BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE MANUAL 11-217, VOLUME 1

22 OCTOBER 2010

Flying Operations

INSTRUMENT FLIGHT PROCEDURES

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RELEASABILITY: There are no releasability restrictions on this publication

OPR: HQ AFFSA/A3OF

Supersedes: AFMAN11-217V1, 3 January 2005

Certified by: HQ USAF/A3O-B (Mr. Steven Pennington)

Pages: 285

This instruction implements AFPD 11-2, *Flight Rules and Procedures*, by providing guidance and procedures for standard Air Force instrument flying. Since aircraft flight instrumentation and mission objectives are so varied, this instruction is necessarily general regarding equipment and detailed regarding accomplishment of maneuvers. The guidance found in this manual is both technique and procedure. ***Text depicted in bold italics is procedure.*** Compliance with procedures is the responsibility of the pilot but their completion may be delegated to other crewmembers in multicrew aircraft. Individual aircraft flight manuals should provide detailed instructions required for particular aircraft instrumentation or characteristics. This manual, when used with related flight directives and publications, provides adequate guidance for instrument flight under most circumstances, but is not a substitute for sound judgment. Circumstances may require modification of prescribed procedures. Aircrew members charged with the safe operation of United States Air Force aircraft must be knowledgeable of the guidance contained in this manual. This publication applies to the Air National Guard (ANG) and the Air Force Reserves. This publication is applicable to all USAF aircraft, to include Unmanned Aerial Vehicles (UAS), unless specifically exempted in the text of the manual. This manual applies to all military, civilian and/or contractor personnel operating USAF aircraft.

Note: This manual is designed to complement AFI 11-202, Volume 3 *General Flight Rules*. While General Flight Rules instructs aircrews in WHAT to do, AFMAN 11-217 instructs aircrews in HOW to do it. In case of conflict between this manual and AFI 11-202V3, AFI 11-202V3, takes precedence.

WAIVERS: In general, waivers are not granted to AFMAN 11-217 as this manual describes procedures for complying with rules in AFI 11-202V3. Waivers are more appropriately granted to the rules in General Flight Rules. Waivers granted to AFI 11-202V3 also apply to corresponding applicable sections of AFMAN 11-217. A separate waiver is not required. If a MAJCOM desires a waiver to a bold italic procedure in AFMAN 11-217 that is not addressed in General Flight Rules, comply with the Waiver and Exemption guidance in AFI 11-202V3.

Note: The Aeronautical Information Manual (AIM) published by the Federal Aviation Administration (FAA) is not regulatory. However, it provides information that reflects examples of operating techniques and procedures that may be requirements in other regulations. AIM is not binding on USAF aircrews. Furthermore, it contains some techniques and procedures not consistent with USAF mission requirements, regulatory guidance, waivers, exemptions, and accepted techniques and procedures. However, AIM is the accepted standard in the civil aviation community and reflects general techniques and procedures used by other pilots. Much information contained in this AFMAN is reproduced from AIM and adapted for USAF use. ***If a particular subject is not covered in this AFMAN or other USAF regulations, follow guidance in AIM unless mission requirements dictate otherwise.***

SUMMARY OF CHANGES

This manual has been substantially revised and must be thoroughly reviewed. Major changes include paragraph renumbering, significant reorganization of material and removal of certain information. Most material in the previous version that would be considered “technique” or supplemental in nature has been moved to AFMAN 11-217 Vol 3, *Supplemental Flight Information* leaving primarily instrument procedural guidance in this volume.

Chapter 1

BASIC INSTRUMENT FLYING

1.1. Instrument Categories. Aircraft performance is achieved by controlling the aircraft attitude and power. Aircraft attitude is the relationship of its longitudinal and lateral axes to the Earth's horizon. An aircraft is flown in instrument flight by controlling the attitude and power as necessary to produce the desired performance. This is known as the "control and performance concept" of attitude instrument flying (Figure 1.1) and can be applied to any basic instrument maneuver. The three general categories of instruments are:

1.1.1. Control instruments: Display immediate attitude and power indications and are calibrated to permit adjustments in definite amounts. Control is monitored by referencing the attitude direction indicators (ADIs). Measures of power vary with aircraft and include tachometers, engine pressure ratio (EPR), manifold pressure, fuel flow, torque, etc.

1.1.2. Performance instruments: Indicate the results of pilot control input. Performance instruments include the altimeter, airspeed or mach indicator, vertical velocity indicator, heading indicator, angle of attack indicator, and turn and slip indicator.

1.1.3. Navigation Instruments indicate the position of the aircraft in relation to a selected navigation facility or fix. This group of instruments includes various types of course indicators, range indicators, glide slope indicators, and bearing pointers.

Figure 1.1. Attitude Instrument Flying.

1.2. Control and Performance Concept. The pilot establishes an attitude and power setting that will result in the desired aircraft performance, trims the aircraft for hands-off flight, and references the performance instruments. If deviations occur, power and attitude corrections are made and the process repeats. In general, small smooth corrections coupled with an efficient crosscheck will result in the best aircraft performance. (The instrument crosscheck is discussed later in the chapter.).

1.2.1. Attitude Control. Proper instrument aircraft attitude control is accomplished by making appropriate control inputs and verifying the result on the ADI. The ADI provides an immediate, direct and corresponding indication of any change in aircraft pitch or bank.

1.2.1.1. Pitch Control. Changing the vertical position of the miniature aircraft or fuselage dot in relation to the artificial horizon makes pitch changes. These changes are measured in degrees or bar widths depending on the type of ADI.

1.2.1.2. Bank Control. Changing the "bank attitude" or bank pointers a definite amount in relation to the bank scale makes bank changes. The bank scale is normally graduated at 0°, 10°, 20°, 30°, 60°, and 90° and may be located at the top or bottom of the attitude reference.

1.2.1.3. Yaw axis control. Yaw control references on an ADI are normally located at the bottom of the case in the form of a ball in a fluid filled tube and a turn needle or on an indicator below the ADI on the MFD if equipped with electronic flight instrument display. These indicators are called the turn and slip indicator but are commonly referred to as the "needle and ball." The use of rudders or anti-torque to maintain coordinated flight is important in all aircraft but is critical to instrument flight in helicopters. Yaw is usually the most unstable axis in helicopters, particularly in those not equipped with a Stability Augmentation System (SAS). The instability in the yaw axis is compounded by power changes that cause a yawing moment which can cause induced vertigo. Pilot anticipation and smoothness of rudder or anti-torque inputs during power changes will keep yaw moments to a minimum.

1.2.2. Power Control. Proper power control allows the pilot to smoothly establish or maintain desired airspeeds in coordination with attitude changes. Power changes are made by throttle adjustments or collective pitch in helicopters and referencing power indicators. With experience pilots learn approximately how far to move the throttles or collective to change the power a given amount. Learning how to set approximate power settings, crosschecking and then fine tuning prevents fixating on performance instruments and over-controlling power.

1.2.3. Trim. Aircraft trim relieves control pressure and improves attitude control. The decrease in attention required to maintain aircraft attitude increases the amount of attention the pilot can give to clearing and other cockpit duties.

1.2.3.1. To trim properly, first use the controls to set the desired aircraft attitude, then use the trim to relieve the control pressure. Do not use trim to control the aircraft.

1.2.3.2. Any change in attitude, power or airspeed will usually result in the need for a trim adjustment. Experienced pilots develop a feel for minor out-of-trim conditions and correct them smoothly. In asymmetric power situations (e.g. engine failure) trim can be useful for reducing cockpit workload and enhancing pilot efficiency.

Figure 1.2. Instrument Cross-Check Technique.

1.2.4. Cross-Check Technique (Figure 1.2).

1.2.4.1. Crosschecking is the efficient division of attention between control and performance instruments, the ability to interpret the information given by those instruments, and the correction of any discrepancies noted in aircraft flight parameters. The act of crosschecking is often compared to the hub and spokes of a wagon wheel where the ADI is the hub and the other instruments are the spokes. In general, the crosscheck will progress from the ADI, out to another instrument, back to the ADI and then out again.

1.2.4.2. Performance Instrument Lag. Due to mechanical characteristics of some instruments and the inertial properties of flight, there is an inherent lag between a control input and the appearance of the effects of that input on the performance instruments. A common mistake is to watch the performance instruments while making control inputs, resulting in overshoot of desired flight parameters. Experienced pilots learn to make small calculated inputs and allow the performance instruments to catch up before making another input.

1.2.4.3. Fixating on a single instrument is a common and dangerous error made by inexperienced pilots. If one flight parameter, (e.g. altitude) is frequently wandering, the pilot will devote too much time to the altimeter and lose track of other critical parameters (e.g. attitude). The pilot must remember that the attitude of the aircraft, not the altimeter, is what is causing the aircraft to be off altitude. Returning to the basic crosscheck flow will solve the problem and prevent the aircraft from entering a dangerous attitude.

Figure 1.3. Typical Instrument Cockpit Layout.

1.3. Display of Flight Instrumentation (Figure 1 3). Display options vary widely from aircraft to aircraft and incorporate different symbologies and terminology for similar functions. Electronic displays allow the pilot to optimize cockpit instrumentation for a particular mission by decluttering, removing, or relocating presentations. However, with very few exceptions, Air Force instrument cockpits must adhere to the following specific rules of instrumentation, equipage and setup:

1.3.1. Primary Flight Instrumentation. Primary flight instrumentation must always be present. It must provide full-time attitude, altitude, and airspeed information, an immediately discernible attitude recognition capability, an unusual attitude recovery capability, and complete fault indications.

1.3.2. Position of Flight Instrumentation. Primary Flight Instrumentation information must be positioned and arranged in a manner that enables the pilot to perform an efficient crosscheck.

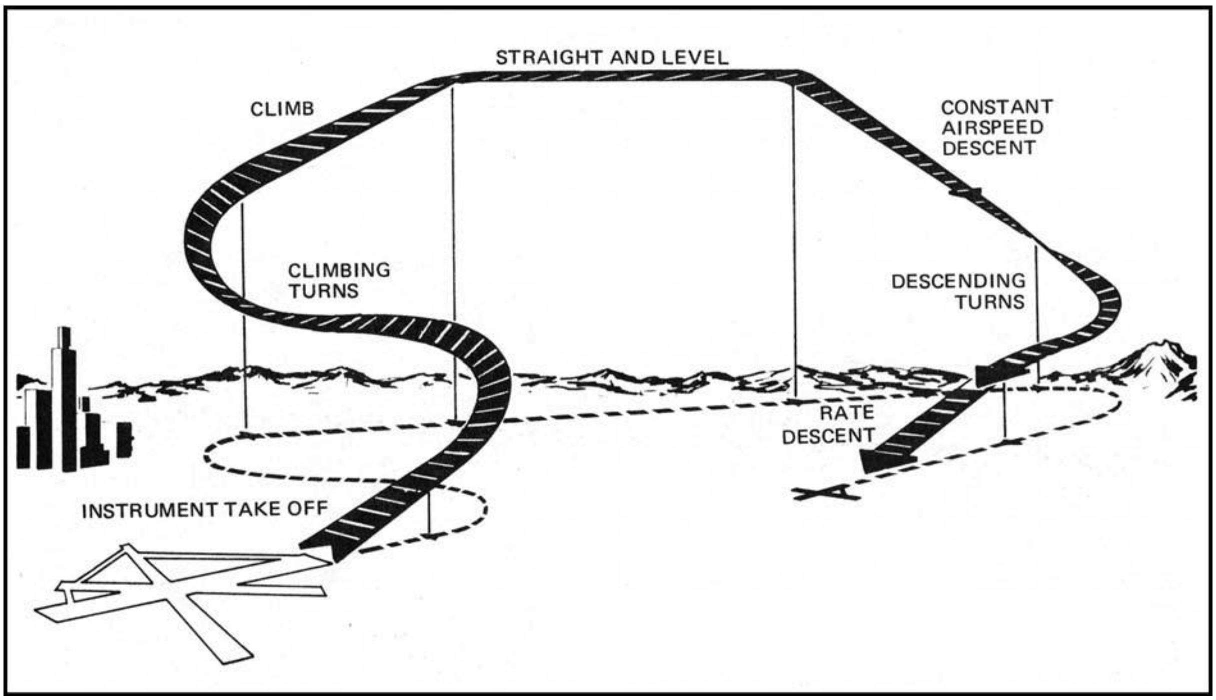
1.3.3. Standardization of Flight Instrumentation. Primary Flight Instrumentation must be standardized in terminology, symbology, mechanization, and arrangement. Standardization of instrumentation display elements provides a common training base and allows the retention of good flying habits during transition to different aircraft.

Chapter 2

INSTRUMENT FLIGHT MANEUVERS

2.1. Basic Maneuvers. The procedures described in this section are those most commonly used during instrument flight (Figure 2.1). A high level of proficiency employing these procedures is necessary to avoid the hazards of instrument flight. Additional procedures may be required for specific training requirements or helicopter operations. Refer to applicable sections of your flight manual. (The ability of the helicopter to maneuver in a smaller amount of airspace has led to some differences between fixed-wing and helicopter instrument procedure obstacle clearance criteria. AFMAN 11-226 *United States Standard for Terminal Instrument Procedures (TERPS)* outlines these differences as they apply to the rotary-wing environment. Except where specifically addressed in this chapter, helicopters should apply normal procedures to flying instrument approaches, departures, and enroute operations.)

Figure 2.1. Typical Instrument Flight.



2.2. The Instrument Takeoff (ITO).

2.2.1. The ITO is accomplished by referring to both outside visual references and the flight instruments (composite cross-check). The amount of attention given to each reference will vary depending on the existing weather conditions. ITO procedures and techniques are invaluable aids at night, toward and over water or deserted areas, and during periods of reduced visibility. ***The pilot shall immediately transition to instrument references any time he or she becomes disoriented or when outside visual references become unreliable.***

2.2.2. Before performing an ITO, accomplish a thorough before-takeoff check of all flight and navigation instruments and publications. Select the appropriate navigational aids to be used for the departure and set the navigation instruments and switches as required based on the departure assigned by Air Traffic Control (ATC). Thoroughly review, have available and brief crewmembers on the appropriate emergency return approach procedures.

2.2.3. Perform the ITO the same as you would a normal visual departure except that as outside visual cues begin to disappear, shift more attention to the instrument cockpit check and confirm a stable and safe climbout flight path using ADI, altimeter, VVI, airspeed indicator, etc. Once all visual cues are gone, transition solely to instruments and comply with the assigned departure procedure. If clouds are layered, use caution not to trust outside visual cues as a high possibility of spatial disorientation exists.

2.2.4. In helicopters, an ITO may be accomplished from a hover or from the ground as visibility restrictions permit. Normally, a composite takeoff is accomplished using normal visual meteorological conditions (VMC) procedures and combining reference to the flight instruments with outside visual references to provide a smooth transition from VMC to instrument meteorological conditions (IMC) flight. Helicopter ITOs may have to be accomplished entirely on instruments due to restrictions to visibility induced by rotor downwash on dust, sand, or snow. Follow flight manual procedures for an ITO where visibility is restricted due to rotor downwash.

2.3. Individual Maneuvers.

2.3.1. Straight and Level Flight. Straight and level unaccelerated flight consists of maintaining desired altitude, heading, and airspeed.

2.3.1.1. Maintaining a Desired Altitude.

2.3.1.1.1. Maintaining altitude is accomplished by setting a specific pitch on the ADI. In general, as airspeed decreases, a higher pitch attitude will be required to maintain altitude due to the loss of lift. Conversely, higher airspeeds will require lower pitch attitudes. Each aircraft has basic pitch and power settings to maintain altitude and airspeed but these may need to be adjusted slightly for various atmospheric conditions.

2.3.1.1.2. Pitch corrections. While maintaining altitude, continue the instrument crosscheck. If the altimeter or VVI indicate an altitude deviation, a pitch change will be necessary. It is important to use control pressure more than movement, make smooth and small pitch changes, and allow the performance instruments time to sense the new attitude before making an additional correction. The most common errors when correcting altitude deviations are "chasing" the VVI rather than setting a new pitch on the ADI, and making erratic or large control inputs. Once back on the desired altitude, make another small and smooth pitch correction on the ADI to maintain altitude remembering that it will be slightly different than the pitch setting held when the altitude deviation originally occurred.

2.3.1.1.2.1. As a rule of thumb, when making pitch corrections, a VVI one to two times the amount of the altitude deviation will prevent overshoots. (e.g. If you are 100 feet off altitude, set a pitch that will produce a 100 to 200 foot per minute climb or descent on the VVI.) Refer to AFMAN 11-217V3 for a discussion of the 60:1 rule and its use for setting a VVI. Approaching the desired altitude, begin the pitch change to level off approximately 10% of your vertical rate. (e.g. If VVI shows 100 feet per minute, level off 10 feet prior to your altitude. Figure 2.2)

Figure 2.2. Leading the Level Off.

2.3.1.2. Maintaining a Desired Heading.

2.3.1.2.1. Maintaining a desired heading is accomplished by maintaining a zero bank attitude in coordinated flight. If a heading deviation occurs, make a smooth bank change on the ADI to return to the desired heading. As a guide, the bank attitude change on the ADI should equal the heading deviation in degrees, not to exceed 30°. For example, if the heading deviation is 10°, then 10° of bank would produce a suitable rate of correction. (At high true airspeeds a larger bank may be needed to prevent a prolonged correction.)

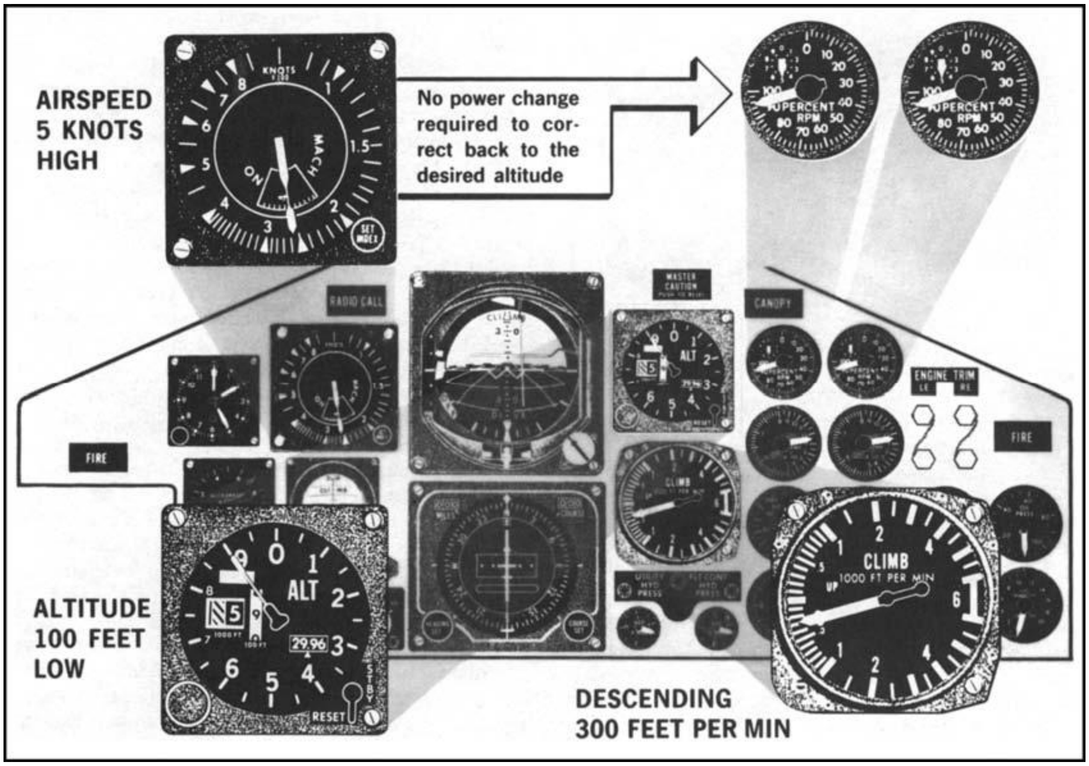
2.3.1.2.1.1. If a zero bank attitude is maintained and the heading changes, the ADI may be precessing. Confirm this by referencing backup ADI's. If precession is noted, it may be necessary to transition to the backup ADI depending on the severity of the precession.

2.3.1.3. Maintaining Airspeed.

2.3.1.3.1. Establishing or maintaining an airspeed is accomplished by referring to the airspeed or mach indicator and adjusting the power, drag devices (for large airspeed changes) or aircraft attitude. Knowledge of the approximate power required to establish a desired airspeed at a specific attitude will aid in making power adjustments. After the approximate power setting is established, a crosscheck of the airspeed indicator will indicate if subsequent power adjustments are required.

2.3.1.3.1.1. An airspeed deviation may be the result of a pitch change, not an incorrect power setting. (See Figure 2.3) Check all other flight parameters when an airspeed deviation occurs. Conversely, if in level flight and a power change is necessary to correct airspeed, the new power setting or the employment of drag devices coupled with a change in airspeed may induce a climb or descent. This relationship between airspeed and aircraft attitude further illustrates the importance of a good instrument crosscheck.

Figure 2.3. Airspeed Deviation.



2.3.2. Level Turns. Many of the pitch, bank, and power principles discussed in maintaining straight and level flight apply while performing level turns. Performing a level turn requires an understanding of several factors: how to enter the turn, how to maintain bank, altitude, and airspeed during the turn; and how to return to level flight. A standard rate turn is defined as a rate at which the aircraft will make a 360 degree turn in two minutes (120 seconds).

2.3.2.1. Bank Control. As a guide, to prevent heading overshoots or prolonged turns, for heading changes of 30° or less, the bank angle should approximate the number of degrees to be turned (Figure 2.4). For heading changes of more than 30°, use a bank angle of 30°. High turn airspeeds or flight manual procedures may require other angles of bank. Helicopters should use no more than standard rate turns (15^0 to 20^0) when operating between 80 and 120 knots.

2.3.2.2. To enter a turn, refer to the ADI while applying smooth and coordinated control pressures to establish the desired angle of bank. It will normally be necessary to increase pitch slightly to counteract the loss of vertical lift due to the bank. The increased pitch in prolonged turns will require consistent back pressure on the elevator control. Trimming off the pressure on the elevator will aid in smooth aircraft control and enhance crosscheck capability in the turn. Additionally, to maintain airspeed, an increase in power will be required to counteract the induced drag produced by the elevator inputs. The bank, pitch change and power increase should all be applied smoothly as the aircraft enters the turn to prevent the need for large corrections during the turn.

Figure 2.4. Level Turns.

2.3.2.3. To roll out of a turn on a desired heading, calculate a lead point that is, as a guide, approximately one-third the angle of bank used in the turn. (Figure 2.4) When the lead point is reached, simply reverse the bank, pitch, trim and power inputs used to roll into the turn, smoothly and simultaneously. Once on the new heading, check for deviations from straight and level flight and apply corrections as needed.

2.3.2.4. Steep Turns. Steep turns are practiced in simulated instrument conditions (hooded or goggled) and are normally any turn greater than 30° of bank. The entry and exit into and from a steep turn is identical to a normal turn except that all inputs will be more pronounced. The increased bank will require more pitch, more back pressure and more power to counteract the further reduced vertical lift. The rate of turn will be much faster in a steep turn and will require a more aggressive lead point as well as smooth yet positive control inputs to roll out on the correct heading without significant altitude or airspeed deviations. For helicopters, any rate greater than standard is considered a steep turn, most helicopters practice steep turns using 30° of bank, which is the maximum angle of bank recommended under instrument conditions.

2.3.3. Timed Turns and Use of the Magnetic Compass. Heading indicator failure may require use of the magnetic compass for heading information. The magnetic compass provides reliable information only during straight, level, and unaccelerated flight. Because of this limitation, timed turns are recommended when making heading changes by reference to the magnetic compass.

2.3.3.1. A timed turn is accomplished by establishing a bank attitude on the ADI that will result in a desired rate of turn as shown by the turn needle. A single needle width deflection on a 4-minute turn needle indicates 1 1/2° per second rate of turn, while a double needle width deflection indicates 3° per second rate of turn. Therefore, a 90° turn can be made by establishing a bank angle that produces a double needle width deflection for 30 seconds.

2.3.3.2. Alternate method. Although timed turns are preferred when using the magnetic compass, turns to headings can be made by referring directly to the magnetic compass and rolling out of the turn at a predetermined "lead" point. Dip error (or magnetic dip) must be considered in computing the lead point for rollout. Magnetic dip is the tendency of the compass needles to point down as well as to the magnetic pole. Dip is greatest near the poles and least near the Magnetic Equator. The compass card is designed to operate in the horizontal, therefore, any movement from the horizontal plane introduces dip error. Turns to the north require a normal lead point plus a number of degrees equal to the flight latitude while turns to the south require turning past the desired heading by the number of degrees equal to the flight latitude minus the normal lead. Dip error is negligible when turning to east or west.

2.3.4. Climbs and Descents. Climbing and descending maneuvers can be performed as constant airspeed or constant rate. The constant airspeed maneuver is accomplished by setting power and varying pitch to maintain a specific airspeed. The constant rate maneuver is accomplished by varying both pitch and power to maintain a specific airspeed <u>and</u> vertical velocity. Either type of climb or descent may be performed while maintaining a constant heading or while turning and should be practiced using airspeeds, configurations, and altitudes used in actual instrument flight.

2.3.4.1. Constant Airspeed Climbs and Descents.

2.3.4.1.1. Most aircraft have a standard set of pitch and power settings for certain airspeeds and configurations. For instance, in order to maintain 300 KIAS in a clean configuration, an aircraft might require 10° nose down pitch at idle power. A pilot might also know that for that aircraft, each degree of pitch change at a constant power setting and configuration will change the airspeed 10KIAS. With this simple knowledge, a pilot has a very high level of control over his aircraft.

2.3.4.1.2. To perform the constant airspeed climb or descent make a smooth and simultaneous change in pitch and power corresponding to the desired airspeed and configuration. Once the initial attitude is established, fine-tune the airspeed by adjusting pitch. Confirm the pitch change by noting a change on the VVI and wait for the airspeed to stabilize. Continue this process until the desired airspeed is attained. Remember that this procedure must be accomplished as part of a complete instrument crosscheck.

2.3.4.1.3. Approaching your level-off altitude (approximately 10% of your vertical velocity is a good lead point) smoothly adjust pitch and power to maintain a constant altitude without changing airspeed. **Note:** For climb or descent rates of 2000 or more, at 1000 feet prior to the level off altitude it is a good technique to cut the pitch attitude in half to enable a smoother level-off. Adjust power as necessary to maintain airspeed. (On most aircraft, changing the total fuel flow in pph the same amount as the change in VVI will result in a constant airspeed.)

2.3.4.2. Rate Climbs and Descents.

2.3.4.2.1. Rate climbs and descents are similar to constant airspeed climbs and descents but require a constant VVI. Using the 60 to 1 rule (AFMAN 11-217V3, Chapter 3) we know pitch multiplied by airspeed in nm/min gives VVI in 100's of ft/min. (e.g. Traveling 300 KIAS or 5 nm/min, a 2° pitch change will result in a VVI of 1000 ft/min). Another rule of thumb that works for most aircraft: A change in total fuel flow in pph equal to the change in VVI will maintain a given airspeed. (e.g. On a two engine aircraft, reducing power by 500 pph on each engine will maintain a constant airspeed if the aircraft pitches down to maintain 1000 ft/min VVI)

2.3.4.2.2. EXAMPLE: From level flight at 240KIAS (4 nm/min) a C-130 pilot desires to maintain 240 KIAS with a VVI of 2000 ft.min. Smoothly decreasing pitch by 5° and reducing fuel flow on each engine by 500 pph will achieve the desired descent rate at the approximate desired airspeed. A good instrument crosscheck and some minor power adjustments will fine-tune the descent profile. Accomplish the level off as described in 2.3.5.1.3.

2.3.4.3. Emergency Descent. (Helicopters) Basic instrument techniques may be used to safely perform an emergency descent in IMC. Because there is no set procedure, you must consider all variables when executing an emergency descent. If your helicopter is equipped with a radar altimeter, it is a good technique to set the low altitude warning marker at or slightly above the required flare altitude. This will give you a reminder to start a flare if the flare altitude is reached prior to breaking out of IMC.

2.3.4.3.1. Power-On Descent. If a long distance must be covered, then a constant airspeed descent could be selected using higher than normal airspeeds. If a short distance is to be covered, then a constant rate descent could be selected using high rates of descent and slower than normal airspeeds.

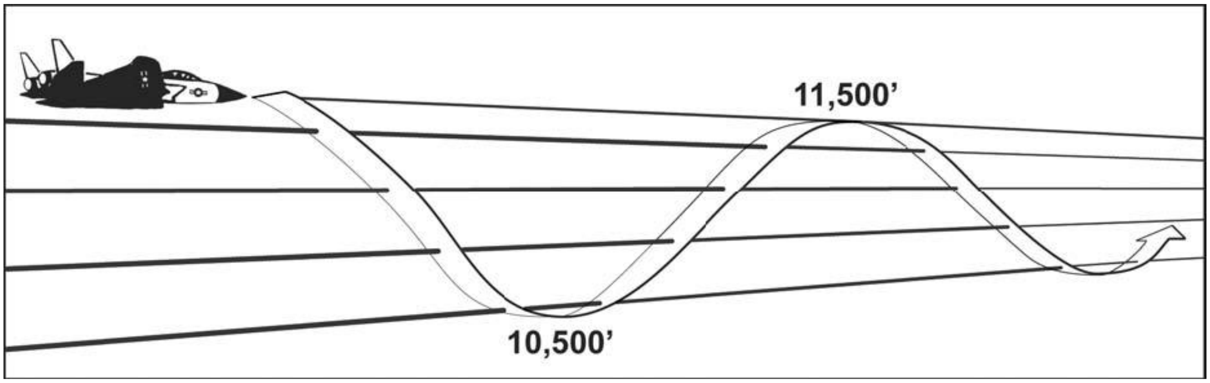
2.3.4.3.2. Power-Off Descent (Autorotation). If an emergency requires autorotation, enter smoothly by lowering the collective and closely cross-checking the control and performance instruments. Knowing (and briefing) the approximate ceiling will aid in determining when to begin a systematic scan for outside references. Crew coordination will be critical and should be briefed prior to flight by the aircraft commander.

2.4. Basic Aircraft Control Maneuvers—Fixed Wing.

2.4.1. Vertical "S" Series. The vertical "S" maneuvers are proficiency maneuvers designed to improved a pilot's crosscheck and aircraft control. There are four types: the A, B, C, and D which can be flown utilizing various configurations, airspeeds, turn and decent rates, etc. to practice all phases of instrument flight (cruise, approach descent, missed approach, etc.).

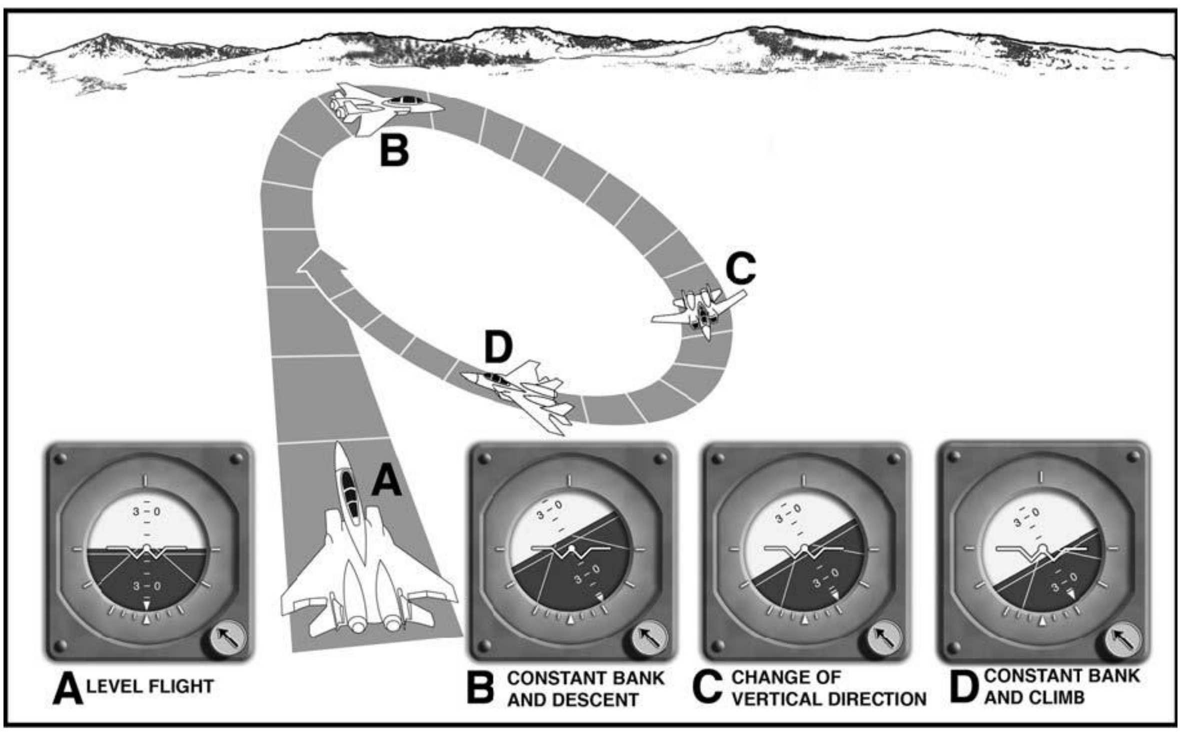
2.4.1.1. The vertical "S"-A maneuver (Figure 2.5). The vertical S-A is a continuous series of rate climbs and descents flown on a constant heading utilizing a vertical velocity compatible with aircraft performance.

Figure 2.5. Vertical "S"- A.



2.4.1.2. The vertical "S"- B (Figure 2.6). The vertical “S”-B is the same as the vertical "S"- A except that a constant angle of bank is maintained during the climb and descent. The angle of bank used should be compatible with aircraft performance (usually that required for a normal turn). The turn is established simultaneously with the initial climb or descent.

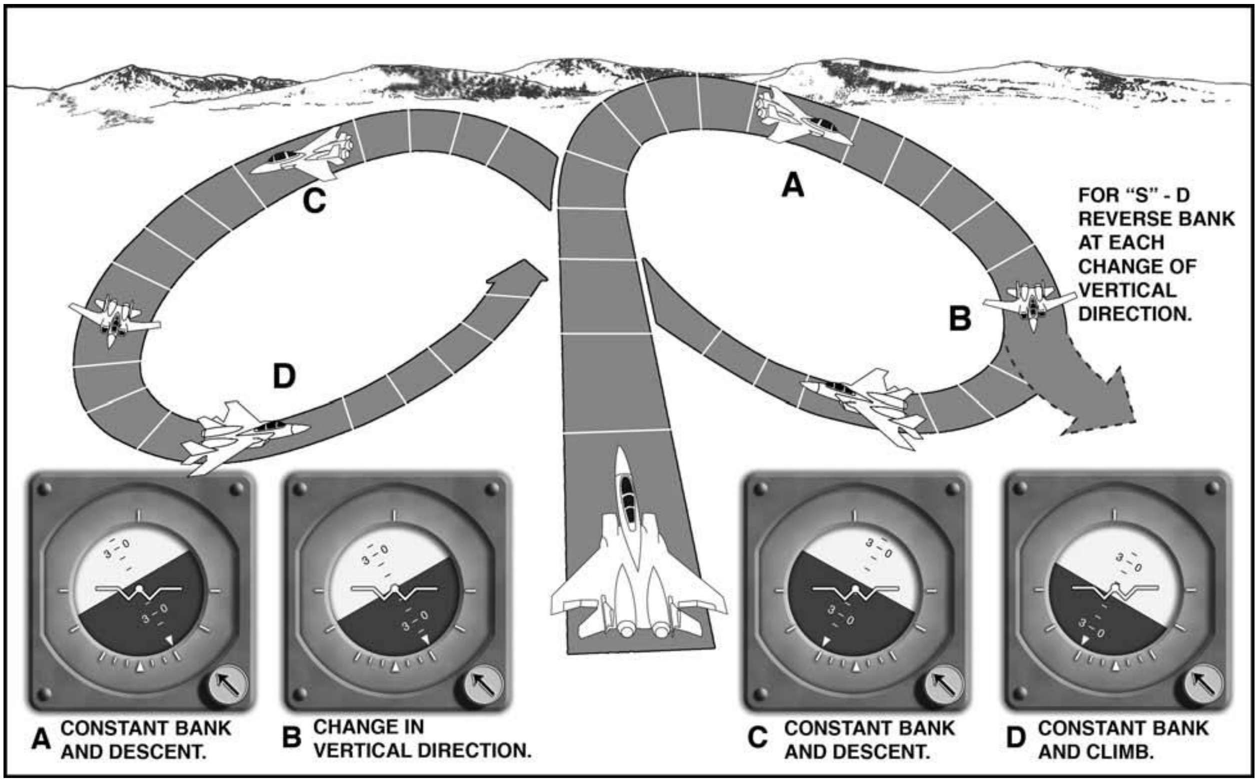
Figure 2.6. Vertical "S"- B.



2.4.1.3. The vertical "S"- C (Figure 2.7). The vertical “S”-C is the same as vertical "S"- B, except that the direction of turn is reversed at the beginning of each descent. Enter the vertical "S" - C in the same manner as the vertical "S"- B.

2.4.1.4. Vertical "S"- D. (Figure 2.7). The vertical "S"- D is the same as the vertical "S"- C, except that the direction of turn is reversed simultaneously with each change of vertical direction. Enter the vertical "S"- D in the same manner as the vertical "S"- B or C.

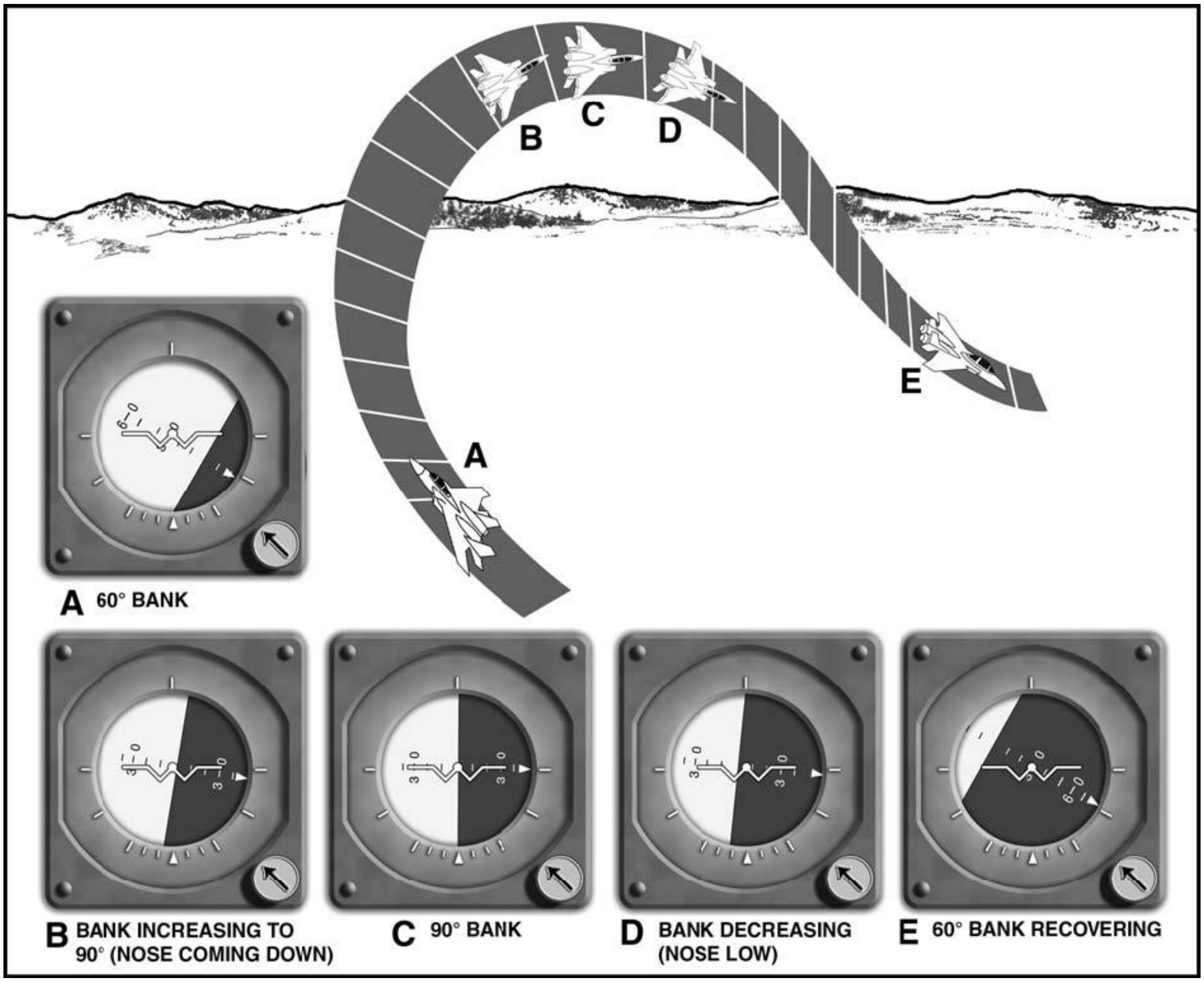
Figure 2.7. Vertical "S"- C and "S"- D.



2.4.2. Confidence Maneuvers. Present missions require some aircraft to be flown in all attitudes under instrument conditions. Such aircraft have ADIs capable of indicating these attitudes. Confidence maneuvers are basic aerobatic maneuvers designed to gain confidence in the use of the ADI in extreme pitch and bank attitudes. Mastering these maneuvers will be helpful when recovering from unusual attitudes. The pilot should consult the aircraft flight manual for performance characteristics and limitations before practicing these maneuvers.

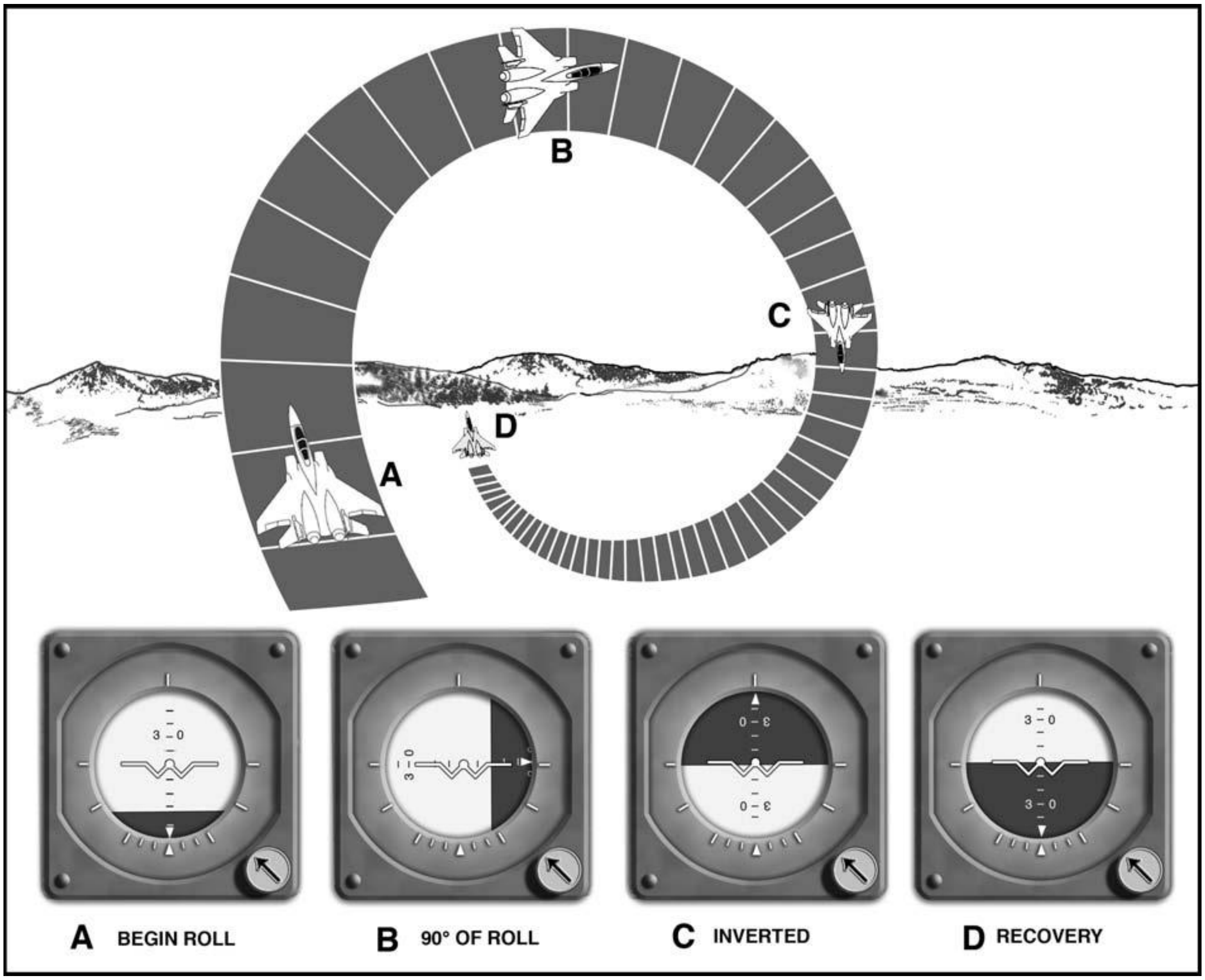
2.4.2.1. Wingover (Figure 2.8). Begin the maneuver from straight and level flight. After obtaining the desired airspeed, start a climbing turn in either direction while maintaining the wing tip of the miniature aircraft on the horizon bar until reaching 60° of bank. Allow the nose of the aircraft to start down while continuing to increase the angle of bank, planning to arrive at 90° of bank as the fuselage dot of the miniature aircraft reaches the horizon bar. Begin decreasing the angle of bank as the fuselage dot of the miniature aircraft reaches the horizon bar so that the wing tip of the miniature aircraft reaches the horizon bar as 60° of bank is reached. Maintain the wing tip on the horizon bar while rolling to a wings level attitude. The rate of roll during the recovery should be the same as the rate of roll used during the entry. Control pitch and bank throughout the maneuver by reference to the ADI.

Figure 2.8. Attitude Indications During Wingover.



2.4.2.2. Aileron Roll (Figure 2.9). Begin the maneuver from straight and level flight. After obtaining the desired airspeed, smoothly increase the pitch attitude with the wings level 15° to 25° nose up on the ADI. Start a roll in either direction and adjust the rate of roll so that, when inverted, the wings will be level as the fuselage dot of the miniature aircraft passes through the horizon bar. Continue the roll and recover to level flight. The entire maneuver should be accomplished by reference to the ADI. Use sufficient back pressure to maintain normal seat pressures (approximately 1 g) throughout the maneuver.

Figure 2.9. Attitude Indications During Aileron Roll.



2.5. Unusual Attitudes.

2.5.1. Definition. An unusual attitude is an aircraft attitude occurring inadvertently. It may result from one factor or a combination of several factors such as turbulence, channelized attention, instrument failure, inattention, spatial disorientation, lost wingman, or transition from VMC to IMC. In most instances these attitudes are mild enough to recover by reestablishing the proper attitude for the desired flight condition and resuming a normal crosscheck. As a result of extensive tactical maneuvering, the pilot may experience unusual attitudes even in VMC. This may be aggravated by the lack of a definite horizon or by lack of contrast between the sky and ground or water.

2.5.1.1. WARNING: ***The pilot will immediately transition to instrument references any time he or she becomes disoriented or when outside visual references become unreliable.***

2.5.1.2. WARNING: NVGs may be distracting during unusual attitude recoveries. Once transition to instruments has occurred, do not rely on outside NVG cues until the aircraft is recovered.

2.5.2. Techniques of recovery. Techniques of recovery should be compatible with the severity of the unusual attitude, the characteristics of the aircraft, and the altitude available for the recovery. The procedures in this section are not designed for recovery from controlled tactical maneuvers.

2.5.3. Principles and considerations. The following aerodynamic principles and considerations are applicable to the recovery from unusual attitudes:

2.5.3.1. Reducing bank in a dive or increasing bank in a climb aids pitch control.

2.5.3.2. Power and drag. Power and drag devices used properly aid airspeed control if the flight manual allows their use in unusual attitude situations.

2.5.3.3. Sky pointer. For ADIs with a bank pointer and bank scale at the top, the bank pointer that is always aligned above and perpendicular to the surface of the earth is considered a sky pointer. Rolling towards the sky pointer to place it in the upper half of the case will correct an inverted attitude.

2.5.3.4. Ground pointer. For ADIs with the bank scale at the bottom, rolling in the direction that will place the pitch reference scale right side up will correct an inverted attitude.

2.5.4. Recognizing an Unusual Attitude is critical to a successful recovery. Normally, an unusual attitude is recognized in one of two ways -- an unusual attitude "picture" on the ADI or unusual performance on the performance instruments. Regardless of how the attitude is recognized, verify that an unusual attitude exists by comparing control and performance instrument indications prior to initiating recovery on the ADI (Figure 2.10). This precludes entering an unusual attitude as a result of correcting for erroneous instrument indications. Additional independent attitude indicating sources (standby ADI, copilot's ADI, etc.) should be used to verify the actual aircraft attitude. If there is any doubt as to proper ADI operation, then recover using ADI inoperative procedures.

Figure 2.10. Verify That an Unusual Attitude Exists.

2.5.5. Fixed Wing Recovery Procedures--ADIs Operative. For fixed-wing aircraft, use the following procedures if specific unusual attitude recovery procedures are not in the flight manual.

2.5.5.1. If diving, adjust power or drag devices as appropriate while rolling to a wings level, upright attitude, and correct to level flight on the ADI. Do not add back pressure until less than 90° of bank.

2.5.5.2. If climbing, use power and bank as necessary to assist pitch control and avoid negative G forces. As the ADI airplane symbol approaches the horizon bar, adjust pitch, bank, and power to complete recovery and establish the desired aircraft attitude. When recovering from a steep climb, care must be exercised in some aircraft to avoid exceeding bank limitations.

2.5.5.3. Bank and power. During unusual attitude recoveries, unless necessary to avoid a greater emergency, ensure bank and power do not exceed aircraft limitations.

2.5.6. Fixed Wing Recovery Procedures--ADIs Inoperative. With no functioning ADI's, successful recovery from unusual attitudes depends greatly on pilot proficiency and early recognition of ADI failure. ADI failure should be immediately suspected if control pressures are applied without corresponding ADI changes. Another example would be performance instrument indications that contradict the "picture" on the ADI. Should an unusual attitude be encountered with no functioning ADI's, the following procedures are recommended:

2.5.6.1. If the flight manual allows and an available autopilot is not slaved to gyros of the malfunctioning ADI's, consideration may be given to engaging the autopilot and setting it to straight and level flight. If airspeed or vertical velocity are excessive, use the procedures below to return the aircraft to acceptable flight parameters before attempting to engage the autopilot.

2.5.6.2. Climb or dive. Determine whether the aircraft is in a climb or a dive by referring to the airspeed, altimeter, and vertical velocity indicators.

2.5.6.3. If diving, roll to center the turn needle and recover from the dive. Adjust power or drag devices as appropriate. (Except for vertical attitudes, rolling "away" from the turn needle and centering it will result in an upright attitude).

2.5.6.4. If climbing, use power as required. If the airspeed is low or decreasing rapidly, pitch control may be aided by maintaining a turn of approximately standard rate on the turn needle until reaching level flight.

2.5.6.5. Level flight. Upon reaching level flight, center the turn needle. The aircraft is level when the altimeter stops. The vertical velocity indicator lag error may cause it not to indicate level until the aircraft passes level flight.

2.5.7. Helicopter Recovery Procedures -- Attitude Indicators Operative. Recoveries from helicopter unusual attitudes are unique due to rotary-wing aerodynamics as well as application of the control and performance concept to helicopter flight. Application of improper recovery techniques can result in blade stall, power settling, or an uncontrollable yaw if recovery is delayed. Due to these differences, unusual attitude recoveries for helicopters are decidedly different from fixed-wing recoveries and require immediate action.

Use the following guidance if specific unusual attitude recovery procedures are not contained in the flight manual:

2.5.7.1. Diving. If diving, consider altitude, acceleration limits, and the possibility of encountering blade stall. If altitude permits, avoid rolling pullouts. To recover from a diving unusual attitude, roll to a wings level indication then establish a level flight attitude on the attitude indicator. Adjust power as necessary and resume a normal crosscheck.

2.5.7.2. Climbing. If climbing, consider pitch attitude and airspeed. If the inadvertent pitch attitude is not extreme (10° or less from level flight), smoothly lower the miniature aircraft back to a level flight indication, level the wings, and resume a normal crosscheck using power as required. For extreme pitch attitudes (above 10°), bank the aircraft in the shorter direction toward the nearest 30° bank index. The amount of bank used should be commensurate with the pitch attitude and external conditions, but do not exceed 30° of bank in making the recovery. Allow the miniature aircraft to fall toward the horizon. When the aircraft symbol is on the horizon, level the wings and adjust the aircraft attitude to a level flight indication. Use power as necessary throughout the recovery.

2.5.7.3. Hover. If the aircraft is in a hover or low speed when the unusual attitude is recognized, smoothly but immediately roll to a wings level attitude and apply maximum power available. Once attitude control is reestablished, execute an ITO, or refer to hover velocity instrumentation to maintain position (if available). This condition is most common during dust or white out situations, or when performing terminal operations at night and/or over water.

2.5.7.3.1. NOTE: In helicopters encountering an unusual attitude as a result of blade stall, collective must be reduced before applying attitude corrections if the aircraft is in a climbing unusual attitude. This will aid in eliminating the possibility of aggravating the blade stall condition. To aid in avoiding blade stall in a diving unusual attitude recovery, reduce power and bank attitude before initiating a pitch change. In all cases avoid abnormal positive or negative G loading which could lead to additional unusual attitudes or aircraft structural damage.

2.5.8. Helicopter Recovery Procedures -- Attitude Indicators Inoperative. With an inoperative attitude indicator, successful recovery from unusual attitudes depends greatly on pilot proficiency and early recognition of attitude indicator failure. For example, attitude indicator failure should be immediately suspected if control pressures are applied for a turn without corresponding attitude indicator changes. Another example would be satisfactory performance instrument indications that contradict the "picture" on the attitude indicator. Should an unusual attitude be encountered with an inoperative attitude indicator, the following procedures are recommended:

2.5.8.1. Climb or dive. Determine whether the aircraft is in a climb or a dive by referring to the airspeed, altimeter, and vertical velocity indicators.

2.5.8.2. Diving. If diving, roll to center the turn needle and recover from the dive. Adjust power as appropriate. (Disregarding vertical attitudes, rolling "away" from the turn needle and centering it will result in an upright attitude.)

2.5.8.3. Climbing. If climbing, use power as required. If the airspeed is low or decreasing rapidly, pitch control may be aided by maintaining a standard rate turn on the turn needle until reaching level flight. If the turn needle in a flight director system is used, center the turn needle. This is because it is very difficult to determine between a standard rate turn and full needle deflection.

2.5.8.4. Level off. Upon reaching level flight, center the turn needle. The aircraft is level when the altimeter stops. The vertical velocity indicator lag error may cause it not to indicate level until the aircraft passes level flight.

2.5.9. WARNING: Spatial disorientation may become severe during the recovery from unusual attitudes with inoperative ADI's. Extreme attitudes may result in an excessive loss of altitude and possible loss of aircraft control. ***If a minimum safe altitude for unusual attitude recovery is not in the flight manual, if applicable, the pilot shall decide upon an altitude at which recovery attempts will be discontinued and the aircraft abandoned.***

2.5.10. CAUTION: Due to limited attitude information, recovery from unusual attitudes using a HUD may be difficult or impossible.

Chapter 3

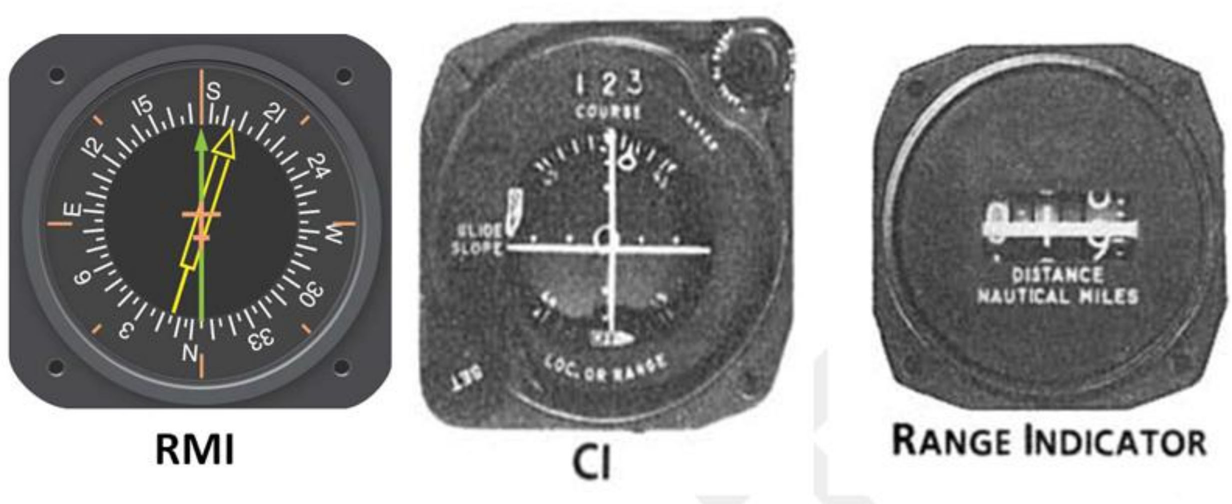
NAVIGATION INSTRUMENTS

3.1. Application. The navigation instruments explained in this chapter are still common in many USAF aircraft or are incorporated in digital (glass) cockpit displays. These instruments are the radio magnetic indicator (RMI), course indicator (CI), range indicator, bearing-distance-heading indicator (BDHI), flight director, and Flight Management System (FMS).

3.2. Basic Systems.

3.2.1. Radio Magnetic Indicator (RMI) (Figure 3.1). The RMI displays aircraft heading with navigational bearing data. It normally consists of a rotating compass card and two bearing pointers. The compass card is actuated by the aircraft compass system. The aircraft magnetic heading is displayed on the compass card beneath the top index. The bearing pointers display automatic direction finding (ADF), VHF Omni directional Range (VOR), or Tactical Air Navigation (TACAN) magnetic bearing to the selected navigation station. Placards on the instrument or near a selector switch are normally used to identify the bearing pointer display. VOR or TACAN radials are displayed under the tail of their respective bearing pointers. Bearing pointers do not function in relation to instrument landing system (ILS) signals.

Figure 3.1. Navigation Instruments.



3.2.1.1. Compass System Malfunction. If there is a malfunction in the compass system or compass card, the ADF bearing pointer continues to point to the station, and displays relative bearing only but the VOR or TACAN pointers may still indicate magnetic bearing. Until verified by radar or other navigational equipment, consider this bearing information unreliable. VOR and TACAN bearing pointers do not "point" to an area of maximum signal strength, as does an ADF. VOR and TACAN navigation receivers electronically measure the magnetic course which is then displayed by the pointers on the RMI.

3.2.2. Course Indicator (CI) (Figure 3.1). The course indicator operates independently of the RMI. It displays aircraft heading and position relative to a selected VOR/TACAN course, and lateral and vertical position relative to an ILS localizer and glide slope. Most USAF aircraft now have the functions of the CI incorporated in the Horizontal Situation Indicator (HSI).

3.2.2.1. VOR or TACAN Display.

3.2.2.1.1. Course indicator. When the course indicator is used to display VOR or TACAN information, aircraft heading and position are indicated relative to a selected course. The desired course is set in the course selector window with the course set knob.

3.2.2.1.2. The Heading Pointer. The heading pointer interfaces with the course set knob and the compass system and displays aircraft heading relative to the selected course. When the aircraft heading is the same as the course selected, the heading pointer indicates 0° heading deviation at the top of the course indicator. The heading deviation scales, at the top and bottom of the course indicator are scaled in 5° increments up to 45°. The TO-FROM indicator indicates whether the course selected, if properly intercepted and flown, will take the aircraft to or from the station. When the aircraft passes a line from the station perpendicular to the selected course, the TO-FROM indicator changes. Aircraft heading has no effect on the TO-FROM indications.

3.2.2.1.3. Course Deviation Indicator. The course deviation indicator (CDI) displays aircraft course deviation relative to the course selected. Most course indicators are adjusted so the CDI is fully displaced when the aircraft is off course more than 10°. Each dot on the course deviation scale represents 5°.

3.2.2.1.4. Course Warning Flag. Appearance of the course warning flag indicates that the course indicator is not receiving a signal strong enough for reliable navigation information. See Chapter 7 for discussion on Navigation Aid (NAVAID) identification.

3.2.2.1.4.1. *NOTE: Although the course indicator may be receiving a signal strong enough to keep the course warning flag out of view, consider the signal reliable only if the warning flag is not displayed, the station identification is being received and the bearing pointer is pointing to the station.*

3.2.2.2. ILS Display.

3.2.2.2.1. Localizer Course. When used to display ILS signals, the course indicator provides precise ILS localizer course information for a specified approach. The following information pertains to course indicator functions and displays when used with an ILS:

3.2.2.2.1.1. *The TO-FROM indicator is unusable.*

3.2.2.2.1.2. *Full-scale deflection. Full-scale deflection on the course deviation scale differs with the width of the localizer course (up to 6°). Example: If the localizer course is 5° wide, then full-scale deflection is 2½° and each dot is 1¼°; if the localizer course is 3° wide, then full-scale deflection is 1½° and each dot is*

¾°.

3.2.2.2.1.3. *When flying the localizer, the course set knob and course selected have no effect on the CDI display. The CDI displays only if the aircraft is on course or in a 90- or 150-Hz zone of signals originating from the ILS localizer transmitter. The CDI always deflects to the left of the instrument case in the 150-Hz zone and to the right in the 90-Hz zone. It centers when the signal strength of both zones is equal. Although the course selected has no effect on the CDI, to enhance situational awareness, the pilot should always set the published inbound FRONT COURSE of the ILS in the course selector window.*

3.2.2.2.2. The glide slope indicator (GSI) displays glide slope position relative to the aircraft. Full-scale deflection of the GSI is dependent upon the width of the glide slope. Example: If the glide slope width is 1.4°, full-scale deflection would be .7°, and each dot would be .35°.

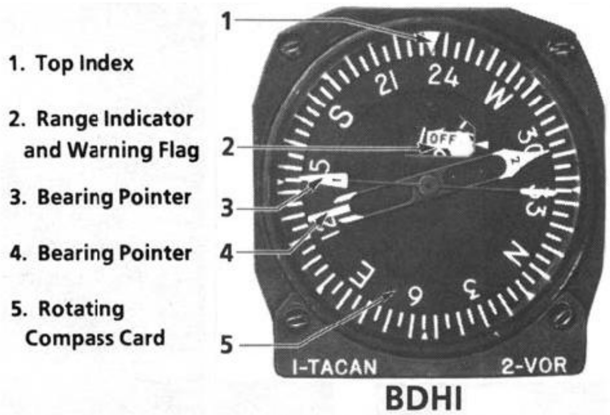
3.2.2.2.3. Warning Flags. Appearance of the course or glide slope warning flags indicates that the course or glide slope signal strength is not sufficient. Absence of the identifier indicates the signal is unreliable. See Chapter 7 for discussion on NAVAID identification.

3.2.2.2.3.1. *CAUTION: It is possible under certain conditions for the CDI or GSI to stick in any position with no warning flags while reliable station identification is being received. Pilots should use extreme caution and maintain good situational awareness while flying an ILS or localizer approach in actual weather conditions.*

3.2.2.2.4. Marker Beacon. The marker beacon light and aural tone indicate proximity to a 75-MHz marker beacon transmitter; for example, ILS outer marker (OM), middle marker (MM), inner marker (IM), etc. As the aircraft flies through the marker beacon signal pattern, the light flashes and the aural tone sounds in Morse code indicating the type of beacon. The marker beacon light functions independently of ILS/VOR/TACAN signals.

3.2.3. Range Indicator (Figure 3.1). Range indicators display slant range distance in nautical miles to a DME transponder. For practical purposes, you may consider this a horizontal distance except when the aircraft is very close to the station. DME range information is subject to line-of-sight restrictions and altitude directly affects the reception range. Most USAF aircraft now incorporate DME into the HSI or a separate digital readout display.

Figure 3.2. Bearing Distance Heading Indicator (BDHI).



3.2.4. Bearing-Distance-Heading Indicator (BDHI) (Figure 3.2).

3.2.4.1. BDHI Display. The BDHI displays aircraft heading with navigational bearing data and range information. Except for the range indicator, the BDHI is similar in appearance and function to the RMI previously described.

3.2.4.2. BDHI Components. The BDHI consists of a rotating compass card, two bearing pointers, a range indicator, and a range warning flag. Some BDHIs also have a heading marker, a heading set knob, and a power warning flag.

3.2.4.3. Compass Card Actuation. The compass card is actuated by the aircraft compass system which normally includes pilot-operated controls that permit the BDHI compass card to operate in a slaved or non-slaved direct gyro (DG) mode. In the slaved mode, the aircraft magnetic heading is displayed beneath the top index or lubber line. In the non-slaved DG mode, the compass card serves as a heading reference after being corrected to a known heading. The card is manually corrected for the DG mode by a switch on the compass control panel.

3.2.4.4. Heading Marker. The heading marker, if incorporated, may be positioned on the compass card by use of the heading set knob. Once positioned, the marker remains on a fixed heading. To maintain the selected heading, turn to place the heading marker beneath the upper lubber line.

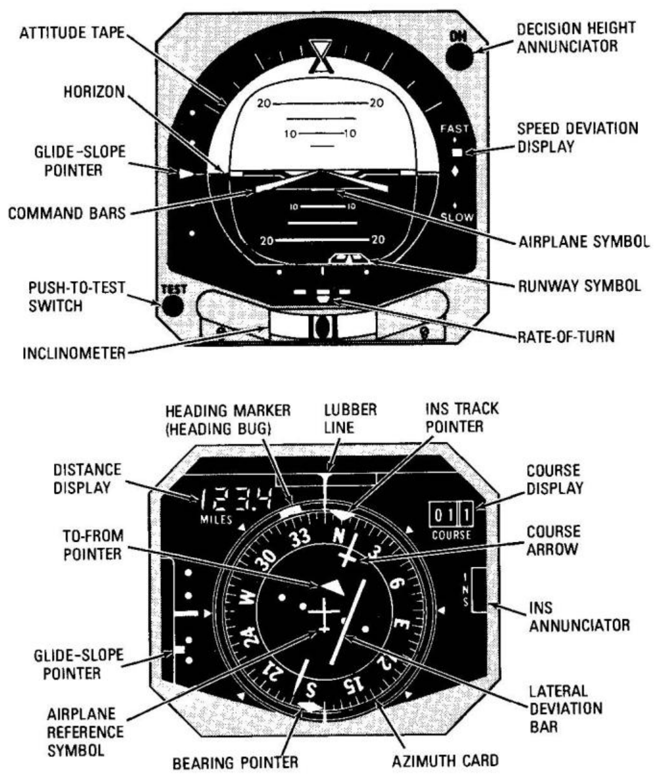
3.2.4.5. Bearing Pointers. The bearing pointers indicate the magnetic bearing to the selected ADF, VOR, or TACAN station. Placards on the instrument or near a selector switch are used in most aircraft to identify the bearing pointer display.

3.2.4.5.1. NOTE: When tuned to an ILS frequency, bearing pointers will normally slave to a position 45 or 90 degrees from the upper lubber line. Refer to flight manual for details.

3.2.4.6. Malfunctions. If there is a malfunction in the compass system or compass card, an ADF bearing pointer continues to point to the station and displays relative bearing only. TACAN/VOR pointers may continue to indicate proper magnetic bearings. Until verified by radar or other navigation equipment, consider this bearing information unreliable.

3.3. Flight Director. The flight director provides the pilot with displays of pitch and bank attitudes and the navigation situation of the aircraft. The flight director, when combined with round dial performance instruments, is termed the flight director system (FDS). When the flight director is combined with vertical scale instruments it is termed the integrated flight instrument system (IFIS). The three components of the flight director of major interest are the attitude director indicator (ADI), the horizontal situation indicator (HSI), and the flight director computer.

Figure 3.3. Typical Flight Director.



3.3.1. Attitude Director Indicator (ADI) (Figures 3.3 and 3.4).

3.3.1.1. Parts of Attitude Director Indicator. The ADI usually consists of an attitude indicator, rate of turn and slip indications, glide slope indicator, command bars, attitude warning flag, glide slope warning flag, and course warning flag. Additional information displayed on some ADIs includes radar altitude information, approach speed deviation, and a runway symbol that displays lateral and vertical displacement from the runway.

3.3.1.1.1. Glide Slope Pointer. The glide slope pointer (GSP) displays glide slope position in relation to the aircraft. If the GSP is above or below center the glide slope is above or below the aircraft respectively. GSP scale deflection differs with the width of the glide slope (1° to 1.8°). Example: If the glide slope width was 1°, full-scale deflection would be ½° and each dot would be ¼° (Figure 3.3).

Figure 3.4. ADI and HSI.

3.3.1.1.2. Command Bars. The command bars display steering information to intercept or maintain a desired flight path. To utilize the steering function, simply "fly" the ADI's aircraft symbol by adjusting the aircraft attitude until it is snugly aligned beneath the command bars. The bars will command the proper pitch and bank to turn, intercept, and maintain a course and altitude.

3.3.1.1.2.1. NOTE: Warning flags are incorporated in the ADI to indicate failure or unreliability of presentations. Check the aircraft flight manual for specific warning flags applicable to your aircraft. In some ADIs, if power fails to the pitch and bank steering bars, no warning flags will appear, and the pitch and bank steering bars will center. Monitor the identifier to ensure that the signal is reliable. In most aircraft a warning flag appears when the signal strength is insufficient.

3.3.2. Horizontal Situation Indicator (HSI) (Figures 3.3 and 3.4). The horizontal situation indicator combines the heading indicator, RMI, CI, and range indicator into one display. (See explanations of these functions in previous sections of this chapter.) Additional features available on electronic HSIs include arc formats to display a segment of the standard display as well as map formats used to pictorially display aircraft position in relation to NAVAIDS or waypoints. (Figure 3.5.)

Figure 3.5. Electronic HIS.

3.3.2.1. Course Selector Knob. The course selector knob on most HSI's may be used to select any course by rotating the head of the course arrow to the desired course on the compass card. Check the course selector window for the proper setting.

3.3.2.2. Heading Set Knob. The heading set knob moves the heading marker to a desired heading. With the proper mode selected on the flight director control panel, the heading marker can be slaved to the flight director computer. Thus, when a heading is set, the command bars will command the bank attitude required to turn to and maintain the selected heading.

3.3.3. Flight Director Computer. The flight director computer receives navigation information from the navigation systems and attitude information from the attitude gyro. Depending on the modes available and selected, the computer supplies pitch or bank commands to the command bars of the ADI. The command bars can be used for many functions such as intercepting VOR, TACAN, and Doppler courses or performing data link intercepts. Pitch command information can vary from terrain avoidance to flying a glidepath or changing altitudes. In all cases, the command bars display command information and do not reflect actual aircraft position. Refer to the appropriate flight manual for the specific capabilities of the system installed in your aircraft.

3.3.4. Flight Director Modes.

3.3.4.1. Heading Mode. The flight director will sync the command bars to the heading marker to keep the aircraft on the selected heading.

3.3.4.2. ILS Intercept Mode. The flight director will cause the command bars to steer the aircraft onto and maintain the ILS course selected in the navigation radios.

3.3.4.2.1. Wind drift. Some computers supply wind drift compensation.

3.3.4.2.2. Bank angle. Maximum bank angle commanded is usually 25° to 35°, depending on the system.

3.3.4.2.3. Intercept angle. Maximum intercept angle commanded is normally about 45°.

3.3.4.2.4. ILS Final Approach Mode. Adds pitch inputs to the command bars to fly to and maintain the glideslope. In this mode, commanded bank angle is normally limited to a maximum of 15° and maximum pitch attitude commanded is 10° to 17°, depending on the system.

3.4. Flight Management System (FMS). Many newer aircraft are equipped with an FMS consisting of a Flight Management Computer (FMC), one or more Control Display Units (CDU), an internal navigation database, and various displays and annunciators (Figure 3.6). The FMS utilizes aircraft sensors and navigation database information to compute and display aircraft position, performance data, and navigation information during all phases of flight. The FMS may interface and provide guidance commands to autopilot, flight director, and auto-throttle systems.

Figure 3.6. Typical Flight Management System.

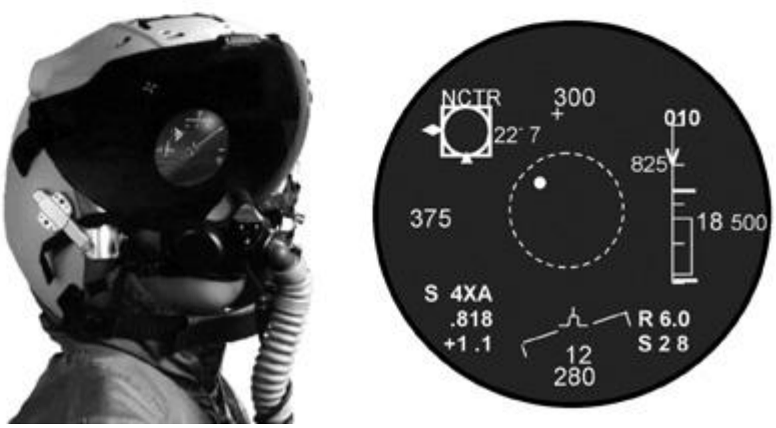
3.4.1. Flight Management Computer. The FMC gathers aircraft position information from multiple onboard sensors and navigation aids including VOR, DME, TACAN, Inertial Reference Systems (IRS), Inertial Navigation Systems (INS), Global Positioning System (GPS), and Air Data Computers. Using this aircraft position information, navigation functions such as course and distance to a waypoint, desired track, groundspeed, and estimated time of arrival are computed and displayed on the CDU and other aircraft instruments. Additionally, fuel flow information may be used by the FMC to calculate and update fuel consumption, specific range, and fuel overhead destination information.

3.4.2. Control Display Unit. The CDU allows the aircrew to interface with the FMC. The CDU normally consists of a display screen, data entry pad, and function and line select keys. The CDU allows menu-driven selection of various FMS modes, such as initialization, fuel planning, performance, and navigation. The pilot may input flight plan route and various other flight parameters into the CDU to enhance situational awareness and the navigational capabilities of the aircraft.

3.4.3. Navigation Database. An FMS normally contains an internal navigation database with either regional or worldwide coverage. The database typically includes information on navigation aids, airports, runways, waypoints, routes, airways, intersections, departures and arrivals, and instrument approaches. Aircrews may also store defined routes and waypoints in the database. Navigation databases require periodic updates, normally on a 28-day cycle, to ensure data is current.

3.5. Single Medium Displays. A single medium display is a Head-Up Display (HUD), Head-Down Display (HDD), or Helmet-Mounted Display (HMD) (Figure 3.7). These systems can display control, performance, and navigation data in the pilot's outside field of view, enabling him to clear and monitor instruments simultaneously. ***Information received from HUD equipment that is not certified for sole-reference instrument flight by HQ USAF/A3O must be verified with other cockpit indications.***

Figure 3.7. Helmet Mounted Display.



3.5.1. Some single medium displays have the ability to project a Flight Path Marker (FPM) to display vector flight paths. This projection gives a predictive line that shows where the aircraft is going based on current flight parameters. On HUDs the FPM can be used to plan terrain clearance maneuvers on low levels, determine where the aircraft will touch down when landing, etc. Drawbacks to the FPM include the tendency of the display to float around, especially in crosswinds, the bobbing motion of the FPM as it lags behind the movement of the nose of the aircraft, and the degraded usefulness of the FPM when it exceeds the limits of the instrument's field-of-view at high angles of attack and in large drift or yaw situations.

3.5.2. More advanced displays use a Climb/Dive Marker (CDM) as the command flight symbol for vector flying. The CDM will utilize the concept of the above FPM and flight path scale, but both will be caged to the center of the display to prevent the symbology from drifting off the usable area of the instrument.

Chapter 4

NAVIGATION AIDS

4.1. Precautions. Various types of navigation aids are in use today, each serving a special purpose. Although operating principles and cockpit displays will vary among navigation systems, there are several precautionary actions that must be taken to prevent in-flight use of erroneous navigation signals:

4.1.1. Identification. ***The pilot will check the identification of any navigation aid and monitor it during flight IAW*** **Chapter 7** ***of this manual.***

4.1.2. Crosscheck Information. Use all suitable navigation equipment aboard the aircraft and crosscheck heading and bearing information.

4.1.3. Estimated Time of Arrival. Never overfly an estimated time of arrival (ETA) without a careful crosscheck of navigation aids and ground checkpoints.

4.1.4. Notices to Airmen. ***The pilot will check notices to airmen (NOTAM) and flight information publication (FLIP) before flight for possible malfunctions or limitations to navigation aids.***

4.1.5. Suspect Navigation Aid. Discontinue use of any suspect navigation aid and confirm aircraft position with radar (ground or airborne) or other equipment. Advise ATC of any problems receiving NAVAIDs. The problem may be the ground station and not the aircraft equipment.

4.2. VHF Omni-Directional Range (VOR). The theoretical and technical principles of operation of VOR equipment are discussed in depth in AFMAN 11-217V3.

4.3. Tactical Air Navigation (TACAN). The theoretical and technical principles of operation of TACAN equipment differ from those of VOR; however, the end result, as far as reading the cockpit display is concerned, is the same. TACAN components and operation are discussed in depth in AFMAN 11-217V3.

4.4. VHF Omni-Directional Range/Tactical Air Navigation (VORTAC). A VORTAC is a unified navigation aid consisting of two components, VOR and TACAN, which provides three individual services: VOR azimuth, TACAN azimuth, and TACAN distance (DME) from one site. Both components of a VORTAC operate simultaneously and provide the three services at all times. Additional information on VORTACs is available in AFMAN 11-217V3.

4.5. Distance Measuring Equipment (DME). DME operation utilizes paired pulses transmitted from the aircraft to a ground station at a specific spacing. The ground station then transmits paired pulses back to the aircraft at the same pulse spacing but on a different frequency. The time required for the round trip of this signal exchange is measured in the airborne DME unit and is displayed to the pilot as a distance in nautical miles from the aircraft to the ground station. Additional information on DME is available in AFMAN 11-217V3.

4.6. Instrument Landing System (ILS). The theoretical and technical principles of operation of ILS equipment are discussed in depth in AFMAN 11-217V3.

