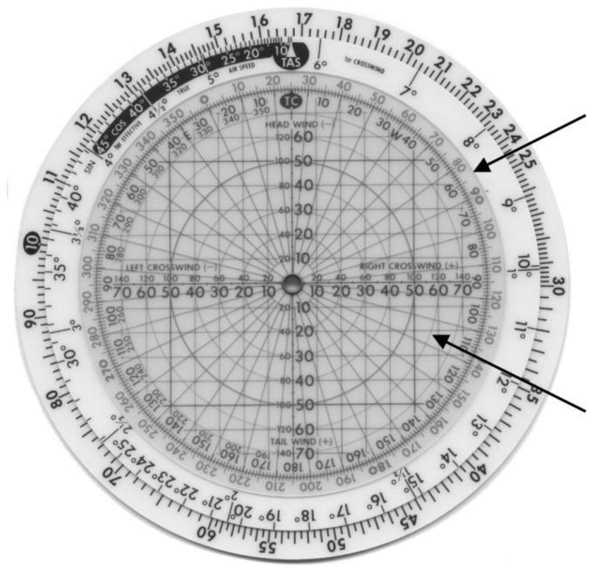

Figure 4-23 Range Indicator

Time permitting, you may use the CR-2 to compute a point-to-point. When using the CR-2 computer, you must visualize the computer as a map with the center of the circular (green) grid representing the TACAN station. Now, the green numbers around the edge of the circular grid represents radials of that TACAN station. Each of the (green) concentric circles around the station represent range rings. There is no particular value assigned to each ring. You must choose an appropriate value of range scale. The choice of range scale is based on the greatest range to be used in your computations. For example, you are on the 270 radial at 30 miles and want to go to the 180 radial at 25 miles; 30 NM is the greatest range, so you must adjust your range scale so that the 30 NM will fit on the grid. Since the grid has 8 concentric circles, each circle would represent 4 NM, giving a maximum usable radius of 32 NM.

NOTE

With a smaller scale, a more accurate course can be determined.

Once the range scale has been determined, merely place a dot at your present location (270 R/30 NM) and another dot at the destination (180 R/25 NM). These dots are drawn on the computer at the radial and range of each position. Now hold the computer so that the heavy black line with "TAS" at one end is at the top of the computer. Directly underneath the "TAS" you will now see a black circle with a "TC" inside it. The "TC" stands for "**TRUE COURSE**." This will now be referred to as the "top" of the computer.

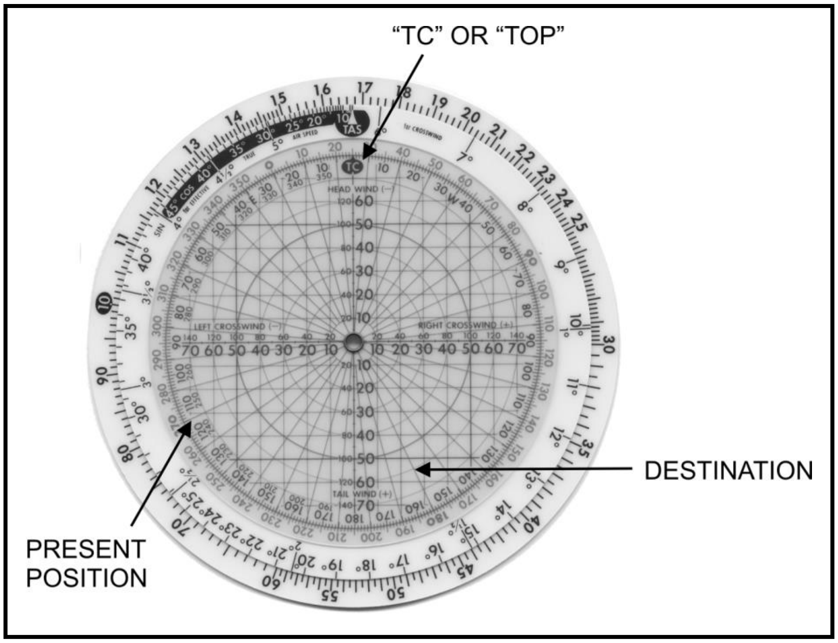

Figure 4-24 Range Scale

Now we have our two dots plotted, and the computer correctly oriented, we can compute the direct course between the two fixes. To do this, we must use the **square** (black) grid located behind the circular (green) grid. Turn the circular grid until a line connecting our two dots is exactly parallel to the vertical lines of the square (black) grid. Additionally, the dot representing our destination **must** be above the dot representing our present position. Your computer should now look like this:

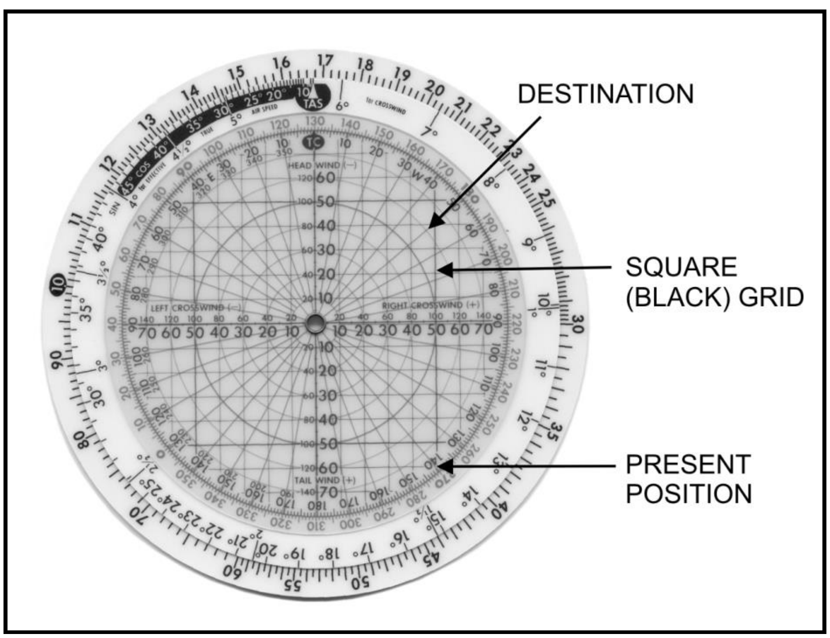

Figure 4-25 Square Grid

To find the direct course, read the number directly above the "TC" symbol at the top of the computer (130). This number (130) is the ***magnetic course*** to fly to the desired destination. The fact the "TC" stands for ***true course*** is not relevant in this particular operation.

In effect, what we have done is to draw a point on a chart (green circular grid) showing our present location, and another point showing the destination. Then we drew a line connecting these two points and used a nearby compass rose to determine the magnetic course of that line. Since the points are all drawn to scale, the distance between the dots is also to scale. To measure the distance, we merely assume the square (black) grid underneath the circular grid has the same range scale. In other words, we assume each square represents 4 NM, just like each circle was 4 NM. Now we count the number of squares between the 2 points, multiply by 4 (NM), and we have the distance between the two points. In this case, we get 39 NM. Thus, if we fly on a magnetic course of 130º for 39 NM (no wind), we will arrive at the desired destination.

Winds will affect this solution, so the point-to-point should be updated frequently using the RMI.

REVIEW QUESTIONS

1. What does the acronym TACAN stand for? ______________________________________

2. There are ________ X-band and ________ Y-band TACAN channels for a total of ______.

3. The KNI-582 (RMI) is used to display radial, course, and heading information to the pilot. If a TACAN channel is tuned in to the NAV-1, what needle on the RMI will indicate the TACAN radial? _______________________

4. The normal interference-free reception range of a TACAN ground station when below 18,000 feet MSL is ________ NM.

5. To tune a TACAN channel on a NAV-1, after turning the equipment on, select _______________ using the mode select knob. After selecting the desired TACAN channel with the data input knob, identify the station by _____________. The distance measuring equipment displays will show ________________, ________________, ________________.

6. When flying in the cone of confusion, the only reliable information will be ____________ ____________.

7. "Slant range" is the aircraft's actual distance over the ground from the station. ________________ (True/False)

8. The most reliable means of determining TACAN station passage is __________________.

9. You have just received the following holding clearance: "Hold north on the Alexander VORTAC 160 radial/10 DME fix . . . " Is this a station-side or nonstation-side holding? ________________________

10. In reference to question 9, what is the outbound holding course? ________________

11. Your holding clearance reads "Hold southeast on the Monroe VORTAC 330 radial/10 DME fix . . ." At initial holding fix passage, you are headed 050°. To enter holding, you would turn ________________ (right/left) to _________ (heading).

12. Your holding instructions read "Hold west on the lake Charles VORTAC 260 radial/15 DME fix . . ." At initial holding fix passage, your heading is 195°. To enter holding you would turn ________________ (right/left) to __________ (heading).

13. Your holding clearance reads "Hold west on the Hayes VORTAC 070 radial/20 DME fix, 2-mile legs . . ." On the outbound leg, the pilot would turn to intercept the inbound holding course at _______ DME.

14. You are presently 15 NM from the Fort Hayes VORTAC on the 060 radial and you have received clearance to fly to the 200 radial/21 fix. Using the CR-2 computer, determine the course and distance between the two fixes.

15. Your present position is on the 135 radial at 10 DME. What course would you fly to the 020 radial/20 DME fix? _______________

16. The first step in arcing is to turn the aircraft in the desired direction until the head of the RMI needle is exactly __________ degrees from the aircraft's heading.

17. When flying an arc, it is important to remember that when the head of the RMI needle is above the wingtip, the DME to the station should _______________.

18. The initial approach fix for a TACAN arcing approach is on the 160 radial at 15 DME and the final approach radial is 080°. How many miles will you have to fly on the 15-mile arc? __________

19. In reference to question 18, what is the average course between the 160/15 DME fix and the 080/15 DME fix? _______________

20. The VOR navigation receiver used in the TH-57C is the _______________.

21. The HSI is used by the _______________ (pilot/copilot) to maintain the aircraft on the desired radial in the TH-57C, while the _______________ (pilot/copilot) uses the CDI for the same purpose.

22. To tune a VOR frequency on the NAV-1, use the data select knob to select the desired frequency. For navigating the airways using the VOR, select _______________ mode. Depressing the CHK on the NAV-1 will display _______________ and _______________ on the NAV-1 panel if the VOR frequency is paired with a TACAN channel.

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REVIEW ANSWERS

1. Tactical Air Navigation
2. 126 . . . 126 . . . 252
3. Double
4. 40
5. TAC . . . pulling the ON/OFF switch and adjusting volume (ensuring the DME button on the audio panel is depressed) . . . slant range from the station, groundspeed, time-to-station
6. distance
7. False
8. minimum DME.
9. station-side
10. 340
11. right . . . 150º
12. teardrop right . . . 230
13. 18 DME
14. 217 . . . 34
15. 359 . . . 25
16. 90°
17. decrease
18. 20 NM
19. 030
20. KNS-81
21. pilot . . . copilot
22. VOR . . . radial . . . distance

CHAPTER FIVE
INSTRUMENT LANDING SYSTEM

500. INTRODUCTION

The Instrument Landing System (ILS) is designed to provide an approach path for exact alignment and descent of an aircraft on final approach to a runway.

The ground equipment consists of two highly directional transmitting systems and three (or fewer) marker beacons. The directional transmitters are known as the localizer and glideslope transmitters.

The system may be divided into three parts:

1. Guidance information – localizer, glideslope

2. Range information – marker beacon, DME

3. Visual information – approach lights, touchdown and centerline lights, and runway lights

Compass locators located at the Outer Marker (OM) or Middle Marker (MM) may be substituted for marker beacons. DME, when specified in the procedure, may be substituted for the OM.

Some locations have a complete ILS installed on each end of a runway; on the approach end of Runway 4 and the approach end of Runway 22, for example. When such is the case, the ILS systems are not in service simultaneously.

501. LESSON TOPIC LEARNING OBJECTIVES

Terminal Objective

Upon completion of this chapter, the student will interpret the functions of the instrument landing system as it applies to the TH-57C by answering related questions with a minimum score of 80%.

Enabling Objectives

1. Define the purpose of ILS.

2. List the two types of information received from the ILS.

3. Describe how the HSI is used by the pilot to maintain the helicopter on the ILS glideslope and course.

4. Describe how the CDI is used by the copilot to maintain the helicopter on the ILS glideslope and course.

5. Describe the function of the KR-21 marker beacon receiver.

6. Define the MAP (Missed Approach Point) on an ILS approach.

7. Interpret information from a published ILS approach procedure.

8. Select the correct minimums on a published ILS approach procedure.

9. Describe an ILS back course localizer approach.

10. Interpret information from a published back course localizer approach.

11. Interpret information from a published ILS/DME approach procedure.

502. ILS COMPONENTS

Localizer

The localizer transmitter, operating on one of the 40 ILS channels within the frequency range of 108.10 MHz to 111.95 MHz, emits signals which provide the pilot with course guidance to the runway centerline.

The approach course of the localizer, which is used with other functional parts; e.g., glideslope, marker beacons, etc., is called the front course. The localizer signal emitted from the transmitter at the far end of the runway is adjusted, if possible, so the distance between a full scale ***fly-left*** to a full scale ***fly-right*** indication equates to a linear width of approximately 700 feet at the runway threshold to provide a uniform sensitivity/response rate.

The course line along the extended centerline of a runway, in the opposite direction to the front course, is called the back course.

CAUTION

> Unless the aircraft's ILS equipment includes reverse sensing capability, when flying inbound on the back course it is necessary to steer the aircraft in the direction opposite of the needle deflection on the airborne instrument when making corrections from off-course to on-course. This "flying away from the needle" is also required when flying outbound on the front course of the localizer. ***DO NOT USE BACK COURSE SIGNALS*** for approach unless a ***BACK COURSE APPROACH PROCEDURE*** has been published for the particular runway and is authorized by ATC.

Identification is in International Morse Code and consists of a three-letter identifier preceded by the letter I (**..**) transmitted on the localizer frequency.

The localizer provides course guidance throughout the descent path to the runway threshold from a distance of 18 NM from the antenna between an altitude of 1000 feet above the highest terrain along the course line and 4500 feet above the elevation of the antenna site. Proper off-course indications are provided throughout the following angular areas of the operational service volume:

1. To 10º either side of the course along a radius of 18 NM from the antenna, and

2. From 10 to 35 degrees either side of the course along a radius of 10 NM.

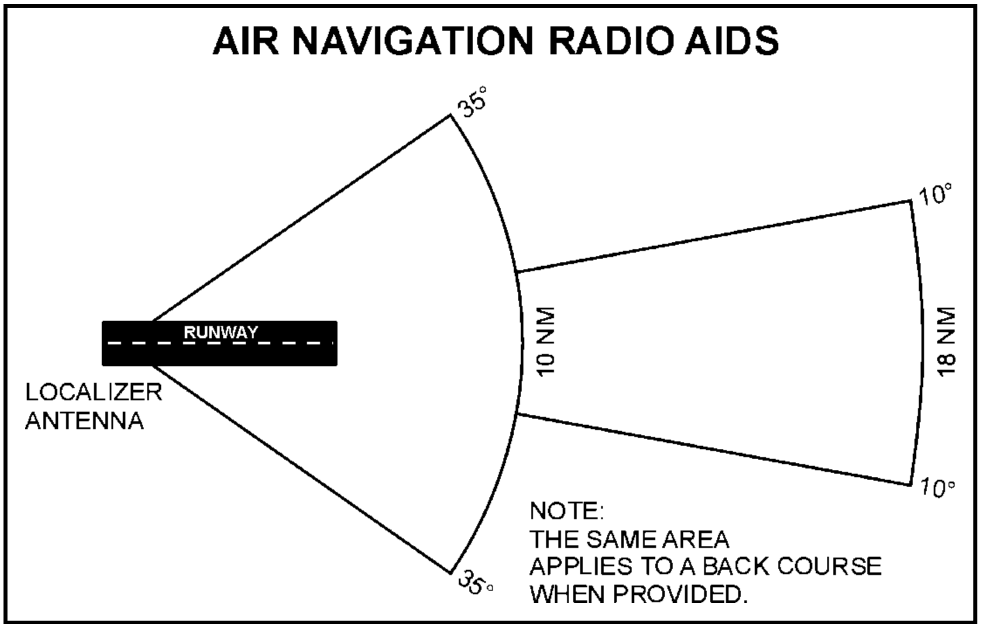


Figure 5-1 Normal Limits of Localizer Coverage

Proper off-course indications are generally not provided between 35–90 degrees either side of the localizer course. Therefore, instrument indications of possible courses in the area from 35–90 degrees off-course should be disregarded.

Glideslope

The UHF glideslope transmitter, operating on one of the 40 ILS channels within the frequency range 329.15 MHz, to 335.00 MHz radiates its signals primarily in the direction of the localizer front course. Normally, a glideslope transmitter is not installed with the intent of radiating signals toward the localizer back course; however, there are a few runways at which an additional glideslope transmitter is installed to radiate signals primarily directed toward the localizer back course to provide vertical guidance. The two glideslope transmitters will operate on the same channel but are interlocked to avoid simultaneous radiation to support either the front course or the back course, but not both at the same time. Approach and landing charts for the runways which have glideslopes on the localizer back course will be depicted accordingly.

CAUTION

Spurious glideslope signals may exist in the area of the localizer back course approach which can cause the glideslope flag alarm to disappear and present unreliable glideslope information. Disregard all glideslope signal indications when making a localizer back course approach unless a glideslope is specified on the approach and landing chart.

The glideslope transmitter is located between 750 and 1250 feet from the approach end of the runway (down the runway) and offset 250–650 feet from the runway centerline. It transmits a glidepath beam 1.4° wide.

NOTE

The term "glidepath" means that portion of the glideslope that intersects the localizer.

The glidepath projection angle is normally adjusted to 3° above horizontal so that it intersects the MM at about 200 feet and the OM at about 1400 feet above the runway elevation. The glideslope is normally usable to the distance of 10 NM. However, at some locations, the glideslope has been certified for an extended service volume which exceeds 10 NM.

In addition to the desired glidepath, false course and reversal in sensing will occur at vertical angles considerably greater than the usable path. The proper use of the glideslope requires the pilot to maintain alertness as the glidepath interception is approached and interpret correctly the "fly-up" and "fly-down" instrument indications to avoid the possibility of attempting to follow one of the higher angle courses. If procedures are correctly followed and pilots are properly indoctrinated in glidepath instrumentation, these high angle courses should cause no difficulty in the glidepath navigation.

Every effort should be made to remain on the indicated glidepath. Exercise extreme caution to avoid deviations below the glidepath so that the predetermined obstacle/terrain clearance provided by an ILS IAP is maintained.

A glidepath facility provides a glidepath suitable for navigation down to the lowest authorized DH specified in the approved ILS approach procedure. The glidepath may not be suitable for navigation below the lowest authorized DH and any reference to glidepath indications below that height must be supplemented by visual reference to the runway environment. Glideslopes which support low visibility operations with no published DH are usable to runway threshold.

The published glideslope threshold crossing height (TCH) does not represent the height of the actual glideslope indication above the runway threshold. It is a theoretical height which represents a projection of the average or mean glidepath between four miles and the middle marker. For practical application, it is a reference used for planning purposes which represents the height above the runway threshold that an aircraft's glideslope antenna should be, if that aircraft remains on a trajectory formed by the four-mile-to-middle marker glidepath segment. Pilots must be aware of the vertical height between the aircraft's glideslope antenna and the main gear in the landing configuration and, at the DH, plan to adjust the descent angle accordingly if the published TCH indicates that the wheel crossing height over the runway threshold may not be satisfactory. Tests have indicated a comfortable wheel crossing height to be approximately 20 to 30 feet, depending on the type of aircraft.

Distance Measuring Equipment (DME)

When installed with an ILS and specified in the approach procedure, DME may be used in lieu of:

1. The OM.

2. A back course final approach fix (FAF).

3. For ARC initial approach courses.

In some cases, DME from a separate facility may be prescribed for use.

Marker Beacon

ILS marker beacons have a rated power output of 3 watts or less and an antenna array designed to produce an elliptical pattern with dimensions, at 1000 feet above the antenna, of approximately 2400 feet in width and 4200 feet in length. Airborne marker beacon receivers with a selective sensitivity feature should always be operated in the "low" sensitivity position for proper reception of ILS marker beacons.

Ordinarily, there are two marker beacons associated with an ILS, the outer marker (OM) and middle marker (MM). However, some locations may employ a third marker beacon to indicate the point at which the decision height should occur when used with a Category II ILS.

1. The OM normally indicates a position at which an aircraft at the appropriate altitude on the localizer course will intercept the ILS glidepath. The OM is modulated at 400 Hz and identified with continuous dashes at the rate of two dashes per second and a blue marker beacon light.

2. The MM normally indicates a position at which an aircraft is approximately 3500 feet from the landing threshold. This will also be the position at which an aircraft on the glidepath will be at an altitude of approximately 200 feet above the elevation of the touchdown zone (i.e., the point where the glide slope intercepts the decision height, at or near the missed approach point). The MM is modulated at 1300 Hz and identified with alternate dots and dashes keyed at the rate of 95 dot/dash combinations per minute and an amber marker beacon light.

3. The inner marker (IM), where installed, will indicate a point at which an aircraft is at a designated decision height (DH) on the glidepath between the MM and landing threshold for a Category II approach. The IM is modulated at 3000 Hz and identified with continuous dots

keyed at the rate of six dots per second and a white marker beacon light.

A back course marker, where installed, normally indicates the ILS back course final approach fix where approach descent is commenced. The back course marker is modulated at 3000 Hz and identified with two dots at a rate of 72 to 95 two-dot combinations per minute and a white marker beacon light.

Compass Locator

Compass locator transmitters are often situated at the MM and OM sites. The transmitters have a power of less than 25 watts, a range of at least 15 miles and operate between 190 and 535 KHz.

NOTE

> At some locations, higher powered radio beacons, up to 400 watts, are used as OM compass locators. These generally carry Transcribed Weather Broadcast (TWEB) information.

Compass locators transmit two-letter identification groups. The outer locator transmits the first two letters of the localizer identification group, and the middle locator transmits the last two letters of the localizer identification group.

Inoperative Components

1. Inoperative localizer: When the localizer fails, an ILS approach is not authorized.

2. Inoperative glideslope: ***When the glideslope fails, the ILS reverts to a non-precision localizer approach.***

NOTE

> Refer to the Inoperative Component Table in the U.S. Government low altitude approach Procedures, Supplementary Information Section, for adjustments to minimums due to inoperative airborne or ground system equipment.

503. ILS MINIMUMS

The lowest authorized ILS minimums, with all required ground and airborne systems components operative, are:

1. Category I - Decision Height (DH) 200 feet and Runway Visual Range (RVR) 2400 feet (with touchdown zone and center line lighting, RVR 1800 Category A, B, C; RVR 2000 Category D).

2. Category II - DH 100 feet and RVR 1200 feet.

3. Category IIIA - RVR 700 feet.

NOTE

> Special authorization and equipment are required for Category II and IIIA.

504. ILS COURSE DISTORTION

All pilots should be aware that disturbance to ILS localizer and glideslope courses may occur when surface vehicles or aircraft are operated near the localizer and glideslope antennas. Antenna locations are such that few ILS installations are not subject to signal interference by either surface vehicles, aircraft, or both. ILS critical areas are established on the surface about each localizer and glideslope antenna. Air Traffic Control (ATC) procedures exist to control the operation of vehicle or aircraft traffic on the portions of taxiways and runways that lie within the critical areas and to adjust the flow of arrival or departure traffic so that the proximity of one aircraft to an ILS antenna does not cause interference to the ILS course signals being used by another when the weather or visibility conditions are below specific values.

ATC issues control instructions to avoid interfering operations within ILS critical areas at controlled airports during the hours the Airport Traffic Control Tower (ATCT) is in operation as follows:

1. Weather Conditions - At or above ceiling 800 feet and/or visibility 2 miles

    a. No critical area protective action is provided under these conditions.

    b. If an aircraft advised the tower that an autoland or coupled approach will be conducted, an advisory will be promptly issued if a vehicle or aircraft will be in or over a critical area when the arriving aircraft is inside the ILS MM.

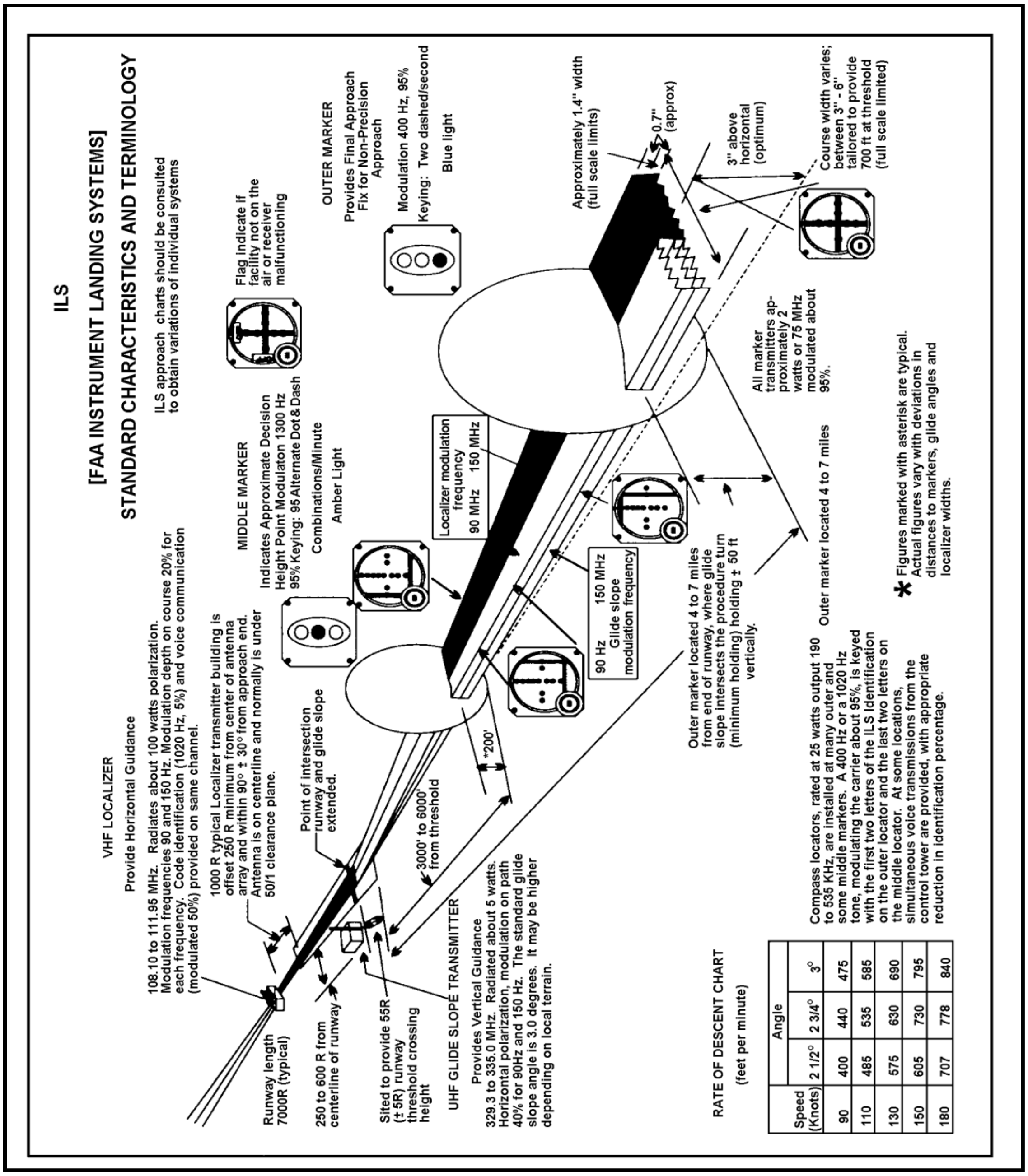
Example: GLIDESLOPE SIGNAL NOT PROTECTED

2. Weather Conditions - Less than ceiling 800 feet and/or visibility 2 miles.

    a. GLIDESLOPE CRITICAL AREA - Vehicles and aircraft are not authorized in the area when an arriving aircraft is between the ILS final approach fix and the airport unless the aircraft has reported the airport in sight and is circling or sidestepping to land on a runway other than the ILS runway.

    b. LOCALIZER CRITICAL AREA - Except for aircraft that may operate in or over the area when landing or exiting a runway or for departures or missed approaches, vehicles and aircraft are not authorized in or over the area when an arriving aircraft is between the ILS final approach fix and the airport. Additionally, when the ceiling is less than 200 feet and/or the visibility is RVR 2000 or less, vehicle and aircraft operations in or over the area are not authorized when an arriving aircraft is inside the ILS MM.

3. While a critical area is not specifically established outward from the airport to the final approach fix, and aircraft holding below 5000 feet AGL inbound toward an airport between the ILS final approach fix and the airport can cause reception of unwanted localizer signal reflections by aircraft conducting an ILS approach. Accordingly, such holding is not authorized when weather or visibility conditions are less than ceiling 800 feet and/or visibility 2 miles.



Speed (Knots)	Angle 2 1/2°	2 3/4°	3°
90	400	440	475
110	485	535	585
130	575	630	690
150	605	730	795
180	707	778	840

Figure 5-2 FAA Instrument Landing Systems

505. GUIDANCE INFORMATION

Localizer transmitters emit highly directional signals that provide very precise course guidance to the runway. These transmitters are located approximately 1000 feet beyond and to the side of the nonapproach end of the ILS runway. The antenna is in line with the runway and radiates 90 and 150 Hz signal patterns on opposite sides of the extended runway centerline. The 150 Hz signal is on the right when looking at the runway from the approach end. (This is the shaded area of the localizer symbol on Enroute Charts and approach plates.) The 90 Hz signal is on the left. The course is formed along the runway centerline extended (toward the outer marker) where the signals overlap and are of equal strength. This course is called the FRONT COURSE (see the illustration below). The front course sector is approximately 5º wide extending 2½º either side of the course centerline. The course sector width may be tailored to provide an optimum width of 700 feet at the runway threshold. The localizer signal has a usable range of at least 18 miles within 10º of the course centerline.

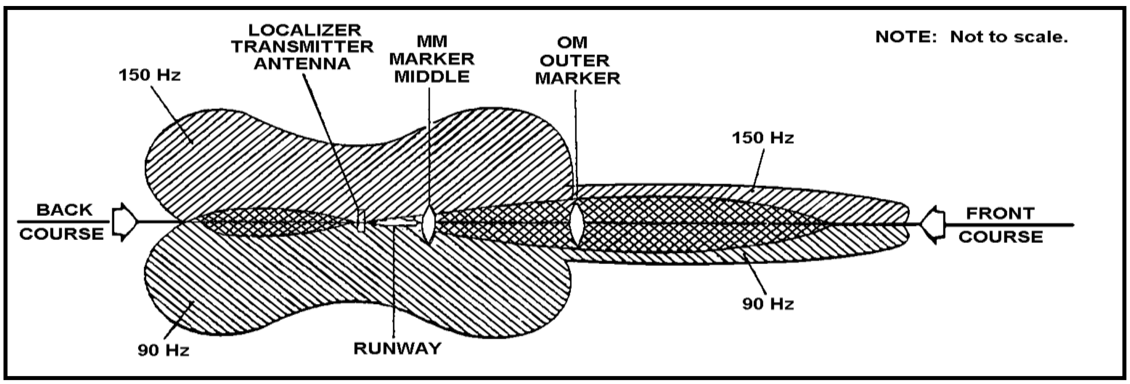


Figure 5-3 Localizer Transmitters

Most localizer transmitters also provide a signal pattern around the runway so that course signals also overlap in the opposite direction forming a BACK COURSE. Civilian operated localizer transmitters provide a usable back course signal, but military operated localizer transmitters do not. Localizer back course instrument approach procedures, as depicted on the approach plate are often published for civil airports. (Note that the shaded or 150 Hz portion of the localizer symbol is to the left when approaching the transmitter on the back course. The significance of this will be discussed in the flight procedures section of this workbook.) Normally, the glideslope information is not available during back course operations.

ILS localizer transmitters use the odd decimal VHF frequencies from 108.1 to 111.95 MHz (e.g., 110.3 MHz). The localizer transmitter emits continuous identification in the form of a coded three-letter station identifier preceded by the letter "I" (e.g., I-CRP). Some have voice capabilities.

The glideslope is normally intercepted from below, but may be intercepted from above. As the aircraft approaches the glideslope, a descent is initiated (or adjusted if intercepting from above) to establish the aircraft on glideslope. Power and nose attitude are then adjusted as necessary to maintain airspeed and glideslope until reaching DH.

The importance of precise aircraft control cannot be overemphasized. The size of the localizer course and glideslope envelope decreases progressively throughout the approach. As the approach progresses, smaller pitch and bank corrections are required to maintain glidepath.
On an ILS approach the missed approach point is defined as that point along the localizer course and glideslope where the aircraft reaches its decision height (DH) expressed in feet above MSL. When glideslope information is not available, such as localizer-only approaches, timing or DME is used to define the missed approach point.

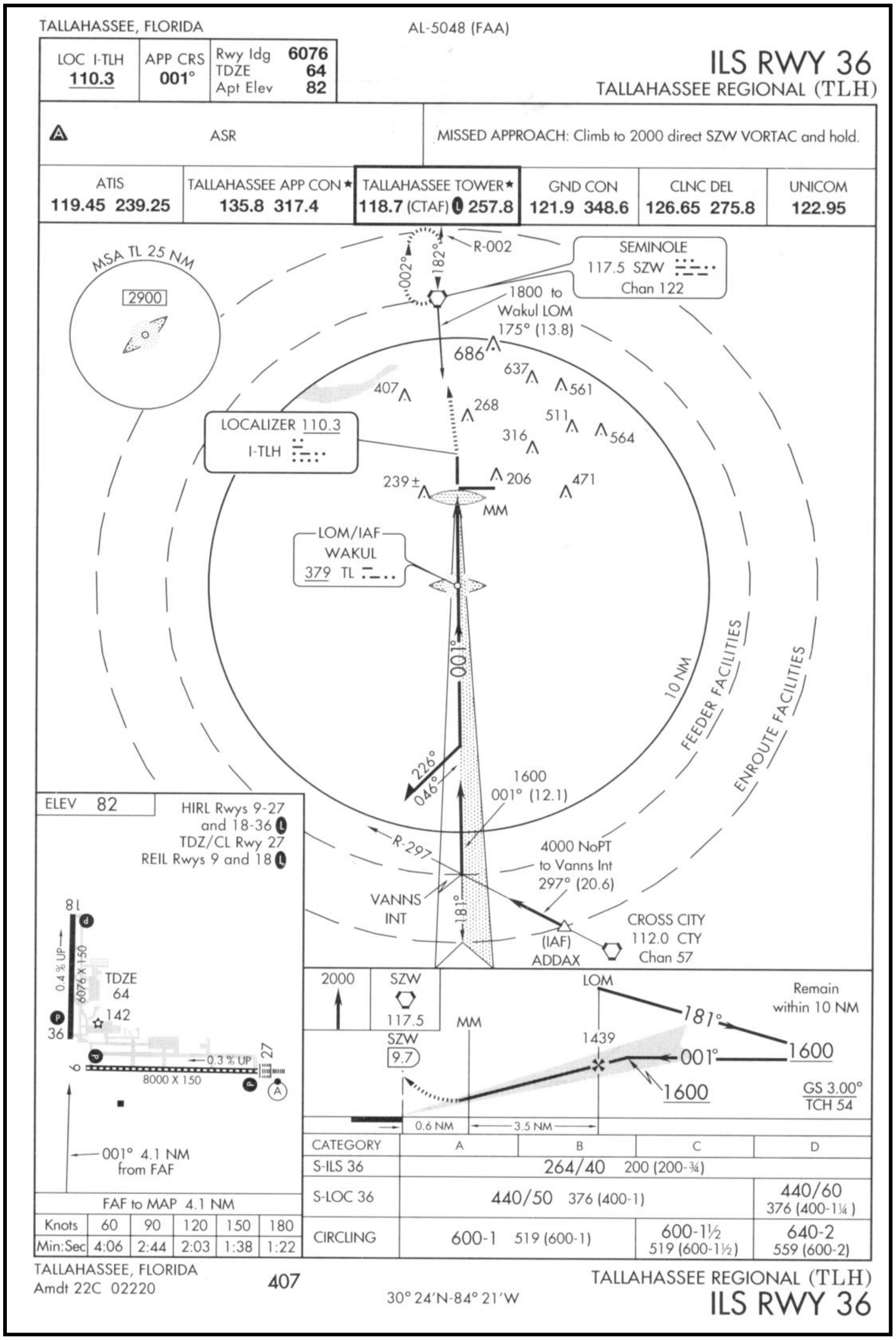


Figure 5-4 ILS RWY 36

Visual Information

Special approach lighting systems are installed on main runways serviced by ILS approaches to aid the pilot in acquiring the runway environment under reduced ceiling and visibility conditions.

NOTE

When certain visual aids are inoperative or unusable, decision height and visibility minimums may have to be adjusted by the pilot. Refer to FAR Part 91 or the INOP Components table in the approach plates for specific information.

506. TH-57C ILS RECEIVERS AND DISPLAYS

The Instrument Landing System (ILS) is a precision approach system that provides azimuth and glideslope information to the pilot. It consists of a highly directional localizer (course) and glideslope transmitter with associated marker beacons, compass locators and, at some sites, distance measuring equipment.

The equipment installed in the TH-57C required to execute an ILS approach consists of the KNS-81 (NAV-1), the KR-21 marker beacon receiver and the KDI-525A (HSI) or the KI-206 (CDI). The KR-87 (ADF) would be used to receive the compass locator when appropriate. The number 1 and number 2 needles on the RMI are not used when executing an ILS unless the ILS has a compass locator or other NAVAID in the vicinity which has also been selected.

The NAV-1 equipment is designed to automatically function in the ILS mode whenever an ILS frequency is selected and the USE button is pressed. The signal is sent to the HSI and CDI when NAV-1 is selected.

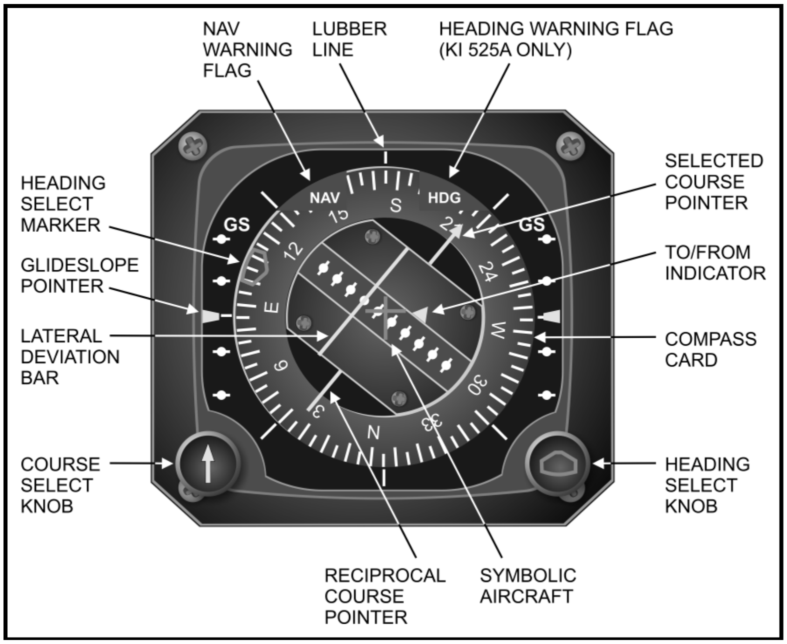


Figure 5-5 KDI-525A HSI

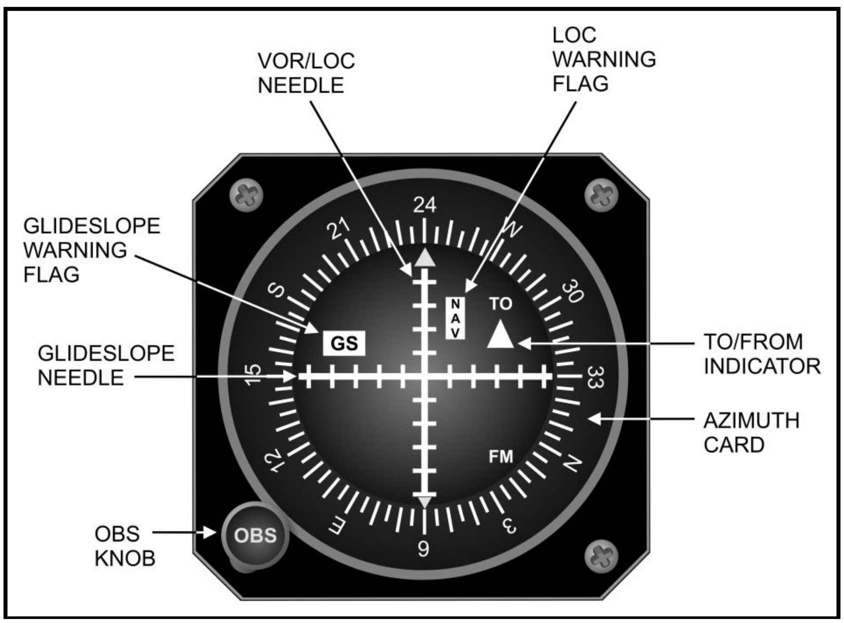


Figure 5-6 KDI-206 CDI

The HSI receives its input from the NAV-1. The HSI glideslope pointer has a full scale sensitivity of 0.7°. It represents the actual aircraft deviation from the glideslope. When usable information is present, the glideslope pointer is out of view. When a valid signal is received, there is a 2–12 second delay before the pointers come into view. The lateral deviation bar on the HSI represents the localizer course deviation. When referenced to the symbolic aircraft, the position of the deviation bar is the same as the position of the chosen localizer course. The lateral deviation bar has a full scale sensitivity of 3–6 degrees (depending upon ground facility).

The NAV flag will appear if the localizer signal is lost.

The CDI receives its input from the NAV-1 or NAV-2 GPS. The glideslope needle moves up or down, depending upon whether the aircraft is below or above glideslope. The glideslope warning flag appears if the signal is lost. The localizer needle indicates deviation from the localizer course. If the localizer signal is lost, the localizer warning signal appears. The sensitivity of both needles is similar to that of the HSI.

The CDI and HSI glideslope and course deviation indicators are extremely sensitive when used for an ILS approach. The pilot will make all corrections toward the needle/bar/pointer. When executing a back course localizer approach, reverse sensing occurs in the CDI; therefore, the pilot must make turns away from the course deviation or lateral deviation bar. The HSI will indicate proper sensing if the front course is set in. The localizer is considered reliable within 18 NM of the transmitter and within 10° of the localizer course. The glideslope information is considered reliable within 10 NM of the transmitter, provided the aircraft is on the localizer course. Small, deliberate adjustments in rate of descent/climb and heading are necessary to keep the aircraft on glideslope and on course.

NOTE

If the front course is set in the HSI it will provide proper sensing.

The marker beacon receiver is energized regardless of whether an ILS frequency is selected or not. It provides audio signals to the KMA24H audio unit. If the MKR button is depressed on the pilot's audio panel, the pilot will hear the signals discussed previously when the aircraft passes over the marker beacons during the ILS or localizer approach. The blue light (labeled 0) on the KR-21 panel will flash on/off at a rate of two per second when the aircraft passes over the outer marker. The amber light (labeled M) will flash synchronously with the audio dots and dashes when the aircraft passes over the middle marker. The white light (labeled A) will be lighted while over the inner marker beacon. The inner marker is normally used to identify the decision height of a CAT II ILS, wherein the aircraft's altitude above the runway is normally 100 feet. The HI/LO switch on the KR-21 allows the pilot to vary the sensitivity of the KR-21 to the marker beacons 75 MHz signal. The effect of the "HI" position is to greatly enlarge the size of the cone-shaped "area of indication" above the station. An aircraft slightly off course would therefore be ensured of marker beacon signal reception. The high sensitivity position may be used to effectively give the pilot an advance indication that he is approaching the outer marker. The aural tone will begin about one mile from the outer marker at which time the pilot can slow to desired approach speed and perform final cockpit checks.

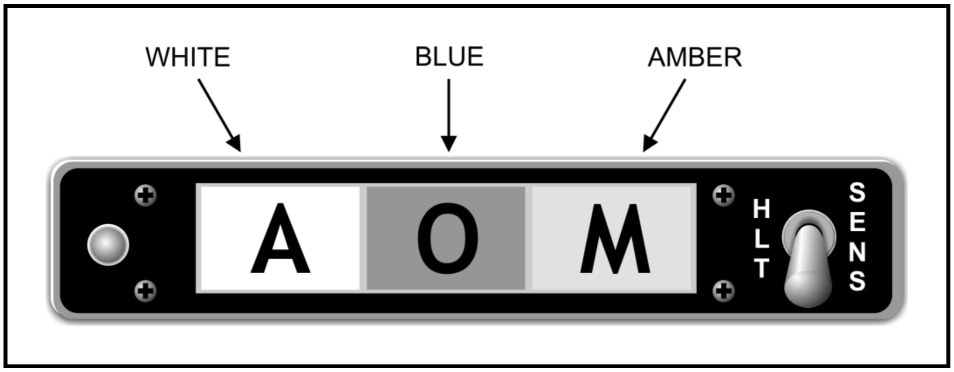
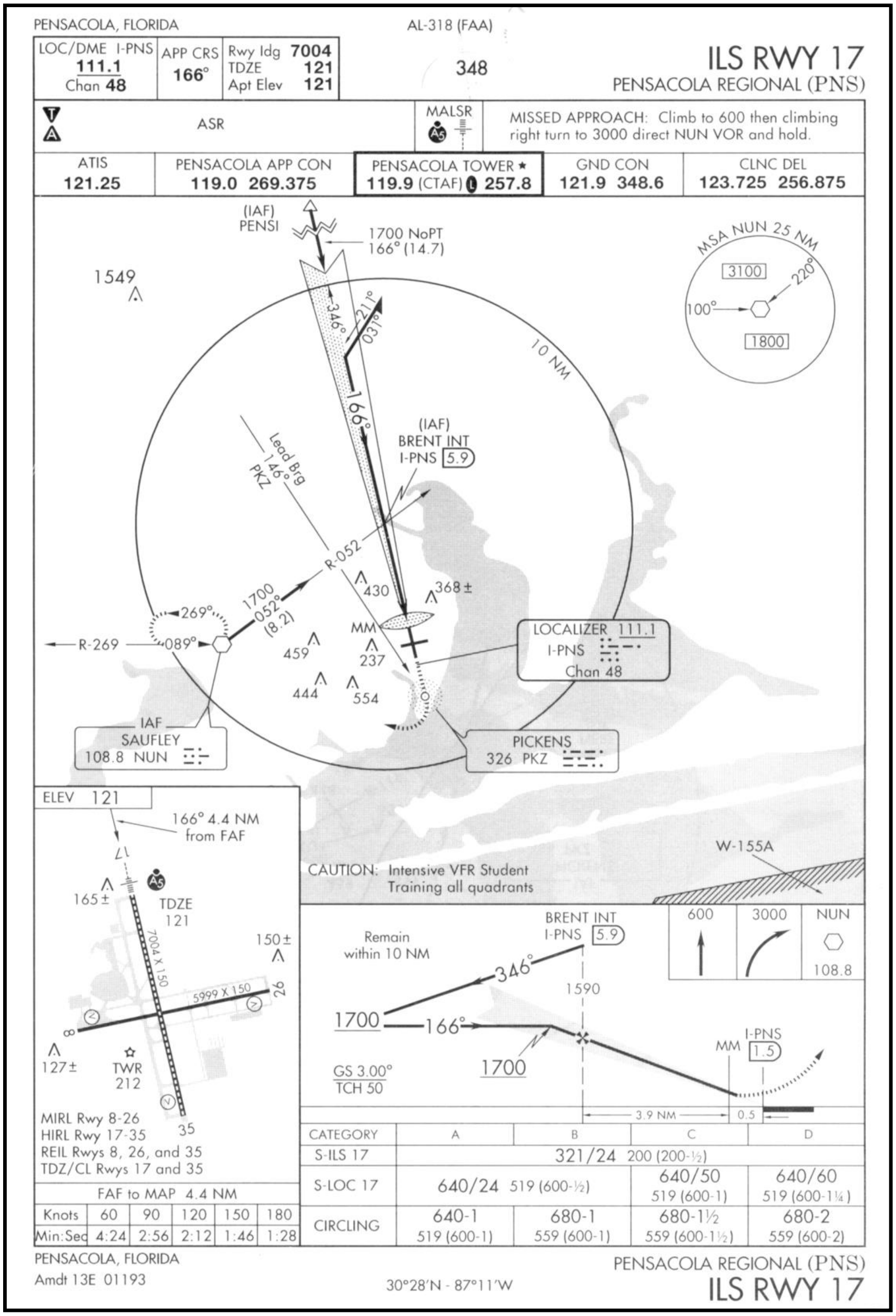


Figure 5-7 KR-21

Figure 5-8 shows ILS RWY 17 approach at Pensacola Regional Airport. There are three initial approach fixes listed: SAUFLEY VOR, BRENT Intersection and PENSI Intersection. If the pilot files to SAUFLEY or BRENT, he should plan to execute the 45° procedure turn as shown. If the pilot has filed to PENSI, he would execute a straight-in ILS.



FAF to MAP 4.4 NM					
Knots	60	90	120	150	180
Min:Sec	4:24	2:56	2:12	1:46	1:28

CATEGORY	A	B	C	D
S-ILS 17	321/24 200 (200-½)			
S-LOC 17	640/24 519 (600-½)		640/50 519 (600-1)	640/60 519 (600-1¼)
CIRCLING	640-1 519 (600-1)	680-1 559 (600-1)	680-1½ 559 (600-1½)	680-2 559 (600-2)

Figure 5-8 ILS RWY 17

On the profile section, the glideslope and threshold crossing heights of 3° and 50 feet respectively are listed. The glideslope can be used in the rate of descent table to determine an appropriate descent rate for the approach. If the duty runway is 17, the DH is 321 feet and the RVR requirement 2400 feet. The DH designates the ILS MAP (Missed Approach Point). If maintained on the glideslope, the aircraft's altitude upon reaching the MAP should be 321 feet. Upon reaching the DH, if the visual reference with the runway environment (runway or runway/approach lights) is insufficient to complete the landing, the published missed approach procedures shall be executed.

Figure 5-9 shows the ILS Z RWY 19 at Eglin AFB. In this approach, aircraft Distance Measuring Equipment (DME) is required only if flown as a localizer. After intercepting the ILS final approach course and glide slope, the pilot descends to the decision height of 265 feet (TH-57 helicopters are CAT A). On this approach, the MM serves as a back-up for the MAP (decision height) for the ILS approach.

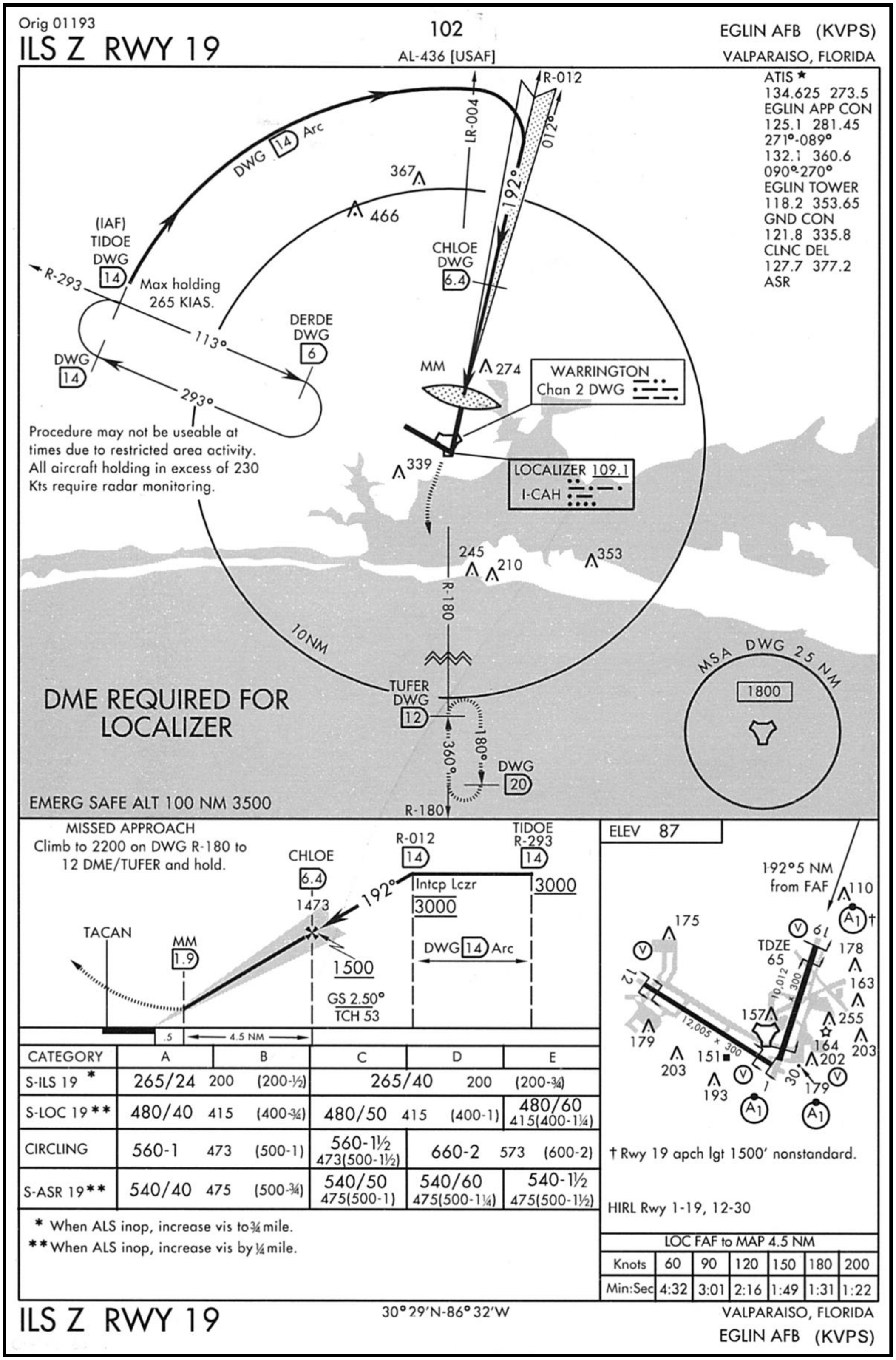
507. LOCALIZER APPROACHES PROCEDURES

The procedures used are very similar to those used on an ILS approach except the pilot must use timing from the FAF to identify the MAP. The localizer minimums for Figure 5-9 are listed as either S-LOC 19 or circling. For example, if the duty runway is 19, the pilot executing the localizer approach would descend (without the aid of a glideslope) to the MDA of 480 feet after crossing the FAF and time for 3:01 minutes from the FAF (at 90 knots groundspeed) to determine the MAP. If the runway in use is something other than 19, the circling MDA of 560 feet (CAT A) would be used.

A TH-57C pilot may execute a back course localizer approach to a straight-in or a circle to land. Figure 5-10 shows the LOC BC RWY 16R approach at Jackson International. The most significant difference between a front course localizer and a back course localizer is the reversal of the azimuth signal on the back course. The pilot would be required to make course corrections away from the lateral deviation bar or course deviation needle because of this "reverse sensing."

NOTE

Only if using the CDI. With the front course set in the HSI, it will automatically compensate for "reverse sensing."

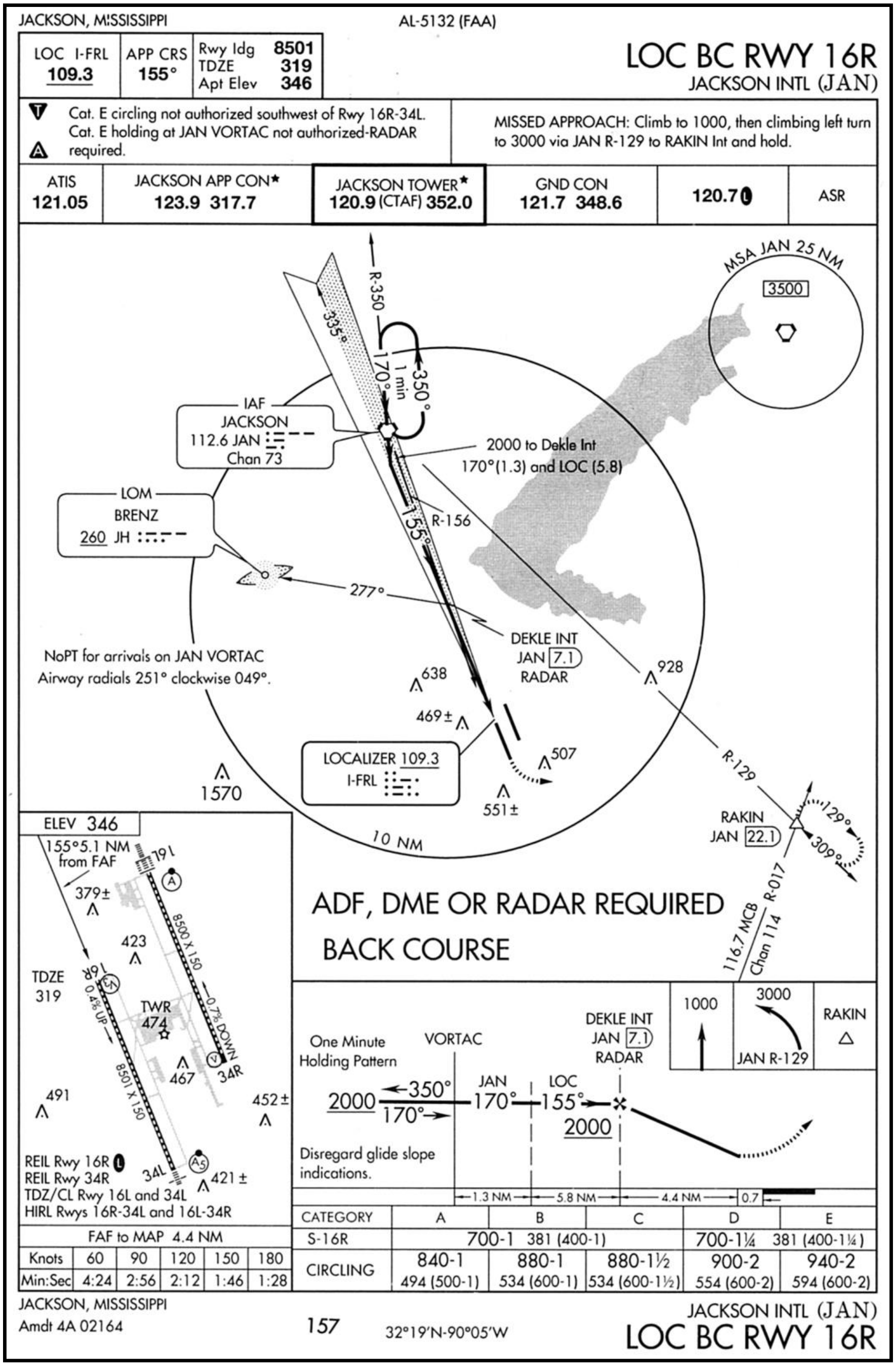


CATEGORY	A	B	C	D	E
S-ILS 19 *	265/24 200 (200-½)		265/40 200 (200-¾)		
S-LOC 19 **	480/40 415 (400-¾)		480/50 415 (400-1)		480/60 415(400-1¼)
CIRCLING	560-1 473 (500-1)		560-1½ 473(500-1½)	660-2 573 (600-2)	
S-ASR 19 **	540/40 475 (500-¾)		540/50 475(500-1)	540/60 475(500-1¼)	540-1½ 475(500-1½)

* When ALS inop, increase vis to ¾ mile.
** When ALS inop, increase vis by ¼ mile.

LOC FAF to MAP 4.5 NM						
Knots	60	90	120	150	180	200
Min:Sec	4:32	3:01	2:16	1:49	1:31	1:22

Figure 5-9 ILS Z RWY 19



Knots	60	90	120	150	180
Min:Sec	4:24	2:56	2:12	1:46	1:28

CATEGORY	A	B	C	D	E
S-16R	700-1 381 (400-1)			700-1¼ 381 (400-1¼)	
CIRCLING	840-1 494 (500-1)	880-1 534 (600-1)	880-1½ 534 (600-1½)	900-2 554 (600-2)	940-2 594 (600-2)

Figure 5-10 LOC BC RWY 16R

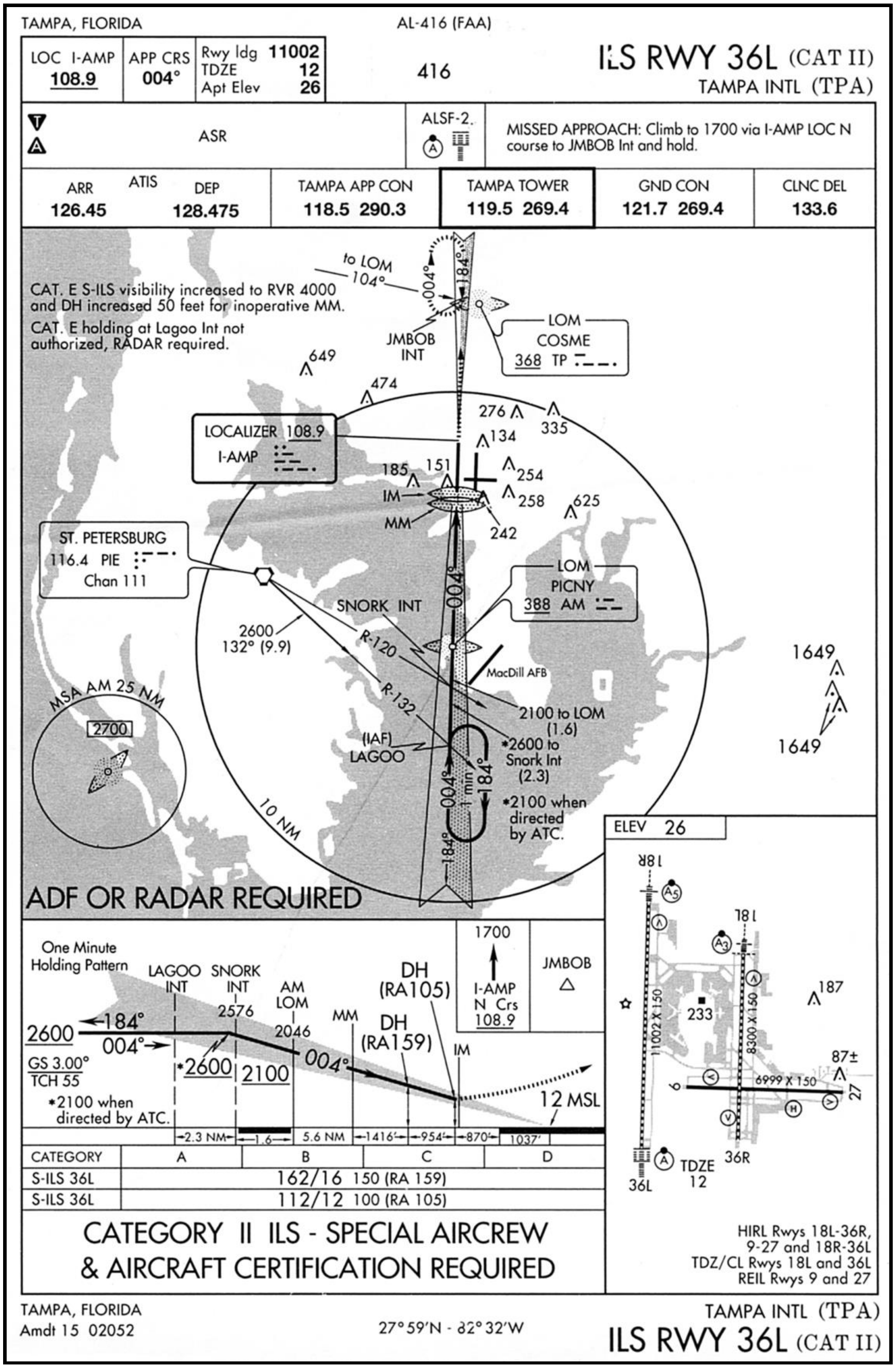


Figure 5-11 ILS RWY 36L

Figure 5-11 shows the ILS RWY 36L at Tampa International. It is a category II ILS approach, which means the HAT (Height Above Touchdown) is not less than 100 feet and the runway visual range is less than 1800 feet (but not less than 1200 feet). Radar altimeter equipment in the aircraft is required to identify the DH/MAP. The (RA 159, RA 105) in the minima section of the approach indicates a radar altimeter reading of 159 or 150 feet identifies the respective MAP.

Single-piloted aircraft in the Navy are limited to "200 feet ceiling/height above touchdown (HAT) and visibility 1/2 statute mile/2400 feet RVR or published minimums," whichever is higher (1/4 mile for copters). According to FAR Part 91, among the equipment required for CAT II ILS approaches down to a HAT of 150 feet is a marker beacon receiver with outer and middle marker aural and visual indicators and an automatic approach coupler or a flight director system. For CAT II approaches with a HAT of less than 150 feet, the aircraft must have an inner marker beacon capability or a radar altimeter in addition to the above mentioned equipment. ***At this writing the TH-57C is not equipped with a flight control guidance system; therefore, the aircraft is not certified for CAT II ILS operations.***

508. SDF AND LDA APPROACHES PROCEDURES

Two other approaches using similar techniques and procedures are Simplified Directional Facility (SDF) and Localizer-type Directional Aid (LDA) approaches (Figure 5-12). SDF signals transmitted between 108.10 to 111.95 MHz provide a final approach course similar to that of the ILS localizer, but do not provide glideslope information. An SDF course may not be aligned with the runway and the course may be wider, resulting in less precision.

Usable off-course indications are limited to 35° either side of the course centerline; therefore, indications received beyond 35° should be disregarded.

The SDF antenna may be offset from the runway centerline. Because of this, the angle of convergence between the final approach course and the runway bearing should be determined by reference to the Instrument Approach Procedure Chart. This angle is generally not more than 3°; however, it should be noted that since the approach course originates at the antenna site, an approach which is continued beyond the runway threshold will lead the aircraft to the SDF offset position rather than along the runway centerline.

The SDF signal is fixed at either 6 or 12 degrees course width as necessary to provide maximum flyability and optimum course quality.

The Localizer-type Directional Aid (LDA) is of comparable use and accuracy to a localizer but is not part of a complete ILS. The LDA course usually provides a more precise approach course than the similar SDF installation. As with the SDF, the LDA is not aligned with the runway, but may be published with straight-in minimums where alignment does not exceed 30° between the course and runway. Circling minimums **only** are published where this alignment exceeds 30°.

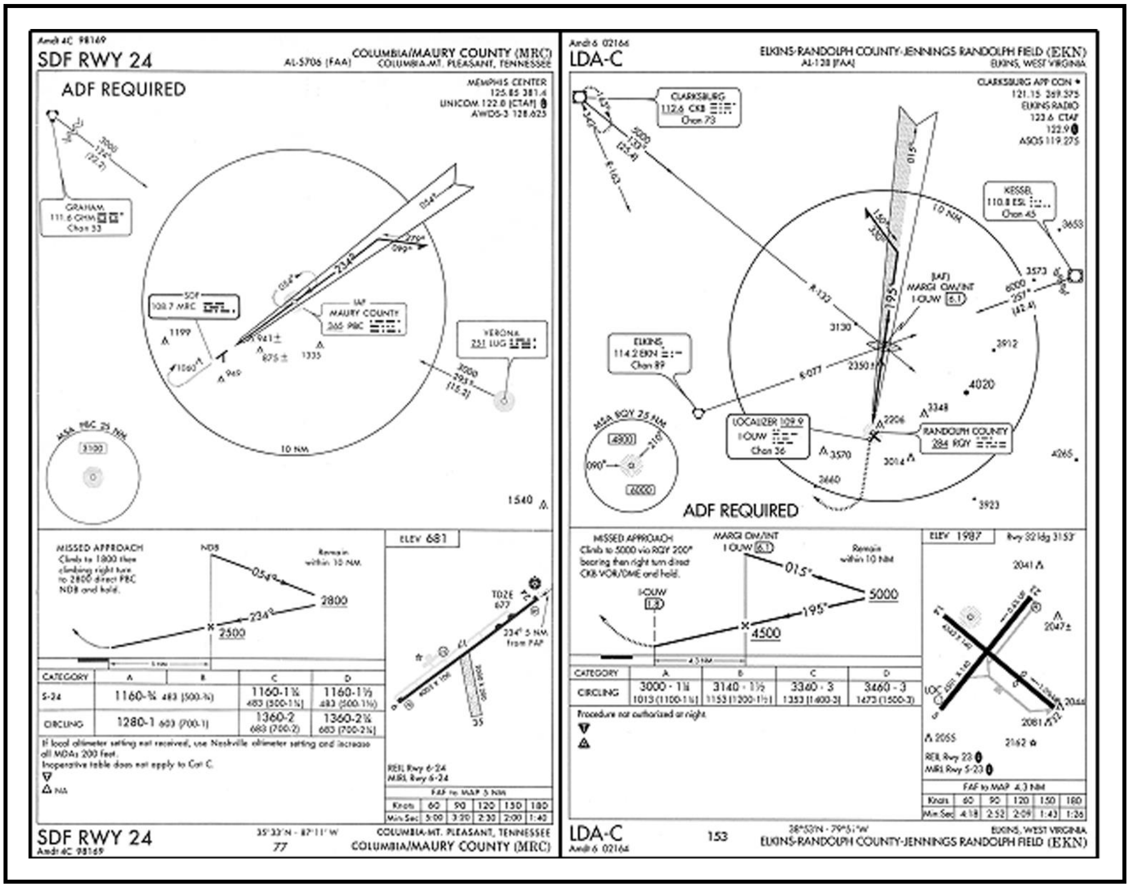


Figure 5-12 SDF RWY 24 – LDA-C

509. ILS FLIGHT PROCEDURES

The procedures discussed in this text assume that the navigational facilities are properly tuned and identified, all aircraft equipment is operating correctly, and all switches are properly positioned. These procedures are generally accepted, but should not be construed as established, routine, or mandatory.

Course Orientation, Intercept and Tracking

When a compass locator is part of an ILS installation, orientation is simply a matter of ADF orientation as discussed in a previous instructional unit. The value read under the head of the ADF needle is the course to the compass locator. Since the compass locator is collocated with either the outer marker or middle marker, the pilot merely tracks inbound toward the compass locator until he is within the reception range of the localizer.

As the aircraft approaches the localizer course, a smooth intercept is made using the same procedures as discussed in ADF procedures.

In the following illustration (Figure 5-13), the aircraft is located on the 300 course to the compass locator.

Figure 5-13 Compass Locator

As the aircraft moves within the reception range of the localizer, the HSI may be used as an aid in orientation. When the inbound front course localizer bearing is selected with the course selector, the aircraft's position relative to the localizer course will be the same as that presented in the VOR and TACAN units. If the inbound back course localizer bearing is selected with the course selector, the HSI will present "reverse sensing." When the aircraft is left of course, the lateral deviation bar is deflected to the left and when the aircraft is right of course, the lateral deviation bar is deflected to the right. Therefore, the inbound front course localizer bearing should always be selected. Until the aircraft moves within the cone of the localizer, the lateral deviation bar will be deflected to one side. (Full scale deflection of the lateral deviation bar is 2½º either side of centerline.) As the aircraft moves within the cone of the localizer course, each dot on the lateral deviation scale represents ½º deviation from the localizer course. The following depictions, when applied to the accompanying approach plates, should help you visualize the aircraft's lateral position.

The ***outbound front course*** localizer bearing (126º) has been improperly selected; therefore, reverse sensing is displayed. The aircraft (in both depicted positions) is 1½º left (NE) of the localizer course (Figures 5-14/15).