4.6.1. The 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, optional DME transmitters, and as many as three marker beacons or compass locators. The directional transmitters are known as the localizer and glide slope which are received by aircraft ILS equipment and displayed on the cockpit instrument panel. A runway serviced by ILS equipment will also include approach, touchdown, and sometimes centerline lighting systems. Figure 4.1 offers a visual depiction of a standard ILS configuration.

4.6.2. ILS System on Each End of Runway. Some locations have a complete ILS system installed on opposite ends of a runway. Such ILS systems should not be operating simultaneously. In most cases, each ILS will have its own frequency. Sometimes the frequency for both runways will be the same, however each runway will have its own unique Morse code identifier.

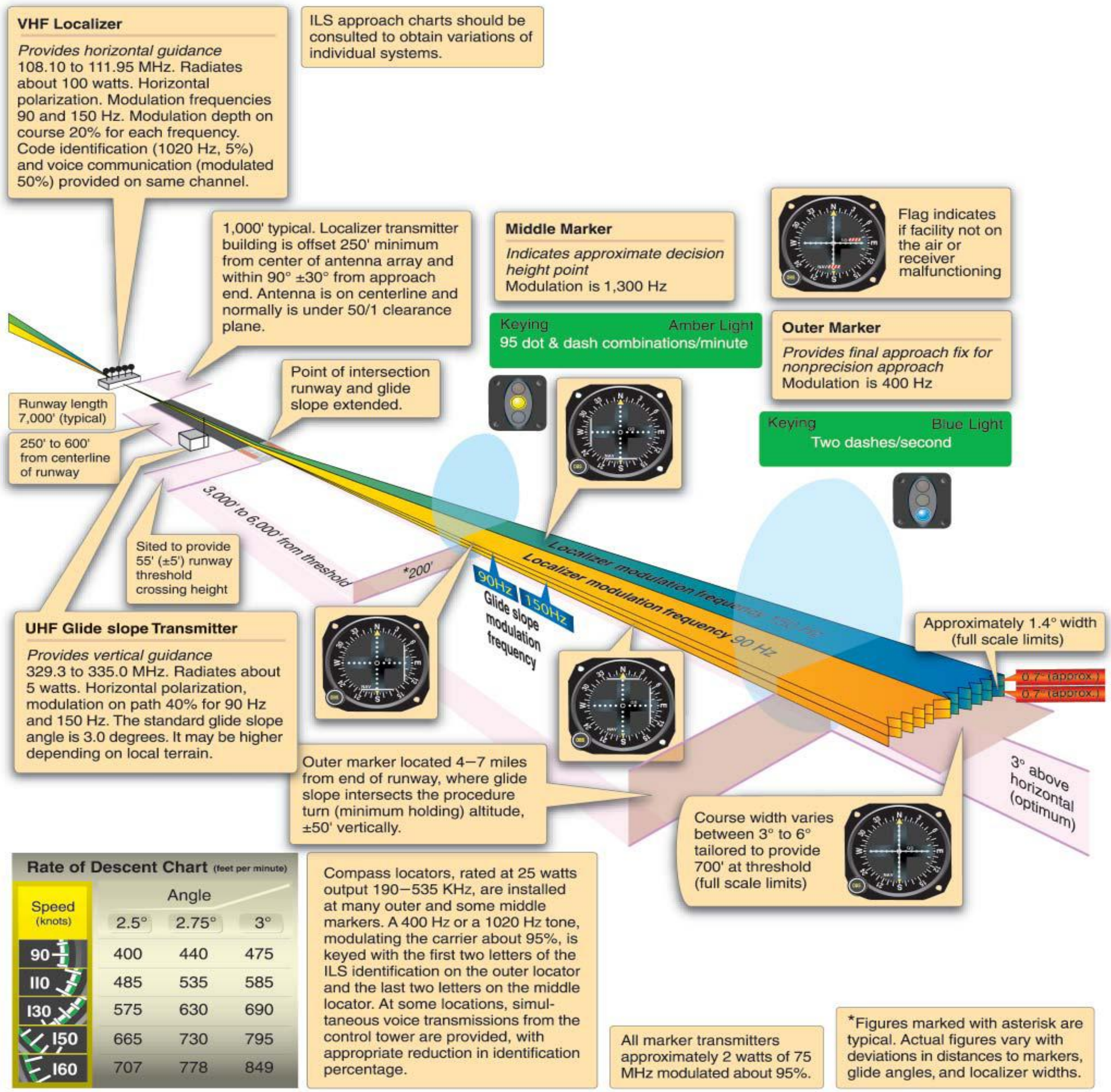
4.6.2.1. WARNING: ***The pilot shall listen to the Morse code identifier or monitor the alphanumeric display IAW* Chapter 7*, especially when flying an ILS where the same frequency is used for two runways.*** If both ILSs are inadvertently left on, or the incorrect ILS is turned on, it is possible to receive back course and false glide slope indications.

4.6.3. False Course Indications. False course indications may be received when the aircraft is not within the depicted area of coverage. Therefore, localizer course information received outside the area depicted in Figure 4.2 should be considered invalid unless the procedure is published otherwise (for example, localizer type directional aid or back course localizer). There is also a remote chance electromagnetic interference may cause false course indications within the depicted area of coverage. For these reasons, it is essential to confirm the localizer on course indication by reference to aircraft heading and any other available navigation aids, such as an ADF bearing pointer, before commencing final descent. Any abnormal indications experienced within 35 degrees of the published front course or back course centerline of an ILS localizer should be reported immediately to the appropriate ATC facility.

4.6.4. False Glideslope Indications. False glideslope indications may be received when the aircraft is not within the depicted area of coverage, or the glide slope power status is in alarm. There is also a chance that aircraft or vehicles parked in the ILS Critical Area may interfere with the glideslope signal. For these reasons, it is essential to confirm glideslope intercept altitudes and expected altitudes as depicted on the IAP. If indications are suspect, transition to localizer procedures or execute a missed approach.

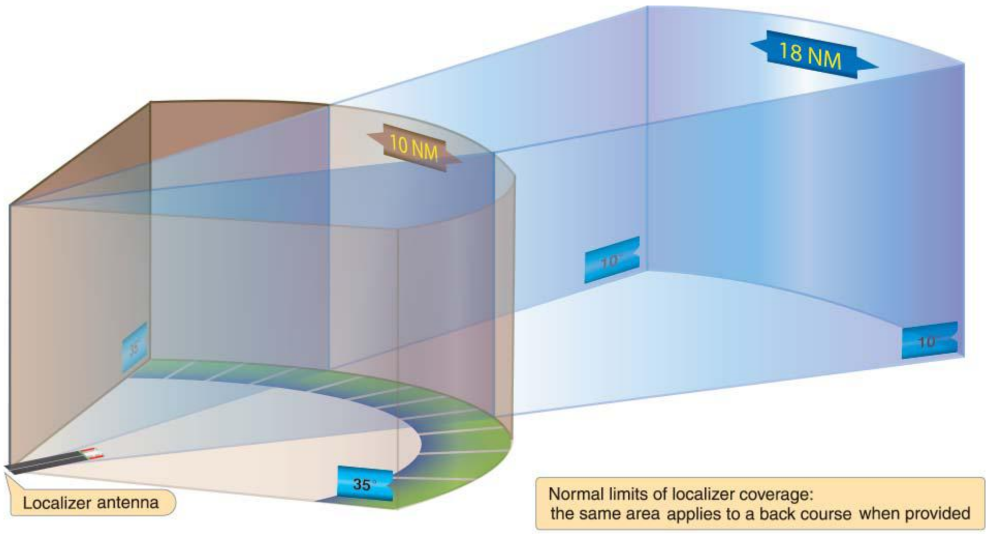
4.6.5. ILS Facilities with Associated DME. ILS facilities sometimes have associated DME. These facilities are usually found at civilian fields. Some instrument approach procedures require TACAN or VOR associated DME on the initial segment and the ILS associated DME during the final portion of the approach. Pilots must exercise extreme caution to ensure the proper DME channel is tuned to preclude premature or late descents.

Figure 4.1. Standard ILS Characteristics and Terminology.



Speed (knots)	Angle 2.5°	2.75°	3°
90	400	440	475
110	485	535	585
130	575	630	690
150	665	730	795
160	707	778	849

Figure 4.2. Normal Localizer Signal Coverage.



4.7. Microwave Landing System (MLS). The MLS provides precision navigation guidance for exact aircraft alignment and descent during an approach to a selected runway. It integrates azimuth (AZ), elevation angle (EL), and range (DME) information to provide precise aircraft positioning. The components of an MLS are similar to an ILS. Instead of a glide slope antenna, the MLS has an elevation station, and instead of a localizer antenna, it has an azimuth station. The MLS also has a precision DME (DME/P) transmitter. The DME/P signal is more accurate than traditional DME. Additional information on MLS is available in AFMAN 11-217V3.

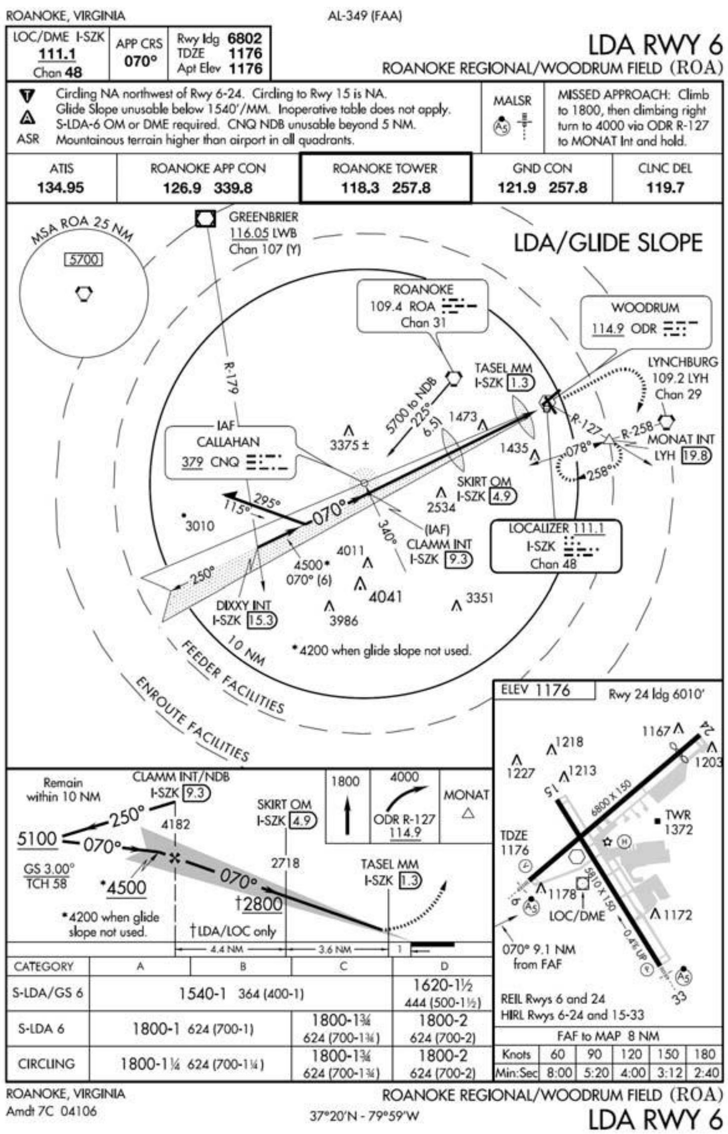
4.8. Marker Beacon (Figure 4 1). Marker beacons are discussed in depth in AFMAN 11-217V3.

4.9. Localizer Type Directional Aid (LDA). The LDA is of comparable utility and accuracy to a localizer but is not always aligned with the centerline of the runway. TERPS requires the Localizer (LOC) signal alignment within 3° of the runway alignment. If the alignment exceeds 3°, the LOC will be identified as an LDA. Once designated as an LDA, the maximum angle of convergence of the final approach course and the extended runway centerline is 30°. The signal accuracy of the LDA is the same as a LOC, however the LDA course alignment will be greater than 3°, not to exceed 30°. Straight-in minima can be published only where alignment conforms to the straight-in criteria specified in AFMAN 11-226 (TERPS). Circling minima are published where this alignment exceeds straight-in criteria. The LDA is usually considered a non-precision approach; however, in some installations with a glide slope, a decision altitude will be published. If a decision altitude is published, it can be flown just like an ILS approach.

4.9.1. Localizer (LLZ). In International Civil Aviation Organization (ICAO) Procedures for Air Navigation Services-Aircraft Operations (PANS-OPS) abbreviates the localizer facility as LLZ. The accuracy of the signal generated by the LLZ is the same as a LOC. PANS-OPS normally requires the LLZ final approach track alignment to remain within 5° of the runway centerline. However, in certain cases, the alignment can exceed 5°. Where required, PANS-OPS allows an increase of the final approach track to 15° for categories C, D, and E. For aircraft categories A and B, the maximum angle formed by the final approach track and the runway centerline is 30°.

4.9.1.1. NOTE: Prior to flying a LDA or LLZ, compare the final approach course with the runway heading. The aerodrome sketch should provide a visual indication of the angle formed between the final approach track and the runway centerline.

Figure 4.3. LDA With Glide Slope.



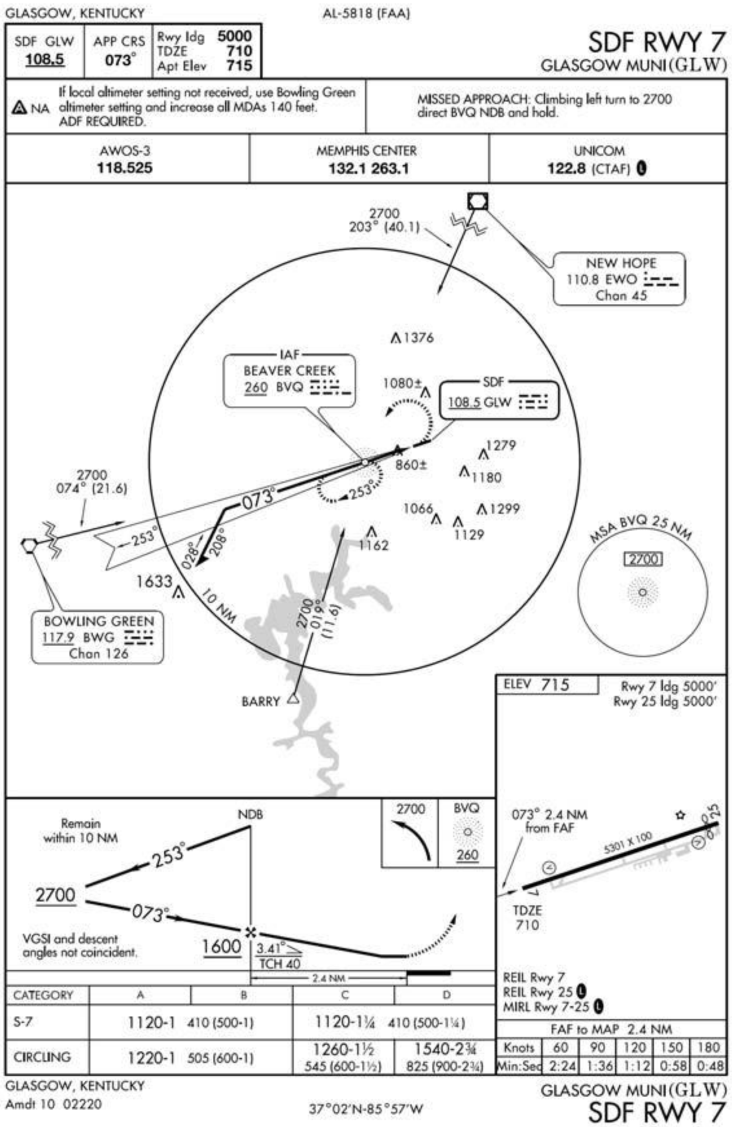
CATEGORY	A	B	C	D
S-LDA/GS 6	1540-1 364 (400-1)			1620-1½ 444 (500-1½)
S-LDA 6	1800-1 624 (700-1)		1800-1¾ 624 (700-1¾)	1800-2 624 (700-2)
CIRCLING	1800-1¼ 624 (700-1¼)		1800-1¾ 624 (700-1¾)	1800-2 624 (700-2)

FAF to MAP 8 NM

Knots	60	90	120	150	180
Min:Sec	8:00	5:20	4:00	3:12	2:40

4.10. Simplified Directional Facility (SDF). The SDF provides a final approach course that is similar to that of the ILS localizer and LDA. The SDF transmits signals within the range of 108.10 MHz to 111.95 MHz. However, the SDF may have a wider course width of 6° or 12°. It does not provide glide slope information. For the pilot, the approach techniques and procedures used in the performance of an SDF instrument approach are essentially identical to those used in executing a standard no glide slope localizer approach except that the SDF course may not be aligned with the runway and the course may be wider, resulting in less precision.

Figure 4.4. SDF Approach.



CATEGORY	A	B	C	D
S-7	1120-1 410 (500-1)		1120-1¼ 410 (500-1¼)	
CIRCLING	1220-1 505 (600-1)		1260-1½ 545 (600-1½)	1540-2¾ 825 (900-2¾)

Knots	60	90	120	150	180
Min:Sec	2:24	1:36	1:12	0:58	0:48

4.11. Nondirectional Radio Beacon (NDB).

4.11.1. Frequencies. NDB is a low, or medium, or ultra high frequency radio beacon that transmits nondirectional signals whereby an aircraft properly equipped can automatically determine and display bearing to any radio station within its frequency and sensitivity range.

4.11.2. Compass Locator. When a radio beacon is used in conjunction with the ILS markers, it is called a "compass locator." Sometimes the low-powered NDB [i.e. compass locator] will be a stand alone NAVAID with limited range (usually less than 15 miles). These locators may be identified by an "L" and the use of the two-digit identifier.

4.11.3. Identification. Most radio beacons within the U.S. transmit a continuous three-letter identifier. A two-letter identifier is normally used in conjunction with an ILS. Some NDBs have only a one-letter identifier. Outside of the contiguous U.S., one, two, or three-letter identifiers are transmitted; for example, BB.

4.11.4. Voice Transmissions. Voice transmissions can be made on radio beacons unless the letter "W" (without voice) is included in the class designator (HW).

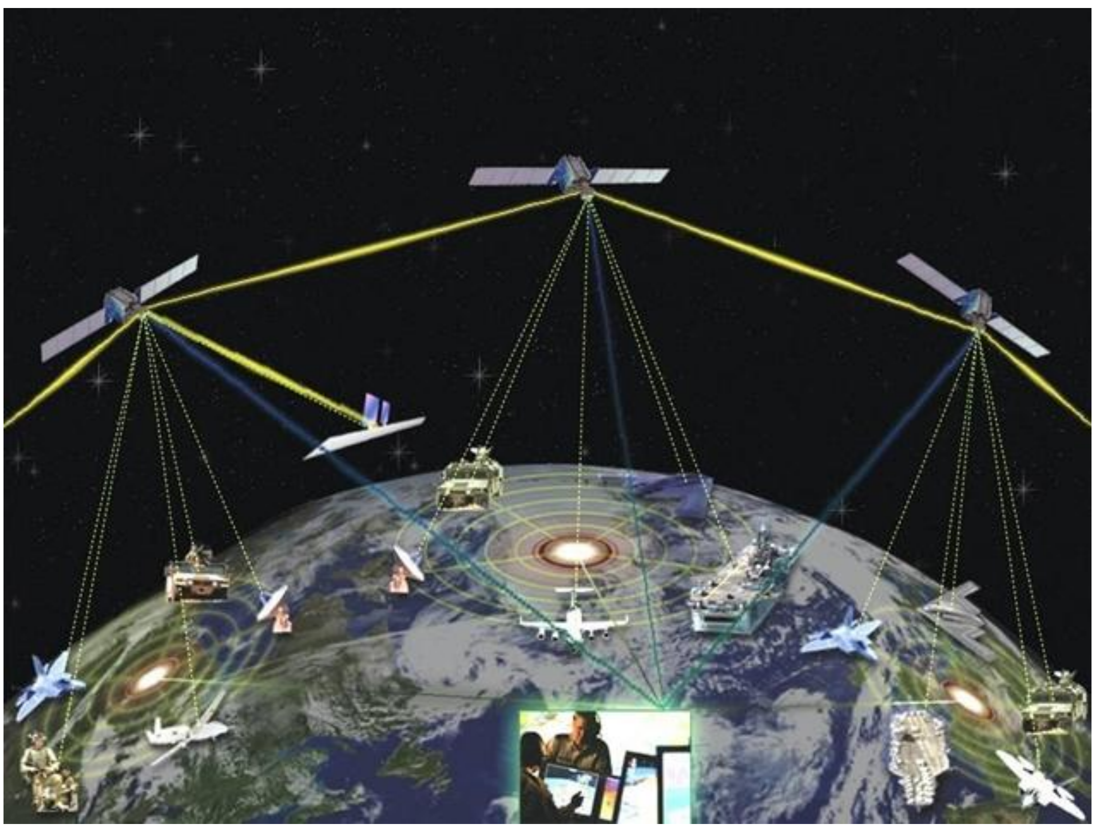
4.11.5. Disturbances. Radio beacons are subject to disturbances that may result in erroneous bearing information. Such disturbances result from intermittent or unpredictable signal propagation due to such factors as lightning, precipitation, static, etc. At night, radio beacons are vulnerable to interference from distant stations. Nearly all disturbances that affect the ADF bearing also affect the facility's identification. Noisy identification usually occurs when the ADF needle is erratic. Voice, music, or erroneous identification will usually be heard when a steady false bearing is being displayed.

4.11.5.1. WARNING: ***Since ADF receivers do not have a "flag" to warn the pilot when erroneous bearing information is being displayed, the pilot must continuously monitor the NDBs identification.***

4.12. Global Positioning System (GPS).

4.12.1. Principles of Operation. GPS is a satellite-based navigation system that has the capability to provide highly accurate three-dimensional position, velocity, and time to an infinite number of equipped users anywhere on or near the Earth (Figure 4.5). GPS is discussed in depth in AFMAN 11-217V3.

Figure 4.5. GPS.



4.13. Inertial Navigation System (INS).

4.13.1. Description. The INS is a source of groundspeed, attitude, heading, and navigation information. A basic system consists of acceleration sensors mounted on a gyro stabilized, gimbaled platform, a computer unit to process raw data and maintain present position, and a control display unit (CDU) for data input and monitoring. It allows the aircrew to selectively monitor a wide range of data, define a series of courses, and update present position. The INS operates solely by sensing the movement of the aircraft. Since it neither transmits nor receives any signal, it is unaffected by electronic countermeasures or weather conditions. The INS can also supply data to many other aircraft systems.

4.13.2. Operation. Before an INS can be used, it must be aligned. During alignment, present position coordinates are inserted manually while the INS derives local level and true north. This operation must be completed before moving the aircraft. If alignment is lost in flight, navigation data may be lost, but, in some cases, attitude and heading information may still be used. Coordinate or radial and distance information describing points that define the route of flight are inserted as needed through the CDU. For complete operation procedures of any specific INS, consult the appropriate aircraft technical order.

Chapter 5

NAVIGATION TECHNIQUES AND PROCEDURES

5.1. Application. Instrument procedures are flown using a combination of techniques (arc to radial, radial to arc, course intercepts, etc.). Individual aircraft flight manuals should provide proper procedures for using the navigation equipment installed.

5.1.1. ***Where procedures depict a ground track, the pilot is expected to correct for known wind conditions. In general, the only time wind correction should not be applied is during radar vectors.*** The following general procedures apply to all aircraft.

5.1.1.1. Unless otherwise authorized by ATC (or as necessary for safety if ATC coordination is not possible), no person may operate an aircraft within controlled airspace under IFR except as follows:

5.1.1.1.1. On a Federal airway, along the centerline of that airway.

5.1.1.1.2. Along the direct course between navigational aids or fixes defining a route.

5.1.2. Utilizing ground based NAVAIDS.

5.1.2.1. ***Tune and Identify. The pilot will tune or select the desired frequency or channel, then positively identify the selected station via an aural (Morse Code) or visual (alphanumeric) signal.***

5.1.2.1.1. For aircraft with the capability to translate Morse code station identification into an alphanumeric visual display, it is acceptable to use the visual display as the sole means of identifying the station identification provided: (MAJCOMs will determine which aircraft can use this method for identifying NAVAIDS.)

5.1.2.1.1.1. The alphanumeric visual display must always be in view of the pilot.

5.1.2.1.1.2. Loss of the Morse code station identification will cause the alphanumeric visual display to immediately disappear, or a warning to be displayed.

5.1.2.1.1.2.1. WARNING: It is imperative that crews are cognizant of what station identification is being displayed. For example, if the station identification being displayed is from the DME portion of a VOR/DME station, then only the DME alphanumeric display may be used. The VOR azimuth station must still be identified aurally.

5.1.2.1.1.2.2. WARNING: Voice communication is possible on VOR, ILS, and ADF frequencies. The only positive method of identifying a station is by its Morse code identifier (either aurally or alphanumeric display) or (for VORs) the recorded automatic voice identification, indicated by the word “VOR” following the station name. Identifying a NAVAID by listening to other voice transmissions broadcast on a Flight Service Station or other facility is not a reliable method of station identification and shall not be used.

5.1.2.1.2. VOR. The station identification may be a repeated three-letter Morse code group, or a three-letter Morse code group alternating with a recorded voice identifier.

5.1.2.1.3. TACAN. The TACAN station transmits an aural three-letter Morse code identifier approximately every 35 seconds.

5.1.2.1.4. NDB/ADF. The nondirectional radio beacon transmits a repeated two or three-letter Morse code group depending on power output.

5.1.2.1.5. ILS. The ILS localizer transmitter puts out a repeated four-letter Morse code group. In the US, the first letter of the identifier is always "I" to denote the facility as an ILS.

5.1.3. ***Monitor. The pilot will monitor station identification (either aural or visual as applicable) to ensure a reliable signal is being transmitted.*** Removal of identification serves as a warning to pilots that the facility is officially off the air for tune-up or repairs and may be unreliable even though intermittent or constant signals are received. The navigation signal must be considered unreliable when the station identifier is not being received. For NDBs, there is a direct correlation between the strength of the identifier and the strength and reliability of the signal with no off flags to indicate loss of signal. ***Therefore, on approaches that require an NDB, pilots will monitor the NDB identifier for the entire approach.***

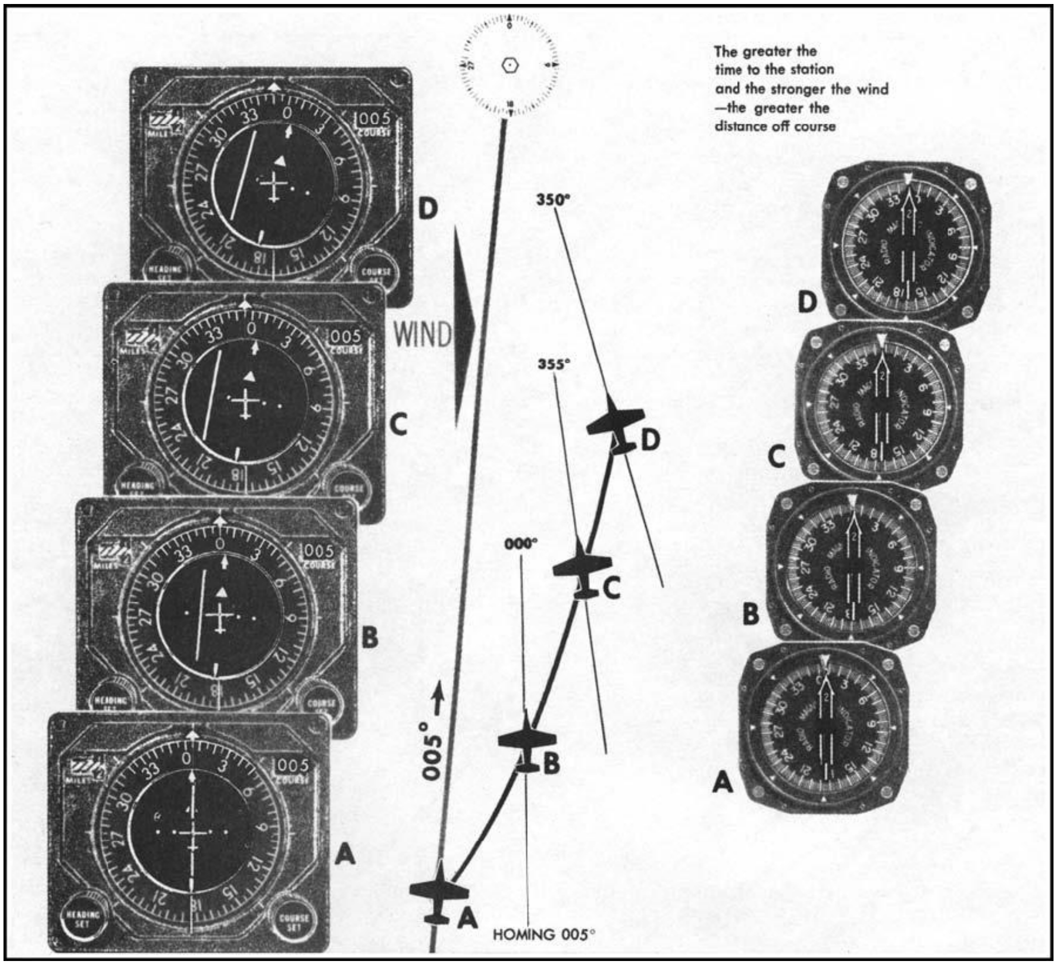
5.1.4. ***Select. The pilot will select proper position for the navigation system switches.***

5.1.5. ***Set. The pilot will set the selector switches to display the desired information on the navigation instruments.***

5.1.6. ***Check. The pilot will check the appropriate instrument indicators for proper operation***.

5.2. Homing to a Station (Figure 5 1). Homing occurs when the pilot places the head of the bearing pointer under the upper lubber line (or Top Index) and makes periodic heading changes to keep it there. Failure to apply wind drift corrections results in a curved flight path to the station.

Figure 5.1. Curved Flight Path as a Result of Homing with a Crosswind.



5.3. Proceeding Direct to a Station. ***Turn the aircraft in the shorter direction*** to place the head of the bearing pointer under the top index or upper lubber line. ***Center the CDI with a TO indication*** (N/A RMI only) ***and apply wind drift corrections to maintain the selected course to the station***.

5.3.1. If either the compass card or the bearing pointer is inoperative, a course indicator or HSI may be used to determine the bearing to the station by rotating the course set knob until the CDI centers and "TO" is read in the "TO-FROM" indicator. The magnetic bearing from the aircraft to the station then appears in the course selector window. ***Pilots will attempt to verify bearing information by any other means available before considering it reliable.***

5.4. Course Intercepts.

5.4.1. Successful Course Interception. Course interceptions are performed in many phases of instrument navigation. ***To ensure successful course interception, an intercept heading must be used that results in an angle or rate of intercept sufficient to complete a particular intercept problem.***

5.4.1.1. Intercept Heading. The intercept heading (aircraft heading) is the heading determined to solve an intercept problem. When selecting an intercept heading, the essential factor is the relationship between distance from the station and the number of degrees the aircraft is displaced from the course. Adjustments to the intercept heading may be necessary to achieve a more desirable rate of intercept.

5.4.1.1.1. A technique for determining intercept headings is:

5.4.1.1.1.1. Inbound: From the desired course, look in the shorter direction to the head of the bearing pointer. Continue beyond the head of the bearing pointer by 30 degrees or the number of degrees off course, whichever is less. This will give a recommended intercept angle of 30 degrees or less. Any heading beyond the bearing pointer, within 90° of the desired inbound course, is a no-wind intercept heading.

5.4.1.1.1.2. Outbound: From the tail of the bearing pointer, move in the shorter direction to the desired course. Continue beyond the course by 45 degrees, or the number of degrees off course, whichever is less. This will give the recommended intercept angle of 45 degrees or less. Any heading beyond the desired course, within 90°, is a no-wind intercept heading.

5.4.1.2. Angle of Intercept. The angle of intercept is the angular difference between the heading of the aircraft (intercept heading) and the desired course. The minimum acceptable angle of intercept for an inbound course interception must be greater than the number of degrees the aircraft is displaced from the desired course. The angle of intercept should not exceed 90°.

5.4.1.3. Rate of Intercept. The rate of intercept is determined by observing bearing pointer and CDI movement. The rate of intercept is a result of intercept angle, groundspeed, distance from the station, and if you are proceeding to or from the station.

5.4.1.4. Completing the Intercept.

5.4.1.4.1. Lead point. A lead point to roll out on the course must be determined because of turn radius of the aircraft. The lead point is determined by comparing bearing pointer or CDI movement with the time required to turn to course. Refer to AFMAN 11-217V3 for techniques to determine a lead point.

5.4.1.4.2. Rate of intercept. To determine the rate of intercept, monitor the bearing pointer or CDI movement.

5.4.1.4.3. Turn. The time required to make the turn to course is determined by the intercept angle and the aircraft turn rate.

5.4.1.4.4. Complete the intercept. Use the CDI, when available, for completing the course intercept.

5.4.1.4.5. Undershoot or Overshoot. If it is obvious that the selected lead point will result in undershooting the desired course, either reduce the angle of bank or roll out of the turn and resume the intercept. If the selected lead point results in an overshoot, continue the turn and roll out with a correction back to the course.

5.4.1.4.6. Maintain course. The aircraft is considered to be maintaining the course centerline when the CDI is centered or the bearing pointer points to the desired course. A correction for known winds should be applied when completing the turn to a course.

5.4.1.4.7. NOTE: Pilots should always attempt to fly as close to the course centerline as possible. TERPS design criteria will provide maximum obstacle clearance protection when the course centerline is maintained.

5.4.2. In-bound (HSI, CI and RMI) (Figure 5.2).

5.4.2.1. ***Tune and identify the station***.

5.4.2.2. ***Set inbound course.*** Set the desired inbound course in the course selector window and check for a TO indication.

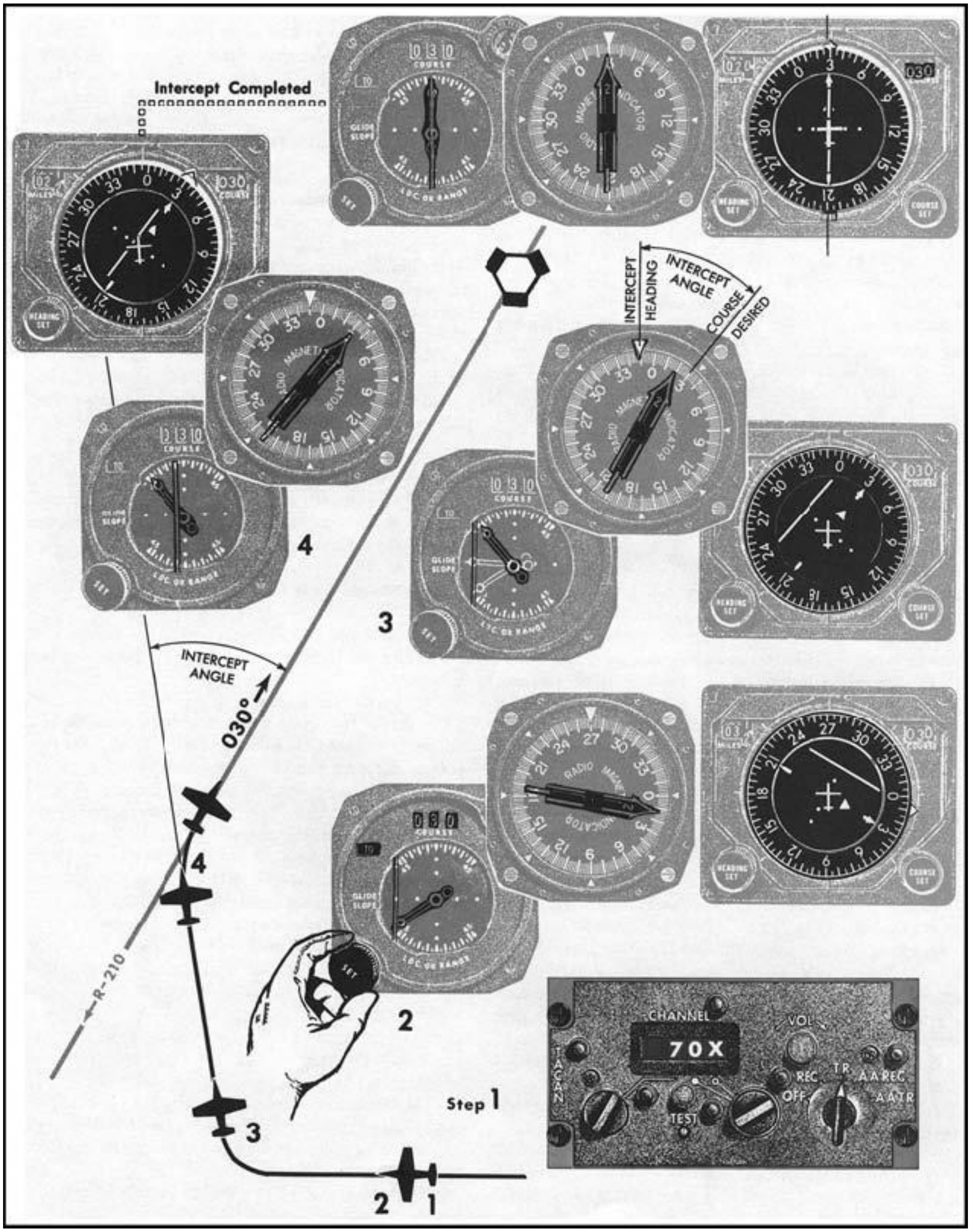
5.4.2.3. ***Turn.*** Turn to an intercept heading.

5.4.2.3.1. CI and RMI. Turn in the shorter direction to place the heading pointer toward the CDI. Continue the turn to place the heading pointer in the top half of the instrument case. This precludes an intercept angle in excess of 90°. Roll out with the RMI/BDHI bearing pointer between the desired inbound course and top index. The angle of intercept must be greater than the number of degrees off course, not to exceed 90°. The intercept heading may be adjusted within these limits to achieve the most desirable rate of intercept. Displacing the bearing pointer approximately 30° from the top index will normally ensure a moderate rate of intercept.

5.4.2.3.2. HSI. Turn in the shorter direction toward the CDI. The shorter direction is displayed by the aircraft symbol and CDI relationship. Continue the turn to place the head of the course arrow in the top half of the instrument case. This precludes an intercept angle in excess of 90°. Roll out of the turn when the bearing pointer is between the upper lubber line and the head of the course arrow to establish an intercept heading. Displacing the bearing pointer 30° from the upper lubber line will normally ensure a moderate rate of intercept. The aircraft symbol will appear to be proceeding toward the CDI at an intercept angle equal to the angle formed between the upper lubber line and the head of the course arrow. The angle of intercept must be greater than the number of degrees off course, but not more than 90°.

5.4.2.4. ***Maintain intercept.*** Maintain the intercept heading until a lead point is reached, then complete the intercept. The lead point depends on bearing pointer or CDI rate of movement and the time required to turn on course.

Figure 5.2. Inbound Course Interceptions (HSI, CI and RMI).



5.4.3. Inbound (RMI Only) (Figure 5.3).

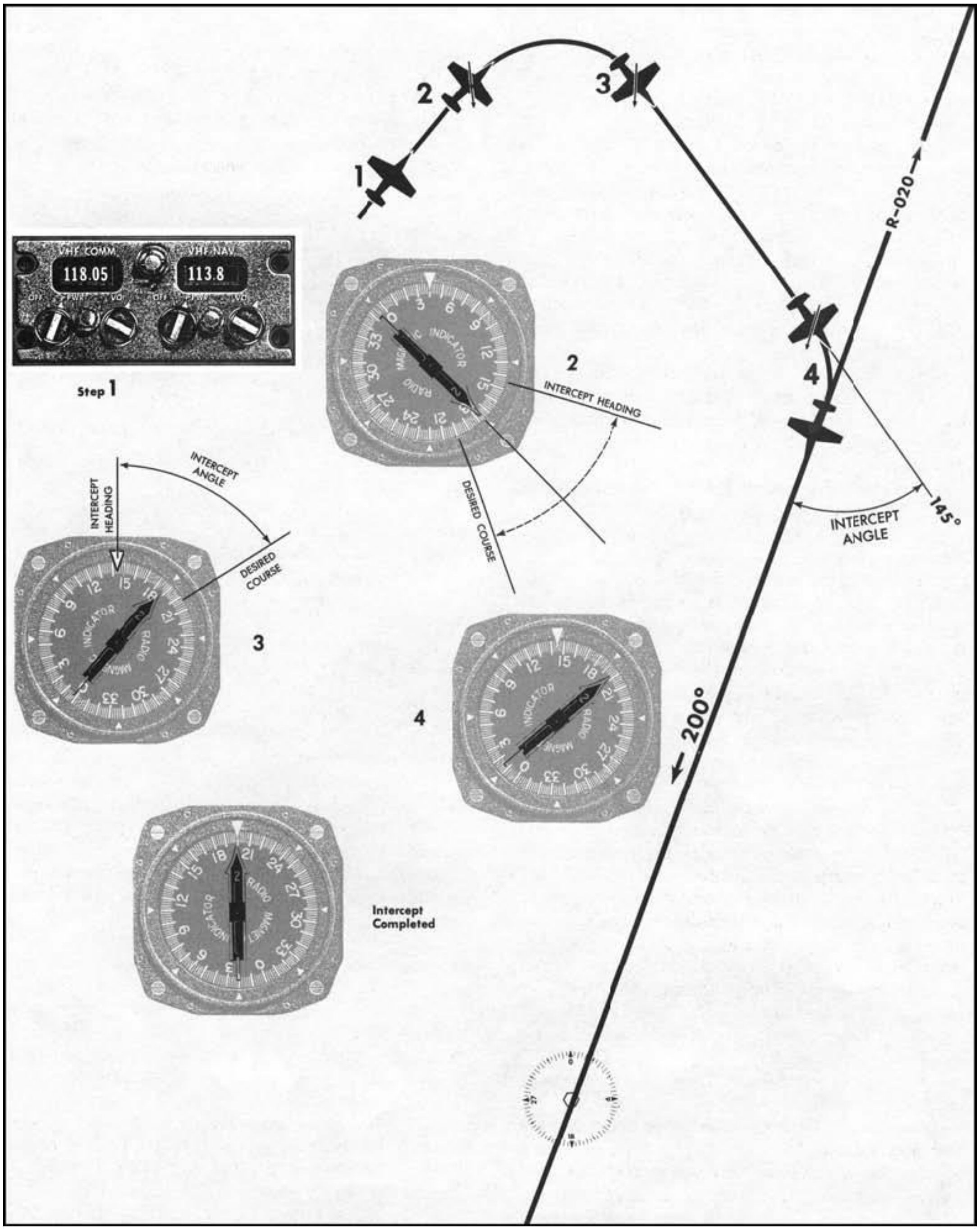
5.4.3.1. ***Tune and identify.*** Tune and identify the station.

5.4.3.2. ***Determine heading.*** Determine an intercept heading. Locate the desired inbound course on the compass card. From the desired course, look in the shorter direction to the head of the bearing pointer. Any heading beyond the bearing pointer, within 90° of the desired inbound course, is a no-wind intercept heading. In many instances, an intercept heading selected 30° beyond the bearing pointer ensures a rate of intercept sufficient to solve the problem. An intercept angle is formed when the head of the bearing pointer is between the desired course and the top index on the RMI.

5.4.3.3. ***Turn.*** Turn in the shorter direction to the intercept heading.

5.4.3.4. ***Maintain intercept.*** Maintain the intercept heading until a lead point is reached, then complete the intercept. Lead point depends on bearing pointer rate of movement and the time required to turn on course.

Figure 5.3. Inbound Course Interceptions (RMI Only).



5.4.4. Outbound -- Immediately After Station Passage (HSI, CI and RMI) (Figure 5.4).

5.4.4.1. ***Tune and Identify.*** Tune and identify the station. This should have already been accomplished.

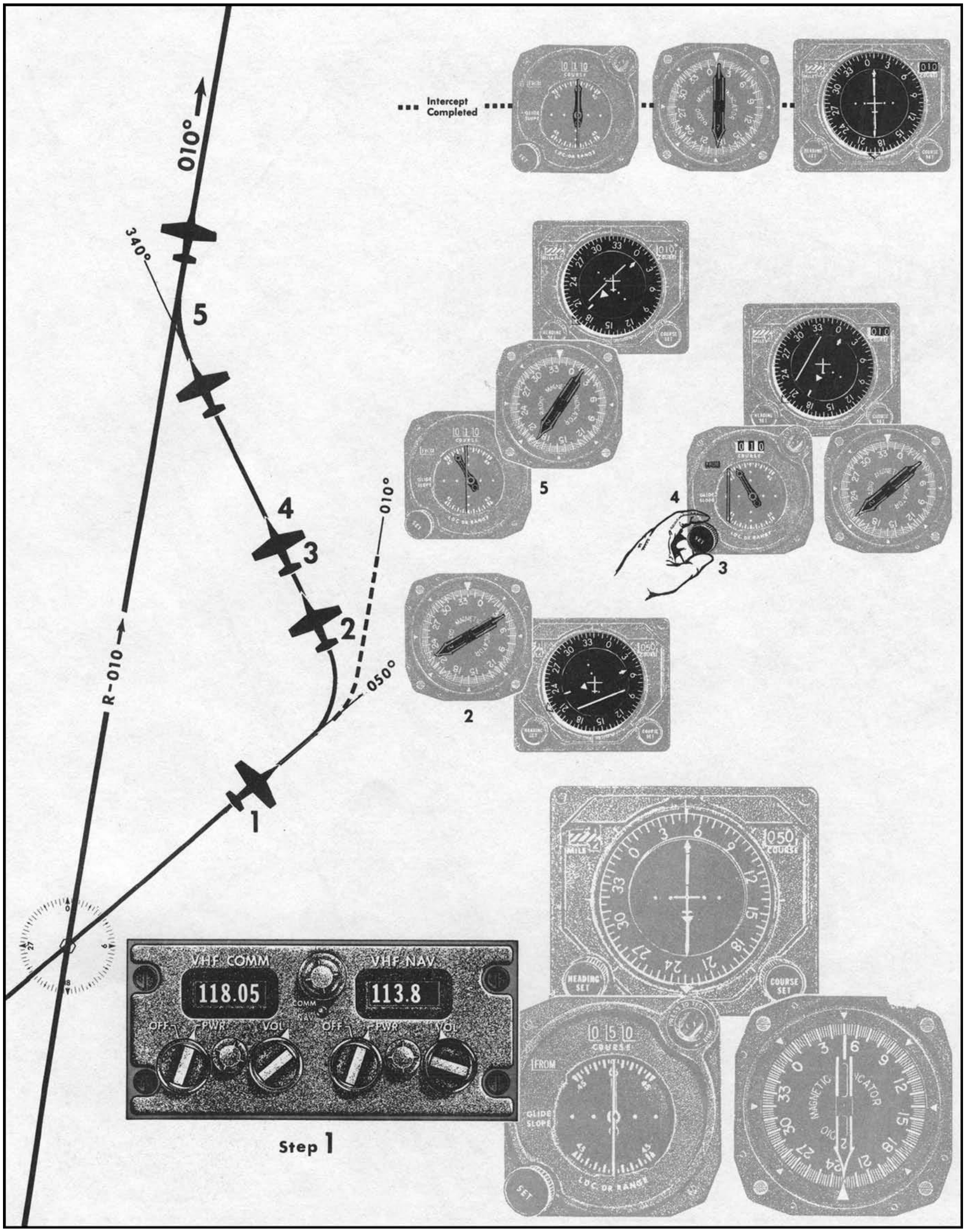
5.4.4.2. ***Turn.*** Turn in the shorter direction to a heading that will parallel or intercept the outbound course. Turning to parallel the desired outbound course is always acceptable. Continuing the turn to an intercept heading may be preferable when the bearing pointer is stabilized or when you know your position in relation to the desired course. The effect that airspeed, wind, and magnitude of turn will have on aircraft position during the turn to an intercept heading should be considered.

5.4.4.3. ***Set course.*** Set the desired course in the course selector window and check for FROM indication.

5.4.4.4. ***Turn to Intercept.*** Turn to an intercept heading if not previously accomplished. Determine the number of degrees off course as indicated by CDI displacement or angular difference between the tail of the bearing pointer and the desired course. If the initial turn was to parallel the desired course, turn toward the CDI to establish an intercept angle approximately equal to the number of degrees off course. Normally, to avoid overshooting, an intercept angle greater than 45° should not be used.

5.4.4.5. ***Maintain.*** Maintain the intercept heading until a lead point is reached, then complete the intercept. The lead point depends on bearing pointer or CDI rate of movement and the time required to turn on course.

Figure 5.4. Outbound Course Interceptions-Immediately After Station Passage (HSI, CI and RMI).



5.4.5. Outbound -- Immediately After Station Passage (RMI Only) (Figure 5.5).

5.4.5.1. ***Tune and Identify.*** Tune and identify the station. This should have already been accomplished.

5.4.5.2. ***Turn.*** Turn in the shorter direction to a heading that will parallel or intercept the outbound course. Refer to paragraph 5.4.4 above (Outbound - Immediately After Station Passage (HSI and CI)).

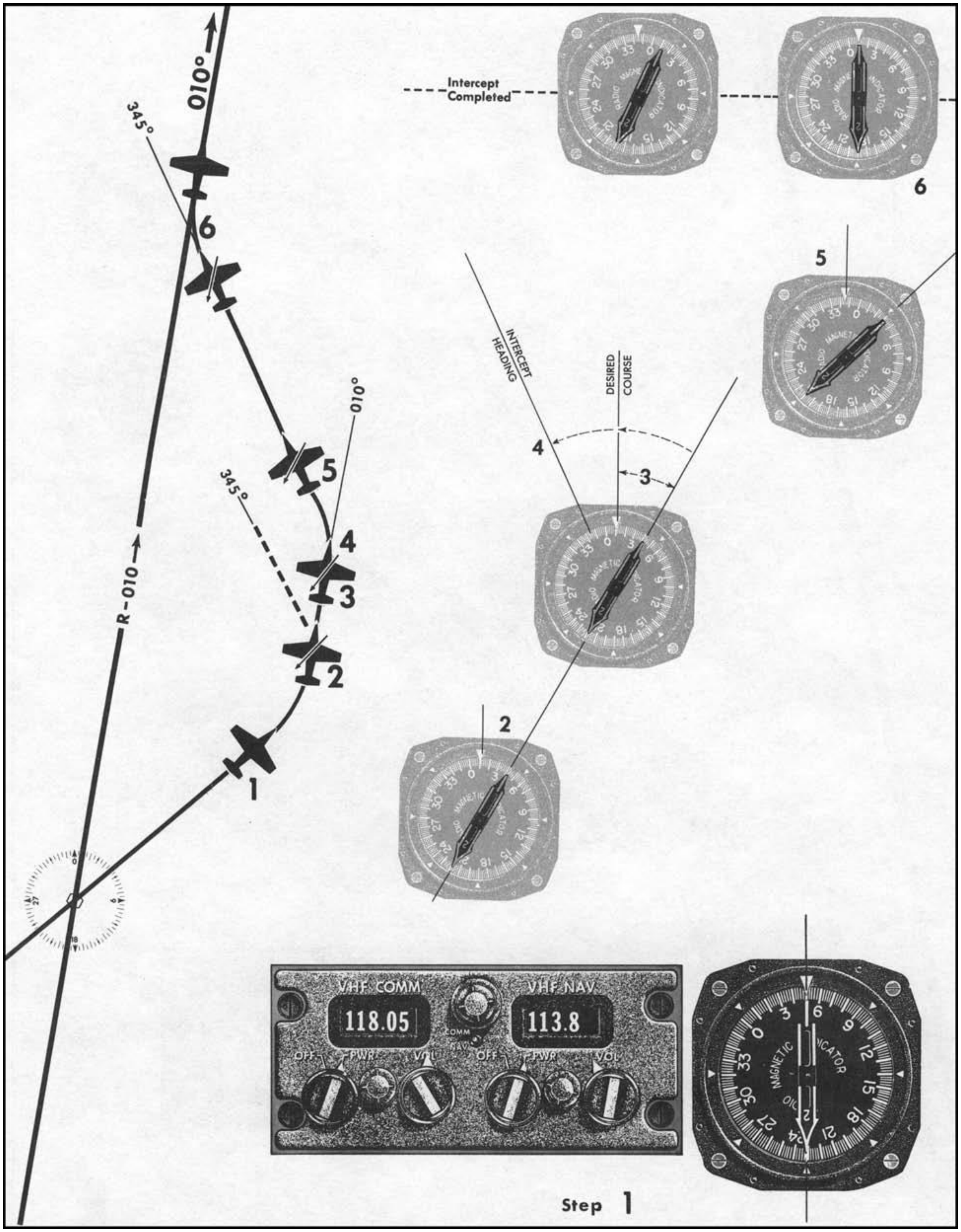
5.4.5.2.1. Degrees Off Course. Determine the number of degrees off course. Note the angular difference between the tail of the bearing pointer and the desired course.

5.4.5.3. ***Intercept Heading.*** Determine an intercept heading. Determine and turn to an intercept heading if a suitable intercept angle was not established during the initial turn. Look from the tail of the bearing pointer to the desired course. Any heading beyond the desired course is a no-wind intercept heading. Turn in this direction an amount approximately equal to the number of degrees off course. Normally, to avoid overshooting the course, do not use an intercept angle greater than 45°.

5.4.5.3.1. Note: On some aircraft, the RMI/BDHI bearing pointer does not have a tail. In this case, turn to the magnetic heading of the desired course. Continue on the outbound magnetic heading of the desired course until the bearing pointer stabilizes. Note the number of degrees the bearing pointer is off the tail of the aircraft. This is the number of degrees off course. Any heading change in the direction toward the head of the bearing pointer is a no-wind intercept heading. Turn in the direction of the head of the bearing pointer an amount approximately equal to the number of degrees off course. Normally, to avoid overshooting the course, do not use an intercept angle greater than 45°.

5.4.5.4. ***Maintain.*** Maintain the intercept heading until a lead point is reached, then complete the intercept. The lead point depends on the bearing pointer rate of movement and the time required to turn on course.

Figure 5.5. Outbound Course Interceptions-Immediately After Station Passage (RMI Only).



5.4.6. Outbound-Away from the Station (HSI, CI and RMI) (Figure 5.6).

5.4.6.1. ***Tune and identify.*** Tune and identify the station.

5.4.6.2. ***Set.*** Set the desired outbound course in the course selector window.

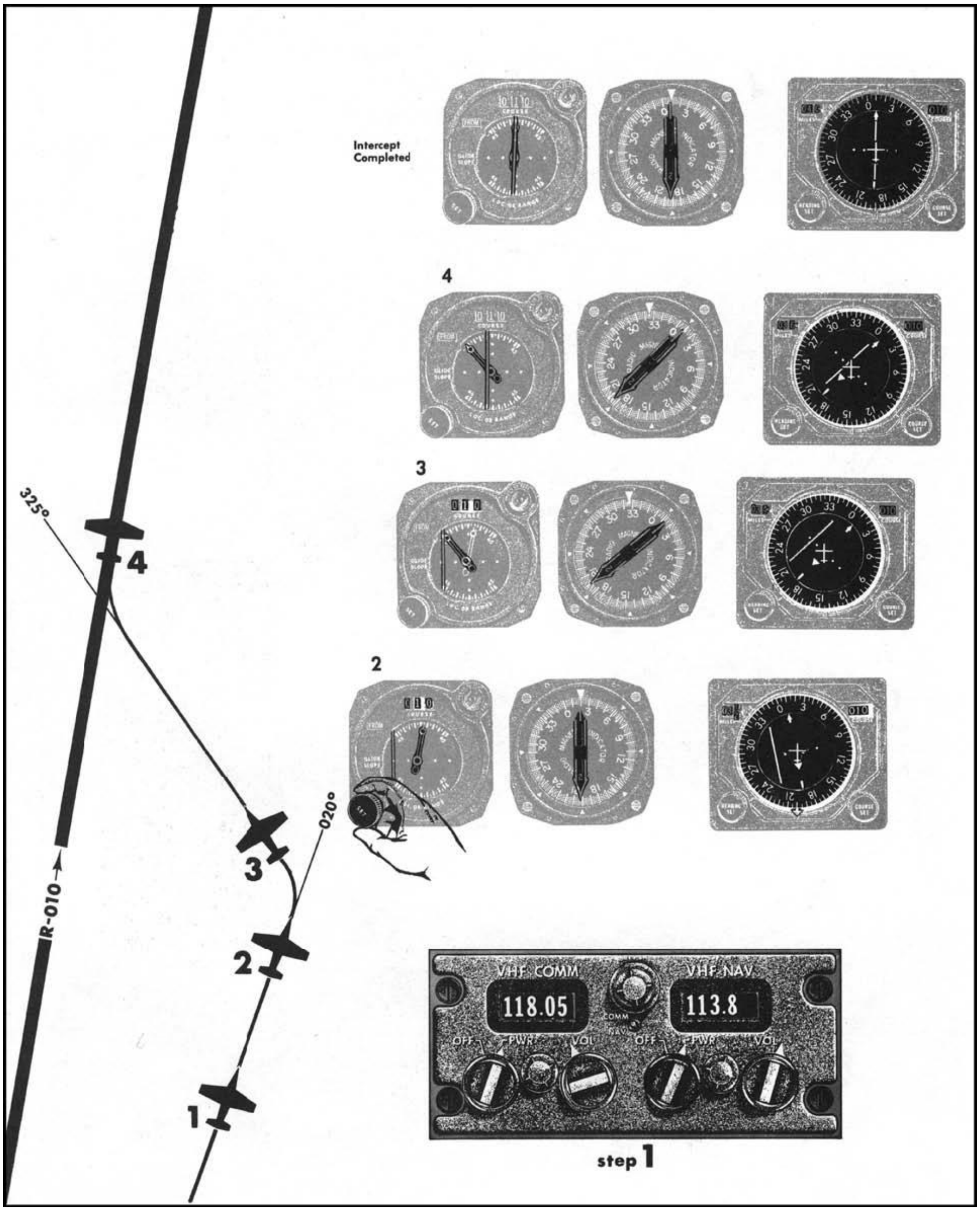
5.4.6.3. ***Turn.*** Turn to an intercept heading:

5.4.6.3.1. CI. Turn in the shorter direction to place the heading pointer toward the CDI. Continue the turn to place the heading pointer in the top half of the instrument case and roll out on an intercept heading. This precludes an intercept angle in excess of 90°. Roll out of the turn on an intercept heading with a suitable intercept angle, normally 45°. A 45° intercept angle is established by rolling out with the desired course under the appropriate 45° index, or with the heading pointer displaced 45° from the top index and toward the CDI.

5.4.6.3.2. HSI. Turn in the shorter direction toward the CDI. Continue the turn until the head of the course arrow is in the top half of the instrument case. This precludes an intercept angle in excess of 90°. Roll out of the turn on an intercept heading with a suitable angle of intercept, normally 45°. A 45° intercept angle is established by rolling out with the head of the course arrow under the appropriate 45 ° index (aircraft symbol directed toward the CDI).

5.4.6.4. ***Maintain.*** Maintain the intercept heading until a lead point is reached, then complete the intercept. The lead point depends on the bearing pointer or CDI rate of movement and the time required to turn on course.

Figure 5.6. Outbound Course Interceptions-Away From the Station (HSI, CI and RMI).



5.4.7. Outbound-Away From the Station (RMI Only) (Figure 5.7).

5.4.7.1. ***Tune and identify.*** Tune and identify the station.

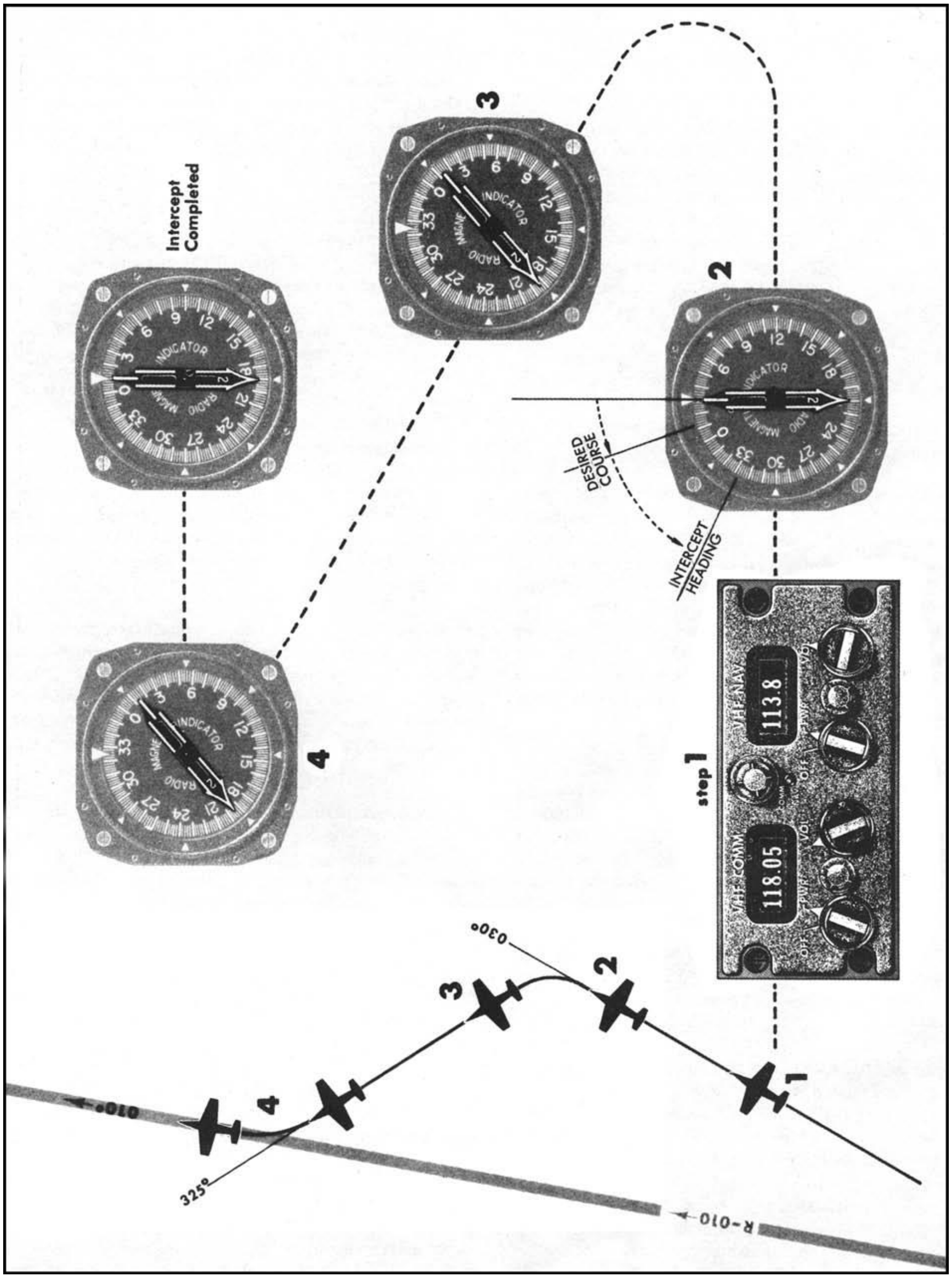
5.4.7.2. ***Determine an intercept heading.*** Look from the tail of the bearing pointer past the desired course and select an intercept heading. Any heading beyond the desired course, within 90°, is a no-wind intercept heading. A heading selected 45° beyond the desired course will normally ensure a moderate rate of intercept.

5.4.7.2.1. Note: On some aircraft, the RMI or BDHI bearing pointer does not have a tail. In this case, turn the shorter direction to the outbound magnetic heading of the desired course. Note the number of degrees the bearing pointer is off the tail of the aircraft. This is the number of degrees off course. Any heading change in the direction toward the head of the bearing pointer within 90° is a no-wind intercept heading. A turn in the direction of the head of the bearing pointer of 45° past the desired course will normally ensure a moderate rate of intercept.

5.4.7.3. ***Turn.*** Turn in the shorter direction to the intercept heading.

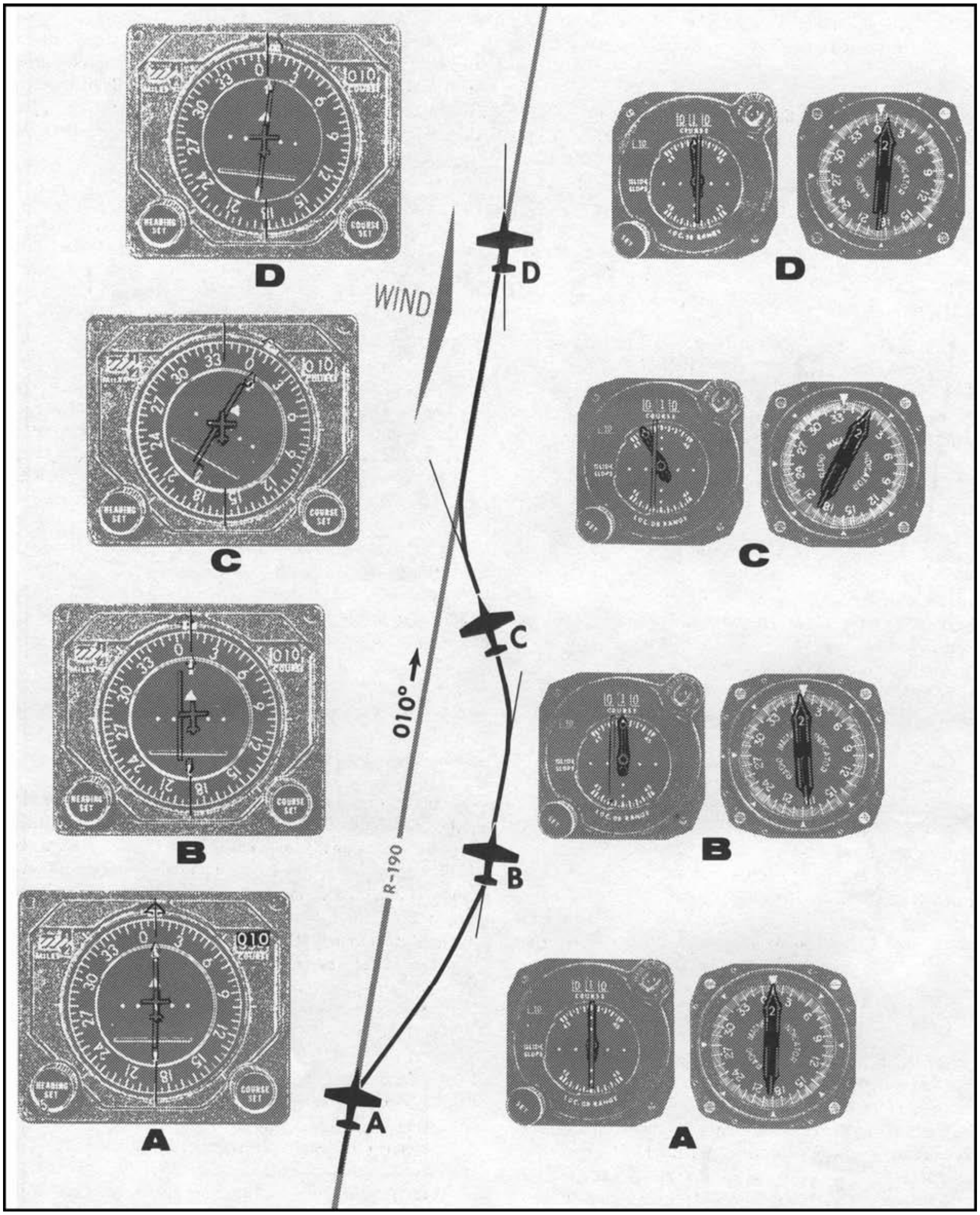
5.4.7.4. ***Maintain.*** Maintain the intercept heading until a lead point is reached, then complete the intercept. The lead point depends on the bearing pointer or CDI rate of movement and the time required to turn on course.

Figure 5.7. Outbound Course Interceptions-Away From the Station (RMI Only).



5.4.8. Maintaining Course (Figure 5.8). To maintain course, fly a heading estimated to keep the aircraft on the selected course. If the CDI or bearing pointer indicates a deviation from the desired course, return to course avoiding excessive intercept angles. After returning to course, again estimate the drift correction required to keep the CDI centered or the bearing pointer pointing to the desired course. (The CDI and bearing pointer may show a rapid movement from the on-course indication when close to the station. In this situation, avoid making large heading changes because actual course deviation is probably small due to proximity to the station).

Figure 5.8. Maintaining Course.



5.5. Station Passage.

5.5.1. VOR and VOR/DME. Station passage occurs when the TO-FROM indicator makes the first positive change to FROM. For RMI/BDHI only, station passage is determined when the bearing pointer passes 90 degrees to the inbound course.

5.5.2. TACAN. Station passage occurs when the range indicator stops decreasing.

5.5.3. ADF. Station passage occurs when the bearing pointer passes 90° to the inbound course.

5.5.3.1. NOTE: When established in an NDB holding pattern, subsequent station passage occurs at the first definite move by the bearing pointer through the 45° index on the RMI.

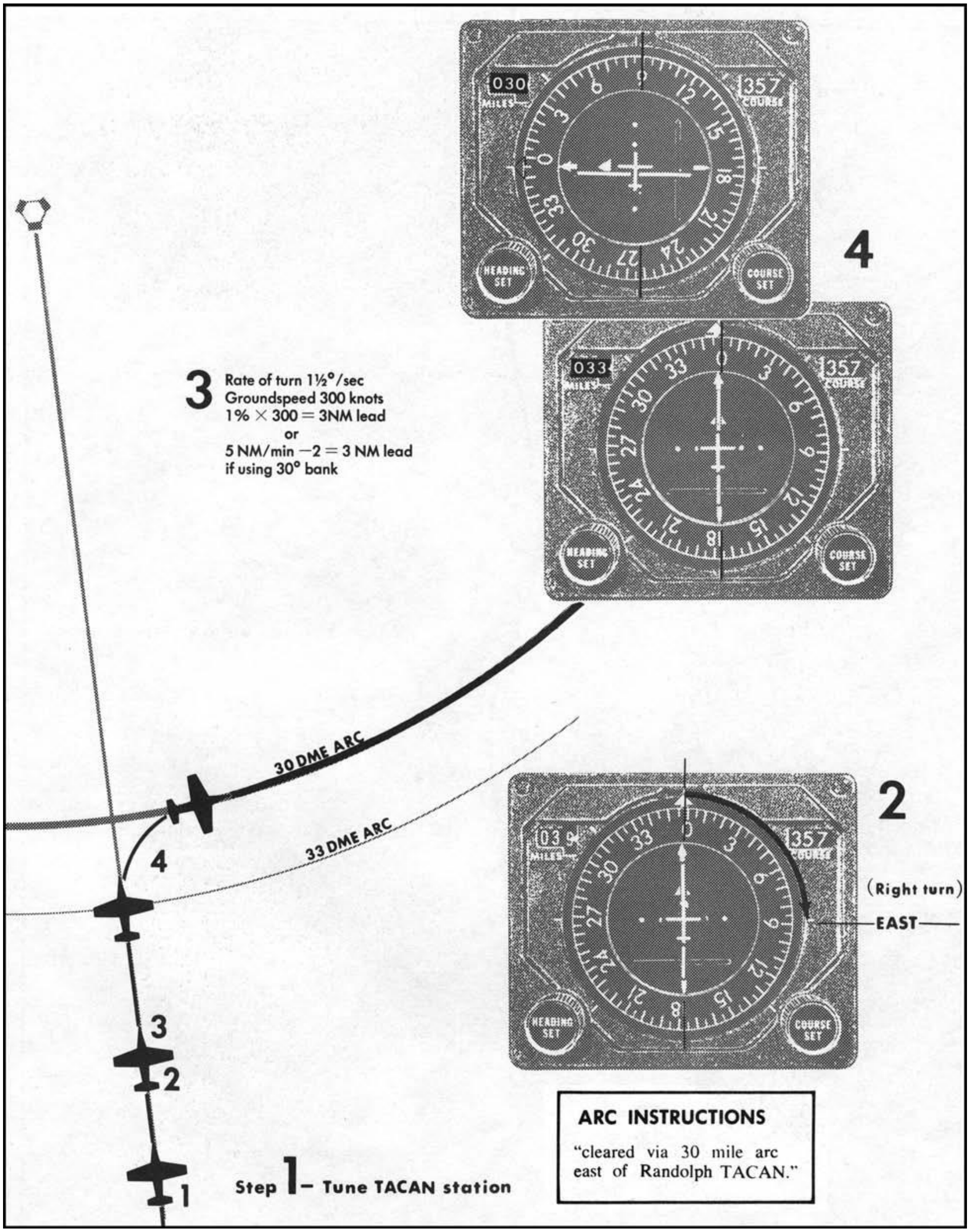
5.6. Groundspeed Check. Groundspeed checks are done to aid in calculating ETAs to fixes, which are useful for position reports, fuel computations and other mission timing problems.

5.6.1. Conditions. A groundspeed check can be made while maintaining a course to or from a TACAN/VORTAC station. As a guide, however, groundspeed checks should be performed only when the aircraft slant range distance is more than the aircraft altitude divided by 1,000. For example, if the aircraft is at FL 200, groundspeed checks should be performed when beyond 20 nautical miles. Checks made below 5,000 feet are accurate at any distance.

5.6.2. Begin Timing. To perform the groundspeed check, begin timing when the range indicator shows a whole number. After the predetermined time has elapsed, check the range indicator and note the distance flown. Apply the following formula to determine groundspeed: Multiply the distance flown times 60 and then divide the product by the elapsed time in minutes. For example, if you fly 12 NM in 2 minutes, then your groundspeed is 360 knots. ((12 NM x 60)/2 min = 360 knots)

5.6.2.1. NOTE: For precise computation, time for longer periods and solve the problems on a computer. To simplify computations, use a 2-minute time check and multiply the distance traveled by 30, a 3-minute time check, distance times 20; or a 6-minute time check, distance times 10. A rapid groundspeed check can be accomplished by timing the range indicator for 36 seconds and multiplying the distance traveled by 100.

Figure 5.9. Arc Interception From a Radial.



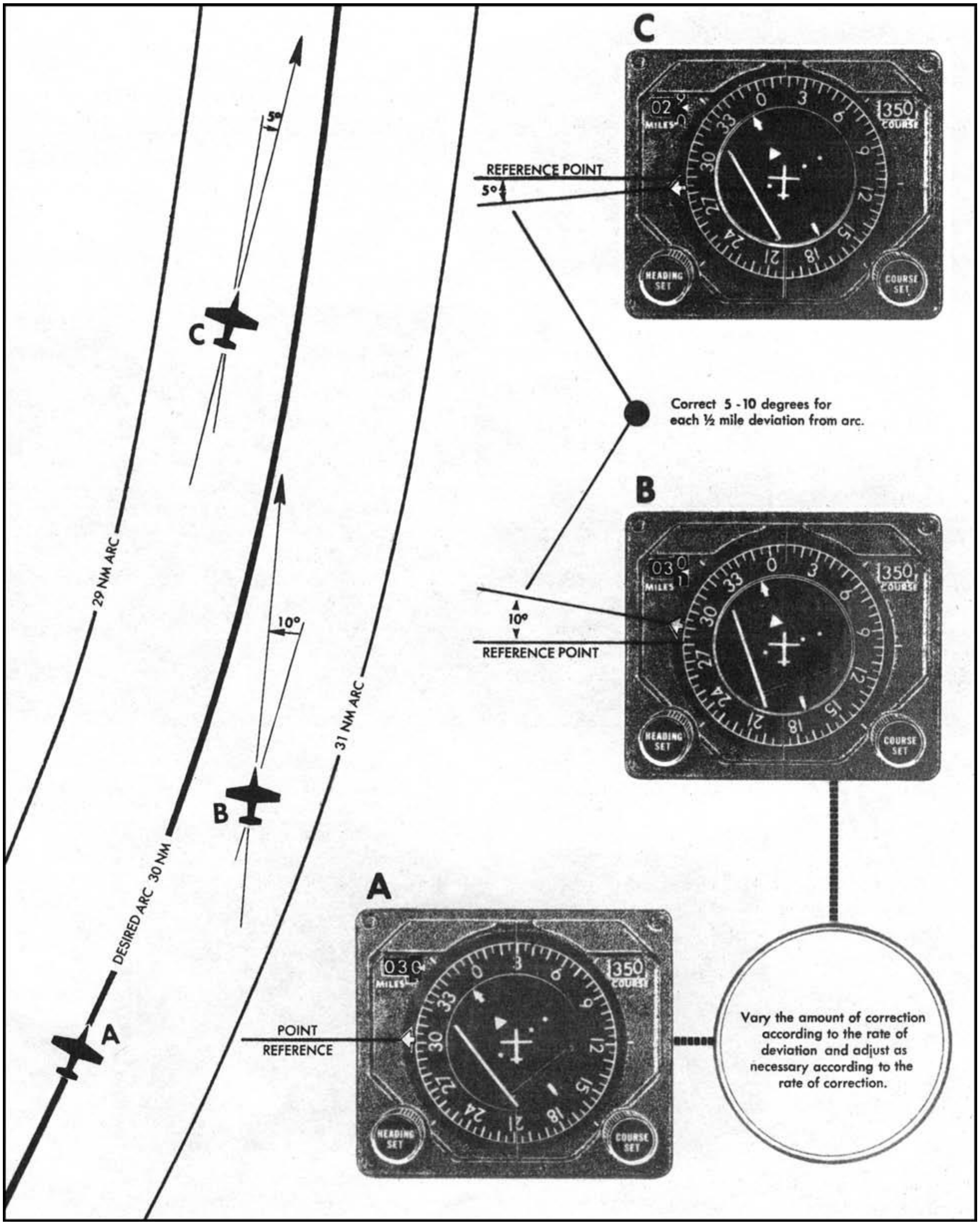
5.7. Arc/Radial Intercepts. TACAN and VOR/DME arcs are used during many phases of flight. Arcs are normally intercepted from radials (either inbound or outbound) and vice-versa, making the turn from one to the other, in general, 90° of heading change . Use accurate lead points and account for variations in aircraft turn radius due to winds to prevent excessive under or overshoots.

5.7.1. Arc Interception from a Radial (Figure 5.9). ***Tune and identify*** the NAVAID used for the intercept and ***determine the direction of turn***. Using aircraft calculations found in AFMAN 11-217V3, determine the lead point necessary to intercept the arc. When the lead point is reached, turn to place the bearing pointer on the 90° index.