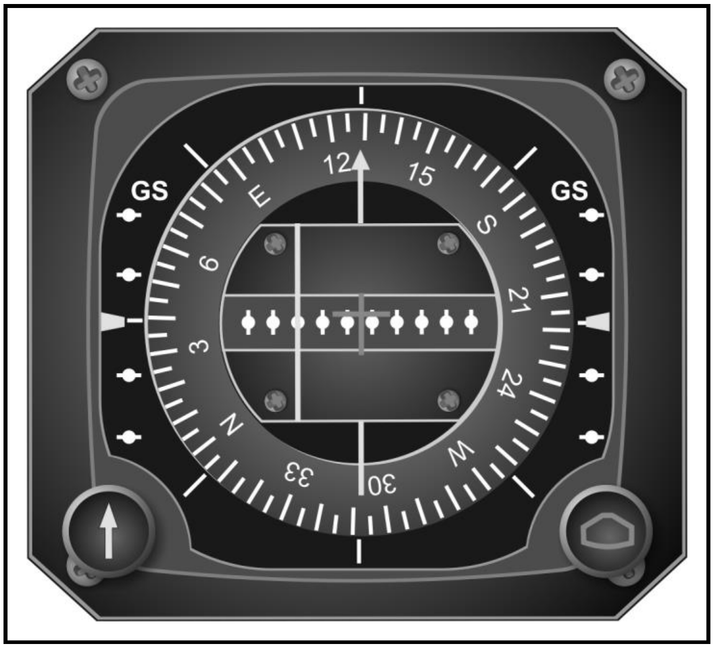


Figure 5-14 Outbound Front Course Localizer

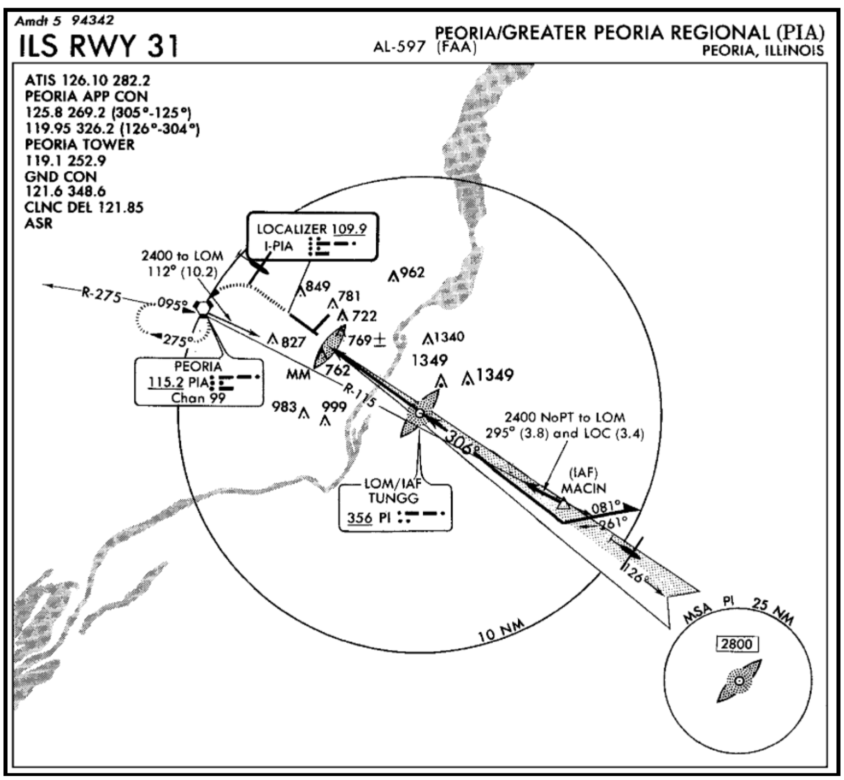


Figure 5-15 ILS RWY 31

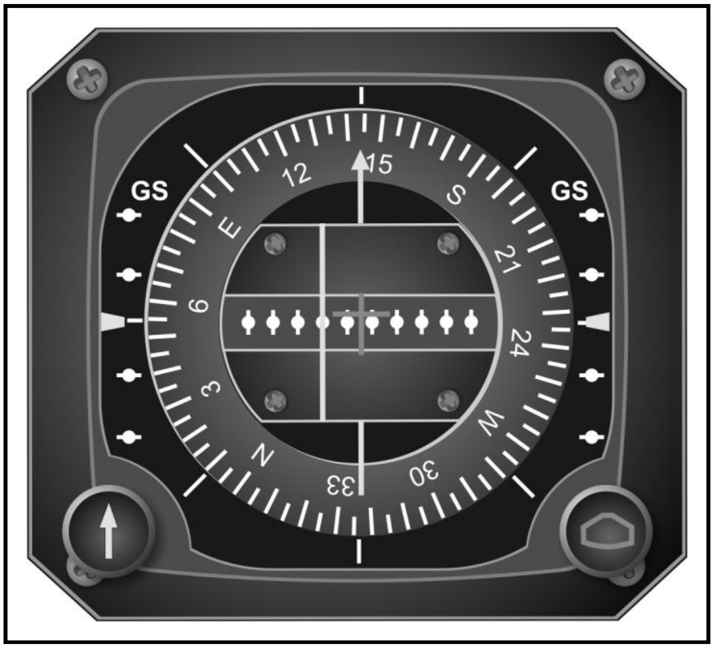


Figure 5-16 Southwest of Localizer Course

The aircraft (in the depicted position) is 1º right (Southwest) of the localizer course.

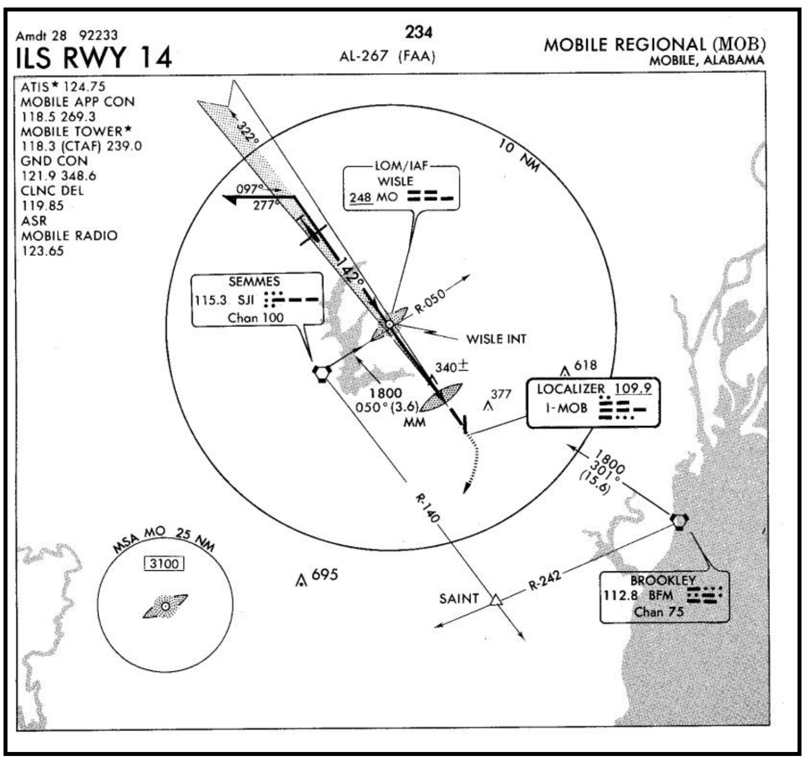


Figure 5-17 ILS RWY 14

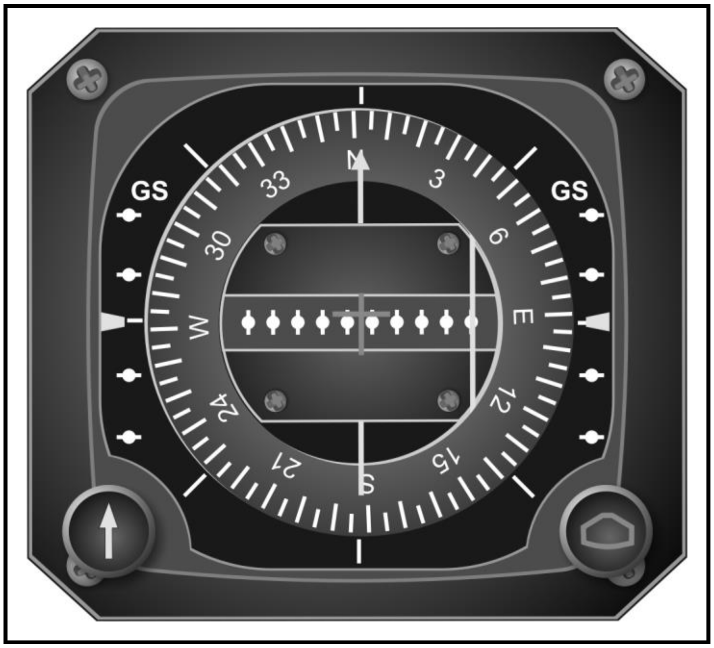


Figure 5-18 West of the Localizer Course

The aircraft (in all depicted positions) is 2 ½º or more West (left) of the localizer course.

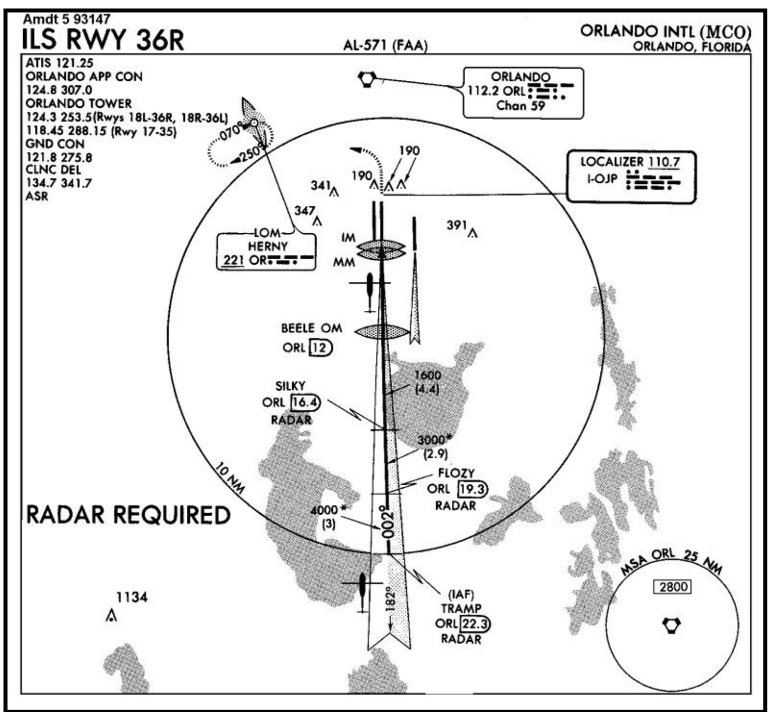


Figure 5-19 ILS RWY 36R

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REVIEW QUESTIONS

1. What does ILS stand for? ____

2. The purpose of the ILS is to allow the pilot to conduct an approach in conditions of low ceiling/visibility using only visual references inside the cockpit. ____________ (True/False)

3. The ILS is a precision approach because it provides _____________ and _____________ information.

4. The localizer transmits in the ________ to ________ MHz frequency range and provides _______________ information to the pilot.

5. The glideslope transmits in the UHF frequency of ________ to ________ MHz.

6. The outer, middle, and inner marker beacons transmit at ________ MHz. The outer marker indicates to the pilot he is beginning the final approach and is approximately ________ miles from the approach end of the runway.

7. Published minimums are normally reached at the _______________ marker except in the case of CAT II ILS approach.

8. The compass locator operates in the ________ to ________ KHz frequency range and serves to aid the pilot in navigating around an ILS approach.

9. ILS CAT I approaches provide for an approach to a height above touchdown or not less than ________ feet and RVR of not less than ________ feet.

10. CAT II ILS approaches provide for an approach to a height above touchdown of not less than ________ feet and RVR of not less than ________ feet if the aircraft is properly equipped IAW FAR Part 91.

11. When the pilot selects an ILS frequency on the NAV-1, the mode must be manually switched to ILS. ____________ (True/False)

12. The pilot uses the HSI and the copilot uses the CDI when executing an ILS approach. ____________ (True/False)

13. If both HSI and CDI are to be used during an ILS approach, then NAV-1 must be selected by both pilots. ____________ (True/False)

14. The pilot should make all glideslope corrections toward the ____________ on the HSI and all course corrections toward the ____________ on the HSI when executing an ILS approach.

15. When executing a back course localizer approach, the pilot must make course corrections _______________ (towards/away from) the HSI lateral deviation bar, with the front course dialed in.

16. The KR-21 marker beacon receiver in the TH-57C gives the pilot which of the following?

    a. Outer and middle marker visual ident
    b. Outer and middle visual and aural ident
    c. Outer, middle and inner visual ident
    d. Outer, middle and inner visual and aural ident

17. The localizer is considered reliable when the aircraft is

    a. Within 10° of the localizer course and within 18 NM of the transmitter.
    b. Within 30 NM of the transmitter and within 30° of the localizer course.
    c. Within 35° of the localizer course and within 10 NM of the transmitter.
    d. Within 10° of the localizer course and within 30 NM of the transmitter.

18. The MAP (Missed Approach Point) on an ILS is the point where the aircraft is at _______________.

19. The MAP on a localizer approach is based upon _______________ from the FAF.

USE FIGURE 5-20 TO ANSWER QUESTIONS 20 THROUGH 26.

20. If the pilot filed to CADZU Intersection, upon arrival he would be expected to execute the

    a. holding pattern procedure turn.
    b. straight-in ILS with no procedure turn.

21. What ILS frequency would the pilot select in the NAV-1?

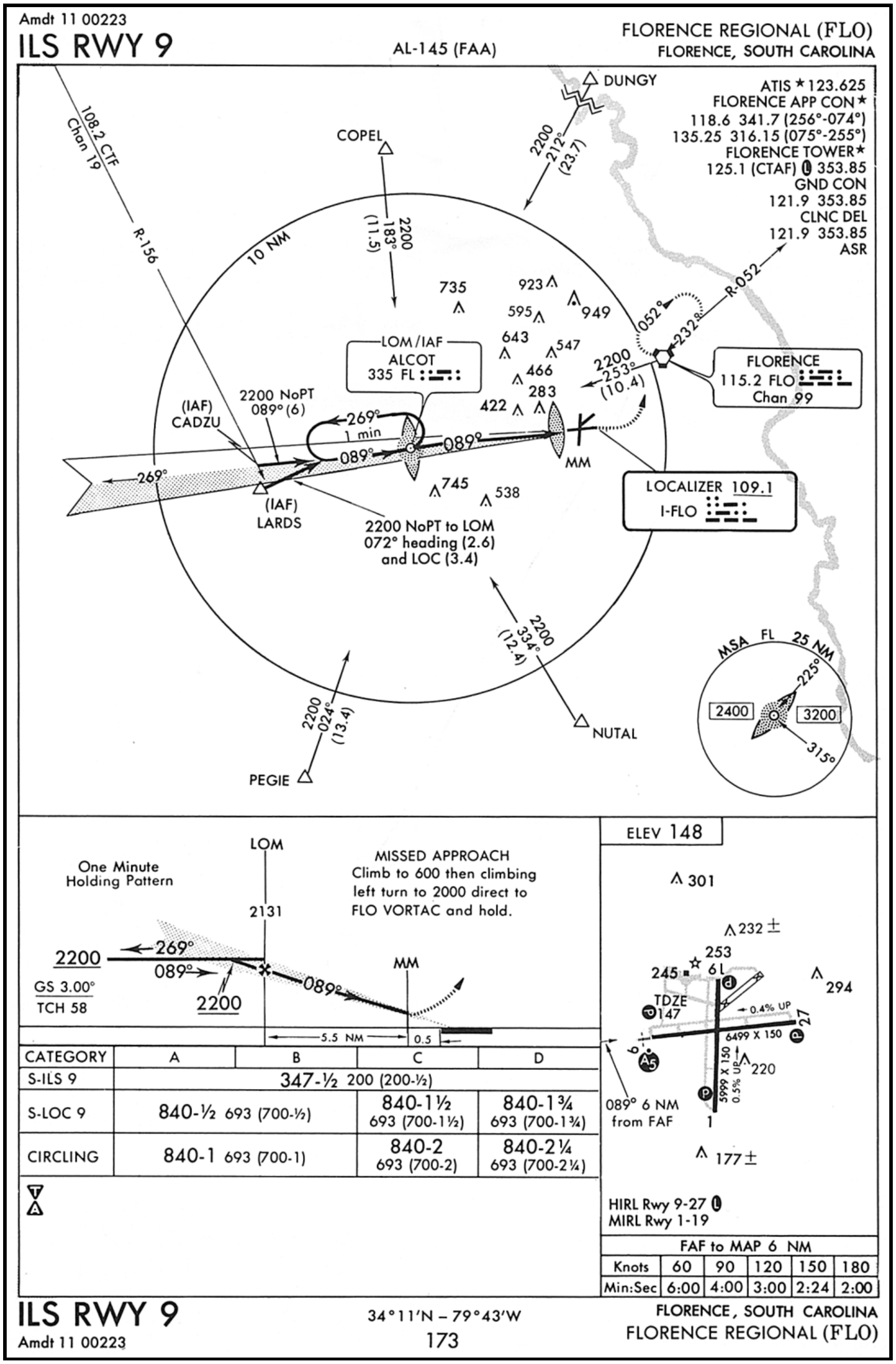
22. What frequency would the pilot select on the KR-87 (ADF) to receive the compass locator?

23. What is the glideslope angle on this approach?

24. To execute the missed approach procedure, the pilot must select the VORTAC on NAV-1.

25. The TH-57C pilot's decision height for this ILS approach is

26. What would your BAR ALT read upon crossing the threshold?

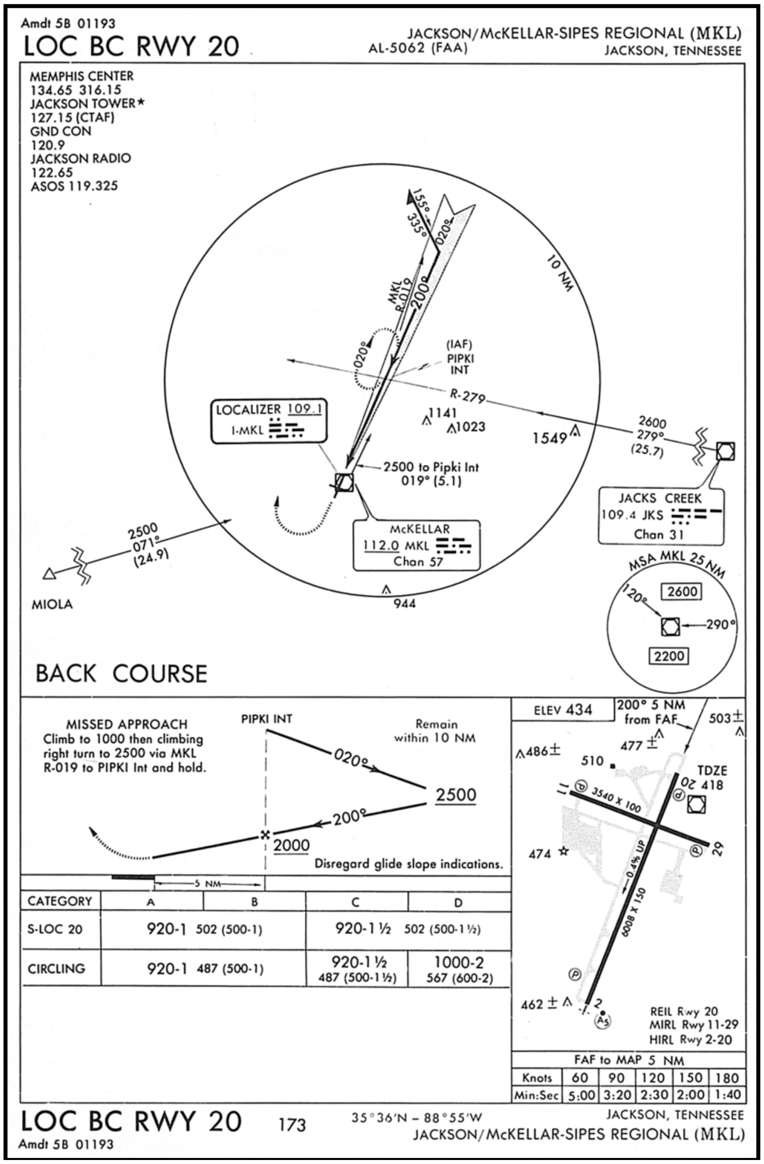


CATEGORY	A	B	C	D
S-ILS 9	347-½ 200 (200-½)			
S-LOC 9	840-½ 693 (700-½)		840-1½ 693 (700-1½)	840-1¾ 693 (700-1¾)
CIRCLING	840-1 693 (700-1)		840-2 693 (700-2)	840-2¼ 693 (700-2¼)

FAF to MAP 6 NM					
Knots	60	90	120	150	180
Min:Sec	6:00	4:00	3:00	2:24	2:00

Figure 5-20 ILS RWY 9

USE FIGURE 5-21 TO ANSWER QUESTIONS 27 THROUGH 30.



CATEGORY	A	B	C	D
S-LOC 20	920-1 502 (500-1)		920-1½ 502 (500-1½)	
CIRCLING	920-1 487 (500-1)		920-1½ 487 (500-1½)	1000-2 567 (600-2)

FAF to MAP 5 NM					
Knots	60	90	120	150	180
Min:Sec	5:00	3:20	2:30	2:00	1:40

Figure 5-21 LOC BC RWY 20

27. The IAF for this approach is _______________.

28. The 45-degree procedure turn is mandatory on this approach.____________(True/False)

29. If the duty runway is 29, the TH-57C pilot's MDA is _______________.

30. The pilot identifies the MAP by ____.

USE FIGURE 5-22 TO ANSWER QUESTIONS 31 TO 35.

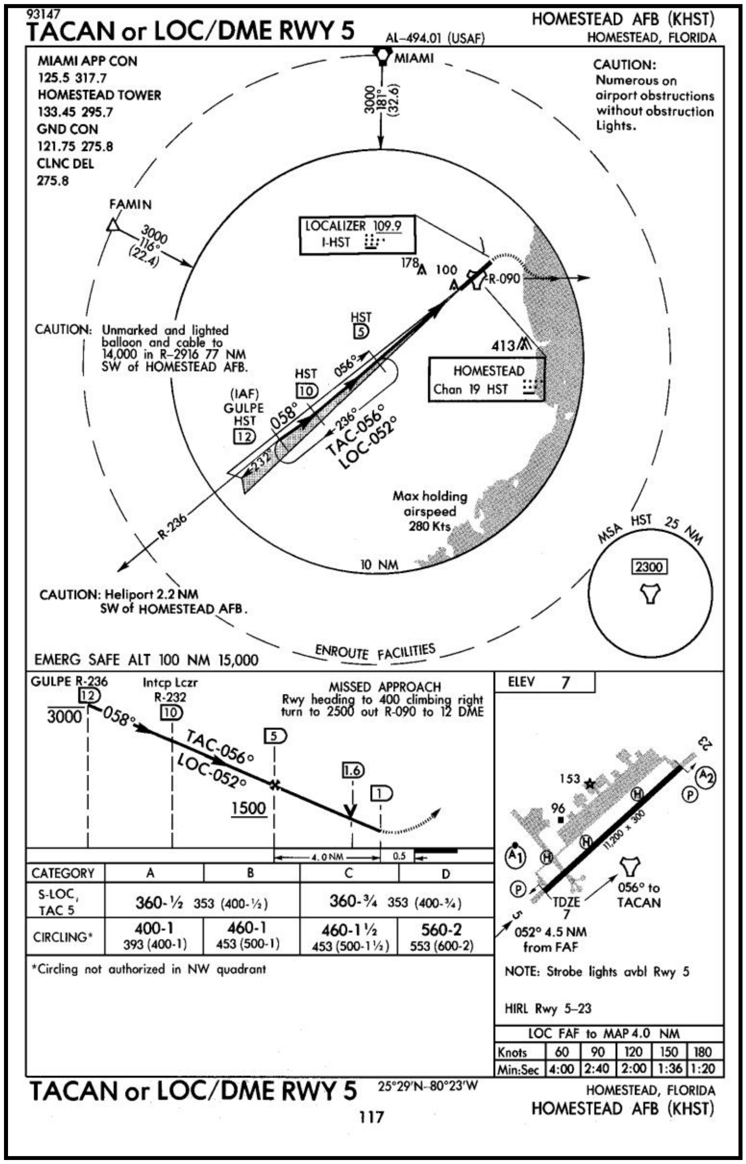


Figure 5-22 TACAN or LOC/DME RWY 5

31. Can the TH-57C shoot the LOC/DME approach? _______________

32. The IAF on this approach is _______________.

33. When are you clear to descend below MDA when flying VMC? _____________________

34. The FAF is identified as _______________ when flying a TH-57C.

35. The pilot would execute the missed approach upon reaching _______________.

REVIEW ANSWERS

1. Instrument Landing System
2. True
3. glideslope . . . course
4. 108.1 . . . 111.9 . . . course
5. 329.15 . . . 335.0
6. 75 . . . 4-7
7. middle
8. 190 . . . 535
9. 200 . . . 1800
10. 100 . . . 1200
11. False
12. True
13. True
14. glideslope pointer . . . lateral deviation bar
15. toward
16. d.
17. a.
18. decision height
19. timing
20. b.
21. 109.1
22. 335 KHz
23. 3.0º
24. Florence
25. 347 feet
26. 205 feet
27. PIPKI Int.
28. True
29. 920 feet
30. timing from the FAF (PIPKI Int.)
31. No, Localizer frequency and DME channel are not paired. TH-57 cannot tune both navaids required.
32. Gulpe
33. at the visual descent point
34. 5 DME from HST
35. 1 DME from HST

CHAPTER SIX
ADF/NDB PROCEDURES

600. INTRODUCTION

This chapter will introduce the student to the characteristics and procedures of Nondirectional Beacon (NDB).

601. LESSON TOPIC LEARNING OBJECTIVES

Terminal Objective

Upon completion of this chapter, the student will be able to state the use of nondirectional radio beacons, ADF procedures, and the TH-57C helicopter direction finding equipment by responding to questions on the post test with a minimum score of 80%.

Enabling Objectives

1. State the following characteristics common to all nondirectional radio beacons.

2. Method of signal propagation.

3. Accuracy of azimuth derived from nondirectional radio beacons as compared to that derived from other navigational aids.

4. Normal navigational uses.

5. Compatibility with voice transmissions.

6. State the following characteristics peculiar to LF/MF nondirectional beacons.

7. Frequency range.

8. Maximum reception range.

9. Susceptibility to atmospheric interference.

10. Normal uses.

11. List the power output and operational range of NDBs by radio class code.

12. List ADF procedures.

13. State the characteristics and function of the loop antenna.

14. Define the terms.

15. ADF.

16. Null.

17. Dip Error.

18. Identify and list the functions of the controls of the KR-87 ADF radio.

19. State the type of bearing information presented by the needle when the RMI operates properly and when the RMI malfunctions.

20. Define the terms "course to" and "bearing from" as they apply to direction finding navigation.

21. Name the FAA facilities which provide VHF/DF services.

22. List the uses of UHF NDBs.

23. List the primary function of the radar beacon system.

24. List the uses of NDBs.

25. List the frequency range of LF/MF NDBs.

26. List the characteristics and uses of NDBs as identified by the "Radio Class Code."

602. ADF/NDB

The group of navigational aids referred to collectively as nondirectional beacons transmits a continuous carrier wave signal, which is radiated equally around the station. Unlike VOR or TACAN stations, the signals transmitted by these stations have no directional properties themselves; thus the name "nondirectional beacon" or NDB. The azimuth information presented by the NDB is relative to the ***nose of the aircraft***, unlike VOR or TACAN, which presents its information as a magnetic radial from the station.

Because of the nondirectional characteristics of their signals and other factors discussed later, azimuth information derived from an NDB is generally less accurate than information derived from a VOR or TACAN.

Aircraft need not be capable of navigating via NDB to fly within most of the contiguous United States Victor or Jet Route system. They serve as terminal approach NAVAIDs and additional means of identifying certain airways and approach fixes. These NDBs transmit a three-letter identifier continuously. It should be noted that when an NDB is used for an approach, the associated landing minimums will normally be higher than those for other types of NAVAIDs.

Low- or medium-frequency radio beacons transmit in the frequency band of 190 to 535 KHz. They transmit a continuous wave which can carry voice transmissions. Radio beacons are employed as additional NAVAIDs and fixes by which the pilot of an aircraft equipped with a Radio Compass receiver (e.g., KR-87) can determine his bearing and "home" to the station.

The power output of the facility, atmospheric conditions (thunderstorms, precipitation, and time of day), the surface over which the signal travels, and the sensitivity of the aircraft's receiver combine to determine the reception range of LF/MF NDB signals. Under ideal conditions, LF/MF NDB signals can be received from several hundred miles away, but the directional accuracy of signals at these ranges is very susceptible to atmospheric interference. In the vicinity of thunderstorms, LF/MF NDB signals may become totally unreliable.

Although they may sometimes be received from several hundred miles away, the power output and generally accepted ranges of the various classifications of LF/MF NDBs are as follows:

Radio Class Code	Power Output	Operational Range
HH	2000 watts or more	75 NM
H	50 to 2000 watts	50 NM
MH	50 watts or less	25 NM

This information is presented, for your reference, in the front of the IFR Supplement, in the table labeled ***Radio Class Code***.

The distances listed in the preceding paragraph should not be misconstrued to mean maximum reception ranges. These NAVAIDs are not limited to line-of-sight.

It is not expected that pilots carefully commit to memory the power output and the operational distance of the various class radio beacons. A general knowledge, however, will preclude the frustrating experience of trying to tune and receive a radio beacon classed as MH at, say, a distance of 100 miles.

Many instrument approach procedures listed in the FLIP Terminal use LF radio beacons. These are termed NDB approaches.

When a radio beacon is used together with an ILS, it is called a Compass Locator.

All radio beacons, except the Compass Locators, transmit a ***continuous*** three-letter identification in Morse code. (The identification of Compass Locators will be a two-letter Morse code group.)

If continuous automatic transcribed weather broadcast is available on a radio beacon frequency, the symbol AB will follow the appropriate "Radio Class" designator; e.g., NDB (MHAB) (Nondirectional beacon, less than 50 watts, 25 NM range with transcribed weather broadcast).

If voice is not available on a radio beacon frequency, the symbol W will follow the "Radio Class" designator; e.g., NDB (HW).

To navigate by either LF/MF or UHF/NDB, the aircraft must be equipped with some type of direction finding equipment (DF). Most Navy aircraft now have Automatic Direction Finding (ADF) equipment installed on board. This equipment automatically determines the bearing to any selected radio station within its frequency and sensitivity range. This equipment may also be used as an auxiliary receiver for weather or lost communications information.

The operation of DF or ADF equipment depends chiefly on the characteristics of a loop antenna. A loop-receiving antenna gives maximum reception when the plane of the loop is parallel to (in line with) the direction of wave travel. As the loop is rotated from this position, volume gradually decreases and reaches a minimum when the plane of the loop is perpendicular to the direction of wave travel.

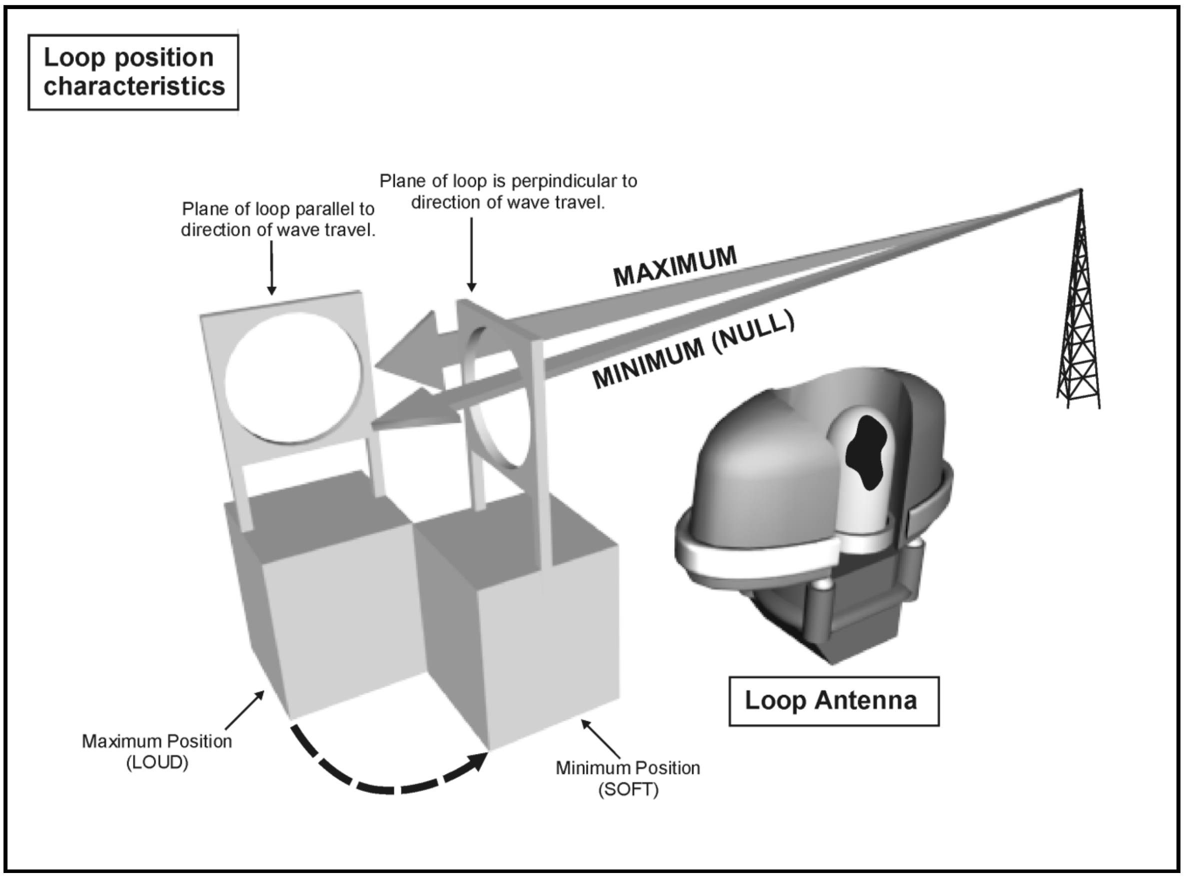


Figure 6-1 Loop Antenna

These characteristics occur in a loop antenna because the receiver input from a loop antenna is the resultant of opposing voltages in the two halves of the loop. When current flows in a looped conductor, it flows in opposite directions in each half of the loop. This occurs when the plane of the loop is in line with the station. Because one side of the loop is closer to the station, there is a slight delay between the time the signal reaches the closer side and when it reaches the farther one. This creates a phase difference between the voltages induced in each half of the loop. This causes a resultant current flow through the transformer, which creates a signal input to the receiver. As the antenna is turned perpendicular to the wave flow, this phase differential is reduced, thereby reducing the signal to the receiver, and reducing the volume. When the loop antenna is exactly perpendicular to the station, the induced voltage is theoretically zero, and the receiver strength is at a minimum. This position of the antenna is called the NULL position.

The null position of the loop antenna, rather than the maximum position, is used for direction finding; that is, a bearing is obtained when the plane of the loop is perpendicular to the line on which the radio waves are traveling when they strike the antenna. The null position is preferred because it can be determined more accurately than the maximum. A 25° rotation away from the maximum position causes a signal strength reduction of about 10%, while a 25° rotation away from the null position causes a 50% change in the signal strength.

With the loop antenna rotated to the null position, the radio station being received is on a line perpendicular to the plane of the loop. However, this still leaves two possible directions, 180° apart from each other. The inability of the loop antenna to determine which of the two possible directions is correct is called the 180° ambiguity of the loop. This 180° ambiguity is eliminated with a sensing antenna, when automatic direction finding equipment is used.

The loop antenna of the radio compass is automatically rotated to the null position when signals are being received over both the sensing and loop antennas, providing you have selected automatic direction finding as your mode of operation. The combination of signals energizes a phasing system which operates a motor attached to the loop antenna. Anytime the loop antenna is turned away from the null position, the phasing system activates the motor to return the loop to the null position. The bearing pointer on the RMI is electrically synchronized and turned with the loop, thus indicating the direction from which the radio waves are coming.

When using ADF equipment, the loop antenna is automatically positioned to the null position. However, the antenna can only rotate about the vertical axis (in relation to the aircraft), and cannot tilt. Anytime the antenna is tilted, as when the aircraft is banked, the loop is tilted away from the null, and the motor is not capable of correcting for this error. This is called "dip error," and is present anytime the aircraft is not in level flight. The magnitude of this error depends upon the position of the aircraft from the station, altitude, range from the station, and the angle of bank used. "Dip error" is most noticeable when the aircraft is banked and the station is on the nose or tail. ***The ADF bearings should be considered accurate only when the aircraft is in level flight.***

In the TH-57C, the KR-87 is the radio receiver for LF/MF reception. It is capable of receiving signals in the frequency range of 200-1799 KHz. This allows the pilot to select LF/MF NDBs and commercial broadcast stations (550-1700 KHz). It should be noted that commercial broadcast stations are not under FAA jurisdiction nor are they part of the airway system. They do not necessarily operate continuously, their signals are often highly directional, and the station does not identify itself often enough for airborne use. Even though not compatible with IFR operations, commercial stations can be used as a backup NAVAID, especially with flying off airways.

603. LF AUTOMATIC DIRECTION FINDER KR-87

Automatic direction finder set KR-87 is an airborne low frequency radio compass which provides bearing information and audio information in the 200-1799 kHz range. This receiver enables the pilot to identify stations and listen to transcribed weather broadcasts or commercial radio stations in the AM broadcast band. It may also be used for aircraft homing and position fixing. Control is accomplished from the ADF control panel mounted on the pedestal. Navigational information received on the KR-87 is displayed by the selected ADF needle on the RMI. Power to the KR-87 ADF is supplied from the #1 essential bus.

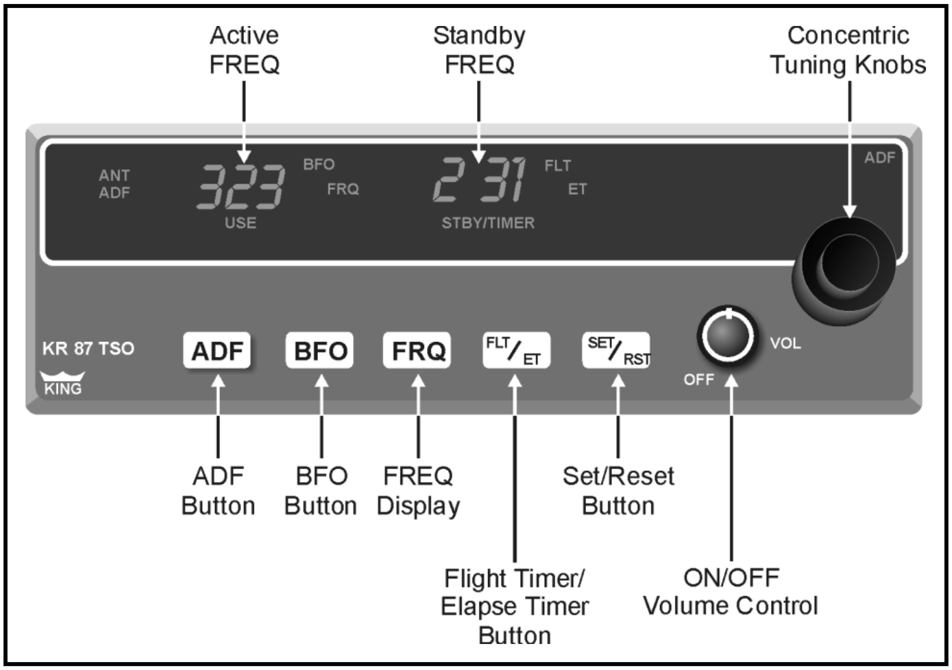


Figure 6-2 KR-87 Automatic Direction Finder

The KR-87 Automatic Direction Finder has two operational modes. In the ANT (Antenna) mode (ADF button out) the loop antenna is disabled, and the unit simply acts as a receiver, allowing audio reception through the headphones. The indicator needle selected for ADF use will remain parked at the 90° relative position and the "ANT" message on the left side of the display will be lighted. This mode provides slightly clearer audio reception, and is used for station identification. In various parts of the world, some LF/MF stations use an interrupted carrier for identification purposes. A Beat Frequency Oscillator (BFO) function is provided to permit these stations to be more easily identified. Pushing the BFO switch will cause a 1000-Hz tone to be heard whenever there is a radio carrier signal present at the selected frequency. It will also light the "BFO" message in the center of the display.

With the ADF button depressed, the unit is placed into the ADF mode and the loop antenna is enabled. The "ADF" message on the left side of the display will be lighted and the indicator needle will point to the relative bearing of the selected station. To tell if there is a sufficient signal for navigational purposes, the pilot should place the KR-87 back into the ANT mode, parking the indicator needle at 090°. When the unit is then switched to the ADF mode, the needle should point to the station bearing in a positive manner, without excessive sluggishness, wavering, or reversals.

The standby frequency is displayed in the right-hand window when the "FRQ" message is lit in the center of the display. This frequency may be changed with the concentric knobs. To set the "tens" digit, push the small inner knob and rotate it. Clockwise rotation increases the digit; counterclockwise rotation decreases the digit. The digit will roll over at 9 to 0 as the digit is increased and roll under at 0 to 9 as the digit decreases. With the small knob pulled out, the "ones" digit may be set.

Turning the large knob changes the "hundreds" digit and the "thousands" digit. The "hundreds" digit carries to the "thousands" digit from 9 to 10. The two digits roll over from 17 to 02 and under from 02 to 17, thus limiting the frequencies to the range of 200 kHz to 1799 kHz.

The active frequency is displayed in the left-hand window. This frequency may be changed in two ways. First, it may be changed with the concentric knobs when either time mode (FLT or ET) is being displayed in the right-hand window. The exception to this is when the "ET" message is flashing. Second, pressing the "FRQ" button when the standby frequency is being displayed causes the current standby and active frequencies to be exchanged.

The "FLT/ET" button serves two functions. If elapsed time ("ET") is currently displayed, pressing the "FLT/ET" button will cause the flight timer to be displayed. Pressing this button again will exchange the two timers in the display. If the standby frequency is displayed, pressing the "FLT/ET" button will cause the time which was last displayed to reappear in the window.

The flight timer is displayed in the right-hand window when the "FLT" message is lit. This timer will count up to 59 hours, 59 minutes, 59 seconds. When the unit is first turned on, this timer is automatically started at 0. Minutes and seconds will be displayed until a value of 59 minutes and 59 seconds is reached. On the next count, the display will shift to hours and minutes. The flight timer is reset to 0 only when the unit is turned off.

The elapsed timer has two modes: count up and count down. When power is applied it is in the count up mode starting on 0. As is true with the flight timer, the elapsed timer will count to 59 hours, 59 minutes, 59 seconds displaying minutes and seconds until one hour has elapsed, then displaying hours and minutes. When in the count up mode the timer may be reset to 0 by pressing the reset button.

NOTE

> Pressing the reset button will reset the elapsed timer regardless of what is currently being displayed.

To enter the countdown mode, the "Reset" button is held depressed for approximately 2 seconds until the "ET" message begins to flash. While the "ET" message is flashing, the timer is set in the ET Set mode. In this mode a number up to 59 minutes, 59 seconds, may be preset into the elapsed timer with the concentric knobs. The timer will remain in the ET Set mode for 15 seconds after a number is set in or until the "Reset," "FLT/ET," or "FRQ" button is pressed. The number preset will remain unchanged until the "Reset" button is pressed.

The timer will start when the "Reset" button is pressed. When the timer reaches 0 it changes to the count up mode and continues up from 0.

Automatic direction finding with the KR-87 is accomplished by tuning in the desired station and identifying it. The needle you have selected on your RMI to display the ADF information will home in on the station. The head of the needle always points toward the station, giving the course to the station, and the tail gives the bearing from the station. FAA controllers will use the phrase "course to" to denote a line of position (LOP) inbound to an NDB. They will also use the phrase "bearing from" to signify a line of position outbound from an NDB. The term "radial" ***shall not*** be used in a clearance relative to an NDB.

The compass card of the RMI rotates, so that aircraft heading is at the top of the card at all times if the RMI is functioning properly. The ADF needle (which moves independently in relation to the compass card) provides relative bearing/course all the time, and magnetic bearing/course anytime the compass card is working. The primary indication of the ADF needle is ***RELATIVE*** bearing/course.

Assuming normal operation of the RMI, the aircraft's heading will always be indicated beneath the heading index at the top of the RMI. This is the actual magnetic heading, regardless of which bearing or course the aircraft is on. Thus, an aircraft could be on the 270 bearing from a station, but heading 360. In a short time he will not be on the 270 bearing, as he is moving northward, toward the 280 bearing from the station. The RMI, however, only indicates the aircraft's present location and heading (Figure 6-3).

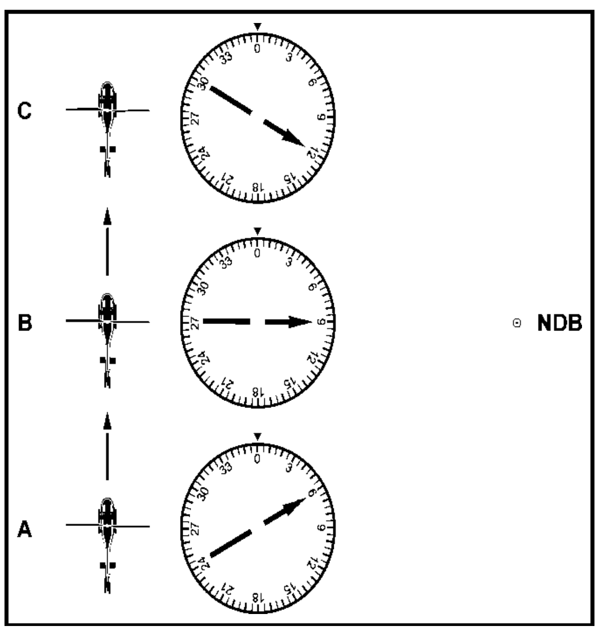


Figure 6-3 ADF Needle

Since the ADF needle provides relative bearings, the actions of the compass card do not affect it. If the needle is 30° left of the nose of the aircraft (top of the RMI), then so is the station. It is just not necessary to know the magnetic heading to fly to get to the station; you just turn the aircraft until the ADF needle is on the nose and you will eventually arrive at the station. This procedure is known as HOMING.

If the compass card is functioning properly, then the ADF needle will also indicate the magnetic bearing to the station. Thus, if the head of the ADF needle is on 080, and you are heading 100, the needle is 20° left of the nose. You must turn left 20° to a magnetic heading of 080 to go to the station. To track a bearing to the station in a no-wind situation, you just keep the needle on the nose of the aircraft, just like homing. If there is a crosswind, you must apply a crosswind correction, or crab angle, to keep the aircraft on the desired bearing. The procedures are similar to those used for VOR or TACAN tracking, except that you do not have a course deviation indicator.

Since the ADF is for backup use, you will mainly use it for an occasional approach, or to assist in identifying a fix. This chapter will not discuss the NDB approach in depth, but will deal with the other uses of the direction finding equipment, such as identifying fixes. One common example of fix identification is when you are flying on an airway and need to locate an intersection. Since the TH-57C has TACAN, which includes DME, the normal procedure to identify an intersection is to locate it with TACAN radial and DME. If DME fails, you could use any LF/MF or commercial station that is nearby to give you a cross-bearing, showing your exact position (Figure 6-4).

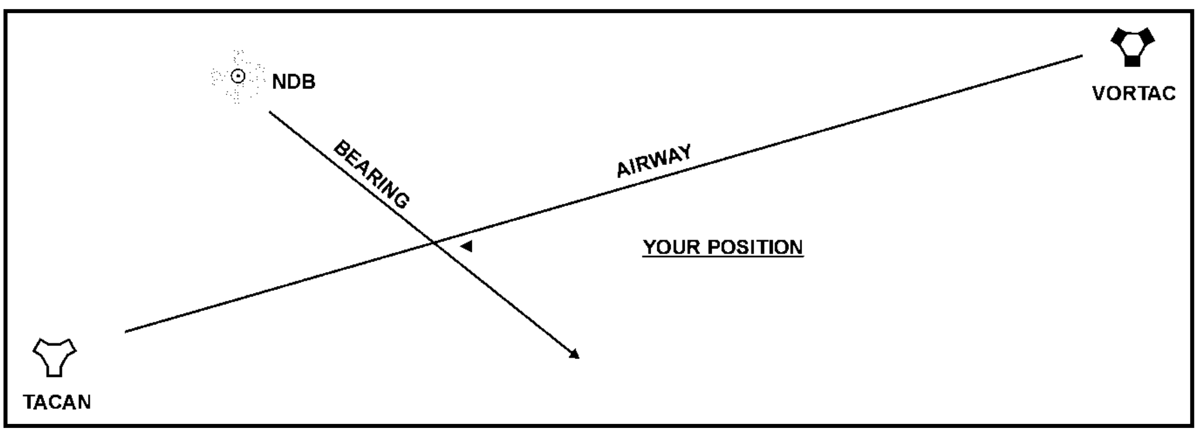


Figure 6-4 Identify Position

In addition to locating the intersection, the NDB would help you keep track of your position along the airway. Since you would keep yourself on the airway with the TACAN and CDI, the airway would constitute one line of position. Your bearing from the NDB would be the other LOP. Where the two LOPs cross is your position.

The aircraft's geographical position in relation to the station can be readily visualized if you use the RMI as a chart. On this chart, the station is always located at the center of the RMI. The airplane is always located on the tail of the ADF needle (bearing from) and the head of the needle indicates the course to the station. The various bearings "from" and courses "to" are also listed by the compass rose around the edge of the RMI.

Thus, if you were in the position indicated in Figure 6-4, and wanted to get to the 160 bearing from the NDB, you could do it three ways. First, you could turn right to intercept the 160 bearing from the station. Second, you could continue on the airway and, upon reaching the 160 bearing, execute an immediate right turn to intercept. Third, you could arc around the station to the proper bearing. The method you choose will normally depend upon how far away from the station you are and which new bearing you plan to intercept.

ADF flight procedures for interception of bearings and courses, tracking, homing, holding, and approaches using NDB facilities will be presented by the squadron FTI procedures.

604. VHF/DIRECTION FINDER

The VHF Direction Finder (VHF/DF) is a ground-based radio receiver used by the operator of the ground station where it is located.

The equipment consists of a VHF receiver and a directional antenna system that feeds into a cathode-ray tube. At a radar-equipped tower or center, the cathode-ray tube indications may be superimposed on the radarscope.

The VHF/DF display indicates the magnetic direction of the aircraft from the station each time the aircraft transmits. Where DF equipment is tied into radar, a strobe of light is flashed from the center of the radarscope in the direction of the transmitting aircraft.

DF equipment is of particular value in locating lost aircraft and in helping to identify aircraft on radar.

VHF/DF services are readily available at selected civil aerodromes and FSS which have the ground direction finding equipment. These aerodromes and flight service stations, listed in the IFR Supplement, have VHF/DF listed under Radio Aids to Navigation.

If time permits, pilots should note any restrictions on the use of VHF/DF such as time of operation, unreliability in certain quadrants, and use of frequencies. As a general rule, however, VHF/DF is immediately available for operation when IFR conditions exist during normal working hours of the station and on 5 minute notice at all other times when the tower is manned. DF coverage is sparse, particularly away from the Atlantic and Pacific coasts. If in doubt about the location or availability of DF service, transmit your request to any ground station (FSS, tower, etc.), which in turn will relay it to an appropriate DF facility.

Because of the fact that VHF is dependent upon direct waves, the effective range is limited to line-of-sight. This means the effective range of the equipment is directly related to the altitude of the aircraft. Assuming no intervening physical obstructions, the average maximum effective range is 100 miles, although greater distances can be obtained, depending on the signal strength of the aircraft's transmitter.

The three types of information that DF stations can provide ***are courses***, ***bearings***, and ***fixes***.

1. The principal use of DF is to provide the pilot a course to steer. A "course" (or "steer") is that magnetic direction in which the aircraft making the request must initially steer to reach the DF station, assuming zero wind.

2. Bearing information will be offered only if the pilot requests it. The DF bearing is the ***true*** bearing of the aircraft ***from*** the DF station.

Fix information can be obtained by having two or more DF stations take simultaneous bearings from a transmitting aircraft. A single DF station cannot fix an aircraft's position, because only azimuth information can be obtained from the equipment; i.e., the distance of the aircraft is unknown. Because of the limited range of VHF/DF equipment and because of the separation between stations, it is seldom possible to obtain a fix except when circumstances are favorable. When obtainable, the fix will usually be stated in miles and magnetic direction from a NAVAID, some prominent surface landmark, or geographical coordinates. A DF net is a network of several DF stations, which has a coordination center with a plotting board to obtain a fix. ARTCCs act as the net control centers, and during DF problems they will exercise control over individual DF stations for verifying and correlating data and maintaining accurate flight advisory (weather, airfield data, etc.) information for the pilot. To obtain ***practice*** position fixes, simply request the DF station to have the FAA DF net give you a fix.

605. LOST AIRCRAFT PROCEDURE

If you are lost, don't hesitate to admit it. If an emergency exists, the pilot should so indicate in his initial transmission, requesting an "EMERGENCY STEER." (Switch the IFF/SIF to the emergency setting so that any nearby ground radar stations can be alerted to render aid as well.) The aircraft can be guided to a point directly over the DF site. If the aircraft is in IFR conditions and unable to execute a standard instrument approach, letdown transmissions will be provided directing the pilot to start descent, to establish aircraft on outbound track, to report starting procedure turn, to report reaching minimum safe altitude and/or when able to continue VFR, and to execute missed approach if he has not reported airport in sight and/or able to continue VFR after reaching minimum altitude.

The following example is typical of the voice procedure used for a DF steer.

1. Pilot calls control tower or any other applicable station such as FSS:

> "(AIRPORT) TOWER, THIS IS (AIRCRAFT), REQUEST EMERGENCY STEER, OVER."

2. Station answers:

> "(AIRCRAFT), THIS IS (AIRPORT) TOWER, TRANSMIT SHORT COUNT FOR STEER, OVER."

Some stations may request either a short or long voice count. Some stations may request the pilot give a 10-20-second "ah-h-h-h." Other stations may direct the pilot to transmit by depressing the microphone button for 10 to 20 seconds. In any case, simply follow instructions.

3. Pilot replies:

   "(AIRCRAFT), ONE-TWO-THREE-FOUR-FIVE-FOUR-THREE-TWO-ONE, THIS IS (AIRCRAFT), OVER."

4. Station answers:

   "(AIRCRAFT), STEER 180, OVER."

5. Pilot acknowledges.

606. NDB (UHF)

Most military fields have a unique NAVAID - a UHF radio beacon, which is not found at civil airports or on the federal airway system. In fact, one of the requirements for a Navy field to be designated an "All-Weather Station" is to have a UHF radio beacon. These NAVAIDs transmit in the band 275 to 287 MHz.

UHF radio beacons were developed specifically for use with an ARA-25 homing adapter. These NAVAIDs have certain distinct advantages over the low-frequency radio beacons in that tuning is crystal-controlled, reception is static-free, and bearings will not fluctuate during poor atmospheric conditions. Approaches, termed NDB (UHF), have been promulgated and are included in the FLIP Terminal with other standard instrument approaches. While using an ARA-25 with these NAVAIDs, the pilot should employ regular ADF principles previously learned. ***The TH-57C is not equipped for NDB (UHF) approaches***.

REVIEW QUESTIONS

1. The KR-87 is capable of receiving transmission from both FAA and commercial broadcast stations. ____________ (True/False)

2. The ADF needle provides the following information regardless of whether the compass card is functioning or not.

   a. Magnetic course to the NDB
   b. Relative course to the NDB
   c. Magnetic radial
   d. Relative radial

3. An NDB provides more precise information about your position than a VOR radial. ____________ (True/False)

4. LF NDBs generally are used for which of the following?

   a. Low altitude (Victor) airway navigation over land
   b. High altitude Jet Route navigation over land
   c. Approaches
   d. Confirming DME Fixes

5. LF NDBs cannot transmit voice information ____________ (True/False)

6. The frequency range of the LF NDBs is

   a. 108.0 - 117.9.
   b. 970 - 1700.
   c. 190 - 535.
   d. 118.0 - 135.9.

7. For the HH NDBs (over 2,000 watts), the reception range is sometimes more than several hundred miles, but the accepted maximum range for navigation purposes of these NAVAIDs is

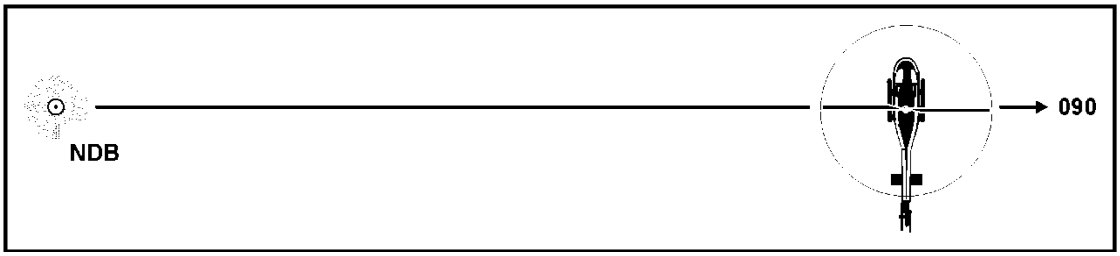
   a. 25 NM.
   b. 15 NM.
   c. 75 NM.
   d. 150 NM.

8. The primary advantage of LF NDBs is that they are not affected by thunderstorms. ____________ (True/False)

9. The primary advantage of UHF NDBs is that they are not affected by atmospheric conditions. ____________ (True/False)

10. The KR-87 and ADF needle will provide bearing information from which of the following?

a. UHF NDBs.
b. UHF tower transmissions.
c. Commercial broadcast stations.
d. VORs.

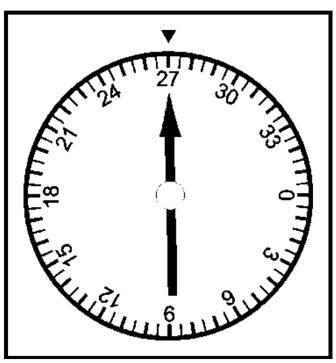


11. The aircraft pictured above is on the

a. 090 bearing to the station.
b. 090 bearing from the station.
c. 090 course to the station.
d. 090 course from the station.

12. The RMI can be used as a map if you assume the NDB is located at the center of the compass card. ____________ (True/False)

13. If the ADF needle was positioned as shown, the aircraft would have to turn to the left to intercept the 330° course to the station. ___________ (True/False)



14. If the RMI card commences to spin (malfunction), the ADF needle will spin with the card, and will continue to provide accurate magnetic course to the station information. ____________ (True/False)

15. The ADF needle displays accurate information when the aircraft is in a turn. ____________ (True/False)

16. All NDBs except ____________ transmit a continuous three-letter identifier in code except during ____________.

17. A class (MH) NDB should not be used farther than ________ NM.

18. In what meteorological conditions should the KR-87 radio be considered unreliable? ______________________________________

19. What does the "W" designation mean when associated with the class code of an NDB? ____________________________________

20. Pilot tunes the ADF when the "ADF" button is in the ________ mode.

21. The timers associated with the ADF are the ____________ timer and the ____________ timer.

22. A radio beacon classed as ABHH has voice on the NAVAID frequency ____________ (True/False)

23. A radio beacon classed as MHW has scheduled weather broadcasts. ____________ (True/False)

24. A radio beacon classed as HSAB broadcasts weather twice each hour - at 15 and 45 minutes past the hour. ____________ (True/False)

25. All radio beacons transmit a coded identifier once every 30 seconds. ____________ (True/False)

26. Which one of the following low-frequency (LF) radio beacons has the greatest power output?

a. HH.
b. L.
c. H.
d. MH.

27. Which one of the following LF radio beacons has the shortest reception range?

a. HH.
b. L.
c. H.
d. MH.

28. Which of the following LF radio beacons is used with an Instrument Landing System (ILS)?

a. HH.
b. L.
c. H.
d. MH.

29. The publication listing the availability of VHF/DF at an aerodrome is the FLIP Enroute Supplement. ____________ (True/False)

30. With an unobstructed line-of-sight and ample aircraft altitude, the average maximum effective range of VHF/DF equipment is 100 miles. ____________ (True/False)

31. A "steer" is the magnetic heading to fly (no-wind) to reach the DF station. ____________ (True/False)

32. A "bearing" is the magnetic course to the DF station and will be given without the pilot's request. ____________ (True/False)

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REVIEW ANSWERS

1. True
2. b.
3. False
4. c.
5. False
6. c.
7. c.
8. False
9. True
10. c.
11. b.
12. True
13. True
14. False
15. False
16. compass locator . . . scheduled weather broadcasts and voice transmissions
17. 25
18. Around thunderstorm and lightning activity
19. No voice capability
20. antenna
21. flight . . . elapsed
22. True
23. False
24. False
25. False
26. a.
27. b.
28. b.
29. True
30. True
31. True
32. False

CHAPTER SEVEN
GLOBAL POSITIONING SYSTEM

700. INTRODUCTION

Prior to conducting any GPS approach training it is essential the student be thoroughly familiar with the components and operation of the KLN-900 system. The GPS is considered a supplemental navigation system and will not be used as a sole source of IFR navigation. Student training will only be conducted utilizing radar vectors to the final portion of a stand-alone or overlay GPS approach.

701. LESSON TOPIC LEARNING OBJECTIVES

Terminal Objective

1. Upon completion of this chapter, the student will recall elements of the GPS and state techniques and procedures as they apply to the TH-57C. To successfully complete the unit post test, the student should achieve a minimum score of 80%.

Enabling Objectives

1. Briefly describe the GPS.

2. State the horizontal accuracy of Standard Positioning Service.

3. Describe the GPS Overly Program.

4. State the requirements of filing a route which uses RNAV.

5. Describe the TAA basic "T" approach, to include the arc boundary and the three areas.

6. Describe RAIM and state its importance.

7. State the difference between conventional and GPS navigation data.

8. Identify the GPS equipment installed in the TH-57C.

9. Identify the functions of the KLN-900.

10. State the procedures for inputting a flight plan.

11. State the procedures for inputting and flying a GPS approach.

12. Describe the sensitivity of the CDI for each step of the approach.

13. Describe the CDI sensitivity and airspeed required for a DP departure.

14. State the procedures for executing a GPS missed approach.

15. State the areas of the GPS a pilot should be proficient in prior to attempting flight in IMC.

702. SYSTEM OVERVIEW

GPS is a United States satellite-based radio navigational, positioning, and time transfer system operated by the Department of Defense (DOD). The system provides highly accurate position and velocity information and precise time on a continuous global basis to an unlimited number of properly-equipped users. The system is unaffected by weather and provides a worldwide common grid reference system based on the earth-fixed coordinate system. For its earth model, GPS uses the World Geodetic System of 1984 (WGS-84) datum.

GPS provides horizontal positioning accuracy of 22 meters, and a vertical accuracy of 27.7 meters.

GPS operation is based on the concept of ranging and triangulation from a group of satellites in space which act as precise reference points. A GPS receiver measures distance from a satellite using the travel time of a radio signal. Each satellite transmits a specific code, called a course/acquisition (CA) code, which contains information on the satellite's position, the GPS system time, and the health and accuracy of the transmitted data. Knowing the speed at which the signal traveled (approximately 186,000 miles per second) and the exact broadcast time, the distance traveled by the signal can be computed from the arrival time.

The GPS receiver matches each satellite's CA code with an identical copy of the code contained in the receiver's database. By shifting its copy of the satellite's code in a matching process, and by comparing this shift with its internal clock, the receiver can calculate how long it took the signal to travel from the satellite to the receiver. The distance derived from this method of computing distance is called a pseudo-range because it is not a direct measurement of distance, but a measurement based on time. Pseudo-range is subject to several error sources; for example: ionospheric and tropospheric delays and multipath.

In addition to knowing the distance to a satellite, a receiver needs to know the satellite's exact position in space; this is known as its ephemeris. Each satellite transmits information about its exact orbital location. The GPS receiver uses this information to precisely establish the position of the satellite.

Using the calculated pseudo-range and position information supplied by the satellite, the GPS receiver mathematically determines its position by triangulation. The GPS receiver needs at least four satellites to yield a three-dimensional position (latitude, longitude, and altitude) and time solution. The GPS receiver computes navigational values such as distance and bearing to a waypoint, groundspeed, etc., by using the aircraft's known latitude/longitude and referencing these to a database built into the receiver.

The GPS constellation of 24 satellites is designed so that a minimum of five are always observable by a user anywhere on earth. The receiver uses data from a minimum of four satellites above the mask angle (the lowest angle above the horizon at which it can use a satellite).

The GPS receiver verifies the integrity (usability) of the signals received from the GPS constellation through receiver autonomous integrity monitoring (RAIM) to determine if a satellite is providing corrupted information. AT least one satellite, in addition to those required for navigation, must be in view for the receiver to perform the RAIM function; thus, RAIM needs a minimum of 5 satellites in view, or 4 satellites and a barometric altimeter (baro-aiding) to detect an integrity anomaly. For receivers capable of doing so, RAIM needs 6 satellites in view (or 5 satellites with baro-aiding) to isolate the corrupt satellite signal and remove to from the navigation solution. Baro-aiding is a method of augmenting the GPS integrity solution by using a nonsatellite input source. GPS derived altitude should not be relied upon to determine aircraft altitude since the vertical error can be quite large. To ensure baro-aiding is available, the current altimeter setting must be entered into the receiver as described in the operating manual.

RAIM messages vary somewhat between receivers; however, generally there are two types. One type indicates there are not enough satellites available to provide RAIM integrity monitoring and another type indicates the RAIM integrity monitor has detected a potential error exceeding the limit for the current phase of flight. Without RAIM capability, the pilot has no assurance of the accuracy of the GPS position.

The Department of Defense declared initial operational capability (IOC) of the U.S. GPS on December 8, 1993. The Federal Aviation Administration (FAA) has granted approval for U.S. civil operators to use properly certified GPS equipment as a primary means of navigation in oceanic airspace and certain remote areas. Properly certified GPS equipment may be used as a supplemental means of IFR navigation for domestic enroute, terminal operations, and certain instrument approach procedures (IAPs). This approval permits the use of GPS in a manner consistent with current navigation requirements as well as approved air carrier operations specifications.

703. GPS NAVIGATION PROCEDURES

Authorization to conduct any GPS operation under IFR requires that:

1. Aircraft using GPS navigation equipment under IFR must be equipped with an approved and operational alternate means of navigation appropriate to the flight. Active monitoring of alternative navigation equipment is not required if the GPS receiver uses RAIM for integrity monitoring. Active monitoring of an alternate means of navigation is required when the RAIM capability of the GPS equipment is lost.

2. Procedures must be established for use in the event that the loss of RAIM capability is predicted to occur. In situations where this is encountered, the flight must rely on other approved equipment, delay departure, or cancel the flight.

3. The GPS operation must be conducted in accordance with the FAA-approved aircraft flight manual (AFM) or flight manual supplement. Flight crewmembers must be thoroughly familiar with the particular GPS equipment installed in the aircraft, the receiver operation manual, the AFM or flight manual supplement. Unlike ILS and VOR, the basic operation, cockpit display presentation to the pilot, and capabilities of GPS equipment can vary greatly. Due to these differences, operation of different brands, or even models of the same brand, of GPS receiver under IFR should not be attempted without thorough study of the operation of that particular receiver and installation. Most receivers have a built-in simulator mode which will allow the pilot to become familiar with operation prior to attempting operation in the aircraft. Using the equipment in flight under VFR conditions prior to attempting IFR operation will allow further familiarization.

4. Prior to any GPS IFR operation, the pilot must review appropriate NOTAMs and aeronautical information. (See GPS NOTAMs/Aeronautical Information)

5. Aircraft navigating by GPS certified for IFR enroute, terminal, and approach operations can use the G(GPS) code as the TD code under the "Advanced RNAV WITH TRANSPONDER AND MODE "C" series of GP Chapter 4 on the DD 175 Flight Plan when operating in accordance with GP Chapter 4 and the Aeronautical Information Manual (AIM).

6. If radar contact is lost, RNAV aircraft may be cleared back to the airway because of the inability to maintain radar separation. If an RNAV aircraft is vectored off the planned random RNAV route, it shall be cleared direct to the next flight plan waypoint or issued a revised clearance. If, at any point, GPS avionics become inoperative, the pilot should advise ATC and amend the equipment suffix.

Use of GPS for IFR Domestic Enroute and Terminal Area Operations

GPS domestic enroute and terminal IFR operations can be conducted as soon as proper avionics systems are installed, provided all general requirements are met. The avionics necessary to receive all of the ground based facilities appropriate for the route to the destination airport and any required alternate airport must be installed and operational. Ground-based facilities necessary for these routes must also be operational.

Published RNAV routes, (T-Routes (low altitudes) and Q-Routes (high altitude)), are depicted in blue on low and high altitude charts and can be flight planned for use by aircraft with RNAV capability, subject to any limitations or requirements noted on enroute charts or by NOTAM.

The GPS Approach Overlay Program is an authorization for pilots to use GPS avionics under IFR for flying designated existing non-precision instrument approach procedures, except localizer (LOC), localizer directional aid (LDA), and simplified directional facility (SDF) procedures. Only those approaches included in the receiver database are authorized. Overlay approaches are predicated upon the design criteria of the ground-based NAVAID used as the basis of the approach. As such, they do not adhere to the design criteria described later for the stand-alone GPS approaches.

GPS IFR approach operations can be conducted as soon as proper avionics systems are installed and the following requirements are met:

1. The authorization to use GPS to fly instrument approaches is limited to U.S. airspace.

2. The use of GPS in any other airspace must be expressly authorized by the FAA Administrator.

3. GPS instrument approach operations outside the United States must be authorized by the appropriate sovereign authority.

4. Authorization to fly approaches under IFR using GPS avionics systems requires that:

    a. A pilot use GPS avionics with TSO C-129, or equivalent, authorization in class Al, B1, B3, C1, or C3; and

    b. All approach procedures to be flown must be retrievable from the current airborne navigation database supplied by the TSO C-129 equipment manufacturer or other FAA approved source.

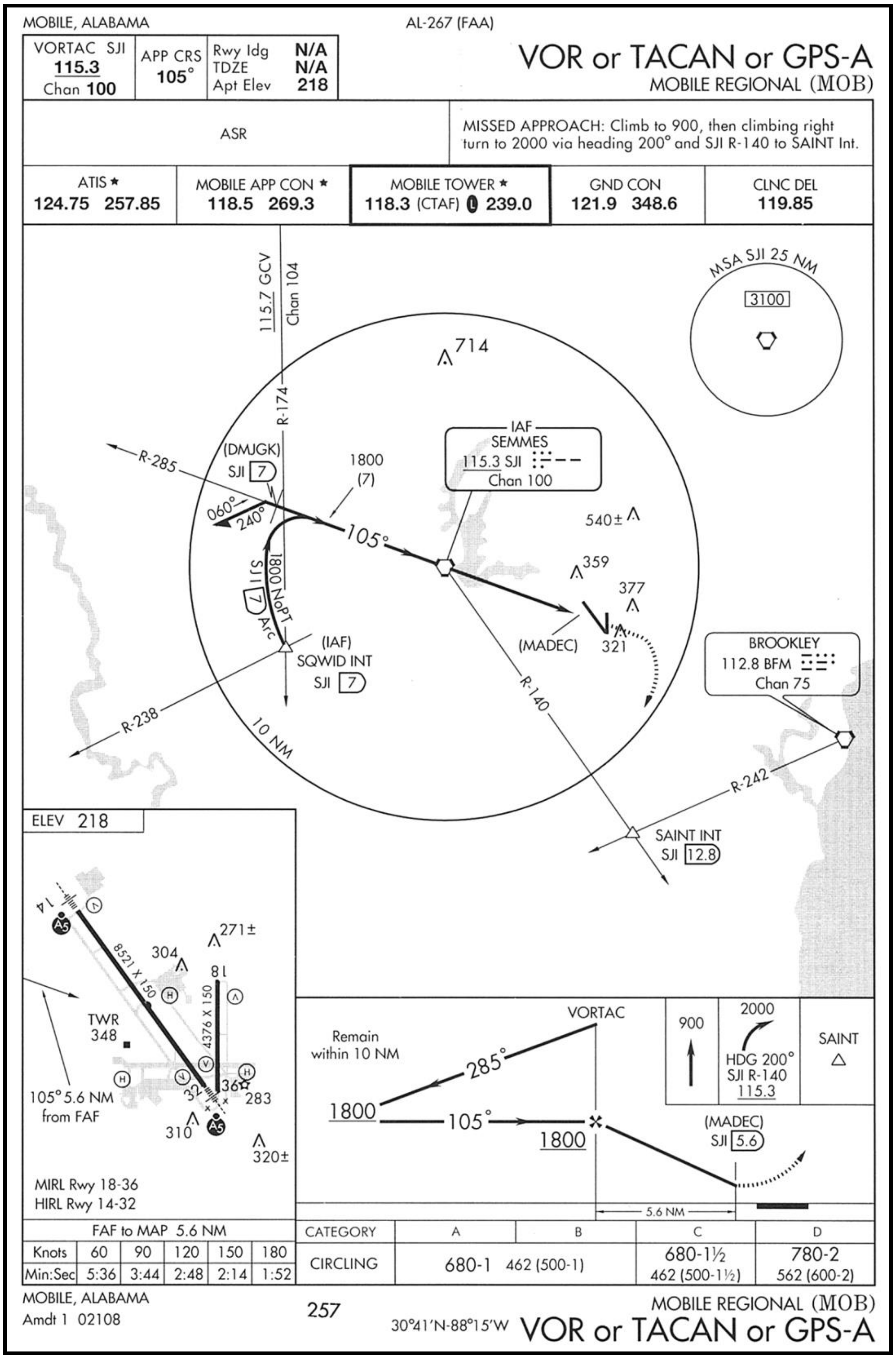
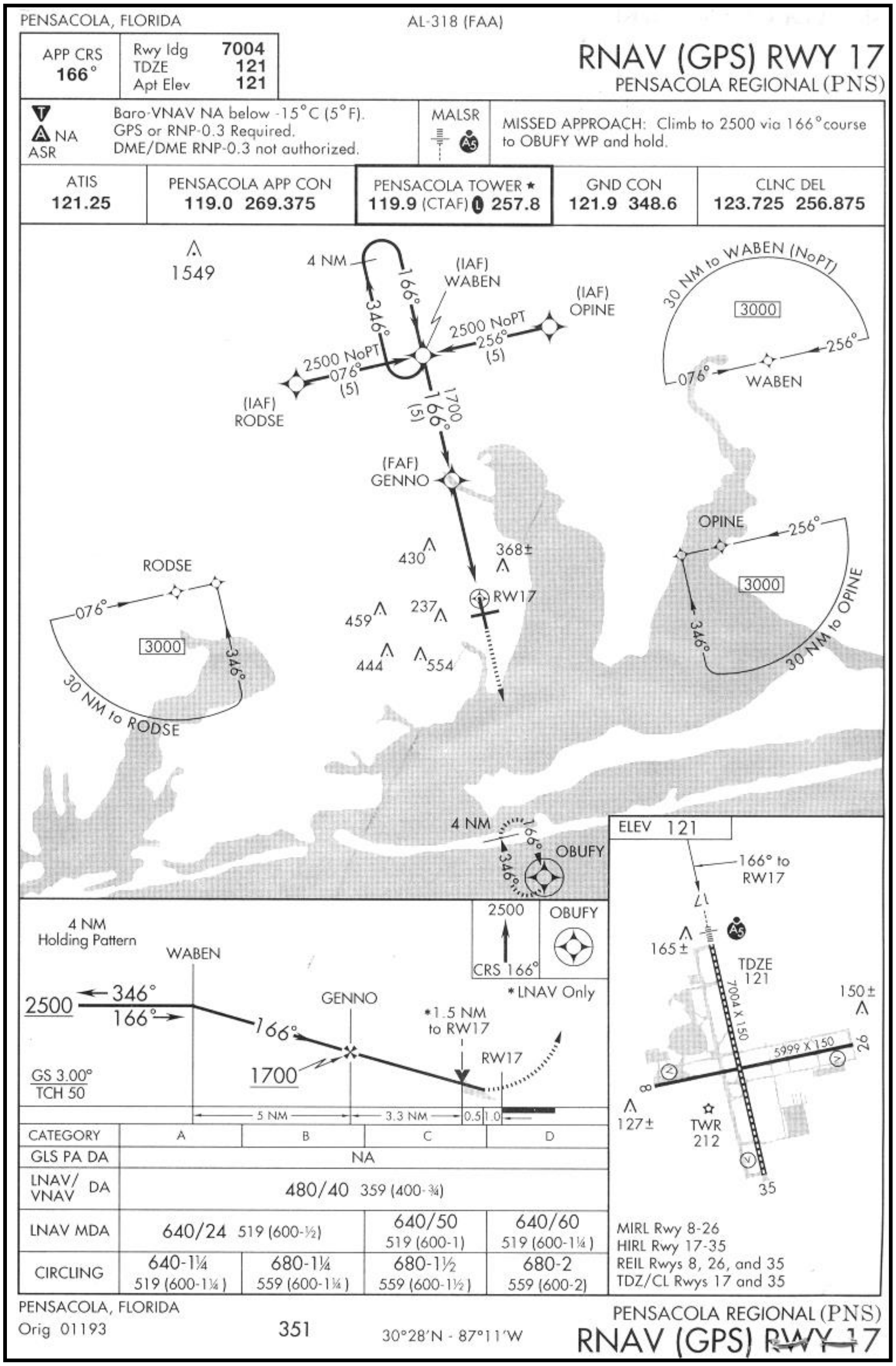


Figure 7-1 VOR or TACAN or GPS-A



CATEGORY	A	B	C	D
GLS PA DA	NA			
LNAV/VNAV DA	480/40 359 (400-¾)			
LNAV MDA	640/24 519 (600-½)		640/50 519 (600-1)	640/60 519 (600-1¼)
CIRCLING	640-1¼ 519 (600-1¼)	680-1¼ 559 (600-1¼)	680-1½ 559 (600-1½)	680-2 559 (600-2)

Figure 7-2 RNAV (GPS) RWY 17

704. GPS STANDARD INSTRUMENT APPROACH PROCEDURE (SIAP) DESIGN CONCEPTS

The objective of the Terminal Arrival Area (TAA) procedure design is to provide a new transition method for arriving aircraft equipped with FMS and/or GPS navigational equipment. The TAA contains within it a "T" structure that normally provides a NoPT for aircraft using the approach. The TAA provides the pilot and air traffic controller with a very efficient method for routing traffic from enroute to terminal structure.