5.7.1.1. Corrections. If the aircraft is outside of the desired arc, turn to place the bearing pointer slightly above the 90° index. If inside, turn to place the bearing pointer slightly below the 90° index. (Rule of Thumb: Displace the bearing pointer 5° below the reference point for each one-half mile deviation to the inside of the arc, and 10° above the reference point for each half mile outside the arc.)

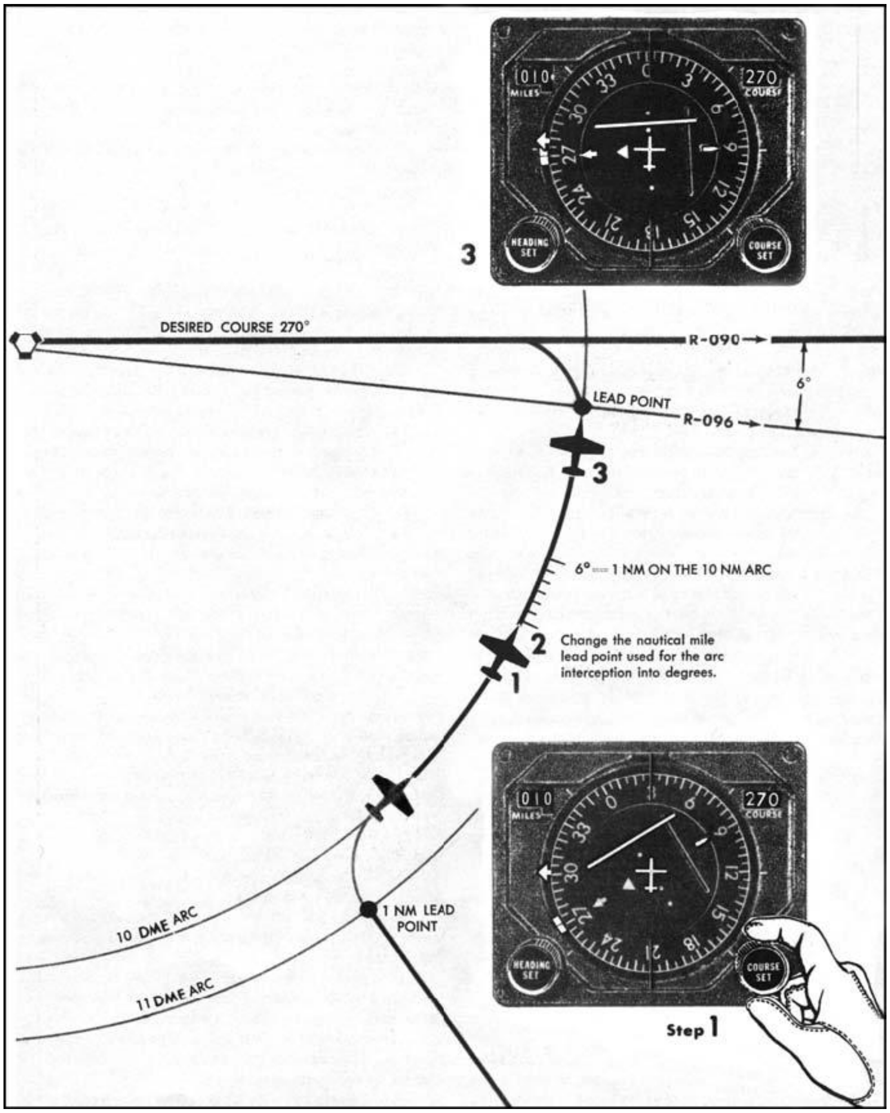
5.7.1.2. While on the arc, as the bearing pointer falls, continue to make small turns to keep it on the 90° index. Alternatively, a series of short straight legs may be flown allowing the bearing pointer to fall a few degrees below the 90° index then turning to place the bearing pointer a few degrees above the 90° index. When using this technique, the aircraft will fly slightly outside and inside the arc alternatively on each leg (Figure 5.10).

Figure 5.10. Correcting to Maintain an Arc.



5.7.2. Radial Interception From an Arc (Figure 5.11). ***Tune and identify the NAVAID*** used for the intercept and ***determine the direction of turn***. Using aircraft calculations found in AFMAN 11-217V3, determine the lead point necessary to intercept the arc. When the lead point is reached, roll to the bank angle used in the lead point calculation and turn to roll out on the radial.

Figure 5.11. Radial Interception From an Arc.



5.8. Proceeding Direct to a VOR/DME or TACAN Fix. Proceeding directly to a radial/DME fix without RNAV equipment is not a normal form of navigation in the NAS. It can, however, be a useful technique for backing up RNAV equipment or navigating in a loss of communication situation. Bearing and range information from a VOR/DME or TACAN facility is sufficient for navigating direct to any fix within reception range.

5.8.1. In order to legally conform to NAS area navigation procedures and the national route program (NRP) as outlined in FLIP GP chapter 4 and FAA AC 90-91, USAF pilots and air traffic controllers should not file, give, or accept a clearance (as applicable) that requires an aircraft to navigate direct to a radial/DME fix (perform a fix-to-fix) except under the following circumstances:

5.8.1.1. The primary navigation equipment onboard the aircraft is either area navigation (RNAV) or advanced RNAV capable and operating normally.

5.8.1.2. Flight will be conducted where radar monitoring by air traffic control (ATC) is available.

5.8.1.3. Locally defined arrival/departure procedures require the navigation to/from a radial-DME fix for the sequencing of aircraft. Locally defined procedures must be evaluated by TERPS and flight checked if flown in instrument meteorological conditions (IMC) and radar monitoring is not available.

5.8.1.4. Operational necessity dictates (i.e. filing and flying an air refueling track) or conforms to military enroute operations.

5.8.2. When operating in the NAS and given a clearance to proceed to a radial/DME fix, unless the aircraft capability or operations meet one of the parameters defined above, pilots should reply with "unable" and state the appropriate suffix code defined in FLIP GP chapter 4. Under these circumstances, ATC should provide navigation guidance to the radial/DME fix either via radar vectors or an alternate routing.

5.8.3. The following are some techniques to accomplish a fix-to-fix (Figure 5.12.):

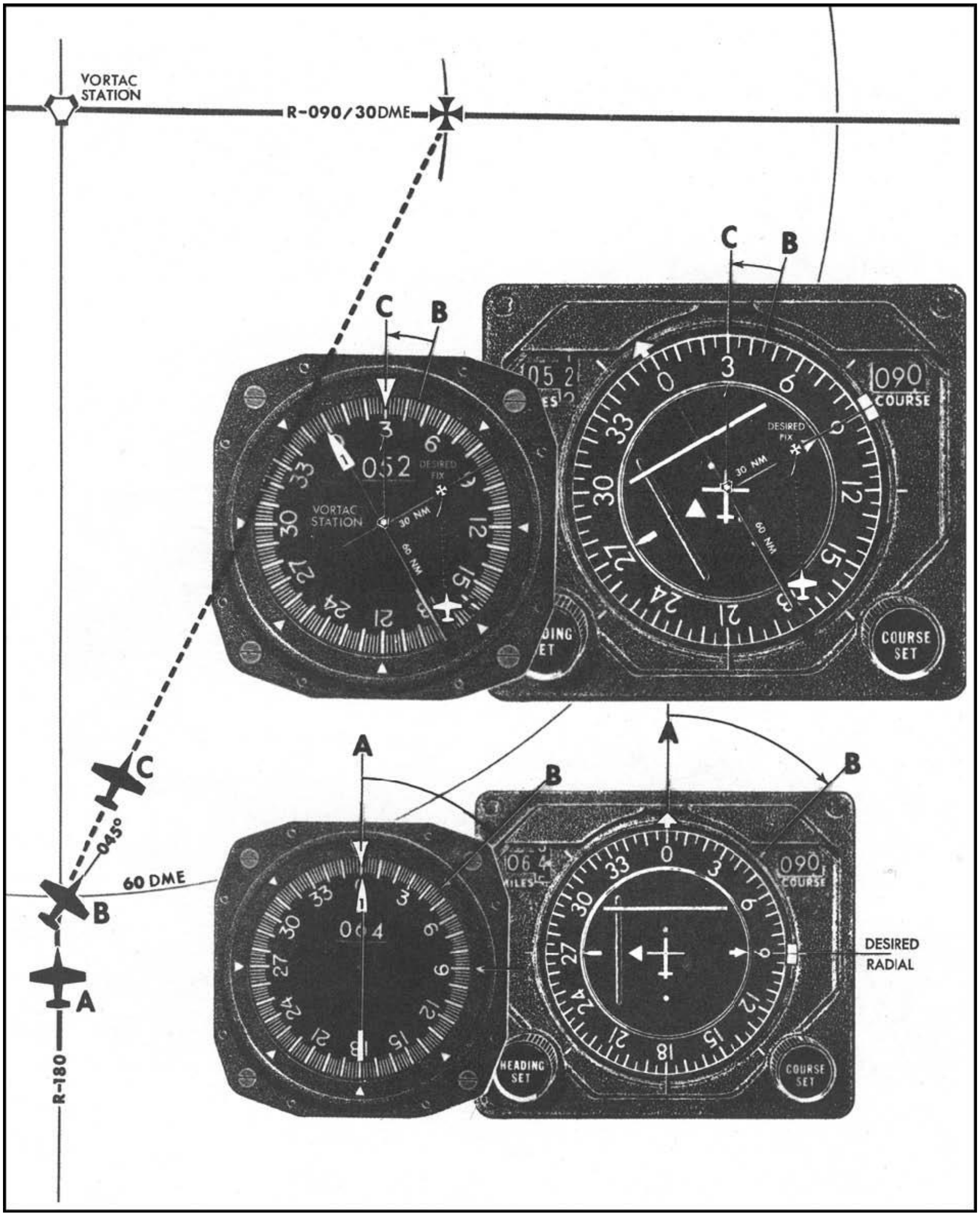
5.8.3.1. Tune the TACAN or VOR/DME equipment (VOR and DME stations must be collocated). Then visualize the navigational situation on the HSI or RMI compass card. The NAVAID will be represented by the center of the compass card. The outer ring of the compass card will represent the greater of either the aircraft's current DME or the DME of the fix.

5.8.3.2. Turn in the shortest direction to a heading somewhere between the head of the bearing pointer and the radial of the desired fix. (Position B of Figure 5.12) If the DME of the fix is greater than the aircraft's current DME, the heading will be closer to the desired radial and vice-versa. This initial heading will get the aircraft moving in the general direction of the fix until the following procedures can fine-tune the heading.

5.8.3.3. To fine-tune the heading to the desired fix, mentally place the aircraft and the desired fix on their respective radials at the appropriate relative position from the center of the compass card (NAVAID). Turn the aircraft until the line between these two points is parallel to a line from the center of the compass card and the upper lubber line with the two fix points vertically one above the other. (Position C of Figure 5.12)

5.8.3.4. Update the fix-to-fix periodically remembering that the relative size of the compass card will change as the airplane moves in relation to the NAVAID. If the initial heading does not keep the aircraft moving toward the fix, there is probably a wind effect. When making adjustments to the fix-to-fix heading, take this wind effect into account in the new heading.

Figure 5.12. Proceeding Direct to a DME Fix.



5.9. Area Navigation. (RNAV) A method of navigation using a variety of onboard equipment including Inertial Navigation System (INS), TACAN/VOR/DME-based Flight Management Systems (FMS), Integrated/Embedded GPS, DME/DME/IRU (if certified for IFR navigation) or LORAN-C that allows the pilot to fly directly to predetermined geographical positions (waypoints) or define routes or instrument procedures in terms of latitude and longitude or radial/distance relative to a ground based navigation facility.

5.9.1. In order to be considered RNAV capable, an aircraft must be able to display a course from a given point (waypoint) to a clearance limit while also providing a continuously updated aircraft position with reference to that course line. An aircraft FMS, INS, LORAN, or integrated GPS navigation system providing course guidance to the aircrew meets this requirement. Mission enhancement GPS systems do not meet this requirement.

5.9.2. Aircraft may fly, with clearance, on either random or designated RNAV routes. A random RNAV route proceeds between RNAV waypoints that are not part of published airways. Designated RNAV routes follow published and charted airways meant for RNAV capable aircraft. ***Whether under radar control or not, Pilots shall use extreme caution when flying random RNAV routes or accepting clearance to navigate via RNAV to a fix or point while below the minimum IFR altitude.***

5.9.3. Required Navigation Performance Type (RNP Type). A value stating the navigation performance of the aircraft for at least 95 percent of the total flying time. The value is a must-remain-within value and is typically expressed as a distance in (longitudinal and lateral) nautical miles (e.g. RNP-5 airspace requires an aircraft to be within 5 miles of its intended position 95 percent of the time). In addition to accuracy, many RNP applications impose functional requirements. Aircrew must comply with training, certification, and equipment requirements prior to flying any RNAV procedure. The RNP Type can be found either directly on the publication or in the legend for various navigational procedures (e.g. STARS, hi and low charts, approaches, etc.)

5.9.3.1. En Route. RNAV aircraft must be able to navigate on the intended RNP Type route or within the RNP Type airspace using their onboard navigation equipment. MAJCOMS provide operational approval for each type of RNP airspace/procedure. Operational approval ensures that RNAV equipment meets accuracy and functional requirements, and that appropriate crew training and procedures are in place. While airspace requirements vary between regions, in some cases backup equipment (VOR/DME, TACAN, etc.) may be required to allow reversion to an alternate means of navigation should RNAV equipment fail.

5.9.3.2. Terminal. RNAV in the terminal area consists of both approach and departure procedures. RNAV equipment may be used as the sole source of navigation information for instrument approaches in suitably equipped and certified aircraft. ***RNAV approaches must be retrieved from an aircraft database and not be manually entered.*** MAJCOMs certify the capabilities of their aircraft in accordance with civil standards as outlined in various Technical Standard Order's (TSO) and Advisory Circular's (AC).

5.9.4. Aircrew Responsibilities. Although RNAV routes (including random routes) may be filed at any time, aircrews should have alternate routing and contingency actions planned. ATC considers radar coverage capability and compatibility with traffic flow and volume prior to assigning random RNAV routes. Although ATC provides radar separation on RNAV routes in the national airspace system (NAS), navigation and collision avoidance on any RNAV route remains the responsibility of the aircrew. Aircrews must consider the limits of RNAV equipment certification prior to accepting clearance for RNAV routes or RNP airspace. Aircrews should also take advantage of opportunities to update the navigation system while en route. In addition, crews should monitor RNAV equipment performance and be prepared to return to an alternate means of navigation should an equipment malfunction require.

5.10. GPS Navigation. The ICAO has adopted "Global Navigation Satellite System (GNSS)" as an umbrella term to identify any satellite navigation system where the user performs onboard position determination from satellite information. Currently there are only two GNSS systems that are recognized by the International Frequency Registration Board (IFRB): the GPS developed by the United States and the Global Orbiting Navigation Satellite System (GLONASS) now under development by the Federation of Russia.

5.10.1. GPS Requirements for IFR navigation. In order to be used for IFR navigation, GPS equipment must meet minimum functional requirements and comply with approved standards for accuracy, integrity, availability, and continuity. Compliance with FAA TSOs and ACs are the primary means of ensuring these standards are met. AFI 11-202V3, lists FAA TSOs and ACs applicable to GPS User Equipment (UE).

5.10.2. GPS equipment properly certified and approved by the MAJCOM may be used as a primary means of IFR navigation. Aircrews will comply with guidance in AFI 11-202V3 and aircraft flight manuals when utilizing GPS as a navigation solution.

5.10.2.1. NOTE. GPS provides two levels of service: Standard Positioning Service (SPS) and Precise Positioning Service (PPS). SPS is based on the C/A data and provides, to all users, a horizontal and vertical signal-in-space positioning accuracy standard of 13 meters and 22 meters, respectively, with a probability of 95 percent. PPS is based on an encrypted Precision (P) code transmitted over two frequencies (L1 and L2) as a P (Y) code which can only be received by military GPS receivers with a valid crypto key inserted and is accurate to within 9 meters. Some countries do not allow the use of GPS (either SPS or PPS) for IFR navigation in their sovereign airspace. Consult the appropriate FLIP Area Planning (AP) document for details.

5.10.2.2. NOTE. IFR navigation using PPS GPS. Without host nation approval, PPS may not be used for IFR navigation in civil airspace, including the US National Airspace System (NAS). For discussion on GPS PPS, see AFMAN 11-217V3.

5.10.2.3. Receiver Autonomous Integrity Monitor (RAIM). The GPS receiver verifies the integrity of the signals received from the GPS constellation through RAIM to determine if a satellite is providing corrupted information. Without RAIM capability, the pilot has no assurance of the accuracy of the GPS position. ***RAIM (or equivalent integrity method) is required for use of GPS in IFR navigation*** and requires at least 5 satellites in view to check GPS integrity.

5.10.2.3.1. NOTE: Barometric aiding allows RAIM to validate GPS integrity utilizing just 4 satellites in conjunction with the current altimeter setting entered in an approved barometric altimetry system.

5.10.2.3.2. NOTE: For sake of simplicity, this document will use the term RAIM to refer to all acceptable integrity monitoring methods. The procedures and guidance discussed are applicable to all approved integrity monitoring algorithms.

5.10.2.3.3. RAIM outages may occur due to an insufficient number of satellites or unsuitable satellite geometry. 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.

5.10.2.3.3.1. RAIM Alerts. There are two types of RAIM alerts. One type indicates that not enough satellites are in view (or in an insufficient geometry) to provide RAIM. The other type indicates that the RAIM has detected a potential error that exceeds the limits (enroute, terminal, or approach) for the current phase of flight.

5.10.2.3.3.2. Predictive RAIM forecasts RAIM availability at a particular location at a time in the future. To effectively check predictive RAIM, aircraft avionics must allow deselection of satellites based on NOTAM information. ***Predictive RAIM must be checked prior to the mission or the flight segment where GPS is required.***

5.10.2.3.3.2.1. A predictive RAIM check is not required on aircraft approved for RNP RNAV operations by the aircraft flight manual. ***Prior to flying RNP RNAV procedures, aircrew must ensure that the appropriate level of RNP will be available to fly a given procedure.*** This may or may not require a predictive RAIM check. Details on methods to confirm RNP RNAV availability are detailed in the aircraft flight manual.

5.10.2.3.3.2.2. If the required RAIM level (e.g., enroute, terminal or approach) is not available, another type of navigation and approach system must be used, another destination selected, or the trip delayed until the RAIM level is acceptable.

5.10.2.3.3.2.3. Pilots should recheck the RAIM prediction for the destination during the flight. This may provide early indications that an unscheduled satellite outage has occurred since takeoff and allow the pilot to determine an alternative course of action.

5.10.2.3.3.2.4. The predictive RAIM check, if required, must be accomplished prior to the intended GPS operation, including both GPS departures and approaches, and may be accomplished either by onboard GPS equipment or via a ground system. The predictive RAIM algorithm should take into account satellites that are NOTAMed out of service between the time of the predictive RAIM check and the flight segment over which GPS is required. Prior to deselecting satellites for predictive RAIM purposes, aircrew should ensure that deselecting would not affect use of the satellite in the active navigation solution. Some systems only allow deselecting from the active navigation solution and do not allow deselecting for predictive RAIM purposes.

5.10.2.3.3.2.5. GPS NOTAMs may be obtained by entering "KGPS" as the “airfield” at the military NOTAM website. Note that the NOTAM website refers to satellites using the PRN, not the SVN. Most, if not all GPS avionics use the PRN to identify satellites to be deselected. For information on the correlation between a particular PRN and SVN, consult the GPS Support

Center web site.

5.10.2.3.3.2.6. For operations in the US NAS, predictive RAIM information for individual destinations may be obtained by contacting an FAA Flight Service Station or at the RAIM prediction website (**http://www.raimprediction.net**) . For operations within Europe, predictive RAIM information may be obtained at the AUGUR website (**http://augur.ecacnav.com/augur/app/home**). Additionally, the military also provides airfield-specific GPS RAIM NOTAMs for non-precision approach procedures at military airfields. The RAIM outages are listed as M-series NOTAMs and may be obtained for up to 24 hours from the time of request. However, this list currently covers only 320 military-use airfields and may not include your intended destination.

5.10.2.4. Fault Detection and Exclusion (FDE). FDE allows GPS equipment to automatically detect and exclude faulty satellites from the navigation solution. FDE requires a minimum of 6 satellites in view (or 5 satellites with baro-aiding). Past experience indicates that without FDE, or the ability to manually determine which satellite is faulty and exclude it from the navigation solution, satellite failure can lead to significant GPS position errors (in excess of 100 nm). ***FDE is required when utilizing GPS as a primary means of navigation in remote/oceanic areas.***

5.10.3. Using GPS in lieu of land-based NAVAIDS (RNAV substitution). GPS equipment certified for IFR operations IAW AFI 11-202V3, may be used in place of land-based NAVAIDS for en route and terminal operations, in the following situations (within the U.S. National Airspace (NAS) and worldwide on procedures constructed by a US-Gov't TERPS authority (FAA/USN/USAF)):

5.10.3.1. Determining the aircraft position over a TACAN, VOR, NDB, compass locator or DME fix.

5.10.3.2. Determine the aircraft position over a named fix defined by a VOR course, NDB bearing, or compass locator bearing crossing a VOR or localizer course.

5.10.3.3. Navigating to or from a TACAN, VOR, NDB, or compass locator. For example, a pilot might proceed direct to a VOR or navigate on a segment of a departure procedure. ***However, pilots may not substitute for the navigation aid providing lateral guidance for the final approach segment.*** This restriction does not refer to instrument approach procedures with "or GPS" in the title when using GPS or WAAS.

5.10.3.4. Hold over a TACAN, VOR, NDB, compass locator or DME fix.

5.10.3.5. Fly a DME arc. These allowances do not include navigation on localizer-based courses (including localizer back-course guidance).

5.10.3.6. NOTE: Consult individual aircraft flight manuals for further guidance concerning use of RNAV equipment as a substitute or alternative means of navigation. Some aircraft may have additional requirements to monitor the land-based NAVAID or restrictions against substituting RNAV guidance for inoperable land-based NAVAIDS. Pilots must ensure their onboard navigation data is current, appropriate for the region of intended operation, and includes the navigation aids, waypoints, and relevant coded terminal airspace procedures for the departure, arrival, and alternate airfields.

5.10.3.6.1. The navigation database should be current for the duration of the flight. If the Aeronautical Information Regulation and Control (AIRAC) cycle will change during flight, operators and pilots should establish procedures to ensure the accuracy of navigation data, including suitability of navigation facilities used to define the routes and procedures for flight. Traditionally, this has been accomplished by verifying electronic data against paper products. One acceptable means is to compare aeronautical charts (new and old) to verify navigation fixes prior to departure. If an amended chart is published for the procedure, the operator must not use the database to conduct the operation.

5.10.4. Procedures for using GPS in lieu of land-based NAVAIDS. In all cases, RAIM must be available and operational, and any fixes used for navigation must be retrieved from a current, approved database. Except for RNAV systems using WAAS as an input, when RNAV equipment using GPS input is planned as a substitute means of navigation guidance for part of an instrument approach procedure at a destination airport, any required alternate airport must have an available instrument approach procedure that does not require the use of GPS. This restriction includes conducting a conventional approach at the alternate airport using a substitute means of navigation guidance based upon the use of GPS.

5.10.4.1. Determining position over a DME fix:

5.10.4.1.1. If the fix is identified by a five-letter name that is contained in the GPS airborne database, select either the named fix or the facility establishing the DME fix as the active GPS waypoint (WP).

5.10.4.1.2. If the fix is identified by a five-letter name, which is not contained in the GPS airborne database, or if the fix is not named, select the facility establishing the DME fix or another named DME fix as the active GPS WP. If selecting the DME providing facility as the active GPS WP, consider yourself over the fix when the GPS distance from the active WP equals the charted DME value and you are on the appropriate bearing and course.

5.10.4.1.3. NOTE: Until all DME sources are in the database, pilots may use a named DME fix as the active waypoint in lieu of using the DME source. If using this method the named DME fix must be on the same course and based on the same underlying DME source. Pilots should be extremely careful to ensure correct distance measurements are used when utilizing this method. Pilots should review distances for DME fixing during preflight preparation.

5.10.4.2. Flying a DME arc:

5.10.4.2.1. ***Select the DME facility from the airborne database as the active WP.*** If this facility is not in your database, do not perform this operation.

5.10.4.2.1.1. Use GPS distance to the WP in lieu of DME.

5.10.4.3. Determining position over an NDB/compass locator

5.10.4.3.1. ***Select the charted NDB/compass locator from database as active WP.*** If facility is not in the airborne database, do not use a facility WP for this operation.

5.10.4.3.2. Select CDI terminal sensitivity (+- 1 nm) if in the terminal area.

5.10.4.3.3. You are over the NDB/compass locator when the GPS system indicates you are over the active WP.

5.10.4.4. Determining position over a fix made up of an NDB/compass locator bearing crossing a VOR/LOC course.

5.10.4.4.1. A fix made up by a crossing NDB/compass locator bearing will be identified by a five-letter fix name. Select either the named fix, or the NDB/compass locator facility providing the crossing bearing to establish the fix as the active GPS WP. If the facility is not in your airborne database, do not use a facility WP for this operation.

5.10.4.4.2. If using the named fix, fix passage is when indicated by the GPS system as you fly the prescribed track from the non-GPS navigation source.

5.10.4.4.3. If using the NDB/Compass locator as the active GPS WP, fix passage occurs when the GPS bearing to the active WP is the same as the charted NDB/Compass locator bearing for the fix as you fly the prescribed track from the non-GPS navigation source.

5.10.4.5. Holding over an NDB/Compass locator.

5.10.4.5.1. Select CDI terminal sensitivity (+- 1 nm) if in the terminal area.

5.10.4.5.2. Select the NDB/compass locator as the active WP. Fix must be retrieved from a current approved database.

5.10.4.5.3. Program holding pattern IAW the flight manual.

5.10.4.5.4. Hold using approved procedures.

5.10.5. GPS In Lieu Of A Named Intersection. GPS equipment certified for IFR terminal area operations IAW AFI 11-202V3 may be used to identify a named intersection for en route and terminal operations, except for use as the principal instrument approach navigation source (U.S. National Airspace only):

5.10.5.1. Determining position over a named intersection.

5.10.5.1.1. Select the charted named intersection from database as active WP. Named waypoints must be retrieved from the database; waypoint data may not be entered manually or modified in any way.

5.10.5.1.2. You are over the named fix when the GPS system indicates you are over the active WP.

5.10.6. GPS Terminal Area Restrictions

5.10.6.1. Definition of Terminal Area Procedures. The FAA does not define the dividing line between terminal area procedures and other types of RNAV procedures (DP, STARS, etc.). In some areas, for example where terrain is a factor, transitioning to terminal area accuracy would be appropriate from the beginning of the STAR. In other areas, for example in eastern Kansas where the terrain is relatively flat, terminal accuracy would not be required until on the approach. To preclude confusion, the USAF has adopted the following as procedure. ***Terminal Area Procedures and Restrictions as described below apply when on any segment of a published instrument approach procedure as defined in AFI 11-202V3.*** As a conservative technique, you may consider yourself "in the terminal area" if you are within 25 NM of the facility, below Class A airspace, or are using a published procedure for navigation (IAP/STAR/SID, etc).

5.10.6.1.1. ***Equipment must meet the requirements of AFI 11-202V3 and have an operational RAIM capability.***

5.10.6.1.2. ***All waypoints, fixes, and facility locations must be retrieved from a current aircraft database.*** Users may not alter terminal procedures retrieved from the equipment database.

5.10.6.1.3. ***Pilots must verify all waypoint names, sequence, course, distance, and altitude information from the database against information listed on the paper copy of the terminal procedure (to include the missed approach)*** as discussed in the section 5.12 of this AFMAN, and as directed by the MAJCOM. ***Aircrew operating aircraft equipped with an Electronic Flight Bag (EFB) are also required to verify FMS against EFB data.***

5.10.6.1.4. ***CDI must be set (either manually or automatically) to terminal sensitivity (+- 1 nm).***

5.10.6.1.5. ***The pilot will ensure that a predictive RAIM check is accomplished prior to commencing the approach.*** If RAIM outages are predicted or occur, the flight must rely on other approved equipment; otherwise the flight must be rerouted, delayed, or canceled.

5.10.6.1.6. ***Comply with alternate requirements IAW AFI 11-202V3.***

5.10.7. RNP Special Aircraft and Aircrew Authorization Required (SAAAR) Instrument Approach. The RNP SAAAR IAP is one of the newest GPS procedures being developed. ***These procedures are only authorized for MAJCOM trained and certified crews*** and are analogous to the special authorization required for Category II or III ILS procedures. SAAAR procedures are to be conducted only by aircrews meeting special MAJCOM training requirements in designated aircraft that are appropriately equipped to meet the specified performance and functional requirements.

5.10.7.1. Unique characteristics of RNP SAAAR Approaches

5.10.7.1.1. RNP value. Each published line of minima has an associated RNP value. The indicated value defines the lateral and vertical performance requirements. A minimum RNP type is documented as part of the RNP SAAAR authorization for each aircraft and may vary depending on configuration or operational procedures (e.g., GPS inoperative, use of flight director vice autopilot).

5.10.7.1.2. Curved path procedures. Some RNP approaches have a curved path, also called a radius-to-a-fix (RF) leg. Since not all aircraft have the capability to fly these arcs, ***pilots are responsible for knowing if they can conduct an RNP approach with an arc or not.*** Aircraft speeds, winds and bank angles have been taken into consideration in the development of the procedures.

5.10.7.1.3. RNP required for extraction or not. Where required, the missed approach procedure may use RNP values less than RNP-1. The reliability of the navigation system has to be very high in order to conduct these approaches. Operation on these procedures generally requires redundant equipment, as no single point of failure can cause loss of both approach and missed approach navigation.

5.10.7.1.4. Non-standard speeds or climb gradients. RNP SAAAR approaches are developed based on standard approach speeds and a 200 ft/NM climb gradient in the missed approach. Any exceptions to these standards will be indicated on the approach procedure, and ***the pilot shall ensure the aircraft can comply with any published restrictions before conducting the operation.***

5.10.7.1.5. Temperature Limits. For aircraft using barometric vertical navigation (without temperature compensation) to conduct the approach, low and high-temperature limits are identified on the procedure. Cold temperatures reduce the glidepath angle while high temperatures increase the glidepath angle. Aircraft using baro VNAV with temperature compensation or aircraft using an alternate means for vertical guidance (e.g., SBAS) may disregard the temperature restrictions. The charted temperature limits are evaluated for the final approach segment only. Regardless of charted temperature limits or temperature compensation by the FMS, the pilot may need to manually compensate for cold temperature on minimum altitudes and the decision altitude.

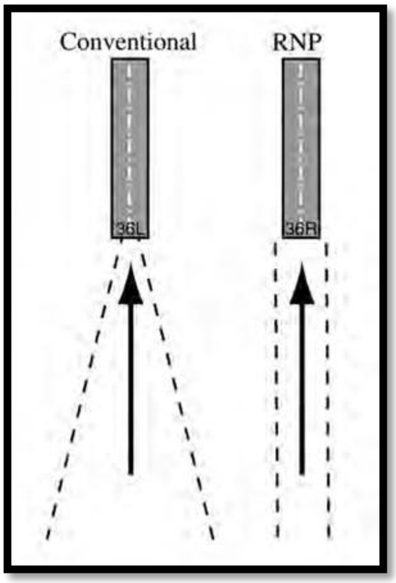
5.10.7.1.6. Aircraft size. The achieved minimums may be dependent on aircraft size. Large aircraft may require higher minimums due to gear height and/or wingspan. Approach procedure charts will be annotated with applicable aircraft size restrictions.

5.10.7.2. Types of RNP SAAAR Approach Operations

5.10.7.1.1. RNP Stand-alone Approach Operations. RNP SAAAR procedures can provide access to runways regardless of the ground-based NAVAID infrastructure, and can be designed to avoid obstacles, terrain, airspace, or resolve environmental constraints.

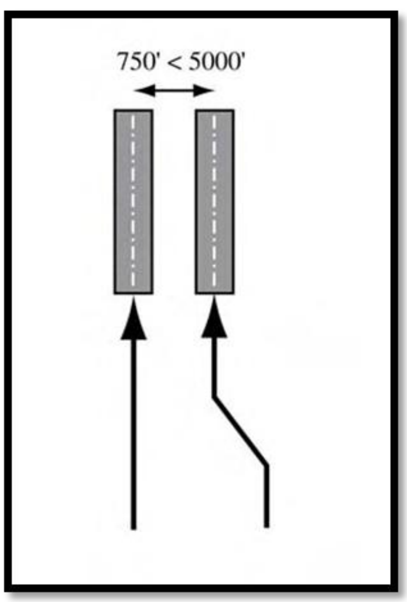
5.10.7.1.2. RNP Parallel Approach (RPA) Operations. RNP SAAAR procedures can be used for parallel approaches where the runway separation is adequate (Figure 5.13). Parallel approach procedures can be used either simultaneously or as stand-alone operations. They may be part of either independent or dependent operations depending on the ATC ability to provide radar monitoring.

Figure 5.13. RNP Parallel Approach (RPA).



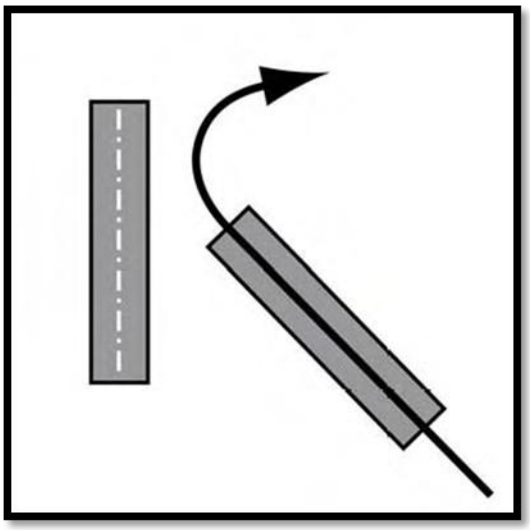
5.10.7.1.3. RNP Parallel Approach Runway Transitions (RPAT) Operations. RPAT approaches begin as a parallel IFR approach operation using simultaneous independent or dependent procedures. (Figure 5.14). Visual separation standards are used in the final segment of the approach after the final approach fix, to permit the RPAT aircraft to transition in visual conditions along a predefined lateral and vertical path to align with the runway centerline.

Figure 5.14. RNP Parallel Approach Runway Transitions (RPAT).



5.10.7.2.4. RNP Converging Runway Operations. At airports where runways converge, but may or may not intersect, an RNP SAAAR approach can provide a precise curved missed approach path that conforms to aircraft separation minimums for simultaneous operations (Fig 5.15). By flying this curved missed approach path with high accuracy and containment provided by RNP, dual runway operations may continue to be used to lower ceiling and visibility values than currently available. This type of operation allows greater capacity at airports where it can be applied.

Figure 5.15. RNP Converging Runway Operations.



5.11. Database Issues for RNAV and GPS Navigation. GPS and other RNAV procedures rely on data extracted from the aircraft navigation database. The potential for serious navigation errors is created by inherent properties of database creation and its use by aircrew and aircraft systems. In order to mitigate these potential errors crews must be familiar with database issues and required procedures.

5.11.1. Aircraft use navigation databases provided by either National Geospatial-Intelligence Agency (NGA) (i.e. DAFIF) or a commercial vendor (i.e. Jeppesen). These databases contain a worldwide list of airports, navigation aids, waypoints, and instrument procedures. Outside the US NAS, this data is provided by host nations, and is not necessarily quality-checked by database providers during database creation. Navigation data may be filtered and tailored to meet individual aircraft requirements. Jeppesen tailors their data to meet customer specifications, while DAFIF data is filtered and formatted by outside contractors. Updated navigation data is published on a 28-day cycle.

5.11.1.1. Database Requirements. In order to use GPS for the terminal area, ***all procedures (DP, Standard Terminal Arrival (STAR), IAP) must be retrieved in their entirety from a current, approved navigation database.*** Only those approaches included in the receiver database are authorized, and must display as full approaches (not advisory approaches which would not allow pilot to "arm" the approach).

5.11.1.1.1. Manual Data Base Manipulation. ***Users may not alter terminal procedures retrieved from the equipment database.*** However, this requirement does not prevent the storage of “user-defined” data. This requirement also does not preclude aircrew from complying with ATC instructions by proceeding direct to a point on a STAR/DP or by receiving ATC vectors onto course. This “user-defined” data, however, cannot be part of a terminal procedure, to include IAF or feeder fixes.

5.11.2. Database related errors have occurred at all stages of database development and use. Host nations have provided inaccurate data; database providers have introduced errors during database creation and aircraft specific tailoring; aircrew have selected incorrect waypoint/procedure data; finally, aircraft flight management systems/navigation computers have flown instrument procedures in a manner that does not match the charted procedure.

5.11.3. ***A paper or EFB copy of the applicable instrument procedure (IAP, SID, STAR) must always be available and crosschecked in the terminal environment.***

5.11.3.1. Data Base Procedures.

5.11.3.1.1. Prior to flight, crews must check navigation database validity. If the database has expired, the crew:

5.11.3.1.1.1. May continue a mission with an expired database if the database information required for the flight can be verified with current FLIP.

5.11.3.1.1.2. Shall get the database updated at the first opportunity.

5.11.3.1.1.3. May not use the database to fly procedures that require terminal or better accuracy (i.e. terminal or approach).

5.11.4. Defining Airways.

5.11.4.1. Conventional (Overlay) Airways. Appropriately certified RNAV equipment may be used to fly conventional airways (e.g. FAA J/V routes). These routes may be either retrieved from the aircraft database or constructed by manually entering waypoints.

5.11.4.1.1. If within aircraft capabilities, conventional airways should be retrieved from the aircraft database using the airway identifier.

5.11.4.1.2. If airways cannot be retrieved from the database using the airway identifier, conventional airways may be constructed by manual entry of associated waypoints/NAVAIDS. These waypoints/NAVAIDS should be retrieved from the database by waypoint name if possible. Entry of all airway waypoints is not required. At a minimum, all compulsory waypoints, all NAVAIDS, and any waypoint associated with a change in course must be entered. On crewed aircraft, if airways are entered manually, waypoint sequence must be verified by another crewmember.

5.11.4.2. RNAV Airways. RNAV airways should be retrieved in their entirety from the database using the airway identifier. If entered manually, aircrew must ensure that all waypoints are entered and flyby/flyover attributes are correctly entered.

5.11.5. RNAV Terminal Area Operations. As the production of stand-alone GPS approaches has progressed, many of the original overlay approaches have been replaced with stand-alone procedures specifically designed for use by GPS systems. The title of the remaining GPS overlay procedures has been revised on the approach chart to “or GPS” (e.g., VOR or GPS RWY 24). Therefore, all the approaches that can be used by GPS now contain “GPS” in the title (e.g., “VOR or GPS RWY 24,” “GPS RWY 24,” or “RNAV (GPS) RWY 24”). During these GPS approaches, underlying ground-based NAVAIDs are not required to be operational and associated aircraft avionics need not be installed, operational, turned on or monitored (monitoring of the underlying approach is suggested when equipment is available and functional). Existing overlay approaches may be requested using the GPS title, such as “GPS RWY 24” for the VOR or GPS RWY 24.

5.11.5.1. Some databases may not contain all transitions or departures from all runways. Terminal area and instrument approach procedures must be retrieved in their entirety from the navigation database. These procedures may not be modified or entered manually.

5.11.5.2. ***Prior to commencing a terminal area or instrument approach procedure, crews must confirm waypoint name, sequence, course, distance, and altitude information match charted information (to include the missed approach segment). Waypoint type (flyby vs. flyover) should also be confirmed if this information is available.*** MAJCOMS should establish procedures for their crews to perform these required actions.

5.11.5.3. ***In the event of differences between the terminal procedure chart or approach chart and database, the published approach chart, supplemented by NOTAMs, holds precedence and the database may not be used to fly terminal area or instrument approach procedures except as noted below.***

5.11.5.3.1. In some cases, waypoints in the navigation database may differ from the charted instrument procedure. The differences listed below are acceptable and do not preclude use of the database procedure.

5.11.5.3.1.1. Step down fixes depicted on the approach chart may not be contained in the aircraft database. Pilots are responsible for ensuring compliance with applicable step down fixes regardless of whether or not they are in the aircraft database.

5.11.5.3.1.2. The database may contain some waypoints (capture fixes, and a point in lieu of a FAF for non-FAF overlay approaches) that are not depicted on the approach chart.

5.11.5.3.2. Small differences may exist in distances between waypoints. ***For GPS and RNAV approaches, the maximum allowable difference is 0.1nm. If distance information varies by more than these tolerances, the procedure shall not be flown.*** If the FMS does not display distances to the tenth of a mile during the approach review, then an acceptable technique would be for the pilot to confirm the distance to the next approach waypoint to a tenth of a mile on the EHSI at each changeover point.

5.11.5.3.3. Computation of the GPS final approach course is based on the station magnetic variation retrieved from the aircraft magnetic variation database. Many aircraft lack the capability to update the magnetic variation database. This will cause a difference between the displayed GPS final approach course and the charted final approach course in the IAP. The discrepancy between displayed and charted magnetic variation will depend on discrepancy between aircraft magnetic variation database (age of database) vs. magnetic variation upon which charted approach course is based (date of magnetic variation survey). Variation between charted final approach course in the IAP and the final approach course computed by the aircraft should be no more than 5 degrees. ***If the two differ by more than 5 degrees, the procedure is not authorized.***

5.11.5.4. Crews must be knowledgeable of system limitations and be ready to manually intervene with RNAV or GPS equipment if necessary. Certain segments of a missed approach, DP, or SID may require some manual intervention by the pilot, especially when radar vectored or required to intercept a specific course to a waypoint.

5.11.5.5. Due to aircraft specific limitations, on some occasions aircraft may not fly a database procedure as indicated on the chart, even though the procedure is correctly coded in the database. This is especially true of missed approach and DP operations that have closely spaced waypoints or require turns initiated at an associated altitude. Crews must carefully monitor aircraft performance to ensure adherence to the charted procedure.

5.11.6. WGS-84 is the worldwide charting standard for coding database information. The use of this common reference system is required to ensure accurate navigation. Although most nations have signed up to the WGS-84 standard, there is no means of ensuring compliance, and not all data from foreign nations is developed IAW WGS-84. A number of database discrepancies have been reported in foreign airspace. Aircrews must monitor underlying ground based navigation aids when available. In the event of discrepancy between RNAV/GPS information and the underlying navigation aids, crews must revert to using underlying ground-based navigation data.

5.11.7. Both Jeppesen and NGA (DAFIF) have established procedures for informing crews of known database problems. ***Crews must check database NOTAMs prior to flight for information on any planned RNAV or GPS procedures.***

5.11.7.1. NGA (DAFIF) database NOTAMs associated with a particular airfield are class "W" NOTAMs and may be obtained by entering an airfield identifier in the Joint Chiefs of Staff (JCS) NOTAM web site (**https://www.notams.jcs.mil/dinsQueryWeb**). DAFIF NOTAMs not associated with a particular airfield (airway NOTAMs, etc.) may be obtained by consulting FLIP change notices via the DAFIF NOTAMs link on the JCS NOTAM web site.. The Jeppesen NOTAM page contains information on airfield specific procedures at the top of the page and has links to regional information at the bottom of the page. Jeppesen database NOTAMs may be accessed through the links section of the JCS NOTAM web site.

Chapter 6

PLANNING AN INSTRUMENT FLIGHT

6.1. Preflight Planning. A successful instrument flight starts with a thorough preflight planning session. This planning should include a number of items including NOTAMS, weather for the entire route of flight including the departure and arrival aerodromes, takeoff and landing data (TOLD), all publications necessary to conduct the flight (e.g. Departure procedures, enroute charts, FIH, Arrival Procedures, Instrument Approach Procedures, applicable FLIP materials, ASRR, etc.), the route of flight, and the production of a flight plan and flight plan log that determines the amount of time and fuel needed for the flight including possible diversion to an alternate, if applicable. See also AFI 11-202V3.

6.2. NOTAMS. NOTAM is defined in AFJMAN 11-208, *DoD Notice to Airmen (NOTAM) System*, as an unclassified notice containing information concerning the establishment of, condition of, or change in an aeronautical facility, service, procedures or hazards; the timely knowledge of which is essential for safe flight operations. Checking NOTAMs is a critical step in the flight planning process. NOTAM information is available from the U.S. NOTAM System (USNS) via the DoD Internet NOTAM Distribution System (DINS). To fully understand where and how to get all available NOTAM information, it is important to understand the USNS.

6.2.1. Defense Internet NOTAM System. DINS is composed of a large central data management system deriving information from the US Consolidated NOTAM Office at the FAA Air Traffic Control System Command Center (ATCSCC) located at Herndon, VA. Real-time NOTAM information is maintained and made available through the internet. **https://www.notams.jcs.mil** Coverage includes all military airfields and virtually all domestic, international, and Flight Data Center (FDC) NOTAMs. If not covered by DINS, the airfield does not transmit NOTAM data to the USNS. A plain language notice in red font is displayed advising the user of that fact. In such a case, you must contact the airfield manager or associated Flight Service Station directly for NOTAM information.

6.2.1.1. NOTAM abbreviations are explained in the FIH and the Notices to Airmen Publication (NTAP). NOTAM abbreviations for DINS can be found in the FIH and FAAO 7930.2M *Notice to Airmen (NOTAMS)*.

6.2.2. A comprehensive discussion of the U.S. and international NOTAM systems can be found in AFMAN 11-217V3, and AFI 11-208, *Department of Defense Notice to Airman (NOTAM) System*.

6.3. Weather. Aircrew can obtain departure, enroute and arrival weather information from a number of sources. For authorized weather sources, see FLIP IFG. At military airfields, the normal source is the DD 175-1 filled out and briefed by a military weather briefer from one of the regional Operational Weather Squadrons. At civil fields, aircrew may obtain weather by contacting the Operational Weather Squadron serving the area, or a FSS and getting a weather brief over the phone by calling 1 800 WX-BRIEF.

6.3.1. Cold Weather Altimeter Corrections. Pressure altimeters are calibrated to indicate true altitude under International Standard Atmospheric (ISA) conditions. Any deviation from these standard conditions will result in an erroneous reading on the altimeter. This error becomes important when considering obstacle clearances in temperatures lower than standard since the aircraft's altitude is below the figure indicated by the altimeter. The error is proportional to the difference between actual and ISA temperature and the height of the aircraft above the altimeter setting source. The amount of error is approximately 4 feet per thousand feet for each degree Celsius of difference. Corrections will only be made for DAs, MDAs, and other altitudes inside, but not including, the FAF. The same correction made to DAs and MDAs can be applied to other altitudes inside the FAF. ***For the current cold weather altimeter correction procedure, you must refer to the Flight Information Handbook (FIH).*** The following guidance is provided as an example of how to accomplish the procedure found in the FIH.

6.3.1.1. To ensure adequate obstacle clearance the values derived from the chart below will be:

6.3.1.1.1. Added to the published DA or MDA and step-down fixes inside the FAF whenever the outside air temperature is less than 0° Celsius

6.3.1.1.2. Added to ALL altitudes in the procedure in Designated Mountainous Regions whenever the outside air temperature is 0° Celsius or less

6.3.1.1.3. Added to ALL altitudes in the procedure whenever the outside air temperature is -30° Celsius or less, or procedure turn, intermediate approach altitude Heights Above Touchdown (HAT)/Heights Above Aerodrome (HAA) are 3000 feet or more above the altimeter setting source.

Table 6.1. Temperature Correction Chart.

Temp °C	Height Above Altimeter Setting															
	200	300	400	500	600	700	800	900	1000	1300	1500	1800	2000	2300	3000	4000	5000
0	20	20	30	30	40	40	50	50	60	80	90	100	120	130	170	230	280
-5	20	30	30	40	50	60	60	70	80	100	120	140	150	180	230	310	380
-10	20	30	40	50	60	70	80	90	100	130	150	180	200	230	290	390	490
-15	30	40	50	60	70	90	100	110	120	160	180	220	240	270	360	480	600
-20	30	50	60	70	90	100	120	130	140	190	210	260	280	330	420	570	710
-25	40	50	70	90	100	120	130	150	170	220	250	300	330	380	490	660	830
-30	40	60	80	100	120	140	150	170	190	250	280	340	380	430	570	760	950
-35	50	60	90	110	130	150	170	190	220	280	320	390	430	490	640	860	1080
-40	50	60	100	120	150	170	190	220	240	310	360	430	480	550	720	970	1210
-45	60	60	110	140	160	190	220	240	270	350	400	480	540	620	800	1080	1350
-50	60	60	120	150	180	210	240	270	300	390	450	530	590	680	890	1190	1500

6.3.1.1.4. Example: For an approach when OAT is -20° C, and the HAA is 760' AGL on the IAP, the pilot should add 110' to the MDA for the approach. Thus, if the MDA was 940' MSL, the pilot would only descend to 1050' (940+110=1050). NOTE: Do not change the value in the RADAR ALTIMETER--you are still descending to the HAA on the IAP, you are only correcting for temperature error in the barometric altimeter (Table 6.1).

6.4. Route. Preflight planning of the enroute portion should be adequate to enseure safe and efficient flight. As a minimum, aircrew should review:

6.4.1. The intended route of flight (to include preferred routing located in AP/1) using current flight publications.

6.4.2. En route NOTAMs.

6.4.3. En route weather.

6.4.4. FLIP products. The appropriate FLIP products to ensure compliance with any special procedures that may apply.

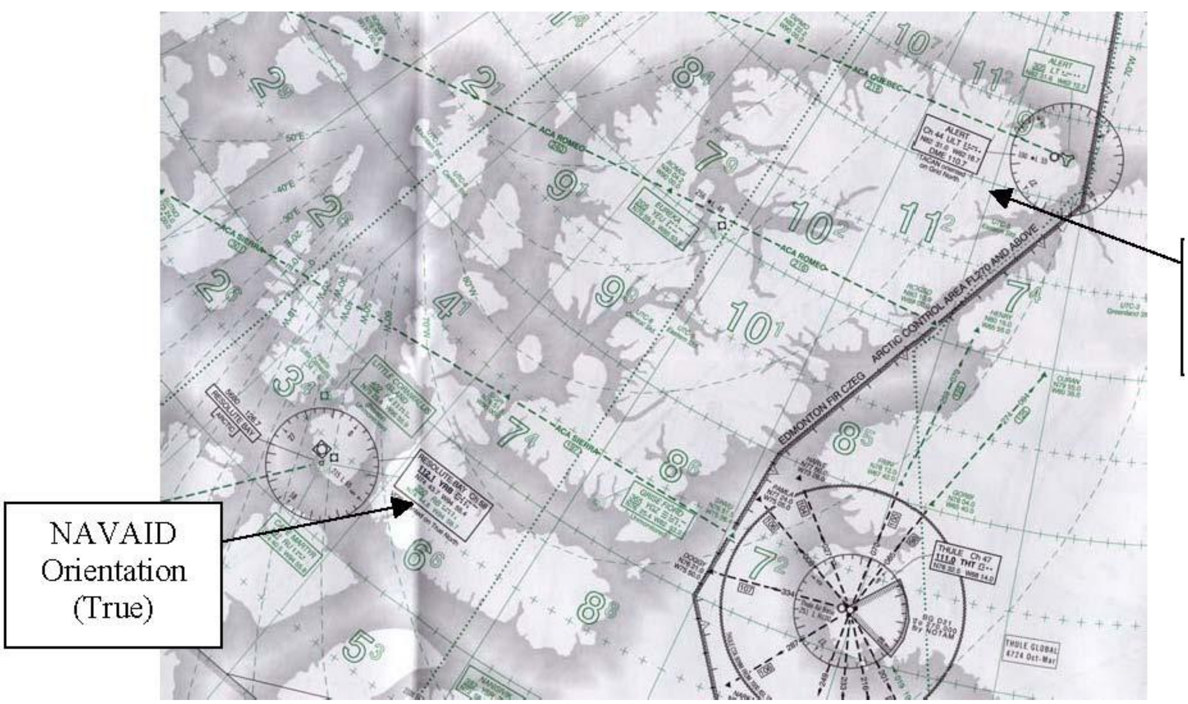
6.4.5. Diversion fields. Emergency diversion fields and approaches.

6.4.6. Compliance. Comply with the jet route or airway system as published on the FLIP en route charts and air traffic clearances. You must also ensure your aircraft is equipped and authorized to operate in the airspace along your route of flight. For example, only aircraft certified through their MAJCOM for RNP-5 may operate in the European Basic RNAV (BRNAV) structure. Consult your MAJCOM and Mission Design Series (MDS)-specific guidance if you have any doubts concerning your aircraft's capabilities.

6.4.7. Enroute Navigation in High Latitudes. Enroute navigation in higher latitude regions may be based on reference to true or grid north instead of the customary reference to magnetic north. Procedures vary greatly between aircraft type and avionics capabilities. Thorough mission planning, including review of applicable aircraft/avionics specific procedures and limitations, is essential to accurate navigation at higher latitudes.

6.4.7.1. When flying at higher latitudes, review the enroute charts carefully to ensure you are cognizant of the heading source required by the instrument procedures in the airspace you are transiting, and the orientation reference of the NAVAID. This is annotated on the enroute chart as shown in Figure 6.1.

Figure 6.1. Enroute Charts for Navigation in Higher Latitudes.



6.4.7.2. Normally, navigation north of 70°North latitude or south of 60°South latitude is conducted with reference to true north or grid north. Specific procedures vary greatly depending on aircraft type, avionics capabilities, and crew complement. Unless otherwise annotated, where there is a reference to true north, the text also applies in southern latitudes and applies to navigation with reference to grid north/south.

6.4.7.2.1. There are areas officially designated Areas of Magnetic Unreliability (AMU). ***Aircraft capable of displaying only magnetic heading are prohibited from operating in designated AMUs***. For areas north of 70°North and south of 60° South that are not officially designated as AMUs, MAJCOMs will determine the highest allowable latitude for aircraftcapable of displaying only magnetic heading (Figure 6.2).

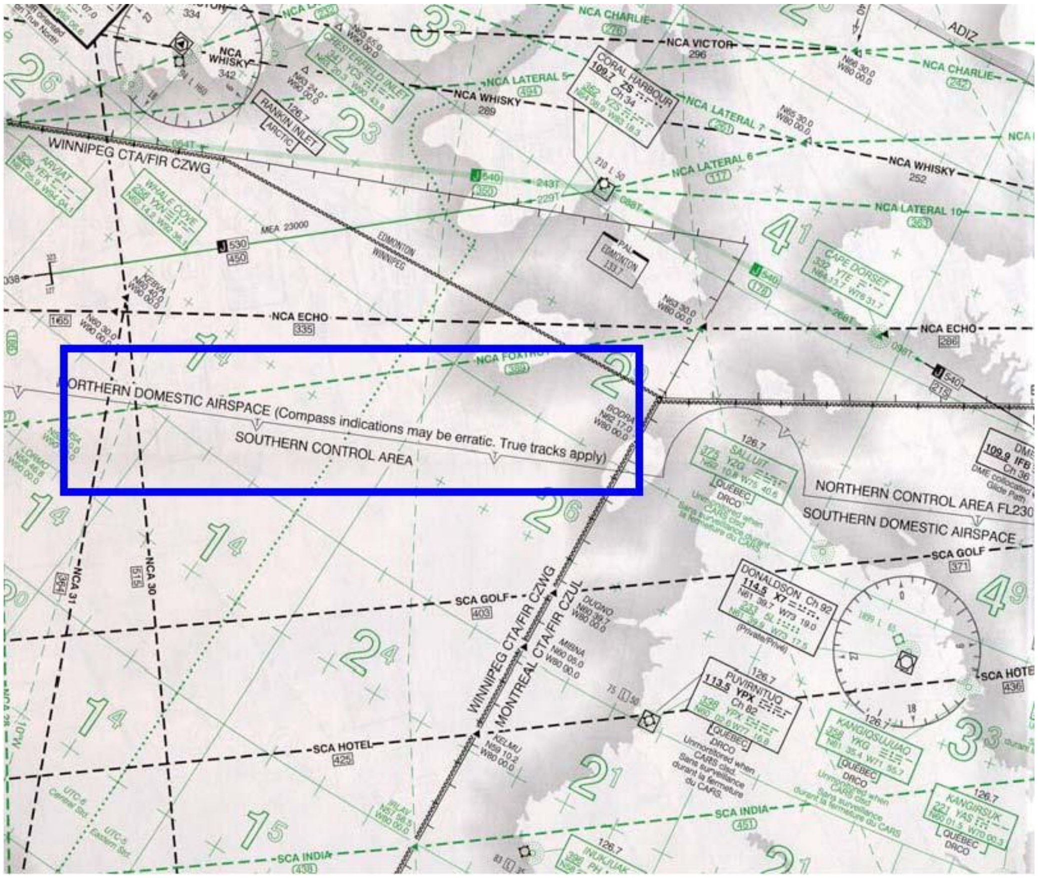
6.4.7.2.1.1. NOTE: Although partly south of 70° North, the entire Canadian Northern and Arctic Control Areas and areas of Northern Domestic Airspace are designated as AMUs.

6.4.7.2.2. ***MAJCOMs must provide aircraft-specific operational approval prior to enroute and terminal area operations using navigation aids oriented to true or grid.*** Operational approval shall be based on development of aircraft specific procedures and training. As a minimum, procedures and training should address: identification of areas where reference to true or grid north is required, procedures for displaying true or grid heading reference, procedures for verifying magnetic variation information from the aircraft navigation computer, procedures for inputting manual magnetic variation information, procedures for returning to automatic magnetic variation computation, minimum equipment requirements, and emergency procedures in the event of true or grid navigation equipment failure while operating in the AMU.

6.4.7.3. ***Aircraft navigation displays must be set to display true north prior to flying true headings or courses. Suitably equipped aircraft may also use grid reference if applicable.***

6.4.7.4. ***Outside of designated AMUs, aircraft unable to display true or grid heading may use navigation aids oriented to true north for enroute navigation provided procedures listed below are followed.***

Figure 6.2. Canadian Northern Control Area Boundaries (Areas South of 70°N Where True Tracks



6.4.7.4.1. Enroute navigation using approved RNAV equipment backed up by display of VOR/TAC/NDB data is recommended. Depending on system architecture, aircraft navigation computers (flight management systems) automatically provide magnetic variation information. Accuracy of this magnetic variation depends on the period of time since the last magnetic variation update. Some systems contain magnetic variation information that cannot be updated. Also, some navigation systems provide magnetic variation information for only a limited portion of the globe. Thus, when true or grid heading information cannot be displayed, aircraft magnetic variation information must be verified with current aeronautical charts prior to use of RNAV equipment to fly true or grid courses. For navigation using FMS or other RNAV system, procedures and system limitations vary widely among aircraft and avionics installations. ***Consult your aircraft flight manual and MAJCOM directives for specific FMS and RNAV procedures for navigation where reference to true or grid north is required.***

6.4.7.5. For navigation using VOR or TACAN, if the NAVAID is oriented to true north, use the following procedures for enroute navigation:

6.4.7.5.1. NOTE: Only VORs and TACANs can be oriented to true north. NDBs cannot be oriented to true north. ADF needles always display relative bearing to the station.

6.4.7.5.2. ***If your aircraft allows selection of true north as a heading reference, select true north.*** No additional corrections are required for courses or headings.

6.4.7.5.3. ***If your aircraft does not allow selection of true north as a heading reference, use the following procedures:***

6.4.7.5.3.1. VOR and TACAN courses do not require correction for magnetic variation.

6.4.7.5.3.1.1. The desired true course must be set into the CDI. The aircraft CDI will indicate deviations left and right of the desired true course. However, with magnetic heading displayed, the bearing pointer will not point to the station, but will instead indicate true bearing to the station. In other words, when established on course, the CDI will be centered on the desired true course, but the bearing pointer will indicate true bearing to the station and will be displaced from aircraft no-wind heading by the amount of station magnetic variation. For example, the Thule magnetic variation is approximately 60 degrees west. When proceeding inbound on the Thule 180 degree radial true (360 course), the aircraft no wind heading will be 060, while the bearing pointer will point to 360. Be aware that this discrepancy between aircraft heading and desired course may make flight director guidance unreliable.

6.4.7.5.3.2. All headings require corrections for magnetic variation.

6.4.7.6. For navigation using NDB, use the following procedures:

6.4.7.6.1. NOTE: Only VORs and TACANs can be oriented to true north. NDBs cannot be oriented to true north. ADF needles always display relative bearing to the station.

6.4.7.6.2. ***If your aircraft allows selection of true north as a heading reference, select true north. No additional corrections are required for relative bearings.***

6.4.7.6.3. ***If your aircraft does not allow selection of true north as a heading reference, all relative bearings require correction for magnetic variation.***

6.4.7.6.3.1. Crews should compute and fly the appropriate magnetic course by correcting the desired true course for the magnetic variation at the current aircraft location. Use the magnetic variation at your current location. This correction should be updated at least every 5° of magnetic variation or every 30 nm, whichever occurs first.

6.4.8. Minimum Altitudes.

6.4.8.1. Altitude Clearances. Ensure altitude clearances received en route do not conflict with minimum en route altitudes (MEA), minimum obstruction clearance altitudes (MOCA), minimum reception altitudes (MRA), or minimum crossing altitudes (MCA) shown on en route charts.

6.4.8.2. Controlled Airspace. In controlled airspace, the air traffic controller will assign altitudes that provide obstacle clearance. You should use all available navigation aids to remain position-oriented and immediately query the controller if there is any uncertainty of the obstacle clearance provided by the assigned altitude. When flying via published routing (a route with minimum altitudes depicted), compliance with the minimum altitude published on the routing ensures obstacle clearance. ***If a published minimum altitude is not available, aircrews must determine minimum altitudes in accordance with AFI 11-202V3.***

6.4.8.3. Uncontrolled Airspace. ***In uncontrolled airspace, you must ensure the altitudes flown will provide obstacle clearance during all phases of flight.***

6.4.8.4. Radio Failure. In case of radio failure, you are responsible for minimum altitude selection. ***Comply with published radio failure procedures in the FIH.***

6.5. Planning the Approach. Preparation for flying an instrument approach begins with a study of the approach depiction during preflight planning. The end result of an approach--a landing or a missed approach--can be directly dependent upon the pilot's familiarity with the approach depiction.

6.5.1. Aircraft Categories and Instrument Approach Procedures Selection.

6.5.1.1. Category. Aircraft approach category is based on 1.3 times the stalling speed in the landing configuration at maximum certificated gross landing weight. ***An aircraft can fly an IAP only for its own category or higher, unless otherwise authorized by AF Instruction or MAJCOM directives.*** If it is necessary to maneuver at speeds in excess of the upper limit of a speed range for a category, the minimums for the next higher category should be used. The categories are as follows:

6.5.1.1.1. Category A - Speed less than 91 knots.

6.5.1.1.2. Category B - Speed 91 knots or more but less than 121 knots.

6.5.1.1.3. Category C - Speed 121 knots or more but less than 141 knots.

6.5.1.1.4. Category D - Speed 141 knots or more but less than 166 knots.

6.5.1.1.5. Category E - Speed 166 knots or more.

6.5.1.1.5.1. NOTE: If MAJCOMs allow aircraft to fly an IAP using a lower category, the MAJCOM must publish procedures to ensure that aircraft do not exceed TERPS airspace for the IAP being flown to include circling and missed approach.

6.5.1.2. IAP chart. ***A current copy of the appropriate IAP chart must be available in the aircraft for the departure base, destination, and all planned alternates.***

6.5.1.2.1. Approved sources for IAP charts used in aircraft include printed FLIP distributed by NGA, National Aeronautical Charting Office (NACO), or other source authorized by your MAJCOM (for example, Jeppesen).

6.5.1.2.1.1. ***Do not print an IAP from DAFIF and then fly that digital version.*** Until the DAFIF is certified for terminal IFR use in your weapon system, always use the IAP distributed electronically or via printed FLIP.

6.5.1.2.1.2. IAPs downloaded from the NGA website in PDF format are identical to those in the printed NGA approach books. Effective dates are printed on the bottom of each downloaded page. The responsibility for ensuring the current version of an IAP is onboard lies with the pilot.

6.5.1.2.1.2.1. Note that comparing amendment numbers or Julian dates on new plates against previously printed plates is not a valid way of determining currency. Information on a plate can change without an amendment number or Julian date change!

6.5.1.2.1.3. If you print an IAP from the JEPPVIEW CD distributed by Jeppesen (or another equivalent commercial product), ensure the CD is current and you are a licensed user of that CD. If you do not know the license arrangement with Jeppesen (or other commercial vendor), do not use the IAP. The vendors and USAF take copyright violations very seriously. It is the responsibility of each pilot to ensure not only currency of IAPs prior to use, but also compliance with copyright and licensing agreements. These agreements may vary from Wing to Wing.

6.5.1.2.1.4. ***Do not fly non-US Government IAPs unless properly trained and the procedure(s) are approved by your MAJCOM TERPS.*** (TERPS will not provide a review on non-US government instrument procedures if a DoD (NGA) or FAA (NACO) product for the same procedure exists.)

6.5.1.2.2. Low altitude IAP charts normally depict instrument approaches for categories A, B, C, and D aircraft. High altitude IAP charts depict instrument approaches for category C, D, and E aircraft. When an operational requirement exists, the low altitude IAP charts may depict category E procedures.

6.5.1.2.2.1. NOTE: If there is a discrepancy between stand-alone GPS approach charts and the database onboard the aircraft, the chart takes precedence.

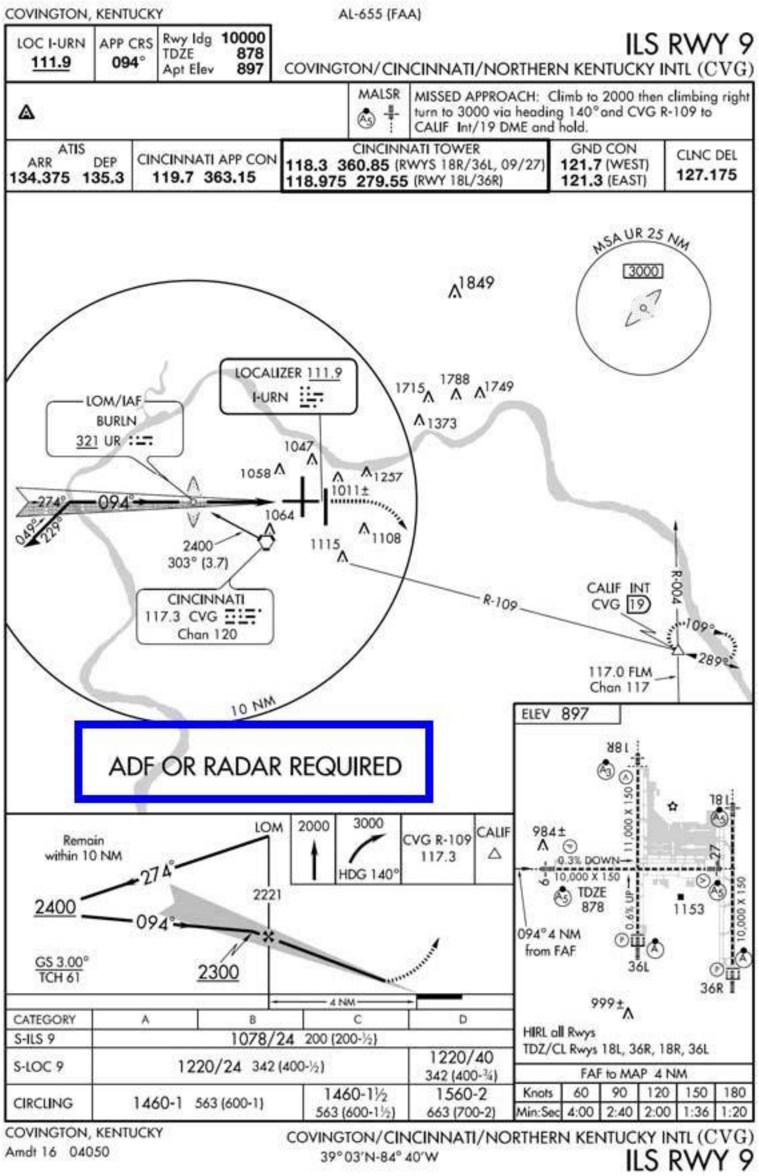
6.5.1.2.2.2. NOTE: Consult the Terminal Change Notice (TCN) to ensure the approach selected is current.

6.5.1.3. Navigation Equipment Compatibility. ***Ensure the approach you select is compatible with the navigation equipment installed and operating on your aircraft, including the missed approach instructions.***

6.5.1.3.1. ***Exception: If there is a requirement to execute an approach procedure with incompatible missed approach instructions, ATC may be able to issue alternate missed approach instructions. Request alternate missed approach instructions prior to accepting approach clearance.***

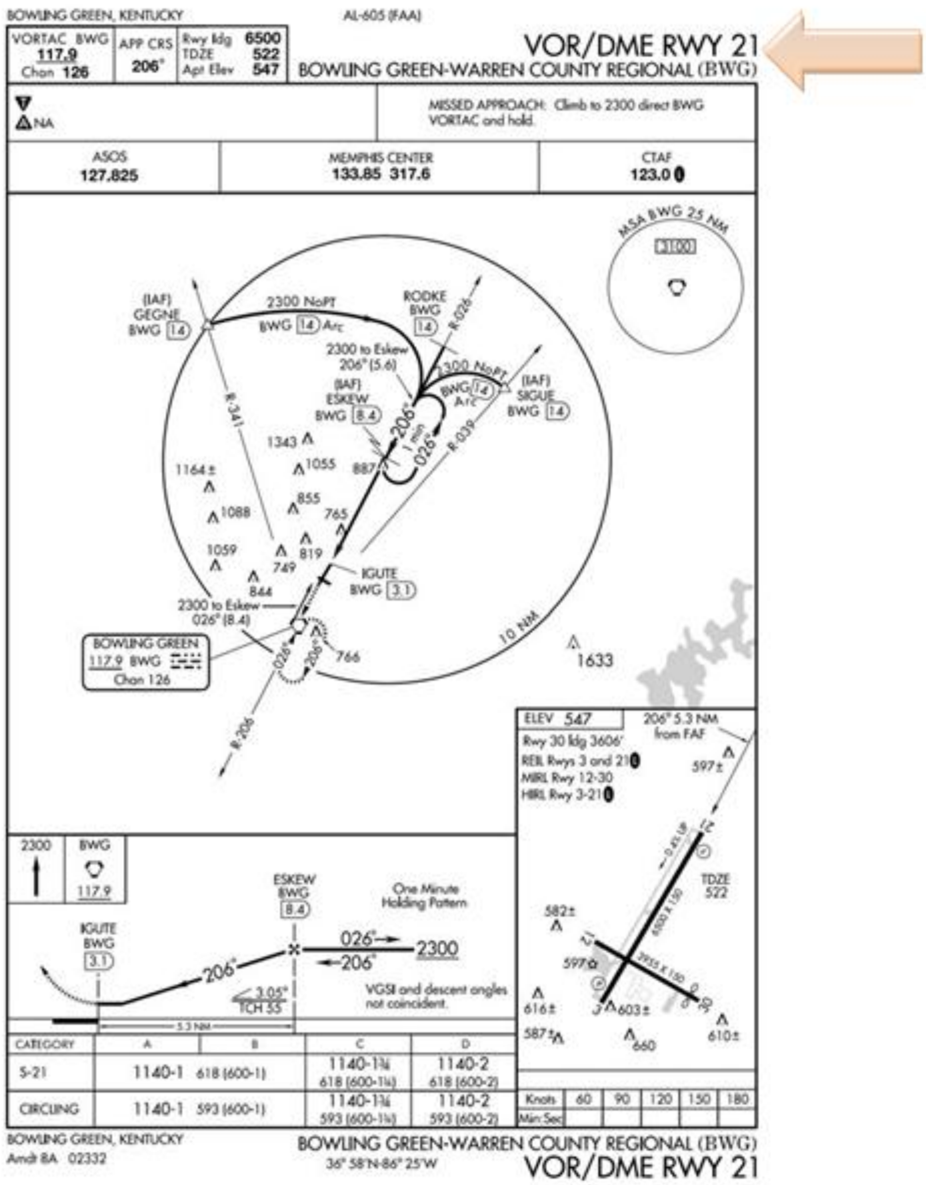
6.5.1.3.1.1. NOTE: This requirement for alternate missed approach instructions does not preclude practice approaches if the field is VFR according to AFI 11-202V3.

Figure 6.3. Equipment Requirements for IAP.



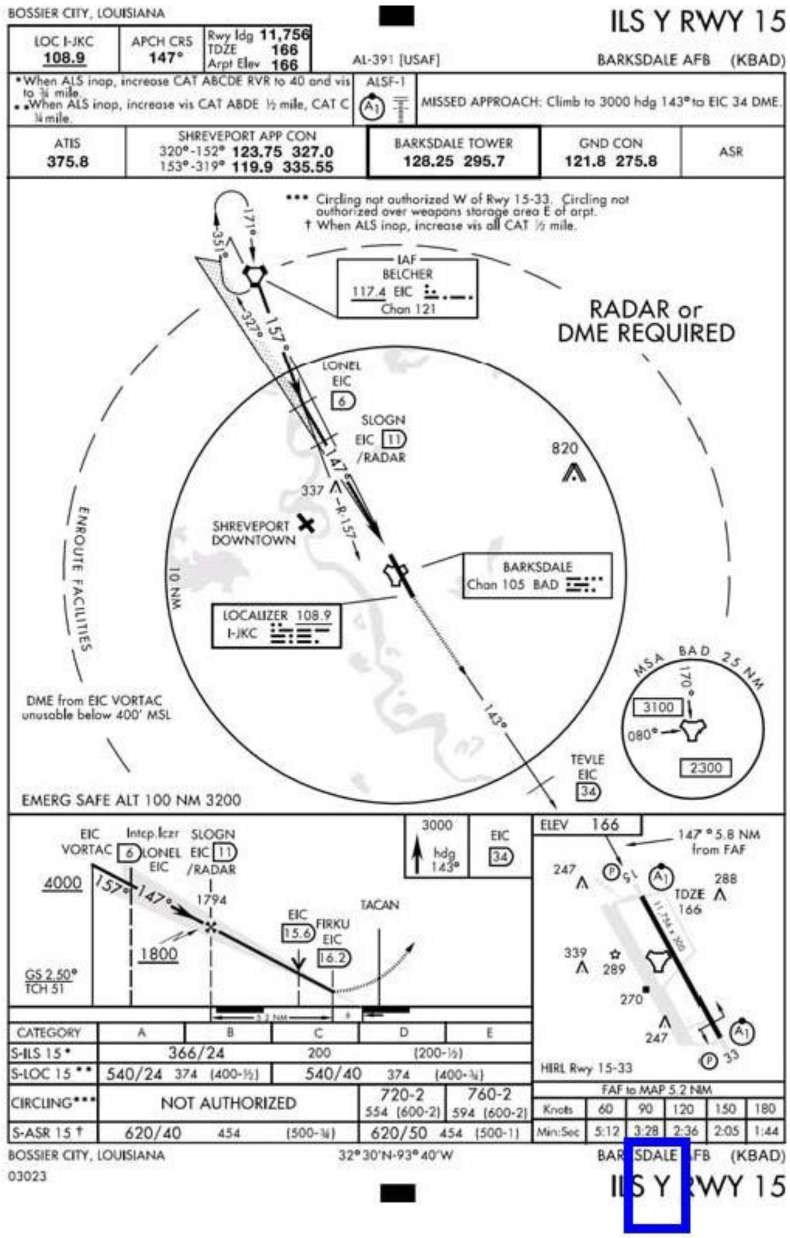
6.5.1.3.2. Straight-in approaches. The types of navigation aids that provide final approach guidance and the runway to which the final approach courses are aligned identify straight-in approaches. A slash (/) indicates that more than one type of equipment may be required to execute the final approach (VOR/DME, ILS/DME, etc.). Be aware that additional equipment may be required to execute the other portions of the procedure (Figure 6.4).

Figure 6.4. IAP With "/" in Title.



6.5.1.3.2.1. Where more than one approach using the same final approach guidance is developed to the same runway, each runway/navigational aid combination will be identified with an alphabetical suffix beginning at the end of the alphabet; e.g. ILS Z RWY 28L (first procedure), ILS Y RWY 28L (second procedure), ILS X RWY 28L (third procedure), etc. Suffixes will be used in reverse alphabetical order, beginning with "Z" (Figure 6.5).

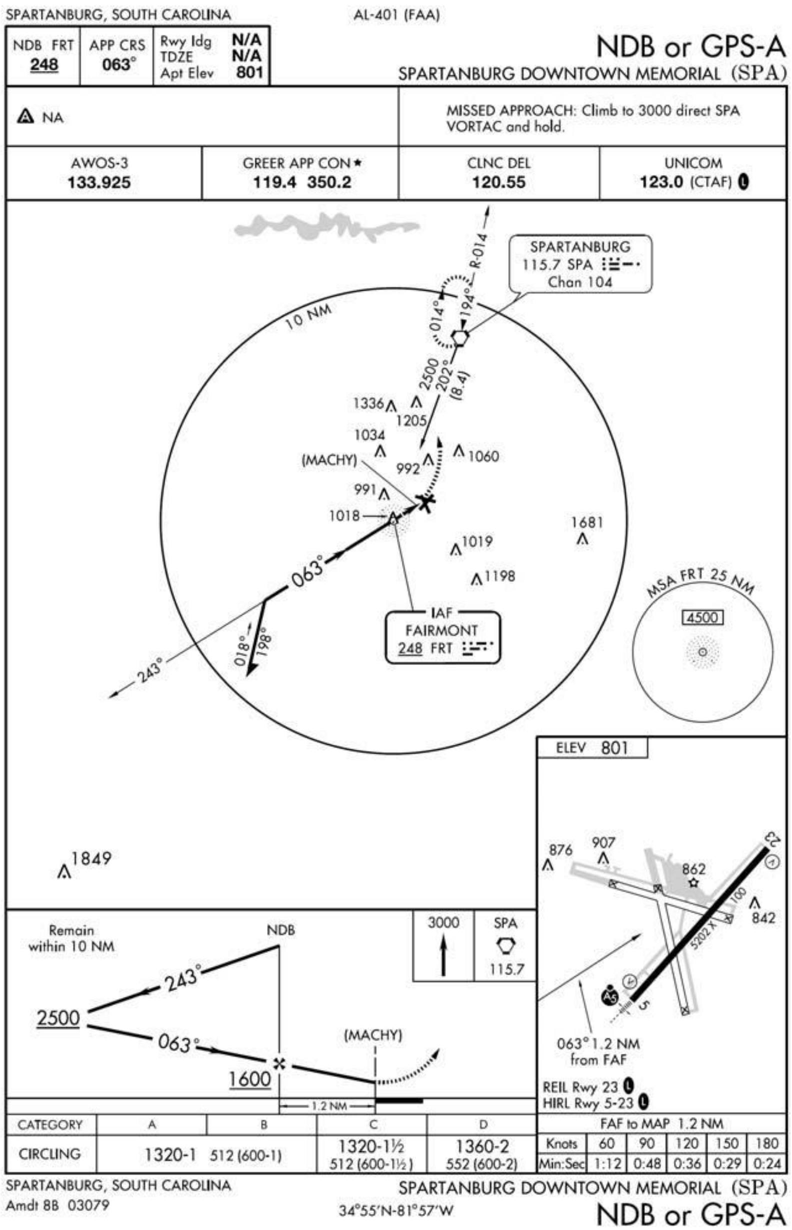
Figure 6.5. More Than One Approach With Same Final Approach Guidance.



6.5.1.3.3. VOR approaches. Some VOR approaches are approved for use by TACAN equipped aircraft. These will be designated by the term "(TAC)" printed adjacent to the name of the procedure, for example, VOR-A (TAC).

6.5.1.3.4. Circling approaches. When the name of the approach is followed by a letter such as A, B, C, etc., the approach is designed for circling minimums only. Circling approaches are designated VOR-A, TACAN-B, NDB-C, etc. Circling approach designators will begin at the beginning of the alphabet (Figure 6.6).

Figure 6.6. Circling Approach.



6.5.1.4. Radar Minimums. Radar minimums by aircraft category may be found in a separate section in the IAP book. 6.5.2. True Approach Procedures.

6.5.2.1. Selected instrument approach procedures in higher latitude regions may be based on reference to true or grid north/south instead of the customary reference to magnetic north/south. Procedures vary greatly between aircraft type and avionics capabilities. Thorough mission planning, including review of applicable aircraft/avionics specific procedures and limitations, is essential to safely flying an instrument approach at higher latitudes.

6.5.2.1.1. When flying at higher latitudes, review the IAP carefully to ensure you are cognizant of the heading source required by instrument procedures and the orientation reference of the NAVAID. This is annotated on the IAP as shown in Figures 6.7, 6.8 and 6.9.

6.5.2.1.1.1. NOTE: At airfields with true or grid approaches, the runway direction number will also be based on reference to true or grid, as appropriate.

6.5.2.1.2. ***USAF aircrews are authorized to fly true or grid approaches in accordance with their aircraft flight manuals and MAJCOM directives.***

6.5.2.1.3. Except as noted below, aircraft must possess a true or grid heading source, and be able to display true or grid heading on appropriate navigation displays in order to fly terminal area true or grid instrument procedures in night or IMC.

6.5.2.1.4. Aircraft without a true or grid heading source may fly true or grid RNAV (GPS) approaches and true or grid RNAV departure procedures in night or IMC providing the RNAV procedure provides all required magnetic course information.

6.5.2.1.5. For terminal area procedures referenced to true north, the following guidance applies:

6.5.2.1.5.1. Note: This section covers general true approach procedures, your flight manual and/or MAJCOM may have additional procedures or limitations.

6.5.2.1.5.2. Radar vectors should be provided with reference to true north. If in doubt, query the controller.

6.5.2.1.5.3. Orientation of an IAP to true north will be indicated by inclusion of the word "true" in the procedure title.

6.5.2.1.5.4. Select true as a heading source IAW with your aircraft flight manual and MAJCOM directives.

6.5.2.1.5.4.1. NOTE: ADF needles always display relative bearing to the station. Localizer signals emanate along a fixed path along the final approach course. CDIs always indicate position relative to the final approach course regardless of what is dialed into the CSW.

6.5.2.1.5.5. Select the published true final approach course as appropriate for the type of approach and aircraft equipment. For aircraft capable of displaying true heading, no further corrections to headings, courses or bearings are required.

6.5.2.1.6. ***For aircraft not capable of displaying true north, instrument approaches in <u>night or IMC</u> are not authorized.*** If your aircraft does not allow selection of true north as a heading reference, use the following procedures when flying a true approach (Day, VMC Only):

6.5.2.1.6.1. WARNING: In certain areas, magnetic heading indications may be unreliable or erratic. If magnetic heading indications are suspect, do not commence the approach. If already established on the approach and magnetic heading indications are suspect, execute a missed approach.

6.5.2.1.6.2. WARNING: Flight director commands and CDI deflection may be grossly inaccurate on aircraft without a true heading source even with proper set-up of courses, bearings, and headings.

6.5.2.1.6.3. VOR and TACAN approaches. VOR and TACAN final approach courses do not require correction for magnetic variation. ***Dial in the true final approach course as depicted on the IAP.*** Although the CDI will be centered when on course, the bearing pointer will point to the true bearing to the station. ***When selecting a heading to fly to intercept/maintain the course, corrections for magnetic variation are required. Use the magnetic variation at the NAVAID the approach is based upon.***

6.5.2.1.6.4. NDB Approaches. NDBs cannot be oriented to true north. ADF needles always display relative bearing to the station. ***Corrections for magnetic variation must be applied to the published bearing(s).*** When selecting a heading to fly to intercept/maintain the published bearing, corrections for magnetic variation are also required. Use the magnetic variation at the NAVAID the approach is based upon.

6.5.2.1.6.5. ILS and Localizer Approaches (includes LDA, SDF, and LOC BC). Localizer signals emanate along a fixed path along the final approach course and cannot be oriented on true north. CDIs always indicate position relative to the final approach course regardless of what is dialed into the CSW. However, selection of the correct final approach course is critical to insuring consistent cockpit indications of position relative to the final approach course. When selecting a course to dial in, corrections for magnetic variation must be applied to the published front course to insure consistent cockpit indications while on final approach. When selecting a heading to fly to intercept/maintain the published final approach course, corrections for magnetic variation are also required. Use the magnetic variation at the airport.

6.5.2.1.6.6. PAR, ASR, and Radar Vectors. When being radar vectored in the vicinity of an airport using true north as a heading reference, all vectors will be issued in true headings. If your aircraft does not allow selection of true north as a heading reference, corrections for magnetic variation are required.

Figure 6.7. True VOR Approach.

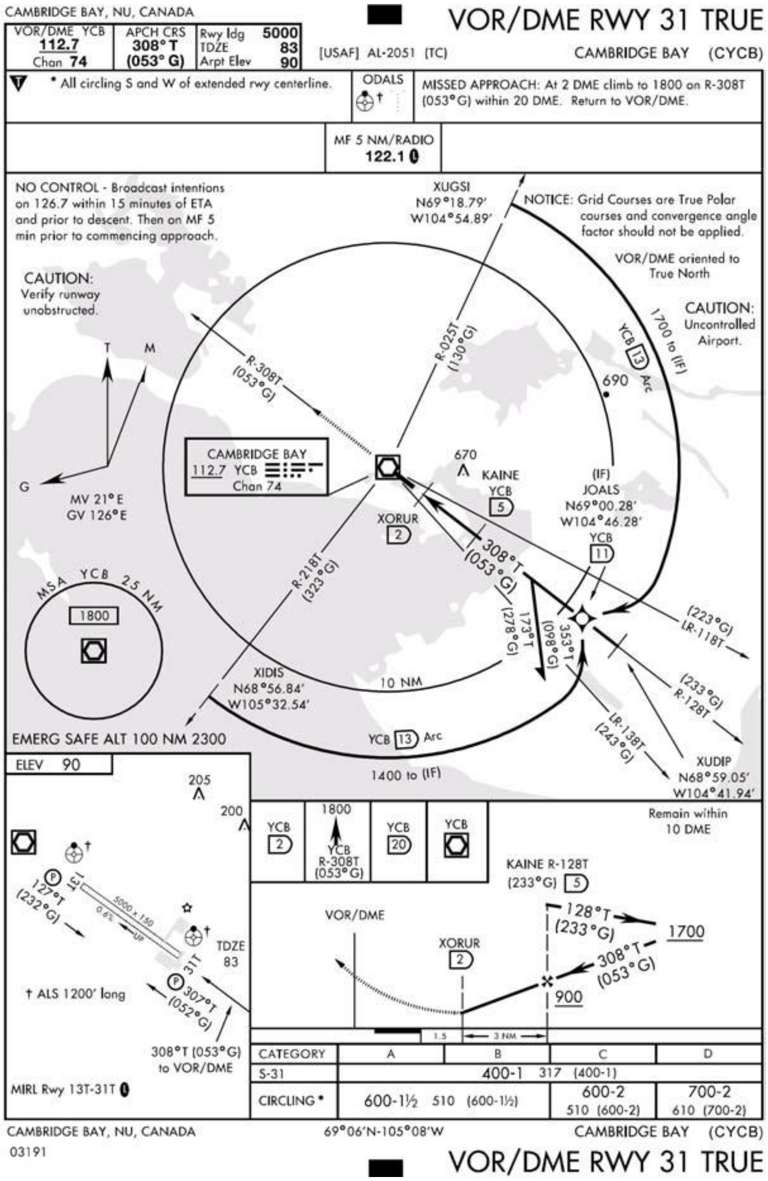
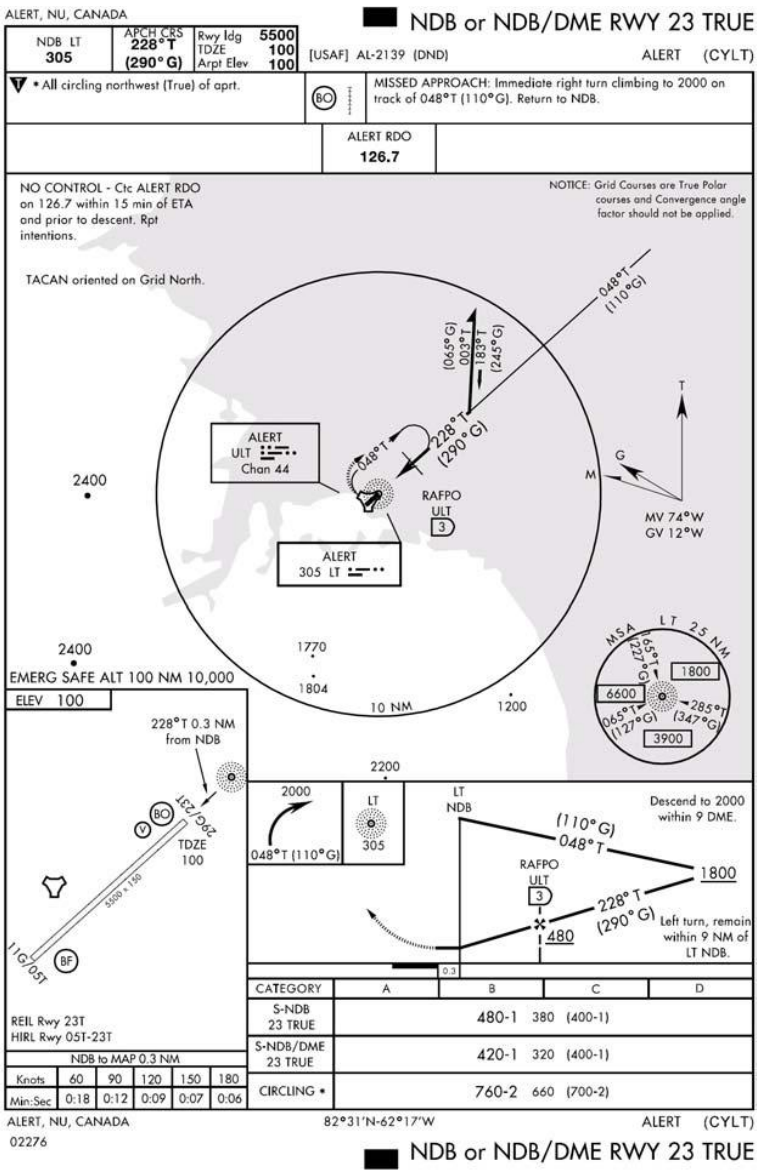


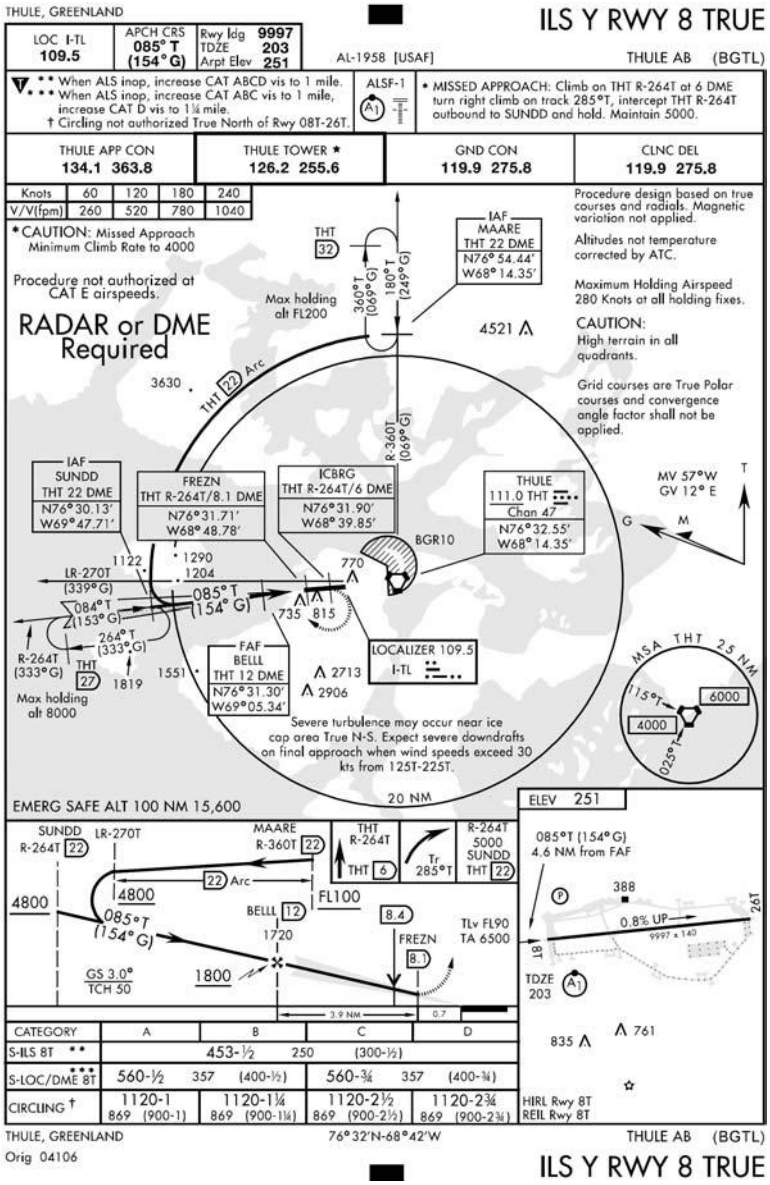
Figure 6.8. True NDB Approach.



NDB to MAP 0.3 NM					
Knots	60	90	120	150	180
Min:Sec	0:18	0:12	0:09	0:07	0:06

CATEGORY	A	B	C	D
S-NDB 23 TRUE	480-1 380 (400-1)			
S-NDB/DME 23 TRUE	420-1 320 (400-1)			
CIRCLING •	760-2 660 (700-2)			

Figure 6.9. True ILS Approach.



6.5.3. Grid Approach Procedures. (Figures 6.10 and 6.11) In some cases a NAVAID may be oriented on grid north, or a grid final approach course may be published alongside a magnetic or true final approach course. Use the following general procedures to fly a grid approach. Consult your aircraft flight manual and MAJCOM directives for specific equipment, procedures, and crew complement to fly grid.

6.5.3.1. ***The heading reference of the primary means of navigation on final approach, the heading reference of the NAVAID the approach is based on, and the orientation of the runway direction number should all be the same.***

6.5.3.1.1. NOTE: The NAVAID the approach is based on and the runway direction number normally will use the same heading reference.

6.5.3.1.2. ***When a final approach course using another heading reference is published on the IAP in parenthesis, this is provided for situational awareness, and is not to be used as the primary means of navigation on final approach.*** Use the grid course IAW with the aircraft flight manual and MAJCOM directives.

6.5.3.1.3. If the NAVAID and runway direction number are oriented on grid north, then grid is the primary means of navigation along final approach. Use aircraft flight manual procedures and MAJCOM directives to fly a grid approach. ***If a magnetic or true final approach course is published alongside the grid course it should only be used as a situational awareness tool, not the primary means of navigation.***

Figure 6.10. Magnetic Heading Reference With Grid Course.

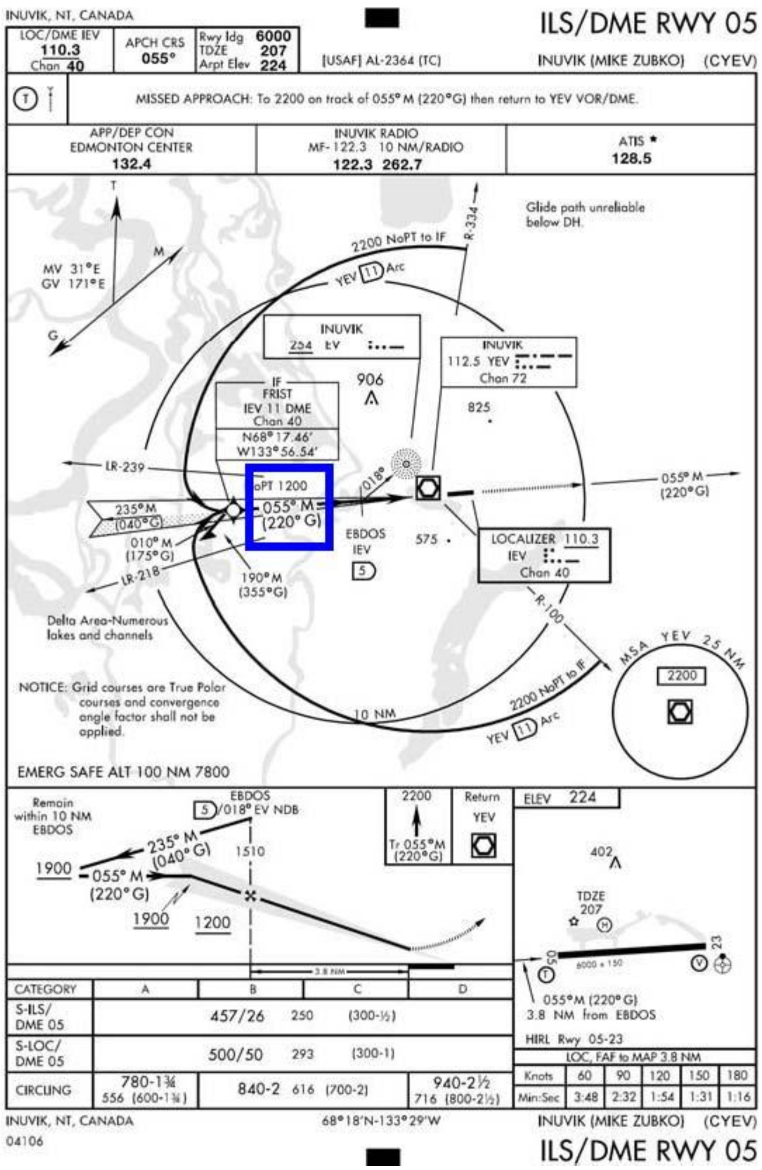
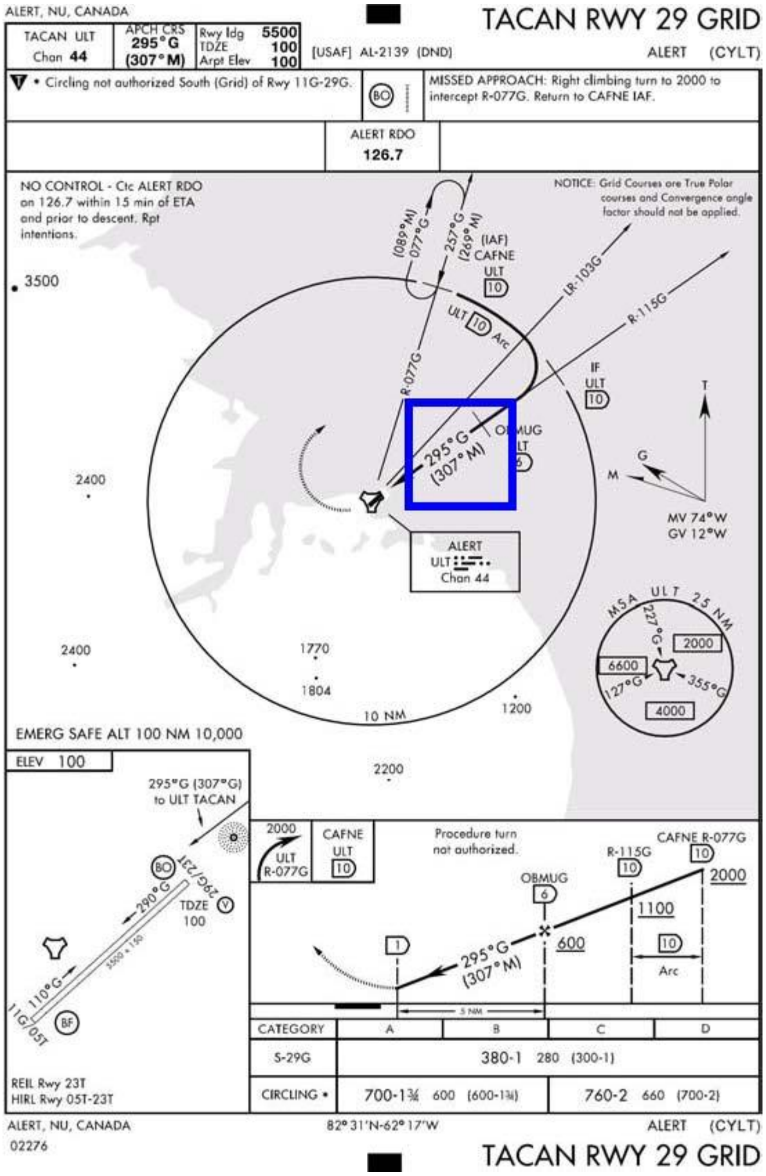
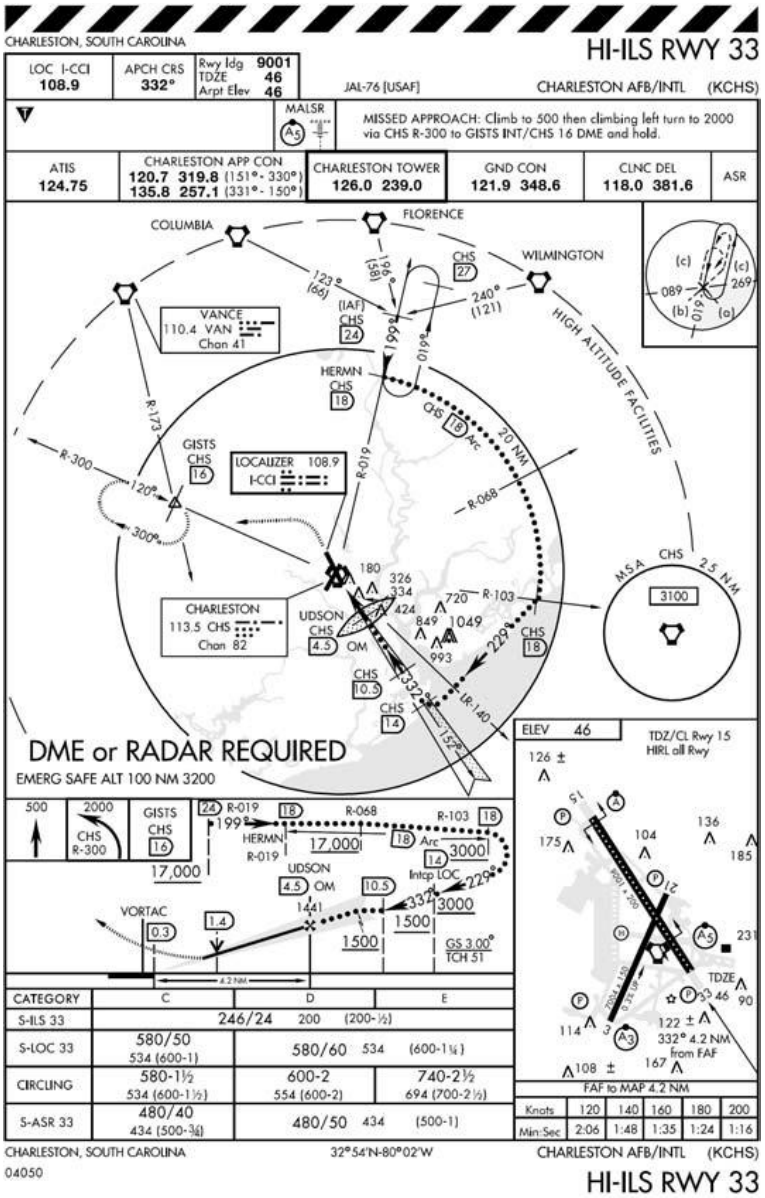


Figure 6.11. Grid Approach.



6.5.4. Reviewing an IAP (Figure 6.12). Prior to departure, you should become familiar with all aspects of the IAP so that during the recovery you can concentrate on flying the maneuver rather than trying to fly and interpret it simultaneously. Here are some important areas to consider and techniques to use:

Figure 6.12. Review of the IAP.



6.5.4.1. Plan View.

6.5.4.1.1. Ground Track. Note the general ground track of the approach, the NAVAIDs that provide the course guidance, and the NAVAID location. (The NAVAIDs that appear in the name of an IAP are the NAVAIDs that provide the final approach guidance. Other types of NAVAIDs may be required to accomplish the approach and missed approach.)

6.5.4.1.2. Initial Approach Fix. Note the location of the IAF you plan to use as well as the NAVAID used to define the fix. Sometimes the IAF is displayed on the IAP by name only, and the NAVAID and radial/DME that defines the point is not listed. In this case, refer to the appropriate en route and terminal charts for the area to determine the NAVAID and the radial/DME that defines the IAF.

6.5.4.1.3. Holding Pattern. Note the location of the holding pattern and its relation to the IAF. It is extremely important that you review the altitude of the holding pattern at the IAF and determine if your aircraft can meet the holding speed restrictions associated with that altitude. If you are unable to comply with that holding speed, coordinate with ATC prior to arriving at the IAF and entering holding. You could exit TERPS protected airspace if you fly faster than the holding pattern design speed.

6.5.4.1.4. Plan the Approach. Mentally fly the approach from the IAF to the MAP and determine the lead points for radial, course, or arc interceptions. Identify the point where the aircraft should be configured for landing.

6.5.4.1.5. Missed Approach. Review the missed approach departure instructions and determine if your aircraft can comply with the required climb gradient if one is published. It is extremely important to review the Missed Approach holding pattern and determine if your aircraft can meet the holding speed restrictions associated with that altitude. If you are unable to comply with the holding speed, coordinate with ATC prior to arriving at the IAF and commencing the approach. If you lose communications and subsequently execute the published missed approach procedures, you could exit TERPS protected airspace if you fly faster than the missed approach holding pattern was designed for. Even when in radio contact, waiting to notify ATC of your requirement for alternate missed approach instructions, it may be too late for ATC to react and you could still exit protected airspace.

6.5.4.1.6. Published Routings. Terminal routings from en route or feeder facilities normally provide a course and range from the en route structure to the IAF but may take the aircraft to a point other than the IAF if operational circumstances so require (Low altitude feeder routes provide minimum altitudes).

6.5.4.1.7. Minimum Safe/Sector Altitudes. Minimum Safe Altitudes consist of minimum sector altitudes and emergency safe altitudes. When more than one Minimum Safe Altitude is required, it is referred to as a Minimum Sector Altitude. A minimum safe altitude is the minimum altitude that provides at least 1000 feet of obstacle clearance for emergency use within a specified distance from the navigation facility upon which the procedure is based (for example VORTAC, VOR, TACAN, NDB, or locator beacon at OM or MM). The minimum sector altitude provides the 1000 feet of obstacle clearance within 25 NM of the facility. An emergency safe altitude is normally developed only for military procedures and will provide 1000 feet of obstacle clearance (2000 feet in designated mountainous areas) within 100 NM of the facility. If it is not clear on which facility the altitude is based, a note should state the facility that is used. Minimum safe altitudes do not guarantee NAVAID reception.

6.5.4.1.8. Scale. The inner ring gives a scale presentation of the approach that is normally within a 10 NM radius for low altitude approaches and 20 NM for high altitude approaches. However, it should be noted that the radius of the rings may differ. Some, but not necessarily all, obstacles are depicted. This inner ring is normally necessary for better portrayal of the IAP. On IAPs with a single ring, the entire plan view is to scale. Instrument approach procedure plan views can use up to three rings to show the approach information needed for the IAP. The addition of outer or middle rings indicates that only approach information inside the inner ring is to scale.

6.5.4.2. Profile View.

6.5.4.2.1. Altitude Restrictions. Note the altitude restrictions. Minimum, maximum, mandatory, and recommended altitudes normally precede the fix or facility to which they apply. If this is not feasible, an arrow will indicate exactly where the altitude applies. In some cases altitude restrictions are published in the plan view and not in the profile view. This is often the case with multiple IAFs where it is not feasible to show all the routings in the profile view.

6.5.4.2.2. Descent Gradients. Consider the descent gradient. For a low altitude IAP, the initial descent gradient will not exceed 500 ft/nm (approximately 5°); and for a high altitude approach, the maximum allowable initial gradient is 1,000 ft/nm (approximately 10°).

6.5.4.3. Landing Minimums. Review the landing minimums for your aircraft category to see how low you can descend on the approach and to determine if the forecast weather conditions will permit use of the IAP.

6.5.4.3.1. NOTE: The minimums published in FLIP must be the lowest possible minimums in accordance with TERPS criteria; however, MAJCOMs may establish higher minimums for their pilots. The visibility values determine whether a straight-in approach may be flown. These values are based on all approach lighting being operational. When approach lighting is inoperative, the visibility minimums will normally be one-half mile higher or as listed in the airfield NOTAMS. If a circling approach is to be flown, the weather must be at or above both the published ceiling and visibility.

6.5.4.3.2. NOTE: There may be situations when you are required to fly a circling approach which does not have a ceiling requirement published. In this case, ***the required ceiling will be the HAA plus 100 feet rounded up to the next one hundred foot value.*** For example, if the HAA is 757 feet, add 100 feet to get 857 feet and then round up to the nearest one hundred foot value, which would be 900 feet. Your ceiling for the approach must be at or above 900 feet.

6.5.4.4. Aerodrome Sketch.

6.5.4.4.1. Field elevation. Check the field elevation. This is the highest point on any usable landing surface.

6.5.4.4.2. Touchdown zone elevation (TDZE). Note the touchdown zone elevation. This is the highest point in the first 3,000 feet of the landing surface.

6.5.4.4.3. Runway. Observe the runway dimensions and layout.

6.5.4.4.4. Lighting systems. Check the types of approach lighting systems available.

6.5.4.4.5. Navigation facility location. Note the direction and distance of the runways from the navigation facility.

6.5.4.4.6. Obstructions. Check the location of prominent obstructions.

6.5.4.4.7. Final Approach Direction. The arrow shows the direction the final approach brings you in relation to the runway. This information can help you know where to look for the runway. It is also useful in determining how much maneuvering may be required to align the aircraft with the runway. A straight-in approach may bring your aircraft to the runway as much as 30 degrees off of the runway centerline and still be considered a straight-in approach.

6.5.4.5. Additional Information. Look carefully for notes on the IAP. Notes are used to identify either nonstandard IAP criteria or to emphasize areas essential for the safe completion of the approach.

6.5.4.6. Alternate minimums. Some civil and foreign approaches may have ▲ or ▲ NA in the remarks. The ▲ tells civilian pilots that the alternate minimums for the approach are non-standard and they must look in the front of the IAP book for new alternate minimums. Since Air Force alternate minimums are published in AFI 11-202V3, Air Force pilots may disregard the weather minimums listed under the ▲. The ▲ NA does apply to USAF aircrews and has very serious implications. ***The ▲ NA tells civilian and military pilots that the specific approach cannot be used to qualify the field as an alternate*** either because of lack of weather reporting facilities and/or the lack of capability to monitor the NAVAID. Without weather reporting facilities at the airport a pilot will not be able to get a specific forecast for that airport as required by AFI 11-202V3. The lack of monitoring capability of the navigation facilities is a bigger problem. Without a monitoring capability the pilot won't get any advance warning if the NAVAID is not operating. This means if the NAVAID goes off the air, there is no one to issue a NOTAM to inform the pilot of the situation before an attempt is made to identify and use the NAVAID.

6.5.4.7. Declared Distances. Declared distances are normally associated with airports affected by close-in development, or encroachment. In order to maintain standard "safety zones" around runways, the airport manager may implement declared distances to artificially reduce the size of the runway for the purpose of increasing the distance from the runway to close-in encroachment. Runways outside of the NAS and ICAO airports may also have declared distances. These may not be indicated on the IAP or airfield diagram, and additional pre-flight planning may be required to determine what the distances are. During mission planning, you will know if the airport you intent to transit has declared distances assigned if you see a black square with a white D (**D**) on the aerodrome sketch portion of the approach plate and the Airport Diagram. Since this symbol is in negative writing, it is referred to as the "Negative D". The distances referred to by the "Negative D" symbol are found in the NACO produced Airport/Facility Directory (A/FD) or region supplement, and in the NGA-produced IFR Supplement. If checking the IFR Supplement, they are listed in the "RMKS" section under the "RSTD" title. Declared distances do not affect the actual runway dimensions as published in the airport sketch. Declared distances for takeoff and landing are not provided on airport diagrams. Stored runway data in the FMS NAV database does not include declared distances.

6.5.4.7.1. Declared distances include the following four terms (which may or may not match the definitions in your aircraft performance manual).

6.5.4.7.1.1. **TORA.** TAKE-OFF RUN AVAILABLE-The length of runway declared available and suitable for the ground run of an airplane take-off.

6.5.4.7.1.2. **TODA**. TAKE-OFF DISTANCE AVAILABLE-The length of the takeoff run plus the length of the clearway, if provided.

6.5.4.7.1.3. **ASDA**. ACCELERATE-STOP DISTANCE AVAILABLE–The runway plus stopway length declared available and suitable for the acceleration and deceleration of an airplane aborting a takeoff. (A stopway is comparable to a US Military "overrun"; it is paved and weight-bearing).

6.5.4.7.1.4. **LDA**. LANDING DISTANCE AVAILABLE-The length of runway which is declared available and suitable for the ground run of an airplane landing.

6.5.4.7.2. Declared distances are in place to meet certain FAA airport design criteria. The Runway Safety Area, Runway Obstacle Free Area, and Runway Protection Zone affect the declared distance lengths at certain airfields. Declared distances are a means of obtaining a standard safety area by reducing the usable runway length. A mathematical method is used to determine runway length available. For more information on declared distance standards, see FAA AC 150/5300-13. It may not be possible for transiting aircrews to know specifically why declared distances are published as they are. ***USAF aircrews must adhere to Declared Distances to meet the FAA's intent of providing the best possible safety areas around the runway.***

6.5.4.7.2.1. Some runway elements associated with declared distances may be identifiable through runway markings or lighting (displaced threshold or a designated overrun or stopway), but the individual declared distance limits are not marked or otherwise identified on the runway. Further, aircrews are reminded that climb gradient restrictions are generated from the physical departure end of the runway, not necessarily any specific declared distance.

6.5.4.7.2.2. Takeoff and Landing Data (TOLD) correctly computed from the aircraft performance manual gives the aircrew the distance requirements for takeoff and landing. ***PICs will ensure TOLD computations for the aircraft's takeoff ground run, or landing distance, falls within the published declared distances before the pilot accepts that runway for takeoff or landing.***

6.5.4.7.2.2.1. NOTE: As long as TOLD calculations fall within the Declared Distance limitations, a USAF aircrew may operate beyond a declared distance limit during any takeoff, landing or taxi operation, provided the runway surface is appropriately marked as usable runway. Therefore, when aircraft weight, configuration, and environmental factors allow the aircraft TOLD to meet Declared Distance limits, USAF pilots may operate normally on the runway.

6.5.4.7.3. USAF Aircrews should apply declared distance information in the following manner:

6.5.4.7.3.1. TORA: ***PICs must operate their aircraft at a weight that makes it POSSIBLE to be airborne at or before the TORA distance and then meet or exceed the published climb gradient.*** Normally, the published climb gradient starts at the end of the published physical runway length, at the appropriate screen height.

6.5.4.7.3.2. TODA: ***PICs will not incorporate TODA into planning, but will instead be limited by TORA***. If TODA is longer than the depicted physical runway length, it has taken a clearway into account. Certain non-USAF turbine powered aircraft use it in their TOLD. Clearways are NOT paved nor are they weight-bearing surfaces.

6.5.4.7.3.3. ASDA: ***PICs will use ASDA when computing a refusal speed*** (if applicable), as it provides information on stressed pavement available for stopping. If using the balanced field concept for takeoff, ASDA must be compared to TORA, and the shorter of the two used when computing TOLD.

6.5.4.7.3.4. LDA: ***PICs will land at a weight and configuration that makes it POSSIBLE to touchdown and stop within the LDA.*** LDA starts at the approach end threshold or displaced threshold. However, the full length of the runway, if appropriately marked and available, may be used for roll-out and runway exit, given the aircraft is capable of complying with the published LDA.

6.5.4.7.4. Touch and go operations at airfields with declared distances:

6.5.4.7.4.1. When considering whether the aircraft can safely accomplish touch and goes, at a field with declared distances, the PIC should treat the takeoff and landing as separate operations. Therefore, for the landing, aircraft TOLD must allow it to land, and stop, within the declared LDA for that runway. For the takeoff, aircraft TOLD must permit it to takeoff with the published TORA and ASDA—computed as if it were the initial takeoff operation at that field. Again, if using balanced field method of calculating TOLD for takeoff, use the shorter of TORA or ASDA.

6.5.4.7.4.2. As long as the PIC confirms the aircraft's weight and configuration make it POSSIBLE to make an initial takeoff and a full stop within that runway's declared distances (treated as separate operations), touch and goes are permitted on that runway. Since the PIC ensured compliance with all declared distances, it would then be permissible for the PIC to use the physical length of the runway for a touch and go just as at any other runway. Finally, the full physical runway length must meet the aircraft's flight manual and AFI 11-2MDSV3 series required runway length for touch and go operations.

6.5.5. Reviewing a Radar Approach. Depictions of radar approaches are not normally included in flight publications, but some important aspects of the approach are available.

6.5.5.1. IAP. It is helpful to review a published IAP for the airfield. In addition to helping you prepare for a backup approach in the event of radio failure, the IAP provides:

6.5.5.1.1. NAVAIDs. NAVAID frequencies and locations for position orientation and, in some cases, additional voice reception capability.

6.5.5.1.2. Altitudes. Minimum safe altitudes in the terminal area.

6.5.5.1.3. Stepdown altitudes. A stepdown altitude between the nonprecision FAF and MAP that may alert you to the possibility of a stepdown on an airport surveillance radar (ASR) approach to the same runway.

6.5.5.1.4. Radar minimums. Depiction of radar minimums and the glide slope angle. Normally the precision approach radar (PAR) glide slope will coincide with the ILS glide slope.

6.5.5.1.5. Airport sketch. The airport sketch and all the information associated with it.

6.5.5.2. Operating hours. The IAP books contain complete radar minimums. The IFR Supplement contains time periods when the aerodrome and its NAVAIDs are operational. It also indicates when NAVAIDs will be off the air for NO-NOTAM preventive maintenance, as well as other items unique to the particular operation of the airfield.

6.5.6. Reviewing RNAV (GPS) IAPs. The following section highlights elements of RNAV (GPS) IAPs that differ from IAPs based on conventional NAVAIDs.

6.5.6.1. Equipment requirements. The “TERMS/LANDING MINIMUMS DATA” (Section A) of the U.S. Government Terminal Procedures books provide a description of the aircraft equipment requirements for RNAV (GPS) IAPs. More detailed information can be obtained via the AFFSA web page. Pilots are responsible for ensuring that the aircraft is suitably equipped for the level of minimums used. Be aware that very few RNAV (GPS) IAPs may be flown using DME/DME RNAV systems. Note that the “(GPS)” in the approach title does not indicate the approach may be flown in aircraft with any GPS equipment. GPS equipped aircraft must meet the equipment requirements described in AFI 11-202V3 and FAA AC 91-100A.

6.5.6.1.1. ***Use of LNAV/VNAV DA requires certified VNAV functionality or WAAS on the aircraft. Use of LPV (see 6.5.6.3.3 below) minimums requires WAAS equipment on the aircraft.***

6.5.6.2. Procedure name. Where multiple RNAV procedures exist to the same runway, subsequent RNAV procedure titles will be followed by the suffix X, Y, or Z (e.g., “RNAV (GPS) Z RWY 22”). ATC clearance for the RNAV procedure will authorize the pilot to use any landing minimums for which the pilot and/or aircraft is capable and authorized.

6.5.6.3. Chart Terminology.

6.5.6.3.1. Decision Altitude (DA). On some approaches, DA replaces the familiar term Decision Height (DH). DA conforms to the international convention where altitudes relate to MSL (i.e. referenced on a pressure altimeter) and heights relate to AGL. DA is the correct terminology for CAT I ILS, CAT II ILS with RA-NA published, LNAV/VNAV, LPV etc. The published descent profile is flown to the DA, where a missed approach will be initiated if visual references for landing are not established. Obstacle clearance criteria accounts for a momentary descent below DA while transitioning to the missed approach. Decision Height is a height above touchdown referenced by a RADAR altimeter and should only be referenced for CAT

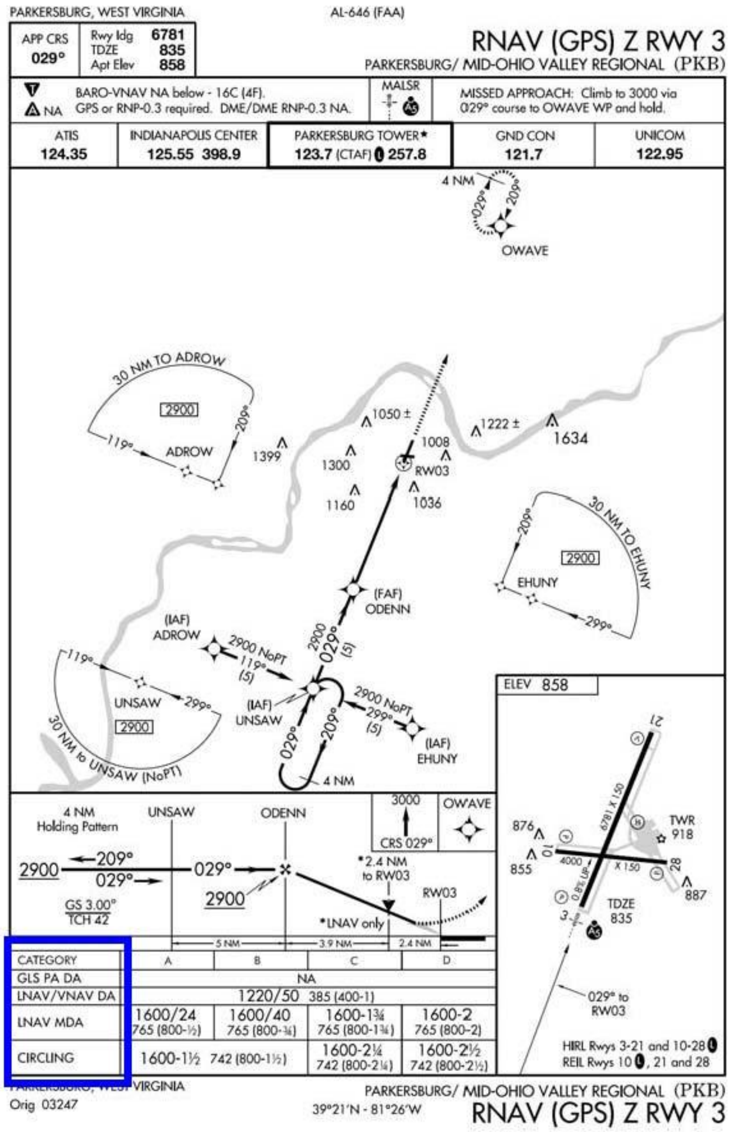
II/III ILS or those procedures using a RADAR altimeter to define minimums/decision points.

6.5.6.3.2. Minimum Descent Altitude (MDA). MDA carries the same meaning as in conventional IAPs, and is associated with LNAV minimums. Obstacle clearance is based on no descent below MDA. Thus, ***if vertical guidance is used down to LNAV minimums, pilots must ensure that the descent is broken in time to level off at MDA if visual references for landing are not established.***

6.5.6.3.3. LPV. Localizer Performance with Vertical Guidance (LPV) minimums are based on augmented GPS systems (WAAS) providing near ILS accuracy. LPV minima can be as low as a DA(H) of 250 feet above the ground, with visibility as low as 1/2 mile.

6.5.6.3.4. Minimums: RNAV instrument approach procedure charts incorporate all types of approaches using Area Navigation systems, both ground and satellite based. The approach charts may contain as many as four lines of approach minimums: Lateral Navigation (LNAV); LNAV/Vertical Navigation (VNAV) (LNAV/VNAV); GNSS Landing System (GLS), also known as LPV; and Circling. The minima are dependent on the navigational equipment capability as outlined in the Terms/Landing Minima Data section at the front of the approach plate book. Typically, the approach chart will indicate the equipment required for the approach, i.e. GPS or RNP-.03 Required (Figure 6.14).

Figure 6.14. RNAV (GPS) Approach Minimums.



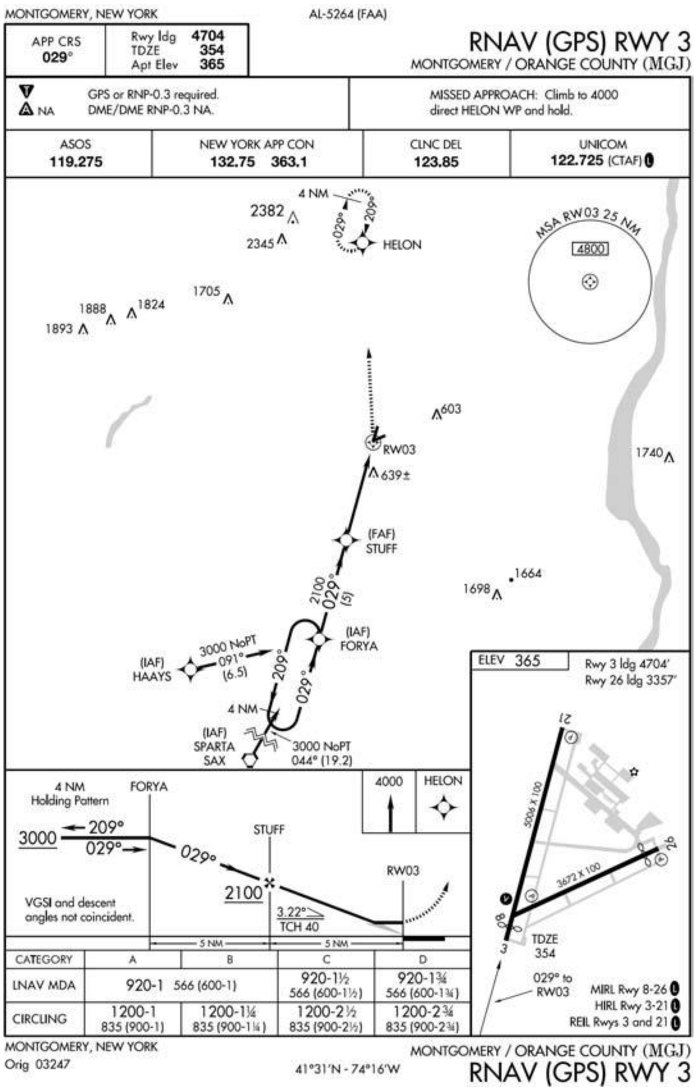
6.5.6.3.4.1. LNAV. These minimums are for LNAV (lateral) –only guidance. Because vertical guidance is not provided, the procedure minimum altitude will be published as a MDA. With an approved VNAV system, VNAV guidance may be used if provided by the RNAV system as long as the aircraft is level prior to MDA.

6.5.6.3.4.2. LNAV/VNAV. LNAV/VNAV minimums are based on lateral and vertical guidance to the published DA.

6.5.6.3.4.2.1. NOTE: Barometric VNAV (BARO-VNAV) systems compute a vertical path based on aircraft barometric altimetry systems. This vertical path may be greatly affected by non-standard temperatures, incorrect or rapidly changing altimeter settings, and altimeter error. Pilots should closely monitor compliance with step down fix altitude constraints and may not use Baro-VNAV guidance for reference below the published DA. Also note that deviations from the VNAV path are often linear as opposed to angular, i.e. one dot deviation represents a fixed number of feet from the vertical path, regardless of distance to the runway waypoint.

6.5.6.3.4.2.2. LPV minimums. LPV minimums may support precision approach minimums as low as 200' HAT and 1/2 statute mile (SM) visibility. Pilots will be informed that the notation "LPV PA" or "GLS" on the first line of minimums in U.S. Government Terminal Procedure Publication charts satisfies all the requirements of the precision system. Pilots will be informed that the precision system requirements are <u>not</u> met by the notation "LPV" without the letters "PA" on the first line of minimums. In this latter case, since the landing environment does not support the low visibility operations, minimums no lower than 300' HAT and 3/4 SM visibility will be published. LPV minimums are published as a Decision Altitude (DA).

Figure 6.15. RNAV (GPS) Chart Symbology.



6.5.7. Chart Symbology (Figure 6.15).

6.5.7.1. Descent Angle. The RNAV (GPS) IAP format provides descent angle to the hundredth of a degree (e.g., 3.00°), with a range from 2.75° to 3.5°. The angle is provided in the graphically depicted descent profile. The optimum RNAV (GPS) descent angle is 3.00°.

6.5.7.1.1. For RNP and WAAS approaches just now being fielded, the minimum descent angle is still 2.75°. However, the maximum angle is based on aircraft category as shown in the table below.

Table 6.2. Maximum Descent Angle for RNP and WAAS Approaches.

Aircraft Category	Maximum Descent Angle
CAT A (less than 80 kts)	6.4 Degrees
CAT A (81-90 kts)	5.7 Degrees
CAT B	4.2 Degrees
CAT C	3.6 Degrees
CAT D and E	3.1 Degrees

6.5.7.2. Threshold Crossing Height (TCH). The concept of TCH is the same as in conventional IAPs. On RNAV (GPS) IAPs, TCH refers to the point where the descent angle crosses above the threshold. Unless required by larger type aircraft, the typical TCH will be 30-50 feet.

6.5.7.3. VDP. The VDP on an RNAV (GPS) IAP only pertains to aircraft using LNAV minimums (not LNAV/VNAV or LPV). The VDP will be accompanied by the notation "*LNAV only."

6.5.7.4. Missed Approach Symbology. In addition to a textual description of the missed approach procedure in the "pilot briefing" at the top of the IAP, missed approach instructions will be graphically depicted in the profile view. Up to four icons will be shown. These icons are intended only for quick reference and may not depict the full missed approach procedure.

6.5.7.5. Waypoints. Two types of waypoints appear in RNAV procedures – "fly-over" and "fly-by" waypoints. "Fly-by" waypoints will be depicted using the standard WP symbol. Turn anticipation is allowed for fly-by waypoints. Fly-over waypoints are indicated by the standard waypoint symbol enclosed in a circle. For a fly-over WP, turn anticipation is not allowed. No turn may be accomplished until the aircraft passes over the waypoint. **Note**: A "Fly By" vertical waypoint is a WP for which an aircraft may initiate a vertical rate change and depart the specified vertical path to the active WP prior to reaching that WP, in order to asymptotically capture the next vertical path. A "Fly Over" vertical waypoint is a WP for which an aircraft must stay on the defined vertical path until passing the active WP, and may not initiate the necessary vertical rate change to capture the next vertical path until after passing the active WP. Hence, after passing the active WP, as the next WP becomes active, and if there is a vertical path change, then the aircraft must re-adjust vertical rate to re-capture the vertical path after having already overshot the first opportunity for an asymptotic capture of that new path.

6.5.7.6. Approach waypoints, except for the MAWP and the missed approach holding waypoint (MAHWP), are normally fly-by waypoints. Overlay approach charts and some early stand alone GPS approach charts may not reflect this convention.

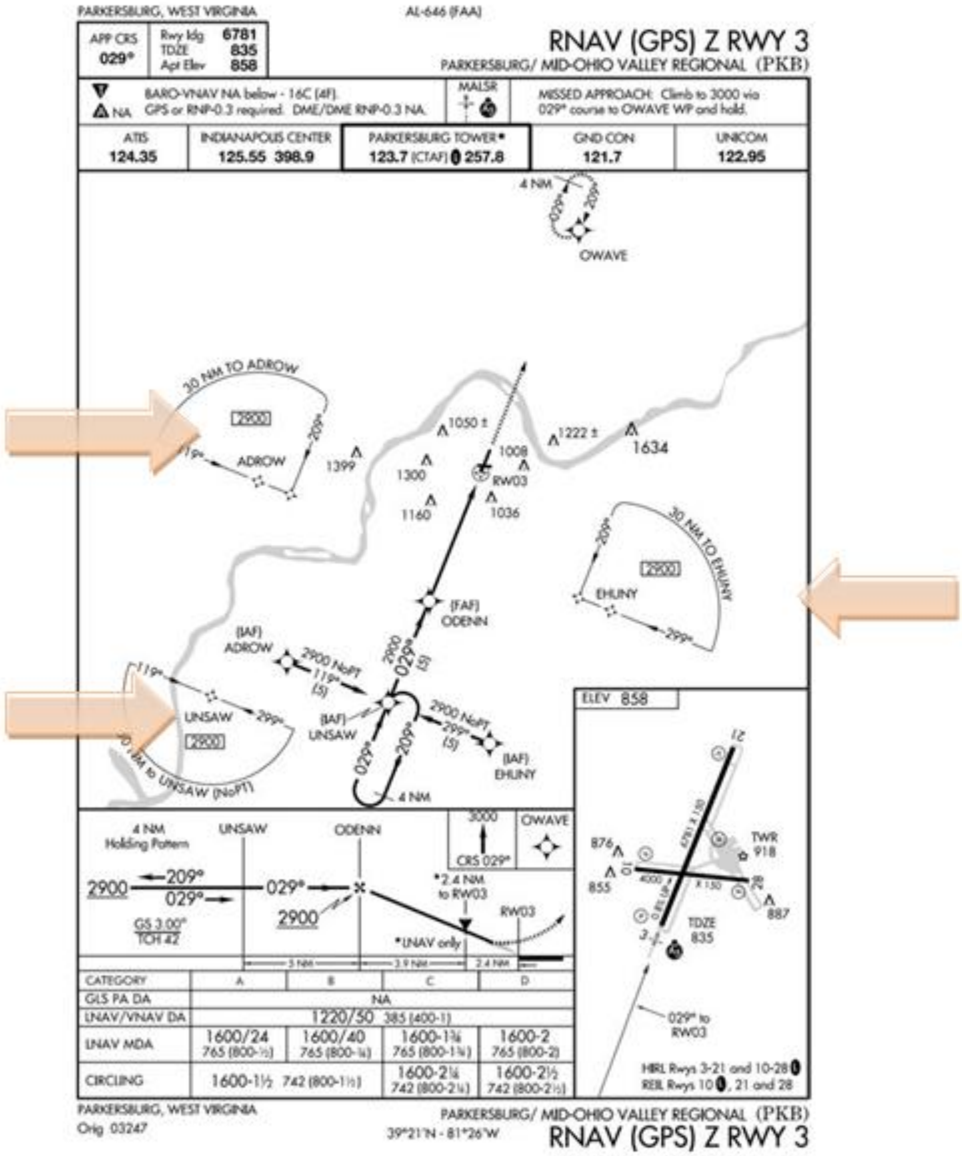
6.5.7.7. Pilots may see terminal 5 letter waypoints outside the U.S. The first 2 letters are airport ID, third letter is cardinal direction from airfield and the fourth/fifth positions are sequential numbers. Approach waypoints may use 4 or 5 alphanumeric characters, where first 3 characters represent runway designation (e.g., 24L, where C/L/R is optional), the fourth character is G for waypoint-type code and last digit is for uniqueness (e.g., 24LG2).

6.5.7.8. Pilot Briefing Area. The pilot briefing consolidates, in one location, pertinent information needed to conduct the approach. It includes final approach course, runway/airport data, procedure restrictions, approach light data, missed approach text, WAAS and BARO-VNAV information, and various NAVAID/ATC radio frequencies.

6.5.7.8.1. Cold Temperature Limitations. The upper left hand area of the pilot briefing lists the airport temperature below which BARO-VNAV will not be authorized to LNAV/VNAV minimums. ***Cold weather corrections should still be applied to all barometrically derived approach minimums and step-down altitudes, whether Baro-VNAV is used or not.*** (Use of barometric VNAV DA is not authorized with a remote altimeter setting.)

6.5.7.9. Terminal Arrival Areas (TAA) (Figure 6.16). The standard TAA consists of three areas defined by the extension of the IAF legs and the intermediate segment course. These areas are called the straight-in, left-base, and right-base areas. TAA area lateral boundaries are identified by magnetic courses TO the IF (IAF). The straight-in area can be further divided into pie-shaped sectors with the boundaries identified by magnetic courses TO the IF (IAF), and may contain stepdown sections defined by arcs based on RNAV distances (DME or along track distance (ATD)) from the IF (IAF). The right/left-base areas can only be subdivided using arcs based on RNAV distances from the IAFs for those areas. Minimum MSL altitudes are charted within each of these defined areas/subdivisions that provide at least 1,000 feet of obstacle clearance, or more as necessary in mountainous areas.

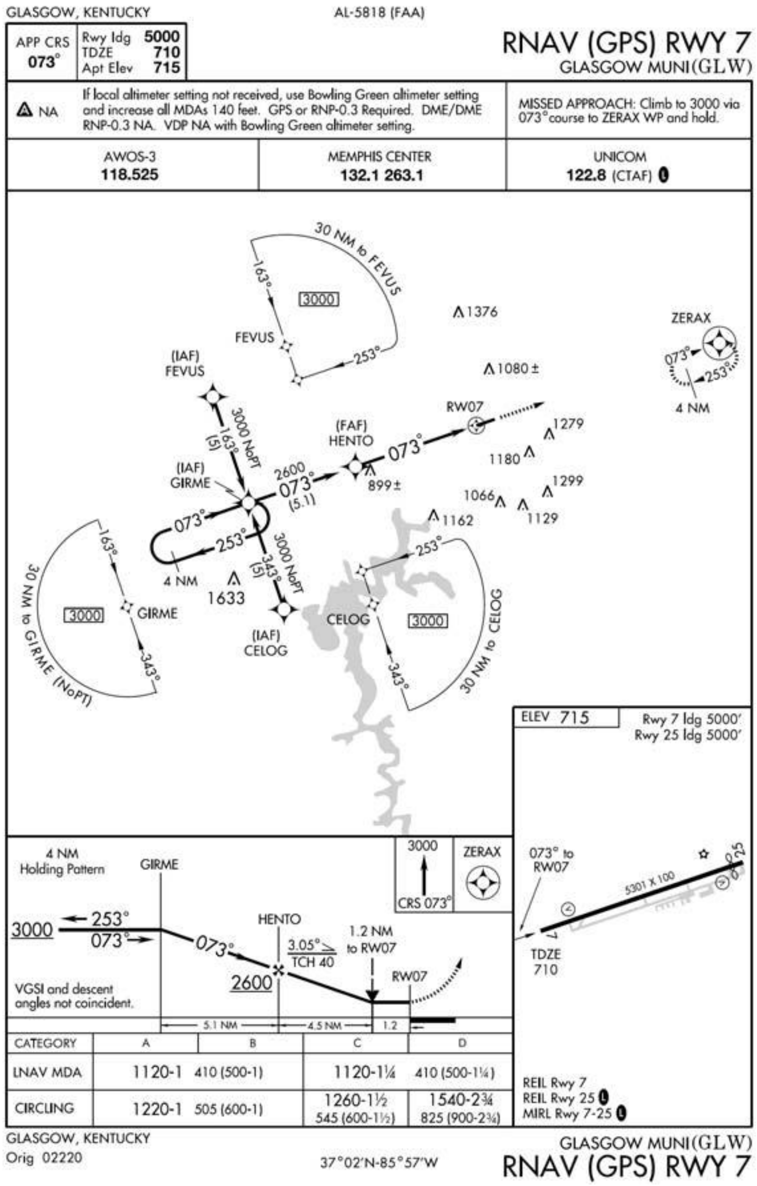
Figure 6.16. Terminal Arrival Area (TAA).



6.5.8. Reviewing GPS instrument approaches. AFI 11-202V3 lists specific equipment requirements for GPS stand-alone and overlay instrument approaches.

6.5.8.1. RNAV (GPS) Approaches (Figure 6.17). RNAV (GPS) stand-alone approaches are constructed specifically for use by RNAV and/or GPS equipped aircraft and are not based on ground based NAVAIDS. RNAV (GPS) stand-alone approaches are identified by the absence of other NAVAIDS in the approach title, for example GPS RWY 35 or RNAV (GPS) RWY 35. ***RNAV (GPS) approaches are authorized in IMC for appropriately equipped and certified USAF aircraft.***

Figure 6.17. Stand Alone GPS Approach.

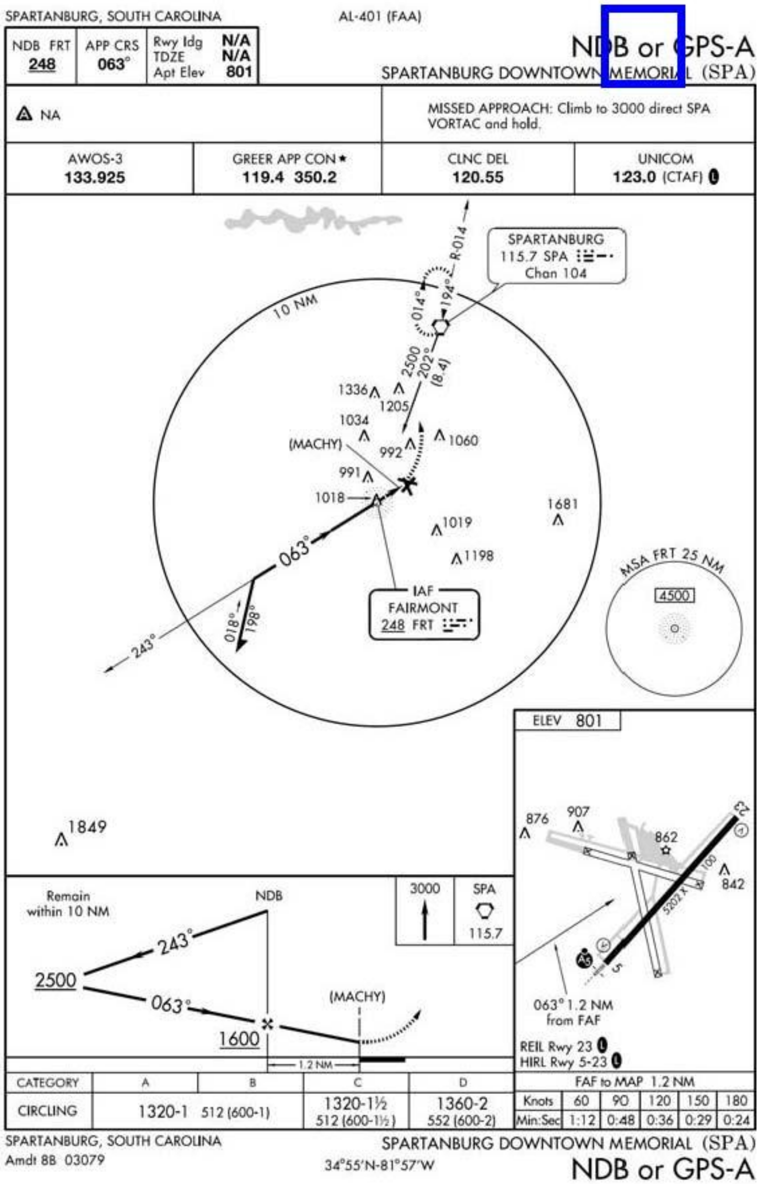


CATEGORY	A	B	C	D
LNAV MDA	1120-1 410 (500-1)		1120-1¼ 410 (500-1¼)	
CIRCLING	1220-1 505 (600-1)		1260-1½ 545 (600-1½)	1540-2¾ 825 (900-2¾)

6.5.8.2. Approaches where ”or GPS" is included in the title of the procedure are retrievable from the database (e.g., "VOR or GPS RWY 35")(Figure 6.18). USAF aircraft may fly these approaches in VMC or IMC if the approach was constructed by a US TERPS authority (USAF/FAA/USN). For approaches without “or GPS” in the title, see RNAV substitution discussion below.

6.5.8.2.1. NOTE: When retrieving an “or GPS” approach from the navigation database, it will be titled in the database by the title of the conventional NAVAID. For example: VOR or GPS Rwy 5 will be titled in the aircraft database as “VOR Rwy 5”. The title on the published IAP chart determines the type of approach, not how it is named in the aircraft database.

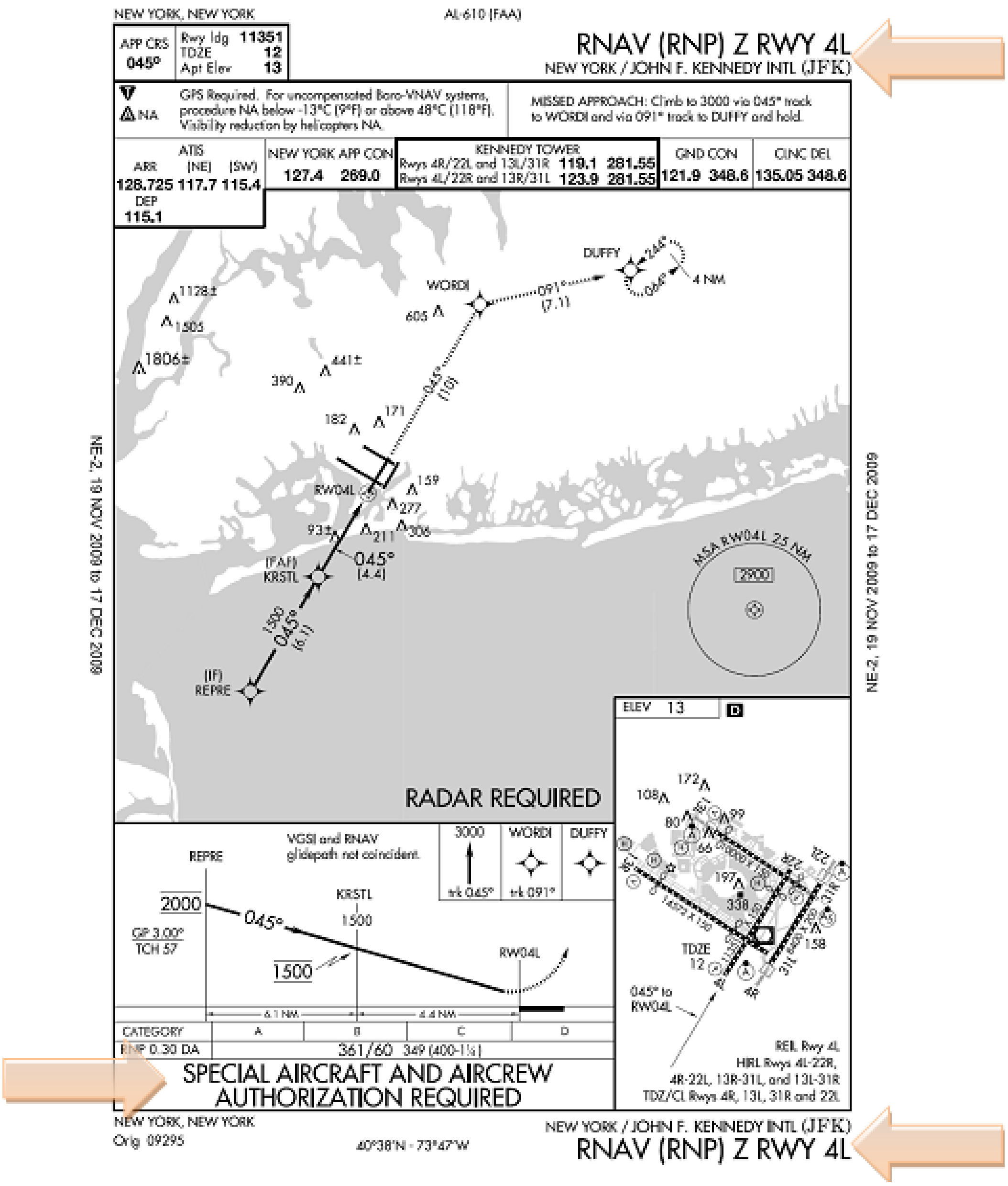
Figure 6.18. "or GPS" Approach.



6.5.8.2.2. Procedures Without a Final Approach Fix. Procedures without a FAF and without a stepdown fix have a Sensor FAF waypoint coded in the database at least 4 NM Actual Track Distance (ATD) to the MAP waypoint. The MAP, in this case, is always located at the NAVAID facility. A Sensor FAF is a final approach waypoint created and added to the database sequence of waypoints to support GPS navigation of an FAA or DoD published, no-FAF, nonprecision instrument approach procedure. The coded name or Sensor FAF appears in the waypoint sequence. If a stepdown fix exists on the published procedure and it is greater than 2 NM to the MAP, the stepdown fix is coded in the database as the Sensor FAF waypoint for the waypoint sequence. If a stepdown fix distance is 2 NM or less to the MAP, a Sensor FAF waypoint is coded at least 4 NM to the MAP.

6.5.8.3. RNP SAAAR Approaches (Figure 6.19). ***USAF pilots shall not fly these procedures until completing MAJCOM-defined training and certification.*** SAAAR procedures are to be conducted by aircrews meeting special training requirements in aircraft that meet the specified performance and functional requirements. RNP SAAAR approaches are clearly marked with (RNP) in the instrument procedure name and SPECIAL AIRCRAFT AND AIRCREW AUTHORIZATION REQUIRED in the comment block.

Figure 6.19. RNP SAAAR.



6.5.8.4. RNAV Substitution. IAW AFI 11-202V3, for procedures developed by a US TERPS authority (FAA/USAF/USN), MAJCOM-approved suitable RNAV systems may be used as a substitute means of navigation for a named fix, VOR, TACAN, NDB, DME or compass locator. In such terminal areas, following a successful predictive RAIM check, approved RNAV systems may be substituted for required NAVAIDS or named fixes on arrivals, departures, and non-localizer based instrument procedures. Any such substitution must be extracted from a current database. These operations are allowable even when a facility is explicitly identified as required on a procedure (e.g., "Note ADF required"), but not if the procedure is NOTAM'ed as NA. Pilots using approved RNAV systems as a substitute means of navigation guidance in lieu of an out of service NAVAID should advise ATC of this intent and capability. ***Pilots will tune, identify, monitor and display the appropriate ground-based NAVAIDs whenever practicable.***

6.5.9. Relationship of Avionics Displayed Waypoints to Charted Data. The GPS Approach Overlay Program waypoints contained in the database represent the waypoints, fixes, NAVAIDs, and other points portrayed on a published approach procedure beginning at the initial approach fix. Certain unnamed points and fixes appearing on a chart are assigned a database identifier. Although there currently is no requirement to provide these database identifiers, most charting agencies are publishing them at their discretion. Database identifiers should not be used for pilot/controller communications or on flight plans.

6.6. Instrument Cockpit Check. Before flight, accomplish a thorough instrument cockpit check. You should check the applicable items listed below (unless your flight manual or command directives dictate otherwise):

6.6.1. Publications. Ensure appropriate, up-to-date publications obtained from an authorized source are in the aircraft.

6.6.1.1. If you are authorized to carry Jeppesen products, ensure you have Book 1 (summary, notices, legend information, etc.) and ALL the pages for the appropriate airport. Important information is contained on the back of the airfield diagram page. Radio out procedures are often contained on a different page from the IAP you are using. Without Book 1 and all the pages for the airport, you may miss crucial information.

6.6.1.2. ***Host nation FLIP documents, enroute charts, IAPs, etc, will not be used without MAJCOM approval IAW AFI 11-202V3.***

6.6.2. Pitot Heat. Check for proper operation.

6.6.3. ADIs.

6.6.3.1. Erect. Ensure it is erect and that the bank pointer is aligned vertically with the zero bank index. Check your flight manual for tolerance limits.

6.6.3.2. Flags. Ensure the warning flags are not visible.

6.6.3.3. Alignment. Check the pitch trim knob alignment and ensure it is within limits, then set the miniature aircraft or horizon bar for takeoff.

6.6.4. Magnetic Compass. Check the accuracy of heading information.

6.6.5. Clock. Ensure the clock is running and the correct time is set.

6.6.6. VVI. Ensure the pointer is at zero. If the indicator does not return to zero, adjust it with a small screwdriver or use the ground indication as the zero position in flight.

6.6.7. Altimeters.

6.6.7.1. Current setting. Set current altimeter setting on barometric scale.

6.6.7.2. Known elevation. Check the altimeter at a known elevation and note any error in feet. If the error exceeds 75 feet, the instrument is out of tolerance for flight.

6.6.7.3. Check pointers. Ensure the 10,000/1000/100 counter-drum-pointers indicate approximate field elevation. Check and ensure the low altitude warning symbol is in view.

6.6.7.4. Modes. Check both reset and standby modes on AIMS altimeter and set in accordance with the flight manual or command directives.

6.6.7.4.1. NOTE: Helicopter rotor operation may affect altimeter indications. Check individual helicopter flight manual for altimeter limitations if published.

6.6.8. Turn and Slip Indicator.

6.6.8.1. Turn needle. Check and ensure the turn needle indicates proper direction of turn.

6.6.8.2. Ball. Check the ball for freedom of movement in the glass tube.

6.6.9. Heading Indicators.

6.6.9.1. Accuracy. Check the accuracy of heading information. In lieu of guidance in aircraft technical orders the aircraft's primary heading indicator should be within approximately 5 degrees of a known heading (i.e., runway heading or designated ground checkpoint).

6.6.9.2. Indicators. Ensure the heading indicators indicate correct movement in turns.

6.6.9.3. Set. Set adjustable heading indicators to the desired heading.

6.6.9.4. Bank steering. For flight director systems, check the bank steering bar for proper commands in the heading mode.

6.6.10. Airspeed and Mach Indicators.

6.6.10.1. Set. Set the airspeed or command mach markers as desired or as directed in the flight manual.

6.6.10.2. Indicators. Check the pointers or rotating airspeed scale for proper indications.

6.6.11. Airspeed Mach Indicator (AMI).

6.6.11.1. Airspeed Warning Flag. Ensure it is out of view.

6.6.11.2. Command Airspeed Marker. Set the marker as desired; that is, decision, rotation, climb speed, etc.

6.6.12. Altitude Vertical Velocity Indicator (AVVI)

6.6.12.1. Vertical velocity. Check for zero indication.

6.6.12.2. Altimeter. Make same check as for conventional altimeter. Ensure warning flag is out of view.

6.6.12.3. Command Altitude Marker. Set the command altitude marker as desired; that is, first anticipated level off, emergency return DH/MDA, etc.

6.6.12.3.1. CAUTION: The command airspeed or altitude slewing switches should not be placed in the side detent position for takeoff due to the possibility of misreading those instruments.

6.6.13. Navigation Equipment and Instruments.

6.6.13.1. Tune and identify.

6.6.13.2. Pointers. Ensure the bearing pointers point to the station.

6.6.13.3. Flags. Check and ensure the range warning flag on the range indicator is out of view and the distance indicated is within one-half mile or 3 percent of the distance to the facility, whichever is greater.

6.6.13.4. Course set knob. Rotate the course set knob and check for proper CDI displacement.

6.6.13.5. To-from. Rotate the course set knob and check that the TO-FROM indication changes when the selected course is approximately 90° to the bearing pointer.

6.6.13.6. Designated checkpoints. When checking the VOR/TACAN at a designated ground checkpoint, the allowable CDI error is ±4° and the CDI and bearing pointer should agree within the tolerances specified for the aircraft. Ensure that distance indicated is within one-half mile or 3% of the distance designated on the checkpoint.

6.6.13.7. Dual systems. If the aircraft has dual VOR or dual TACAN receivers, the systems are considered reliable for instrument flight if they check within ±4° of each other. However, if the VOR/TACAN is also checked at a designated ground checkpoint, the equipment must meet the requirement in the above bullet.

6.6.13.7.1. NOTE: The self-test mode incorporated into some VOR/TACAN/ILS sets provides an operational test of the set. The self-test does not, however, provide a test of the aircraft antennas. If the VOR/TACAN set self-test function checks within the aircraft's flight manual tolerances and the VOR/TACAN station identifier is received, the requirements of the paragraph above are satisfied.

6.6.13.8. VOR Test Facility (VOT). VOT is an FAA facility that transmits a test signal for either a ground or airborne operational test of VOR equipment.

6.6.13.8.1. When using a VOT on the ground, allowable error is ±4 degrees. When using an airborne VOT, allowable error is ±6 degrees.

6.6.13.8.2. Airborne checks using a VOT are limited to those areas/altitudes specifically authorized.

6.6.13.8.3. VOT frequencies are listed in the NAVAIDS section of the Enroute Supplement entry for each airport and on the air/ground voice communications panels on the Enroute Low Altitude charts and Area charts.

6.6.13.8.4. When using a VOT to test VOR equipment, accomplish the following procedures:

6.6.13.8.4.1. Tune the appropriate VOT frequency on your VOR receiver.

6.6.13.8.4.2. With the CDI centered, the Omni Bearing Selector (OBS) should read 0 degrees with a "from" indication; or the OBS should read 180 degrees with a "to" indication. The RMI will indicate 180 degrees regardless of OBS setting.

6.6.13.8.4.3. Identify the VOT station by listening for a series of dots or a continuous tone.

6.6.13.9. Other equipment. Check all other flight and navigation instruments and equipment for proper operation and accurate information.

6.6.13.10. GPS Navigation Database: Ensure the GPS navigation database is current. See AFI 11-202V3 for current database restrictions.

6.7. IFR Flight in Uncontrolled Airspace.

6.7.1. Uncontrolled airspace is that airspace not otherwise designated as controlled airspace. There is little uncontrolled airspace within the CONUS. However, once outside the CONUS, there can be significant areas of uncontrolled, or Class G, airspace.