The basic "T" contained in the TAA is based on the “civilian box pattern.” It normally aligns the procedure on runway centerline, with the missed approach point (MAP) located at the threshold, the FAF 5 NM from the threshold, and the intermediate fix (IF) 5 nautical miles from the FAF. Two initial approach fixes (IAFs) are located 3 to 6 miles from the center IF (IAF). All of these waypoint fixes will be named with a five character pronounceable name. The length of the initial segment varies with the category of aircraft using the procedure or descent gradient requirements. The minimum length of an initial segment designed for Category A aircraft is 3 nautical miles. The minimum length for an initial segment designed for Category E aircraft is 6 nautical miles. These initial segments are constructed perpendicular (90°) to the intermediate segment. There is a holding pattern at the IF (IAF) for course reversal requirements. For example, some pilots may desire to execute a procedure turn (PT) to meet a descent gradient requirement. The missed approach segment is ideally aligned with the final approach course and terminates in a direct entry into a holding pattern. Conditions may require a different routing. (Figure 7-3 and 7-4.)

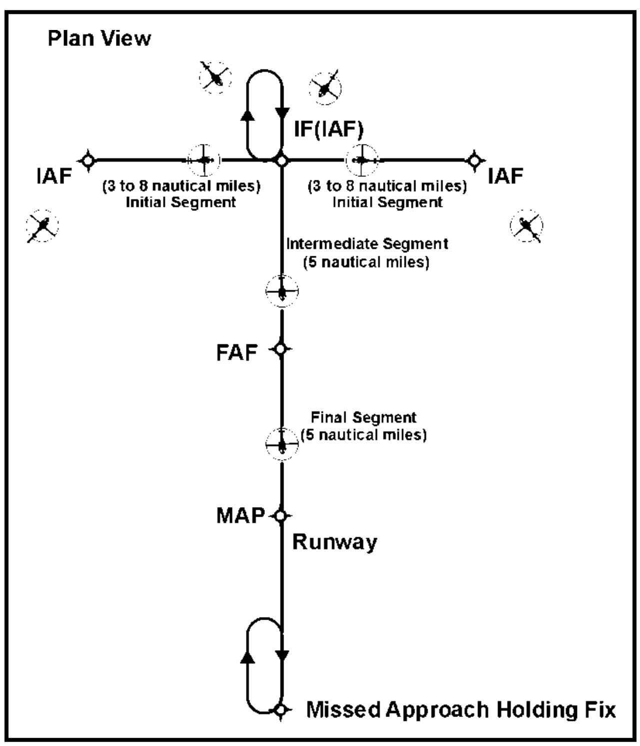


Figure 7-3 Basic "T" Design #1

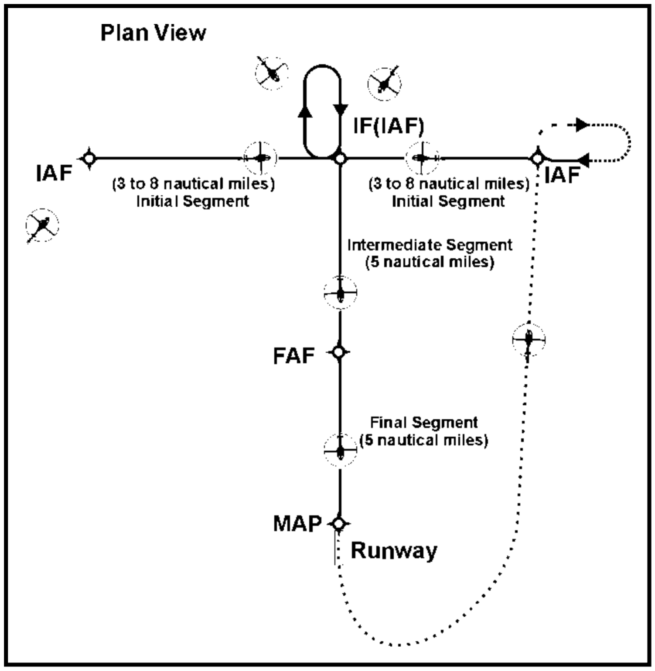


Figure 7-4 Basic "T" Design #2

In order to accommodate descent from a high enroute altitude to the initial segment altitude, the basic "T" configuration may be modified. When this occurs, a PT holding pattern provides aircraft an extended distance for the necessary descent gradient. The holding pattern constructed for this purpose is always established on the IF (IAF) waypoint (Figure 7-5).

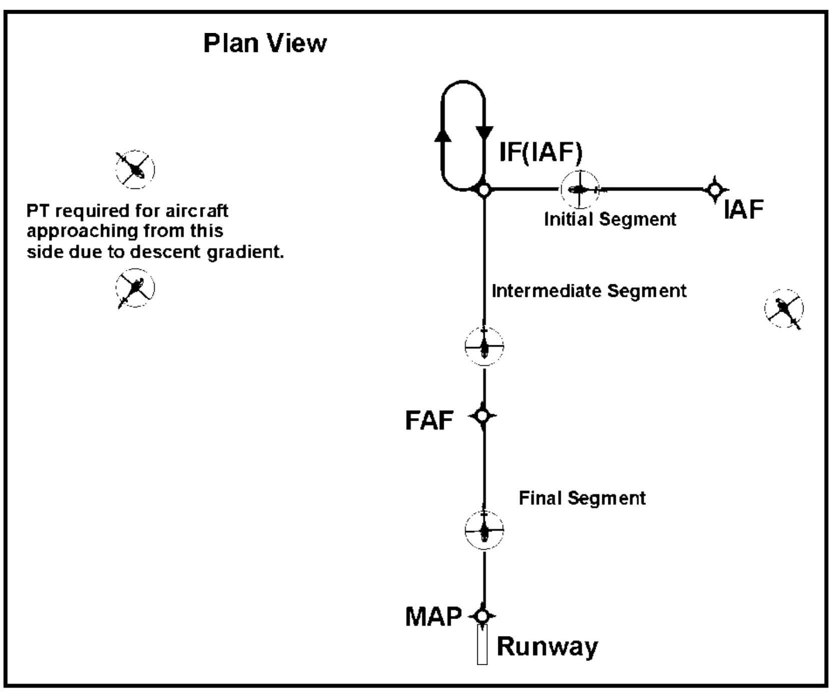


Figure 7-5 Modified Basic "T"

Another modification may be required for parallel runways. The normal "T" IAFs serve all parallel runways. However, only one initial, intermediate, and final segment combination will be depicted on the approach chart for the landing runway (see Figures 7-6, 7-7 and 7-8).

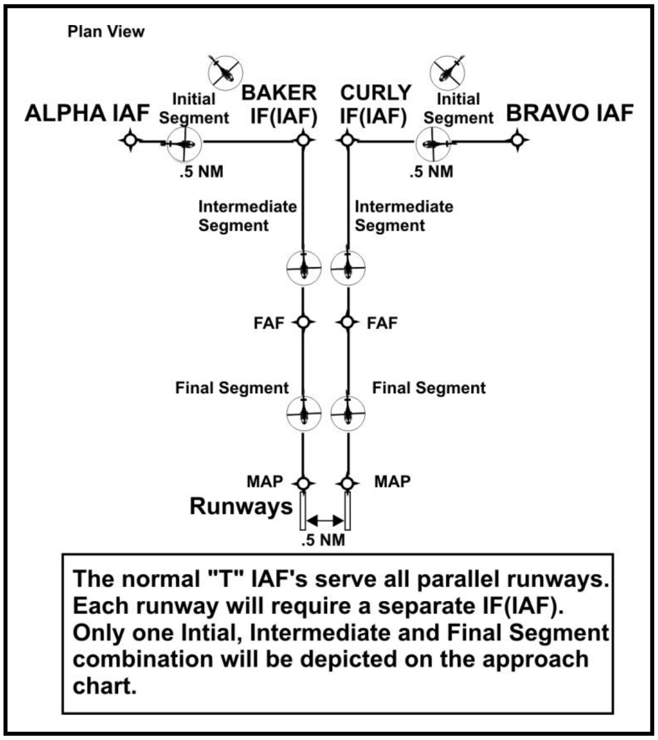


Figure 7-6 Normal "T" IAF

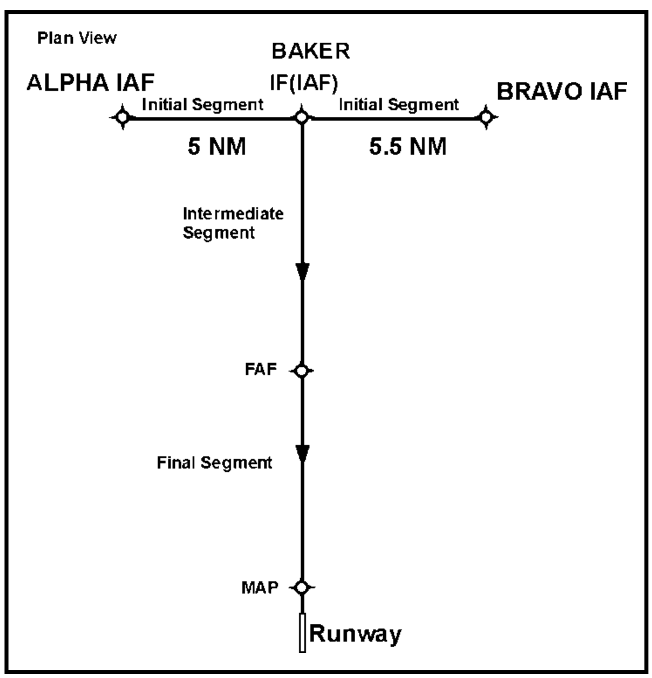


Figure 7-7 Modified Basic "T" – Baker

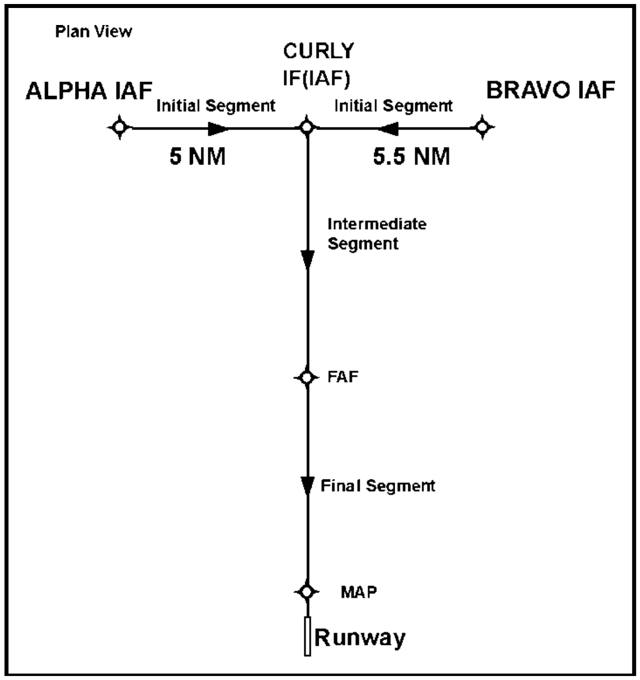


Figure 7-8 Modified Basic "T" – Curly

The standard TAA consists of 3 areas established by the extension of the legs of the basic "T." These areas are: the straight-in, left base and right base. The 30-nautical-mile arc boundary of each area is equivalent to a feeder fix. When crossing the boundary of each of these areas or when released by ATC, within the area, the pilot is expected to proceed direct to the appropriate waypoint IAF for the approach area being flown. A pilot has the option in all areas to proceed direct to the holding pattern for course reversal. The PT holding pattern at the IF (IAF) is standard. The published procedure will be annotated to indicate when the course reversal is not necessary when flying within a particular TAA area; e.g., "NoPT." Otherwise, the pilot is expected to execute the course reversal under the provisions of the 14 CFR Section 91.175. The pilot may elect to use the course reversal pattern when it is not required by the procedures, but must inform air traffic control and receive clearance to do so. (AIM 5-4-5 (d) (b)). Area boundaries are magnetic course lines to the IF (IAF). The charted altitudes within the TAA are maintained by aircraft that traverse these areas (see Figure 7-9).

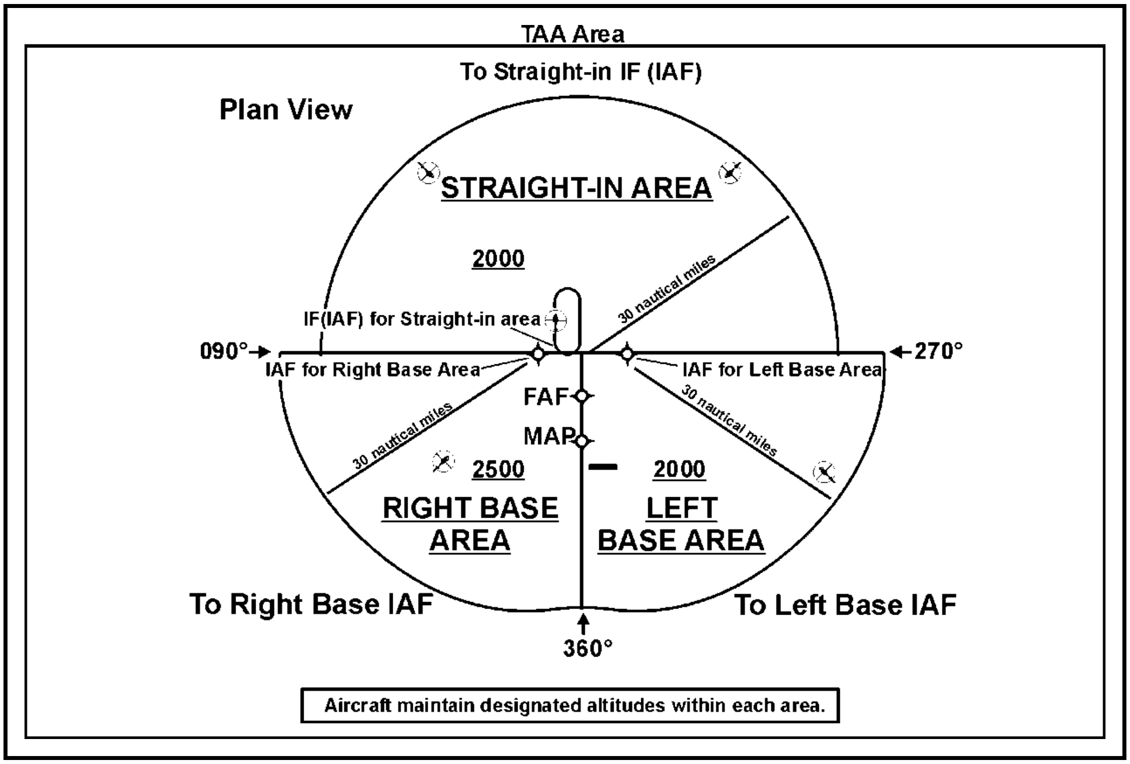


Figure 7-9 TAA Area

Normally, the minimum altitudes specified in the TAA and PT holding pattern are the same. However, there may be locations where terrain or operational situations require minimum altitudes to maintain within a sector of an area. In Figure 7-10, pilots flying into the right or left base areas are expected to maintain a minimum altitude of 6000 feet MSL until within 17 NM of the appropriate IAF and then descend to the lower charted altitudes. Pilots approaching from the northwest are expected to maintain a minimum altitude of 6000 feet MSL until within 22 nautical miles of the IF (IAF) then descend to an altitude not lower than 2000 feet MSL until reaching the IF (IAF).

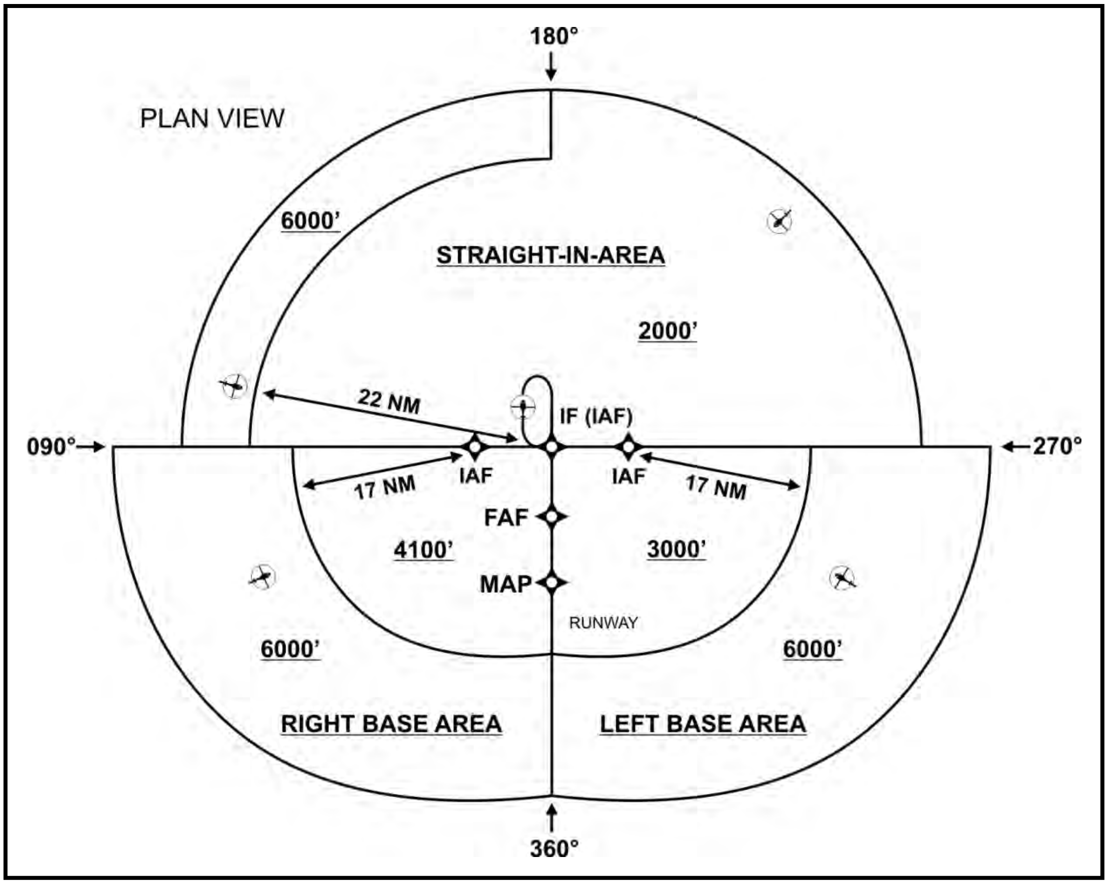


Figure 7-10 Sectored TAA Areas

There may be modifications to the area of the standard TAA because of operational requirements. For example, the right or left base areas may be modified or eliminated. A PT holding pattern can be required when approaching from a certain area. Figure 7-11 is an example of this situation. Pilots approaching the IF (IAF) within 120° of the final approach course (this is the maximum intercept angle, a smaller angle could be required) are expected to fly a NoPT straight-in approach. If the PT is needed for unusual situations, advise ATC of your intentions. Pilots approaching the IF (IAF) on a course greater than 120° (or a specified smaller angle) from the final approach course are required to execute a procedure turn.

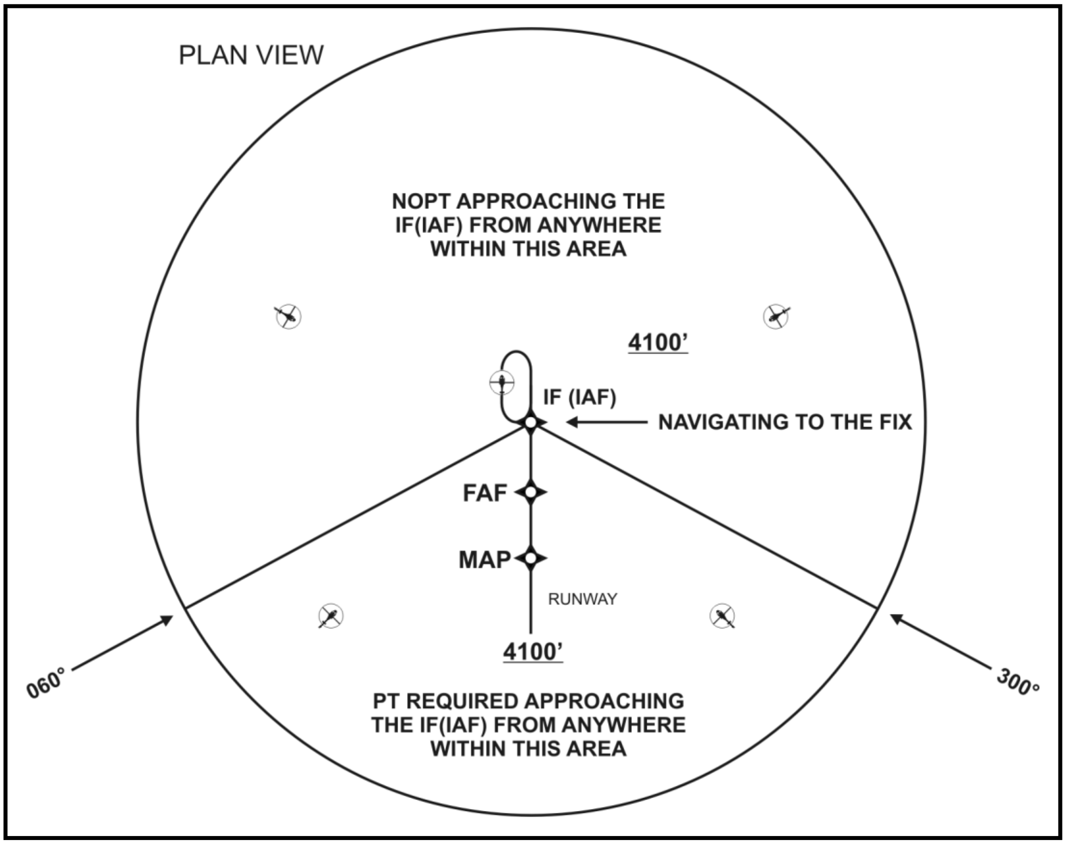


Figure 7-11 TAA with Left and Right Base Areas Eliminated

Figure 7-12 is an example of another modification. The right base is eliminated. Pilots approaching the IF (IAF) from between the courses of 360° clockwise to 060° are required to perform a PT. Pilots are expected to execute a NoPT straight-in approach when approaching the IF (IAF) from between the courses of 060° clockwise to 270°. The left base contains an IAF with an initial leg. NoPT is expected.

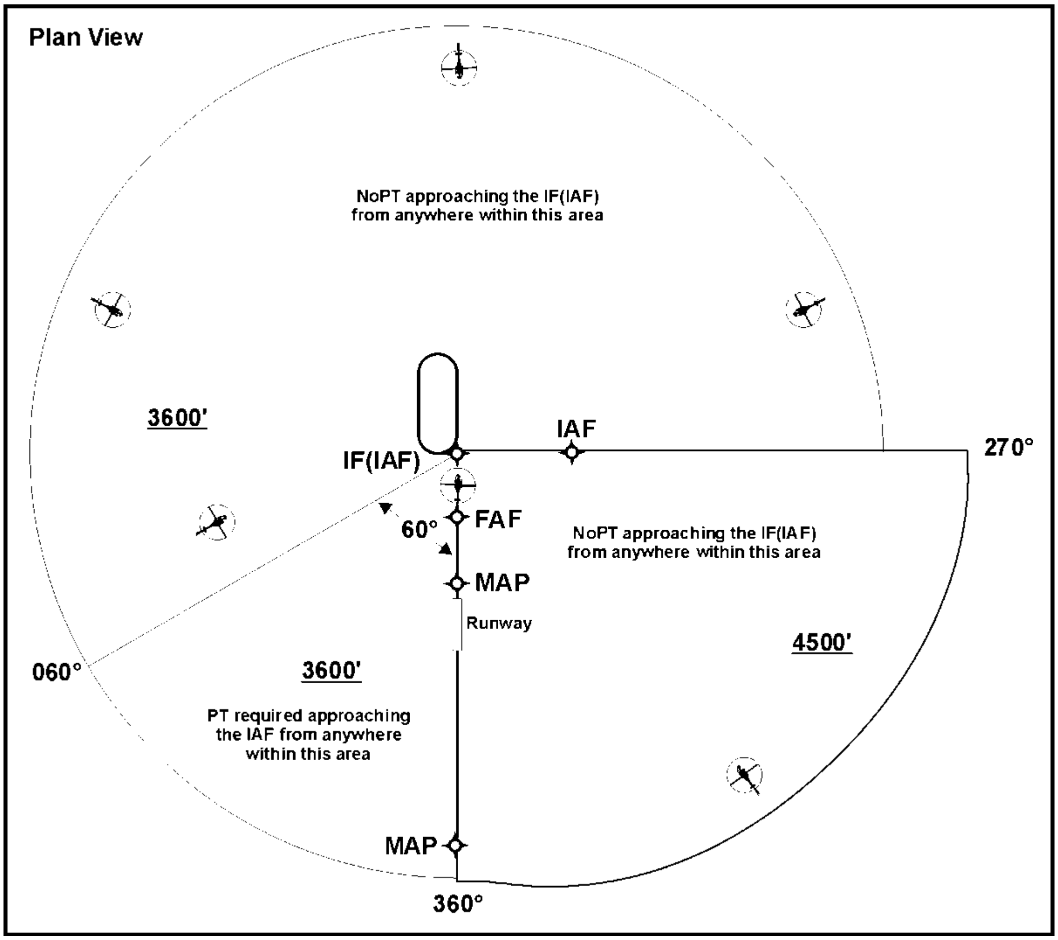


Figure 7-12 TAA with Right Base Eliminated

Normally an airway will overlie a TAA. Figure 7-13 is an example of all airways lying outside of the TAA. The required feeder routes are aligned with the appropriate IAFs of the "T."

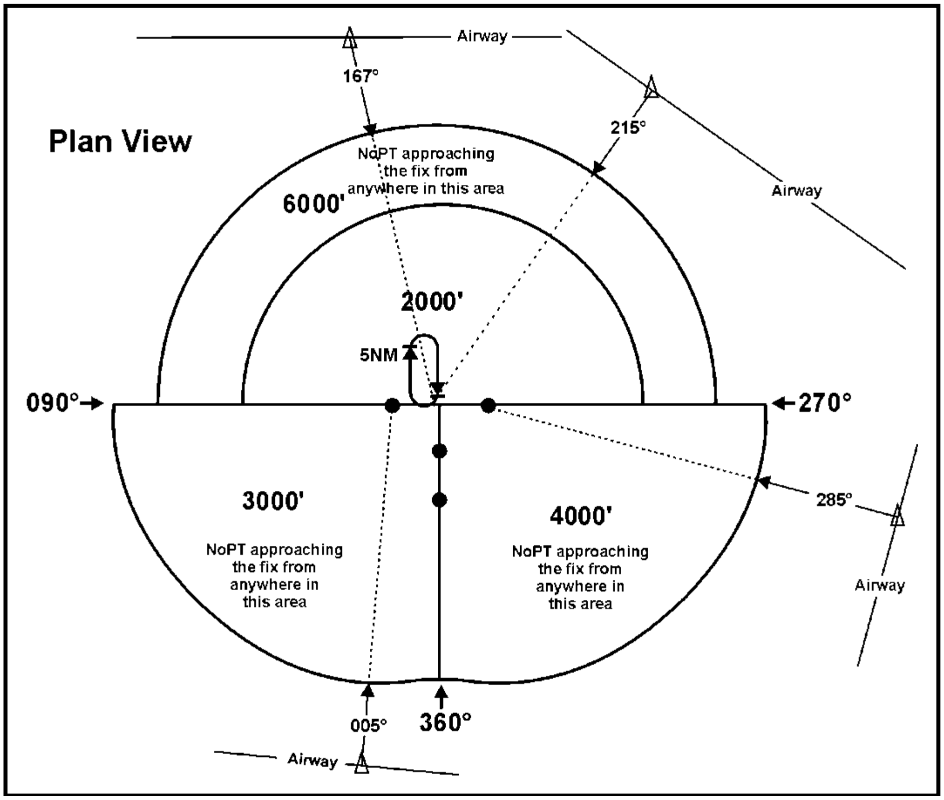


Figure 7-13 Examples of a TAA with Feeders from an Airway

705. GPS NOTAMS/AERONAUTICAL INFORMATION

GPS satellite outages are issued as GPS NOTAMs both domestically and internationally. However, the effect of an outage on the intended operation cannot be determined unless the pilot has a RAIM availability prediction program which allows excluding a satellite which is predicted to be out of service based on the NOTAM information.

Civilian pilots may obtain GPS RAIM availability information for non-precision approach procedures by specifically requesting GPS aeronautical information from an Automated Flight Service Station during preflight briefings. GPS RAIM aeronautical information can be obtained for a period of 3 hours (ETA hour and 1 hour before to 1 hour after the ETA hour) or a 24-hour time frame at a particular airport. FAA briefers will provide RAIM information for a period of 1 hour before to 1 hour after the ETA, unless a specific time frame is requested by the pilot. If flying a published GPS departure, a RAIM prediction should also be requested for the departure airport.

The military provides airfield specific GPS RAIM NOTAMs for non-precision approach procedures at military airfields. The RAIM outages are issued as M-series NOTAMs and may be obtained for up to 24 hours from the time of request.

GPS NOTAMS may be viewed on the Defense Internet NOTAM Service (DINS) website: ***https://www.notams.jcs.mil/dinsQueryWeb/***. Additionally, GPS users must check for receiver manufacturers and/or database supplier notices concerning database errors. For military pilots using Jeppesen databases, these can be found on the DINS website by clicking on the "Jeppesen NAVDATA Alerts/NOTAMs" link. Jeppesen Chart Change Notices and NavData Change Notices include significant information changes affecting enroute, area and terminal environments.

706. RECEIVER AUTONOMOUS INTEGRITY MONITORING (RAIM)

RAIM outages may occur due to an insufficient number of satellites or due to unsuitable satellite geometry which causes the error in the position solution to become too large. Loss of satellite reception and RAIM warnings may occur due to aircraft dynamics (changes in pitch or bank angle). Antenna location on the aircraft, satellite position relative to the horizon, and aircraft attitude may affect reception of one or more satellites. Since the relative positions of the satellites are constantly changing, prior experience with the airport does not guarantee reception at all times, and RAIM availability should always be checked.

If RAIM is not available, another type of navigation and approach system must be used, another destination selected, or the trip delayed until RAIM is predicted to be available on arrival. On longer flights, pilots should consider rechecking the RAIM prediction for the destination during the flight. This may provide early indications that an unscheduled satellite outage has occurred since takeoff.

If a RAIM failure/status annunciation occurs prior to the final approach waypoint (FAWP), the approach should not be completed since GPS may no longer provide the required accuracy. The receiver performs a RAIM prediction by 2 NM prior to the FAWP to ensure RAIM is available at the FAWP as a condition for entering the approach mode. ***The pilot should ensure the receiver has sequenced from "Armed" to "Approach" prior to the FAWP*** (normally occurs 2 NM prior). Failure to sequence may be an indication of the detection of a satellite anomaly, failure to arm the receiver (if required), or other problems, which preclude completing the approach.

If the receiver does not sequence into the approach mode or a RAIM failure/status annunciation occurs prior to the FAWP, the pilot should not descend to MDA, but should proceed to the missed approach waypoint (MAWP) via the FAWP, perform a missed approach, and contact ATC as soon as practical. Refer to the receiver operating manual for specific indications and instructions associated with loss of RAIM prior to the FAF.

If a RAIM failure occurs after the FAWP, the receiver is allowed to continue operating without an annunciation for up to 5 minutes to allow completion of the approach (see receiver operating manual). ***A GPS integrity warning occurring after the FAWP is a serious situation and pilots must be prepared to take immediate action. Transition to your backup approach (if available)***

or proceed to the MAP along the final approach course and execute the missed approach via the route and altitudes specified in the published missed approach procedure or comply with ATC instructions. (NATOPS IFM)

707. GPS NAVIGATION

GPS approaches make use of both fly-over and fly-by waypoints. Fly-by waypoints are used when an aircraft should begin a turn to the next course prior to reaching the waypoint separating the two route segments. This is known as turn anticipation and is compensated for in the airspace and terrain clearances. Approach waypoints, except for the MAWP and the missed approach holding waypoint (MAHWP), are normally fly-by waypoints. Fly-over waypoints are used when the aircraft must fly over the point prior to starting a turn. New approach charts depict fly-over waypoints as a circled waypoint symbol. Overlay approach charts and some early stand-alone GPS approach charts may not reflect this convention.

On overlay approaches (titled "or GPS"), if no pronounceable five-character name is published for an approach waypoint or fix, it may be given an ARINC data base identifier consisting of letters and numbers. These points will appear in the list of waypoints in the approach procedure database, but may not appear on the approach chart. Procedures without a final approach fix (FAF), for instance, have a sensor final approach waypoint (FAWP) added to the data base at least 4 NM prior to the MAWP to allow the receiver to transition to the approach mode. Some approaches also contain an additional waypoint in the holding pattern when the MAWP and MAHWP are co-located. Arc and radial approaches have an additional waypoint used for turn anticipation computation where the arc joins the final approach course. These coded names will not be used by ATC.

Unnamed waypoints in the database will be uniquely identified for each airport but may be repeated for another airport (e.g., RW36 will be used at each airport with a runway 36 but will be at the same location for all approaches at a given airport).

The runway threshold waypoint, which is normally the MAWP, may have a five-letter identifier (e.g., SNEEZ) or be coded as RW## (e.g., RW36, RW36L). Those thresholds which are coded as five-letter identifiers are being changed to the RW## designation. This may cause the approach chart and database to differ until all changes are complete. The runway threshold waypoint is also used as the center of the MSA on most GPS approaches. MAWPs not located at the threshold will have a five-letter identifier.

Position Orientation

As with most RNAV systems, pilot should pay particular attention to position orientation while using GPS. Distance and track information are provided to the next active waypoint, not to a fixed navigation aid. Receivers may sequence when the pilot is not flying along an active route, such as when being vectored or deviating for weather, due to the proximity to another waypoint in the route. This can be prevented by placing the receiver in the nonsequencing mode. When the receiver is in the nonsequencing mode, bearing and distance are provided to the selected waypoint and the receiver will not sequence to the next waypoint in the route until placed back in the auto sequence mode or the pilot selects a different waypoint. On overlay approaches, the pilot may have to compute the along track distance to stepdown fixes and other points due to the receiver showing along track distance to the next waypoint rather than DME to the VOR or ILS ground station.

Conventional Versus GPS Navigation Data

There may be slight differences between the heading information portrayed on navigational charts and the GPS navigation display when flying an overlay approach or along an airway. All magnetic tracks defined by a VOR radial are determined by the application of magnetic variation at the VOR; however, GPS operations may use an algorithm to apply the magnetic variation at the current position, which may produce small differences in the displayed course. Both operations should produce the same desired ground track. Due to the use of great circle courses, and the variations in magnetic variation, the bearing to the next waypoint and the course from the last waypoint (if available) may not be exactly 180° apart when long distances are involved. Variations in distances will occur, since GPS distance-to-waypoint values are along track (straight-line) distances (ATD) computed to the next waypoint and the DME values published on underlying procedures are slant range distances measured to the station. This difference increases with aircraft altitude and proximity to the NAVAID.