6.7.1.1. FAA controllers will only assign an IFR route through Class G airspace when requested by the pilot.

6.7.1.2. For IFR flights in Class G airspace outside the CONUS, consult the appropriate FLIP AP volume, NOTAMs, and local procedures for any specific instructions unique to each theater, area, country, or airport.

6.7.2. IFR operations are permitted in uncontrolled airspace. All normal IFR equipment requirements and rules apply to include minimum altitude and flight levels.

6.7.2.1. While operating in VMC, pilots are solely responsible to see and avoid other traffic, terrain, and obstacles.

6.7.2.2. While operating under IFR in Class G airspace, pilots must strictly maintain the correct altitude for the direction of flight.

6.7.3. Air traffic control only provides separation between aircraft in controlled airspace. Therefore, caution should be exercised when operating in IMC under IFR in uncontrolled airspace.

6.8. Instrument Approaches to Uncontrolled Airports.

6.8.1. ***Instrument approaches to uncontrolled airports are authorized for USAF aircrews unless otherwise restricted by MAJCOM.*** For VFR procedures at uncontrolled airports, see AFMAN 11-217 Volume 2, *Visual Flight Procedures*.

6.8.2. All operations at uncontrolled airports require additional vigilance on the part of the aircrew. Conducting instrument approaches at uncontrolled airports are especially challenging as the ground track of the instrument approach may not coincide with the ground tracks of the VFR traffic pattern, the instrument approach may not terminate at the active runway, altitudes may not coincide with the prevailing traffic patterns, and not all VFR pilots are familiar with the instrument approach procedures at the airport. Aircrews must thoroughly brief reporting procedures and crew coordination procedures prior to accomplishing an instrument approach at an uncontrolled airport.

6.8.2.1. A critical point to remember is that any person on the ground providing traffic advisories at a non-towered airport is only providing advisories. Personnel on the ground are not air traffic controllers. Pilots operating at uncontrolled airports are responsible for their own traffic avoidance, sequencing, and separation.

6.8.2.2. Pilots conducting actual or practice instrument approaches at uncontrolled airports must be especially vigilant for traffic departing in the opposite direction.

6.8.3. Common Traffic Advisory Frequency (CTAF). The CTAF is a frequency designed for the purpose of carrying out airport advisory practices while operating to or from an airport without an operating control tower. The CTAF may be a UNICOM, MULTICOM, FSS, or tower frequency and is identified on the approach plate.

6.8.3.1. A UNICOM is a non-governmental communication facility, which may provide airport information. The frequency will be published on the approach plate as "UNICOM". Many times these radios are located in the airport office or at a fixed base operator (FBO).

6.8.3.2. A MULTICOM is a mobile service not open to public correspondence used to provide communications essential to conduct the activities being performed by or directed from private aircraft. Where there is no tower, FSS, or UNICOM station on the airport, use MULTICOM frequency 122.9.

6.8.3.3. A FSS physically located on an airport may provide airport advisory service (AAS) at an airport that does not have a control tower or where a tower is operated on a part-time basis and the tower is not in operation.

6.8.3.4. When a control tower is not operational 24 hours a day, the CTAF frequency will normally be the same as the tower frequency listed on the approach plate and will be annotated, "TOWER (CTAF)."

6.8.4. There are two ways for pilots to communicate their intentions and obtain airport/traffic information when operating at an airport that does not have an operating tower: by communicating with an FSS that is providing airport advisories on a CTAF or by making a self-announced broadcast on the CTAF.

6.8.4.1. A FSS provides pilots with wind direction and velocity, favored or designated runway, altimeter setting, known traffic, NOTAMs, airport taxi routes, airport traffic pattern, and instrument approach procedures information. Pilots may receive some or all of these elements depending on the current traffic situation. Some airport managers have specified that under certain wind or other conditions, designated runways are used. Therefore, pilots should advise the FSS of the runway they intend to use. It is important to note that not all aircraft in the vicinity of an airport may be in communication with the FSS.

6.8.4.2. "Self-announce" is a procedure whereby pilots broadcast their position, intended flight activity or ground operation on the designated CTAF. This procedure is used primarily at airports that do not have a control tower or an FSS on the airport. The self-announce procedure should also be used when a pilot is unable to communicate with the local FSS on the designated CTAF.

6.8.5. Communication at Uncontrolled Airports.

6.8.5.1. Aircraft operating on an IFR flight plan, landing at an uncontrolled airport will be advised to "Change to advisory frequency", when direct ATC communications are no longer required. When directed, pilots should expeditiously change to the CTAF frequency, as the ATC facility will not have runway in use or airport traffic information.

6.8.5.2. Inbound aircraft should initiate contact approximately 10 miles from the airport and continue to monitor the appropriate frequency until after landing and clear of the movement area.

6.8.5.2.1. NOTE: If your aircraft only has one radio capable of transmitting on the ATC and CTAF frequency, do not leave the assigned ATC frequency until instructed to do so.

6.8.5.3. Inbounds should report altitude, aircraft type, and location relative to the airport; should indicate whether landing or over flight; and should request airport advisory (if UNICOM or FSS).

6.8.5.4. Make position reports at the following locations on the approach.

6.8.5.4.1. When departing the final approach fix inbound;

6.8.5.4.2. When established on the final approach segment or immediately upon being released by ATC;

6.8.5.4.3. Upon completion or termination of the approach; and

6.8.5.4.4. Upon executing the missed approach procedure.

6.8.5.4.5. When exiting the active runway.

6.8.5.4.5.1. NOTE: It is important to remember that most VFR pilots operating in the vicinity of the airport will not be familiar with fix names. Location should be referred to in the simplest terms the average VFR pilot will understand. For example, use the terminology “5 miles south” instead of “Kirby Intersection”.

6.8.5.5. When self-announcing your position, insure you use the following format:

6.8.5.5.1. Name of the airport, followed by the word “traffic.”

6.8.5.5.2. Your call sign.

6.8.5.5.3. Your aircraft type in terms the average VFR pilot will understand.

6.8.5.5.4. Your location in terms the average VFR pilot will understand.

6.8.5.5.5. Your intentions.

6.8.5.5.6. Repeat the name of the airport.

6.8.5.5.6.1. Example: “Shenandoah traffic, Track 66, white Learjet, 5 miles south on the straight-in ILS Runway 5, touch and go, Shenandoah.”

6.9. Flyability Checks.

6.9.1. Instrument procedure flyability checks are flown to ensure procedures are safe, practical, and consistent with good operating procedures before general use. They may be accomplished in lieu of or in addition to an official flight check. Whenever possible, flyability checks should be conducted by instructor/evaluator pilots. Flyability checks are NOT official flight inspections (“flight checks”), but shall include the entire procedure including the missed approach segment and all holding patterns. ***Prior to accomplishing a***

flyability check, pilots will review applicable portions of AFI 11-230, Instrument Procedures.

6.10. Procedure and Database Problem Reporting.

6.10.1. Despite the best quality control measures, it is still possible for aircrews to discover errors in databases, instrument procedures, charts, etc. If you discover a discrepancy or a discrepancy between two sources (ex. procedure pulled from aircraft database differs from paper IAP), report the discrepancy to your unit Standardization/Evaluation function. They, in turn, should report the details to the source of the database or procedure. All sources of databases, instrument procedures, charts, etc. have established procedures for reporting errors. Procedures and points of contact vary by vendor and organization and are located in the documentation that comes with the particular product.

Chapter 7

IFR DEPARTURE PROCEDURES

7.1. Introduction. In order to understand how to apply Air Force IFR Departure Procedures, it is important to understand that the guidance in AFI 11-202V3 and this chapter is written to maximize Air Force global combat capability. Text in this chapter is a compilation of guidance from previous versions of this manual, the Aeronautical Information Manual, the FAA Instrument Procedures Handbook, the FAA Instrument Flying Manual, AFI 11-230, and other sources. For background and other non-procedural information on TERPS criteria and departure planning, see also AFI 11-230, and AFMAN 11-217V3. For information on VFR departures, see AFMAN 11-217V2.

7.2. IFR Departure Philosophy. To maximize mission capability, and to preserve that capability by preventing mishaps, USAF pilots must be able to safely depart any location on the globe, regardless of non-USAF published weather limitations. All published IFR departure procedures are created using criteria that incorporate either a route and/or a minimum climb profile to avoid terrain, obstacles, or air traffic lanes. In determining the minimum climb profile, TERPS uses a "standard" climb rate of 200 ft/NM, normally beginning at the departure end of the runway (DER). If a gradient other than standard is required it will be published. In civil aviation, pilots may takeoff in good or marginal weather as long as they can "see and avoid" obstacles and terrain. USAF pilots departing IFR may not plan to use "see and avoid" in lieu of complying with published or standard climb gradients since Air Force aircraft are issued their own weather minima in AFI 11-202V3 and AFI 11-2MDSV3. In addition, without comparing the aircraft's performance to a TERPS defined standard, there's no way of ensuring an obstacle could be avoided even if acquired by the pilot in visual conditions. By ensuring the aircraft's climb performance meets or exceeds the published minimum climb gradient, weather (ceiling/visibility) is no longer a limiting factor in AF operations. Further, civil multi-engine fixed wing aircraft are certified as airworthy by demonstrating a certain climb capability with one engine inoperative (OEI). In response to this requirement, most manufacturers of USAF aircraft publish engine-out climb performance charts in the aircraft flight manual. Pilots must be extremely familiar with the performance capability of their aircraft and multi-engine aircraft are normally required to meet climb gradients OEI. These concepts, along with the basic rules listed in AFI 11-202V3, are the foundation of IFR departure operations for USAF pilots:

7.2.1. ***USAF pilots operating under IFR must comply with applicable IFR climb gradients (or Special MAJCOM Certification procedure).*** Exception: If the mission justifies the increased risk, and when specifically authorized by the MAJCOM/A3, USAF aircraft may depart any location, in VMC, without regard to the IFR climb gradient.

7.2.2. ***USAF pilots shall comply with takeoff weather minima IAW AFI 11-202V3 and AFI 11-2MDSV3. Pilots of USAF aircraft will not use FAA or civil takeoff weather minima nor fly "see and avoid" in lieu of IFR climb gradients unless specifically authorized by the MAJCOM/A3 or as provided by AFI 11-202V3***. Information on VFR departures may be found in AFMAN11-217V2.

7.2.3. ***USAF pilots flying under IFR will delay all turns until at least 400 feet above the DER elevation unless an early turn is specifically required by the departure***

procedure. (Reduced Takeoff Runway Length (RTRL) and non-standard weather minimum procedures may require more than 400'.)

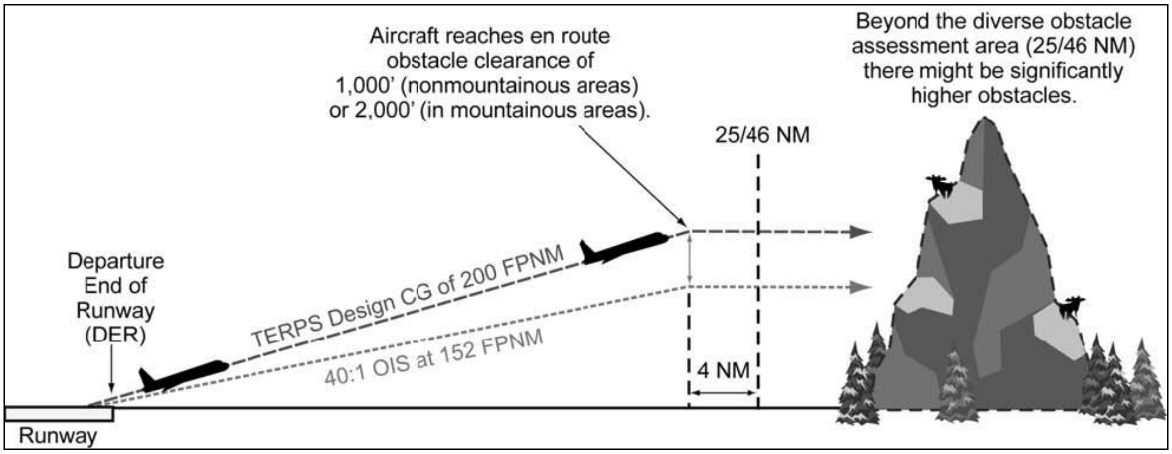
7.2.4. ***USAF pilots will climb at a minimum rate of 200 feet per nautical mile (200 ft/NM) unless a higher gradient is published and must always meet or exceed the minimum/published climb gradient for the runway used with all engines operating.***

7.3. Planning an Instrument Departure. For USAF pilots, planning a safe IFR departure normally consists of three steps: selection of a valid IFR departure method, determining the minimum required climb gradient, and ensuring aircraft performance meets or exceeds that climb gradient. This chapter is organized along that process, and a summary decision tree is provided at the end (Figure 7.23.) It is important to remember that when TERPS constructs an IFR departure, the obstacle avoidance gradients calculated are absolute, and do not assume a loss of thrust on takeoff. FAA and USAF multi-engine aircraft certification requirements, however, do assume a loss of thrust on takeoff. As a result, ***USAF multi-engine aircraft must compute obstacle climb gradients assuming the loss of thrust equal to "one engine inoperative" (OEI).*** Regardless of the type of aircraft flown, on all IFR departures, ***the minimum climb gradient for any IFR departure will be the higher of: 200 ft/NM, as directed by the MAJCOM, as directed by a departure procedure, or as directed by the aircraft flight manual.*** When mission priority dictates, in the absence of more restrictive MAJCOM guidance, an operations supervisor (or equivalent mission execution authority supervisor) may authorize the pilot to reduce the required TERPS climb gradient by up to 48'/NM. (See **Subtraction of 48'/NM from published climb gradient**, later in this chapter, for more procedural guidance on reducing the published required climb gradient.) NOTE: ***USAF pilots must ensure their pre-mission planning includes review of IFR departure restrictions to ensure they do not arrive at, or divert to, a location they are unable to legally depart.***

7.3.1. **Diverse Departure Assessment.** When an instrument approach is constructed, the TERPS specialist determines the need for a departure procedure (DP). If no obstacle or terrain penetrates a 40:1 slope (termed the obstacle clearance surface (OCS) or obstacle identification surface (OIS)) from the departure end of the runway (DER), an aircraft may turn in any direction and remain clear of obstacles while climbing at 200'/NM. That runway has passed a diverse departure assessment (Figure 7.1) and no obstacle departure procedure (ODP) is required.

7.3.1.1. If low, close-in obstacles (published in the ODP section of the approach plate book) penetrate the 40:1 OCS, a diverse departure may still be flown but the pilot must comply with the **Low close-in obstacles** section of this chapter.

Figure 7.1. Diverse Departure Obstacle Assessment to 25 / 46 NM.



7.3.2. **Surrounding Areas.** The pilot must be aware that beyond the diverse departure obstacle assessment area, there may be significant obstacles/terrain that must be avoided. For this reason, ***when planning ANY instrument departure or arrival, pilots must check terrain and obstacle information for areas surrounding the immediate terminal area.*** In many cases, this can be done by checking the MSA/ESA from the IAP or asking the radar controller the height of the minimum vectoring altitude (MVA) for the area of concern (beyond the 25 NM, non-mountainous and 46 NM mountainous diverse departure obstacle assessment area). In other cases, such as non-radar environments, a thorough study of terrain charts, nearby airport IAPs, or IFR enroute charts may provide the pilot with this data in the form of MSAs, ESAs, MCAs, MEAs, MOCAs, etc. Regardless of the departure/arrival method chosen, pilots must be aware of their surroundings, especially in terminal areas.

7.3.3. **Runway End Crossing Height.** Runway End Crossing Height or Screen Height is the aircraft's required AGL altitude at the Departure End of the Runway (DER). The OCS slope begins at the DER at the runway end crossing height. Determining and complying with the proper runway end crossing height is crucial to preventing unsafe operations below the OCS. Runway end crossing heights vary depending on location of the airport, who designed the procedure, terrain, obstacles, etc. The parenthetical notation at the top of DoD approach plates cannot reliably be used to determine what rules were used to produce a departure procedure and screen heights are not consistently published in the ODP section of the approach plates. ***USAF pilots will only consider the type of airfield when determining runway end crossing height: USAF/USN non-joint-use and all others (Civil/Joint Use/ICAO/NATO/etc.) Consult the IFR Supplement or other appropriate FLIP for this information.*** Joint use airfields will be annotated as "MIL/CIV" (Figure 7.2). If an airport is listed as an AFB or NAS and does not include "MIL/CIV" in the listing, then it is non-joint-use.

Figure 7.2. Joint Use Designation From IFR Supplement.

CHARLESTON AFB INTL, SC **KCHS** MIL/CIV N32°53.92' W80°02.43'

7.3.3.1. **USAF/USN non-joint-use bases.** The OCS at USAF and USN bases normally begins at zero feet AGL at the DER, but the OCS may be raised as much as 35 feet in order to clear obstacles. If the TERPS specialist raises the OCS, it will be published in the ODP (Figure 7.3.) ***At non-joint-use USAF or USN bases, assume a zero foot runway end crossing height unless a higher altitude is published.***

Figure 7.3. Specific Runway End Crossing Height.

KEY WEST NAS(BOCA CHICA FLD) (KNQX)
KEY WEST, FL. 07214
Rwy 3, obstacle identification surface begins 25' above DER. Diverse departures authorized between 028° CCW to 216°. Left turn to departure heading only.
Rwy 7, obstacle identification surface begins 20' above DER.

7.3.3.2. **Other than USAF/USN non-joint-use bases (Civil/ICAO/NATO/etc.)** If civil aircraft certification standards mandate, or obstacles penetrate the OCS, TERPS may raise the runway end crossing height up to 35 feet to maintain a normal 200'/NM climb gradient. There is no reliable way, from looking at the DoD/NACO FLIP, to know if TERPS raised the OCS or not. ***Therefore, for any departure at other than non-joint-use USAF or USN bases, if the screen height is not published in the ODP or other reliable source, pilots will plan to cross the DER at or above 35 feet.***

7.3.3.2.1. There is no provision for a runway end crossing height greater than 35 feet. If a runway end crossing height of 35 feet does not eliminate all penetrations of the 40:1 OCS, then a higher than standard (i.e. >200 ft/NM) climb gradient will be published on the departure.

7.3.3.2.2. If in doubt, or the 35 foot restriction limits mission capability, contact the appropriate TERPS authority for the airfield. If further help is required, contact the USAF Instrument Procedures Center at DSN 339-8300 Comm. (405) 739-8300.

7.3.4. **Obstacle Clearance Surface.** When the diverse departure obstacle assessment identifies any obstacle that penetrates the 40:1 OCS, the TERPS specialist must construct an ODP to allow safe aircraft departure. The 40:1 slope used by the TERPS specialist equates to a 152'/NM gradient. During the assessment, the TERPS specialist is required to provide a minimum of 48'/NM or 24% obstacle clearance (Required Obstacle Clearance or ROC) to obtain the normal minimum climb gradient of 200'/NM. If obstacles penetrate the 152'/NM OCS, then the TERPS specialist should publish information so the pilot can make a safe takeoff and avoid obstacles and terrain. This information is normally found in the front of the IAP book in the section titled "IFR Takeoff Minima and (Obstacle) Departure Procedures." For airports outside the US, the separate listing will be titled "IFR Takeoff Minima and Departure Procedures" in the DoD/NACO FLIP. Commercial or foreign government products may differ in title and format. For example, Jeppesen charts do not use the "Trouble T" symbol. Instead, they publish IFR takeoff minima and departure procedures on the back of the airfield diagram page. ***USAF pilots must become familiar with, and refer to the appropriate of available instrument procedures, in order to properly plan IFR departure procedures.***

7.3.5. **Low close-in obstacles** (Figure 7.4) are those that would generate an excessive climb gradient (>200 ft/NM) that terminates at or below 200 feet above the departure end of the runway. Instead of publishing a steep climb gradient or complicated routing, the TERPS specialist will publish the height and location of the obstacles (this information can also appear in NOTAMS). Low close-in obstacles must be accounted for no matter what IFR departure method a pilot chooses. ***Pilots will calculate their aircraft performance to ensure they can vertically clear applicable low close-in obstacles on all departures.*** One technique for determining what obstacles are applicable might be to consider all within 500 feet, laterally, of the planned departure (or emergency return) ground track. Additionally, in order to ensure vertical clearance of those obstacles (valid only for low-close in takeoff obstacles) compare the aircraft's calculated height at the obstacle's distance from liftoff to the height of the offending obstacle. Pilots may conclude after careful analysis of low close-in obstacles that a safe IFR departure cannot be made. In this case, select an alternate departure runway or ground track, or consult your MAJCOM for guidance.

Figure 7.4. Low Close-in Obstacles.

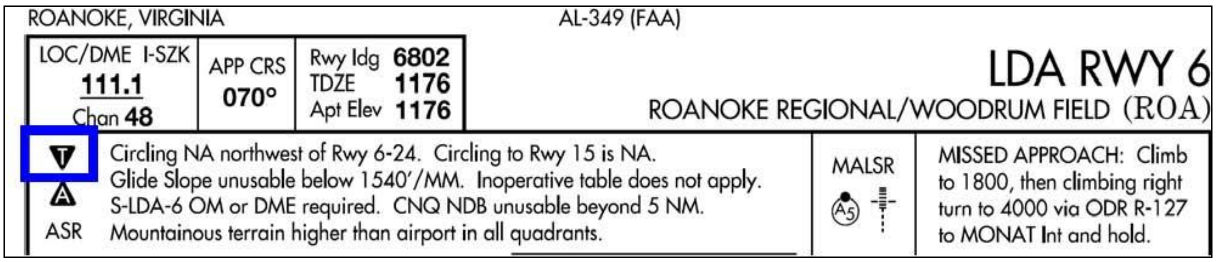
AMARILLO, TX
RICK HUSBAND AMARILLO INTL
DEPARTURE PROCEDURE: **Rwy 22,** climb heading 218° to 4100 before turning northbound. **Rwy 31,** climbing right turn heading 360° to 5400 before turning westbound.
NOTE: **Rwy 31,** sign 23' from departure end of runway, 257' right of centerline, 6' AGL/3605' MSL.

7.4. IFR Departure Procedures (DP). There are two types of DPs: Obstacle Departure Procedures (ODP), printed either textually or graphically, and Standard Instrument Departures (SID), always printed graphically. In many cases, there is more than one departure procedure applicable to a given runway. ***If the pilot does not know in advance which procedure will be assigned by ATC, he or she must plan for the highest climb gradient for the runway of intended departure***. All DPs, either textual or graphic may be designed using either conventional or RNAV criteria. RNAV procedures will have RNAV printed in the title, e.g., SHEAD TWO DEPARTURE (RNAV). The following sections define the valid IFR departure procedures listed in AFI 11-202V3.

7.4.1. **Obstacle Departure Procedures (ODP)**. ODPs include routings, Low Close-in Obstacles, Visual Climb Over the Airport (VCOA), Reduced Takeoff Runway Length (RTRL) procedures and Sector Departures. If TERPS determines that, for a specific runway, a climb gradient greater than 200'/NM is required to clear obstacles, the pilot must be notified and provided a safe obstacle departure procedure. This provision may take the form of listing low close-in obstacles, or the publishing of: non-standard takeoff weather minima, minimum climb gradients, specific routing, or some combination of these criteria. ***Pilots must comply with ODPs prior to commencing a SID or radar vector departure unless different procedures and minima are specified on the SID or issued with the departure clearance.*** When departing an airport and pilot compliance with the ODP is necessary for traffic separation, ATC must include the ODP in your ATC clearance. Example: "Depart via the Vandenberg Runway 32 Departure Procedure."

7.4.1.1. **ODP Notification**. On U.S. Government produced instrument procedures, the pilot is notified that runway specific departure information exists by the placement of a special symbol on all of the IAPs and SIDs for the airport. (Figure 7.5.) The symbol is a white "T" on a black inverted triangle (▼), referred to by some as the "Trouble T" because it indicates potential trouble for departing aircraft. This "Trouble T" should be published in the upper left corner of Volpe-format approach plates, but may be printed elsewhere on the IAP—for this reason, pilots should carefully check for the "Trouble T" on every instrument procedure for that airfield. The presence of the "Trouble T" means IFR takeoff minima and departure procedures are prescribed for specific airports/runways. ***USAF pilots will comply with applicable departure procedures.***

Figure 7.5. "Trouble T".



7.4.1.1.1. **Non-Standard Takeoff Weather Minima.** (Figure 7.6.) When obstacles penetrate the 40:1 OCS, non-standard takeoff weather minima are provided for commercial civil pilots to "see-and-avoid" obstacles during departure. ***Unless specifically authorized by the MAJCOM/A3, USAF aircraft are not authorized to flight plan using "see and avoid" operations in lieu of meeting standard or published climb gradients. USAF pilots may only use non-standard weather minima for takeoff if aircraft performance (if multi-engine, OEI) will allow the aircraft to climb to the non-standard ceiling requirement by the DER and comply with published (or standard if none published) climb gradient requirements thereafter to an appropriate IFR altitude.*** In the example in Figure 7.6., the pilot must climb to 500' AGL by the DER in order to takeoff under IFR from either Runway at Orangeburg. For situational awareness purposes, the visibility portion of the non-standard weather minima provides a clue to the proximity of the obstacle(s). The lower the required visibility, the closer the obstacle(s).

Figure 7.6. Non-Standard Weather Minima.

7.4.1.1.2. **Aircraft Category.** Occasionally, a departure procedure will be published that is specific to a certain category of aircraft. (Figure 7.7.) ***On procedures that specify an aircraft category, use the aircraft approach category from the aircraft flight manual or AFI 11-2MDSV3 to determine which procedure(s) to apply.***

Figure 7.7. ODP Specific to Aircraft Category.

GALLUP, NM
GALLUP MUNI
TAKE-OFF MINIMUMS: **Rwy 6,** CAT A,B 1300-2 or std. with a min. climb of 300' per NM until passing 8000. CAT C,D 1600-3 or std. with a min. climb of 320' per NM until passing 8500. **Rwy 24,** 700-2 or std. with a min. climb of 370' per NM until passing 8000.
DEPARTURE PROCEDURE: **Rwy 6**, turn left.
All aircraft climb direct GUP VORTAC. Departures via GUP R-190 CW R-242 climb on course. Departures via GUP R-243 CW R-189 climb in GUP holding pattern (SW, right turns, 047° inbound) to cross GUP at or above 9000.

7.4.1.1.3. **Minimum Climb Gradient.** (Figure 7.8.) TERPS may provide a minimum climb gradient with or without takeoff weather minima. Some non-standard takeoff weather minima may have an asterisk (*) referring to a note that lists a specific climb gradient that may be used with standard weather minima. ***When using this type of IFR departure, USAF pilots will substitute MAJCOM-directed takeoff weather minima in place of the word "standard."***

Figure 7.8. Minimum Climb Gradient In Lieu of Non-Standard Weather Minima.

SIMMONS AAF (KFBG)
FORT BRAGG, NC
…………**Rwy 27**, 900-1*
*Standard with minimum climb of 250/NM to 1000'.

7.4.1.1.3.1. Occasionally, the terrain or obstacles surrounding an airport are such that the TERPS specialist has no choice but to restrict departures to weather suitable for see-and-avoid operations. In Figure 7.9. below, notice that BOTH non-standard weather minima AND a minimum climb gradient are specified. In this example, to depart IFR from Runway 7 at Eagle County Regional, a USAF pilot must be able to (if multi-engine, OEI) either: climb to 5100' AGL by the departure end of the runway in any weather down to MAJCOM minima, and continue the climb at 200'/NM thereafter, OR climb to 700' AGL by the departure end of the runway, then climb at 480'/NM to 11,800 MSL, then climb at 200'/NM thereafter.

Figure 7.9. Non-Standard takeoff minima AND a required climb gradient:

EAGLE COUNTY RGNL
TAKE-OFF MINIMUMS: **Rwy 7,** 5100-3, or 700-2 with a min. climb of 480' per NM to 11800. **Rwy 25,** 5400-3 or 1300-2 with a min. climb of 750' per NM to 10500.

7.4.1.1.4. **Specific Routing.** (Figure 7.10.) Another ODP method used by TERPS provides a specific route of flight. You must be careful when using this type of IFR departure as a requirement may exist to use non-standard takeoff weather minima in order to execute the procedure. This situation could indicate more than one obstacle along the departure path and would not be allowed unless you comply with paragraph 7.4.1.1.3.1. Pilots must comply with the assigned routing to be assured of obstacle clearance during a Specific Routing departure.

Figure 7.10. ODP with specific routing.

ROANOKE, VA
ROANOKE REGIONAL/WOODRUM FIELD
TAKE-OFF MINIMUMS: **Rwys 6, 33** NA-obstacles.
DEPARTURE PROCEDURE: **Rwy 15,** climb runway heading to intercept the ROA VORTAC R-122 to 4000 before proceeding on course.
Rwy 24, use DIXXY DEPARTURE.

7.4.1.1.5. **Combination ODP.** In Figure 7.11. the TERPS specialist used a combination of the above methods to delineate a safe departure. In this example, the pilot must comply with each requirement: the routing dictated by the procedure along with any required climb gradient.

Figure 7.11. Combination of Methods.

RICHMOND, VA
CHESTERFIELD COUNTY
TAKE-OFF MINIMUMS: **Rwy 15,** 800-1 or std. with a min. climb of 280' per NM to 1200'. **Rwy 33,** 1200-1, or std. with min. climb of 220' per NM to 1700.
DEPARTURE PROCEDURE: **Rwy 15,** climb runway heading to 1200' before proceeding on course. **Rwy 33,** climb runway heading to 1700' before proceeding on course.

7.4.1.2. **Visual Climb Over the Airport (VCOA)** is an ODP that requires a climb in visual conditions over the airfield or an on-airport NAVAID to an altitude where the aircraft enters the standard obstacle protection area of the ODP. (VCOAs may also be termed as Visual Climb to Instrument Departure and abbreviated as either VCTID or

VCID.) The standard 200'/NM climb gradient applies while flying the VCOA as do low close-in obstacles, if listed. While this departure is an authorized ODP, ***USAF pilots must complete MAJCOM- developed, MDS-specific training before flying VCOA departures. Except for MAJCOM- approved NVD trained and equipped aircrew, USAF pilots will not fly VCOA procedures at night.***

7.4.1.2.1. VCOAs are developed when obstacles that are more than 3 SM from the DER require a climb gradient in excess of 200'/NM. A VCOA procedure is indicated by the words "climb in visual conditions" directly associated with a ceiling and visibility in the TAKEOFF MINIMA section of the ODP and either by a specific VCOA listing or "climb in visual conditions" in the DEPARTURE PROCEDURE section of the ODP. NOTE: There are procedures that include the verbiage "climb in visual conditions" that do not include a ceiling and visibility. These are not considered VCOA procedures.

7.4.1.2.2. To properly execute a VCOA, in the absence of more specific MAJCOM guidance***, climb at a minimum of 200'/NM, visually avoid obstacles and terrain, remain within the published distance (or published visibility substituted for distance) from the geographic center of the airfield and climb above the published ceiling. Continue to climb to the IFR enroute altitude at a minimum of 200'/NM after the VCOA procedure.*** If the VCOA does not also include departure procedure instructions at the climb-to altitude, the aircraft can safely proceed on course while maintaining a standard climb gradient to the IFR enroute altitude. USAF pilots are prohibited from constructing their own VCOA by using circling approach minima or applying circling approach obstacle clearance standards to a VCOA.

7.4.1.2.2.1. In the example below (Figure 7.12.), a pilot departing from runway 19 must remain within 3 SM of the center of Stevens Field and visually avoiding any obstacles while climbing to 1900' AGL, then turn southbound over the field continuing the climb to 9400' MSL at 200'/NM, then via the DRO 066° radial towards DRO VOR/DME. Obviously, this is a complex maneuver that requires a thorough study of the airfield and surroundings as well as significant pre-departure planning for safe accomplishment. It is also worth noting that some obstacles may be inside the visibility radius and, due to the nature of "prevailing visibility," may not be continuously visible during the maneuver. Pilots must maintain constant situational awareness throughout the maneuver to preclude an unsafe position in relation to any obstacles within the VCOA maneuver area.

Figure 7.12. Visual Climb Over the Airport (VCOA) Procedure.

PAGOSA SPRINGS, CO
STEVENS FIELD (PSO)
TAKE-OFF MINIMUMS: ....**Rwy 19,** std. w/ min. climb of 296' per NM to 9300', or $\boxed{\text{1900-3 for climb in visual conditions.}}$
DEPARTURE PROCEDURE: ....Rwy 19, climb via heading 194° to intercept DRO VOR/DME R-075 to DRO VOR/DME....for climb in visual conditions cross Stevens Field airport south bound at or above 9400 MSL, then via DRO VOR/DME R-066 to DRO VOR/DME.....

7.4.1.2.3. TERPS specialists construct VCOAs assuming an airspeed of 250 KIAS and a bank angle of 23 degrees unless a different airspeed is published. A bank angle of 30 degrees is recommended to remain within the published visibility radius. The geographic center of the airfield is not a precisely defined point on any published diagram and must be estimated based on the layout of the runways. It is important to remember that ***USAF pilots must not exceed the published distance (or visibility requirement substituted as a distance) until above the altitude specified in the procedure.*** Aircraft turn radius at climbout speed, or aircraft flight manual takeoff procedures, may render this procedure unusable.

7.4.1.2.4. Pilots must be aware that while the VCOA may require a certain prevailing visibility in order to fly the procedure, this only accounts for half of the visibility around the airfield. There is no guarantee that the visibility in the area of the controlling obstacle will be great enough to see the obstacle. Thorough pre-departure planning and MAJCOM training are critical to safe VCOA operations.

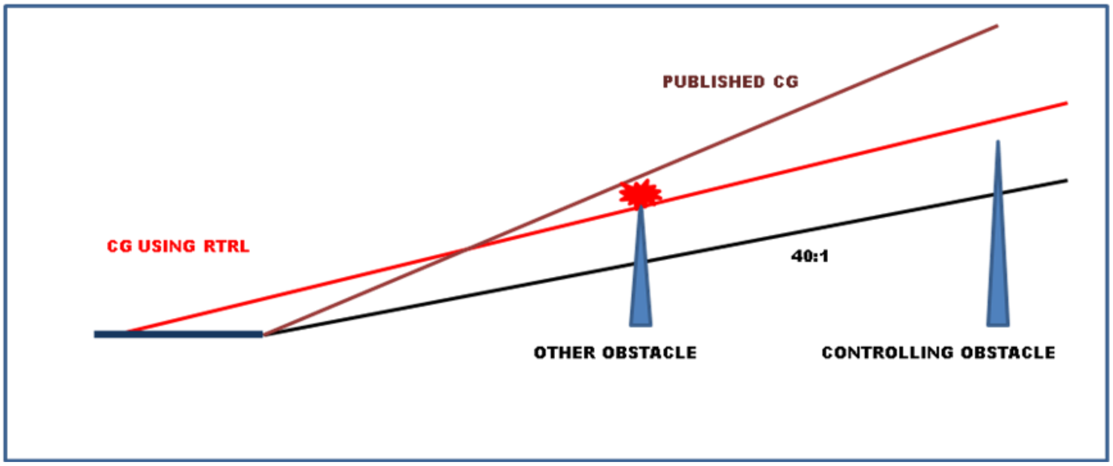
7.4.1.2.5. The VCOA climb area is not necessarily devoid of obstacles. The pilot is still responsible for visually acquiring and avoiding obstacles while executing the VCOA procedure.

7.4.1.3. **Reduced Takeoff Runway Length Procedure.** This procedure was formerly known as "limiting takeoff runway available" (TORA). The TERPS specialist may find that by artificially limiting the takeoff length of the runway, a normal climb gradient may avoid obstacles that penetrate an OCS that begins at the DER (Figure 7.13.) ***USAF pilots shall only use an RTRL procedure if it is published as an ODP in FLIP.*** An RTRL procedure produces a zero screen height and therefore a lower climb gradient by requiring the aircraft to lift off the runway at or prior to a specified distance from the DER. Pilots must check takeoff and landing data (TOLD) carefully when planning this type of departure. In the example below, subtract the value in the RTRL procedure from the usable runway length to determine the "reduced runway length." Compare your aircraft's "takeoff ground run" or "takeoff distance" value to the new reduced runway length. If the reduced length is equal to or greater than your aircraft's calculated "ground run", the procedure may be flown using a standard climb gradient of 200'/NM. Since the TERPS specialist has access to much more obstacle and terrain data than a pilot, and because adjusting the lift-off point may produce a new controlling obstacle (Figure 7.14.), ***USAF pilots are prohibited from creating their own RTRL procedure.***

Figure 7.13. RTRL Procedure.

HOBBS, NM
LEA COUNTY RGNL
TAKE-OFF MINIMUMS: **Rwy 8,** std. w/ a min. climb of 218' per NM to 4300' or alternatively, with standard takeoff minimums and a normal 200' per NM climb gradient, takeoff must occur no later than 1600' prior to the departure end of the runway.

Figure 7.14. RTRL Changing Controlling Obstacle.



7.4.2. **Sector Departures.** (Figure 7.15) Published "sector" diverse departures (i.e. "Diverse Departure authorized 145° CW to 278° with min climb gradient of…) are authorized as an ODP. ***Pilots must ensure that they can meet or exceed any published climb gradient for the departure to be flown.***

Figure 7.15. Sector Diverse Departure.

CHINA LAKE NAWS (ARMITAGE FLD)(KNID)
RIDGECREST, CA 07130
Rwy 3, 8, Diverse departure not authorized.
Rwy 14, Diverse departures authorized 071° to 141° CW with minimum civil climb of 450'/NM to 6900, minimum military climb of 390'/NM to 6300. 141° to 211° CW with minimum civil climb of 310'/NM to 5400, minimum military climb of 290'/NM to 5100.

7.4.3. **Standard Instrument Departure (SID).** A SID is a departure procedure in graphic and/or textual form established at certain airports to simplify clearance delivery procedures, and assist in meeting environmental, capacity, and air traffic control requirements. SIDs may be requested by specific ATC facilities, the military services, or other proponents to enhance operations. SIDs also provide protection from obstacles and are depicted graphically; however, they will not contain the "(OBSTACLE)" designation following the procedure title on the chart, and may not be flown unless approved by ATC. A heavy black line on the graphic version depicts the SID; thin black lines on the graphic version show transition routings. The departure route description should be complete enough that the pilot can fly the SID without the graphic depiction. If a higher than standard climb gradient is required, it will be published on the SID.

7.4.3.1. At locations where SIDs exist, expect an ATC clearance containing a SID. If unable to utilize a SID for departure, inform ATC by putting "NO SID" in the remarks section of the flight plan or as soon as possible by direct communication.

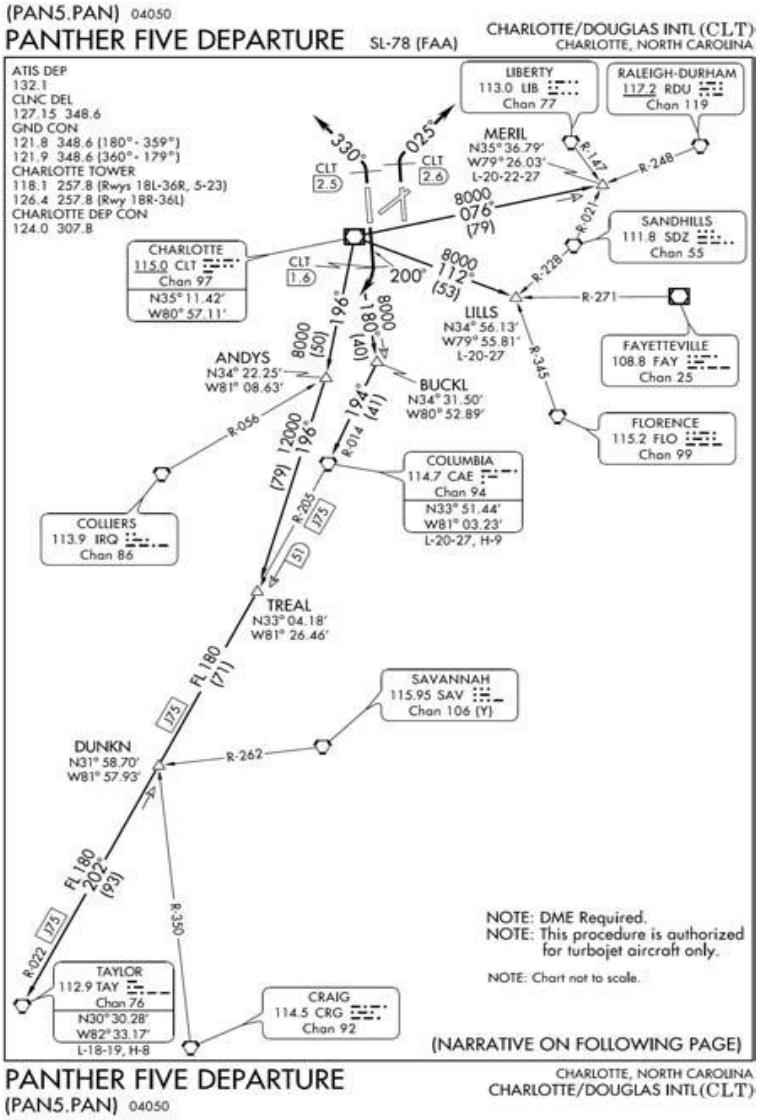
7.4.3.2. SIDs constructed by either military or civilian specialists are designed using either conventional or RNAV criteria. Though both military and civil SIDs are constructed using very similar rules, there are some minor differences in how they display information to the pilot. Both civil and military SIDs may include crossing restrictions necessary for ATC and/or obstacle clearance but the reason for the crossing restriction, whether for ATC or obstacles, will not be published. Additionally, SIDs are published in two formats. In the USAF these are termed pilot navigation SIDs and vector SIDs.

7.4.3.2.1. **Military SIDS** are USAF/USN SIDs in the CONUS. Military SIDs provide climb rate information in a slightly different way than civil SIDS. Both, if required, will provide a table of higher than standard climb rates on the graphic depiction. Obstacle clearance climb rates will be denoted with an asterisk (*) while ATC climb rates will be denoted with a dagger (†). Military SIDs will have some obstacles charted to scale, where civil SIDs will not.

7.4.3.2.2. **Civil SIDs** do not depict obstacles graphically but list low, close-in obstacles textually. Obstacle climb gradients may be published directly on the SID or, in the case of a , in the ODP procedure. Civil SID climb rate tables are either due to obstacles or will be labeled "ATC Climb Rate." Army SIDs are produced by the FAA in the CONUS and should be treated as civil SIDs.

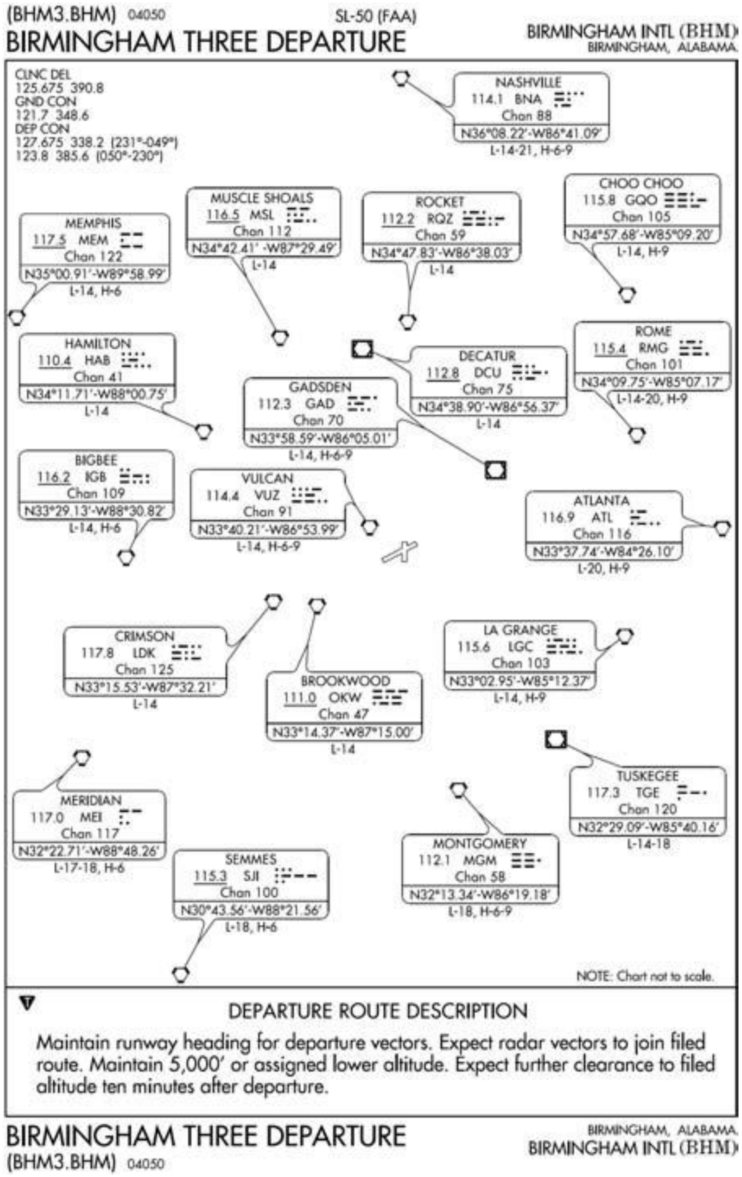
7.4.3.2.3. **Pilot Navigation (NAV) SIDs.** (Figure 7.16) The pilot is responsible for following the SID routing. These SIDs are established for airports when terrain and safety related factors indicate the necessity for a Pilot NAV SID. Some Pilot NAV SIDs may contain vector instructions which pilots are expected to comply with until instructed to resume normal navigation on the filed/assigned route or SID procedure. Pilot NAV SIDs normally have a graphic depiction of the departure routing (thick black lines) followed by transition routing (thin black lines). Multiple routings from multiple runways may be depicted on the same SID.

Figure 7.16. Pilot-Nav SID.



7.4.3.2.4. **Vector SIDs.** (Figure 7.17) Vector SIDs are established where ATC will provide radar navigational guidance to a filed/assigned route or to a fix depicted on the SID. Typically, a vector SID will depict only area navaids or fixes with some simple textual departure instructions*.* ***As on all SIDs, pilots will comply with the ODP, if published for that runway, prior to accepting radar vectors, unless otherwise directed by ATC.***

Figure 7.17. Vector SID.



7.4.3.3. **Climb Rate Chart Usage.** The climb rates published on military SIDs give vertical velocities for given groundspeeds. The easiest way to use this information is to look at the 60 knot column. Using the 60 to 1 rule, 60 knots is 1 NM/min so the vertical velocity for this speed provides the required obstacle climb gradient in ft/NM. (If there is no 60 knot block, simply divide the 120 knot block by 2, the 180 knot block by 3, etc.) (Tech order climb profiles still apply.)

7.4.3.4. **How to Fly a SID.** If an airfield has a published SID for the expected departure runway, pilots may file the SID IAW FLIP GP. Review SIDs for textual instructions that give precise guidance on how to interpret and fly the graphic version of the SID (if included).

7.4.3.4.1. **SID Altitudes/Climb Gradients.** In your initial clearance, ATC will normally assign an altitude to climb and maintain. In some cases, your initial altitude will be published on the SID. In others, the altitude issued with your IFR clearance may be higher than restriction(s) on the SID. ***In all cases, you must comply with the SID restrictions. While flying a SID, if published, use the SID climb gradient.*** The memory aid "SID's stand alone" may assist in remembering which climb gradient to apply. (It is still critical, however, to reference the ODP when a ▼ appears on the approach plate as it may apply prior to joining the SID routing.) ***Pilots must notify ATC immediately if they cannot meet the published climb gradient or, if one is not published, a minimum of 200 ft/nm on each segment of the SID up to the MEA.*** If you are radar vectored or cleared off an assigned SID, you may consider the SID cancelled unless the controller adds "Expect to resume SID." If ATC reinstates the SID and wishes any restrictions associated with the SID to still apply, the controller will state: "Comply with restrictions."

7.4.3.4.2. Amended Clearances. ATC may amend your clearance at any time. It is important to remember that the most recent ATC clearance takes precedence over all others. When the route or altitude in a previously issued clearance is amended, the controller will restate applicable altitude restrictions. In the United States if the altitude to maintain is changed or restated, whether prior to departure or while airborne, and previously issued altitude restrictions are omitted, those altitude restrictions are canceled, including SID/DP/STAR altitude restrictions. ***Pilots must ensure minimum climb gradients for obstacle clearance are still met.***

7.4.3.5. **Equipment Requirements.** DPs (SIDs and ODPs) are further delineated by equipment requirements as follows:

7.4.3.5.1. **Non-RNAV DP.** A DP established for aircraft equipped with conventional avionics using ground-based NAVAIDs; e.g., non-directional beacon (NDB), very high frequency omni-directional range (VOR), VHF omni-directional range/tactical air navigation (VORTAC), localizer (LOC), etc. These DPs may also be designed using dead reckoning navigation.

7.4.3.5.2. **RNAV DP.** A DP established for aircraft equipped with RNAV avionics; e.g., global positioning system (GPS), FMS, etc. Automated vertical navigation must not be required. All RNAV procedures not requiring GPS must be annotated with the note: "RADAR REQUIRED."

7.4.3.5.3. **Radar DP.** Radar may be used for navigation guidance for SID design. Radar SIDs are established when ATC has a need to vector aircraft on departure to a particular ATS Route, NAVAID, or Fix. Radar vectors may also be used to join conventional or RNAV navigation SIDs. SIDs requiring radar vectors must be annotated "RADAR REQUIRED."

7.4.4. **Specific ATC Departure Instructions.** Specific ATC departure instructions include a heading and an altitude. Though a controller assumes shared responsibility for terrain and obstacle clearance once he or she begins to provide navigational guidance, ultimate responsibility always rests with the pilot. ***When told to "fly runway heading," do not apply wind drift corrections.***

7.4.4.1. If the departure instructions do not contain a climb gradient and there are no published gradients for the runway utilized for departure, pilots are required to maintain

200 ft/NM. Controllers are required to issue climb gradients in excess of 200ft/NM with the departure instructions. If terrain or obstacles in the direction of departure appear to require a higher than standard climb gradient or if your specific departure instructions conflict with information published in an ODP, query the controller. ***Except in a Diverse Vector Area (DVA), USAF pilots must fly the ODP prior to the departure instructions.*** However, as a pilot there is nothing to inform you that you are in a DVA. Therefore, if the airport has a "Trouble T" and the departure instructions seem to conflict with the ODP or there is any question about which procedure to fly, query the controller for clarification.

7.4.4.2. **Definition of DVA:** That area, in a radar environment, in which a prescribed departure route is not required to avoid obstacles, and radar vectors may be issued below the minimum vectoring altitude/minimum IFR altitude (established in accordance with the TERPS criteria for diverse departures, obstacles and terrain avoidance) to departing aircraft. When a DVA is developed, the standard climb gradient required is 200'/NM. ATC controllers in the US are required to issue the climb gradient for the DVA in the IFR clearance to the aircrew if it is greater than 200' /NM.

7.4.5. **Diverse Departures (ICAO: Omni-Directional Departures).** If no obstacles (other than low, close-in obstacles) penetrate the 40:1 Obstacle Clearance Surface (OCS) for a particular runway, then a minimum climb gradient of 200'/NM will ensure proper obstacle clearance. If a runway does not have a published DP and does not have an ODP in the IFR Takeoff Minimums and Departure Procedures section of FLIP specifically stating, "Diverse Departure Not Authorized" (Figure 7.19.), then a diverse departure is an acceptable IFR departure procedure for that runway (Figure 7.18.) A diverse departure allows the pilot to execute a turn in any direction from the runway and remain clear of obstacles. There is no special way to file a diverse departure; simply list a fix or NAVAID as the first point on the route of flight IAW FLIP GP. ***To fly a diverse departure, fly the extended runway centerline ground track until 400 feet above DER elevation before executing any turns. Maintain a minimum climb gradient of 200'/NM until reaching a minimum IFR altitude.***

Figure 7.18. Diverse Departure Authorized *(for Runway 10 ONLY!).*

HUNTER AAF (KSVN)
SAVANNAH, GA
………**Rwy 28**, 300-1*
*Or standard with minimum climb of 340 per NM to 400. **Rwy 28**, climbing left turn hdg 230° to 1700 before proceeding on course.

7.4.5.1. ATC will not specifically clear you for a diverse departure. Do not mistake the words "cleared as filed" as clearance for a diverse departure. This is only the case if the required climb gradient is 200'/NM or less and there is no ODP published for the departure runway. ***If there is an ODP for the departure runway, USAF pilots will fly the ODP before beginning the "cleared as filed" portion of the departure.***

7.4.5.2. There are airports around the world where a diverse departure obstacle assessment has not been performed or completed to US TERPS standards. At these airports, a diverse departure may not be authorized for certain runways. The pilot should be notified via NOTAM, or in the case of DoD/NACO FLIP books, by a statement in the front of the book under the section titled, "IFR Takeoff Minima and (Obstacle) Departure Procedures." The statement will say, "Diverse Departure Not Authorized." (Figure 7.19.) Commercial or foreign government products may not follow this convention.

Figure 7.19. Diverse Departure Not Authorized.

OCEANA NAS (KNTU) VIRGINIA BEACH, VA Diverse Departure not Authorized.

7.4.5.3. When a diverse departure is not authorized, it indicates penetration of the 40:1 OCS and there should be at least one SID or IFR Departure Procedure published for that airport. However, this is not always true in DoD FLIP. There are cases where a commercial or host nation procedure will contain a climb gradient not annotated in DoD FLIP. Consequently, where diverse departures are not authorized, absence of a SID or IFR Departure Procedures does NOT indicate a radar departure with a 200'/NM climb gradient is appropriate. ***Therefore, if there is no SID or IFR Departure Procedure AND diverse departures are NOT authorized, coordination with MAJCOM TERPS specialists is required to determine the best departure method and required climb gradient prior to an IFR departure*.** MAJCOM TERPS will assist in coordinating a solution with the agency responsible for the airfield's airspace.

7.4.6. **Special MAJCOM Certification.** At specific airfields, MAJCOMs may develop their own takeoff procedures for use by specific aircraft and MAJCOM-trained and/or certified aircrews under specific conditions. Since these special certifications by definition do not provide an equivalent level of safety as conventional departure procedures, their construction and use must be validated with an Operational Risk Management assessment to operate from that airfield under those conditions. Once developed, MAJCOMs will provide a copy to HQ AFFSA A3OF for review. HQ AFFSA A3OF will keep a copy of the procedure on file for reference.

7.5. Reducing Required Climb Gradients. As previously covered, USAF aircraft must meet or exceed published climb gradients. If multi-engine, fixed-wing aircraft must calculate this climb performance assuming a loss of thrust equal to "one engine inoperative" (OEI) in accordance with the aircraft's certification requirements. ***Mission tasking authorities and pilots will plan missions so that their aircraft always meet or exceed published IFR climb restrictions.*** However, there are instances (e.g. contingency, humanitarian relief, etc.) when the mission dictates an aircraft depart a location with less than the required/published OEI climb performance. In these cases, the only other option may be to use a pre-planned OEI "escape" route or reduce the required climb gradient. WARNING: It is important to remember that in such an instance, if the aircraft experiences a loss of thrust, no safety margin exists and the aircraft will almost certainly impact terrain and/or obstacles, especially if the departure is flown at night or in IMC. While this is always true for single-engine aircraft, aircraft certification requirements normally mitigate this risk for multi-engine aircraft. Use of any method to reduce the required climb gradient eliminates the safety factors designed into the TERPS departure procedure and the aircraft's airworthiness certification. ***When using any method to reduce the required climb gradient, the PIC must still ensure the aircraft, with all engines operating***

(AEO), meets or exceeds the published climb gradient and all ATC or SID climb restrictions for the method selected.

7.5.1. **Methods to reduce required climb gradients.** Delaying a mission until environmental conditions (temperature, pressure altitude, winds, etc.) or mission requirements (fuel load required, stores, cargo load, etc.) allow compliance with the required climb gradient is the safest option. IAW AFI 11-202V3, operations supervisors (or equivalent mission execution authority supervisor) may reduce the required climb gradient by the ROC safety margin. Another method to reduce the required IFR climb gradient is to use a special emergency-use-only procedure termed "Special Departure Procedure" (SDP).

7.5.1.1. **Subtraction of 48'/NM from published climb gradient.** (Requires operations supervisor or equivalent mission execution authority supervisor approval.) If there is no SDP for the departure runway, the only other approved method to reduce the required climb gradient is to subtract 48'/NM from the published minimum climb gradient. In Figure 7.20. the resultant climb gradient the pilot must comply with is 322'/NM to 1700' MSL (370 – 48 = 322).

Figure 7.20. Subtracting 48'/NM.

HUTCHINSON, KS
HUTCHINSON MUNI
TAKE-OFF MINIMUMS: **Rwys 4, 22**, 300-1 or std. with a min. climb of 370' per NM to 1700'.
DEPARTURE PROCEDURE: All Rwys, eastbound departures (030° CW 130°) climb runway heading to 3300' before turning.

7.5.1.2. **Special Departure Procedure (SDP)** (Figure 7.22.) SDPs are MDS-specific, commercially designed and published procedures, that require MAJCOM training and certification before use. SDPs are especially useful for multi-engine aircraft, as the procedure often increases the allowable takeoff gross weight while simultaneously providing the pilot an "escape" routing he or she can use in the event the aircraft loses thrust on takeoff. One example (Figure 7.21.) at Albuquerque Int'l Sunport, reveals that a takeoff on Runway 8 commands an excessive climb gradient (515'/NM). A comparison with Figure 7.22. shows the SDP for runway 8 at KABQ gives maximum gross weights and temperatures which, if adhered to, allow the multi-engine aircraft to depart Rwy 8 without meeting the 515'/NM climb gradient OEI. Notice the SDP routing differs from the ODP routing. ***USAF pilots shall fly SDP routing that differs from ATC routing only in an emergency.***

Figure 7.21. KABQ Normal Obstacle Departure Procedures.

ALBUQUERQUE, NM (Not for Navigation)

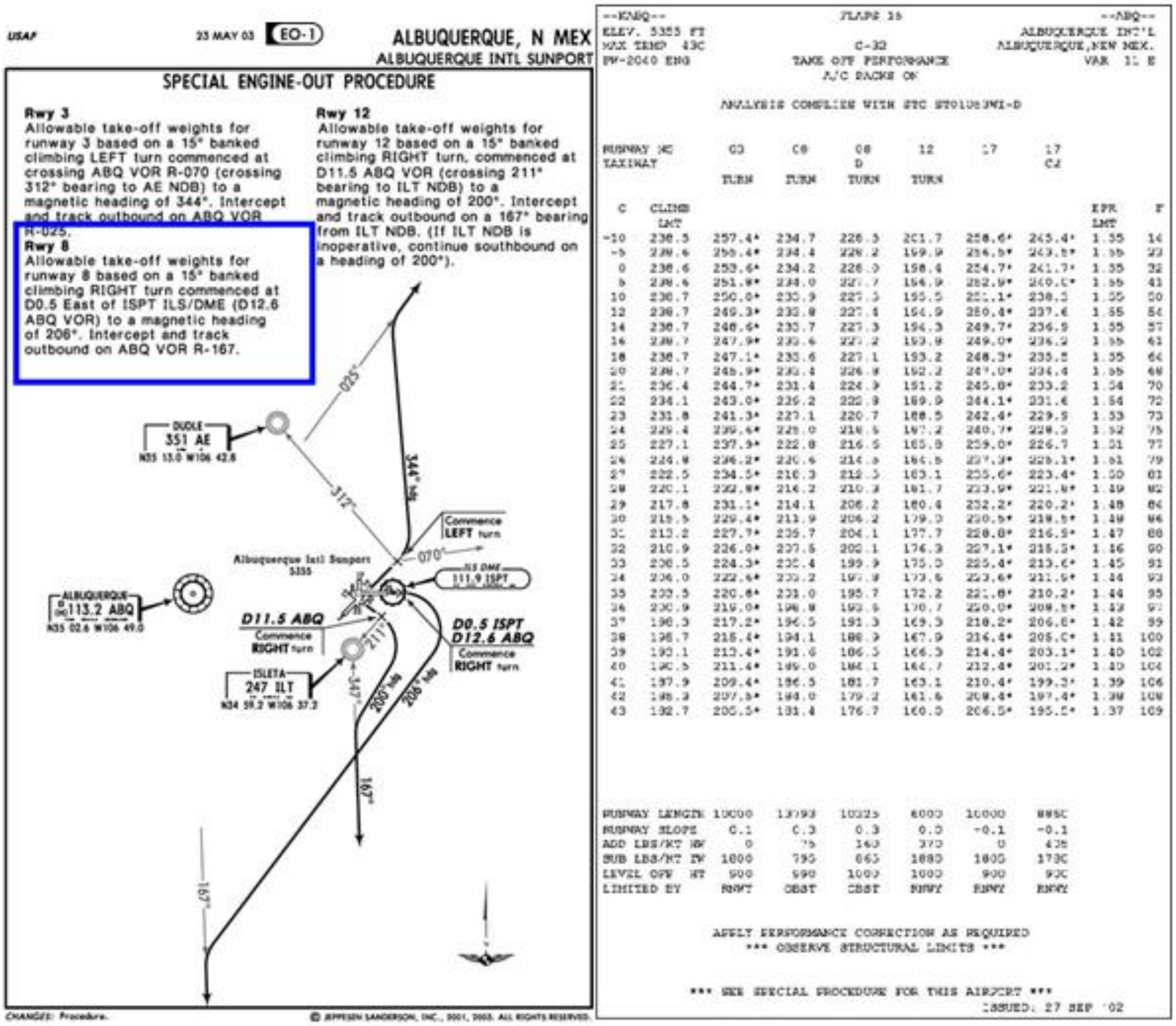
ALBUQUERQUE INTL SUNPORT (ABQ)

TAKE-OFF MINIMUMS: **Rwy 8,** std. w/ min. climb of 515' per NM to 7800'.

DEPARTURE PROCEDURE: **Rwy 8,** climbing right turn direct ABQ VORTAC. If required, continue climb in ABQ VORTAC holding pattern (hold west, left turn, 077° inbound) to cross ABQ VORTAC at or above MEA/MCA for route of flight. (Do not exceed 250 kts until ABQ VORTAC.)

7.5.1.2.1. If the mission justifies the increased risk, and the aircraft cannot meet or exceed the published climb gradient, and a current SDP exists for your aircraft and departure runway, consider using that SDP for departure planning. MAJCOMS may authorize SDP use when operationally necessary. Proper use of the SDP for OEI departure planning requires careful preflight review of the procedure. If flying the filed or cleared routing and an engine failure occurs, the pilot must be ready to immediately transition to the SDP routing and climb profile. This preflight review must also recognize that at a certain point, transition to the SDP may not be feasible (e.g. a turn during the departure takes the aircraft away from the SDP ground track.) ***MAJCOMs must train and certify their pilots prior to use of an SDP.*** Training will include detailed information about SDPs from the OpsData User's Guide. This guide is available from the vendor at **https://www.jeppesen.com/main/shared/account/login.jsp**. Once logged in, under Support select Support Center and click on the User Guide link under the OpsData User Guide section.

Figure 7.22. KABQ Special Departure Procedure.



7.6. RNAV Departure Procedures (Figure 7 23). RNAV Departure Procedures take advantage of RNAV system capabilities to provide more accurate and reliable position information than traditional NAVAID-based systems.

7.6.1. Levels of service. All public RNAV SIDs and graphic ODPs are RNAV 1 which require the aircraft's total system error remain bounded by +/- 1 NM for 95% of the total flight time.

7.6.2. Leg types. RNAV Departure Procedures contain many different leg types: Direct to Fix (DF), Heading to Altitude (VA), Track to Fix (TF), etc.

7.6.3. Waypoint types. RNAV DPs may contain both Flyover and Flyby waypoints.

7.6.3.1. A fly-by waypoint is used when an aircraft should begin a turn to the next course prior to reaching the waypoint connecting the two route segments.

7.6.3.2. Fly-over waypoints are used when the aircraft must fly over the point prior to starting a turn. Fly-over waypoints are normally depicted as a circled waypoint symbol.

7.6.4. Flying RNAV Departure Procedures. In order to fly RNAV DPs, the following conditions must be met:

7.6.4.1. Aircraft equipment must meet requirements specified on the DP.

7.6.4.2. Aircraft RNAV system must meet appropriate certification standards as addressed in AFI 11-202V3.

7.6.4.3. ***Procedure must be retrieved in its entirety from a current, approved navigation database. Waypoint and waypoint type (e.g., flyby, flyover) may not be modified.***

7.6.4.4. ***Pilots must double check all waypoint names, waypoint type (flyby vs. flyover), altitude, and airspeed information from the database against information listed on the paper copy of the terminal procedure. Should differences between the approach chart and database arise, the published approach chart, supplemented by NOTAMs, holds precedence. Users may not alter terminal procedures retrieved from the equipment database.***

7.6.4.5. ***If GPS is used, RAIM must be available to execute the procedure. Terminal (or better) RAIM must be available.***

7.6.4.6. ***Pilots must set CDI sensitivity, either manually or automatically, at terminal (+/-1nm, full scale deflection). For FMS equipped aircraft without the capability of manually setting the CDI, the departure must be flown with a flight director.***

7.6.4.7. The system must either provide RAIM alerts based on terminal criteria or the pilot must be able to monitor actual navigation performance (ANP).

7.6.4.7.1. NOTE: Terminal RAIM for departure may not be available unless the waypoints are part of the active flight plan.

7.6.4.7.2. NOTE: Actual Navigation Performance (ANP) is a technical term that describes the navigation accuracy of the system. Other terms synonymous with ANP are Figure of Merit, Estimation of Position Uncertainty, or Quality Factor.

7.6.4.8. ***Monitor ground-based NAVAIDS that are part of the basic procedure as required by aircraft specific flight manuals.***

7.6.4.9. There are conventional DPs (RNAV and/or GPS does not appear in title of procedure) published in FLIP that are retrievable from selected aircraft navigation databases. These DPs may be flown using the FMS as the primary means of navigation as long as the FMS is FAA AC 90-100A (or equivalent) compliant. USAF aircraft are authorized to fly these procedures in IMC provided it is retrieved from the database and ground-based NAVAIDS are installed, operational, tuned, and monitored.

7.6.4.9.1. ***Aircrews must verify the information in the database with the published DP. The maximum allowable difference between the database course(s) and published course(s) is ±5° and distances must be within 0.1 nm.***

7.6.4.9.2. In some cases, because of the software programming, there can be tracking inaccuracies when flying non-RNAV/FMS DPs using an FMS. These tracking inaccuracies have resulted in less-than-required air traffic control separation and air traffic control intervention to prevent a possible Controlled Flight Into Terrain (CFIT) accident. Non-RNAV/FMS procedures often require navigational tracking over all the specified fixes. Many FMS databases code the points in these procedures as Fly-By waypoints, instead of Fly-Over waypoints. Unlike an RNAV DP, which will specify on the printed FLIP which waypoints are Fly-By and which are Fly-Over, a conventional DP will not make this distinction. Consequently, the FMS will lead the turn on these points. This turn anticipation could result in a turn being started miles prior to the expected turn point depending on the amount of required track change, wind, and true airspeed. ***When verifying waypoints prior to flying a non-RNAV/FMS DP using an FMS, aircrews must determine how the points are coded (Fly-By vs. Fly-Over) in their database. If there are large course changes coded as Fly-By waypoints, the aircrew must be prepared to manually intervene to ensure the aircraft tracks the procedure as published to remain within protected airspace. This is permissible, as this is not altering the waypoints retrieved from the database; it is insuring the navigation system properly executes the procedure.***

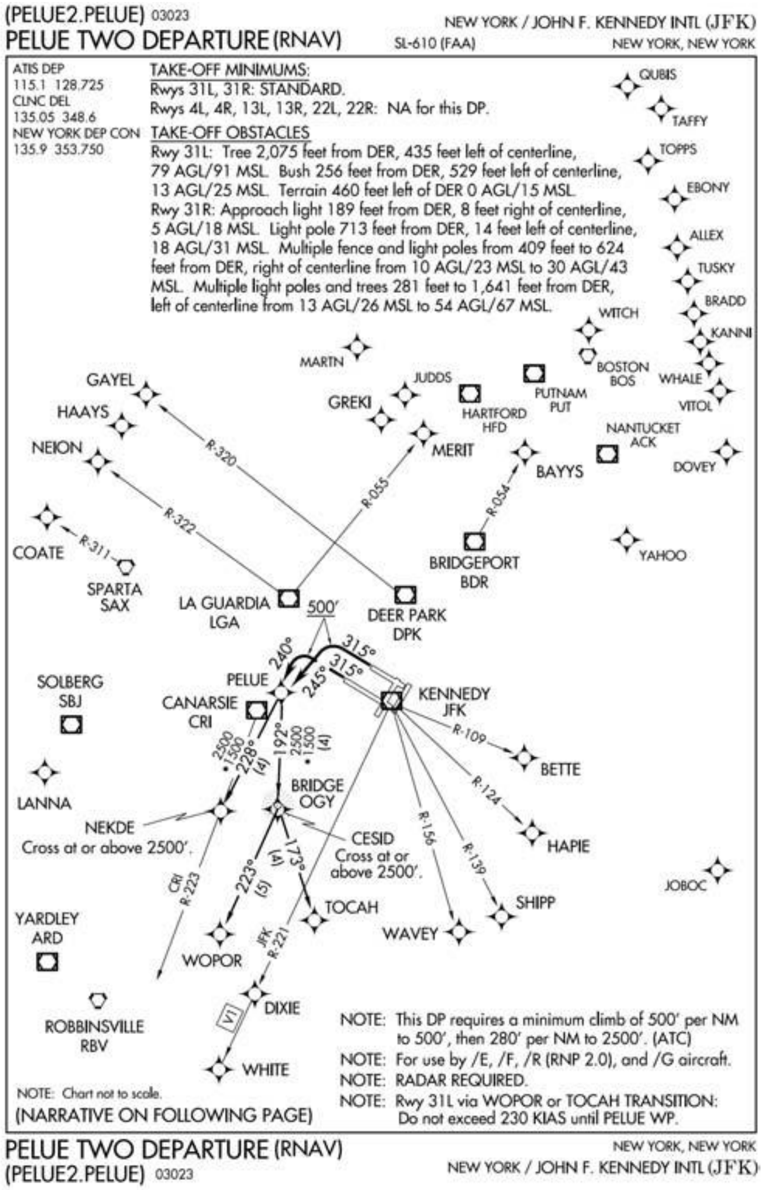
7.6.4.9.3. Certain segments of a DP may require some manual data input by the pilot, especially when radar vectored to a course or required to intercept a specific course to a waypoint. This is permissible, as this is not altering the waypoints retrieved from the database; it is ensuring the navigation system can comply with ATC instructions. The database also may not contain all of the transitions or departures from all runways and some GPS receivers do not contain DPs in the database.

7.6.4.9.4. ***Helicopter-only GPS departure procedures are to be flown at 70 knots or less since turning areas and segment lengths are based on this speed.***

7.6.4.10. Manually selecting aircraft bank limiting functions may reduce the aircraft's ability to maintain its desired track and are not recommended. Pilots should recognize manually selectable aircraft bank-limiting functions might reduce their ability to satisfy ATC path expectations, especially when executing large angle turns. This should not be construed as a requirement to deviate from Airplane Flight Manual procedures; rather, pilots should limit the selection of such functions within accepted procedures.

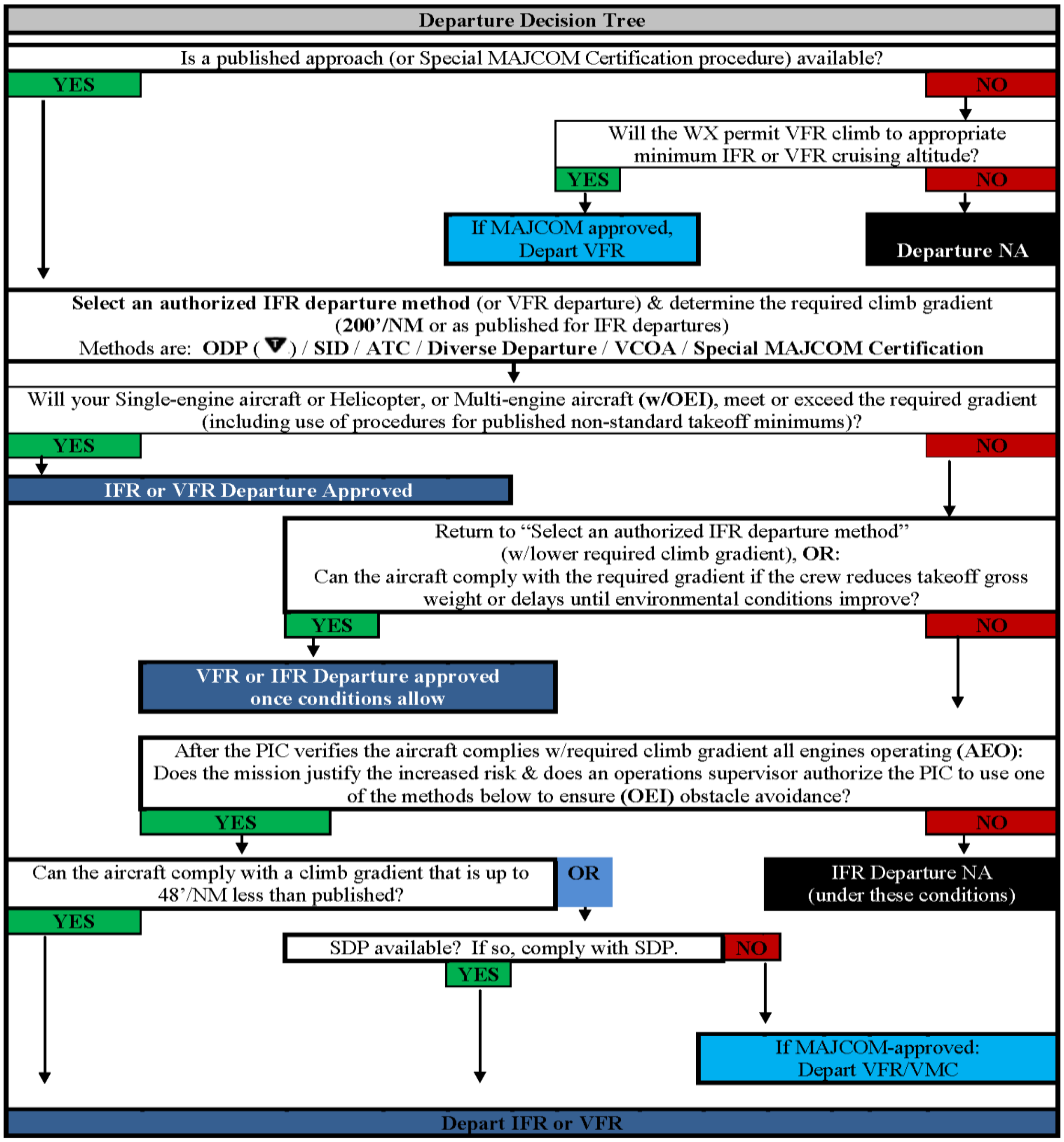
7.6.4.11. RNAV Off-the-Ground Phraseology. At certain large commercial airports (i.e., CLT, DFW and ATL), the FAA is evaluating new phraseology for SIDs from parallel runways. The evaluation may result in system-wide implementation in the future. The phraseology, to be issued with the takeoff clearance, requires aircrew action to validate correct programming of runway and departure in the Flight Management System (FMS) prior to takeoff. Pilots are expected to associate the instruction with the flight path to their planned route of flight. Pilots can expect a takeoff clearance from ATC that will provide instructions to depart the runway either via an RNAV path or via an assigned heading to be maintained. An RNAV path takeoff clearance will direct aircraft to fly the required RNAV path to the initial waypoint on the SID in the ATC clearance. A typical takeoff clearance will state, for example, "REACH 55, RNAV to GIRGY, Runway 18C, Cleared for takeoff". After verifying that the correct runway and departure are loaded and that the correct lateral navigation mode is available and ready for use after takeoff, the expected pilot response is, "REACH 55, RNAV to GIRGY, Runway 18C, Cleared for takeoff". ***All read-backs must be verbatim. Pilots must immediately advise ATC if unable to comply with the RNAV SID or if a different RNAV SID is entered in the aircraft FMS.*** If the takeoff clearance does not match the planned/loaded procedure, either request an initial heading from tower or refuse the takeoff clearance until the discrepancy is resolved. Unless ATC has issued a heading to fly in place of the off-the-ground phraseology, engage lateral navigation flight guidance as soon as practical and fly the departure precisely. Strict compliance with the lateral and vertical tracks is imperative.

Figure 7.23. RNAV DP.



7.7. Decision Tree For Departures. The Departure Decision Tree (Figure 7.24) is an aid to ensure compliance with both IFR and VFR departure rules. It is important to remember that climb gradients must be taken into account when departing any airfield under any rules. Airfields with a published approach have undergone a TERPS review and obstacle assessment. So, although this chapter is specific to IFR departure procedures, it is worth noting that a climb gradient check must also be done in order to depart VFR. Hence, Figure 7.24 applies to both IFR and VFR departures. Bottom line: Even when VFR flight is an option, pilots must be aware of climb gradients, and if OEI aircraft performance makes a successful departure doubtful, then the decision to depart and the method used should be scrutinized at the proper risk mitigation level, which may be unit leadership, or as high as the MAJCOM staff.

Figure 7.24. Departure Decision Tree.



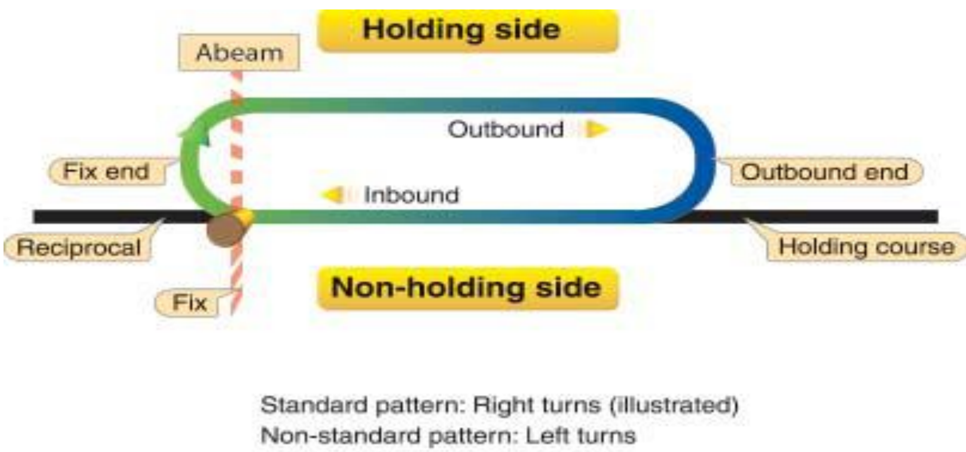
Chapter 8

HOLDING

8.1. Definition.

8.1.1. Basic. Holding is maneuvering an aircraft in relation to a navigation fix while awaiting further clearance. The standard no-wind holding pattern is flown by following a specified holding course inbound to the holding fix, making a 180° turn to the right, flying a heading outbound to parallel the holding course, and making another 180° turn to the right to intercept and follow the holding course to the fix (Figure 8.1). The holding pattern is nonstandard when the turns are made to the left. ***Unless otherwise instructed by ATC, pilots are expected to hold in a standard pattern***. The standard no-wind length of the inbound leg of the holding pattern is 1 minute when holding at or below 14,000 feet MSL and 1½ minutes when holding above 14,000 feet MSL. DME holding patterns specify the outbound leg length. If holding at a DME fix without specified outbound leg length, use timing procedures listed above.

Figure 8.1. Holding Pattern.



8.1.2. Course Guidance. Holding patterns have inbound course guidance provided by a VOR, TACAN, NDB, localizer, or RNAV/GPS. While in holding, the localizer signal is the most accurate method of determining aircraft position. However, if a VOR, TACAN or NDB also defines the holding pattern, it's the pilot's option as to which NAVAID to use.

8.1.2.1. NOTE: AFMAN 11-226 (TERPS), states that the use of TACAN station passage as a fix is not acceptable for holding fixes (regardless of altitude) or high altitude initial approach fixes (those IAFs which are at or above FL180). This restriction is driven by the TACAN fix error involved in station passage. ***Therefore, if the aircraft is TACAN-only equipped, do not hold directly over a TACAN or VORTAC facility or plan to use these facilities as high altitude IAFs. TACAN station passage can be used to identify an IAF below FL180 regardless of whether the approach is published as a Low or High altitude approach.***

8.2. Holding Instruction.

8.2.1. Charted Holding Patterns. ATC clearances requiring holding where holding patterns are charted, include the following instructions:

8.2.1.1. Direction. Direction of holding from the fix.

8.2.1.2. Holding fix. The name of the holding fix.

8.2.1.3. Expect Further Clearance. ATC is responsible to issue an Expect Further Clearance Time (EFC) based on the best estimate of any additional enroute/terminal delays. Pilots should request an EFC any time they are directed to hold without one.

8.2.1.3.1. Example: "Cleared to NIGEL, hold east as published, expect further clearance at 1645Z, time now 1635Z."

8.2.1.3.1.1. NOTE: AIM describes "charted" holding patterns as "those holding patterns depicted on U.S. government or commercially produced (meeting FAA requirements) low/high altitude enroute, and area or STAR charts." Although the AIM and GP do not specifically mention the use of published holding patterns depicted on instrument approach procedures, in day-to-day operations they are used frequently. If the controller clears you to "hold as published" using a holding pattern published on an approach plate, make sure you are holding in the correct pattern. In some situations, there may be more than one published holding pattern at the same fix. (See Figure 8.2) If there is any doubt about your clearance, query the controller. 8.2.2. Non-charted Holding Patterns. If ATC clears you to hold in a non-charted holding pattern, they will provide you with the following information:

8.2.2.1. Direction. Direction of holding from the fix.

8.2.2.2. Holding fix. The holding fix.

8.2.2.3. Holding course. Radial, course, bearing, airway, or route on which the aircraft is to hold.

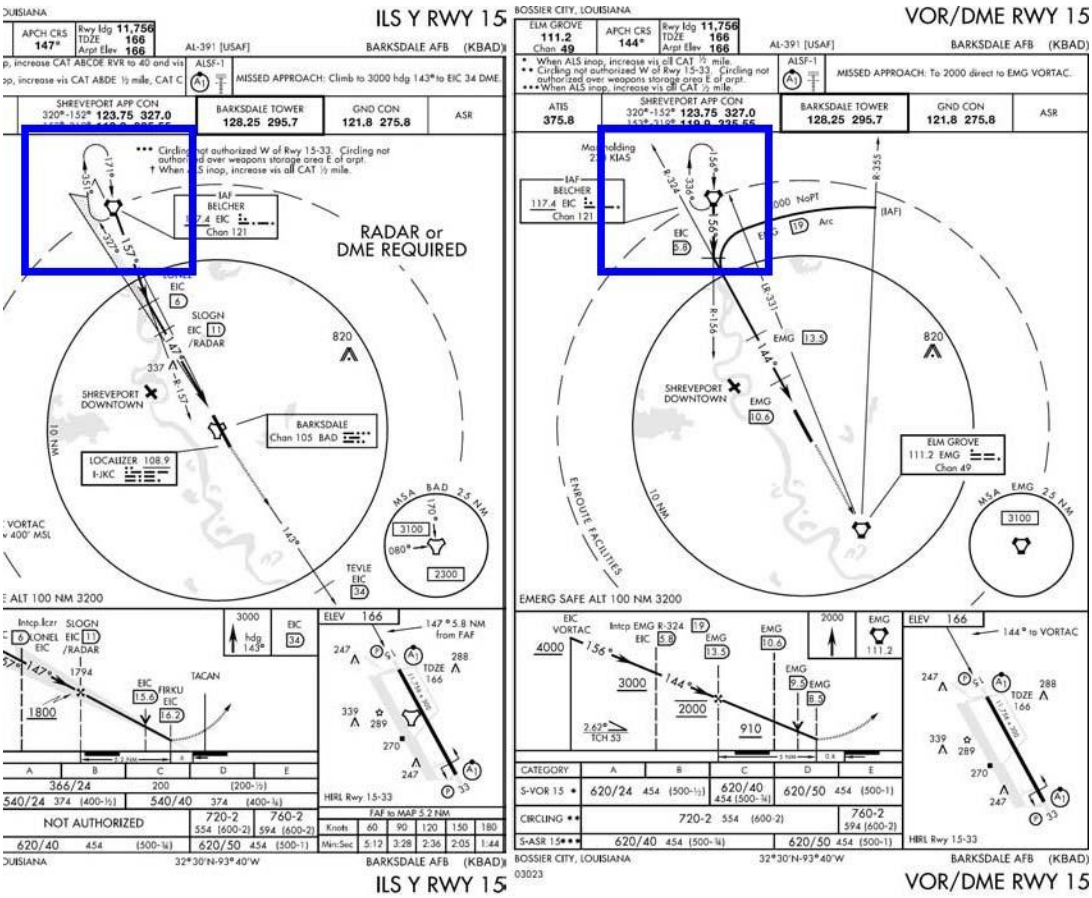
8.2.2.4. Leg length. Outbound leg length in miles, if DME or RNAV is to be used.

8.2.2.5. Direction of turn. Left turns, if nonstandard.

8.2.2.6. Expect Further Clearance. Time to expect further clearance and any pertinent additional delay information.

8.2.2.6.1. Example: Hold Northwest of the 106 radial, 40 DME fix, 10-mile legs, left turns. Expect further clearance at 1725Z, time now 1710Z.

Figure 8.2. Charted Holding Pattern.



8.2.3. Clearance Limit. ATC should issue holding instructions at least 5 minutes before reaching a clearance limit fix. When an aircraft is 3 minutes or less from a clearance limit and a clearance beyond the fix has not been received, the pilot is expected to start a speed reduction so that ***the aircraft will cross the fix at or below the maximum holding airspeed. If holding instructions have not been received upon arrival at the fix, hold in accordance with procedures in FLIP. For two-way radio failure holding procedures, refer to the FIH.***

8.2.4. Maximum Holding Speeds. Maximum holding airspeeds are defined by TERPS and have nothing to do with the holding speed specified in the aircraft flight manual. Holding speeds in the aircraft flight manual are typically minimum speeds that correspond to a maximum endurance speed. ***Do not exceed the maximum holding airspeeds listed below.*** (Table 8.1) ATC may be able to approve holding speeds in excess of these maximums, if aircraft performance considerations require. Adherence to the maximum speeds shown below, or the published maximum holding speed, whichever is lower, will ensure you remain within protected airspace. For ICAO holding airspeeds, refer to Chapter 17.

Table 8.1. Maximum Holding Airspeeds.

ALTITUDE (MSL)	Maximum Speed
MHA through 6,000’	200 KIAS
Above 6,000’ through	230 KIAS

14,000’	
Above 14,000’	265 KIAS

8.2.4.1. NOTE: At USAF airfields, the maximum holding airspeed is 310 KIAS unless otherwise noted. At USN airfields, the maximum holding airspeed is 230 KIAS unless otherwise noted.

8.3. Holding Pattern Procedures.

8.3.1. *Holding Procedure.* The angular difference between the inbound holding course and the heading at initial holding fix passage determines the direction of turn to enter the holding pattern. Holding pattern sizes can vary greatly depending on the altitude of the holding pattern, primary aircraft the procedure was designed for, and other factors. Pilots have no way of knowing the design limits of protected airspace for a particular holding pattern.

8.3.2. Established in Holding. You are considered established in the holding pattern upon initial passage of the holding fix.

8.3.3. Bank Angle. ***Unless correcting for known winds, make all turns during entry and while holding at: 3 degrees per second, or 30 degree bank angle, or bank angle commanded by the flight director system, whichever requires the least bank angle. The bank angle on the entry turn may be varied (up to 30 degrees maximum) to obtain the desired displacement in the holding pattern.***

8.3.4. Entry Turns. There are a number of techniques to enter holding which should keep you within holding airspace. Although any technique may be used to enter holding, using the commonly accepted ones described below will keep you within holding airspace and insure your actions are predictable to the air traffic controller. Therefore, it is recommended that you use one of the described techniques.

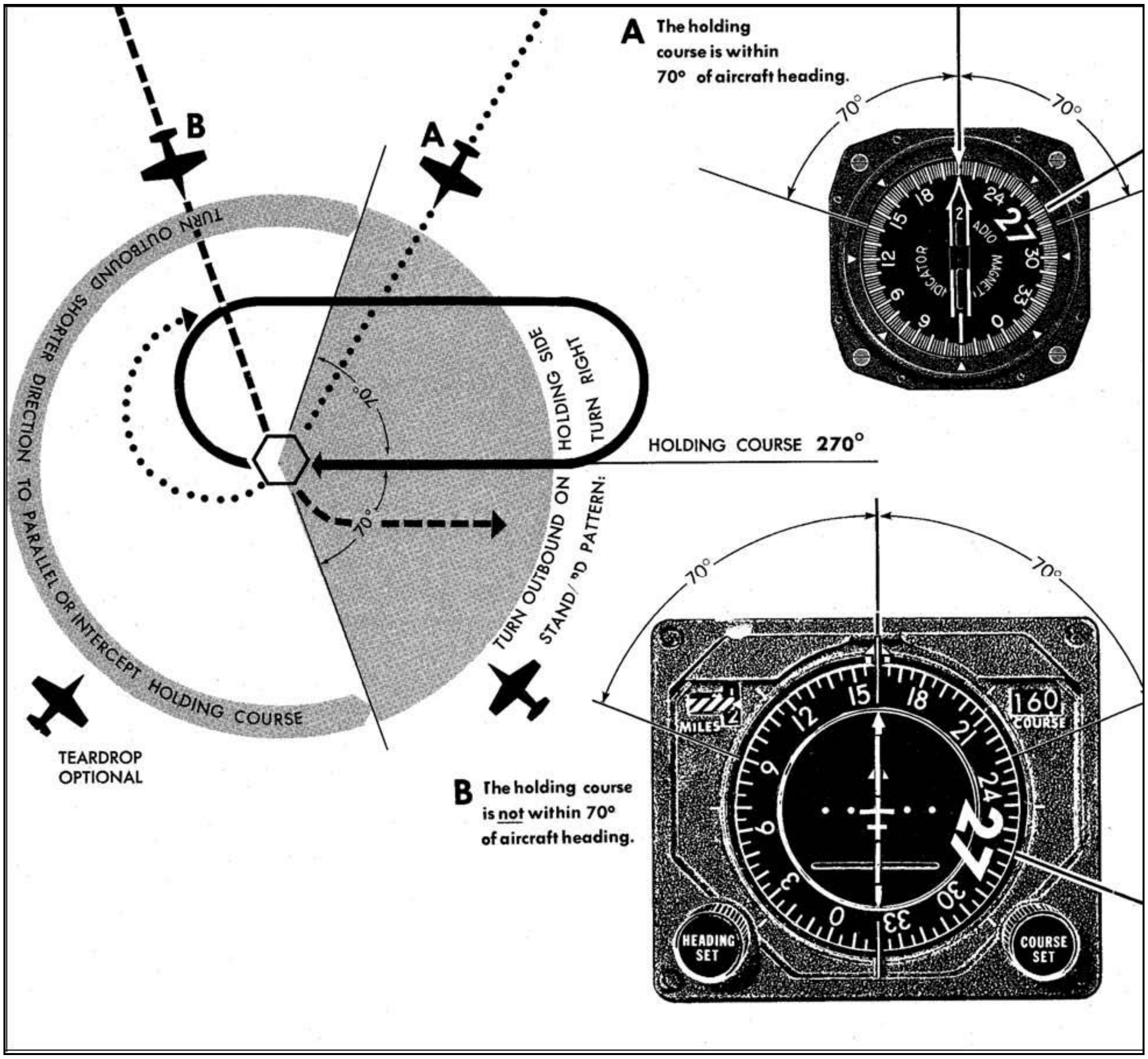
8.3.4.1. Technique A (“70 Degree Method” Figure 8.3):

8.3.4.1.1. Within 70°. If the inbound holding course is within 70° of the aircraft heading, turn outbound in the direction of holding and onto the holding side (direct entry) Upon completion of the outbound leg, proceed direct or intercept the holding course to the fix.

8.3.4.1.2. Not within 70°. If the inbound holding course is not within 70° of the aircraft heading, turn outbound in the shorter direction to parallel the holding course. If this turn places you on the non-holding side, either parallel (adjust for wind) or attempt to intercept the holding course inbound. If you are on the non-holding side or on the holding course at the completion of the outbound leg, turn toward the holding side, then proceed direct or intercept the holding course to the fix.

8.3.4.1.3. Teardrop. The teardrop entry may be used at pilot discretion when entering holding on a heading conveniently aligned with the selected teardrop course. As a guide, consider yourself conveniently aligned when your aircraft heading is within 45° of the selected teardrop course. Upon reaching the holding fix, turn on the holding side and proceed on an outbound track not to exceed 45° from the outbound course. (Depending on your offset requirements, a teardrop course of less than 45° may be desired.) If course guidance is available, attempt to intercept the selected teardrop course outbound. Upon completion of the outbound teardrop course/heading, turn toward the holding course to intercept the holding course inbound.

Figure 8.3. 70 degree Method.



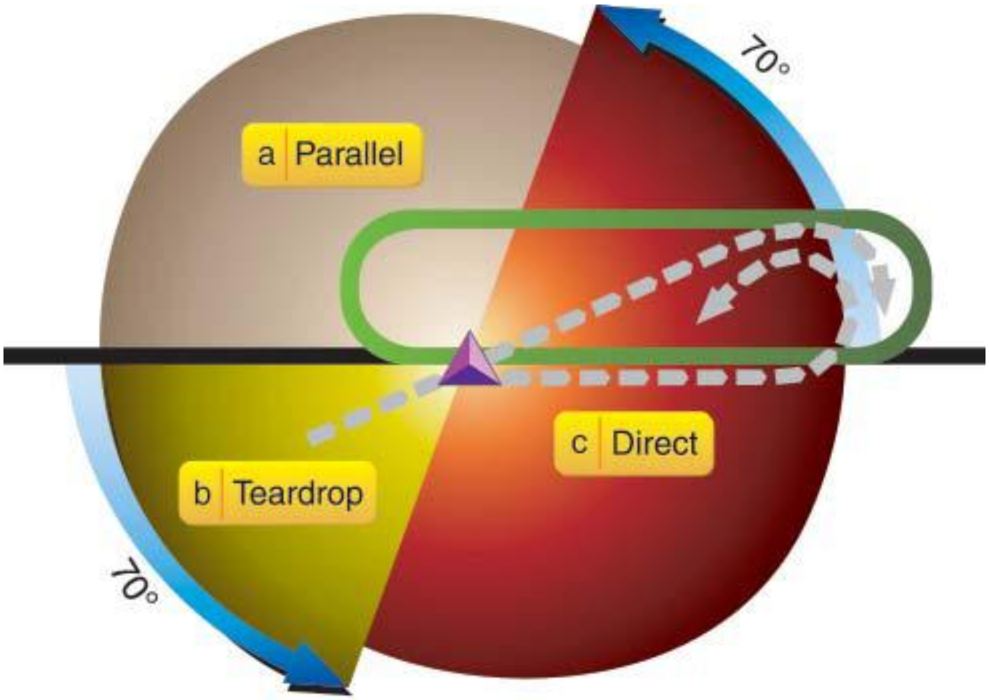
8.3.4.2. Technique B ("AIM Method"): Enter the holding pattern based on your heading (±5°) relative to the three entry sectors depicted in Figure 8.4. Upon reaching the holding fix, follow the appropriate procedure for your entry sector:

8.3.4.2.1. Sector A (Parallel). Turn to a heading to parallel the holding course outbound for the appropriate time or distance, then turn towards the holding side and return to the holding fix or intercept the holding course inbound.

8.3.4.2.2. Sector B (Teardrop). Turn outbound to a heading for a 30-degree teardrop entry (on the holding side) for the appropriate time or distance, and then turn towards the holding course to intercept the inbound holding course.

8.3.4.2.3. Sector C (Direct). Turn to follow the holding pattern.

Figure 8.4. AIM Method.



8.3.5. Timing. ***The maximum inbound leg time is 1 minute at or below 14,000 feet MSL and 1½ minutes above 14,000 feet MSL. On the initial outbound leg do not exceed the appropriate time for the altitude. Adjust subsequent outbound legs as necessary to meet the required inbound time. When a specific DME or RNAV distance is specified, commence the inbound turn at that distance. ATC expects pilots to fly the complete holding pattern as published. Therefore, do not shorten the holding pattern without clearance from ATC.***

8.3.5.1. Outbound. ***Begin outbound timing when over or abeam the fix. If you cannot determine the abeam position, start timing when wings level outbound***.

8.3.5.2. Inbound. ***Begin inbound timing when wings level inbound.***

8.3.5.3. TACAN/DME/RNAV. ***For TACAN, charted DME holding, or RNAV holding; start turns at the specified DME limit or RNAV distance.***

8.3.5.4. Timed Approaches. ***When pilots receive a clearance specifying the time to depart a holding pattern, adjust the pattern within the limits of the established holding procedure so as to depart at the time specified.***

8.4. FMS Holding Procedures. FMSs may provide navigation guidance for holding pattern construction and entry. Depending on specific aircraft equipage, FMS holding pattern entry procedures may not match FAA or ICAO standards. Aircrews are responsible for understanding aircraft-specific FMS holding procedures and ensuring that holding entry procedures match the appropriate FAA/ICAO procedures. In some cases, pilot intervention may be required.

8.5. Holding Pattern Suggestions. Here are some suggestions and points to consider when flying holding patterns (Figure 8.5):

8.5.1. Copying Holding Instructions.

8.5.1.1. Direction. Compare the direction of holding to the wind arrow used in weather depictions. (The wind arrow shows the direction from which the wind comes.)

8.5.1.2. Fix. The head of the arrow is the fix; fly the inbound course to the head.

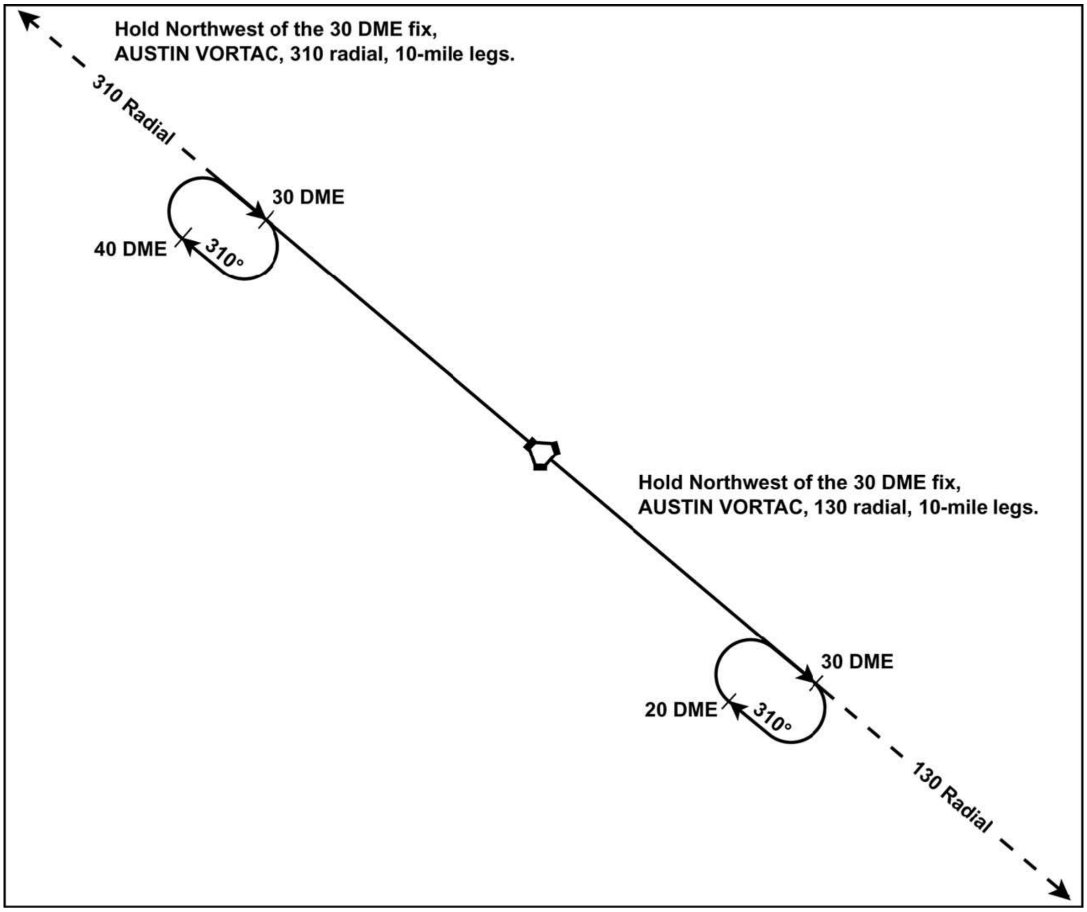
8.5.1.3. Draw. Draw or visualize the remainder of the pattern by the instructions given.

8.5.2. Timing.

8.5.2.1. Inbound Legs. After completing the first circuit of the holding pattern, adjust the time outbound as necessary to provide the desired inbound times. In extreme wind conditions, even though the turn inbound is initiated immediately after completing the outbound turn, the inbound leg may exceed the 1 or 1½ minute limit. In this case, you are authorized to exceed the time limit inbound.

8.5.2.2. Adjustments. Knowing the time it takes you to fly a holding pattern will allow you to meet an EFC. As an approximation, 1/100th of TAS will give the number of minutes to fly a 360° turn at 30° of bank. (For example, at 350 knots true airspeed (KTAS), a 360° turn takes about 3.5 minutes.) Aircraft flying standard rate turns cover 360° in 2 minutes. Add to the time for turning the number of minutes to fly the inbound and outbound legs.

Figure 8.5. Copying Holding Instructions.



8.6. Drift Corrections.

8.6.1. Calculating drift corrections. Knowledge of drift correction and TAS relationship can be very useful, especially in those instances where course guidance is not available; for example, the outbound leg of a holding pattern or a procedure turn. The following techniques may be used to determine approximate drift correction when the crosswind component is known:

8.6.1.1. Mach. Divide the crosswind component by the mach times 10. Example: 50 knots crosswind and 300 KTAS (.5M) = 10° drift correction, or

8.6.1.2. TAS. Divide the crosswind component by the aircraft speed in nautical miles per minute. Example: 30 knots crosswind and 180 KTAS (3NM per minute) 30÷3 = 10° drift correction.

8.6.2. Applying drift corrections. Compensate for wind effect primarily by drift correction on the inbound and outbound legs. When outbound, triple the inbound drift correction; e.g., if correcting left by 8 degrees when inbound, correct right by 24 degrees when outbound.

8.7. High Altitude Approach Plate Depiction (postage stamp). Holding pattern entry turns depicted on high altitude approach charts are provided for pilot convenience and are consistent with the intent of the AIM entry procedures.

8.8. Descent. If established in a holding pattern that has a published minimum holding altitude, and assigned an altitude above that published altitude, pilots may descend to the published minimum holding altitude when cleared for the approach (unless specifically restricted by ATC). Minimum holding altitude is the same as the IAF altitude for holding patterns where the IAF is located in the holding pattern unless otherwise noted or depicted. For those holding patterns where there is no published minimum altitude at the IAF and no depicted holding altitude, the minimum holding altitude is the same as the minimum altitude at the FAF (or next segment). In this case, upon receiving an approach clearance, maintain the last assigned altitude until established on a segment of the instrument approach procedure being flown. (If a lower altitude is desired, request clearance from the controlling agency.)

Chapter 9

ARRIVAL

9.1. En Route Descent Procedure/Technique.

9.1.1. En route. The en route descent frequently allows a pilot to transition from an en route altitude to the final approach instead of flying an entire FLIP IAP. It may be flown either via radar vectors or nonradar routings, using approved navigation aids. ATC will not insist on an en route descent. ATC will not authorize an en route descent if abnormal delays are anticipated, nor will they terminate the service without the pilot's consent except in an emergency.

9.1.2. Final Approach. The type of final approach to be flown must be understood by you and the controller (ILS, PAR, visual pattern, etc.). Except for radar finals, request an en route descent to a specific final approach. If the requested en route descent is to a radar final, select a backup approach that is compatible with existing weather and aircraft equipment. If you experience lost communications, you are automatically cleared to fly any published approach. For further guidance on lost communications, see the FIH.

9.2. Descent. ATC requirements probably have more influence over when to begin the descent than any other single factor. Prior to requesting an enroute descent, consider your range, desired descent rate, weather, terrain, and low altitude fuel consumption. ***Pilots shall maintain last assigned altitude until receiving authorizations/clearance to change altitude. At that time, pilots are expected to comply with all published/issued restrictions.***

9.2.1. Descend at an optimum rate (consistent with the operating characteristics of the aircraft) to 1,000 feet above the assigned altitude then reduce your rate of descent to 500 to 1,500 fpm until the assigned altitude is reached. ***If at any time you are unable to descend at a rate of at least 500 fpm, advise ATC.*** Advise ATC if it is necessary to level off at an intermediate altitude during descent. An exception to this is when leveling off at 10,000 feet MSL on descent, or 2,500 feet above airport elevation (prior to entering a Class B, Class C, or Class D surface area) when required for speed reduction.

9.2.1.1. NOTE: FAA controllers are not required to respond to clearance readbacks. However, if the readback is incorrect or incomplete, the controller should make corrections. Absence of a correction does not imply your readback was correct. The controller may not hear the mistaken readback. If you are unsure of the clearance and/or instructions, query the controller.

9.2.1.2. CAUTION: Descent gradients in excess of 10° (1,000 ft/nm) in IMC may induce spatial disorientation. In addition, exceeding a 10° descent gradient below 15,000 feet AGL substantially decreases margin for error in avoiding obstacles and terrain, and may not provide effective radar monitoring.

9.2.2. Starting Descent. ***Before starting descent, review the IAP, recheck the weather (if appropriate), check the heading and attitude systems, and coordinate lost communication procedures (if required).*** Review of the IAP should include, but is not limited to, the following: minimum and/or emergency safe altitudes, navigation frequencies, descent rates, approach minimums, missed approach departure instructions, and aerodrome sketch. ***The IAP shall be readily available to the pilot for reference throughout the procedure.***

9.2.3. During Descent.

9.2.3.1. Descent Rate. During the descent, control descent rate and airspeed to comply with any altitude or range restrictions imposed by ATC.

9.2.3.2. Reduce Airspeed. ***Reduce airspeed to 250 KIAS or less when below 10,000 feet MSL as required by AFI 11-202V3.***

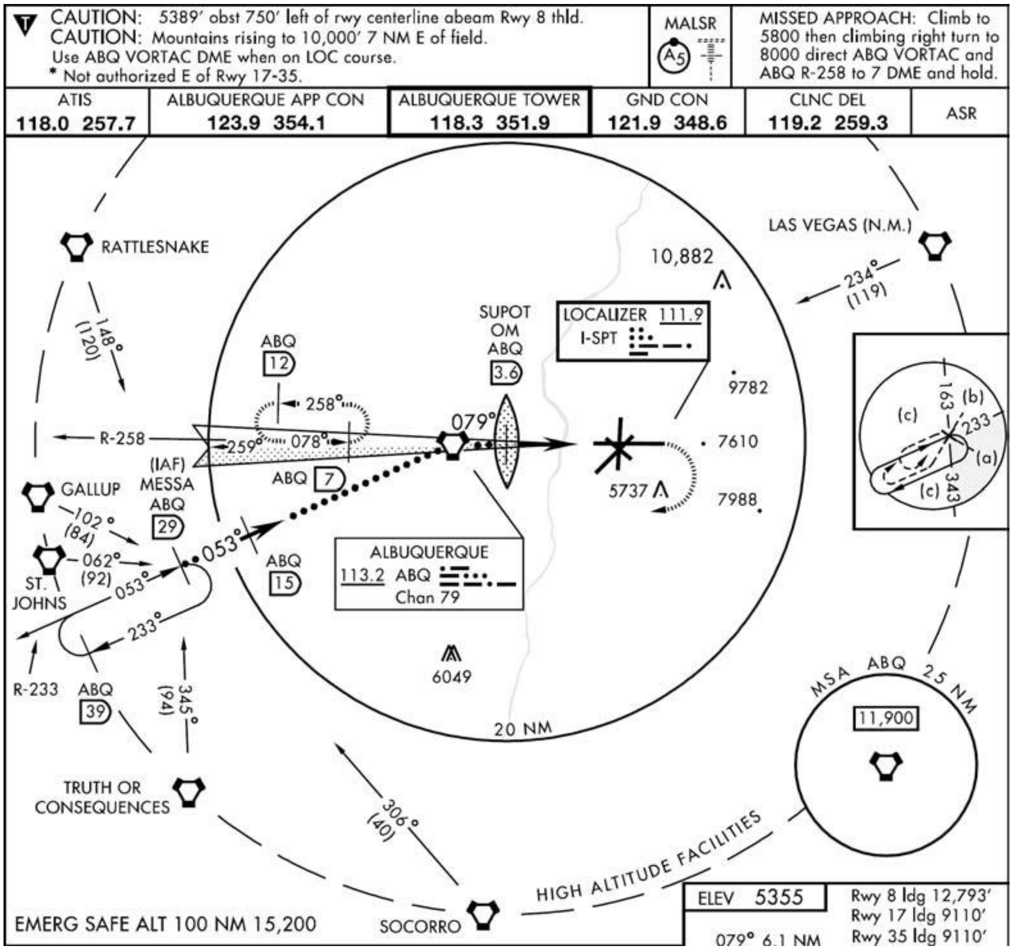
9.2.3.3. Radar Vectors. When descending via radar vectors, remain oriented in relation to the final approach fix by using all available navigation aids. Have the IAP available for the approach to be flown along with an alternate or backup procedure to be used if available. Note the minimum safe, sector, or emergency safe altitudes. ***Once cleared for the approach, maintain the last assigned altitude and heading until established on a segment of a published route or IAP.*** If at any time there is doubt as to whether adequate obstacle clearance is provided or controller instructions are unclear, query the controller. The controller should inform you if radar contact is lost and provide you with a new clearance or additional instructions. If advised that radar contact is lost while in IMC and there is a delay in receiving new instructions, ask the controller for a new clearance or advise the controller of your intentions. This is particularly important if below minimum safe, sector, or emergency safe altitude.

9.3. Established on Course. Established on course is defined as being within half full-scale deflection for a VOR/TACAN/RNAV/GPS course, within ± 5° of the required bearing for an NDB and within full scale deflection for a LOC based course. Therefore, ***do not consider yourself "established on course" until you are within these limits.***

9.4. High Altitude Procedures.

9.4.1. Terminal Routings (Figure 9.1). Terminal routings from en route or feeder facilities normally provide a course and range in nautical miles (not DME) to the IAF but may take you to a point other than the IAF.

Figure 9.1. Feeder Routes (High Altitude).



9.4.2. Before the IAF. ***Before reaching the IAF, review the IAP, recheck the weather (if appropriate), check the heading and attitude systems, and obtain clearance for the approach.*** If holding is not required, reduce to penetration airspeed or below before reaching the IAF. Accomplish appropriate checklists in accordance with the aircraft flight manual.

9.4.3. En route Approach Clearance. ***If cleared for an approach while en route to holding fix that is not collocated with the IAF, proceed to the IAF via the holding fix, unless specifically cleared to proceed direct to the IAF. However, if the IAF is located along the route of flight to the holding fix, begin the approach at the IAF.*** If in doubt as to the clearance, query the controller.

9.4.4. Approach Clearance (Figure 9.2). ***When ATC issues an approach clearance, proceed to the IAF then turn immediately in the shortest direction to intercept the approach course.*** Clearance for the approach does not include clearance to use holding airspace. ***However, if you are established in holding and cleared for the approach, complete the holding pattern to the IAF unless an early turn is approved by ATC.*** If aircraft heading to the IAF is within 90° of the approach course, pilots may use normal lead points to intercept the course (Figure 9.3). If aircraft heading is not within 90° of the approach course and you desire to maneuver the aircraft into a more favorable alignment prior to starting the approach, obtain clearance from ATC.

Figure 9.2. Cleared for the Approach While En Route to the Holding Fix.

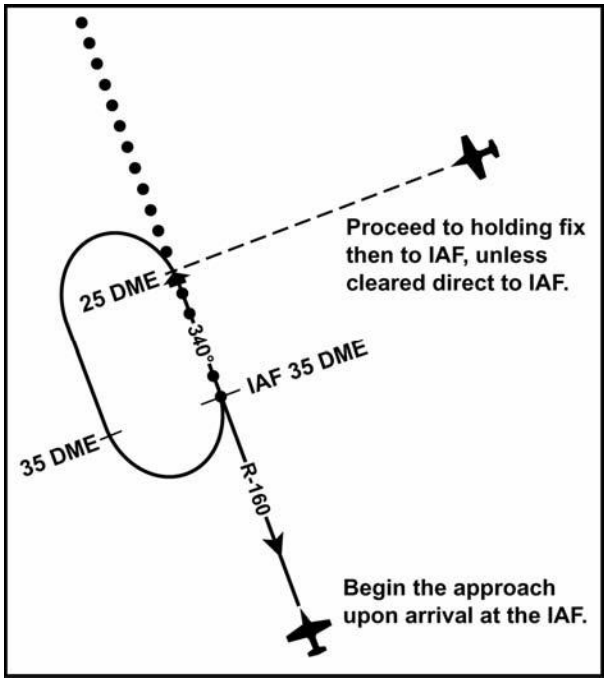
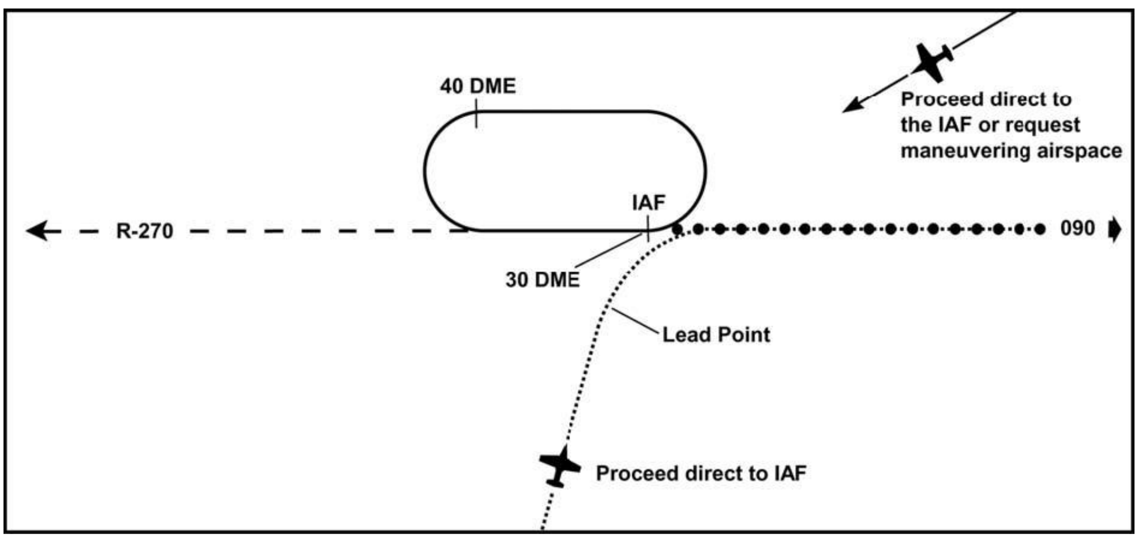


Figure 9.3. Leading the Turn at the IAF.



9.4.5. Altitude. ***When cleared for the approach, maintain the last assigned altitude until established on a segment of the published routing or IAP. Once on the published routing or a segment on the IAP, do not descend below the minimum safe altitude for that segment. High altitude penetration descent may be initiated when abeam or past the IAF with a parallel or intercept heading to the course.*** The controller should assign you the depicted IAF altitude. If you are not assigned the IAF altitude and cannot make the descent gradient by starting the penetration from your last assigned altitude, request a lower altitude.

9.4.5.1. NOTE: For non-DME teardrop approaches, you should not penetrate from an altitude above the depicted IAF altitude. If maneuvering, such as a holding pattern, is necessary to lose excess altitude, obtain clearance to do so in order to comply with subsequent mandatory altitudes.

9.5. Low Altitude Procedures.

9.5.1. Terminal routings. Terminal routings from en route or feeder facilities are considered segments of the IAP and normally provide a course, range, and minimum altitude to the IAF. They may take the aircraft to a point other than the IAF if it is operationally advantageous to do so. A low altitude IAF is any fix labeled as an IAF or any procedure turn/holding-in-lieu-of a procedure turn fix.

9.5.2. Ranges and Altitudes. Ranges published along the terminal routing are expressed in nautical miles (not DME). The altitudes published on terminal routing are minimum altitudes and provide the same protection as an airway MEA.

9.5.3. Before the IAF. ***Before reaching the IAF, review the IAP, recheck the weather (if appropriate), check the heading and attitude systems, and obtain clearance for the approach.*** If holding is not required, reduce to maneuvering airspeed before reaching the IAF. Accomplish appropriate checklists in accordance with the aircraft flight manual.

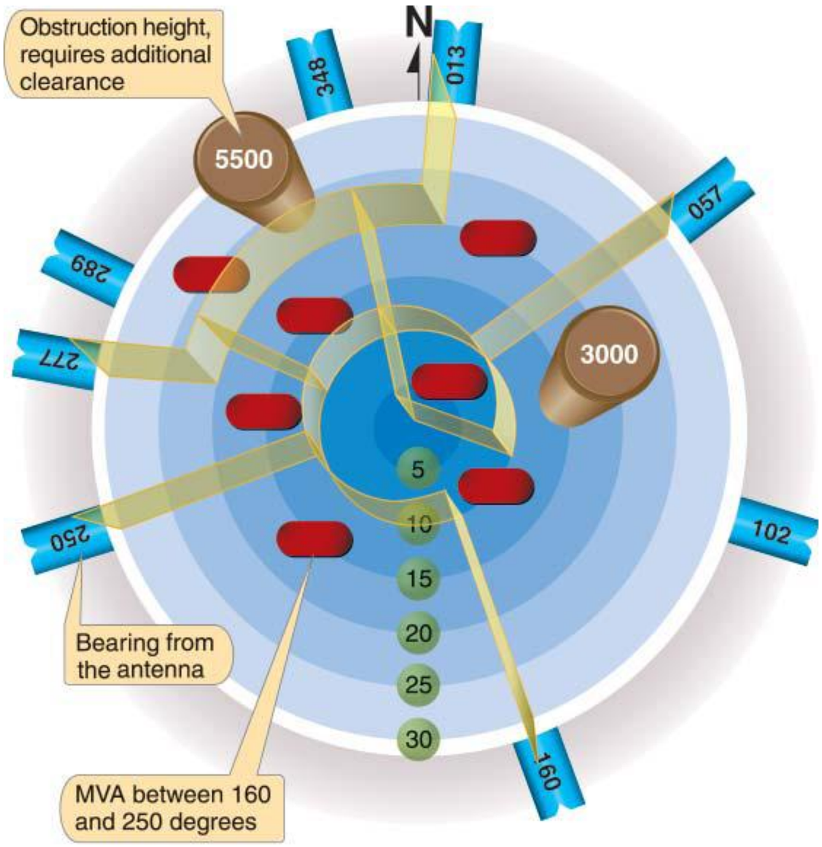
9.5.4. Enroute Approach Clearance. ***If cleared for an approach while en route to a holding fix that is not collocated with the IAF, either proceed via the holding fix or request clearance direct to the IAF (Figure 9.2). If the IAF is located along the route of flight to the holding fix, begin the approach at the IAF. If you overfly a transition fix, fly the approach via the terminal routing.*** If in doubt as to the clearance, query the controller.

9.5.5. Altitude. ***When cleared for the approach, maintain the last assigned altitude until established on a segment of a published route or IAP.*** At that time, the pilot may descend to the minimum altitude associated with that segment of the published routing or instrument approach procedure.

9.5.6. Approach Clearance. When clearance for the approach is issued, ATC expects an immediate turn in the shortest direction to intercept the procedural course upon reaching the IAF. Clearance for the approach does not include clearance for the holding airspace. ***However, if established in holding and cleared for the approach, complete the holding pattern to the IAF unless an early turn is approved by ATC.*** If your heading is within 90° of the procedural course, you may use normal lead points to intercept the course. If your heading is not within 90° of the approach course and you desire to maneuver the aircraft into a more favorable alignment prior to starting the approach, obtain clearance from ATC.

9.6. Radar Vectors (Figure 9 4). The use of radar vectors is the simplest and most convenient way to position an aircraft for an approach. Using radar, air traffic controllers can position an aircraft at almost any desired point, provide obstacle clearance by the use of minimum vectoring altitudes (MVAs), and ensure traffic separation. This flexibility allows an aircraft to be vectored to any segment of a published routing shown on the IAP or to a radar final. Radar controllers use MVA charts that are prepared by the air traffic facilities at locations where there are numerous different minimum IFR altitudes. The MVA chart is divided into sectors that are large enough to accommodate vectoring of aircraft within the sector at the MVA. Minimum altitudes are established at 1,000 feet or 2,000 feet in designated mountainous areas (in mountainous areas, MVAs may be authorized at 1,000 feet in order to achieve compatibility with terminal routes or IAPs). When being radar vectored, IFR altitude assignments will be at or above MVA.

Figure 9.4. Minimum Vector Altitude (MVA) Chart.



9.6.1. "Traffic Advisories" is an additional service that the controller may provide to you if the workload permits. Traffic information while on a PAR final is almost nil due to narrow azimuth scan of the PAR equipment. "Radar monitoring" during a nonprecision instrument approach will not provide altitude warning information if the aircraft descends below a safe altitude. The controller may vector the aircraft to any segment of an IAP prior to the FAF and clear an aircraft for an approach from that point. The controller will issue an approach clearance only after you are established on a segment of the IAP; or you will be assigned an altitude to maintain until you are established on a segment of the IAP. The following general guidance applies to the radar controller when positioning an aircraft for a final approach:

9.6.2. Radar Vector Weather Requirements. When the reported ceiling is at least 500 feet above the minimum vectoring altitude and the visibility is at least 3 miles, aircraft will be vectored to intercept the final approach course as follows:

9.6.2.1. At least 1 mile from the FAF at a maximum intercept angle of 20°.

9.6.2.2. At least 3 miles from the FAF at a maximum intercept angle of 30°.

9.6.3. Final Approach Intercept Requirements. At all other times, unless specifically requested by the pilot, aircraft will be vectored to intercept the final approach course at least 3 miles from the FAF at a maximum intercept angle of 30°.

9.6.4. Vectoring Requirements. In either case, aircraft will be vectored:

9.6.4.1. At an altitude not above the glide slope for a precision approach.

9.6.4.2. At an altitude that will allow descent in accordance with the published procedure for a nonprecision approach.

9.6.4.3. NOTE: These procedures do not apply to vectors to a visual approach.

9.7. Pilot Responsibilities.

9.7.1. During Vectors. ***While being radar vectored, the pilot will repeat all headings, altitudes (departing and assigned), and altimeter settings; and comply with controller instructions.***

9.7.2. Orientation. Remain oriented in relation to the final approach fix by using available navigation aids. ***The pilot will have the IAP available for the approach to be flown.*** Note the minimum sector, or emergency safe altitudes. Start the before-landing checklist (landing check), review approach minimums, and determine the approximate initial rate of descent required on final approach. ***Once approach clearance is received, the pilot will maintain the last assigned altitude and heading until established on a segment of a published routing or IAP.*** Comply with all course and altitude restrictions as depicted on the approach procedure except that you must not climb above the last assigned altitude to comply with published altitude restrictions unless so instructed by the controlling agency. Establish final approach configuration and airspeed prior to the FAF (unless flight manual procedures require otherwise).

9.7.3. Maneuvering. If maneuvering is required to lose excess altitude prior to the FAF, obtain a clearance from the controlling agency. Descent maneuvering may include execution of a procedure turn, descent in a published holding pattern, additional radar vectors, or other such maneuver.

9.7.3.1. CAUTION: If at any time there is doubt as to whether adequate obstacle clearance is provided, or controller instructions are unclear, query the controller. The controller should inform you if radar contact is lost and give a new clearance or instructions. If you are advised that radar contact is lost and there is a delay in receiving new instructions, ask the controller for a new clearance or advise the controller of your intentions. This is particularly important if below minimum sector, or emergency safe altitude.

9.8. Standard Terminal Arrivals (STARs) (Figure 9 5).

9.8.1. Definition. A STAR is an ATC coded IFR arrival route established for assignment to arriving IFR aircraft for certain airports. The purpose of a STAR is to simplify clearance delivery procedures and facilitate transition between enroute and instrument approach procedures.

9.8.1.1. STARs can be based on conventional NAVAIDS or RNAV. For all STARs, follow the guidance in the following paragraphs. For RNAV-specific procedures, see paragraphs 9.8.1.2.

9.8.1.1.1. Mandatory Speeds and/or Altitudes. Some STARs may have mandatory speeds and/or crossing altitudes published. Some STARs have planning information depicted to inform pilots what clearances or restrictions to "expect." "Expect" altitudes/speeds are not considered STAR restrictions until verbally issued by ATC. They are published for planning purposes and should not be used in the event of lost communications unless ATC has specifically advised the pilot to expect these altitudes/speeds as part of a further clearance. Additionally, STARs will normally depict MEAs. MEAs are not considered restrictions. However, pilots are expected to remain above MEAs.

9.8.1.1.2. Altitude Clearance. ***Pilots shall maintain last assigned altitude until receiving authorizations/clearance to change altitude. At that time, pilots are expected to comply with all published/issued restrictions.*** The authorization may be via a normal descent clearance or the phraseology “DESCEND VIA.”

9.8.1.1.2.1. Example of Lateral Routing Clearance Only. “Track 32, cleared the EAU CLAIRE SIX ARRIVAL.” In this case, you are cleared the EAU CLAIRE SIX routing but are expected to maintain your present altitude awaiting further clearance.

9.8.1.1.2.2. Example of Routing with Assigned Altitude. “Fame 22, cleared EAU CLAIRE SIX arrival; descend and maintain flight level two four zero.” In this situation, you are cleared via the EAU CLAIRE SIX routing and cleared to descend to FL240.

9.8.1.1.2.3. “DESCEND VIA” Clearances. A “DESCEND VIA” clearance authorizes pilots to vertically and laterally navigate, in accordance with the depicted procedure, to meet published restrictions. Vertical navigation is at pilot’s discretion; however, ***adherence to published altitude crossing restrictions and speeds is mandatory unless otherwise cleared.*** MEAs are not considered restrictions; however, pilots are expected to remain above MEAs. ***Pilots cleared for vertical navigation using the phraseology “Descend Via” shall inform ATC upon initial contact with a new frequency.*** For example, “Track 32, descending via the EAU CLAIRE SIX ARRIVAL.”

9.8.1.1.2.4. Example of “DESCEND VIA” Clearance. “Track 66, Descend Via the EAU CLAIRE SIX arrival.” If you receive this “DESCEND VIA” clearance, you are expected to vertically and laterally navigate in accordance with the EAU CLAIRE SIX arrival.

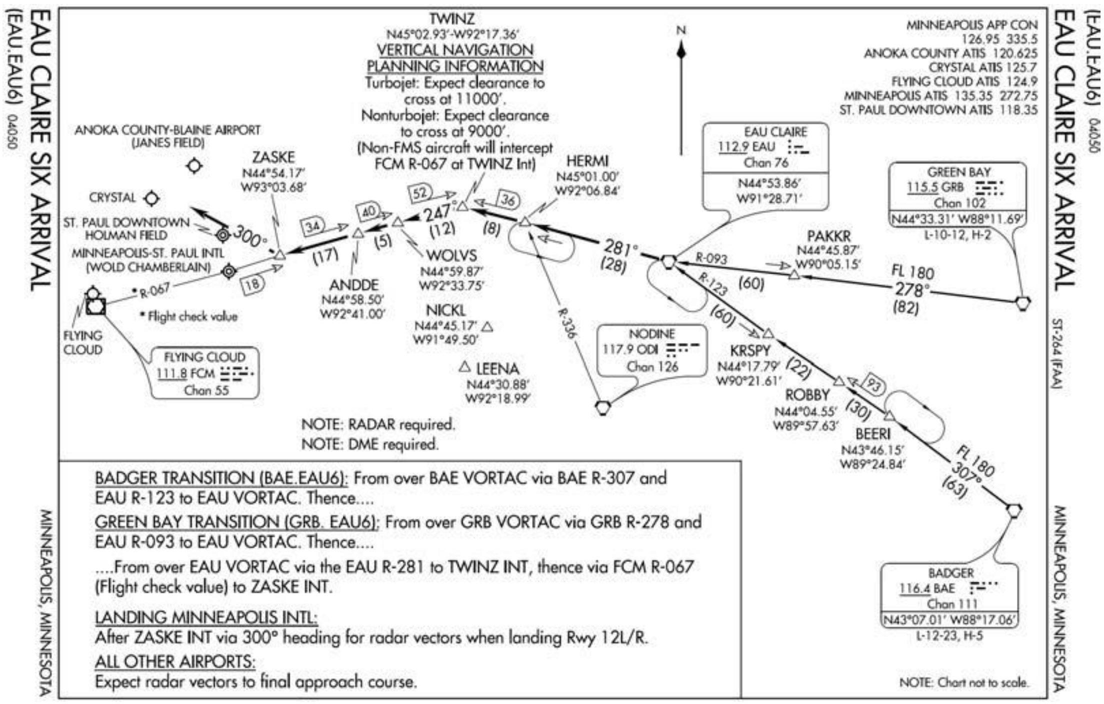
9.8.1.1.3. Anticipate Use of STARs. Normally, pilots of IFR aircraft destined to locations where STARs have been published should expect to be issued a clearance containing the appropriate STAR for the destination airport.

9.8.1.1.4. Chart Requirement. Use of STARs requires pilot possession of at least the approved chart. As with any ATC clearance or portion thereof, it is the responsibility of each pilot to accept or refuse an issued STAR. Pilots should notify ATC if they do not wish to use a STAR by placing “NO STAR” in the remarks section of the flight plan or by verbally stating the same to ATC (this is the less desirable method).

9.8.1.1.5. Pilot Responsibilities. Before filing or accepting a clearance for a STAR, the pilot must ensure that he or she can comply with any altitude and/or airspeed restrictions associated with the procedure. If filed for a STAR in the flight plan, then an initial ATC clearance of “Cleared as filed” constitutes clearance for the STAR routing (not altitudes) as well. Clearance for the STAR is not clearance for the approach the procedure may bring you to.

9.8.1.1.6. Where STARs Are Published. The DoD FLIP STAR book contains many, but not all of the CONUS STARs. Its contents are determined by military requirements.

Figure 9.5. Standard Terminal Arrival (STAR).



9.8.1.2. RNAV STARs (Figure 9.6). RNAV STARs can be stand-alone or "overlay". In order to fly a STAR using RNAV (either stand-alone or "overlay"), the pilot must comply with the following:

9.8.1.2.1. ***Aircraft equipment must meet requirements specified on the STAR.***

9.8.1.2.2. ***Aircraft RNAV system must meet appropriate certification standards as addressed in AFI 11-202V3.***

9.8.1.2.3. ***Procedure must be retrieved in its entirety from a current, approved navigation database.*** Waypoint and waypoint type (e.g., flyby, flyover) may not be modified.

9.8.1.2.4. ***Pilots must verify all waypoint names, waypoint type (flyby vs. flyover), altitude, and airspeed information from the database against information listed on the paper copy of the terminal procedure.*** Should differences between the approach chart and database arise, the published approach chart, supplemented by NOTAMs, holds precedence. Users may not alter terminal procedures retrieved from the equipment database**.**

9.8.1.2.4.1. Aircrews must verify the information in the database with the published STAR. The maximum allowable difference between the database course(s) and published course(s) is ±5°.

9.8.1.2.4.2. Certain segments of a STAR may require some manual intervention by the pilot, especially when radar vectored to a course or required to intercept a specific course to a waypoint. This is permissible, as this is not altering the waypoints retrieved from the database; it is ensuring the navigation system properly executes the procedure.

9.8.1.2.5. ***If GPS is used, RAIM must be available to execute the procedure. Terminal (or better) RAIM must be available.***

9.8.1.2.5.1. System must either provide RAIM alerts based on terminal criteria, or pilot must be able to monitor navigation performance (Actual Navigation Performance).

9.8.1.2.5.1.1. NOTE: Terminal RAIM for a STAR may not be available unless the waypoints are part of the active flight plan.

9.8.1.2.5.1.2. NOTE: Actual Navigation Performance (ANP) is a technical term that describes the navigation accuracy of the system. Other terms synonymous with ANP are Figure of Merit, Estimation of Position Uncertainty, or Quality Factor.

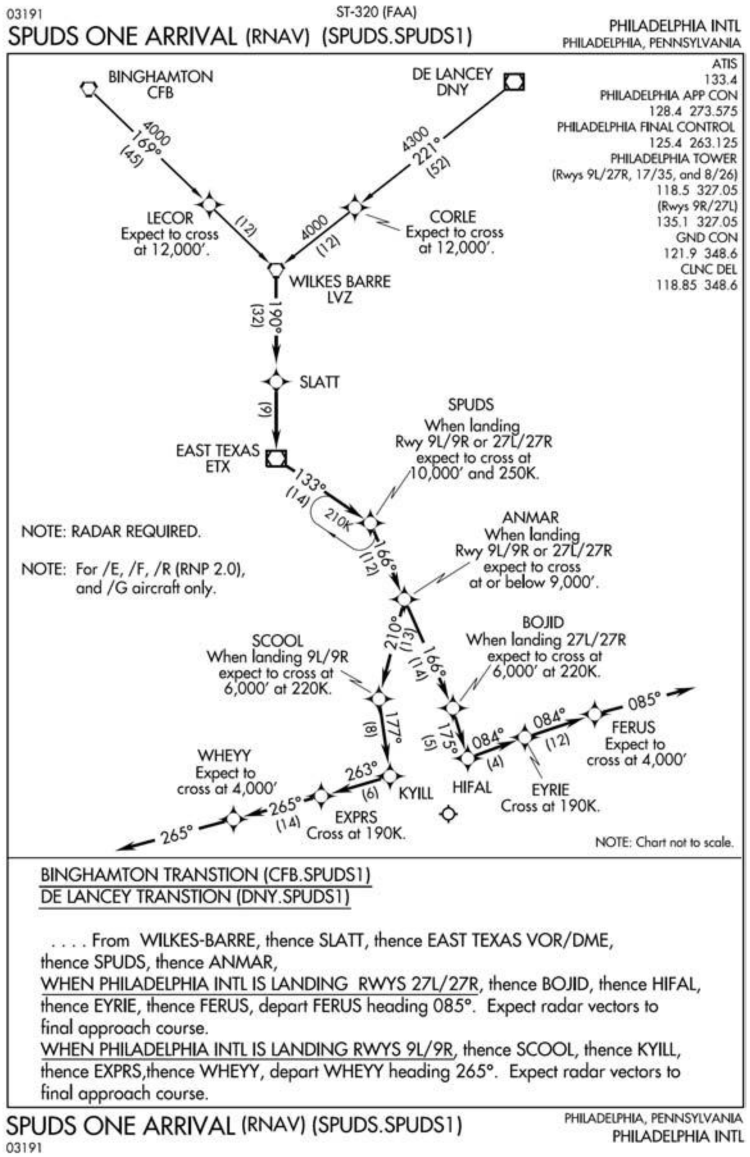
9.8.1.2.6. ***Comply with any navigation system requirements if published on the STAR (ex. /E, /G, etc.).***

9.8.1.2.7. STARs based on conventional NAVAIDS in some cases are retrievable from an RNAV database. ***Pilots will tune, identify, monitor and display the appropriate ground-based NAVAIDs whenever practicable.***

9.8.1.2.7.1. In some cases, because of the software programming, there can be tracking inaccuracies when flying non-RNAV/FMS STARs using an FMS. These tracking inaccuracies have resulted in less-than-required air traffic control separation and air traffic control intervention to prevent a possible Controlled Flight Into Terrain (CFIT) accident. Non-RNAV/FMS procedures often require navigational tracking over all the specified fixes. Many FMS databases code the points in these procedures as Fly-by waypoints, instead of Fly-over waypoints. Unlike a stand-alone RNAV STAR, which will specify on the printed FLIP which waypoints are Fly-by and which are Fly-over, a conventional STAR will not make this distinction. Consequently, the FMS will lead the turn on these points. This turn anticipation could result in a turn being started miles prior to the expected turn point depending on the amount of required track change, wind, and true airspeed. When verifying waypoints prior to flying a non-RNAV/FMS STAR using an FMS, aircrews must determine how the points are coded (Fly-by vs. Fly-over) in their database. If there are large course changes coded as Fly-by waypoints, the aircrew must be prepared to manually intervene to insure the aircraft tracks the procedure as published to remain within protected airspace.

9.8.1.2.8. Manually selecting aircraft bank limiting functions may reduce the aircraft's ability to maintain its desired track and are not recommended. Pilots should recognize manually selectable aircraft bank-limiting functions might reduce their ability to satisfy ATC path expectations, especially when executing large angle turns. This should not be construed as a requirement to deviate from Airplane Flight Manual procedures; rather, pilots should limit the selection of such functions within accepted procedures.

Figure 9.6. RNAV STAR.



9.9. Flight Management System Procedures (FMSP) for Arrivals.

9.9.1. FMSPs for arrivals serve the same purpose as STARs but are only used by aircraft equipped with Flight Management Systems (FMS). Procedures for flying FMSPs are identical to any other STAR. FMSPs will list the equipment requirements for flying the procedure (/E, /F, etc.).

Chapter 10

HIGH ALTITUDE APPROACHES

10.1. Application. An en route descent or a high altitude instrument approach enables an aircraft to transition from the high altitude structure to a position on and aligned with an inbound course to the FAF, at FAF altitude in the final approach configuration. ATC will usually issue a clearance for a specific type of approach. The omission of a specific type in the approach clearance indicates that any published instrument approach to the aerodrome may be used. ***Unless cleared by ATC to deviate, fly the entire instrument approach procedure starting at the IAF.***

10.2. Non-DME Teardrop Approaches. Teardrop approaches are usually associated with VOR or NDB facilities (Figure 10.1).

10.2.1. Station Passage. ***When station passage occurs at the IAF, turn immediately in the shorter direction toward the outbound course and attempt to intercept it. Begin descent when established on a parallel or intercept heading to the approach course and outbound from the IAF. If you arrive at the IAF at an altitude below that published, maintain altitude and proceed outbound 15 seconds for each 1,000 foot the aircraft is below the published altitude before starting descent. If you arrive at the IAF at an altitude above that published, a descent to the published IAF altitude should be accomplished prior to starting the approach. If descent is required at the IAF, obtain clearance to descend in a holding pattern. Set the altimeter in accordance with FLIP.***

10.2.1.1. NOTE: Use a descent gradient of 800-1,000 ft/NM (8-10°) to ensure you remain within protected airspace.

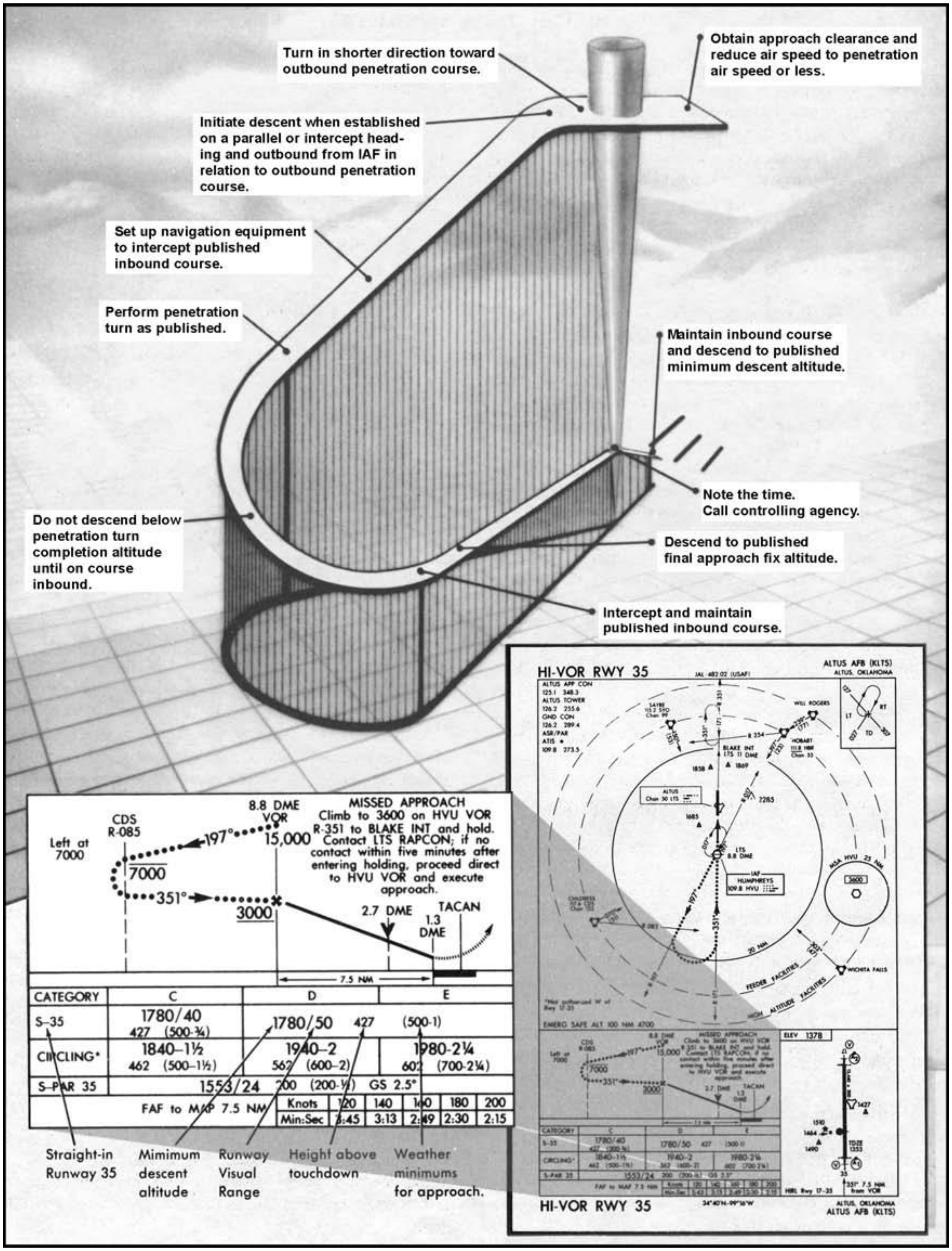
10.2.2. Fly-off. Some approaches use a fly-off (altitude or range) restriction before starting descent. In these cases, ***the pilot will attempt to intercept the outbound course and comply with the altitudes depicted on the approach chart unless otherwise instructed by ATC.*** Since the pilot cannot be expected to determine accurate groundspeed during a constantly changing true airspeed descent, depicted range restrictions should not be shown on non-DME teardrop high altitude approaches. Penetration turns should be annotated "left or right turn at (altitude)." ***When a penetration turn altitude is not published, start the turn after descending one-half the total altitude between the IAF and FAF altitudes.*** One technique to determine the start turn altitude is to add the IAF and FAF altitudes and divide by two. ***Before reaching the penetration turn altitude, set up the navigation equipment to intercept the published inbound approach course. Recheck the altimeter and the direction of penetration turn.***

10.2.3. Penetration Turn. ***Fly the penetration turn in the direction published.*** A 30° angle of bank is normally used during the penetration turn; however, bank may be shallowed if undershooting course. If it is apparent that you will undershoot the inbound penetration course, roll out on an intercept heading. Use normal inbound course interception procedures to intercept the course.

10.2.3.1. NOTE: If a penetration turn completion altitude is depicted, do not descend below this altitude until you are established on the inbound segment of the published approach procedure. Remember, obstacle clearance is based on the pilot attempting to maintain the course centerline; a pilot must use position orientation and pilot judgment to determine when to descend while attempting to intercept the course.

10.2.4. Descent. Continue descent to FAF altitude. Establish approach configuration and airspeed prior to the final approach fix unless the aircraft flight manual procedures require otherwise.

Figure 10.1. Non-DME Teardrop-High Altitude Approach.

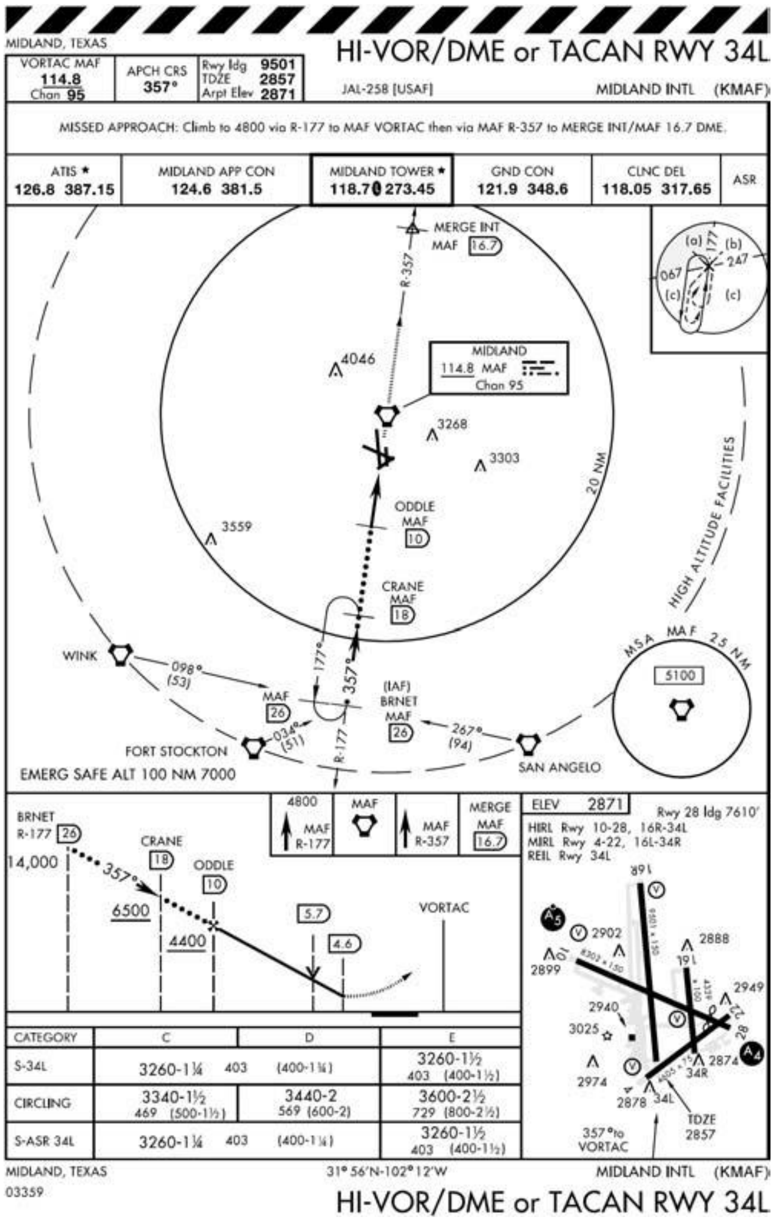


10.3. Radial Approaches. These approaches are associated with TACAN or VORTAC facilities (Figure 10.2). One or more radials form the entire approach track.

10.3.1. Crossing the IAF. ***When over the IAF, turn immediately in the shorter direction toward the approach course.*** Intercept the published approach course using appropriate course intercept procedures. If your heading is within 90° of the approach course, you are not required to overfly the IAF; you may use normal lead points to intercept the course.

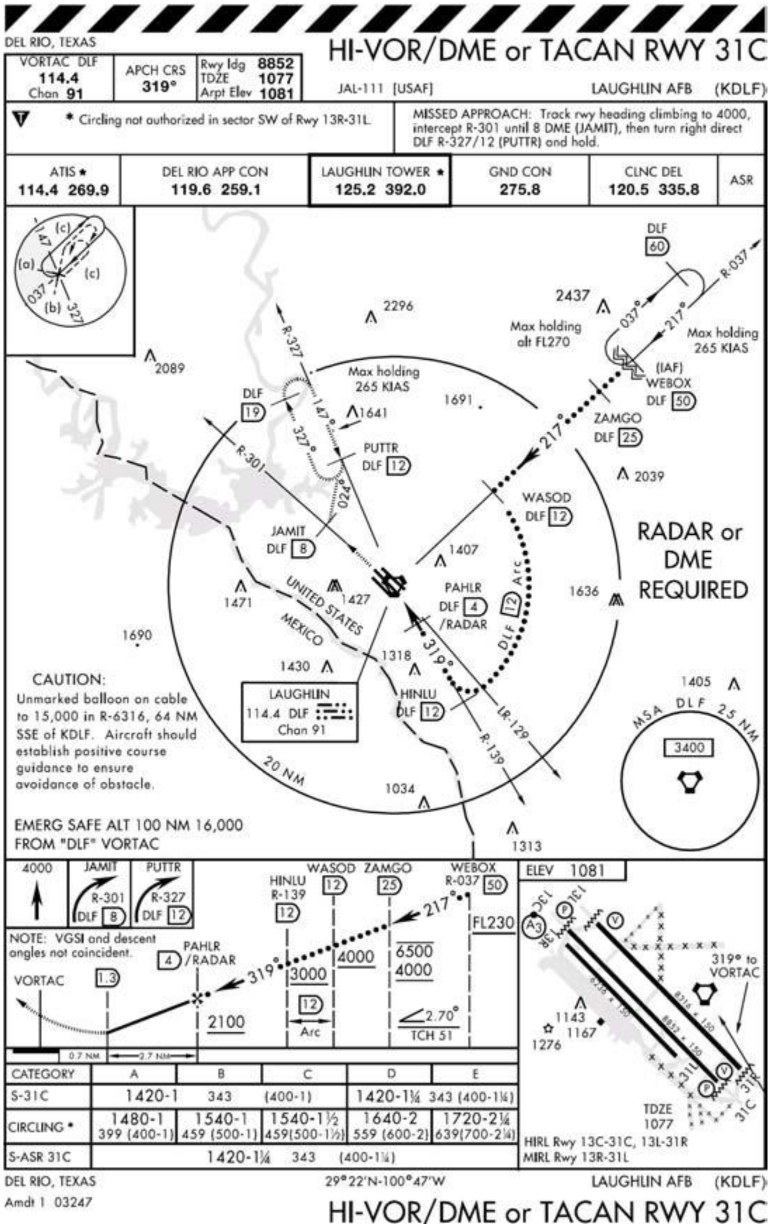
10.3.2. Descent. ***Start the descent when the aircraft is abeam or past the IAF on a parallel or intercept heading to the approach course.*** For DME approaches, crossing the arc is considered abeam the IAF. ***Intercept the course and comply with the altitudes depicted on the approach chart.*** Aircraft configuration and airspeed requirements prior to the FAF are the same as for non-DME teardrop.

Figure 10.2. Radial - High Altitude Approach.



CATEGORY	C	D	E
S-34L	3260-1¼ 403 (400-1¼)		3260-1½ 403 (400-1½)
CIRCLING	3340-1½ 469 (500-1½)	3440-2 569 (600-2)	3600-2½ 729 (800-2½)
S-ASR 34L	3260-1¼ 403 (400-1¼)		3260-1½ 403 (400-1½)

Figure 10.3. Radial and Arc Combination Approach.



10.4. Radial and Arc Combination Approaches (Figure 10 3). These require the use of arc intercept procedures. Flight procedures are the same as for a radial approach. However, if established in a holding pattern and the IAF is located on an arc or on a radial at a distance less than that required for a normal lead point, you may turn early to intercept the arc. ***Start the descent when you are established on an intercept to the arc and abeam or past the IAF in relation to the initial approach track.*** Aircraft configuration and airspeed requirements prior to the FAF are the same as for non-DME teardrop. An arc or radial altitude restriction only applies while established on that segment of the approach to which the altitude restriction applies. Once a lead point is reached, and a turn to the next segment is initiated, the pilot may descend to the next applicable altitude restriction. This may be especially important to facilitate a reasonable rate of descent to final approach fix altitude.

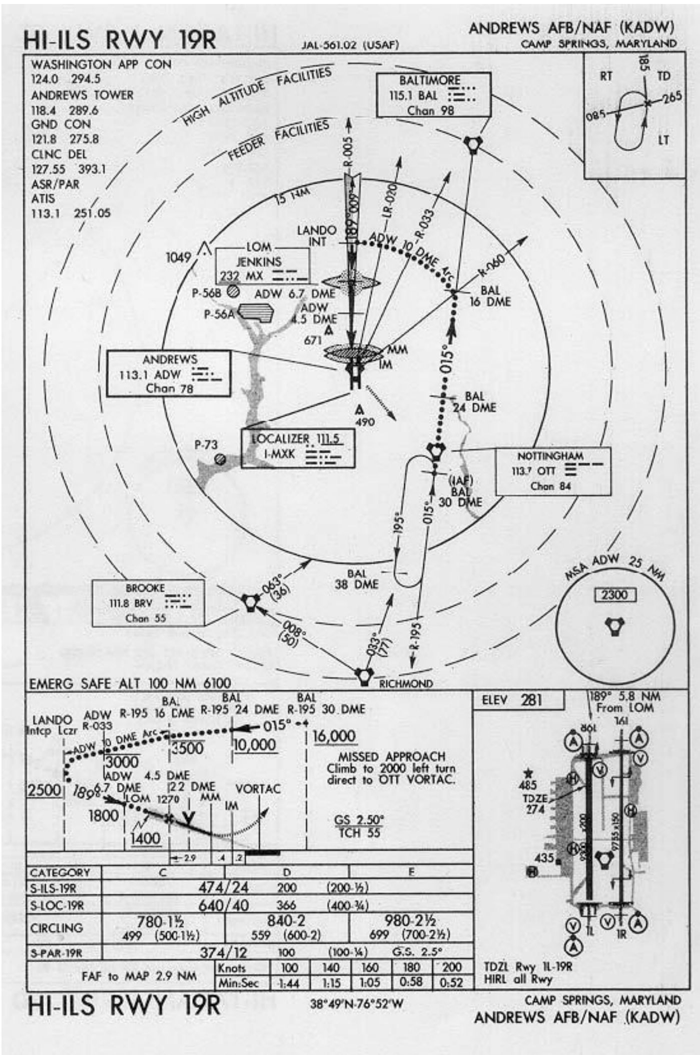
10.4.1. NOTE: When an altitude restriction is depicted at a fix defined as an intersection of a radial and an ARC the restriction must be complied with no later than the completion of the lead turn associated with that fix. If the restriction is met during the lead turn, consider yourself established on the next segment and continue to descend to the next applicable altitude restriction.

10.5. Multiple Facility Approaches (Figure 10 4). The multiple facility type approach normally uses a combination of two or more VORs, NDB, TACANs, etc., to provide the track.

10.5.1. Entry Procedures. The approach entry procedures are the same as prescribed for non-DME teardrop approaches.

10.5.2. Restriction. ***The entire approach must be flown as depicted to comply with all course and altitude restrictions.*** Aircraft configuration and airspeed requirements prior to the FAF are the same as for non-DME teardrop approaches.

Figure 10.4. Multiple Facility Approach.

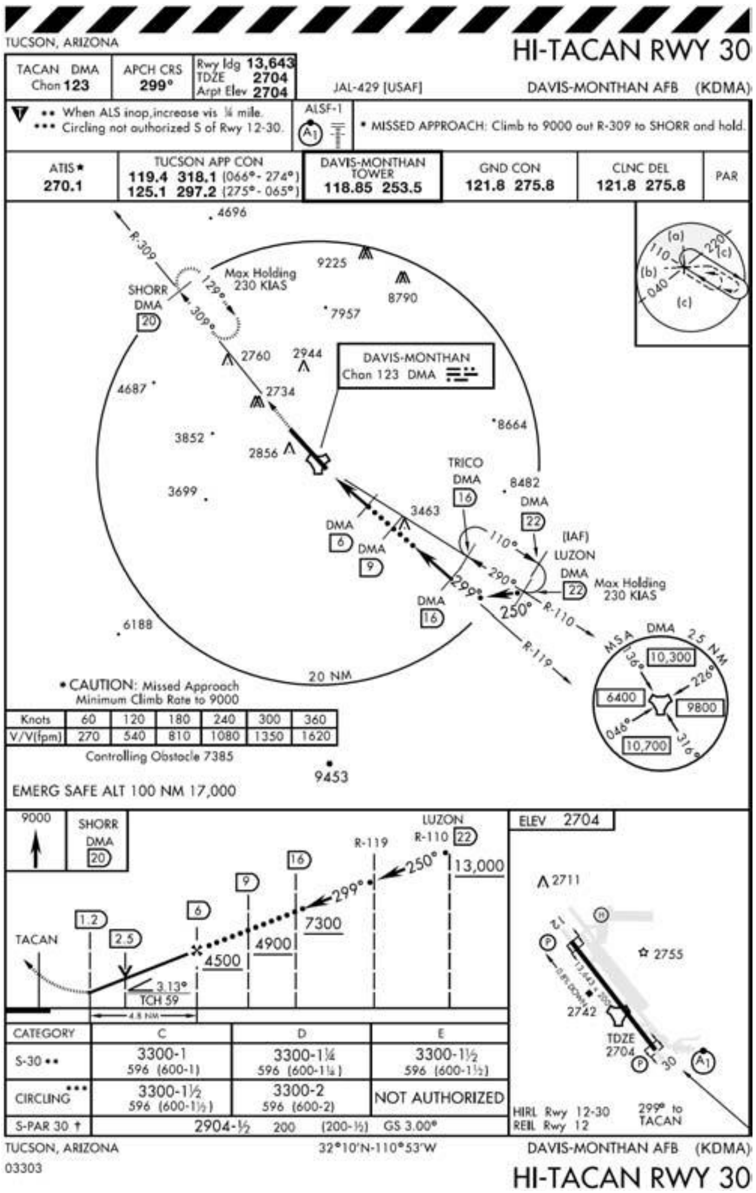


10.6. Approach With Dead Reckoning (DR) Courses. Many IAPs utilize DR courses (Figure 10.5). Course guidance is not available; however, the DR course should be flown as closely as possible to the depicted ground track.