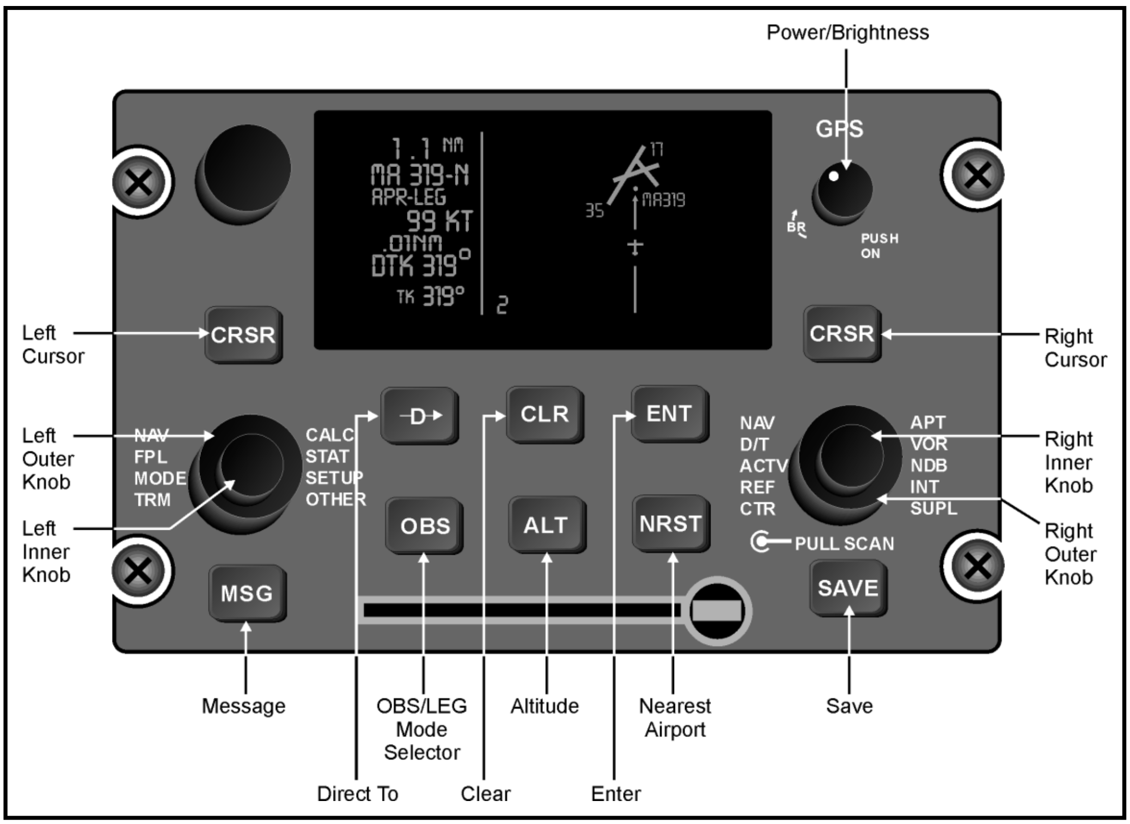


Figure 7-14 GPS System

708. THE KLN 900 GPS SYSTEM

The basic KLN 900 system consists of a panel-mounted KLN 900 GPS sensor/navigation computer, a database card, and an antenna. Additional system components are integrated to increase the capabilities of the system (including the CDI, HSI, and RMI). With these components the GPS becomes a complete, and very powerful navigation system. This section is a brief overview of the system and is not intended to be an in-depth instruction on all of its functions and usages. Please take advantage of NATOPS, the KLN 900 user's manual, computer-based trainers, as well as the GPS practice systems in order to gain a complete understanding and to become proficient with the KLN 900 GPS system.

The KLN 900 Database

The database provides two functions. First, it makes pilot interface with the GPS sensor much easier. Rather than having to manually look up and then enter the latitude and longitude for a specific waypoint, it allows you to merely enter a simple waypoint identifier. The database will automatically look up and display the pertinent information. Secondly, it serves as a means to store and easily access a vast amount of aeronautical information. Want to know the tower frequency or length of the runways at a specific airport? No need to look them up in a book just turn a couple knobs and the information is easily displayed.

Database coverage is worldwide, though broken down into ten different regions. The TH-57's database coverage is based on the U.S. alone, containing information on public and military use airports with a runway of at least 1000 feet in length.

The following is a list of the KLN 900 database contents:

***AIRPORTS**

- Identifier
- Name
- City, State or Country
- Type (public, private, military, or heliport)
- Latitude or Longitude
- Elevation
- Approach indicator for precision, non-precision or no instrument approach at airport
- Radar approach/departure environment indicator
- Whether airport underlies CL B, TRSA, CL, C, CTA, or TMA
- Time relative to UTC (Zulu)
- Communication frequencies (VHF and HF):
  ATIS
  Clearance delivery
  Tower
  Ground control
  Unicom
  Multicom
  Approach (IFR)
  Departure (IFR)
  Class B, Class C, TRSA, CTA, TMA
  (VFR) Center (when used for approach)
  Arrival
  Radar
  Director
  Radio
  ASOS (automatic surface observation system)
  AWOS (automatic weather observing station)
  AAS (aeronautical advisory service)
  ATF (aerodrome traffic frequency)
  CTAF (common traffic advisory frequency)
  MF (mandatory frequency)
  Ramp control
  PCL (pilot-controlled lights)
- Runway data (designation, length, surface, lighting, traffic pattern direction)
- Airport Services (fuel, oxygen, customs, indicator for presence of a landing fee)
- Airport Comments (user may manually enter remarks of up to 33 characters at any 100 airports in database.

VORs

- Identifier
- Name
- Frequency
- DME indicator
- Class (high altitude, low altitude, terminal, undefined)
- Latitude and Longitude
- Magnetic variation

NDBs

- Identifier
- Name
- Frequency
- Latitude and Longitude
  (Note - Outer Compass Locators are stored as intersections)

Intersections (low altitude, high altitude, SID/STAR, approach and outer markers)

- Identifier
- Latitude and Longitude

***SID/STAR/Approach Procedures**

- All compatible pilot-NAV SID/STAR procedures
- Non-precision approaches (except localizer, LDA (Localizer Directional Aid), SDF (Simplified Directional Facility) approved for overlay use. Includes all public GPS-only approaches.

MISCELLANEOUS

- *Air Route Traffic Control Center (ARTCCs and FIRs) name, boundaries and frequencies (VHF and HF)
- *Flight Service Stations (Location of points of communication and associated frequencies - VHF and HF), VOR used.
- Minimum Safe Altitudes
- *Special Use Airspace name and boundaries, lateral and vertical, (Prohibited, Restricted, Warning, Alert, MOA, Class B, TRSA, Class C, CTA, TMA)

1000 USER-DEFINED WAYPOINTS (250 ORS 01 units)

- Identifier
- Latitude and Longitude
- Additional data depending on how user defines waypoint:
  User airports (elevation and surface of longest runway)
  User VOR (frequency and magnetic variation)
  User NDB (frequency)

Information Input and Retrieval

Obviously, with this much information available, one must be able to access it quickly and easily. The KLN 900 is user-friendly once you have figured out how work its two main controls, the right and left inner and outer control knobs. By rotating first the outer knob and then the inner knob you are able to flip through the numerous screens, each of which contain several pages. Each screen and page then allows you to access information, input a flight plan or destination, or determine numerous in-flight calculations.

From Figure 7-15 you can see that the right and left knobs will control your right and left screen functions with the inner knob controlling the pages found within each screen function.

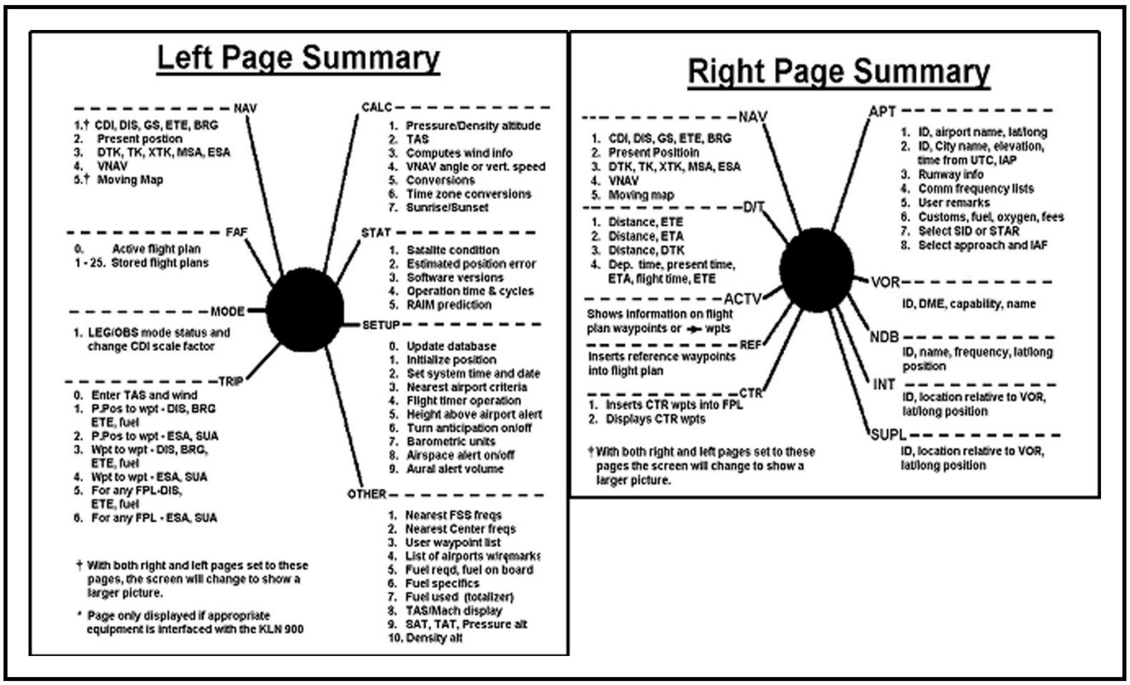


Figure 7-15 Left and Right Page Summary

Flight Plan Input

The KLN 900 has a Direct To function, that when a waypoint is inputted or highlighted in a flight plan and the "DIRECT TO" button is pushed, the GPS will give the distance and heading to that location. This is the primary feature of the GPS, but it can make it rather work-intensive on a long flight. For this reason the pilot is able to input an entire flight plan into the GPS. Up to 25 flight plans can be stored with 30 locations in each plan. To input a flight plan:

1. Select flight plan (FPL) with the left outer knob. Use the inner knob then to select a blank flight plan page (preferably not FPL 0, as this will automatically become the active page).

2. Hit the left "CRSR" button.

3. Use the left inner knob to select the first character of the departure waypoint identifier (the departure point should always be the first waypoint or else it will not sequence properly). Ensure to put a "K" as the first of the four-letter identifier for all airports.

4. Turn the left outer knob one step clockwise to move the flashing portion of the cursor over the second character position, and then use the left inner knob to select the desired waypoint.

5. Press "ENT" to enter the waypoint. The location will be displayed on the right screen, so you can be sure the right waypoint is entered. If correct, press "ENT" again to lock it in and the cursor will move to the next position.

6. When all waypoints and the destination have been entered in the flight plan, the left outer knob may be rotated to move the cursor up and down and to manually "scroll" through the waypoints making up this flight plan. Continue to scroll up until the "USE?" is highlighted at the top. Press "ENT" and the flight plan will then be displayed as FPL 0.

7. A "C" shaped arrow will indicate the sequencing of the flight from one point to another.

8. Changes can be made in flight by using the "CRSR" button and highlighting points in flight.

Once a flight plan is entered, numerous changes can be made by merely highlighting a waypoint and then using the appropriate knobs to enter the new waypoint, approach, or departure (Section 709).

709. INPUTTING AND FLYING GPS APPROACHES

Once a flight plan is entered, it is possible to input the approach desired. The general procedures to input and shoot a GPS non-precision approach are as follows and are pictured in Figure 7-16. Please reference the FTI for complete GPS approach procedures.

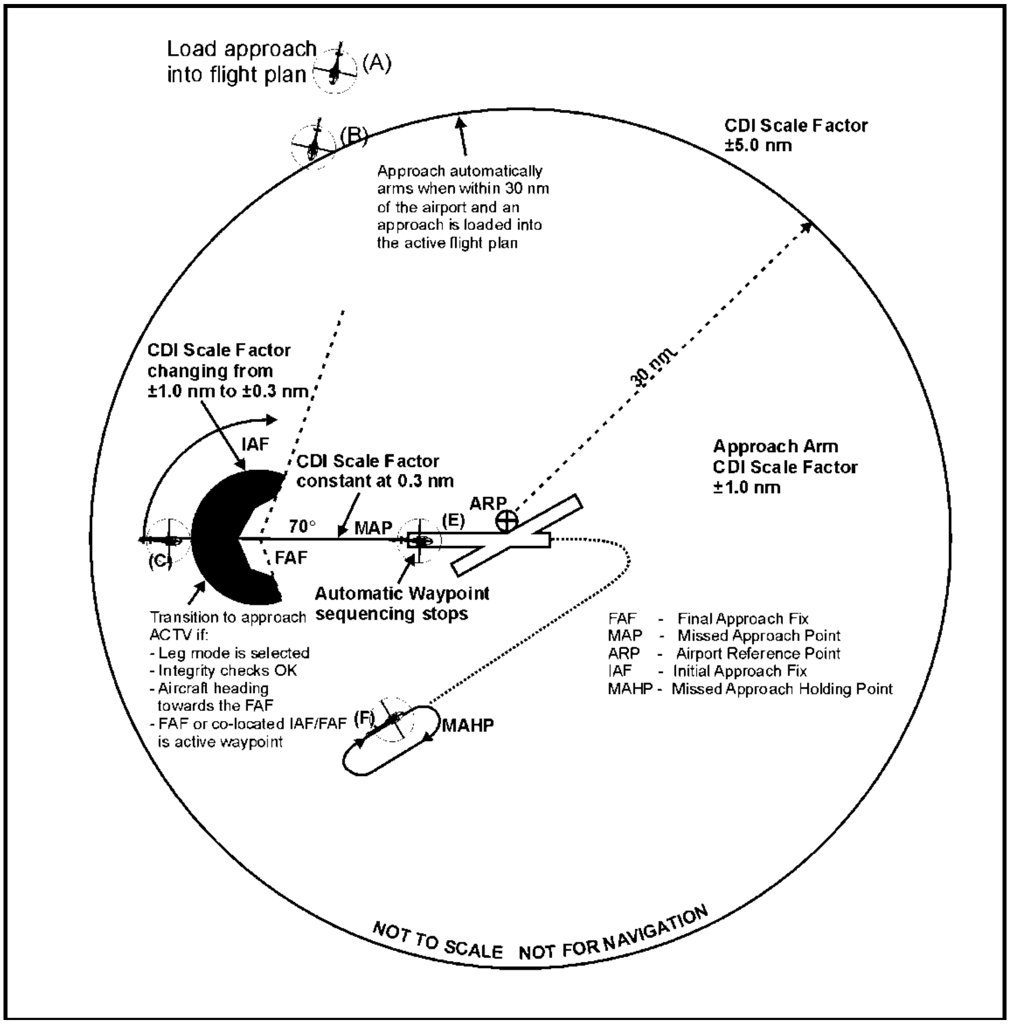


Figure 7-16 KLN 900 Approach Diagram

1. **Select and load the approach into the flight plan.** Can be done at any time, but must be completed by the Final Approach Fix. If aircraft is greater than 30 NM from the airport, then the CDI scale factor will remain at the default 5 NM full-scale deflection.

   a. Approaches are selected from the "APT 8" page (on the right side of the display) for the airport to which you desire to shoot the approach. Use the "CRS" to highlight the current airport and then select the airport using the right inner and outer knobs.

   b. Rotate the knobs then to move the cursor down to the given approaches; highlight the one you want and hit "ENT."

   c. The display will then present a list of IAFs corresponding with the approach. Highlight the one you want and hit "ENT." Be aware that ATC may not give you an IAF, in which case you must choose the one that is correct for your inbound course to the airfield.

d. The display will then list the waypoints that make up the approach. Review these to ensure you have selected the right course.

e. Continue to move the cursor down to highlight "LOAD IN FPL" and hit "ENT." This will automatically sequence the approach into your current flight plan (FPL 0).

2. **Transition to the approach arm mode**. This will occur automatically when the aircraft is within 30 NM of the airport and there is an approach loaded into the flight plan. The CDI scale will smoothly change to +1.0 NM over the next 30 seconds and the external annunciator will indicate ARM.

a. As you approach the IAF, the KLN will provide waypoint alerting on the annunciator as well as on the screen and then will automatically sequence onto the next waypoint.

b. Select the Super NAV 5 page at this time if you have not already done so.

3. **Get established on the final approach course.** This can be via NoPT arrival route, Radar Vectors (remain in OBS mode), Procedure turn or holding pattern (remain in OBS mode), or DME arc. Transition to the approach active mode. This change is automatic when:

a. The aircraft is 2 NM from the FAF and the approach mode is armed.

b. The LEG mode is selected.

c. The FAF or a co-located AIF/FAF is the active waypoint.

d. The KLN 900 confirms that adequate integrity monitoring is available to complete the approach.

e. RAIM is available to FAF and MAP.

If any of these conditions are not met, the KLN 900 will not transition to the approach active mode and a missed approach will be required if the conditions do not change before reaching the FAR. If all of these conditions are met, the CDI scale factor will start to change to ±0.3 NM and the external annunciator will indicate "ACTV."

4. **At the FAF**. The CDI scale factor will be at 0.3 NM and will remain at this scale factor until you manually cancel the approach mode by either pressing the external GPS APR button to change to the ARM mode, by initiating a Direct To operation, or by changing to OBS mode.

5. **Flying to the Missed Approach Point**. The KLN 900 will not automatically sequence to the next waypoint. You must manually change to the appropriate waypoint according to the situation. By default, the KLN 900 will nominate the first waypoint of the published missed approach procedure when the DIRECT TO button is pressed, the active waypoint is the MAP, and you have flown past the MAP.

6. **Conduct the missed approach procedure.** Remember, always refer to published charts. The OBS will be required at some point of the missed approach and will always be required to fly the holding pattern (see below).

There are certain requirements for GPS approach, which the AIM goes into detail about.

710. FLYING GPS APPROACHES

Determining which area of the TAA the aircraft will enter when flying a "T" with a TAA must be accomplished using the bearing and distance to the IF (IAF). This is most critical when entering the TAA in the vicinity of the extended runway centerline and determining whether you will be entering the right or left base area. Once inside the TAA, all sectors and stepdowns are based on the bearing and distance to the IAF for that area, which the aircraft should be proceeding direct to at that time, unless on vectors (see Figures 7-5 and 7-6).

Pilots should fly the full approach from an Initial Approach Waypoint (IAWP) or feeder fix unless specifically cleared otherwise. Randomly joining an approach at an intermediate fix does not assure terrain clearance.

When an approach has been loaded in the flight plan, GPS receivers will give an "arm" annunciation 30 NM straight line distance from the airport/heliport reference point. Pilots should arm the approach mode at this time, if it has not already been armed (some receivers arm automatically). Without arming, the receiver will not change from enroute CDI and RAIM sensitivity of ±5 NM either side of centerline to ±1 NM terminal sensitivity. Where the IAWP is inside this 30-mile point, a CDI sensitivity change will occur once the approach mode is armed and the aircraft is inside 30 NM. Where the IAWP is beyond 30 NM from the airport/heliport reference point, CDI sensitivity will not change until the aircraft is within 30 miles of the airport/heliport reference point even if the approach is armed earlier. Feeder route obstacle clearance is predicated on the receiver being in terminal (±1 NM) CDI sensitivity and RAIM within 30 NM of the airport/heliport reference point, therefore, the receiver should always be armed (if required) not later than the 30 NM annunciation.

The pilot must be aware of what bank angle/turn rate the particular receiver uses to compute turn anticipation, and whether wind and airspeed are included in the receiver’s calculations. This information should be in the receiver operating manual. Over or under banking the turn onto the final approach course may significantly delay getting on course and may result in high descent rates to achieve the next segment altitude.

When within 2 NM of the FAWP with the approach mode armed, the approach mode will switch to active, which results in RAIM changing to approach sensitivity and a change in CDI sensitivity. Beginning 2 NM prior to the FAWP, the full scale CDI sensitivity will smoothly change from ±1 NM, to ±0.3 NM at the FAWP. As sensitivity changes from ±1 NM to ±0.3 NM approaching the FAWP, with the CDI not centered, the corresponding increase in CDI displacement may give the impression the aircraft is moving further away from the intended course even though it is on an acceptable intercept heading. Referencing the digital track displacement information (cross track error), if it is available in the approach mode, may help the pilot remain position oriented in this situation. Being established on the final approach course prior to the beginning of the sensitivity change at 2 NM will help prevent problems in interpreting the CDI display during ramp down. Therefore, requesting or accepting vectors which will cause the aircraft to intercept the final approach course within 2 NM of the FAWP is not recommended.

When receiving vectors to final, most receiver operating manuals suggest placing the receiver in the nonsequencing mode on the FAWP and manually setting the course. This provides an extended final approach course in cases where the aircraft is vectored onto the final approach course outside of any existing segment which is aligned with the runway. Assigned altitudes must be maintained until established on a published segment of the approach. Required altitudes at waypoints outside the FAWP or stepdown fixes must be considered. Calculating the distance to the FAWP may be required in order to descend at the proper location.

Overriding an automatically selected sensitivity during an approach will cancel the approach mode annunciation. If the approach mode is not armed by 2 NM prior to the FAWP, the approach mode will not become active at 2 NM prior to the FAWP, and the equipment will flag. In these conditions, the RAIM and CDI sensitivity will not ramp down, and the pilot should not descend to MDA, but fly to the MAWP and execute a missed approach. The approach active annunciator and/or the receiver should be checked to ensure the approach mode is active prior to the FAWP.

Do not attempt to fly an approach unless the procedure is contained in the current GPS data base. Flying point to point on the approach does not assure compliance with the published approach procedure. The proper RAIM sensitivity will not be available and the CDI sensitivity will not automatically change to ±0.3 NM. Manually setting CDI sensitivity does not automatically change the RAIM sensitivity on some receivers. Some existing non-precision approach procedures cannot be coded for use with GPS and will not be available as overlays.

Pilots should pay particular attention to the exact operation of their GPS receivers for performing holding patterns and in the case of overlay approaches, operations such as procedure turns. These procedures may require manual intervention by the pilot to stop the sequencing of waypoints by the receiver and to resume automatic GPS navigation sequencing once the maneuver is complete. The same waypoint may appear in the route of flight more than once consecutively (e.g., IAWP, FAWP, MAHWP on a procedure turn). Care must be exercised to ensure the receiver is sequenced to the appropriate waypoint for the segment of the procedure being flown, especially if one or more fly-overs are skipped (e.g., FAWP rather than IAWP if the procedure turn is not flown). The pilot may have to sequence past one or more fly-overs of the same waypoint in order to start GPS automatic sequencing at the proper place in the sequence of waypoints.

Incorrect inputs into the GPS receiver are especially critical during approaches. In some cases, an incorrect entry can cause the receiver to leave the approach mode.

As previously discussed, ***Copter only RNAV approaches at civilian fields are designed to be flown at a maximum speed of 70 KIAS***. Copter approaches at military fields are designed to be flown at a maximum speed of 90 KIAS.

711. DEPARTURES AND DEPARTURE PROCEDURES (DPS)

When inputting a flight plan, the KLN 900 is also able to fly any DPs within its database. This is accomplished much like inputting and flying an approach. First, you must ensure the DP is available within the database. Second, be aware any DP completed with the GPS is not intended to be stand-alone, much like the approaches. Third, the pilot must be aware there are differences between an approach and a DP, mainly the change in CDI sensitivity in order to remain safely on a given course. Terminal RAIM should be automatically provided by the KLN 900 (as long as the waypoints are part of the active flight plan rather than proceeding direct to the first destination). Also, be aware ***helicopter departure procedures should be flown at 70 KIAS or less, since helicopter departure procedures and missed approaches are based on a much steeper obstacle clearance surface (OCS) gradient than fixed-wing procedures (20:1 vice 40:1).***

712. MISSED APPROACH

A GPS missed approach requires pilot action to sequence the receiver past the MAWP to the missed approach portion of the procedure. The pilot must be thoroughly familiar with the activation procedure for the particular GPS receiver installed in the aircraft and must initiate appropriate action after the MAWP. Activating the missed approach prior to the MAWP will cause CDI sensitivity to immediately change to terminal (if 1 NM) sensitivity and the receiver will continue to navigate to the MAWP. The receiver will not sequence past the MAWP. Turns should not begin prior to the MAWP. If the missed approach is not activated, the GPS receiver will display an extension of the inbound final approach course and the ATD will increase from the MAWP until it is manually sequenced after crossing the MAWP.

Missed approach routings in which the first track is via a course rather than direct to the next waypoint require additional action by the pilot to set the course. Being familiar with all of the inputs required is especially critical during this phase of flight.

Pilots should practice GPS approaches under visual meteorological conditions (VMC) until thoroughly proficient with all aspects of their equipment (receiver and installation) prior to attempting flight by IFR in instrument meteorological conditions (IMC). Some of the areas which the pilot should practice are:

1. Utilizing the receiver autonomous integrity monitoring (RAIM) prediction function;

2. Inserting a DP into the flight plan, including setting terminal CDI sensitivity, if required, and the conditions under which terminal RAIM is available for departure (some receivers are not DP or STAR capable);

3. Programming the destination airport;

4. Programming and flying the overlay approaches (especially procedure turns and arcs);

5. Changing to another approach after selecting an approach;

6. Programming and flying "direct" missed approaches;

7. Programming and flying "routed" missed approaches;

8. Entering, flying and exiting holding patterns, particularly on overlay approaches with a second waypoint in the holding pattern;

9. Programming and flying a "route" from a holding pattern;

10. Programming and flying an approach with radar vectors to the intermediate segment;

11. Indication of the actions required for RAIM failure both before and after the FAWP; and

12. Programming a radial and distance from a VOR (often used in departure instructions).

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REVIEW QUESTIONS

1. Standard GPS horizontal positioning accuracy is_______ meters.

   a. 100
   b. 50
   c. 22
   d. 400

2. A minimum of_______is always observable by a user anywhere on earth.

   a. 24
   b. 12
   c. 10
   d. 5

3. Aircraft equipped with GPS navigation may use it for its sole means of navigation.

   a. True b. False

4. When on a flight plan, which includes RNAV, prohibited and restricted airspace must be avoided by_______.

   a. 3 NM
   b. 5 NM
   c. 1 NM
   d. 10 NM

5. With the basic "T" design, the length of an initial segment must be at least ______ NM for a Cat A aircraft.

   a. 3
   b. 6
   c. 30
   d. 5

6. A(n) ______________is provided with the "T" design to allow aircraft to descent from a high enroute altitude.

   a. glideslope
   b. holding pattern
   c. arc
   d. Feeder route

7. The three areas for a standard TAA are:

   a. Alpha, Bravo, and Charlie
   b. Forward, Left, and Right
   c. Bow, Starboard, and Port
   d. Straight-in, Right Base, and Left Base

8. The arc boundary associated with each area is ____ NM.

   a. 3
   b. 30
   c. 6
   d. 5

9. The military provides airfield specific GPS RAIM NOTAMs for non-precision approach procedures at military fields. They are issued as ______ series NOTAMs and may be obtained for up to _______ hours from the time of request.

   a. M, 24
   b. M, 3
   c. N, 24
   d. N, 3

10. Unless a specific time frame is requested, FAA briefers will provide a RAIM information for a period of ______ .

   a. 24 hrs
   b. 2 hrs prior to arrival
   c. 1 hr prior to 1 hr after ETA
   d. FAA briefers will not provide RAIM info

11. RAIM is not required to perform a GPS approach.

   a. True b. False

12. If a RAIM flag/annunciation appears after FAWP, you should ______ .

   a. notify ATC
   b. turn RAIM
   c. execute missed approach immediately
   d. continue on with the approach

13. If RAIM is not available, the NAV 1 cannot be used to execute an approach.

a. True b. False

14. Slight differences between heading information portrayed on navigational charts and the GPS navigation display occur due to the fact that headings defined by a VOR airway apply magnetic variation at each individual VOR while the GPS ___________________.

a. applies magnetic variations stored in its vast database
b. references updated variations sent via satellite
c. uses complex algorithms based on your current position
d. does not take into account magnetic variation

15. The KLN 900 database does not contain:

a. Approach frequencies
b. VOR radio class codes
c. TACAN information
d. Aircraft services available

16. Sunrise/Sunset can be calculated for a location by scrolling to the ________________.

a. "MODE" page on the left side
b. "APT" page on right side
c. "CALC page on the left side
d. "D/T" page on the right side

17. The pilot should ensure that the GPS receiver has sequenced to "ARMED" 30 NM prior to the Final Approach Waypoint and to "APPCH" 4 NM prior to the Final Approach Waypoint.

a. True b. False

18. At the FAWP. the CDI scale factor will be at _______and will remain until manually canceling the approach move by pressing the external GPS APR button to change the ARM mode, by initiating a __________function, or by changing to ___________mode.

a. +0.3 NM, canceling, OBS
b. +0.5 NM, Direct To, LEG
c. +0.3 NM, Direct To, OBS
d. +0.2 NM, reset, APPCH

19. The KLN will automatically sequence to the missed approach upon reaching the MAWP.

a. True b. False

20. Activating the missed approach sequence prior to the missed approach while on final change the CDI sensitivity to NM.

a. +1.0
b. +0.5
c. +0.3
d. +3.0

21. Unlike GPS approaches, published GPS Departures Procedures can be stand-alone and do not require the use of a back-up DP.

a. True b. False

22. GPS Helicopter DPs, when available, are based on what airspeed.

a. 65 KIAS
b. 70 KIAS
c. 90 KIAS
d. 50 KIAS

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REVIEW ANSWERS

1. c
2. d
3. b
4. a
5. d
6. b
7. d
8. b
9. a
10. c
11. b
12. c
13. b
14. c
15. c
16. c
17. b
18. c
19. b
20. a
21. b
22. b

CHAPTER EIGHT
KT-79 TRANSPONDER

800. INTRODUCTION

The transponder set is an identification, position, and emergency tracking device. An operating transponder receives, decodes and responds to interrogation by search radar.

801. LESSON TOPIC LEARNING OBJECTIVES

Terminal Objective

Upon completion of this chapter, the student will recall facts about the development, uses, and operation of the KT-79 Transponder with a minimum score of 80% on the unit post test.

Enabling Objectives

1. State the two major uses of SIF equipment.

2. Write the meaning of the acronym SIF.

3. State which mode can be adjusted by the pilot on the KT-79 Transponder.

4. State the purpose of each mode on the KT-79 Transponder.

5. State the function of each position of the Master Control Switch on the KT-79 Transponder.

6. State the details of Mode C operation.

7. State the event that causes the KT-79 Transponder to emit a signal.

8. State two reasons for the use of Mode 3/A by Air Traffic Controllers.

9. State the number of codes available on Mode 3/A.

10. State the Mode 3/A codes that are used to indicate a/an: hijacking, lost communications, and emergency.

11. State the action which will be taken by ground personnel when Code 7700 is squawked.

12. State when the transponder should be activated and to which position.

802. TRANSPONDER - GENERAL

Airborne transponders and ground interrogators making up the air traffic control radar beacon system give controllers a positive radar return. The primary function of the radar beacon system is to provide reinforcement of radar replies, permitting the aircraft to be tracked reliably through heavy ground clutter and precipitation. Moreover, the system provides the radar controller in an ARTCC with a display of aircraft identity, altitude, and other required data to aid him in maintaining target identity and coordinating the hand-off of targets between similarly equipped sectors.

The Selective Identification Feature (SIF) is added to aircraft for two major reasons. First, it makes the aircraft easier to locate on the radarscope, and increases the range from which the aircraft can be seen. This becomes extremely important with small aircraft and low flying helicopters, as they cannot be seen on most radarscopes without the aid of their SIF. Secondly, this system provides the controller with the identity of your aircraft and has the potential to provide considerable additional information, at the pilot's or the controller's discretion.

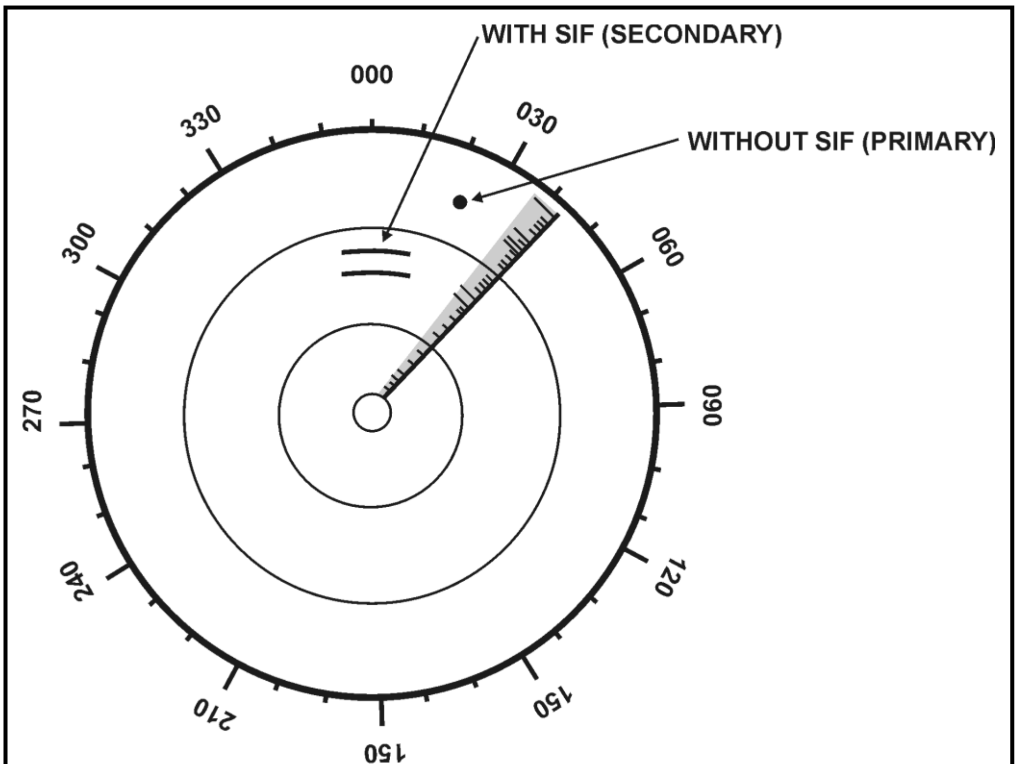

Figure 8-1 Primary and Secondary Radars Combined on One Display

The display in Figure 8-1 shows a radarscope that combines both Primary and Secondary radars on one display. Primary radar displays only the energy reflected off any solid object. Therefore, clouds, mountains, and all other solid objects, including aircraft, may show up on the scope. The aircraft shows up as a tiny blip and is hard to distinguish from the other solid objects.

Secondary radar emits a beam that triggers a transponder within the aircraft. This transponder then emits its own signal, which is picked up by the radar antenna. The radarscope displays transponder signals as a coded return.

Primary radar shows all aircraft, with or without transponders, but it has limited range, due to the requirement for radar beam reflection. It also shows so much information about other objects that the scope may become too cluttered to see the aircraft. Secondary radar shows only aircraft with operating transponders. It also has greater range, and the individual blips can be identified by the code that they are emitting. ATCs generally have both Primary and Secondary displays available to them simultaneously.

The SIF helps controllers distinguish between aircraft. It uses secondary radar only, and does not show the echoes from Primary radar.

What SIF does is provide codes which can be displayed on a radar screen. Currently there are 4096 possible SIF codes. This is called Mode A by the civilians and Mode 3 by the military.

The FAA requires all military aircraft and many civilian ones to have Mode C, which tells the controller your altitude, regardless of what the aircraft's altimeter reads. Mode C is automatic and functions by telling the controller what pressure is being sensed by the aircraft's static ports. It does not compensate for local atmospheric pressure. This is done automatically by a computer at the site to prevent the pilot from accidentally setting the wrong altimeter setting in his altimeter and making the controller think he is at a different altitude. The transponder (Mode C) is preset to standard barometric pressure, 29.92. Thus, if you have the incorrect altimeter setting set into your altimeter, the controller will still be able to tell your correct altitude. The pilot can only turn this mode on or off. He cannot adjust it.

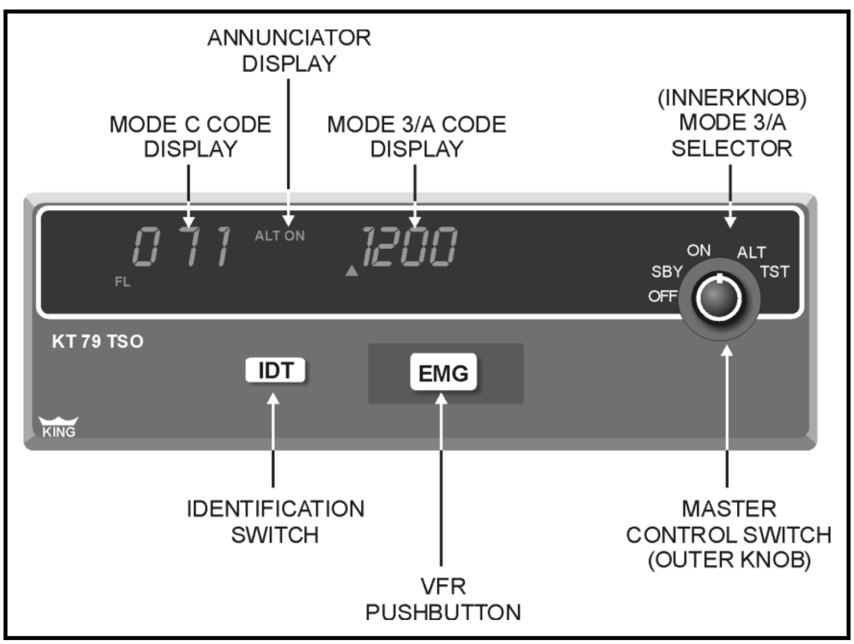

Figure 8-2 KT-79 Transponder Control Panel

Figure 8-2 is the control panel for the KT-79 Transponder. The labeled parts will be discussed in the following paragraphs, specifically covering the positions of the switches and the various functions of each of those positions.