10.6.1. Lead points. Use lead points for turns to and from the DR legs so as to roll out on the depicted ground track.

10.6.2. Ground track. Attempt to fly the depicted ground track by correcting for wind.

Figure 10.5. Dead Reckoning Courses.



Chapter 11

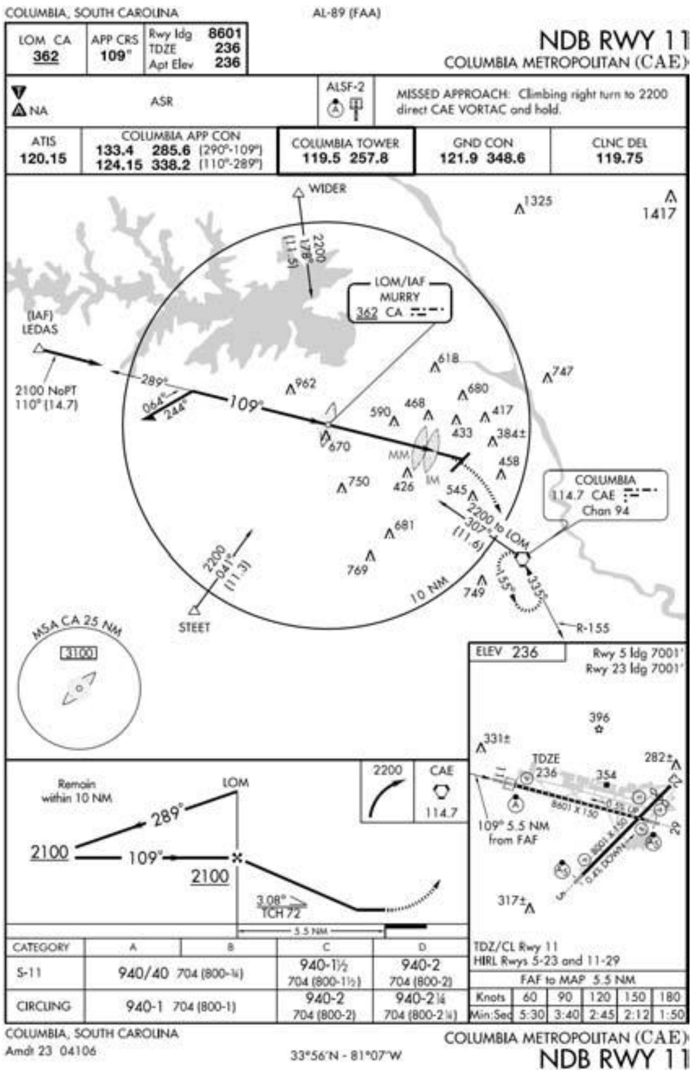
LOW ALTITUDE APPROACHES

11.1. Introduction. Low altitude approaches are used to transition aircraft from the low altitude environment to final approach for landing. Low altitude instrument approach procedures exist for one purpose -- to assist you in guiding your aircraft to the final approach fix, on course, on altitude, and in the final approach configuration (Figure 11.1). It has become normal to expect ATC to provide radar vectors to final; however, you must always be prepared to execute the "full procedure" when appropriate.

11.1.1. NOTE: This chapter deals primarily with low altitude approaches flown in FAA airspace. All procedures detailed in this chapter apply to FAA and ICAO airspace unless annotated otherwise in Chapter 17, ICAO Procedures.

11.1.2. CAUTION: Aircrews should use caution when flying a "high altitude" IAP in the low altitude environment, especially if there are multiple approaches based on the same NAVAID at the airport. If you are receiving radar vectors in the low altitude structure, ATC expects you to fly the low altitude version of the approach. Often the high and low altitude approaches are the same, but sometimes they are not. Ask for and receive a clearance for the exact approach you intend to fly. Query the controller if you receive an unclear or incomplete approach clearance.

Figure 11.1. Low Altitude Approach.

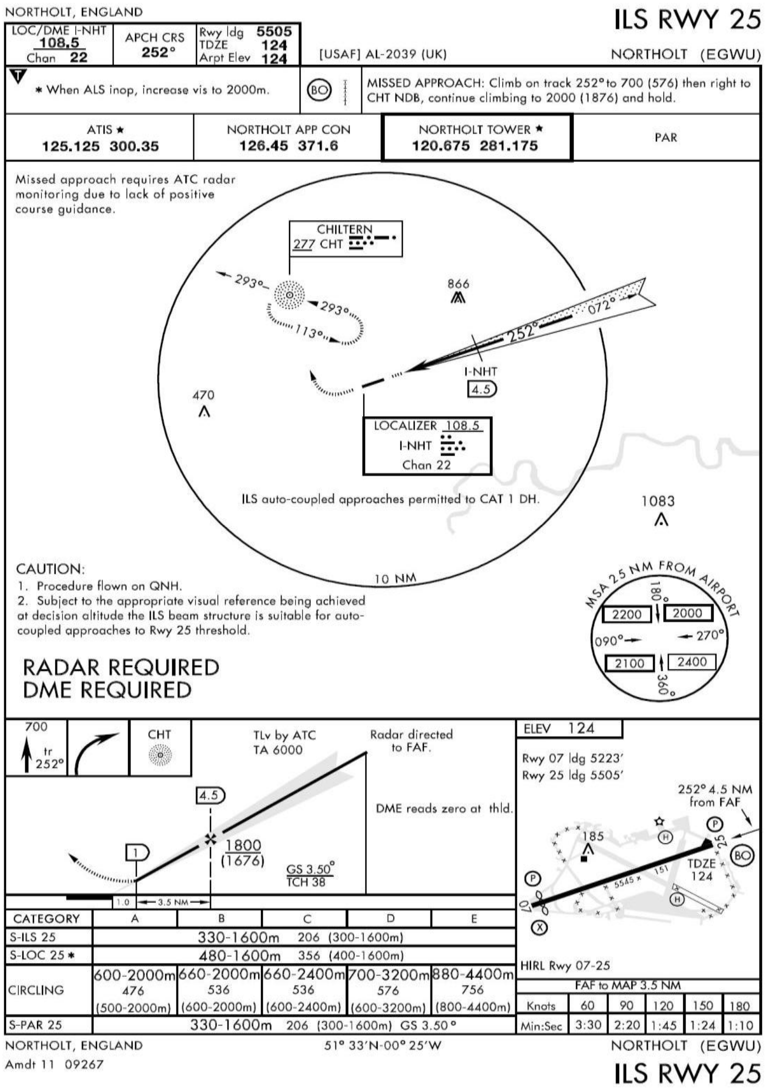


11.2. Overview. There are two broad categories of low altitude approaches: course reversals and procedure tracks. Before we look at each type in detail, here are some guidelines that apply to all low altitude approaches:

11.2.1. Initial Approach Fix (IAF). Most approaches begin at an IAF. ATC will normally clear you to the appropriate IAF and then clear you for the approach. ***Unless ATC specifically clears you otherwise, you are expected to fly to the IAF and execute the full instrument approach procedure as published.***

11.2.2. Final Approach Segment. Some approaches depict only a final approach segment, starting at the FAF (Figure 11.2). In these cases, radar is required to ensure you are properly aligned with the final approach course at the appropriate altitude. ***When ATC clears you for the approach, maintain the last assigned altitude until established on a segment of the published IAP.***

Figure 11.2. Approach Depicting Only the Final Approach Segment.



11.2.3. Aircraft Speed. ***Prior to reaching the initial approach fix, the pilot must slow to aircraft maneuvering speed.*** Use holding airspeed if maneuvering airspeed is not specified for your aircraft. Establish approach configuration and airspeed before the final approach fix unless your aircraft flight manual procedures require otherwise.

11.3. Types of Course Reversals. There are two common types of course reversals: the procedure turn (PT) (Figure 11.3) and the holding pattern in lieu of procedure turn (HILO PT) (Figure 11.4).

11.3.1. Restrictions. ***Do not execute a procedure turn or HILO PT in the following situations.*** (Many people use the memory aid – SNERT).

11.3.1.1. When ATC gives you clearance for a "Straight-in" approach.

11.3.1.2. If you are flying the approach via No PT routing (Figure 11.5).

11.3.1.3. When you are Established in holding, subsequently cleared the approach, and the holding course and procedure turn course are the same.

11.3.1.3.1. NOTE: This generally applies if you are already established at the minimum holding altitude. If you are in doubt as to what action the controller expects, query the controller.

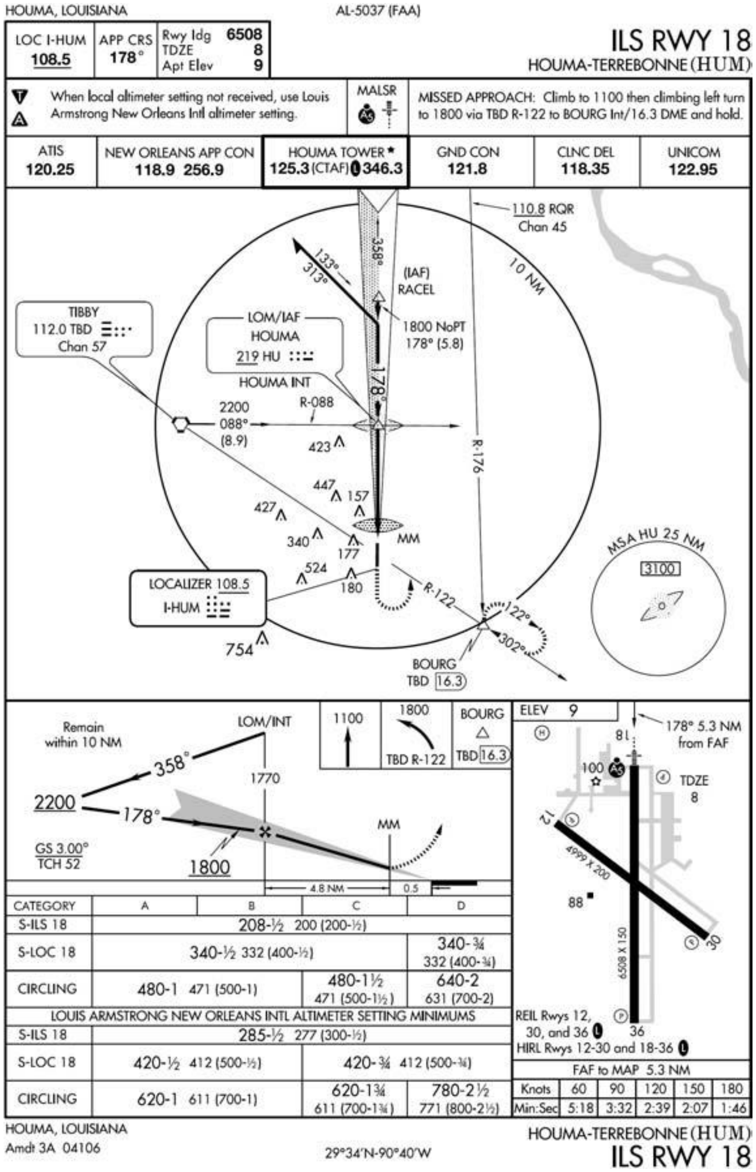
11.3.1.4. When ATC provides Radar vectors to the final approach course.

11.3.1.5. When ATC clears you for a Timed approach. Timed approaches are in progress when you are established in a holding pattern and given a time to depart the FAF inbound.

11.3.1.6. ***In any of the situations described above, proceed over the FAF at the published FAF altitude and continue inbound on the final approach course without making a procedure turn, holding pattern, or any other aligning maneuver before the FAF unless otherwise cleared by ATC.*** If you need to make additional circuits in a published holding pattern or to become better established on course before departing the FAF, it is your responsibility to request such maneuvering from ATC.

11.3.1.6.1. NOTE: Historically, these restrictions have created a lot of confusion between pilots and controllers. If you are ever in doubt about what ATC expects you to do, query the controller.

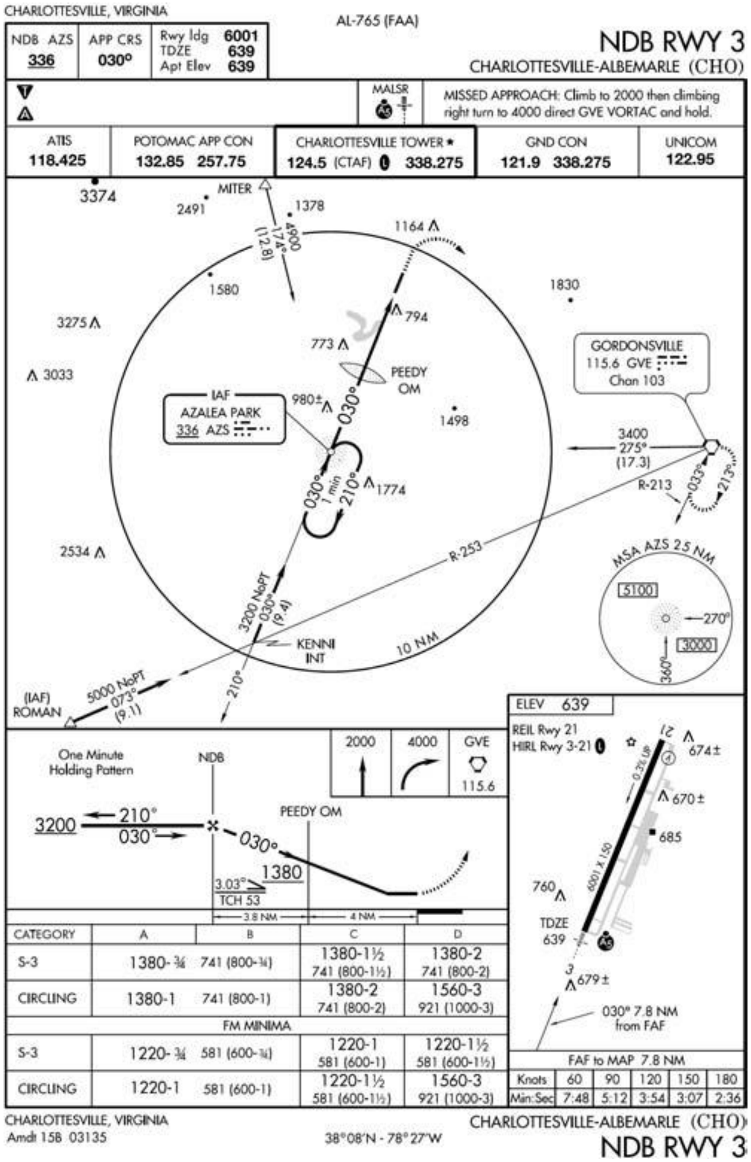
Figure 11.3. Procedure Turn Course Reversal.



CATEGORY	A	B	C	D
S-ILS 18	208-½ 200 (200-½)			
S-LOC 18	340-½ 332 (400-½)			340-¾ 332 (400-¾)
CIRCLING	480-1 471 (500-1)		480-1½ 471 (500-1½)	640-2 631 (700-2)
LOUIS ARMSTRONG NEW ORLEANS INTL ALTIMETER SETTING MINIMUMS				
S-ILS 18	285-½ 277 (300-½)			
S-LOC 18	420-½ 412 (500-½)		420-¾ 412 (500-¾)	
CIRCLING	620-1 611 (700-1)		620-1¾ 611 (700-1¾)	780-2½ 771 (800-2½)

FAF to MAP 5.3 NM					
Knots	60	90	120	150	180
Min:Sec	5:18	3:32	2:39	2:07	1:46

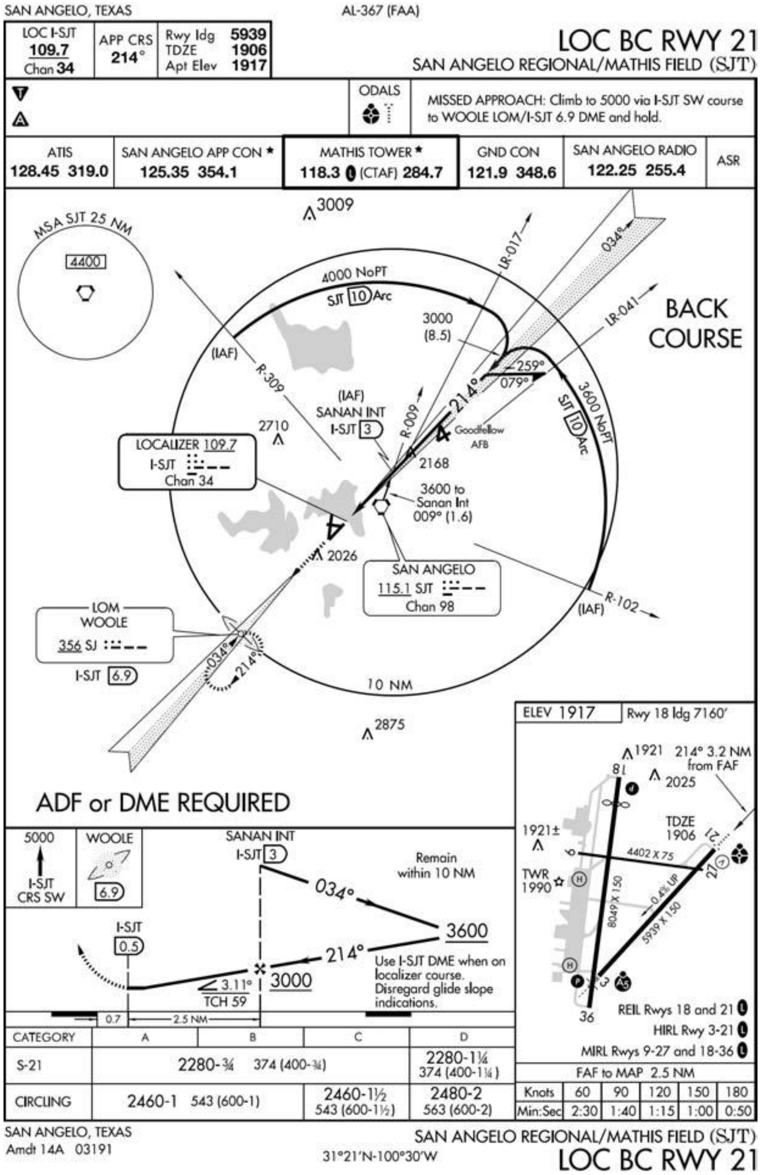
Figure 11.4. HILO Approach.



CATEGORY	A	B	C	D
S-3	1380-¾ 741 (800-¾)		1380-1½ 741 (800-1½)	1380-2 741 (800-2)
CIRCLING	1380-1 741 (800-1)		1380-2 741 (800-2)	1560-3 921 (1000-3)
FM MINIMA				
S-3	1220-¾ 581 (600-¾)		1220-1 581 (600-1)	1220-1½ 581 (600-1½)
CIRCLING	1220-1 581 (600-1)		1220-1½ 581 (600-1½)	1560-3 921 (1000-3)

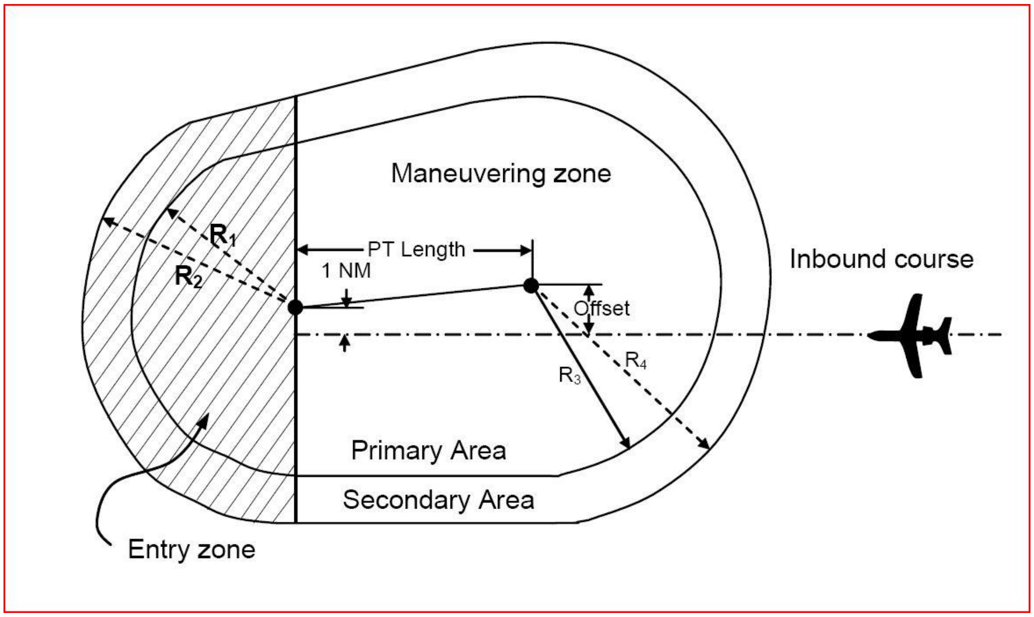
Knots	60	90	120	150	180
Min:Sec	7:48	5:12	3:54	3:07	2:36

Figure 11.5. NoPT Routing.



11.4. Procedure Turns. One of the most common types of low altitude course reversals is the procedure turn. Procedure turns are depicted in the plan view of U.S. government charts with a barb symbol ( ) indicating the direction or side of the outbound course on which the procedure turn or maneuvering is to be accomplished (Figure 11.3). The procedure turn fix is identified on the profile view of the approach at the point where the IAP begins. To give you an idea of what the procedure turn airspace looks like, refer to Figure 11.6. The actual radii of a PT area are dependent on the altitude and airspeed of the specific procedure.

Figure 11.6. Procedure Turn Area.



11.4.1. Aircraft Speed. Procedure turns may be safely flown at speeds up to 250 KIAS provided the pilot takes into consideration all factors which may affect the aircraft's turn performance (e.g., winds, TAS at altitude, bank angle, etc.).

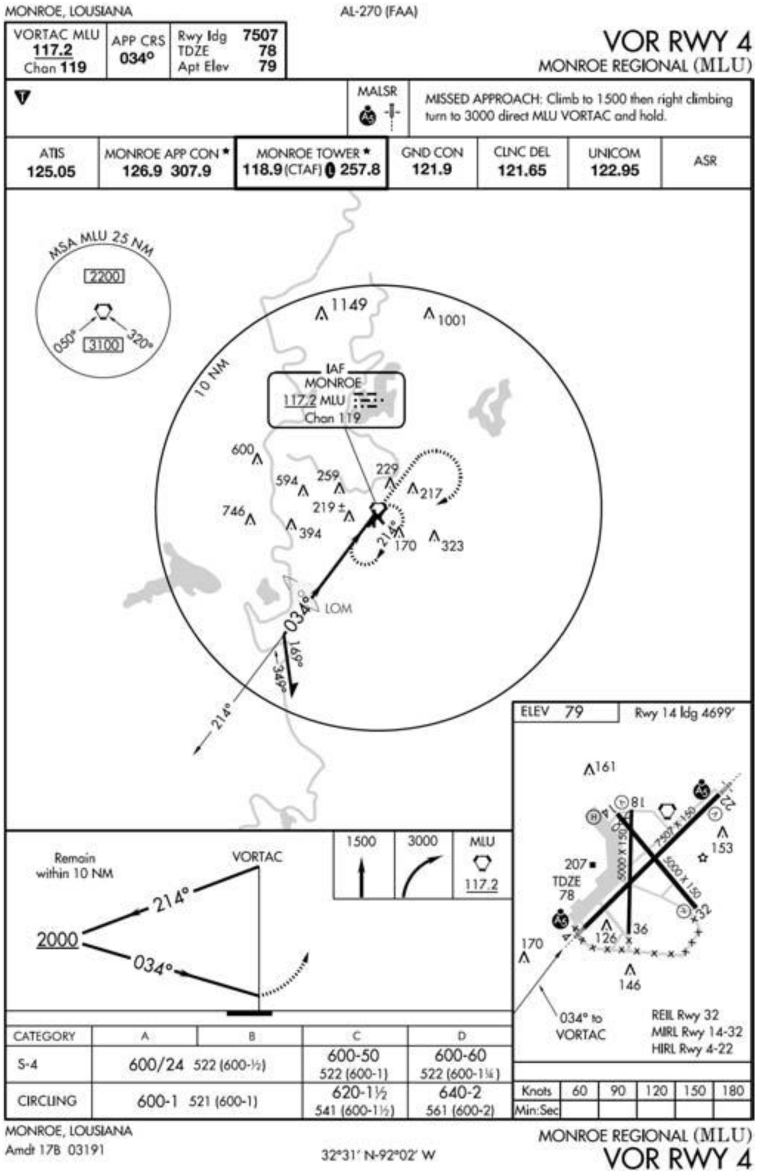
11.4.1.1. NOTE: The FAA recommends a maximum airspeed of 200 KIAS while performing procedure turn course reversals, and when possible, USAF aircraft should also observe this speed restriction. If a speed of 200 KIAS is not practical, you must exercise caution to ensure your aircraft remains in the protected airspace provided by TERPS.

11.5. Methods for Flying Procedure Turns. There are three common methods for executing a procedure turn course reversal: the holding technique, the 45/180, and the 80/260. Regardless of the method you choose to fly the procedure turn, take the following two notes into consideration when planning your approach:

11.5.1. Plan the outbound leg to allow enough time for configuration and any descent required prior to the FAF. ***Adjust the outbound leg length to ensure your aircraft will stay inside the "remain within distance" noted on the profile view of the approach plate.*** The remain within distance is measured from the procedure turn fix unless the IAP specifies otherwise. At the completion of the outbound leg, turn to intercept the procedure turn course inbound.

11.5.2. When the NAVAID is on the field and no FAF is depicted (Figure 11.7), plan the outbound leg so the descent to MDA can be completed with sufficient time to acquire the runway and position the aircraft for a normal landing. Consideration should be given to configuring on the outbound leg to minimize pilot tasking on final. When flying this type of approach, the FAF is considered to be the point when you begin your descent from the procedure turn completion altitude. Since this point is considered the FAF, you should establish approach configuration and airspeed prior to departing procedure turn completion altitude unless your aircraft flight manual procedures require otherwise.

Figure 11.7. Procedure Turn Approach with No FAF Depicted.



11.6. Holding Method.

Enter the procedure turn according to the holding procedures described in Chapter 8 with the following exceptions:

11.6.1. If your heading is within 90° of the outbound procedure turn course, you may use normal lead points to intercept the procedure turn course outbound.

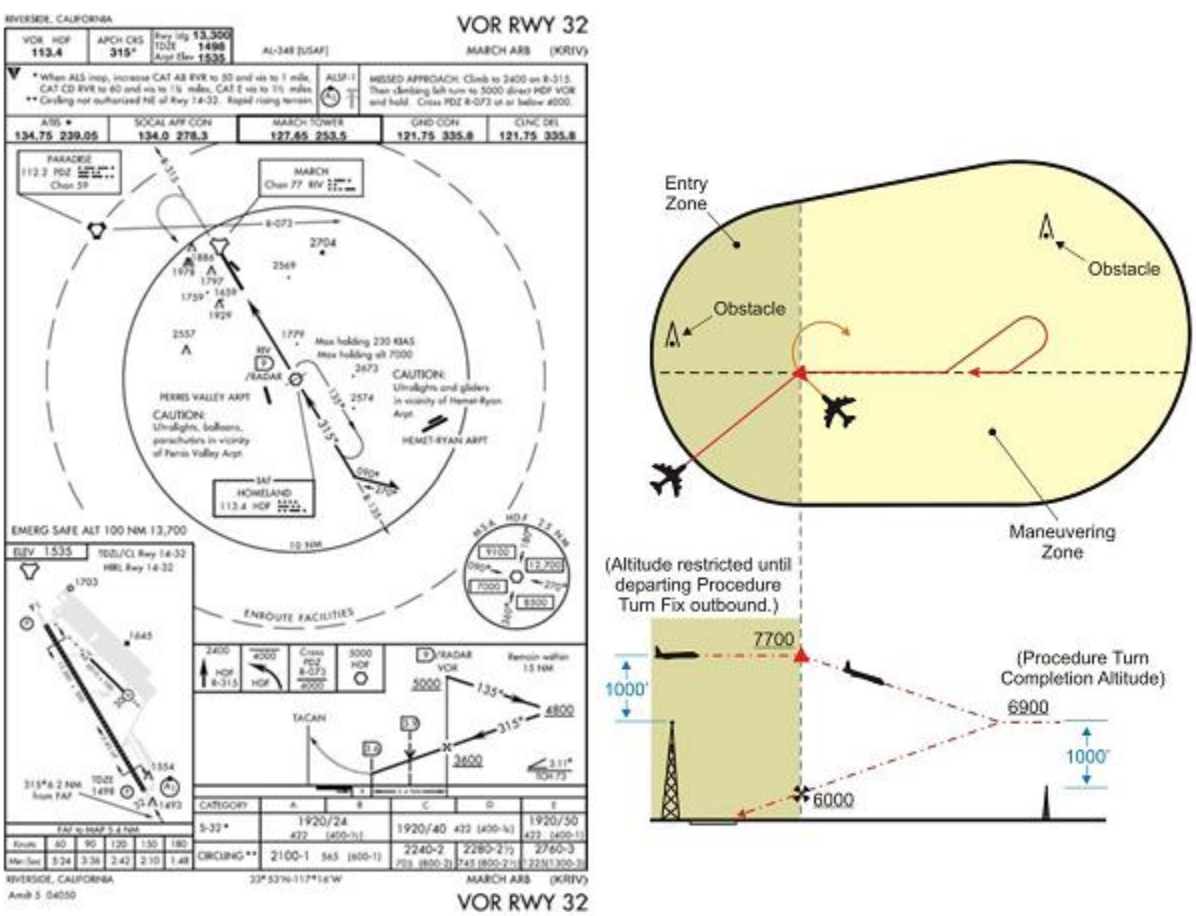
11.6.2. ***If you elect a teardrop entry, your teardrop course must be within 30 degrees of the procedure turn course.*** Use course guidance if it is available.

11.6.3. ***If you intercept the procedure turn course outbound, maintain the course for the remainder of the outbound leg, then turn toward the maneuvering side to reverse course.***

11.6.4. Timing. ***Begin timing once you are outbound abeam the procedure turn fix. If you cannot determine the abeam position while in the turn, start timing after completing the outbound turn.***

11.6.5. Descent. ***Do not descend from the procedure turn fix altitude (published or assigned) until abeam the procedure turn fix heading outbound. If unable to determine when you are abeam, start descent after completing the outbound turn. Do not descend from the procedure turn completion altitude until established on the inbound segment of the approach.*** Some procedures may contain a note in the chart profile that says "Maintain (altitude) or above until established outbound for procedure turn". Newer procedures will simply depict an "at or above" altitude at the PT fix without a note. Both are there to ensure required obstacle clearance is provided in the procedure turn entry zone (Figure 11.8). Absence of a chart note or a specified minimum altitude adjacent to the PT fix is an indication that descent to the procedure turn altitude can commence immediately upon crossing over the PT fix, regardless of the direction of flight.

Figure 11.8. PT Fix Altitude.



11.7. The 45°/180° and the 80°/260° Course Reversals. Two other methods to accomplish a procedure turn approach are the 45°/180° and the 80°/260° course reversal maneuvers. The procedures for flying each maneuver are identical with the exception of the actual course reversal.

11.7.1. Entry. Upon reaching the procedure turn fix, turn in the shortest direction to intercept the procedure turn course outbound. Use normal lead points if practical.

11.7.2. Proceeding Outbound. ***Intercept and maintain the procedure turn course outbound as soon as possible after passing the procedure turn fix.***

11.7.3. Descent. ***Do not descend from the procedure turn fix altitude (published or assigned) until abeam the procedure turn fix and on a parallel or intercept heading to the outbound track. Do not descend from the procedure turn completion altitude until established on the inbound segment of the approach.***

11.7.3.1. NOTE: When flying procedure turns designed in FAA airspace, there is no requirement to wait until you are on a parallel or intercept heading to begin descent from the procedure turn fix altitude; however, when flying these types of course reversals in ICAO airspace, this procedure is MANDATORY due to different TERPS criteria. In the interest of forming good habit patterns, the ICAO method has been adopted by the USAF as procedural.

11.7.4. Executing the Course Reversal Maneuver. ***At the appropriate time on the outbound leg, begin the course reversal maneuver. In both cases, comply with the published remain within distance.***

11.7.4.1. The 45°/180°. ***To begin the reversal maneuver, turn 45° away from the outbound track toward the maneuvering side.*** Begin timing upon initiating the 45° turn; time for 1 minute (Categories A and B) or 1 minute and 15 seconds (Categories C, D, and E); then begin a 180° turn in the opposite direction from the initial turn to intercept the procedure turn course inbound.

11.7.4.2. The 80°/260°. ***To begin the reversal maneuver, make an 80° turn away from the outbound track toward the maneuvering side followed by an immediate 260° turn in the opposite direction to intercept the inbound course.***

11.8. Holding Pattern in Lieu of Procedure Turn (HILO PT). The HILO PT is another common way to execute a low altitude course reversal. The HILO PT is depicted like any other holding pattern except the holding pattern track is printed with a heavy black line ( ) in the plan view. The depiction of the approach in the profile view varies depending on where the descent should begin.

11.8.1. Flying the Holding Pattern. The holding pattern should be flown as depicted, to include leg length or timing. ***Enter and fly the HILO PT holding pattern according to the holding procedures described in Chapter 8.***

11.8.2. Descent. Descent from the minimum holding altitude may be depicted in two ways: descent at the holding fix or descent on the inbound leg. ***When a descent is depicted on the inbound leg, you must be established on the inbound segment of the approach before beginning the descent.***

11.8.3. Additional Guidance for HILO PTs. ***If cleared for the approach while holding in a published HILO PT, complete the holding pattern and commence the approach without making additional turns in the holding pattern (altitude permitting).*** If an additional turn is needed to lose excessive altitude, request clearance from ATC since additional circuits of the holding pattern are not expected by ATC. If the aircraft is at an altitude from which the approach can be safely executed and you are ready to turn inbound immediately, you may request approval for an early turn from ATC.

11.9. Procedural Tracks.

11.9.1. Depiction. There is no specific depiction for a procedural track. (Figures 11.9, 11.10 and 11.11) It may employ arcs, radials, courses, turns, etc. When a specific flight path is required, procedural track symbology is used to depict the flight path between the IAF and FAF. The depiction used is a heavy black line showing intended aircraft ground track.

Figure 11.9. Procedure Track Approach (Straight-in).

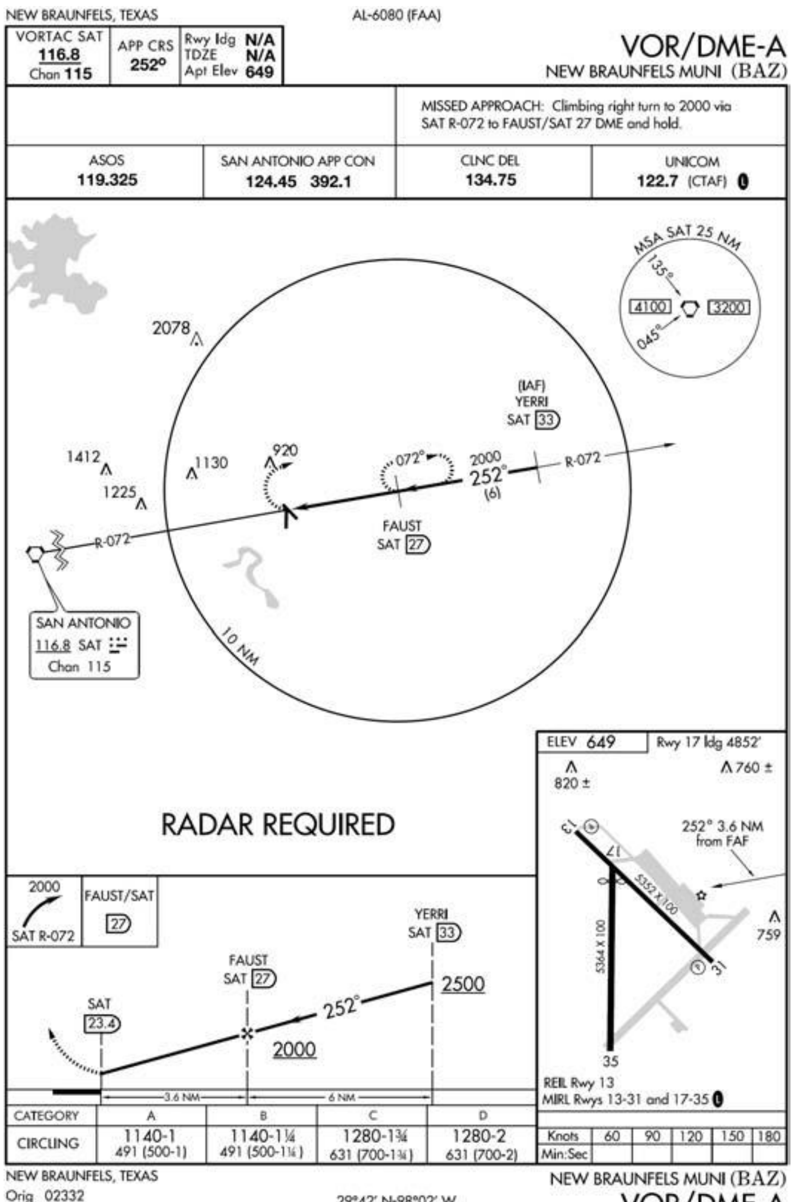
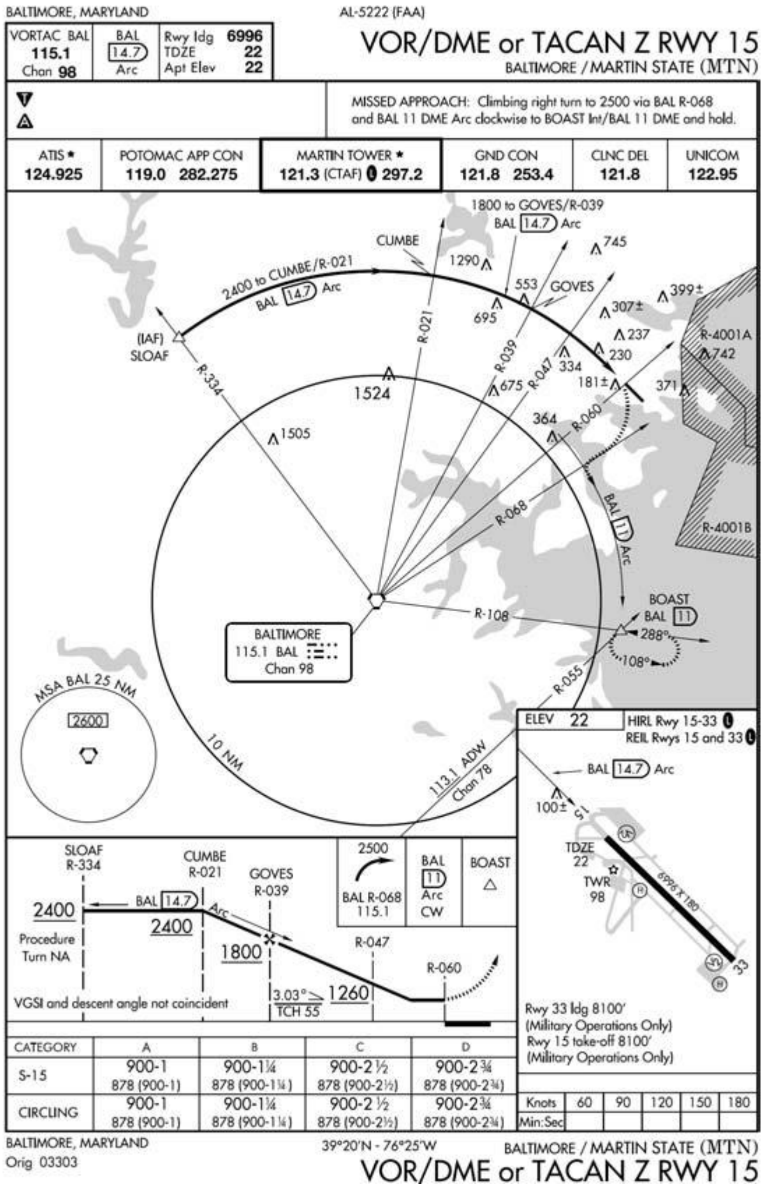
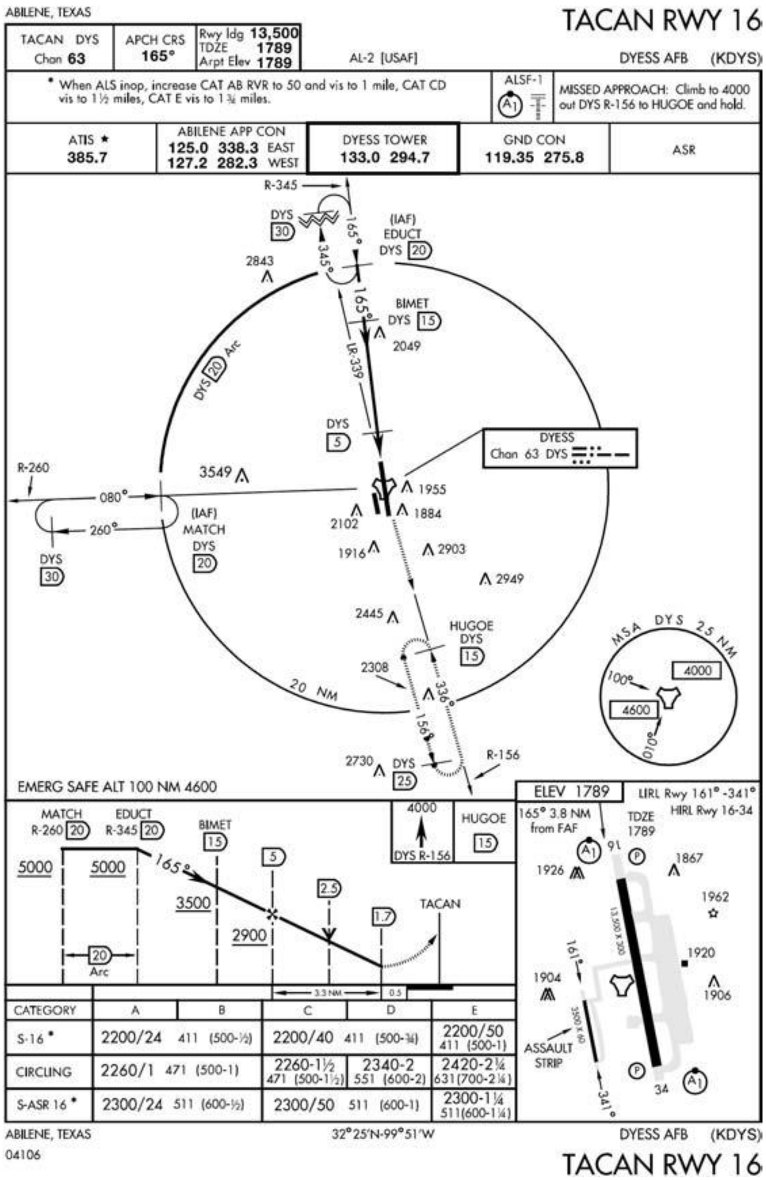


Figure 11.10. Procedure Track Approach (Arcing Final).



CATEGORY	A	B	C	D
S-15	900-1 878 (900-1)	900-1¼ 878 (900-1¼)	900-2½ 878 (900-2½)	900-2¾ 878 (900-2¾)
CIRCLING	900-1 878 (900-1)	900-1¼ 878 (900-1¼)	900-2½ 878 (900-2½)	900-2¾ 878 (900-2¾)

Figure 11.11. Procedure Track Approach (Arc to Radial).



11.9.2. Entry. ***When over the IAF, turn immediately in the shorter direction to intercept the published track.*** If your heading is within 90° of the procedure track course, you may use normal lead points to intercept the course. If your heading is not within 90° of the course, overfly the fix and turn in the shorter direction to intercept the procedure track course.

11.9.3. Maneuvering. ***Conform to the specific ground track shown on the IAP.*** Where a teardrop turn is depicted, you may turn to the inbound course at any time unless otherwise restricted by the approach plate. Determine when to turn by using the aircraft turn performance, winds, and the amount of descent required on the inbound course; however, ***do not exceed the published remain within distance.***

11.9.4. **Descent.** A descent can be depicted at any point along the procedural track.

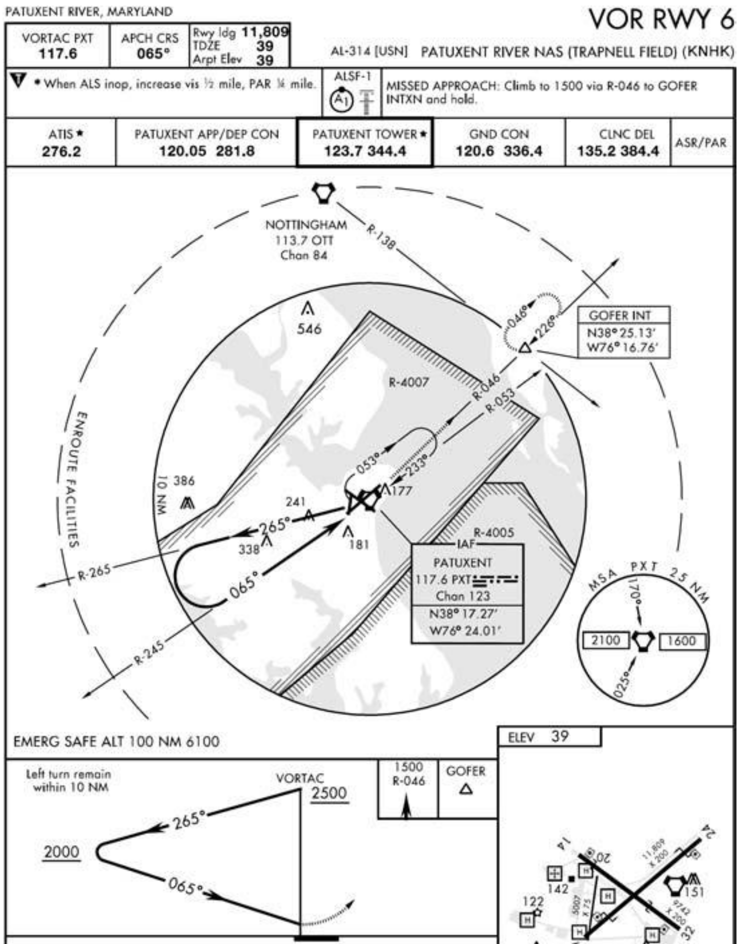
11.9.4.1. IAF. ***When a descent is depicted at the IAF, start descent when abeam or past the IAF and on a parallel or intercept heading to the procedural track course.*** Except for initial descents at an IAF, be established on the appropriate segment of the procedural track before descending to the next altitude shown on the IAP.

11.9.4.1.1. Note: Low altitude approaches may include arc-to-radial, arc-to localizer and radial-to-arc combinations. An arc-to-radial and arc-to localizer altitude restrictions apply only while established on that segment of the IAP. Once a lead point is reached and a turn to the next segment is begun, you may consider yourself established on the next segment and descend to the next applicable altitude. ***When an altitude restriction is depicted at a fix defined as an inter a radial and an arc, the restriction must be complied with no later than the completion of the lead turn associated with that fix.*** If the restriction is met during the lead turn, consider yourself established on the next segment, and you may continue to descend to the next applicable altitude restriction.

11.9.4.1.2. CAUTION: Maximum designed obstacle clearance is based on your ability to maintain the course centerline; you must use your position orientation and your judgment to determine when to descend while attempting to intercept the procedural track.

11.9.4.2. Teardrop. (Figure 11.12) ***Where a teardrop is depicted, do not descend from the turn altitude until you are established on the inbound segment of the procedural track.***

Figure 11.12. Procedure Track Approach (Teardrop).



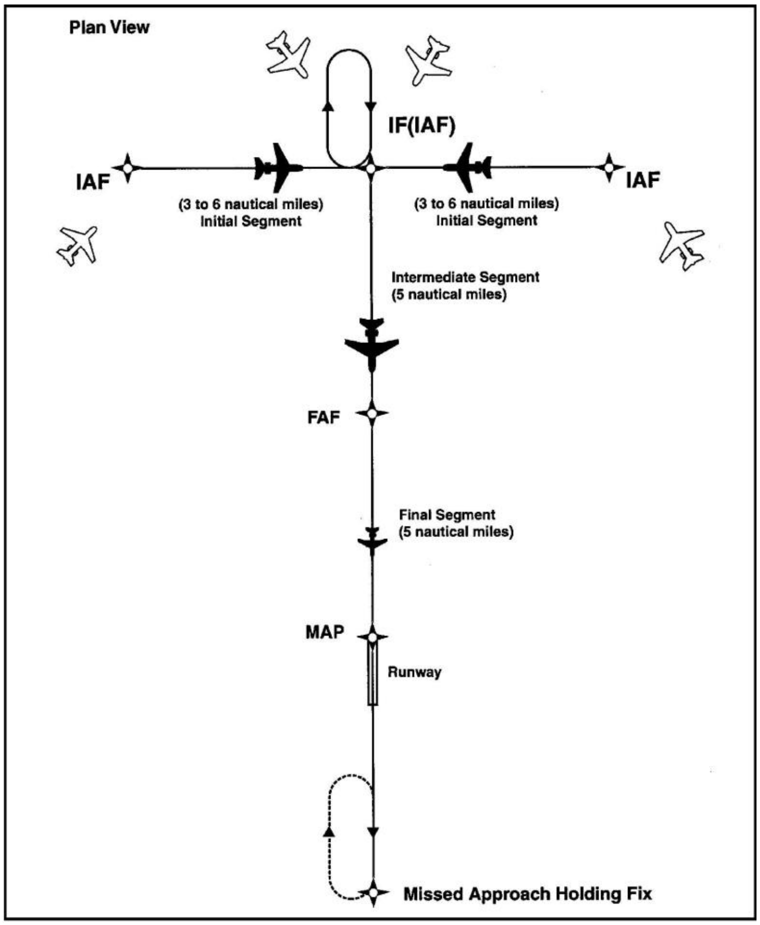
CATEGORY	A	B	C	D
S-6	640-½	601 (700-½)	640-1¼ 601 (700-1¼)	640-1½ 601 (700-1½)
CIRCLING	640-1 601 (700-1)		640-1¾ 601 (700-1¾)	640-2 601 (700-2)
S-PAR 6	139-¼	100	(100-¼) GS 3.0°	

11.10. RNAV (GPS) Entry Procedures Via the Terminal Arrival Area (TAA). Entry for RNAV (GPS) approaches is normally accomplished via the TAA. Entry may be accomplished either via a NoPT routing, or via a course reversal maneuver if depicted.

11.10.1. Objective. The objective of the TAA is to provide a seamless transition from the en route structure to the terminal environment for arriving aircraft equipped with Flight Management System (FMS) and/or Global Positioning System (GPS) navigational equipment. The TAA will not be found on all RNAV procedures, particularly in areas of heavy concentration of air traffic. When the TAA is published, it replaces the MSA for that approach procedure.

11.10.2. The TAA structure. The RNAV procedure underlying the TAA will be the "T" design (also called the "Basic T"), or a modification of the "T." The "T" design incorporates from one to three IAFs; an intermediate fix (IF) that serves as a dual purpose IF (IAF); a final approach fix (FAF), and a missed approach point (MAP) usually located at the runway threshold (see Figure 11.13). The three IAFs are normally aligned in a straight line perpendicular to the intermediate course, which is an extension of the final course leading to the runway, forming a "T." The initial segment is normally from 3-6 NM in length; the intermediate 5-7 NM, and the final segment 5 NM. Specific segment length may be varied to accommodate specific aircraft categories for which the procedure is designed. However, the published segment lengths will reflect the highest category of aircraft normally expected to use the procedure.

Figure 11.13. Terminal Arrival Area (TAA).

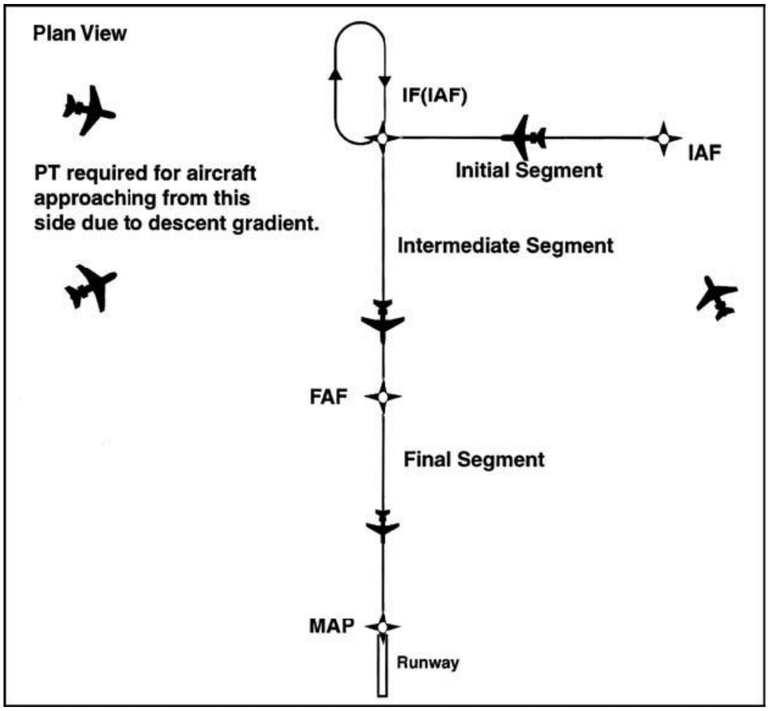


11.10.3. Holding-in-Lieu Entry. A standard racetrack holding pattern may be provided at the center IAF, and if present may be necessary for course reversal and for altitude adjustment for entry into the procedure. In the latter case, the pattern provides an extended distance for the descent required by the procedure. Depiction of this pattern in U.S. Government publications will utilize the "hold-in-lieu-of-PT" holding pattern symbol.

11.10.4. Entry via NoPT routing. 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. ***The pilot may elect to use the course reversal pattern when it is not required by the procedure, but must inform air traffic control and receive clearance to do so.***

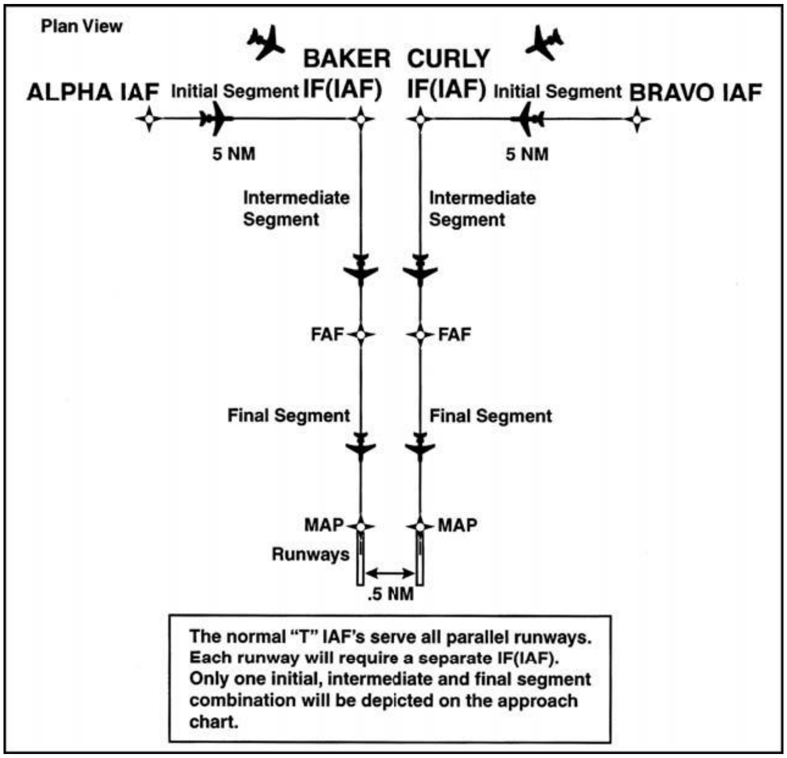
11.10.4.1. Modified “T” designs. The "T" design may be modified by the procedure designers where required by terrain or air traffic control considerations (Figure 11.14). For instance, the "T" design may appear more like a regularly or irregularly shaped "Y", or may even have one or both outboard IAFs eliminated resulting in an upside down "L" or an "I" configuration. Further, the leg lengths associated with the outboard IAFs may differ.

Figure 11.14. Modified T Design.



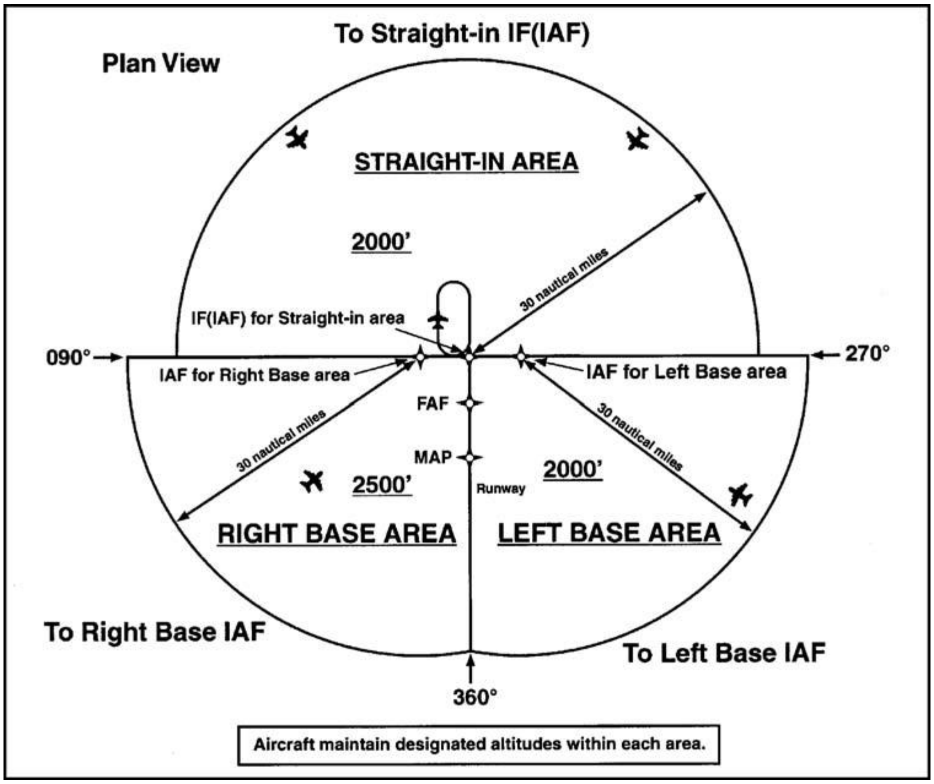
11.10.4.1.1. Parallel Runway “T”. Another modification of the "T" design may be found at airports with parallel runway configurations (Figure 11.15). Each parallel runway may be served by its own "T" IAF, IF (IAF), and FAF combination, resulting in parallel final approach courses. Common IAFs may serve both runways; however, only the intermediate and final approach segments for the landing runway will be shown on the approach chart.

Figure 11.15. Parallel T Design.



11.10.5. TAA areas. The standard TAA consists of three areas defined by the extension of the IAF legs and the intermediate segment course (Figure 11.16). These areas are called the straight-in, left-base, and right-base areas. TAA area lateral boundaries are identified by magnetic courses TO the IF (IAF). The straight-in area can be further divided into pie-shaped sectors with the boundaries identified by magnetic courses TO the IF (IAF), and may contain stepdown sections defined by arcs based on RNAV distances (DME or ATD) from the IF (IAF). The right/left-base areas can only be subdivided using arcs based on RNAV distances from the IAFs for those areas. Minimum MSL altitudes are charted within each of these defined areas/subdivisions that provide at least 1,000 feet of obstacle clearance, or more as necessary in mountainous areas.

Figure 11.16. Standard TAA Area.

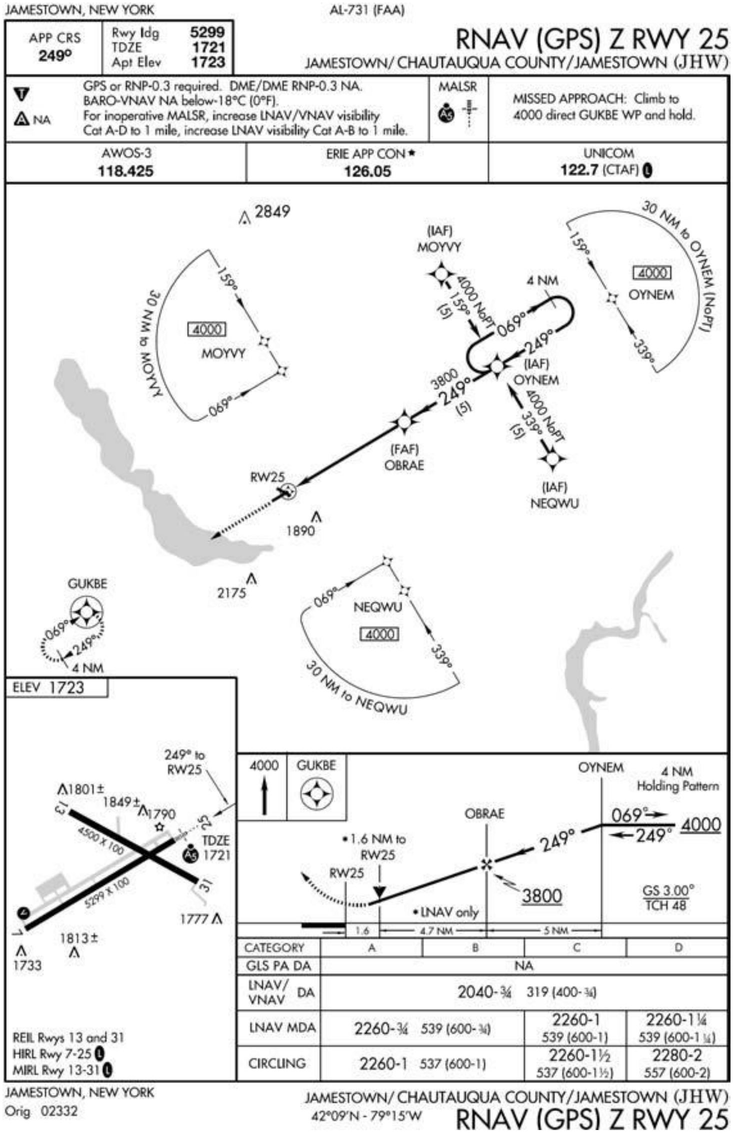


11.10.6. Selecting the Entry IF. ***Prior to arriving at the TAA boundary, the pilot should determine which area of the TAA the aircraft will enter by selecting the IF (IAF) and determine the magnetic bearing TO the IF (IAF). That bearing should then be compared with the published bearings that define the lateral boundaries of the TAA areas.*** This is critical when approaching the TAA near the extended boundary between the left and right-base areas, especially where these areas contain different minimum altitude requirements.

11.10.7. Proceeding Direct to IAF. ***Pilots entering the TAA and cleared by air traffic control are expected to proceed directly to the IAF associated with that area of the TAA at the altitude depicted, unless otherwise cleared by air traffic control. If in doubt, query ATC. Pilots entering the TAA with two-way radio communications failure must maintain the highest altitude assigned, expected, or filed until arriving at the appropriate IAF.***

11.10.8. Depiction of TAA Icons. Depiction of the TAA on U.S. Government charts will be through the use of icons located in the plan view outside the depiction of the actual approach procedure (Figure 11.17). Use of icons is necessary to avoid obscuring any portion of the "T" procedure (altitudes, courses, minimum altitudes, etc.). The icon for each TAA area will be located and oriented on the plan view with respect to the direction of arrival to the approach procedure, and will show all TAA minimum altitudes and sector/radius subdivisions for that area. The IAF for each area of the TAA is included on the icon where it appears on the approach, to help the pilot orient the icon to the approach procedure. The IAF name and the distance of the TAA area boundary from the IAF are included on the outside arc of the TAA area icon. Examples here are shown with the TAA around the approach to aid pilots in visualizing how the TAA corresponds to the approach and should not be confused with the actual approach chart depiction.

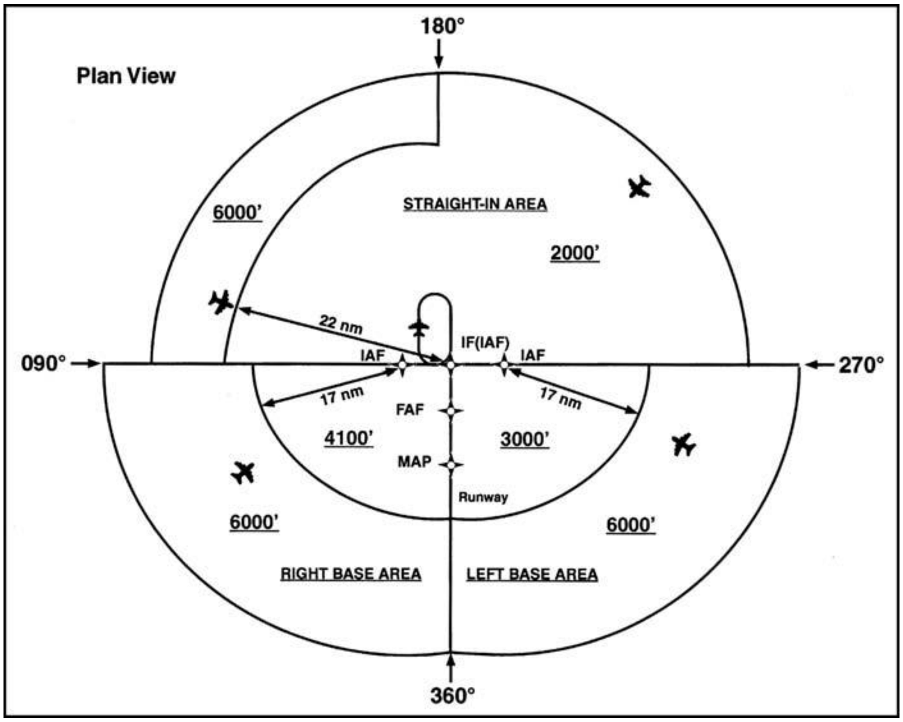
Figure 11.17. RNAV GPS Approach With TAA.



11.10.9. Waypoint names. Each waypoint on the "T", except the missed approach waypoint, is assigned a pronounceable 5-character name used in air traffic control communications, and which is found in the RNAV databases for the procedure. The missed approach waypoint is assigned a pronounceable name when it is not located at the runway threshold.

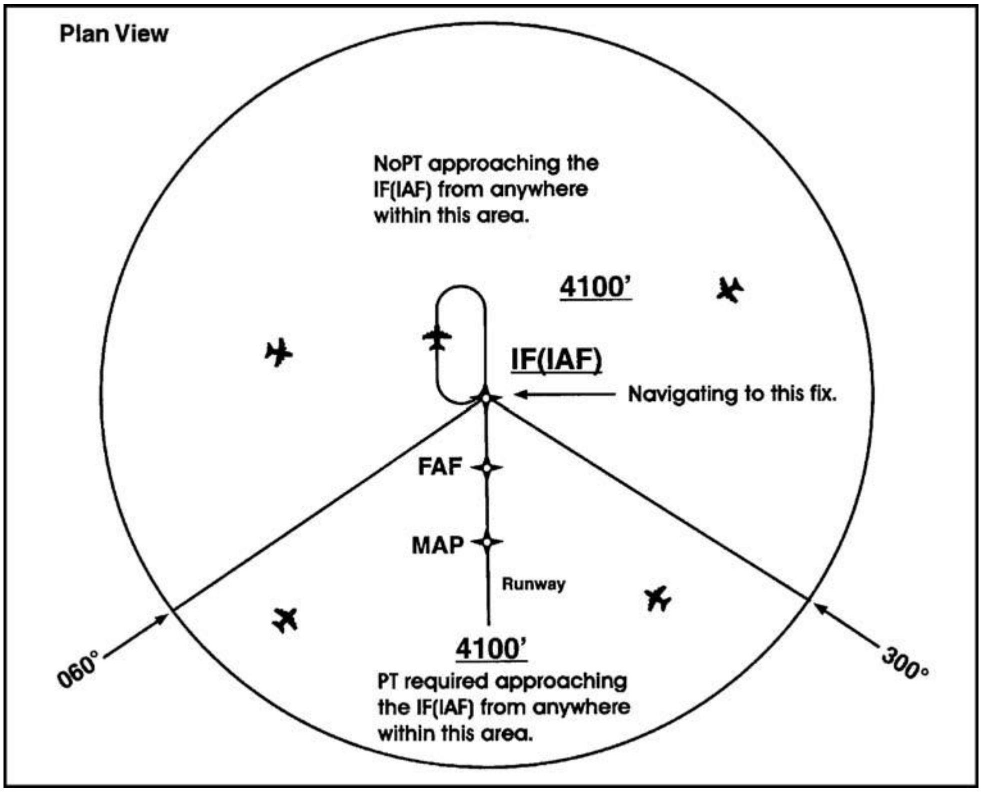
11.10.10. Descents. ***Once cleared to fly the TAA, pilots are expected to obey minimum altitudes depicted within the TAA icons, unless instructed otherwise by air traffic control.*** In Figure 11.18, pilots within the left or right-base areas are expected to maintain a minimum altitude of 6,000 feet until within 17 NM of the associated IAF. After crossing the 17 NM arc, descent is authorized to the lower charted altitudes. Pilots approaching from the northwest are expected to maintain a minimum altitude of 6,000 feet, and when within 22 NM of the IF (IAF), descend to a minimum altitude of 2,000 feet MSL until reaching the IF (IAF).

Figure 11.18. Descents in TAA.



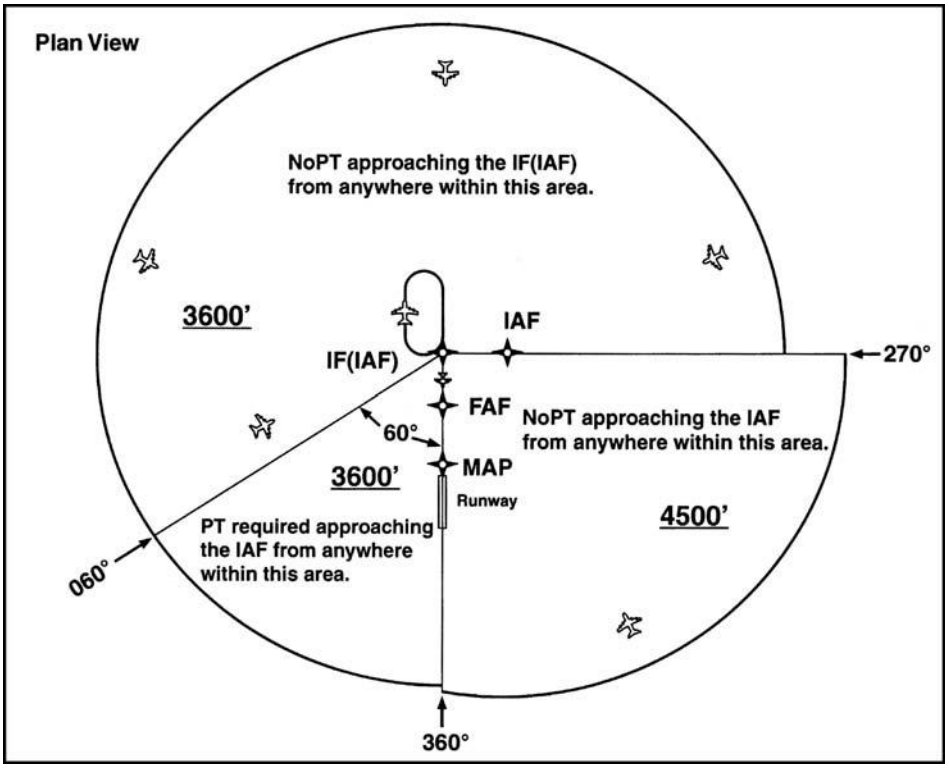
11.10.11. Entry procedures for Modified TAAs. Just as the underlying "T" approach procedure may be modified in shape, the TAA may contain modifications to the defined area shapes and sizes. Some areas may even be eliminated, with other areas expanded as needed. Figure 11.19 is an example of a design limitation where a course reversal is necessary when approaching the IF (IAF) from certain directions due to the amount of turn required at the IF (IAF). Design criteria require a course reversal whenever this turn exceeds 120 degrees. In this generalized example, pilots approaching on a bearing TO the IF (IAF) from 300° clockwise through 060° are expected to execute a course reversal. The term "NoPT" will be annotated on the boundary of the TAA icon for the other portion of the TAA.

Figure 11.19. Entry Procedures for Modified TAAs.



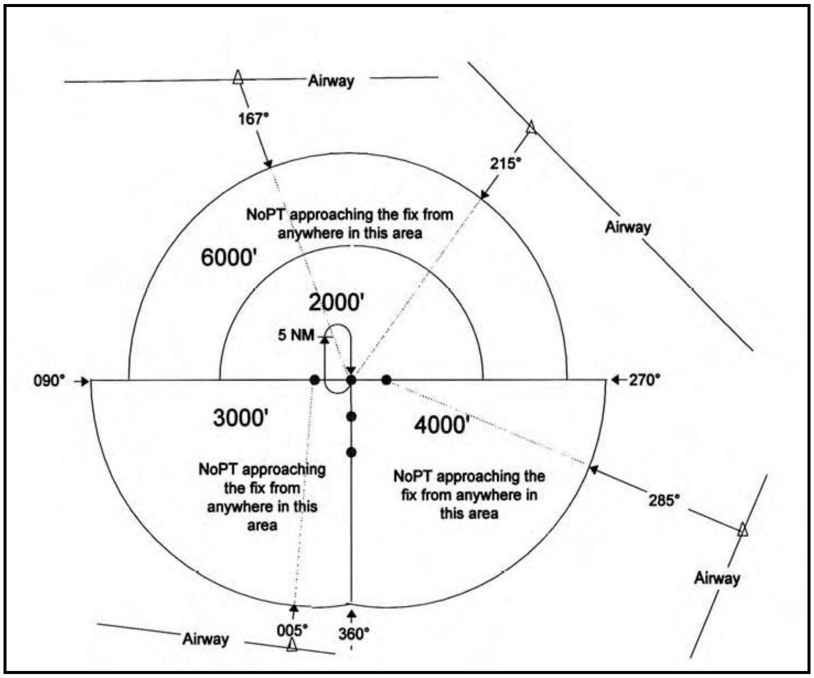
11.10.12. Entry Procedures for one-base TAAs. Figure 11.20 depicts another TAA modification that pilots may encounter. In this generalized example, the right-base area has been eliminated. Pilots operating within the TAA between 360° clockwise to 060° bearing TO the IF (IAF) are expected to execute the course reversal in order to properly align the aircraft for entry onto the intermediate segment. Aircraft operating in all other areas from 060° clockwise to 360° degrees bearing TO the IF (IAF) need not perform the course reversal, and the term "NoPT" will be annotated on the TAA boundary of the icon in these areas.

Figure 11.20. Entry Procedures for One-Base TAAs.



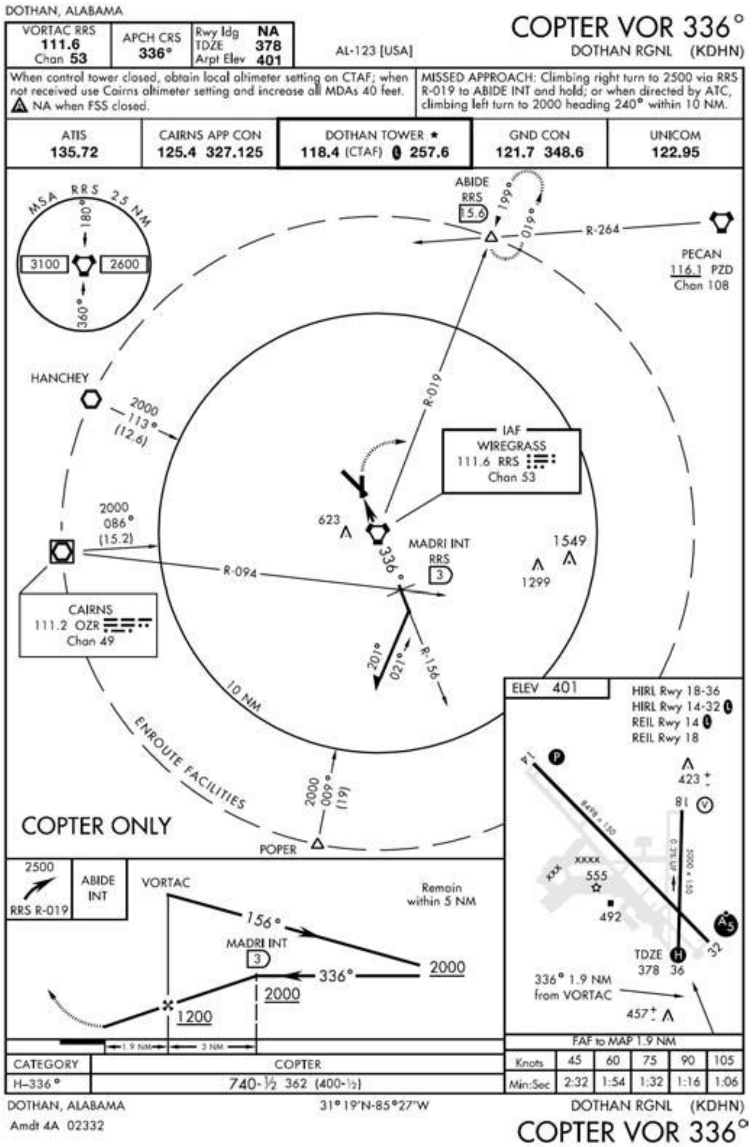
11.10.13. Feeder Routes. When an airway does not cross the lateral TAA boundaries, a feeder route will be established to provide a transition from the en route structure to the appropriate IAF (Figure 11.21). Each feeder route will terminate at the TAA boundary, and will be aligned along a path pointing to the associated IAF. ***Pilots should descend to the TAA altitude after crossing the TAA boundary and cleared by air traffic control.***

Figure 11.21. TAA with Feeders from an Airway.