The Master Control Switch (outer knob) controls the power input to the transponder. The function modes are as follows:

1. OFF - The unit is not energized.

2. Standby (SBY) - The unit is energized, but is inhibited from replying to any interrogations. "SBY" is enunciated on the display in this mode.

3. ON - The unit is able to reply to Mode 3/A interrogations, but the altitude information of a Mode C reply is suppressed. "ON" is enunciated on the display in this mode.

4. Altitude Enabled (ALT) - All information pulses are supplied in both mode 3/A and C replies. This is the normal mode of operation. "ALT" is enunciated on the display in this mode.

5. Test (TST) - Allows the pilot to evaluate the integrity of the unit. All display segments should illuminate in this mode. Transmissions are suppressed.

Mode selection is accomplished by rotating the outer knob.

The identification code for the aircraft is displayed in the right-hand position of the display. Note that beneath each digit is a triangular pointer. The pointer designates which digit will be increased or decreased when the Mode 3/A Selector (Inner) Knob is rotated clockwise or counterclockwise. The pointer is moved left to right by pressing the Mode 3/A Selector Knob against its spring-loaded switch. Thus, when a pilot wishes to enter an ID code, he can do so by rotating and depressing a single knob.

A reply indicator ("R") illuminates in the display when the transponder is replying to valid interrogations.

The Identification Switch marked "IDT" enables you to identify yourself to an air traffic controller. When the controller requests you to "Ident," momentarily depress the "IDT" push-button. The transponder will now cause the special ident pulse to be appended to Mode 3/A replies for approximately 23.5 seconds. During this period, "IDT" is illuminated on the KT-79 display and the ident symbol appears at the aircraft's location on the ground controller's screen.

The KT-79 provides the pilot with continuous Flight Level altitude readouts. Flight Level is a term used to indicate that the altitude under consideration is not true altitude, but barometric altitude which has not been corrected for local pressure. The display is in hundreds of feet, for example, "FL 040" corresponds to an altitude of 4000 feet at standard pressure of 29.92 inches of mercury. Thus, if you have the incorrect barometric pressure set in your altimeter, the controller will still be able to tell your correct altitude. Thus, it is possible for your altimeter to be reading one altitude (e.g., 2500) and the Mode C to be transmitting another (e.g., 3000).

Depressing the guarded "EMR" push-button will automatically display and squawk the preprogrammed Mode 3/A emergency code. Mode 3/A code 7700 will automatically supersede any previously assigned code. Upon recognition of an emergency, the pilot need only momentarily depress the "EMR" push-button to alert the ground controller of an emergency condition.

803. MODE-3 SQUAWKS

When issuing your flight clearance, ATC will assign you a Mode 3/A squawk. Computers at the center will then use this code to keep track of your flight's progress. The computer will think that you are airborne as soon as it picks up your Mode 3/A code on radar. Therefore, turn your Master Control Switch from SBY to ALT as late as practicable before takeoff. The controller has crosschecks to ensure that you are actually airborne, but you can cause a delay while he straightens the problem out. Additionally, squawk only your assigned code while in the air. Any random code might be assigned to someone else, again causing confusion, if you made the computer think you were another aircraft.

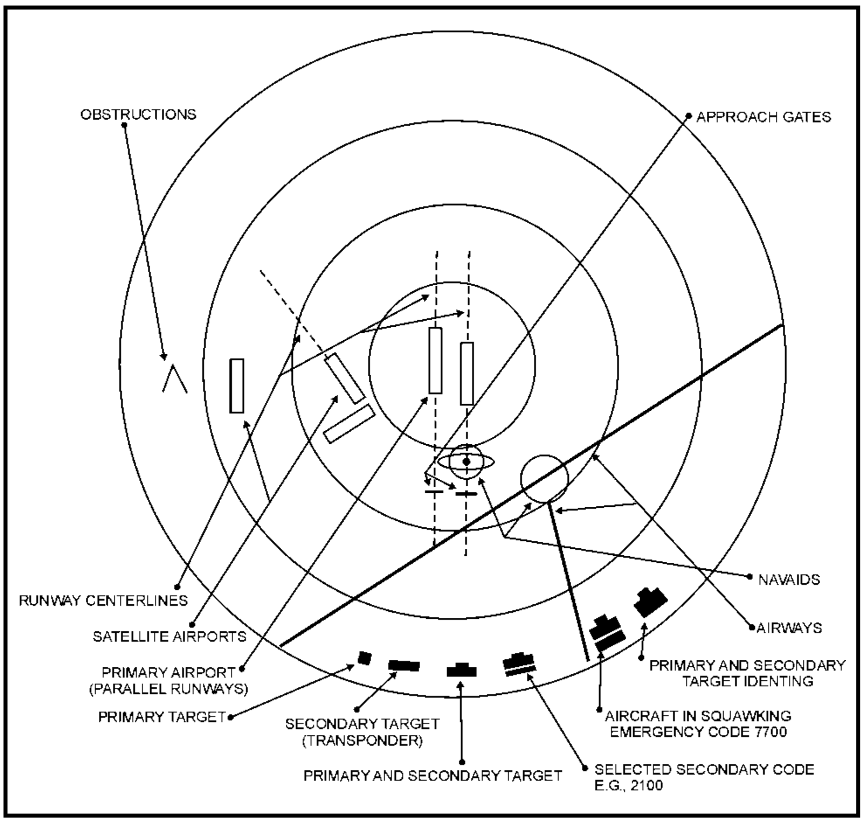

Figure 8-3 Radarscope – Primary and Secondary Radar Returns Shown

Here is the radarscope showing both Primary and Secondary radar returns. The aircraft without SIF is only a small dot using primary radar. The others using Secondary radar, show up much better. When you "Ident", the controller sees a large blip.

When you depress the EMR push-button, the controller sees a double blip, a light flashes and an aural tone sounds, alerting him to the fact that there is an emergency.

As you can see, certain Mode 3/A codes can be used to tell the controller specific things. There are three codes you must memorize.

1. 7700 Emergency

2. 7600 Lost Communications

3. 7500 Hijacking

If you have a loss of radio communications, with this system, squawk 7600. The hijacking code is 7500. When the controller sees this code he will ask you if you are squawking 7500. If you say yes or do not answer, the controller will assume you have been hijacked and will take appropriate action, including clearing all traffic away from whatever route the hijacker forces you to take and providing vectors as necessary.

It is conceivable the hijacker will not permit you to set the hijacking code into your transponder. As an alternative, you may state you are squawking 7500, or mention you are being hijacked. In fixed-wing aircraft, leaving the flaps down or saying, "My flaps are full down," will inform the tower you have been hijacked, and are requesting armed intervention. While on ground, changing from 7500 to 7700 is also considered a request for armed intervention. The controller would probably ask you if you were squawking 7700 before taking action. While airborne, if you squawk 7500 and later switch to 7700 the controller will assume an airborne emergency in addition to the hijacking. After landing, be sure to go back to 7500 to prevent unnecessary armed intervention.

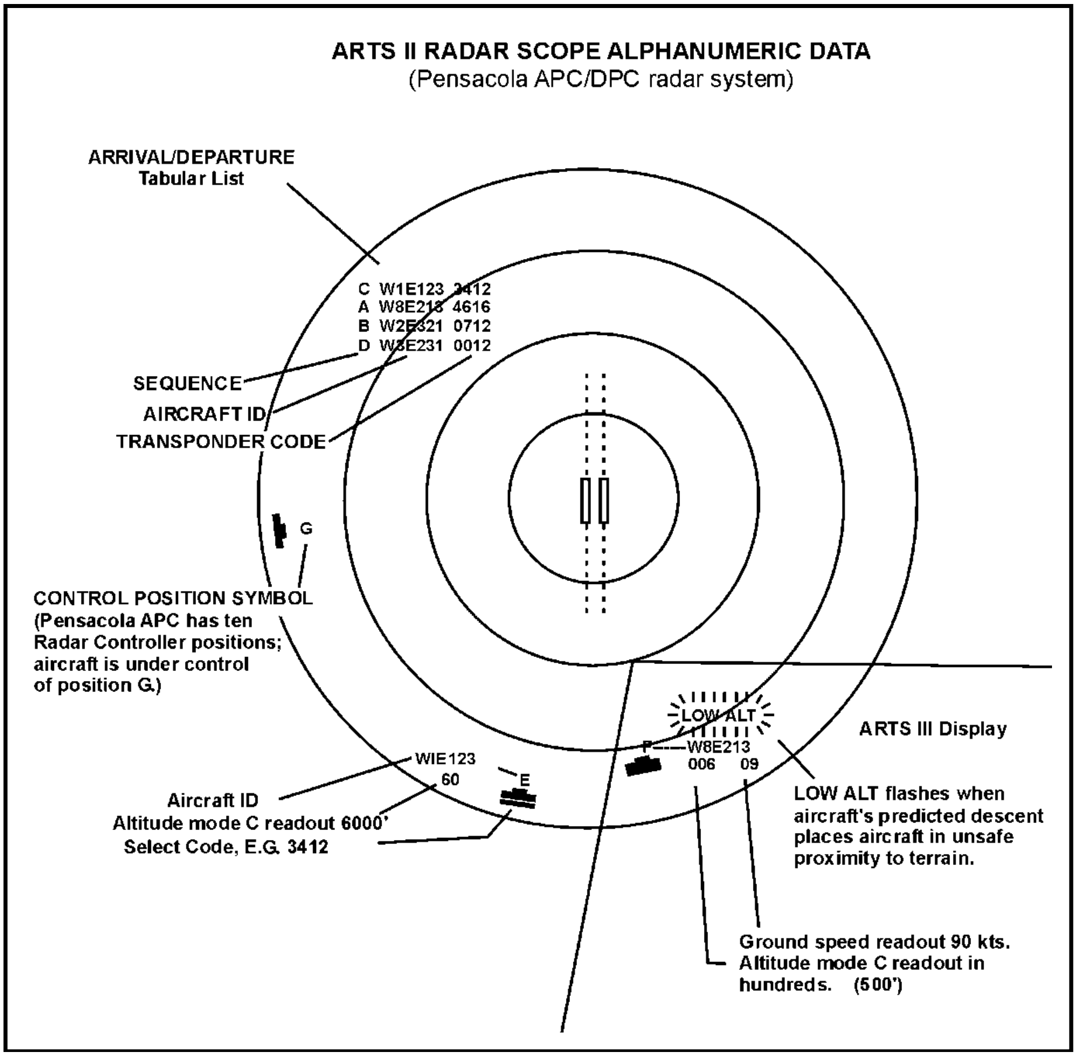

Figure 8-4 Radarscope Alphanumeric Data

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REVIEW QUESTIONS

1. What does the acronym IFF/SIF mean?

   a. ______________________________________
   b. ______________________________________

2. Low altitude aircraft show up better on Primary radar than high altitude ones. ___________ (True/False)

3. The pilot can alter Mode 3/A. ____________ (True/False)

4. The transponder emits a 23.5-second pulse each time it is struck by secondary radar. ___________ (True/False)

5. State the Mode 3/A codes for the following:

   a. Hijacking ____________
   b. Emergency ____________
   c. Lost Communications ____________

6. When should the Master Control Switch be rotated from SBY to the ALT position? ___________________ _____________________

7. The pilot can alter the Mode C response by changing the setting in the Kollsman window of his altimeter. ____________ (True/False)

8. The IDT push-button must be depressed for at least 5 seconds to enable the controller to detect the ident blip. ____________ (True/False)

9. How many Mode 3/A codes does the FAA authorize? ____________

10. Match the positions of the Master Control Switch with their function.

a.	OFF	1. Evaluate unit integrity	1.____________
b.	SBY	2. Unit replies to Mode 3/A only	2.____________
c.	ON	3. Unit energized, replies inhibited	3.____________
d.	ALT	4. Power secured	4.____________
e.	TST	5. Normal mode responding to Mode 3/A and C	5.____________

11. The primary reasons for the use of SIF and secondary radar are to eliminate unwanted targets on the radarscope, identify transponder-equipped aircraft, and to provide increased surveillance ranges. ____________ (True/False)

12. What Mode 3/A squawk will automatically supersede any previously selected squawk when the EMR push-button is depressed? ____________

13. If a hijacker does not allow you to get the hijacking code into the transponder, how may you indicate to the controller that you are being hijacked?

a. Declare an emergency.
b. Say you are squawking 7600 or mention you are being hijacked.
c. Mention that you are being hijacked.
d. While on the ground, switch from 7500 to 7700.

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REVIEW ANSWERS

1. a. Identification Friend or Foe
   b. Selective Identification Features
2. False
3. True
4. False
5. a. 7500
   b. 7700
   c. 7600
6. As late as practicable before takeoff
7. False
8. False
9. 4096
10. 1. e.
    2. c.
    3. b.
    4. a.
    5. d.
11. True
12. 7700
13. c.

CHAPTER NINE
GROUND CONTROLLED APPROACHES

900. INTRODUCTION

This chapter will introduce the student to characteristics and procedures of Radar Approaches.

901. LESSON TOPIC LEARNED OBJECTIVES

TERMINAL OBJECTIVE

Upon completion of this chapter and in response to questions and examples given on the post test, the student will recall the procedures and general information required for executing Ground Controlled Approaches. To successfully complete the unit post test, the student should achieve a minimum score of 80%.

ENABLING OBJECTIVES

1. List the two types of Ground Controlled Approaches.

2. Name the FLIP in which radar approach minimums and information is published.

3. List the differences between ASR and PAR approaches.

4. List OPNAV restrictions for radar approaches.

5. Define the terms that apply to ASR and PAR approaches.

6. State the instructions repeated by the pilot during the transition to final approach.

7. State the function of an "x" following a frequency.

8. State the time limit between voice communications on final approach before assuming lost communications.

9. State the rate-of-turn restrictions for ASR/PAR approaches.

10. State the importance of glideslope and groundspeed in establishing a rate of descent.

11. State the absolute approach minima for a single-piloted aircraft executing a precision approach.

12. State the requirements for a PAR/ASR missed approach.

13. List the procedures by which a pilot may receive altitude information while on an ASR approach.

14. List the lost communications procedures for ASR/PAR approaches.

15. List the missed approach procedures for ASR/PAR approaches.

16. List the procedures for a "no-gyro" approach.

17. Name the controlling agency that grants clearances for aircraft to land at airports.

18. Write the example voice reports using the correct phraseology for ASR/PAR approaches.

19. Apply the correct procedures for radar approaches.

902. GROUND CONTROLLED APPROACHES

Radar control is one of the most precise methods for performing an instrument approach. Radar controllers interpret radar displays and transmit course and glideslope information to pilots. As directed, the pilot flies the aircraft down the glideslope until he establishes visual contact with the landing area and is in a position to make a safe landing or he executes missed approach.

A radar approach system consists of an ASR and/or PAR, plus the associated communications equipment.

Information such as radar availability, type of approaches, communication frequencies, minimums, and glideslope angles can be found in the FLIP Low Altitude Instrument Approach Procedures. The availability of the ASR/PAR approaches is sometimes listed beneath the communications section in the upper left-hand corner of each approach plate. The absence of the ASR and/or PAR lists does not mean radar approaches are not available at that aerodrome. You must check the Radar Instrument Approach Minimums section in the front of the approach plates.

Runway and airfield pictorial information (e.g., length and width of runways, approach lighting, obstructions, and the relative positions of navigational aids) can only be found in the FLIP Low Altitude Instrument Approach Procedures (approach plates). The pilot is responsible for this information although is receiving radar vectors for the approach.

Precision approach radar only looks at a very small section of airspace so there must be some means of vectoring aircraft into that section of the sky. This is normally accomplished with radar vectors from an ASR controller or Approach Control, but can also be accomplished using other NAVAIDs. Once the aircraft has been "picked up" by the PAR controller, that controller can issue instructions for the descent and final approach course using the precision approach radar scopes. These scopes display course, range and glideslope information in a manner permitting a high degree of accuracy.

PAR weather minimums are frequently as low as 100 feet and ¼ mile visibility. This requires having several PAR installations if approaches to more than one runway are to be offered. Due to obstructions, etc., the minimums may be different for each approach.

The Surveillance Radar (ASR) scope depicts aircraft within the entire area around the airport, and can be used to vector aircraft to the final approach course as well as to fly the approach. Since this radar only indicates an aircraft's bearing and range from the airport, the ASR controller is not able to provide glideslope information. The pilot must control his own rate of descent to arrive at the missed approach point at the proper altitude.

In addition to the absence of glideslope information, ASR equipment is less accurate than PAR for final approach. Thus, course corrections will not be as precise or timely. Because of this, ASR weather minimums are higher than PAR minimums.

A radar approach may be given to any aircraft upon the pilot's request and may be offered to aircraft in distress or to expedite traffic. However, the pilot must adhere to OPNAVINST 3710.7 minimums for the type of aircraft as well as any NATOPS or squadron limitations when accepting an approach clearance. For example, OPNAV prohibits single-piloted aircraft from executing ***practice approaches*** (no landing intended) at the filed destination or alternate if the weather is below published minimums.

For the execution of this approach, the visibility minima may be reduced, per OPNAVINST 3710.7, to one-half the published visibility minimum for category A (helicopters) aircraft, but in no case may it be reduced to less than one-fourth of a mile or 1200 feet runway visual range (RVR). Remember, however, ***single-piloted absolute minimums are 200 feet ceiling/height above touchdown.***

Radar approach minimums have been established to provide an adequate margin of safety for an aircraft making a radar approach. These minimums are established based on the electronic accuracy of the equipment, the safe clearance of terrain or obstructions in the approach area, the runway environment, and the aircraft approach category. Therefore, these minimums should not be construed as an indication of the limitations of radar to assist a pilot in establishing visual contact with the landing area.

Two terms associated with approaches are "Decision Height" (DH) and "Minimum Descent Altitude" (MDA). DH applies to precision approaches -- approaches with glideslope information such as PAR and ILS. DH is the altitude, specified in feet above MSL, at which a missed approach shall be initiated when either visual reference has not been established with the runway environment or the aircraft is not in a position to make a safe normal landing. MDA applies to non-precision approaches -- approaches without glideslope information such as ASR, localizer, TACAN, VOR, and ADF. MDA is the altitude, specified in feet above MSL, below which descent will not be made until visual reference with the runway environment has been established **and** the aircraft is in a position to make a safe normal landing.

In summary - the pilot may not operate the aircraft below the prescribed MDA during an ASR approach, or continue a PAR approach below the DH unless:

1. The approach threshold of that runway, or approach lights or other markings identifiable with the approach end of that runway are clearly visible to the pilot ***and***;

2. The aircraft is in a position from which a normal safe approach to runway of intended landing can be made.

PAR and ASR approaches are divided into two segments, the transition to final and the ***final approach.*** The transition to final is supervised by radar controllers (Approach Control) and includes all maneuvering up to the point where the aircraft is inbound on the final approach course and about 5 to 9 miles from touchdown.

During the transition to final, the pilot must repeat all ***altimeter settings***. Unless otherwise advised, all other information may be simply acknowledged with a "Roger." Keep transmissions brief and specific, commensurate with safety of flight. During high density operations, a limiting factor is the communications time available (too many people on one frequency). Never sacrifice aircraft control to acknowledge receipt of instructions. Turns and descents should be initiated immediately after instructions are received.

To enable the controller to anticipate your position, all turns should be made at standard rate, but never more than 30° angle of bank. If aircraft or mission characteristics dictate very low turn rates, inform the controller and he will correct the instructions accordingly.

Because of the limited communication time available, there are special radio frequencies for radar approaches. If you wish to execute a radar approach you should contact Approach Control, and they will switch you over to an appropriate radar frequency. When a radio frequency is followed by an "x" (384.6x) it is available upon request. Many airports do not even list their radar frequencies because pilots calling to request an approach can disrupt approaches already in progress.

The following approach information will be transmitted to the pilot by the controller at some time before the final approach:

1. The latest altimeter setting.

2. The current weather and any subsequent changes.

3. The direction of landing and runway information.

The controller will advise the pilot to perform the landing check while the aircraft is on the downwind leg and in time to complete it before turning onto the base leg. If an incomplete pattern is used (modified base leg), the controller will issue this instruction before handoff to the final controller for a PAR approach, or before starting descent on the final approach for an ASR approach. The pilot should consider several factors before transitioning to the landing configuration: Fuel remaining, position in the approach, and possible aircraft emergencies.

The controller will inform the pilot of his position at least once before starting the final approach.

Example: Five miles south of the airport.
Downwind leg, eight miles north of the airport.

After the aircraft has been established inbound on the final approach, control will be transferred from the ASR controller to the final approach controller.

Example: "NAVY ONE ECHO ONE FIVE ONE, PENSACOLA APPROACH STAND BY FOR YOUR FINAL CONTROLLER."

On initial contact the final controller will ask for a communications check.

Example: "NAVY ONE ECHO ONE FIVE ONE, THIS IS YOUR FINAL CONTROLLER. HOW DO YOU HEAR ME?"

If communications are satisfactory, the controller will instruct the pilot not to acknowledge further transmissions while on the final approach.

Example: "DO NOT ACKNOWLEDGE FURTHER TRANSMISSIONS."

Before the aircraft begins the final descent, the controller will issue missed approach instructions according to the specific missed approach procedure approved for the radar approach in use if the procedure is different from the general rules found in the Flight Information Handbook.

Example: "IN THE EVENT OF MISSED APPROACH CLIMB STRAIGHT AHEAD TO ONE THOUSAND FIVE HUNDRED AND STAND BY FOR FURTHER INSTRUCTIONS."

Before the aircraft begins the descent on final, the controller will remind the pilot the wheels should be down.

If radar contact is lost during an approach and the aircraft has not started the final approach, the controller will clear the pilot to an appropriate NAVAID for an instrument approach. Once the aircraft has commenced the final approach, the pilot will be instructed to execute missed approach procedures.

Clearance to land can only be granted by the tower. However, to simplify the approach, the radar controller may obtain a landing clearance from the tower and relay it to the pilot. If this landing clearance cannot be obtained, or is canceled, the controller will inform the pilot and issue alternative instructions.

Example: "TOWER CLEARS YOU TO LAND ON RUNWAY ONE THREE LEFT; CONTACT GROUND CONTROL ON 341.0 AFTER LANDING."

Example: "LANDING CLEARANCE HAS BEEN CANCELED, EXECUTE MISSED APPROACH."

Compliance with a waveoff order from the tower is ***mandatory*** at all times. Consider that the tower may have knowledge of an obstruction on the runway (which the final controller may not know about) such as a crash truck or another aircraft. Only an inflight emergency in your aircraft can override the waveoff order.

903. LOST COMMUNICATIONS

Standard lost communications procedures are published in the Flight Information Handbook. Therefore, if you do not receive additional lost communications procedures, be absolutely certain you understand the general rules. Do not hesitate to request additional information, if necessary. As soon as practical after establishing the aircraft's identification, the controller will inform the pilot of the procedures to follow (if they are different from the general rules, usually the pilot will follow the lost communications procedure) if voice communications are lost for a specified amount of time, i.e., not more than ***one minute*** -- during the transition before final approach.

Example: IF NO TRANSMISSIONS ARE RECEIVED FOR ONE MINUTE IN THE PATTERN (alternative procedures)

If voice communications are lost during the ***final approach*** segment, the specified time is **15 seconds** on a surveillance approach or **5 seconds** on a precision approach.

ASR Example: IF NO TRANSMISSIONS ARE RECEIVED FOR ONE MINUTE IN THE PATTERN, OR FOR FIFTEEN SECONDS ON FINAL APPROACH, ATTEMPT CONTACT ON (frequency) AND if possibility exists, PROCEED VFR; IF UNABLE: if approved, PROCEED WITH (nonradar approach) or (alternative instructions)

In the arrival phase of flight, pilots shall read back all altimeter settings received from approach control agencies during instrument approaches, entering and departing holding patterns, and during all approaches to a landing. (Exception: When under the control of the final controller on a PAR approach and the pilot has been released from further transmission requirements.)

904. PRECISION FINAL APPROACH

The final approach starts when the aircraft is within range of the precision radar and voice contact is established with the final controller. The controller will issue final approach course guidance and altitude corrections as necessary. Before the aircraft intercepts the glideslope, the controller will provide the decision height to any pilot who requests it.

NOTE

The DH* will only be provided if it is requested.

*It will be published DH and may give only 100 feet HAT; use with extreme caution.

Before glideslope intercept, the pilot should slow to the appropriate approach airspeed. The controller will inform the pilot when the aircraft is approaching the glidepath (about 10 to 30 seconds warning). When the aircraft reaches the point where the final descent is to start, the controller will instruct the pilot to begin descent. When the controller advises the aircraft has ***intercepted the glidepath***, lower the collective to establish the predetermined rate of descent. The controller will inform the pilot when the aircraft is on glidepath and on course and frequently inform the pilot of any deviation from glidepath or course.

Example: "ASSIGNED HEADING 330. ON GLIDEPATH, ON COURSE."

Example: "SLIGHTLY ABOVE GLIDEPATH, SLIGHTLY LEFT OF COURSE. TURN RIGHT TO HEADING 335."

The controller will issue trend information as required to indicate target position with respect to the azimuth and elevation cursors on his scopes and to describe target movement as appropriate corrections are issued. Trend information may be modified by the terms "RAPIDLY" or "SLOWLY" as appropriate.

Example: "SLIGHTLY LEFT OF COURSE AND CORRECTING, GOING SLOWLY BELOW GLIDEPATH."

Maintain a ***constant airspeed*** throughout the approach by adjusting the attitude of the aircraft. Control the rate of descent with the collective. Once the desired airspeed and rate of descent have been obtained, note the torque, attitude, and VSI settings and use these as guides throughout the remainder of the approach.

Rate of descent on a PAR approach is dependent upon two factors, the glideslope's angle of elevation above the horizontal and the groundspeed of the aircraft. Most PAR approaches use a 3° glideslope. Glideslope information for individual approaches are found in the Low Altitude Approach Plates with the approach minimums (see Figure 9-1). Thus, the rate of descent should be about the same for most helicopters if all other factors are equal.

GLIDESLOPE

	RWY	GS/TCH/RPI	CAT	DH/ MDA-VIS	HAT/ HAA	CEIL-VIS
PARⓐⓑ	4L	2.6°/35/767	ABCDE	338/16	100	(100-¼)
	22R	2.8°/52/1072	ABCDE	341/16	100	(100-¼)
	22L	3.0°/39/749	ABCDE	335/16	100	(100-¼)
	4R	2.6°/34/752	ABCDE	337/16	100	(100-¼)
ASRⓐⓑ	22R		ABCD	660/40	419	(500-¾)
			E	660/50	419	(500-1)
	4L		ABC	720/50	482	(500-1)
			D	720/60	482	(500-1¼)
			E	720-1½	482	(500-1½)
	22L		ABCD	660/40	425	(500-¾)
			E	660/50	425	(500-1)
	4R		ABC	720/50	483	(500-1)
			D	720/60	483	(500-1¼)
			E	720-1½	483	(500-1½)
CIR	All Rwy		AB	800-1¼	559	(600-1¼)
			C	800-1½	559	(600-1½)
			D	840-2	599	(600-2)
			E	840-2½	699	(700-2½)

ⓐNo--NOTAM preventive maint sked: PAR-Mon-Fri 0930-1130Z ++, Sat-Sun 1500-1700Z++; ASR-Sat-Sun 1300-1500Z ++, Mon 0700-0900Z. ⓑWhen ASR is out, PAR not avbl unless acft has opr TACAN.

Figure 9-1 Glideslope Information

The groundspeed of the aircraft is just as important in determining the rate of descent as the glideslope angle. The glideslope is a fixed line in space which the aircraft should follow. Thus, the faster the aircraft moves over the ground the faster it must descend to remain on glideslope. Now you can see why it is so important to maintain a constant airspeed while on final. Each time you change your airspeed; you alter the groundspeed and must alter the rate of descent to remain on glideslope.

Accuracy of heading is most important during the final approach phase. When instructed to make heading changes, make them immediately. Instructions to fly a new heading will be preceded by the phrases "TURN LEFT" or "TURN RIGHT."

Example: TURN RIGHT TO HEADING 340.

To prevent overshooting, the angle of bank should approximate the number of degrees to be turned, but never more than a half-standard rate while on final. To turn 6°, use a 6° angle of bank. To turn 20°, use only a half-standard rate turn. After a new heading has been assigned, the controller will assume it is being maintained and will make new corrections (TURN LEFT 2°) in addition to the last assigned heading.

The controller will inform the pilot of the aircraft's distance from touchdown at least once each mile on final.

Example: "ON GLIDEPATH, ON COURSE, THREE MILES FROM TOUCHDOWN."

The controller will also inform the pilot when the aircraft reaches the published decision height.

Example: "DECISION HEIGHT, ON COURSE, ON GLIDEPATH."

This does not relieve the pilot of the responsibility of obeying OPNAVINST 3710.7 or NATOPS responsibility placed on his type of aircraft. For example, OPNAVINST 3710.7 approach minimums for a single-piloted helicopter executing a precision approach are 200 feet ceiling/height above touchdown or published minimums, whichever is higher, and ½-mile visibility or published minimums, whichever is higher. Remember, OPNAVINST 3710.7 authorizes the reduction of visibility to one-half the published minimums for Category A aircraft, and this reduction also applies to single-piloted helicopters. Therefore, absolute single-piloted helicopter minimums 200-1/4.

A pilot shall not descend below the MDA or continue an approach below the DH unless he has the runway environment in sight ***and***, in his judgment, there is no doubt a safe landing can be executed, either straight-in or from a circling approach, whichever is specified in the clearance. A missed approach shall be executed immediately upon reaching the missed approach point if the runway environment is not in sight or a safe landing cannot be made. For precision approaches, the point at which the glideslope elevation and the DH coincide shall be used to identify the missed approach point. On precision radar approaches, the pilot may expect instructions until over the landing threshold; however, course and glideslope information given after the aircraft has passed the DH shall be considered advisory in nature.

The controller will issue instructions to execute a missed approach, or climb and maintain a specific altitude and fly a specific course whenever the completion of a safe approach is questionable because of one or more of the following conditions:

1. Safe limits are exceeded or radical aircraft deviations are observed.

2. Position or identification of the aircraft is in doubt.

3. Radar contact is lost or malfunctioning radar is suspected.

4. The tower informs the controller that there are unsafe runway conditions which have forced the cancellation of the landing clearance.

Execution of the missed approach is ***not necessary*** for conditions 1., 2., and 3**. *if the pilot has the runway environment in sight.***

Example: "RADAR CONTACT LOST, IF RUNWAY OR APPROACH LIGHTS ARE NOT IN SIGHT EXECUTE A MISSED APPROACH."

In short, whenever the aircraft is in IFR conditions, an order by the controller to execute a missed approach shall be mandatory. However, under certain conditions, such as a malfunctioning radar, if you have established visual contact with the runway environment, the missed approach is optional. A missed approach because of reason 4. is always mandatory. If reasons 1., 2., or 3. apply, and the field is in sight, inform the controller you have the runway environment in sight and he will clear you as necessary.

The control tower is not required to tell the GCA controller the reason for issuing a waveoff order. Therefore, when you receive a tower-initiated waveoff, it is mandatory under all conditions.

905. SURVEILLANCE FINAL APPROACH

When the precision radar equipment is inoperative or not available for the landing runway, surveillance radar (ASR) can be used to furnish the information required to align the aircraft with the approach runway.

Surveillance approach instructions are similar to those received during the precision approach to the point of establishing the descent. Before starting final approach, the controller will inform the pilot of the runway to which the approach will be made. The controller will specify the name of the airport when the approach is to a secondary airport.

Example: "THIS WILL BE A SURVEILLANCE APPROACH TO RUNWAY ONE THREE AT NAVY JACKSONVILLE AIRPORT."

The controller will also specify the MAP in miles relative to the runway threshold.

If the pilot specifically requests it, the controller will give the recommended altitudes (MSL) each mile of the approach - down to the last mile, which is at or above the published MDA.

Example: "RECOMMENDED ALTITUDES WILL BE FURNISHED EACH MILE OF FINAL APPROACH EXCEPT THE LAST TWO MILES."

Recommended altitudes decrease 300 feet per mile (unless a level-off is directed). When instructed to descend, the pilot should establish a predetermined rate of descent based on 300 feet per mile, or approximately the same as for a 3° glideslope.

The rate of descent can be determined for an approach by consulting the RATE OF DESCENT TABLE in the back of any INSTRUMENT APPROACH PROCEDURES booklet. This table should be consulted before commencing the approach and is used primarily for ILS/PAR approaches where the glideslope is specifically stated. For ASR approaches, the glideslope is stated as 300 feet per mile. This is just a little less than 3°, so the table will not be exact for your desired rate of descent. For ASR approaches, the rate of descent can be found by multiplying the groundspeed by five.

Example: Indicated airspeed is 120 kts with a headwind of 15 kts. This equals a groundspeed of 105 kts. 105 times 5 equals 525. The correct rate of descent with 105 kts and groundspeed is 525 FPM.

Controllers will issue advance notice of where descent will begin and issue the straight-in MDA before issuing final descent instructions for a straight-in approach.

Example: "PREPARE TO DESCEND IN TWO MILES. PUBLISHED MINIMUM DESCENT ALTITUDE IS 1290."

If the pilot requests it, the controller will issue the circling MDA. When requesting the circling MDA, the pilot is expected to provide the approach category of his aircraft. The MDA for a particular runway is the same for all aircraft categories on a straight-in approach, but varies with different aircraft categories on a circling approach.

When the aircraft reaches the point where descent on an ASR final approach begins, the controller will advise the pilot to start the descent.

Example: "SIX MILES FROM THE RUNWAY, BEGIN DESCENT TO YOUR MINIMUM DESCENT ALTITUDE."

The controller will specify any altitude restrictions prescribed in the approach procedure.

Example: "FIVE MILES FROM THE RUNWAY, DESCEND AND MAINTAIN 1200 FEET."

After the aircraft has passed the altitude limiting obstruction, the controller will advise the pilot to continue the descent to the MDA.

The controller will issue course guidance and inform the pilot of the aircraft's distance each mile from the landing threshold. The controller will inform the pilot when the aircraft is on course, and will frequently inform the pilot of any deviation from course. Recommended altitudes will be furnished if requested. If the aircraft altitude is other than that given at these checkpoints, the rate of descent should be adjusted accordingly.

The controller will issue trend information as required to indicate aircraft position with respect to the extended runway centerline and to describe aircraft movement as appropriate corrections are issued. These course corrections are not as accurate as those on a PAR approach because of the less precise radarscope presentations. However, by accurately following the controller's directions, the aircraft should be within 500 feet left or right of the runway at one mile.

The controller will request the pilot to report sighting the runway, approach runway lights, or airport as appropriate at the missed approach point. Unlike a PAR approach where the final controller will key down the microphone so that the pilot cannot transmit voice, on an ASR approach there may be intervals of silence lasting up to 15 seconds where the pilot does have the opportunity to transmit voice. Once the pilot reports the runway environment in sight, the surveillance approach guidance may be discontinued and the pilot instructed to take over visually.

906. MISSED APPROACH

The controller will discontinue approach guidance and instruct the pilot to execute a missed approach if the pilot has not sighted the runway environment when the aircraft is at the missed approach point (usually one mile from the landing threshold).

Example: "ONE MILE FROM RUNWAY, IF RUNWAY LIGHTS NOT IN SIGHT EXECUTE MISSED APPROACH."

The missed approach procedures must be executed when:

1. PAR - The runway environment is not in sight upon reaching the DH.
ASR - The runway environment is not in sight upon reaching the missed approach point.

2. instructed by the final controller and the pilot is still in IFR conditions.

3. a safe landing is not possible.

4. directed by the control tower.

WARNING

> The missed approach is a most critical maneuver. Although the controller will render all possible assistance, it is the pilot's prime responsibility to have the aircraft safely under control (stop the sink rate and regain a safe altitude before attempting to comply with an issued heading). It is **not** expected that the pilot should attempt a turn at low altitude. Usually, missed approach instructions provide for a climb straight ahead to about 400 feet before a heading change of over 15º is directed.

If the heading indicator fails in flight, advise the radar controller and request a "no-gyro" approach. This approach may be either PAR or ASR, as previously discussed. Before issuing a vector, the controller will inform the pilot of the type of approach and the manner in which turns are to be made.

Example: "THIS WILL BE A NO-GYRO APPROACH TO RUNWAY 13. MAKE ALL TURNS STANDARD RATE."

If unable to comply with this turn rate, alert the controller and he will use this information to help in determining different lead points for turns and heading corrections. The controller will instruct the pilot when to start and stop the turns.

Example: "TURN RIGHT . . . STOP TURN."

Turns should be executed immediately upon receipt of the instruction to turn left or right.

After the aircraft has turned onto the final approach, the controller will instruct the pilot to make half-standard rate turns for the duration of the approach. The approach will be performed just like a regular approach, except you will not be told to turn to a particular heading, and you will not be told to turn a certain number of degrees, but rather to start turns and stop turns.

907. SUMMARY OF VOICE PHRASEOLOGY FOR RADAR-CONTROLLED APPROACHES

General

This section promulgates basic voice procedures for the control of air traffic during radar approaches. This section is further divided into three subsections: Basic Pattern, Surveillance Final Approach, and Precision Final Approach.

Pattern Controller

THIS IS PENSACOLA GCA (Radar identification or reidentification).

PERFORM LANDING CHECK (on downwind in time for the pilot to complete it before base leg).

Inform the aircraft of its position at least once before starting final approach.

DOWNWIND/BASE LEG (number of miles) MILES (direction) OF AIRPORT.

ASR ONLY -- If the pilot requests recommended altitudes:

RECOMMENDED ALTITUDES WILL BE FURNISHED EACH MILE ON FINAL APPROACH EXCEPT THE LAST MILE.

If the pilot requests a low approach, DO NOT DESCEND BELOW 200 OR CLIMB ABOVE 700 UNTIL TWO MILES OUT.

If applicable -- AFTER COMPLETING TOUCH AND GO/LOW APPROACH MAINTAIN 700 UNTIL TWO MILES OUT.

YOUR MISSED APPROACH PROCEDURE IS CLIMB STRAIGHT AHEAD TO 1500 AND STAND BY FOR FURTHER INSTRUCTIONS (ONLY GIVEN IF NECESSARY).

Surveillance Final Approach

THIS IS YOUR FINAL CONTROLLER, HOW DO YOU HEAR ME?

DO NOT ACKNOWLEDGE FURTHER TRANSMISSIONS.

(Before aircraft descent)

WHEELS SHOULD BE DOWN.

HEADING____________, ____________MILES FROM RUNWAY, PREPARE TO DESCEND IN ONE MILE, PUBLISHED MINIMUM DESCENT ALTITUDE____________.

HEADING____________, ____________MILES FROM RUNWAY, DESCEND TO YOUR MINIMUM DESCENT ALTITUDE.

Ranges and headings should be given each mile on final.

If the pilot requests recommended altitudes:

5 MILES FROM RUNWAY, ALTITUDE SHOULD BE 1500 FEET.

4 MILES FROM RUNWAY, ALTITUDE SHOULD BE 1200 FEET.

3 MILES FROM RUNWAY, ALTITUDE SHOULD BE 900 FEET.

2 MILES FROM RUNWAY, ALTITUDE SHOULD BE 600 FEET.

1 MILE FROM RUNWAY, MINIMUM DESCENT ALTITUDE (MDA) - (not spoken).

TWO AND ONE-HALF MILES FROM RUNWAY, WIND______DEGREES AT________. CLEARED TO LAND/TOUCH AND GO/LOW APPROACH (specify runway number left/right).

1 MILE FROM RUNWAY (see below)
VFR Conditions --full stop or touch and go

TAKE OVER VISUALLY.

Low approach

LEVEL OFF, TAKE OVER VISUALLY AND COMPLETE YOUR LOW APPROACH.

IFR Conditions -- issue only if pilot has not previously reported either runway or approach/runway lights in sight. (Distance) MILE(S) FROM RUNWAY. IF RUNWAY ENVIRONMENT NOT IN SIGHT, EXECUTE MISSED APPROACH. (Alternative instructions.)

Precision Final Approach

THIS IS YOUR FINAL CONTROLLER, HOW DO YOU HEAR ME?

Provide the decision height to any pilot who requests it.

THE PUBLISHED DECISION HEIGHT IS (number of feet).

DO NOT ACKNOWLEDGE FURTHER TRANSMISSIONS.

WHEELS SHOULD BE DOWN.

APPROACHING GLIDEPATH.

BEGIN DESCENT.

Issue trend information.

SLIGHTLY LEFT OF COURSE, ON GLIDE PATH; ON COURSE, ON GLIDE PATH; ON COURSE, BELOW GLIDE PATH.

Inform the aircraft of its distance from touchdown at least once each mile on final approach:

THREE MILES FROM TOUCHDOWN, ON COURSE, ON GLIDE PATH

TWO AND ONE-HALF MILES FROM TOUCHDOWN, WIND______DEGREES AT________ KNOTS, CLEARED TO LAND (or LOW APPROACH or FOR TOUCH AND GO) (depending on what the pilot has requested and Tower has authorized.) If the pilot has requested a touch and go or low approach, specific climb-out procedures will normally be issued for rejoining the GCA pattern, separate from the missed approach instructions.

Approximately one-half to one mile from touchdown expect the decision height call:

AT DECISION HEIGHT, PROCEED VISUALLY, IF RUNWAY NOT IN SIGHT EXECUTE MISSED APPROACH.

Depending on when the pilot acquires visual reference to the runway, he may be directed to contact the Tower before landing or be told:

“CONTACT NORTH WHITING TOWER (frequency) AFTER LANDING”. GCA will sometimes continue trend calls until the aircraft is over the landing threshold.

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REVIEW QUESTIONS

1. The two radar approach systems are ___________ .

   a. VOR and TACAN
   b. PAR and ILS
   c. ASR and PAR
   d. GCA and LOC

2. The weather minimums for radar approaches are found in FLIP ____________.

   a. Enroute (VFR) Supplement
   b. Enroute (IFR) Supplement
   c. Approach Plates
   d. AP-1

3. Unless otherwise instructed, pilots must read back all ____________ instructions during the transition to final approach.

   a. Heading, altitude and missed approach
   b. Missed approach
   c. Altimeter, heading and altitude
   d. Altitude and heading

4. If a pilot requests a circling radar approach and requests MDA information from the controller, the pilot must provide the controller

   a. the approach category of his aircraft.
   b. the weather minima for his category of aircraft.
   c. the duty runway he desires.

5. Precision approaches do not provide ____________ information.

   a. final approach course
   b. final approach glideslope
   c. distance from landing threshold
   d. groundspeed

6. During a PAR RWY 29 approach to Dobbins ARB (Vol 18) the DH for a single-piloted aircraft is 1215 feet MSL.

   a. True b. False

7. Which FLIP publication, normally available to a pilot in flight, lists the lost communication procedures for radar approaches at each airport?

a. Enroute (IFR) Supplement
b. Approach Plates
c. Area Charts
d. FIH

8. A pilot may not descend below the DH or MDA until visual reference has been established with the ___________ and the aircraft is in position to execute a ____________.

a. Runway environment, normal landing
b. Airport, missed approach
c. VORTAC, normal landing
d. Field boundary, missed approach

9. A frequency for a radar approach, as listed in the Enroute (IFR) Supplement, followed by an "x" means ____________.

a. For use by aircraft in the high altitude airway structure only
b. The frequency is continuously monitored
c. That a facility can only transmit on that frequency
d. The frequency is available upon request

10. A pilot on final for a radar approach at an airport with an operating control tower would be granted clearance to land from ____________.

a. ASR controller
b. PAR final approach controller
c. Approach control
d. Tower

11. If a headwind decreases while on a radar final approach, the rate of descent must be ____________ to stay on glideslope.

a. Decreased
b. Increased
c. Constant

12. A controller may issue a clearance for an approach regardless of an airfield's actual weather at the time the clearance is issued.

a. True b. False

13. The rate of descent table can be found in FLIP

a. Enroute (VFR) Supplement.
b. Enroute (IFR) Supplement.
c. Approach Plates.
d. FIH.

14. During the transition to final approach on a "no-gyro" approach, all turns should be made using ____________ rate turn, while on final ____________ rate turns should be used.

a. Half-standard, standard
b. Standard, half-standard
c. Standard, quarter-standard
d. Half-standard, quarter-standard

15. At pilot request, recommended altitudes will be provided each ____________ on an ASR approach.

a. ¼ mile
b. ½ mile
c. 1 mile
d. 2 miles

16. A radar controller will assume the pilot is flying the ____________ heading when giving a course correction and "trend" information.

a. Final approach
b. Course intercept
c. Teardrop
d. Last assigned

17. The rate of descent or glideslope of an ASR approach is ____________.

a. 300 feet per minute
b. Listed in the Enroute (IFR) Supplement
c. 300 feet per mile
d. Equal to 3°

18. A pilot would consult the FLIP ____________ for information such as length and width of runways, approach lighting and obstructions at IFR airports.

a. Enroute (VFR) Supplement
b. Enroute (IFR) Supplement
c. Low Altitude Instrument Approach Procedures
d. Low Altitude Enroute Charts

19. Military pilots of single-piloted aircraft may not accept a clearance for a practice approach when the weather is below the published minimums

a. at any airport.
b. if no landing is intended
c. at the filed destination.
d. at the departure airfield.

20. To enable the controller to anticipate your position during the transition to final, all turns should be make at ____________, but never more than _______________.

a. 30-degree angle of bank, half-standard rate
b. 15-degree angle of bank, standard rate
c. Standard rate, 30 degree angle of bank
d. Standard rate, 20 degree angle of bank

21. During the transition to final, if voice communications are lost for more than ____________, the pilot should execute lost communication procedures

a. 2 minutes
b. 1 minute
c. 30 seconds
d. 15 seconds

22. Once the aircraft is on final approach, if voice communications are lost for more than ____________ for an ASR approach and ____________ for a PAR approach, the pilot should execute lost communication procedures.

a. 30 seconds, 15 seconds
b. 15 seconds, 5 seconds
c. 5 seconds, 15 seconds
d. 10 seconds, 5 seconds

23. If radar contact is lost during a radar approach during the transition to final, the controller will:

a. Clear the aircraft to an appropriate NAVAID for an instrument approach.
b. Expect the pilot to continue VFR.
c. Expect the pilot to execute lost communication procedures.
d. Instruct the pilot to execute missed approach procedures.

24. Glideslope information for individual PAR approaches can be found in the FLIP ____________.

a. Enroute (IFR) Supplement
b. Approach Plates
c. Low Altitude Enroute Charts
d. FIH

25. Absolute minima for a single-piloted aircraft executing a precision approach are ______ feet ceiling and ______ -mile visibility or published minima, whichever is higher.

a. 300, One
b. 1000, 3
c. 200, ½
d. 100, ¼

26. A missed approach order from the final controller because the position or identification of the aircraft is in doubt is ____________ if the pilot has the field in sight.

a. Mandatory
b. Optional
c. Predictable
d. Mandatory during a "no-gyro" GCA

27. The MDA for a straight-in ASR approach to a particular runway is the same for _______________.

a. all standard card pilots
b. all special card pilots
c. all aircraft categories
d. all other runways at that airport

28. Unlike a PAR approach, the controller will request the pilot executing an ASR approach to report

a. beginning descent to MDA.
b. final approach fix inbound.
c. level at the MDA.
d. field/runway in sight.

29. During a "no-gyro" radar approach, a pilot would disregard his

a. attitude gyro.
b. heading gyro.
c. turn needle.
d. torque meter.

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REVIEW ANSWERS

1. c.
2. c.
3. c.
4. a.
5. d.
6. a.
7. d.
8. a.
9. d.
10. d.
11. b.
12. a.
13. c.
14. b.
15. c.
16. d.
17. c.
18. c.
19. c.
20. c.
21. b.
22. b.
23. a.
24. b.
25. c.
26. b.
27. c.
28. d.
29. b.

APPENDIX A
GLOSSARY

A100. NOT APPLICABLE

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APPENDIX B
TACTICAL AIR NAVIGATION (TACAN)

General

Although VOR was a great improvement over earlier navigational systems, a gap still existed in the information available when navigating. The TACAN system was developed to fill this gap by providing information needed for precise geographical fixing of the aircraft's position. In addition to the displayed bearing information, TACAN adds a continuous display of range information. Like VOR, TACAN provides 360 courses radiating from a station. DME, an integral part of TACAN, provides continuous slant-range distance information. An additional advantage is that TACAN ground equipment is compact and relatively easy to transport. This provides great versatility in beacon installation and mobility. Stations that have VOR and TACAN systems collocated are called VORTAC stations.

Frequencies and Ground Equipment

1. Frequencies. TACAN operates in UHF (1000 megahertz) band with a total of 126 two-way channels in the operational mode (X or Y). The DME air-to-ground frequencies for these channels are in the 1025 to 1150 megahertz range and the associated ground-to-air frequencies are in the 962 to 1213 megahertz range.

2. Ground Equipment. TACAN ground equipment consists of a rotating type antenna for transmitting bearing information and a receiver-transmitter (transponder) for transmitting distance information. The TACAN station is identified by an international Morse-coded tone modulated at 1350 MHz with a reception interval of approximately 35 seconds. Permanent TACAN ground stations are usually dual transmitter equipped (one operating and one on standby), fully monitored installations which automatically switch to the standby transmitter when a malfunction occurs. The ground monitor, set to alarm at any radial shift of plus or minus 1°, is usually located in the base control tower or approach control and sets off a light and buzzer to warn the ground crew when an out-of-tolerance condition exists. Sometimes TACAN reception might be suspected of being in error or bearing/distance unlock conditions might be encountered in flight. When this occurs, call ATC to check the status of the ground equipment. When ground equipment is undergoing tests or repairs which might cause it to transmit erroneous signals, its identification is silenced. Therefore, identification signals can be heard during flight.

Signal Patterns

The signal pattern for bearing information is formed by varying the nondirectional pattern sent from the stationary central element of the TACAN transmitter antenna. The two types of bearing signal patterns are the coarse and fine azimuth patterns.

1. Coarse Azimuth Pattern. This pattern is created by rotating a plastic cylinder around the central element of the antenna is 15 revolutions per second (RPS). A metal wire embedded vertically in the cylinder distorts the radiated signal into a cardioid (heart-shaped) pattern. Its

rotation causes the cardioid pattern to also revolve at 15 RPS. This resulting rotating pattern is referred to as the coarse pattern. From this, the aircraft receives an amplitude modulation of 15 cps. This means that the strength of the signal goes from maximum to minimum and back to maximum at the rate of 15 cps.

2. Fine Azimuth Pattern. To produce the fine pattern, another larger plastic cylinder containing nine wires is mounted around the central element and the smaller cylinder, and also rotates 15 RPS. This is the fine antenna which superimposes nine lobes on the already formed coarse pattern. This forms a 135 cps signal.

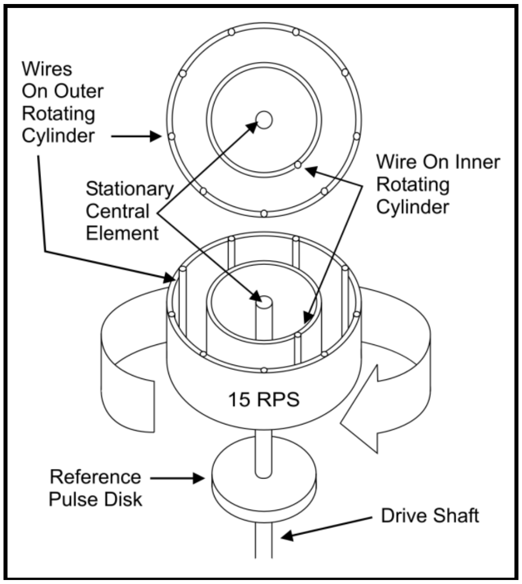

Figure B-1 TACAN Ground Beacon Antenna

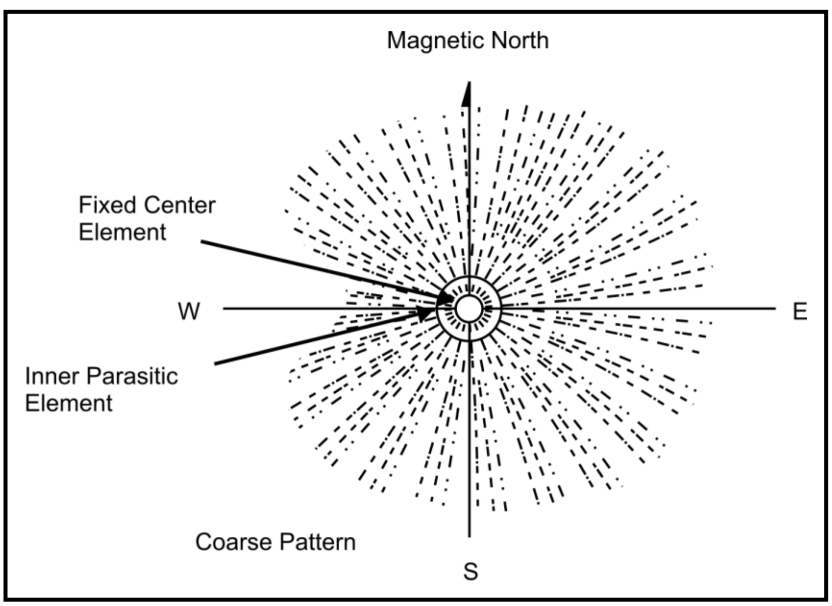

Figure B-2 Cardioid Pattern

3. Determination for Bearing. To determine the aircraft's bearing from the station, a phase angle must be electronically measured. To measure the phase signal, a fixed reference is established. This fixed reference is a 15 pulse-per-second nondirectional signal normally referred to as the main reference bearing pulse. One main reference pulse occurs with each revolution of the antenna when the peak of the cardioid is at a magnetic direction of 90°. In addition to the main reference pulse, eight auxiliary reference pulses also occur during one revolution of the ground beacon antenna. Therefore, a reference pulse occurs each 40° of antenna rotation (360° ÷ 9 pulses). The airborne equipment electronically measures the time lapse between the main reference pulse and the maximum amplitude (signal strength) of the 15 hertz rotating signal pattern. This determines the aircraft's bearing from the station within a 40° sector. Then, the time lapse between the auxiliary reference pulses and the maximum amplitude of the 135 hertz signal is measured to determine the aircraft's position within the 40° sector. The accuracy of this measurement determines the position of the aircraft relative to the station within ± 1° DME.

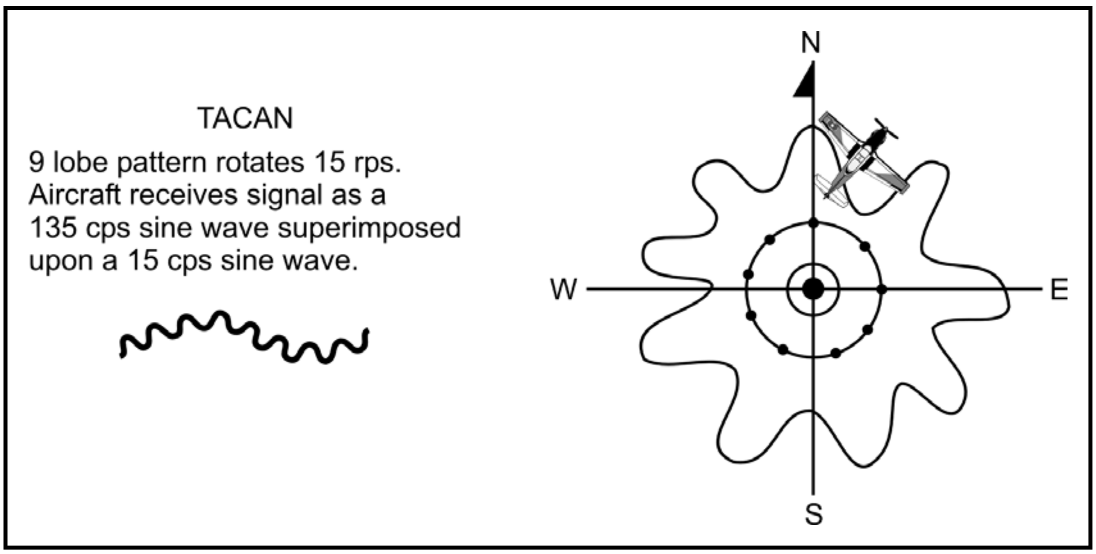

Figure B-3 Fine Azimuth Pattern

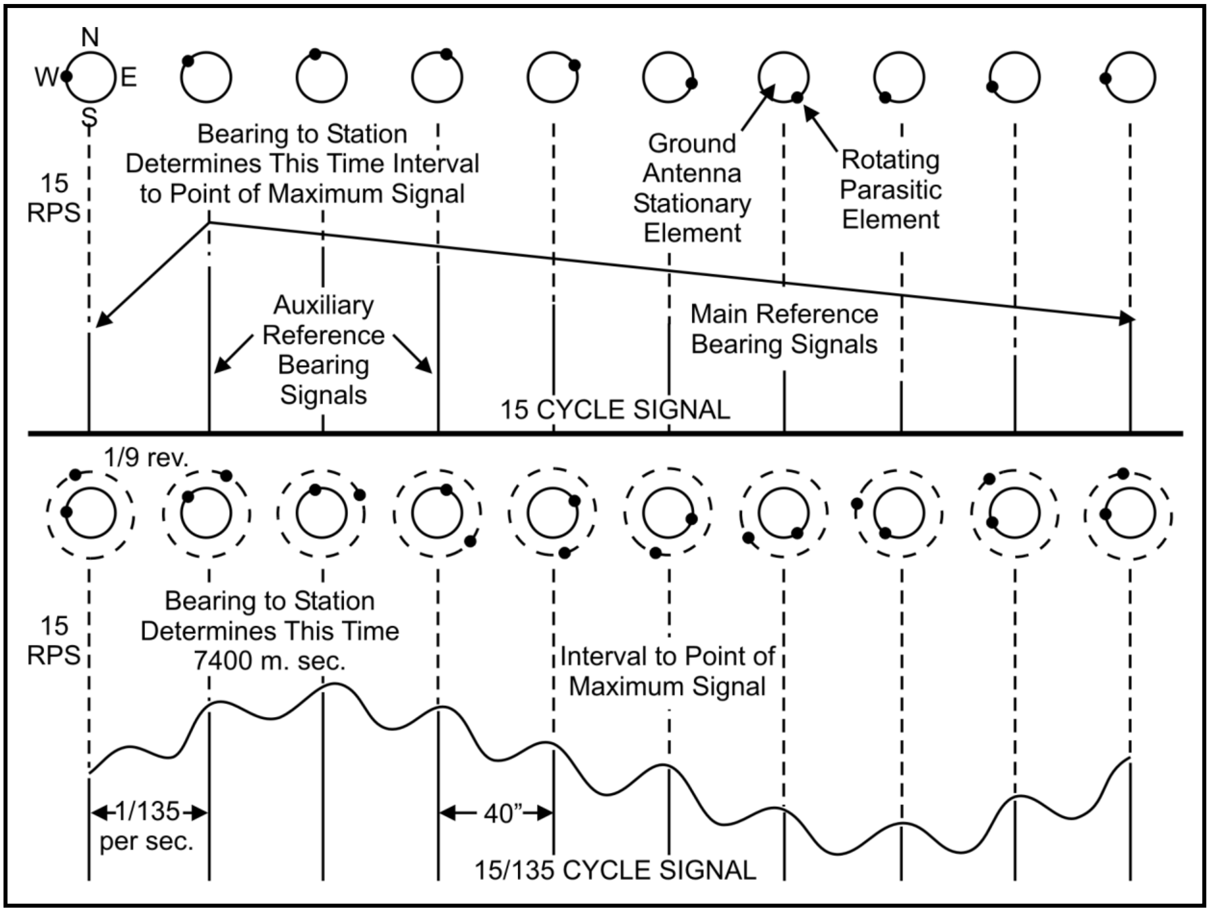

Figure B-4 Combination of Signal Received by Aircraft

Distance between the aircraft and the ground station is determined with DME equipment by measuring the elapsed time between transmission of interrogating pulses of the airborne set and reception of corresponding reply pulses of the ground station. The aircraft transmitter starts the process by sending out the distance interrogation pulse signals. Receipt of these signals by the ground station receiver triggers its transmitter which sends out the distance reply pulse signals. These pulses require approximately 12 microseconds round trip travel time per nautical mile of distance from the ground beacon. The range indicator displays slant-range distance to the TACAN beacon in natural miles. Since a large number of aircraft could be interrogating the same beacon, any particular airborne set must sort out only the pulses which are replies to its own interrogations. Interrogation pulses are transmitted on an irregular, random basis by the airborne set which then "searches" for replies synchronized to its own interrogations. If the signals are interrupted, a memory circuit maintains the last distance indication on the range indicator for approximately 10 seconds after the airborne set is tuned to a new beacon or when there is a major interruption in beacon signals. Depending upon the aircraft's actual distance from the beacon at the time, the searching process may require up to 22 seconds.

TACAN Characteristics

1. Bearing/Distance Unlock. TACAN bearing and distance signals are subject to line-of-sight restrictions because of their utilization of UHF frequencies. Because of the transmission/reception principles, unlock (indicated by rotating of bearing pointer and/or range indicator) will occur if these signals are obstructed. Temporary obstruction of TACAN signals can occur in flight when aircraft fuselage, wing, or gear; external stores; or wingmen get between the ground and the aircraft antenna. Aircraft receiver memory circuits prevent unlock for short periods (approximately 10 seconds for DME and 2 seconds for azimuth.) But beyond this unlock occurs and will persist until the obstruction is removed and search cycles are completed. Unlock may occur during maneuvers, such as procedure turns, which cause the aircraft antenna to be obstructed for longer than 2 to 10 seconds.

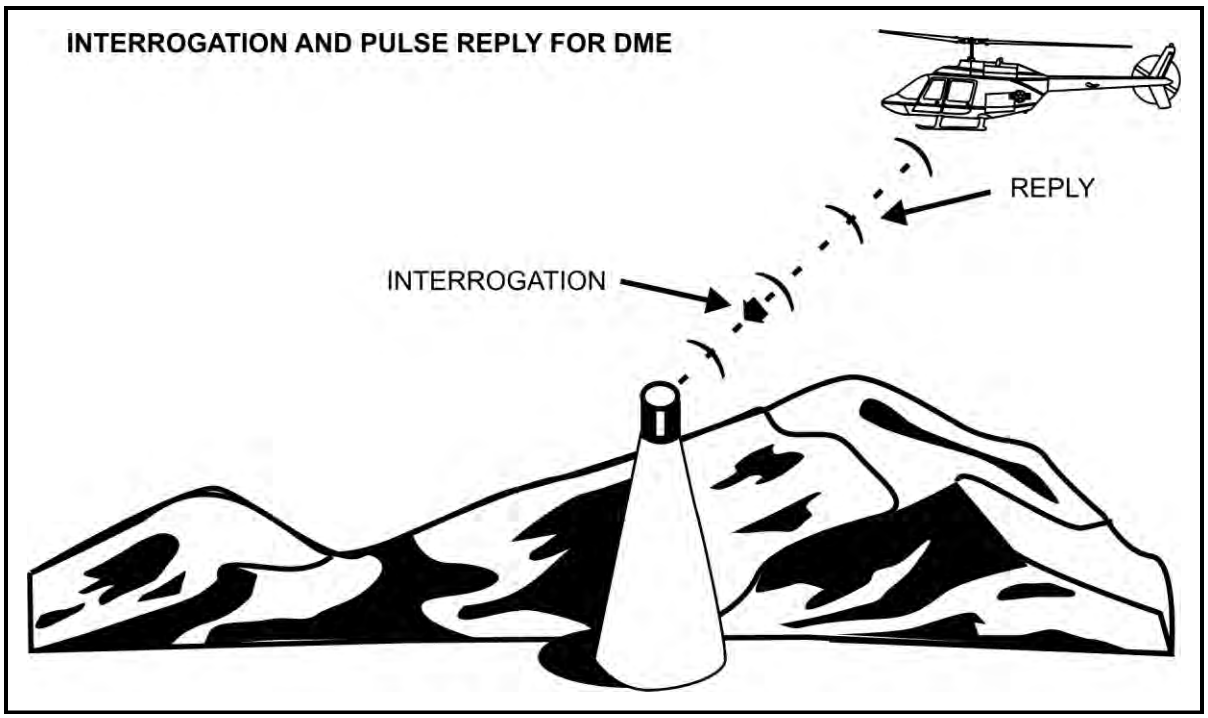

Figure B-5 DME Principles

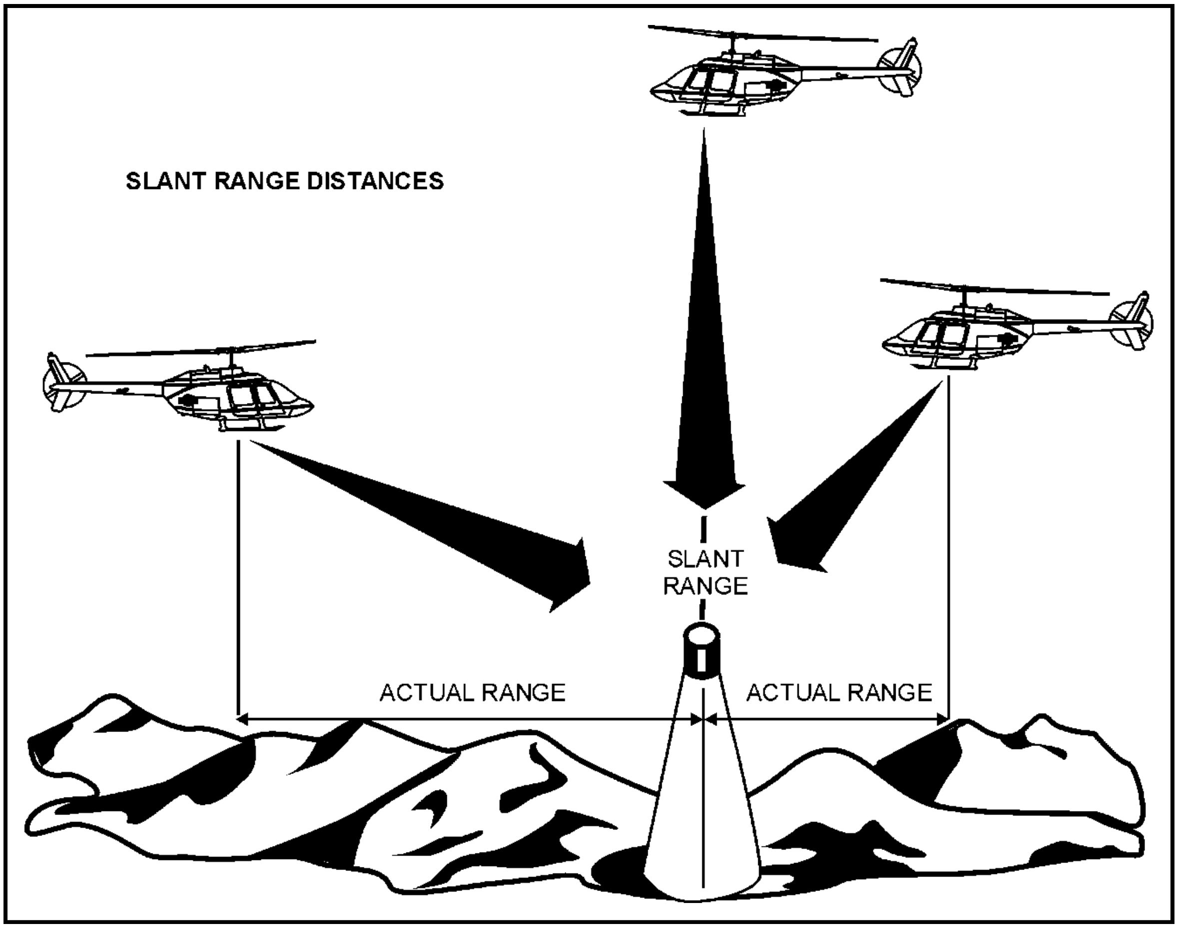

Figure B-6 DME Distances

2. The Azimuth Cone of Confusion. The structure of the azimuth cone of confusion over a TACAN station is considerably different from other NAVAIDs. The azimuth cone can be up to 100° or more in with approximately 15 nautical miles wide at 40,000 feet. Indications on the aircraft instruments make it appear even wider. Approaching the TACAN station, usable azimuth information is lost before the actual cone is reached. This is correct even though actual azimuth unlock is prevented by the memory circuit until after the aircraft has entered the cone. After the cone is crossed and usable signals are regained, the search cycle extends the unusable area beyond the actual cone. Only azimuth information is unusable in the cone of confusion; slant-range distance information continues to be displayed on the range indicator.

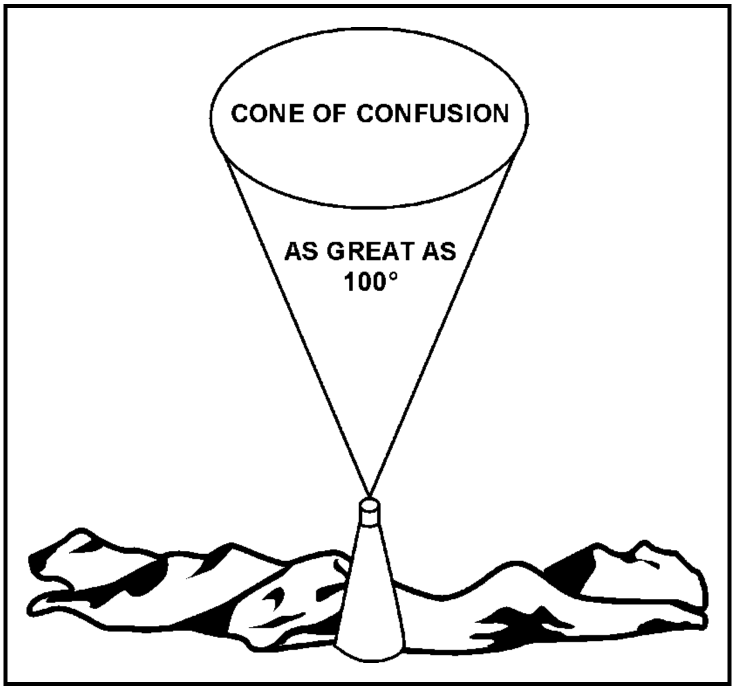

Figure B-7 TACAN Azimuth Cone of Confusion

3. Range Indicator Fluctuations. Slight oscillations up to approximately ¼ NM are normal for range indicator operation. When a usable signal is lost, the memory circuit maintains the indicated range for about 10 seconds. If the signal is regained during this period, the indicator will "jump" to the correct reading.

4. Erroneous TACAN Indications. Several forms of malfunction of airborne equipment or interference between ground stations can give false or erroneous TACAN navigational information to an aviator. These discrepancies are easier to recognize and guard against if the aviator is aware they can occur. The more common erroneous indications are:

a. A 40° azimuth error lock-on/off. The construction of the TACAN ground antenna is such that if transmits a series of nine signal lobes (eight auxiliary and one main reference pulse) 40° apart. With the airborne receiver working correctly, the main reference pulse (which occurs when the peak of the rotating cardioid pattern is at the 90° slot of the receiver, the main reference pulse may "slide over" or miss the 90° slot and lock on at one of the auxiliary positions. When this occurs, azimuth indications will be 40° or some multiple of 40° in error. Rechanneling (returning) the airborne receiver to deliberately cause unlock may cause the receiver to lock on properly. When other bearing information such as VOR or ADF is available, it should be used to verify the position periodically. This type error is unusual, but possible in present day TACAN sets.

b. Co-channel interference. Co-channel interference occurs when an aircraft is in a position to receive TACAN signals from more than one ground station on the same frequency. Normally this occurs only at very high altitudes when distance separation between like frequencies is inadequate. DME, azimuth, or identification from either ground station may be received. This is not a malfunction of either air or ground equipment, but a result of interfering signals of two ground facilities.

c. False or incorrect lock-on. False or incorrect lock-on indications in the aircraft can be caused by misalignment or excessive wear of the airborne crystal selector assembly. Selection of a numbered TACAN channel activates a drum and wiper arrangement which rotates until the wiper contacts the proper crystal on the drum. These crystal contact points are very small and close together. Wear or misalignment can cause the wiper to miss the proper crystal and contact the wrong one. This can result in no station being tuned in or the wrong station. When this occurs, rechanneling of the may result in the correct channel being selected.

5. Precautionary Actions. The following precautionary actions should be taken to guard against in-flight use of erroneous navigational signals:

a. ALWAYS check the identification of any NAVAID station and monitor it during flight.

b. ALWAYS use all suitable navigational equipment aboard the aircraft and cross-check heading and bearing information.

c. NEVER overfly preplanned estimated time of arrivals without careful cross-check of NAVAIDs and ground checkpoints.

d. CHECK notices to Airmen (NOTAMs) and FLIP before flight for possible malfunctions or limitations on NAVAIDs to be used.

e. DISCONTINUE USE of any suspected NAVAID and confirm aircraft position with radar or other equipment.

APPENDIX C
LIST OF PUBLICATIONS

The naval aviator should be familiar with the following list of publications.

		Publication Cycle
1.	Low Altitude Instrument Approach Procedures (Vols. 1 - 22)	8 weeks
2.	Enroute Low Altitude Charts (L-1 to L-36)	8 weeks
3.	Area Charts (A-1 and A-2)	8 weeks
4.	IFR Enroute Supplement	8 weeks
5.	VFR Enroute Supplement	24 weeks
6.	Area Planning (AP/1, AP/2, AP/3, AP1A, and AP1B)	8 & 16 weeks
7.	VFR Sectional Charts	
8.	General Planning (GP)	32 weeks
9.	Flight Information Handbook	32 weeks
10.	Airman's Information Manual	2 years
11.	OPNAV Instruction 3710.7	As needed
12.	NATOPS Instrument Flight Manual	As needed
13.	Foreign Clearance Guide	Quarterly

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