11.11. Helicopter Only Approaches (Figure 11 22). Helicopter only approaches are identified by the term "COPTER", the type of facility producing final approach course guidance, and a numerical identification of the final approach course; for example, COPTER VOR 336. The criteria for copter only approaches are based on the unique maneuvering capability of the helicopter at airspeeds not exceeding 90 knots (EXCEPT 70 KIAS when on the final approach or missed approach segment and, if annotated, in holding. See AFI 11-202V3). On the basis of this airspeed, these special helicopter only approaches may be used with the helicopter being considered an approach Category A aircraft. These approaches should all be considered "straight-in" and, therefore, a visibility only approach may be accomplished. Once the instrument approach has been accomplished, you should plan to touch down on the threshold of the procedure runway or helipad. If there are several helipads, the designated instrument helipad will be identified using “negative symbology”.

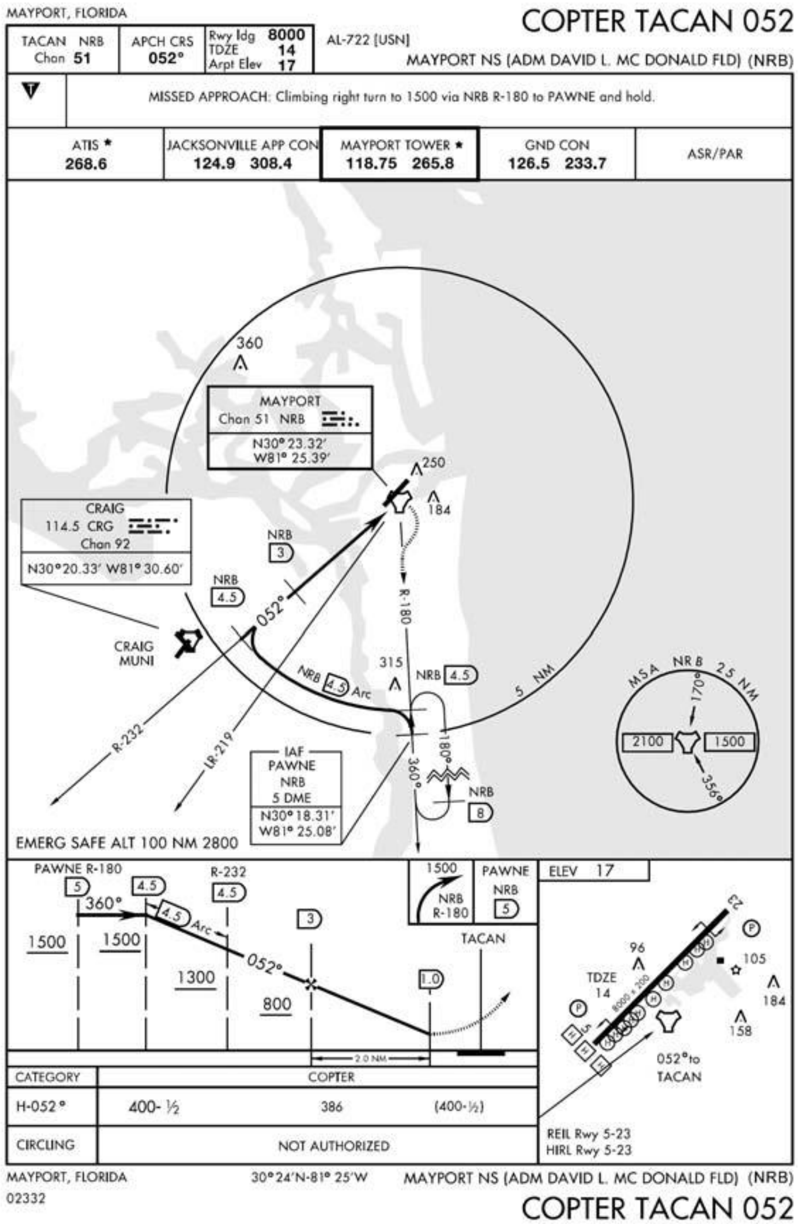
Figure 11.22. Copter Only Approach.



11.11.1. Low Altitude Approach. In a low altitude approach, a maximum 400 feet per nautical mile descent is normally planned. In copter only approaches, however, the gradient may be as high as 800 feet per nautical mile.

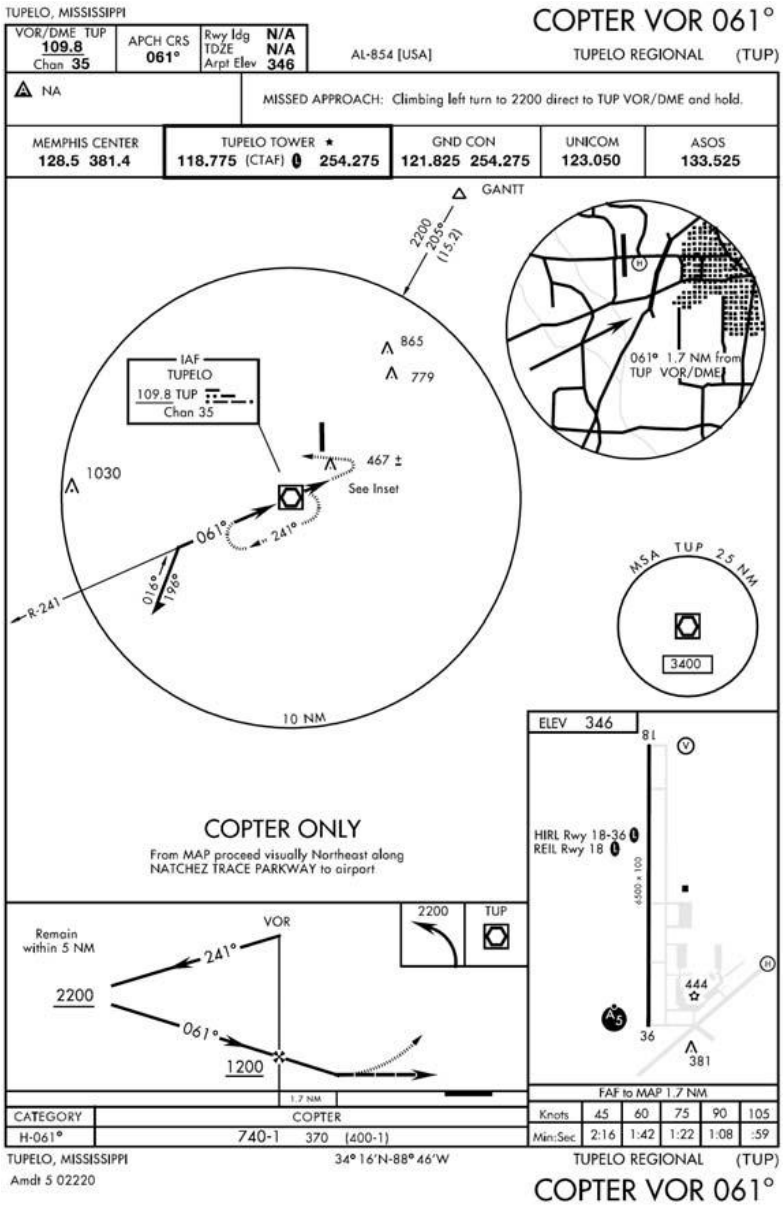
11.11.2. Short Procedures. Looking at Figure 11.23, we can see an example of a very short procedure. The initial approach fix is only .5 miles from the distance measuring equipment (DME) arc procedural track. From the final approach fix (FAF) to the missed approach point (MAP) is 2.3 miles. While this approach should not be difficult to accomplish, careful review could prevent you from becoming rushed during the maneuver.

Figure 11.23. Short Final Approach.



11.11.3. Point In Space. While the point in space approach (Figure 11.24) is rare, it does illustrate how approach design takes advantage of helicopter capability. This approach (see AFMAN 11-226 TERPS) places the helicopter up to 2,600 feet from the landing pad, and the pilot is expected to proceed visually, by ground reference, to the pad. If planning to use this type of approach, pay careful attention to weather conditions upon arrival, as VMC conditions are required to maneuver.

Figure 11.24. Point in Space Approach.



Knots	45	60	75	90	105
Min:Sec	2:16	1:42	1:22	1:08	:59

Chapter 12

FINAL APPROACH

12.1. Final Approach Guidance. There are several types of final approach guidance. For the purposes of this chapter, final approach guidance will be categorized as: Non-radar, Radar, Procedures with a Visual Component (visual approach, contact approach, IAP with a visual segment and charted visual chart procedures), and Other Specialized Procedures (converging approaches, ILS Precision Runway Monitor (ILS/PRM), Simultaneous Offset Instrument Approaches (SOIA), and Transponder Landing System (TLS).) ***Once inside the final approach fix, one navigation receiver available to the pilot flying must remain tuned to and display the facility that provides final approach course guidance.***

12.1.1. Final Approach Components. In general, final approach segments consist of a few basic items: The final approach fix (FAF), stepdown fixes, visual descent point (VDP), missed approach point (MAP), minimum descent altitude (MDA) and decision height/decision altitude (DH/DA). The first four can be defined by a NAVAID, a waypoint, crossing radials of two NAVAIDs, or a radial and DME. The optimum final approach course length is 5 miles but may be as long as 10 miles.

12.1.1.1. The FAF is the point where the final approach begins and will be depicted by a Maltese cross in the profile view of the approach along with a recommended, minimum, or mandatory crossing altitude. Normally, aircraft will cross the FAF at approach speed in the landing configuration. Certain extenuating circumstances or unique aircraft procedures may cause procedural variations but the pilot should strive to have the aircraft on a stabilized profile by the FAF in order to mitigate spatial disorientation or deviations from the approach.

12.1.1.2. Stepdown Fixes. Some non-precision approaches may have one or more stepdown fixes between the FAF and the MAP. These fixes are normally included to avoid an obstacle inside the FAF. ***Descent below stepdown fix altitude is limited to aircraft capable of simultaneous reception of final approach course guidance and the stepdown fix.*** Regardless of the type or number of navigation facilities used to define the stepdown fix, one navigation receiver must remain tuned to and display final approach course guidance. For example, aircraft equipped with a single VOR receiver will not descend below a stepdown fix altitude when two VOR radials define that fix.

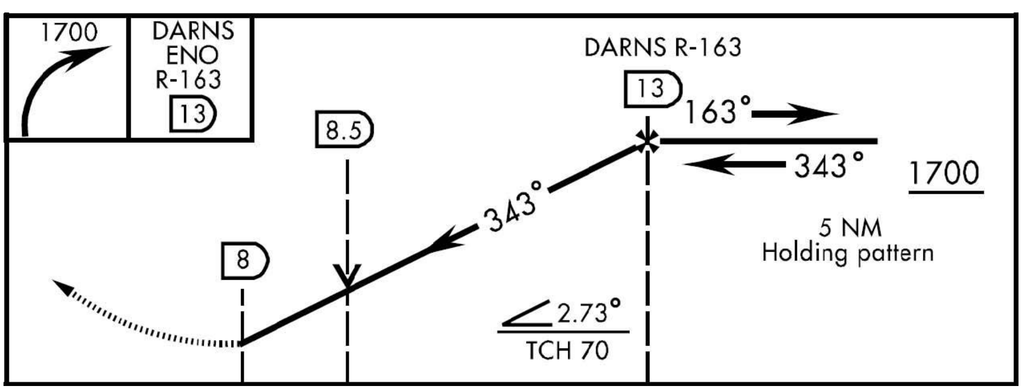
12.1.1.3. The VDP is a defined point on the final approach course of a non-precision straight-in approach procedure from which a normal descent (approximately 3°) from the MDA to the runway touchdown point may be commenced, provided visual reference with the runway environment is established. The VDP is normally identified by DME and is computed for the non-precision approach with the lowest MDA on the IAP. A 75 MHz marker may be used on those procedures where DME cannot be implemented. VDPs are not a mandatory part of the procedure, but are intended to provide additional guidance where they are implemented. A visual approach slope indicator (VASI) lighting system is normally available at locations where VDPs are established. Where VASI is installed, the VDP and VASI glide paths are normally coincident. If VASI is not installed, the descent is computed from the MDA to the runway threshold. On multifacility approaches, the depicted VDP will be for the lowest MDA published. Therefore, on an approach with a higher MDA, the published VDP will not be correct and must be computed by the pilot. No special technique is required to fly a procedure with a VDP; however, to be assured of the proper obstacle clearance, the pilot should not descend below the MDA before reaching the VDP and acquiring the necessary visual reference with the runway environment. The VDP is identified on the profile view of the approach chart by the symbol "V" (Figure 12.1.)

12.1.1.3.1. In some cases a published VDP may be absent from an IAP due to an obstacle that penetrates a 20:1 surface. In addition, there was a period of time where the FAA did not place any emphasis on publishing VDPs on IAPs. As a result, many IAPs were designed without published VDPs. When an IAP is published without a VDP, there is currently no way for the pilot to know why. WARNING: While pilots should calculate a VDP if one is not published, if performing a non-precision approach to an unfamiliar field at night (or very low visibility) without a published VDP, and no visual or "normal" electronic glide path guidance to that runway is available, use extreme caution when departing the MDA, as there may be an obstacle penetrating the 20:1 surface. Unless familiar with the airfield, if visibility is limited, consider remaining at the MDA even if the runway environment is in sight if terrain and obstacles along the final approach cannot be discerned. See Chapter 15, Visual Glide Slope Indicators (VGSI) for more information on obstacles in the 20:1 surface.

12.1.1.3.2. One technique for calculating a VDP is to divide the HAT by the glideslope in degrees times 100. For instance, for a HAT of 450 feet and a desired glideslope to the runway of 3 degrees, divide 450 by (3 x 100) to get 1.5 miles to descend from the MDA to field elevation.

12.1.1.3.3. On approaches with no distance reference (i.e. DME), another technique involves making a calculation based on final approach timing. For most aircraft in the USAF inventory, about 10 percent of the HAT in seconds is the approximate amount of time needed to descend from the HAT to the runway on a normal glidepath. Using the numbers in the previous example, 10 percent of the 450 foot HAT would put the VDP 45 seconds prior to the end of the runway. For a final approach that is six miles long and a groundspeed of 180 knots (3 miles per minute), total time from FAF to the runway is 2 minutes. Subtracting 45 seconds from 2 minutes, the VDP would occur 1 minute and 15 seconds past the FAF.

Figure 12.1. Visual Descent Point (VDP).



12.1.1.4. The MAP is the point on non-precision approaches where an aircraft will execute a missed approach if the runway environment is not in sight or a safe landing cannot be accomplished. A more detailed description of the MAP and associated procedures is found in Chapter 14. CAUTION: Depending on the location of the MAP, the descent from the MDA (once the runway environment is in sight) will often have to be initiated prior to reaching the MAP in order to execute a normal (approximately 3°) descent to landing. (See previous discussion on VDPs.) On precision approaches there is no MAP. Rather, the pilot executes the missed approach upon reaching the Decision Altitude (DA).

12.1.2. Flying the approach. In general: Avoid rapid descents on final by crossing the FAF at the published altitude. ***When a turn is required over the FAF, turn immediately and intercept the final approach course to ensure that obstruction clearance airspace is not exceeded. Do not descend to the minimum descent altitude (MDA) or step down fix altitude until past the FAF (if published).*** Note that when the FAF is the NAVAID for the approach, a course change of up to 30 degrees may be required and the approach still be considered a straight-in approach. The Instrument Procedure Designer (TERPS) accounts for turns and designs the procedure to ensure obstacle clearance with a descent commencing at the FAF. Arrive at the MDA with enough time and distance remaining to identify and descend to the runway environment at a normal rate for your aircraft (i.e. At or prior to the VDP.) To determine the approximate initial descent rate required on final approach by referring to the VVI chart in the IAP books or by using one of the formulas for two of the most common glideslopes:

$$3° \text{ glideslope VVI} = \frac{\text{Groundspeed x 10}}{2}$$

$$2½° \text{ glideslope VVI} = \frac{\text{Groundspeed x 10 - 200}}{2}$$

Example: For a final approach groundspeed of 180 knots and a 3° glideslope:

$$\text{VVI} = \frac{180 \text{ x } 10}{2} = 900 \text{ fpm}$$

12.1.2.1. Timing is required when the final approach does not terminate at a published fix***. If timing is required to identify the missed approach point, begin timing when passing the FAF or the starting point designated in the timing block of the approach plate.*** This point is usually the FAF but it may be a fix not co-located with the FAF such as a LOM, NDB, crossing radial, or DME fix. Time and distance tables on the approach chart are based on groundspeed; therefore, the existing wind and TAS must be factored when computing final approach timing.

12.1.2.1.1. If timing is not specifically depicted on the instrument approach procedure, timing is not authorized as a means of identifying the MAP.

12.1.2.1.2. If both timing and another means of identifying the MAP are published (e.g. DME), timing will only be used as a backup unless the other means of MAP identification is not operational or fails during the approach. If the primary means of identifying the MAP indicates arrival over the MAP, do not delay execution of the missed approach based on calculated timing.

12.1.2.2. Runway Environment. ***Descent below MDA/DA/DH is not authorized until sufficient visual reference with the runway environment has been established and the aircraft is in position to execute a safe landing.*** Thorough preflight planning will aid in locating the runway environment (lighting, final approach displacement from runway, etc.) The runway environment consists of one or more of the following elements:

12.1.2.2.1. The approach light system, except that the pilot may not descend below 100 feet above the TDZE using the approach lights as a reference unless the red termination bars or the red side row bars are also visible and identifiable. CAUTION: Most approach lighting systems serving runways where no electronic glide path guidance is available do not have red termination bars or red side row bars.

12.1.2.2.2. The threshold, threshold markings or threshold lights.

12.1.2.2.3. The runway end identifier lights.

12.1.2.2.4. The touchdown zone, touchdown zone markings, or touchdown zone lights.

12.1.2.2.5. The runway or runway markings.

12.1.2.2.6. The runway lights.

12.1.2.2.7. The visual approach slope indicator.

12.2. Non-radar Approaches. Defined as approaches that do not require radar vectoring or radar services on final and may or may not provide electronic glide path guidance. Examples of non-radar approaches include ILS, VOR, TAC, NDB, RNAV/GPS and MLS. Procedures that can be flown with or without glide path guidance using the same final approach course guidance include ILS, MLS, and RNAV/GPS. (There are instances of all of these types of approaches where radar is required to identify some portion of the approach procedure, which will be discussed in a later section.)

12.2.1. ILS (Includes LOC, Localizer Back Course, Localizer Type Directional Aid (LDA), and Simplified Directional Facility (SDF).

12.2.1.1. Required Components. In the United States, the glide slope, localizer, and outer marker are required components for an ILS. If the outer marker is inoperative or not installed, it may be replaced by DME, another NAVAID, a crossing radial, or radar, provided these substitutes are depicted on the approach plate or identified by NOTAM. If the glide slope fails or is unavailable, the approach reverts to an approach without glide path guidance. ***If the localizer fails, the procedure is not authorized. If the OM (or at least one of its substitutes) is not available, then the procedure is not authorized.***

12.2.1.2. Transition to the ILS Localizer Course. This is performed by using either radar vectors or a published approach procedure.

12.2.1.2.1. Tune. Tune the ILS as soon as practicable during the transition, and monitor the identifier during the entire approach.

12.2.1.2.1.1. NOTE: Airborne marker beacon receivers that have a selective sensitivity feature should always be operated in the “Low” sensitivity position to ensure proper reception of the ILS marker beacons.

12.2.1.2.2. Front Course. ***Set the published localizer front course in the course selector window prior to attempting localizer interception.*** The front course is the proper course to set even when flying a back course approach.

12.2.1.2.3. Orientation. Where available, use other NAVAIDs (e.g. TACAN) to help identify the localizer course and glide slope intercept point. (The glide slope has a usable range of 10 miles.) WARNING: It is possible to receive a false or erroneous glide slope signal with both the ground and air components of the glide slope system operating normally, normal ident, and no off flags or warnings, while established on the localizer course. Where available, use other navigational resources to confirm aircraft position on the approach.

12.2.1.3. Localizer signal. The localizer signal typically has a usable range of 18 miles within 10° of the course centerline unless otherwise stated on the IAP. ATC may clear you to intercept the localizer course beyond 18 miles or the published limit, however, this practice is only acceptable when the aircraft is in radar contact and ATC is sharing responsibility for course guidance.

12.2.1.3.1. CAUTION: The ILS/LOC approach must be discontinued if the localizer course becomes unreliable, or any time full-scale deflection of the CDI occurs on final approach. Do not descend below localizer minimums if the aircraft is more than one dot (half scale) below or two dots (full scale) above the glide slope. If the glide slope is recaptured to within the above tolerance, descent may be continued to DA/DH.

12.2.1.3.2. NOTE: If making an autopilot coupled approach or landing, use the aircraft flight manual procedures for the category of ILS approach being conducted. When the weather is below 800 foot ceiling and/or 2 miles visibility, vehicles and aircraft are not authorized in or over the ILS critical area when an arriving aircraft is between the ILS final approach fix and the airport (except for aircraft that land, exit a runway, depart or miss approach). However, ***when autopilot coupled or auto land operations are to be conducted, and the weather is above ceiling 800 feet and/or visibility 2 miles, advise the ATC approach or tower controller as soon as practical but not later than the FAF.*** This will allow time for the appropriate ILS critical area to be cleared or an advisory issued. The advisory used by controllers will be: "Localizer/glide slope signal not protected." In this case be alert for unstable or fluctuating ILS indications that may prevent an autopilot-coupled approach. When aircraft equipment and crew qualification permit, the localizer and glide slope may be used for autopilot operations to the points specified in FLIP for each category of ILS approach, unless a restriction is published on the approach procedure.

12.2.1.3.3. NOTE: Some types of tests performed by ground technicians may produce “erroneous” glide slope or course indications in the cockpit with no off flags. Usually technicians carry out these tests in good weather with the affected runway not in use, however this is not always possible. It is extremely important to monitor for a proper identifier and have current NOTAM information for the approach being flown. You must also listen for your specific approach clearance (i.e. glide slope out of service) in addition to doing a proper altitude check at the glide slope intercept point. Several near Controlled Flight Into Terrain (CFIT) incidents involving commercial airliners highlight the seriousness of this problem.

12.2.1.4. Descent. When on the localizer course, maintain glide slope intercept/FAF altitude (published or assigned) until intercepting the glide slope/passing the FAF. Published altitudes may be minimum, maximum, mandatory, or recommended altitudes. The glide slope intercept altitude is identified by a lightning bolt (). When the glide slope intercept altitude is a recommended altitude, you must only comply with other IAP altitudes (FAF altitude for example) until established on the glide slope. On some ILS approaches a "Glide slope Altitude at Outer Marker/FAF" will be published to allow the pilot to verify proper position on the glideslope when crossing the Outer Marker/FAF. ***Do not descend below a descent restrictive altitude (minimum or mandatory) unless established on final approach course***.

12.2.1.5. Steering Commands. If using pitch and bank steering commands supplied by a flight director system or FMS, monitor flight path and aircraft performance instruments to ensure the desired flight path is being flown and aircraft performance is within acceptable limits. Failure of the flight director computer (steering bars) may NOT always be accompanied by the appearance of warning flags. Steering commands must be correlated with flight path (CDI/GSI) and aircraft performance instruments.

12.2.1.6. Decision Height (DH). DH is a height above touchdown referenced by a radar altimeter and is the height at which a decision must be made during a precision approach to continue the approach or execute a missed approach. ***Do not descend below DH if sufficient visual reference with the runway environment is not established.*** Obstacle clearance is provided to allow a momentary descent below DH while transitioning from the final approach to the missed approach. Definition of runway environment is found in paragraph 12.1.2.2.

12.2.1.7. LOC Procedures Without Glide Path Guidance.

12.2.1.7.1. ***The middle marker may never be used as the sole means of identifying the MAP.*** The middle marker may assist you in identifying the MAP on certain localizer approaches provided it is coincident with the published localizer MAP. To determine the location of the MAP, compare the distance from the FAF to MAP adjacent to the timing block. It may not be the same point as depicted in the profile view. If the MM is received while executing such an approach, and your primary indications (DME and/or timing) agree, you may consider yourself at the MAP and take appropriate action. ***If the middle marker is the only way to identify the MAP (e.g. no timing published and DME out of service), then the approach is not authorized.***

12.2.1.7.2. CAUTION: Approach procedures without glide path guidance (i.e. LOC) published in conjunction with an ILS cannot always clearly depict the FAF crossing altitude. Careful review of the IAP using the following guidance is required. The minimum altitude to be maintained until crossing the fix following the glide slope intercept point (normally the FAF will be the next fix) is the published glide slope intercept altitude, altitude published at that fix, or ATC assigned altitude. For most approaches without glide path guidance the glide slope intercept altitude will be the minimum FAF crossing altitude.

12.2.1.7.3. "Back Course" Localizer. In order to fly a back course localizer approach, ***set the published front course in the course selector window***. The term "front course" refers to the inbound course depicted on the ILS/localizer approach for the opposite runway. On the back course approach plate, the published front course is depicted in the feather as an outbound localizer course.

12.2.2. MLS. There are two types of MLS approaches: non-computed and computed (Figures 12.2 and 12.3). These approaches may be flown in the automatic mode (preferred) or the manual mode. MLS approaches are assumed to be non-computed unless noted on the approach procedure. Computed MLS approaches will have the following note in the plan view of the approach plate: "COMPUTED APPROACH: FOR USE BY AIRCRAFT CAPABLE OF COMPUTING OFFSET RUNWAY CENTERLINE ONLY." An example of a computed approach is provided in Figure 12.2.

Figure 12.2. Computed MLS Approach.

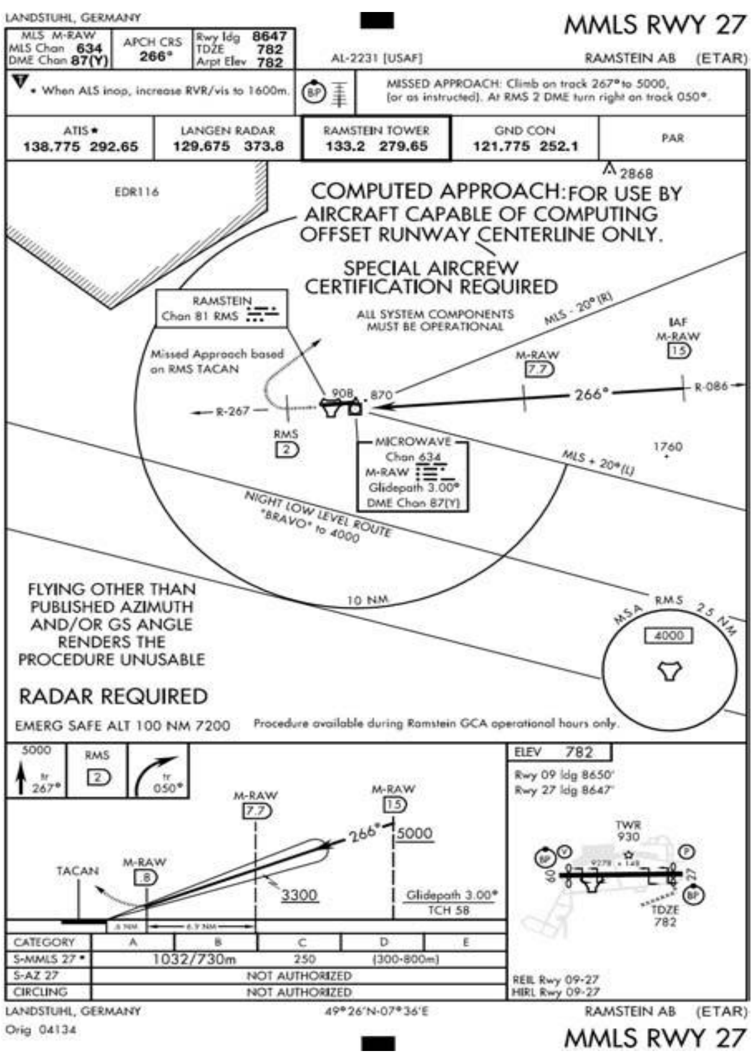
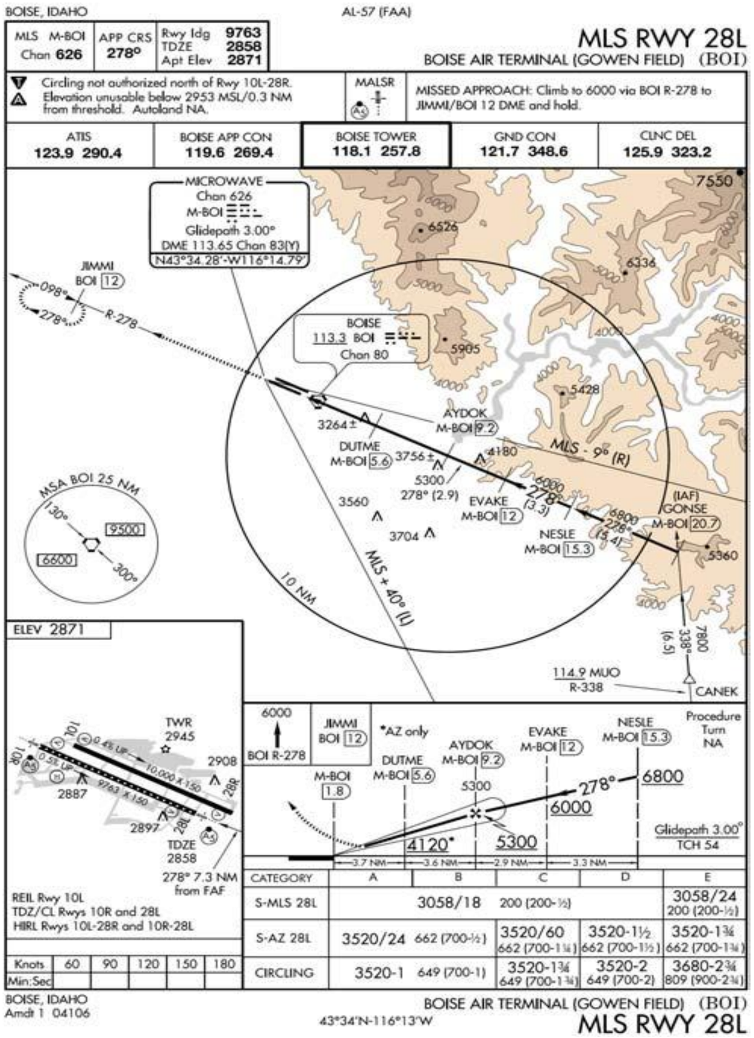


Figure 12.3. Non-Computed MLS Approach at Boise, ID.



12.2.2.1. Non-Computed (Figure 12.4). When flying a non-computed MLS approach, the azimuth signal steers your aircraft to the azimuth antenna just as approaches to traditional NAVAIDs such as VOR or TACAN do. Consequently, it is important for you to know where the azimuth antenna is located on the airfield. In the most common MLS installation, the antenna is located along the runway centerline between 1,000 and 1,500 feet from the departure end of the runway. When flying a non-computed approach to this type of installation, your final approach will normally be lined up along the extended runway centerline. Non-computed approaches should be flown using the default settings (AUTO and NON-COMP) of your MLS equipment.

12.2.2.1.1. Offset Installation. In some installations, the azimuth antenna may be installed alongside the runway (offset). In this case, when flying a non-computed approach, the azimuth guidance will not steer the aircraft to the runway along the extended runway centerline. In this particular configuration, the azimuth is rotated so that the azimuth signal guides the aircraft to the azimuth antenna along a course that is not parallel to the runway centerline. Review the approach plate carefully for notes to that effect and for the arrow leading up to the aerodrome sketch to determine where to look for the runway at the missed approach point.

12.2.2.1.2. WARNING: If you are flying a non-computed MLS approach, and you select the “COMPUTED” approach mode on your MLS equipment, the published approach is no longer valid and the actual approach flown will no longer guarantee obstacle clearance. The only time the “COMPUTED” mode should be selected is when the approach to be flown is a computed approach as indicated on the approach plate.

12.2.2.2. Computed (COMP) (Figure 12.4). A computed MLS approach steers your aircraft to the runway along a course aligned with the extended runway centerline regardless of the location of the ground transmitters. Only aircraft having MLS receivers capable of using computed approach guidance can fly computed approaches. Computed approaches should be flown using the AUTO and COMP settings of your MLS equipment.

12.2.2.2.1. WARNING: In order to fly a computed MLS approach, all system components (AZ, EL, and DME) must be operational. Failure of any component will result in aircraft receiver course and glide slope off/warning flags and loss of course information.

12.2.2.2.2. WARNING: If flying a computed MLS approach and the “NON-COMPUTED” approach mode on the MLS is selected, the published approach is no longer valid and the actual approach flown will no longer guarantee obstacle clearance. “COMPUTED” mode should be selected when the approach to be flown is a computed approach as indicated in the plan view on the approach plate.

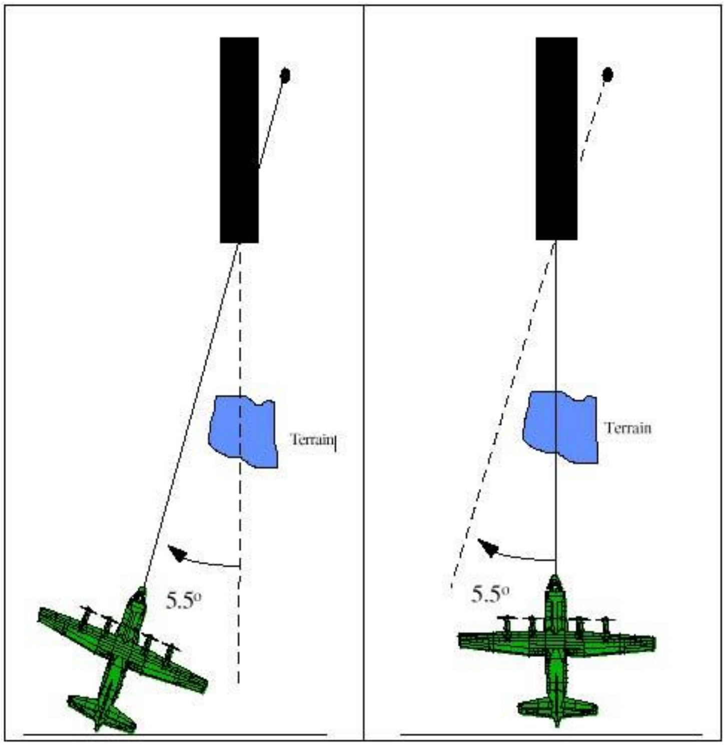
12.2.2.3. Manual vs. Automatic Mode. Likewise, if you switch to manual mode and change either the approach azimuth or glide slope, the IAP you are using is no longer valid.

12.2.2.3.1. Elevation Angle. An elevation angle less than what the approach was designed for may not provide obstacle clearance, and an elevation higher than the published angle mandates higher approach minima.

12.2.2.3.2. Approach Azimuth. Changing the published approach azimuth in manual mode, will steer the aircraft to the runway along a different course than published, which may take the aircraft outside of protected airspace.

12.2.2.3.3. WARNING: If operating in manual mode, selecting an azimuth and/or elevation angle different from the published procedure invalidates the approach and obstacle clearance. Follow MAJCOM directives regarding flying MLS approaches in the manual mode.

Figure 12.4. Non-Computed Mode/Computed Mode.



12.2.2.4. Tune the MLS as soon as practicable during the transition to final and monitor the MLS identifier during the entire approach. The MLS is identified by a four-letter identifier always beginning with the letter "M." The four-letter ident is transmitted at least six times per minute by the approach azimuth (or back azimuth) ground equipment. Some aircraft installations do not include the audible identification feature; in this case, observing the correct 4-letter identifier on the aircraft's avionics display can identify the MLS.

12.2.2.5. Azimuth and Glide Slope Selection. The MLS receiver will automatically select the appropriate azimuth and glide slope as well as tune the TACAN for distance information. When operating in the manual mode, you may change the published azimuth and glide slope angle.

12.2.2.5.1. WARNING: If operating in manual mode and the pilot selects a course and/or glide slope different from the published procedure, the published approach is no longer valid and the actual approach flown will no longer guarantee obstacle clearance.

12.2.2.6. Orientation. Use appropriate navigation facilities (for example: VOR, TACAN, GPS, or NDB) to remain position-oriented during the approach.

12.2.2.7. If using a flight director, it should be configured in accordance with instructions in the aircraft flight manual for the intercept and final approach modes of operation.

12.2.2.7.1. NOTE: aircraft may only fly MMLS approaches with the proper equipment as determined by aircraft flight manual and/or MAJCOM. All other procedures to fly the approach will be the same as for conventional MLS.

12.2.2.7.2. WARNING: The MLS approach must be discontinued if the course becomes unreliable, or any time full-scale deflection of the CDI occurs on final approach. Do not descend below azimuth-only minimums if the aircraft is more than one dot (half scale) below or two dots (full scale) above the glide slope. If the glide slope is recaptured to within the above tolerances, descent may be continued to DH.

12.2.2.7.3. NOTE: If making an autopilot-coupled approach or landing, follow the aircraft flight manual procedures. When autopilot coupled operations are to be conducted, advise the ATC approach controller as soon as practical, but not later than the FAF. This will allow time for the appropriate critical area to be cleared or an advisory issued.

12.2.2.8. When flying the final approach without glide path guidance, the automatic mode is referred. In that mode the receiver will automatically select the appropriate azimuth as well as tune the TACAN or DME for distance information. If operating in manual mode, you must manually set the desired azimuth.

12.2.2.8.1. NOTE: Computed MLS azimuth-only approaches may only be flown by aircraft with the proper equipment, and all system components (azimuth, elevation, and DME) must be operational.

12.2.2.8.2. WARNING: When flying an MLS azimuth-only approach, if operating in manual mode and the pilot selects an azimuth different from the published procedure, the published approach is no longer valid and the actual approach flown will no longer guarantee obstacle clearance.

12.2.2.8.3. WARNING: If you are flying a non-computed approach and you select the "COMPUTED" approach mode on your MLS equipment, the published approach is no longer valid and the actual approach flown will no longer guarantee obstacle clearance. The only time the "COMPUTED" mode should be selected is when the approach to be flown is a computed approach.

12.2.2.8.4. WARNING: If you are flying a computed MLS approach, and you select the "NON-COMPUTED" approach mode on your MLS equipment, the published approach is no longer valid and the actual approach flown will no longer guarantee obstacle clearance. "COMPUTED" mode should be selected when the approach to be flown is a computed approach as indicated on the approach plate.

12.2.2.9. Flying the Approach. In general: Avoid rapid descents on final by crossing the FAF at the published altitude. ***When a turn is required over the FAF, turn immediately and intercept the final approach course to ensure that obstruction clearance airspace is not exceeded.*** Non-precision approach procedures published in conjunction with an MLS do not always clearly depict the FAF crossing altitude. The minimum altitude to be maintained until crossing the fix following the glide slope intercept point (normally the FAF will be the next fix) is the published glide slope intercept altitude, altitude published at that fix, or ATC assigned altitude. For most non-precision approaches, the glide slope intercept altitude will be the minimum FAF crossing altitude. ***Do not descend to the***

minimum descent altitude (MDA) or step down fix altitude until you are established on course and past the FAF (if published). Arrive at the MDA with enough time and distance remaining to identify and descend to the runway environment at a normal rate for your aircraft (i.e. At or prior to the VDP.)

12.2.2.9.1. Timing is required when the final approach does not terminate at a published fix***. If timing is required to identify the missed approach point, begin timing when passing the FAF or the starting point designated in the timing block of the approach plate.*** This point is usually the FAF but it may be a fix not co-located with the FAF such as a LOM, NDB, crossing radial, or DME fix. Time and distance tables on the approach chart are based on groundspeed; therefore, the existing wind and TAS must be factored when computing final approach timing. ***If timing is not specifically depicted on the instrument approach procedure, timing is not authorized as a means of identifying the MAP.***

12.2.2.9.2. VDP. Arrive at MDA (MDA is determined by the barometric altimeter) with enough time and distance remaining to identify runway environment and depart MDA from a normal visual descent point to touchdown at a rate normally used for a visual approach in your aircraft. Descent below MDA is not authorized until sufficient visual reference with the runway environment has been established and the aircraft is in a position to execute a safe landing. Be aware that the final approach course on a non-radar final may vary from the runway heading as much as 30° and still be published as a straight-in approach.

12.2.2.10. Inoperative System Components.

12.2.2.10.1. In non-computed approaches, if the azimuth transmitter is inoperative, no approach is authorized. Additionally, if the elevation transmitter is inoperative, only the non-precision (azimuth-only) approach is authorized. Ensure you can identify all required fixes with the MLS DME inoperative.

12.2.2.10.2. In computed approaches. All components must be fully operational; if any component is not available (as indicated by aircraft receiver course and glide slope off/warning flags and loss of course information), then the approach is not authorized.

12.2.3. RNAV (GPS), GPS and RNP SAAAR Approach Procedures. A Receiver Autonomous Integrity Monitor (RAIM) check is required prior to flying a GPS approach. This is necessary since delays of up to two hours can occur before an erroneous satellite transmission can be detected and corrected by the satellite control segment. The RAIM function is also referred to as fault detection. If predictive 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. A predictive RAIM check allows crews to plan for an alternate means of navigation if necessary. If a RAIM failure occurs prior to the Final Approach Way Point (FAWP) or the approach mode does not activate prior to the FAWP, do not commence the approach and coordinate for an alternate clearance. If a RAIM failure occurs after the FAWP, the receiver, based on equipage, is allowed to continue operating without an annunciation for up to 5 minutes to allow completion of the approach. You must check the receiver operator manual to ensure you have this capability. If you do not have this capability and a RAIM flag/status annunciation appears after the FAWP, climb to the missed approach altitude, proceed to the MAWP and execute a missed approach.

12.2.3.1. Flying the Approach Procedure

12.2.3.1.1. Retrieving the procedure from the Data Base. Do not fly the approach unless it can be retrieved in its entirety from a current approved database. Cross check data base waypoints against those contained on the published approach plate. If discrepancies exist, do not fly the approach. Exception: The FAWP altitude may be raised above that shown on the published chart in order to ensure adequate clearance at a step down fix.

12.2.3.1.1.1. Note: Manually selecting aircraft bank limiting functions may reduce the aircraft's ability to maintain its desired track and are not recommended. Pilots should recognize manually selectable aircraft bank-limiting functions might reduce their ability to satisfy ATC path expectations, especially when executing large angle turns. This should not be construed as a requirement to deviate from Airplane Flight Manual procedures; rather, pilots should limit the selection of such functions within accepted procedures.

12.2.3.1.2. Prior to commencing the approach. Determine which area of the TAA the aircraft will enter using bearing and distance to the IF (IAF). ***Fly the full approach from an Initial Approach Waypoint (IAWP) or feeder fix unless specifically cleared otherwise.*** Entry from other than an IAWP does not assure terrain clearance.

12.2.3.1.3. Approach Arming. Some receivers automatically arm the approach mode, while others require manual arming. Arming the approach mode switches the aircraft to terminal CDI scaling (± 1 NM). If the IAWP is beyond 30NM from the airfield, CDI sensitivity will not change until the aircraft is within 30NM of the airport reference point. Feeder route obstacle clearance is predicated on terminal sensitivity and RAIM at the IAWP. ***For manual systems, aircrews must ensure the approach is loaded prior to being established on any portion of the approach.***

12.2.3.1.4. Activating the approach. When within 2NM of the FAWP with the approach mode armed, the receiver will automatically initiate a RAIM check, and switch to approach sensitivity and RAIM (0.3NM). Distance is provided based on the active WP. Pilots must cross check the active WP identifier to ensure situational awareness. Some operations (e.g., holding, course reversal maneuvers) may require manual intervention to either stop or resume automatic waypoint sequencing. ***Pilots must ensure the receiver is sequenced to the appropriate waypoint, especially if not flying the full procedure. If on vectors to final, ensure that receiver is set IAW flight manual procedures.*** Being established on the final approach course prior to the initiation of the sensitivity change at 2 NM from the FAWP will aid in CDI interpretation prior to descent to MDA/DA. Also, requesting or accepting vectors that 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 non-sequencing mode prior to the FAWP and manually setting the course. This provides an extended final approach course in cases when vectors will place the aircraft outside any existing segment that 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 also be considered.

12.2.3.1.5. Flying point to point on the approach does not assure compliance with the published 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.

12.2.3.1.6. Loss of final approach guidance on an RNAV or GPS approach procedure is annunciated in a variety of ways depending on your particular avionics installation. In some aircraft the CDI will center when the "GPS Integrity" light illuminates and can give the illusion that you are on course. Insure you are thoroughly familiar with failure annunciations for your aircraft and discontinue the approach immediately if course guidance is suspect.

12.2.3.2. Final Approach

12.2.3.2.1. Descent to MDA or DA. Do not descend to MDA, DA, or step down fix altitude until the aircraft is established on course and past the FAF.

12.2.3.2.2. Vertical Navigation. ***Unless circling from the approach, VNAV guidance should be followed if provided by aircraft avionics and certified for use IAW AFI 11-202V3.*** VNAV guidance may be used to LNAV minimums; however, the aircraft must level off prior to MDA if the runway environment is not in sight. Due to the temperature and pressure altitude effects, USAF crews shall not use VNAV guidance below published MDA or DA.

12.2.3.2.3. Step Down Fixes. ***USAF pilots must comply with all stepdown fixes depicted on the IAP.*** VNAV guidance should provide clearance from all step down fix altitudes, however, crews must monitor altitude at all step down fixes to ensure compliance.

12.2.3.2.4. Runway Environment. Do not descend below MDA/DA unless sufficient visual reference with the runway environment has been established and the aircraft is in position to execute a safe landing.

12.2.3.2.4.1. Missed Approach. ***To execute a missed approach, activate the missed approach after crossing the MAWP.*** GPS missed approach procedures require pilot action to sequence from the MAWP to the missed approach procedure. If the missed approach is not activated, the GPS receiver will display an extension of the inbound final approach course, and displayed distance will increase from the MAWP. ***Do not activate the missed approach prior to the MAWP.*** Once the missed approach is activated, CDI sensitivity is set to 1NM. Missed approach routings in which the first track is via a course rather than direct to the next waypoint require additional action from the pilot to set the course (consult your flight manual). ***Do not turn off of the final approach course prior to the MAWP.***

12.3. Radar. These are approaches that require radar services. There are two basic types of approaches: the precision approach (PAR) and the surveillance approach (ASR). NOTE: Fixes that require RADAR for identification are depicted with the word "RADAR" appearing next to the fix and the words "RADAR REQUIRED" will appear on the approach plate. Only ground-based radar, such as airport surveillance, precision, or air route surveillance radar, may be used to position the aircraft.

12.3.1. The PAR provides the pilot with precise course, glideslope, and range information; the ASR provides course and range information and is classified as a non-precision approach. During an ASR and upon request, the controller will provide recommended altitudes on final to the last whole mile that is at or above the published MDA. Recommended altitudes are computed from the start descent point to the runway threshold. (At the MAP, the straight-in surveillance system approach error may be as much as 500 feet from the runway edges.)

12.3.2. Lost Communications.

12.3.2.1. Backup. ***In preparation for the radar approach, select a backup approach that is compatible with the existing weather and your aircraft where available.*** If you experience lost communications, you are automatically cleared to fly any published approach unless the controller issues a lost communications approach.

12.3.2.2. Contact. Attempt contact with the controlling agency if no transmissions are received for approximately:

12.3.2.2.1. One minute while being vectored to final,

12.3.2.2.2. Fifteen seconds while on final for an ASR approach, or

12.3.2.2.3. Five seconds while on final for a PAR approach.

12.3.2.3. Backup Approach. If unable to reestablish communications and unable to maintain VFR, transition to your backup approach. Intercept the approach at the nearest point that will allow a normal rate of descent and not compromise safety. ***Maintain the last assigned altitude or the minimum safe/sector altitude (emergency safe altitude if more than 25 NM from the facility), whichever is higher, until established on a segment of the published approach.***

12.3.2.4. No Backup Approach. If there are no backup approaches compatible with the weather or with your aircraft, advise the controller upon initial contact of your intentions in the event of lost communications. It is the pilot's responsibility to determine the adequacy of any issued lost communications instructions.

12.3.3. Voice Procedures. The radar approach relies entirely on voice instructions from the radar controller. ***Repeat all headings, altitudes (departing and assigned), and altimeter settings until the final controller advises "do not acknowledge further transmissions."*** During high-density radar operations, keep transmissions brief and specific, commensurate with safety of flight. Never sacrifice aircraft control to acknowledge receipt of instructions.

12.3.4. Transition to Final. The radar controller directs heading and altitude changes as required to position the aircraft on final approach.

12.3.4.1. Weather information issued by the radar controller will include altimeter setting, ceiling, and visibility. The controller is required to issue ceiling and visibility only when the ceiling is below 1,500 feet (1,000 feet at civil airports) or below the highest circling minimum, whichever is greater, or if the visibility is less than 3 miles.

12.3.4.2. Field Conditions. The controller will furnish pertinent information that the controller considers necessary to the safe operation of the aircraft. Request additional information, as necessary, to make a safe approach.

12.3.4.3. Orientation. Use available navigation aids to maintain situational awareness. The controller will report aircraft position at least once before starting final approach.

12.3.5. Accomplishing the Approach.

12.3.5.1. ASR

12.3.5.1.1. Controller. The controller will inform the pilot of the runway to which the approach will be made, the straight-in MDA (if a straight-in approach is being made), the MAP location, and the start descent point. When the approach will terminate in a circling approach, furnish the controller with your aircraft category. The controller will then issue the circling MDA. Circling MDA for ASR approaches are found in the FLIP Terminal Book (the circling MDA found on the individual IAP refers only to non-radar approaches).

12.3.5.1.2. Descent. At the descent point, the controller will advise you to "begin descent." If a descent restriction exists, the controller will announce the restriction altitude. When the aircraft is past the altitude limiting point, the controller will advise you to continue descent. The descent rate should be sufficient to allow the aircraft to arrive at the MDA in time to see the runway environment and make a normal descent to landing. NOTE: Upon request, the controller will provide recommended altitudes on final to the last whole mile that is at or above the published MDA. Due to the possible different locations of the MAP, recommended altitudes may position you at MDA at or slightly prior to the MAP. Consider this in relation to the normal VDP required for your aircraft.

12.3.5.1.3. Runway Environment. Arrive at the MDA with enough time and distance remaining to identify the runway environment and descend from MDA to touchdown at a rate normally used for a visual approach in your aircraft.

12.3.5.1.4. Course Guidance. The controller will issue course guidance when required and will give range information each mile while on final approach. You may be instructed to report the runway in sight. Approach guidance will be provided until the aircraft is over the MAP unless you request discontinuation of guidance. The controller will inform you when you are at the MAP.

12.3.5.1.5. MDA. ***Fly the aircraft at or above MDA until arrival at the MAP or until establishing visual contact with the runway environment.*** If the runway environment is not reported in sight, missed approach instructions will be given. CAUTION: Depending upon the location of the MAP, the descent from the MDA (once the runway environment is in sight) often will have to be initiated prior to reaching the MAP to execute a normal (approximately 3°) descent to landing.

12.3.5.2. PAR. The PAR is accomplished the same as the ASR with the exception that the controller will also provide glidepath guidance. Approximately 10 to 30 seconds before final descent, the controller will advise that the aircraft is approaching the glide path. When the aircraft reaches the point where final descent is to start, the controller will state "begin descent." The pilot should descend at a standard precision descent rate. The controller will advise "On, Above, Below, Well above, Well below glidepath, etc." ***If the runway environment is not in sight at DA/DH, execute the appropriate missed approach procedure.***

12.3.5.2.1. Approach Guidance Termination. The controller will cease providing course and glide path guidance when: The pilot reports the runway/approach lights in sight, and the pilot elects to proceed visually (e.g. "BRICK 10, runway in sight, taking over visual.") **Note:** A pilot's report of "runway in sight" OR "visual" alone does not constitute a request/advisement to proceed visually and the controller will continue to provide course and glide path guidance.

12.3.5.2.1.1. If the decision is made to discontinue the approach, advise the controller as soon as practical.

12.3.5.3. No-Gyro Approach (Heading Indicator Inoperative). If the heading indicator should fail during flight, advise the radar controller and request a no-gyro approach. The final approach may be either precision or surveillance.

12.3.5.3.1. Perform turns during the transition to final by establishing an angle of bank on the ADI that will approximate a standard rate turn, not to exceed 30°. Perform turns on final by establishing an angle of bank on the ADI that will approximate a half-standard rate turn. NOTE: Do not begin using half-standard rate turns on final until the controller tells you. The controller may want standard rate turns even on final if abnormal conditions exist (i.e., strong crosswinds, turbulence, etc.) If unable to comply with these turn rates, advise the controller. Initiate turns immediately upon hearing the words "turn right" or "turn left." Stop the turn on receipt of the words "stop turn." ***Acknowledge the controller's commands to start and stop turns until advised not to acknowledge further transmissions.***

12.4. Visual Approach. Visual approaches reduce pilot/controller workload and expedite traffic by shortening flight paths to the airport. A visual approach is conducted on an IFR flight plan and authorizes the pilot to proceed visually and clear of clouds to the airport. ***The pilot must have either the airport or the preceding identified aircraft in sight, and the approach must be authorized and controlled by the appropriate ATC facility.***

12.4.1. Before a visual approach can be authorized, the airport must have a ceiling at or above 1,000 feet and visibility 3 miles or greater, ATC must determine that it will be operationally beneficial and pilots must be able to proceed visually while remaining clear of clouds. Additionally, ATC will not issue clearance until the pilot has the airport or the preceding aircraft in sight. If the pilot has the airport in sight but cannot see the preceding aircraft, ATC may still clear the aircraft for a visual approach; however, ATC retains both aircraft separation and wake separation responsibility. When visually following a preceding aircraft, acceptance of the visual approach clearance constitutes acceptance of pilot responsibility for maintaining a safe approach interval and adequate wake turbulence separation.

12.4.2. A Visual Approach is an IFR Approach. Although you are cleared for a "visual" approach, you are still operating under IFR. ***Do not cancel your IFR clearance when***

cleared for a visual approach. Be aware that radar service is automatically terminated (without advising the pilot) when the pilot is instructed to change to advisory frequency.

12.4.3. After being cleared for a visual approach, ATC expects you to proceed visually and clear of clouds to the airport in the most direct and safe manner to establish the aircraft on a normal straight-in final approach. Clearance for a visual approach does not authorize you to do an overhead/VFR traffic pattern.

12.4.4. Visual Approaches Have No Missed Approach Segment. A visual approach is not an instrument approach procedure and therefore does not have a missed approach segment. If a go-around is necessary for any reason, aircraft operating at controlled airports will be issued an appropriate advisory, clearance, or instruction by the tower. At uncontrolled airports, aircraft are expected to remain clear of clouds and complete a landing as soon as possible. If a landing cannot be accomplished, the aircraft is expected to remain clear of clouds and contact ATC as soon as possible for further clearance (separation from other IFR aircraft will be maintained under these circumstances).

12.4.5. Pilot Responsibilities During Visual Approaches. When cleared for a visual approach, the pilot has the following responsibilities:

12.4.5.1. ***Advise ATC as soon as possible if a visual approach is not desired.***

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

12.4.5.3. ***After being cleared for a visual approach, proceed visually and clear of clouds to the airport in the most direct and safe manner to establish the aircraft on a normal final approach. You must have the airport or the preceding aircraft in sight.***

12.4.5.4. ***If instructed by ATC to follow another aircraft, notify the controller if you do not see it, are unable to maintain visual contact with it, or for any other reason you cannot accept the responsibility for visual separation under these conditions.***

12.5. Contact Approach. Pilots operating on an IFR flight plan, when clear of clouds with at least 1-mile flight visibility and can reasonably expect to continue to the destination airport in those conditions, may request ATC authorization for a contact approach.

12.5.1. ATC may only issue clearance for a contact approach under the following conditions:

12.5.1.1. The pilot specifically requests the approach. ATC cannot initiate this approach.

12.5.1.2. The reported ground visibility at the destination airport is at least 1 SM.

12.5.1.3. The contact approach is made to an airport having a standard or special instrument approach procedure.

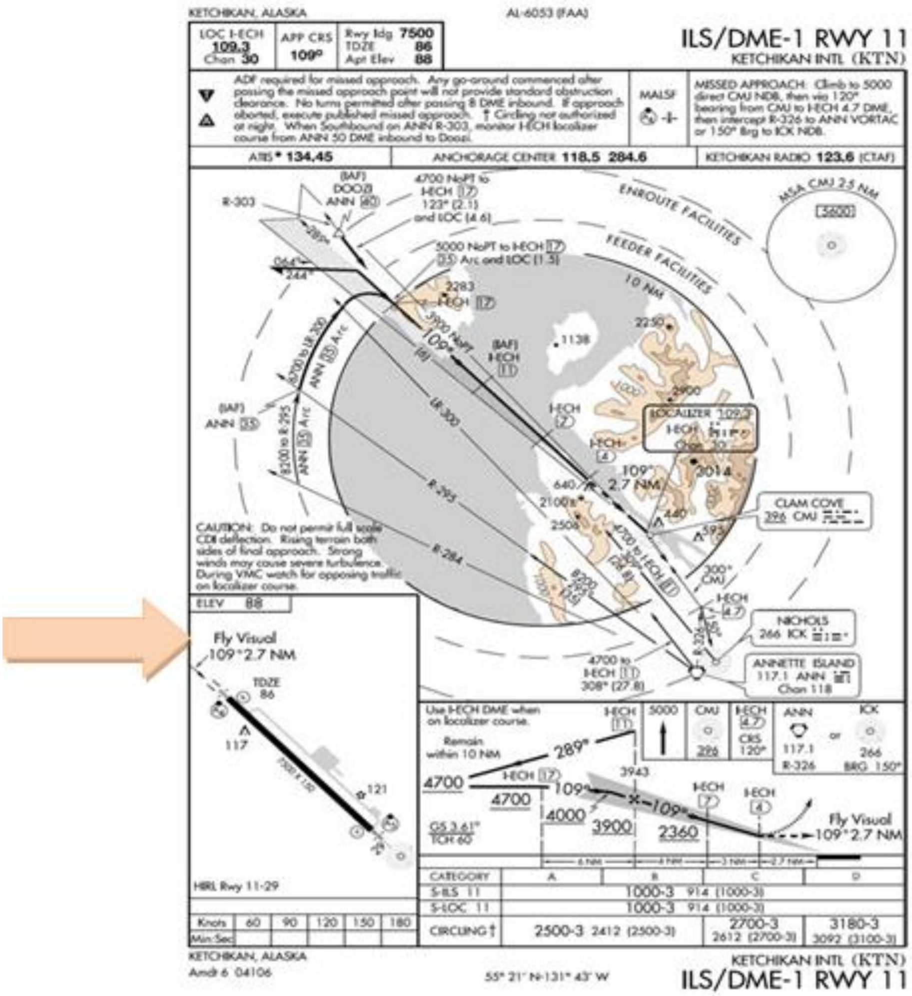
12.5.1.3.1. NOTE: A contact approach is a procedure that may be used by a pilot in lieu of conducting a standard or special approach IAP to an airport. It is not intended for use by a pilot to operate into an airport without a published and functioning IAP. Nor is it intended for an aircraft to conduct an approach to one airport, and then in the clear, proceed to another airport.

12.5.2. When executing a contact approach, the pilot assumes responsibility for obstruction clearance. If radar service is being received, it will automatically terminate when the pilot is instructed to change to advisory frequency.

12.5.3. Being cleared for a visual or contact approach does not authorize the pilot to fly a 360° overhead traffic pattern. An aircraft conducting an overhead maneuver is VFR and the instrument flight rules (IFR) flight plan is canceled when the aircraft reaches the "initial point." ***Aircraft operating at an airport without a functioning control tower must initiate cancellation of the IFR flight plan prior to executing the overhead maneuver or after landing.***

12.6. IAP with Visual Segment. Some IAPs contain a published visual segment (Figure 12.5). In general, when the distance from the MAP to the end of the runway exceeds 3SM, the words "fly visual " will appear in the profile view of the IAP. A long dashed line in the profile view with an approximate heading and distance to the end of the runway will be depicted. The depicted ground track associated with the visual segment should be flown as "DR" course. ***When executing the visual segment, remain clear of clouds and proceed to the airport maintaining visual contact with the ground.*** Since missed approach obstacle clearance is assured only if the missed approach is commenced at the published MAP or above the MDA, the pilot should have preplanned climbout options based on aircraft performance and terrain features.

Figure 12.5. IAP with Visual Segment.



12.7. Charted Visual Flight Procedures (CVFPs). Charted Visual Flight Procedures (CVFPs) are published visual approaches where an aircraft on an IFR flight plan, operating in VMC and when authorized by air traffic control, may proceed to the destination airport under VFR via the route depicted on the CVFP (Figure 12.6). ***When informed CVFPs are in use, the pilot must advise the arrival controller on initial contact if unable to accept the CVFP.***

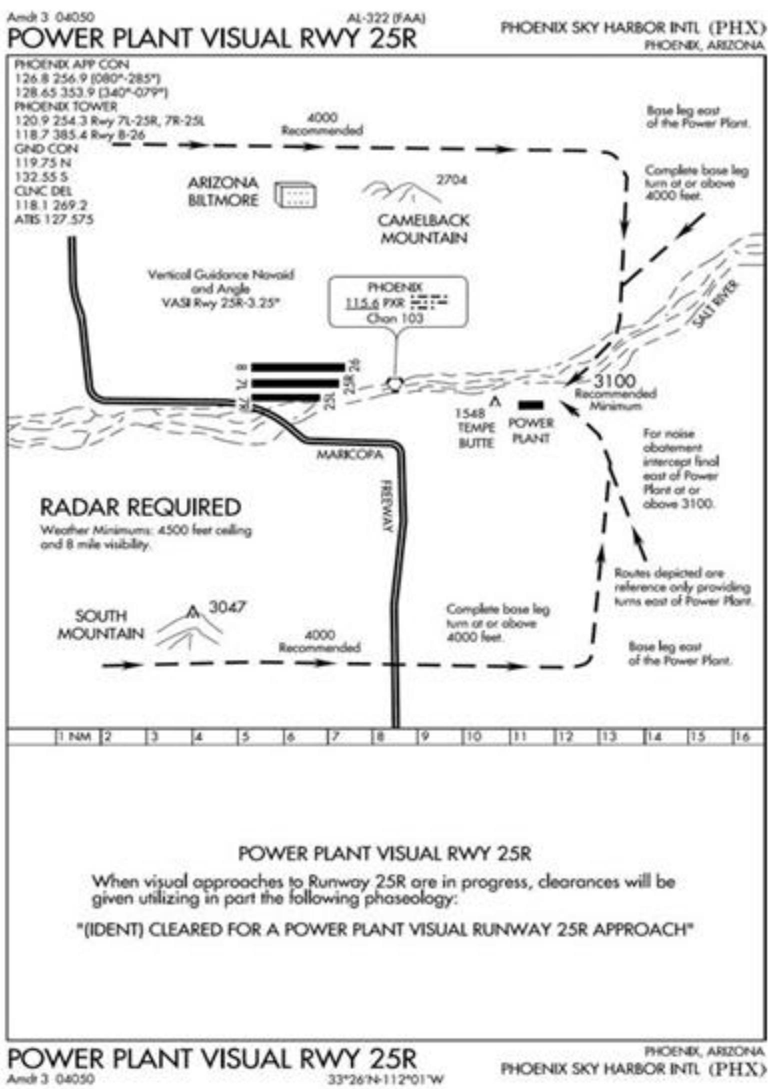
12.7.1. Characteristics. CVFPs are established for noise abatement purposes to a specific runway equipped with a visual or electronic vertical guidance system. These procedures are used only in a radar environment at airports with an operating control tower. The CVFPs depict prominent landmarks, courses, and altitudes and most depict some NAVAID information for supplemental navigational guidance only.

12.7.2. Altitudes. Unless indicating a Class B airspace floor, all depicted altitudes are for noise abatement purposes and are recommended only. Pilots are not prohibited from flying other than recommended altitudes if operational requirements dictate. Weather minimums for CVFPs provide VFR cloud clearance at minimum vectoring altitudes. Therefore, clearance for a CVFP is possible at MVA, which may be below the depicted altitudes.

12.7.3. Clearance. CVFPs usually begin within 20 miles from the airport. When landmarks used for navigation are not visible at night, the approach will be annotated "PROCEDURE NOT AUTHORIZED AT NIGHT." ATC will clear aircraft for a CVFP after the pilot reports sighting a charted landmark or a preceding aircraft. If instructed to follow a preceding aircraft, pilots are responsible for maintaining a safe approach interval and wake turbulence separation. ***Pilots should advise ATC if at any point they are unable to continue an approach or lose sight of a preceding aircraft***.

12.7.4. Climb-outs. CVFPs are not instrument approaches and do not have missed approach segments. Missed approaches are handled as a go-around (IAW FLIP, GP). The pilot should have preplanned climb-out options based on aircraft performance and terrain features.

Figure 12.6. Charted Visual Flight Procedure.



12.8. Converging Approaches (Figure 12 7). Converging approaches provide procedures for conducting simultaneous precision instrument approaches (normally ILS) to converging runways. Converging runways are defined as runways having a 15° to 100° angle between them.

In simpler terms, if the runways are pointed at each other (extended centerlines intersect) they are converging runways and procedures must be established to de-conflict possible simultaneous missed approaches.

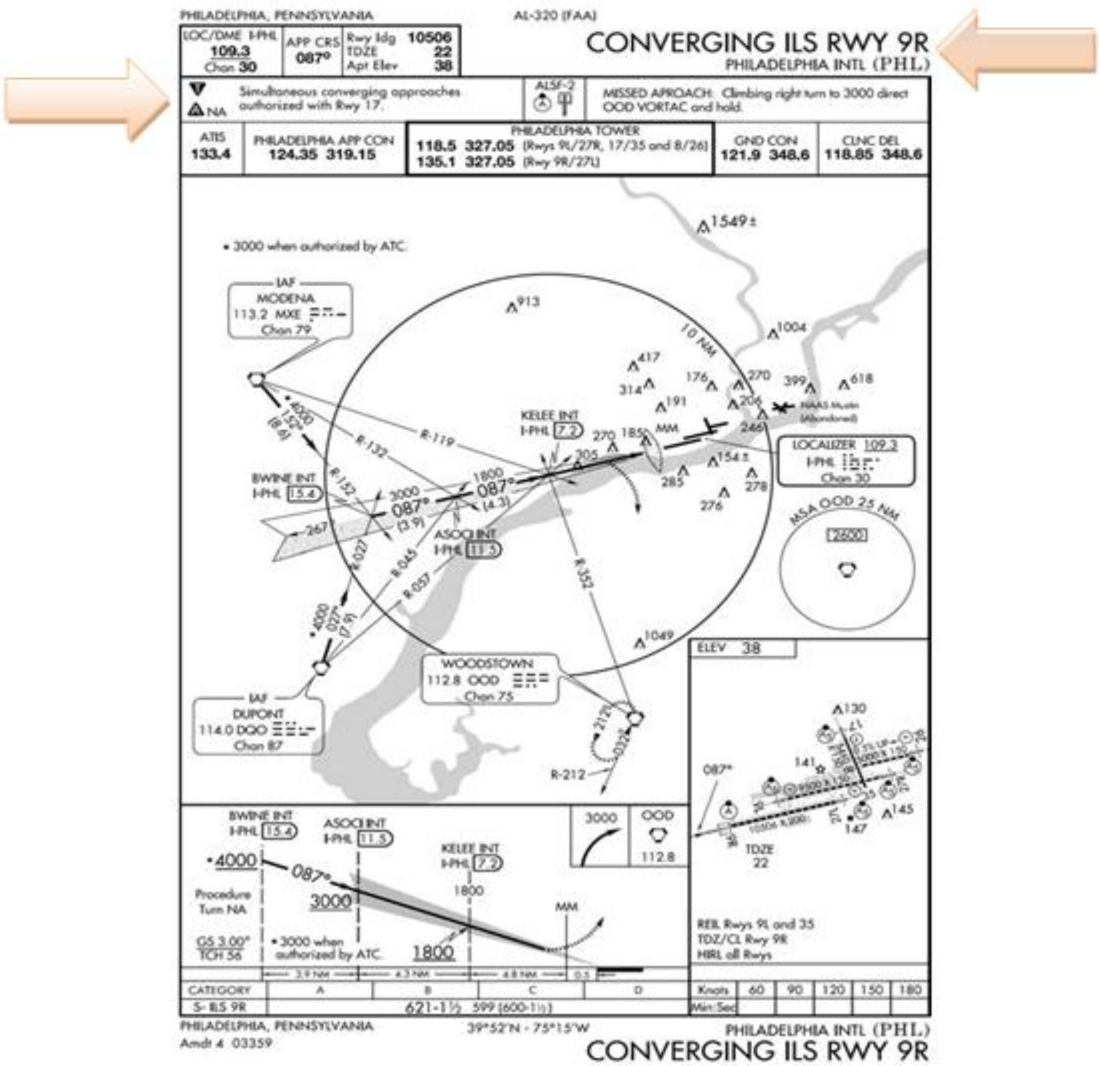
12.8.1. Procedures. Converging approaches are implemented when the volume and complexity of aircraft operations require the use of simultaneous converging instrument approaches. These approaches are specifically designed to ensure traffic deconfliction during all phases of the arrival procedure. Converging approaches are labeled as "converging" and ATC clearance must specify this type of approach. Theoretically no operational hardships on users and control facilities will result from these operations.

12.8.2. Differences. There are two subtle differences found in converging approaches that a pilot must be aware of. The missed approach departure instruction printed on the approach is the procedure the controller expects to be flown during a missed approach and it will not normally be modified. Although missed approach departure instructions for regular approaches are based primarily on obstacle clearance, converging approaches also include the deconfliction of aircraft on the other converging approach's missed approach. This is often done by moving the MAPs of each converging approach further out from the runway and turning the aircraft away from each other.

12.8.3. Missed Approach. ***If on arrival at the MAP or DH/DA (or at any time thereafter) any of the requirements in* paragraph 12.1.2.2 *are not met, the pilot shall immediately execute the appropriate missed approach procedure, ATC issued climb out instructions or other ATC clearance.*** Delaying initiation of missed approach may result in traffic conflict with other aircraft. For this reason, anytime a pilot continues flight beyond the MAP the pilot must be highly confident of completing the landing since traffic deconfliction cannot be assured for missed approaches initiated beyond the MAP.

12.8.4. Decision Altitude. Since converging approaches must provide precision approach guidance (normally ILS) the only way to adjust the missed approach point is to increase the decision altitude. Therefore, normally the primary difference between the converging approach and the regular approach to the same runway will be the approach minimums and the missed approach departure instruction. This increase in approach minimums will also result in an increase in the weather minimums required for the approach.

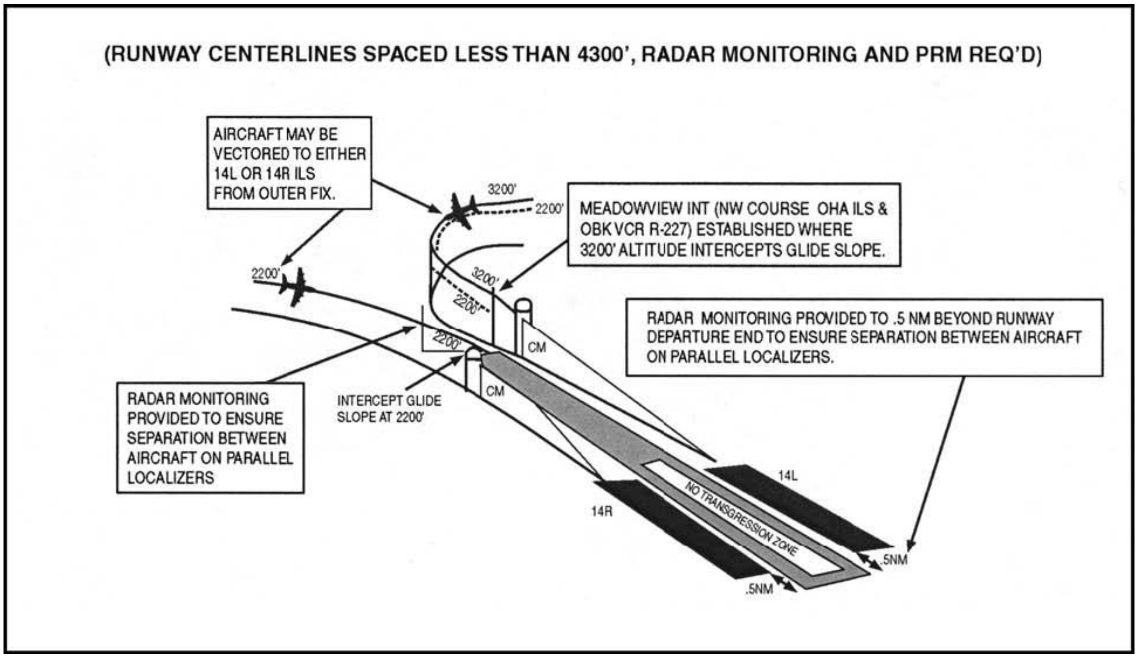
Figure 12.7. Converging ILS Approach.



12.9. ILS Precision Runway Monitor (ILS/PRM) Approaches (Figure 12 8).

12.9.1. ILS/PRM approaches are authorized at selected airports where parallel runways are separated by less than 4300 feet. Specialized equipment, procedures and training for both air traffic controllers and pilots are required prior to conducting an ILS/PRM approach at these airports. All USAF aircrews must be cognizant of the requirements for operations at these airports when ILS/PRM approaches are in use. ILS/PRM approaches allow for increased arrival operations at airports with closely spaced parallel runways. All pilots flying into these airports must be able to accept a clearance for the ILS/PRM approach when the services are offered or risk extensive delays.

Figure 12.8. ILS/PRM Approach.



12.9.2. Simultaneous close parallel ILS/PRM approaches are published on a separate Approach Procedure Chart titled ILS/PRM Rwy XXX (Simultaneous Close Parallel) (Figure 12.9).

12.9.3. For an airport to qualify for reduced lateral separation between runways there must be "high update radar" and associated high resolutions radar displays (Final Monitor Aids - FMAs) installed. The high update radar provides near instantaneous position and altitude information to the FMAs. Automated tracking software provides "monitor controllers" with aircraft identification, position, altitude, and the predicted position ten seconds ahead, as well as visual and aural alerts to the controller. This equipment, trained controllers, an enhanced communications capability that includes a secondary monitor frequency with tower override, and the ILS equipment collectively make up the ILS/PRM system.

12.9.3.1. ***When flying appropriately equipped aircraft and trained as outlined in AFI 11-202V3 and MAJCOM directives, USAF aircrews are authorized to fly ILS/PRM approaches.***

12.9.4. Simultaneous close parallel ILS/PRM approaches require a "monitor controller" using the PRM system be assigned to each runway and to ensure prescribed separation standards are met. Standard radar and/or vertical separation is used during turn-ons to final approaches. Vertical separation will continue until reaching an intermediate fix between ten and fifteen miles from the runway. From this point to the airport, aircraft may be at the same altitudes, be side by side, or pass traffic on the parallel final approach. Also from this point, or just outside, a block of airspace has been established as a buffer between the final approach courses. This airspace is 2,000-foot wide, equal distance from the finals, and is called the No Transgression Zone (NTZ). The NTZ is shown on the "monitor controller's" display and as the name implies, if planes enter or approach the NTZ, the "monitor controllers" issue instructions to correct the transgression.

12.9.5. When conducting an ILS/PRM approach, the following procedures shall be used:

12.9.5.1. ***ILS/PRM approach charts have an "Attention All Users Page" that must be referred to in preparation for flying this approach.*** (Figure 12.8) The Attention All Users Page covers the following:

12.9.5.1.1. Two operational VHF radios are required.

12.9.5.1.1.1. Each runway will have two frequencies, the primary tower frequency for that runway and a monitor frequency discreet to that runway. To avoid blocked transmissions during a breakout, ATC transmissions will be transmitted on both frequencies simultaneously. Transmissions from the "monitor controller" will over-ride the "tower controller" on both frequencies. Pilots will ONLY transmit on the primary tower frequency. It is important that pilots do not select the monitor frequency audio until instructed to contact the tower. The volume levels should be set about the same on both radios so the pilots will be able to hear transmissions on at least one frequency if the other is blocked.

12.9.5.1.2. The approach must be briefed as an ILS/PRM approach IAW AIM.

12.9.5.1.2.1. When the ATIS broadcast advises ILS/PRM approaches in progress, pilots should brief to fly the ILS/PRM approach. If later advised to expect the ILS approach, the ILS/PRM chart may be used after completing the following briefing items:

12.9.5.1.2.1.1. Minimums and missed approach procedures are unchanged.

12.9.5.1.2.1.2. Monitor frequency no longer required.

12.9.5.1.3. ***If unable to accept an ILS/PRM approach, notify ATC within 200NM of the landing airport to coordinate alternative arrival procedures.***

12.9.5.1.3.1. NOTE: Failure to pre-coordinate a non-ILS/PRM arrival during a period when ILS/PRM procedures are in use may result in denial of approach clearance and/or diversion to an alternate airport.

12.9.5.1.4. ***All breakouts from the approach shall be hand flown. Autopilots shall be disengaged when a breakout is directed.***

12.9.5.1.4.1. A "blunder" is an unexpected turn by an aircraft already established on the localizer toward another aircraft on an adjacent approach course. A "breakout" is a technique used to direct aircraft out of the approach stream. For close parallel operations, a breakout is used to direct an aircraft away from a blundering aircraft while simultaneous operations are being conducted.

12.9.5.1.4.2. Breakouts differ from other types of abandoned approaches in that they can happen anywhere and unexpectedly. Pilots directed by ATC to break off an approach must assume that an aircraft is blundering toward them and a breakout must be initiated immediately.

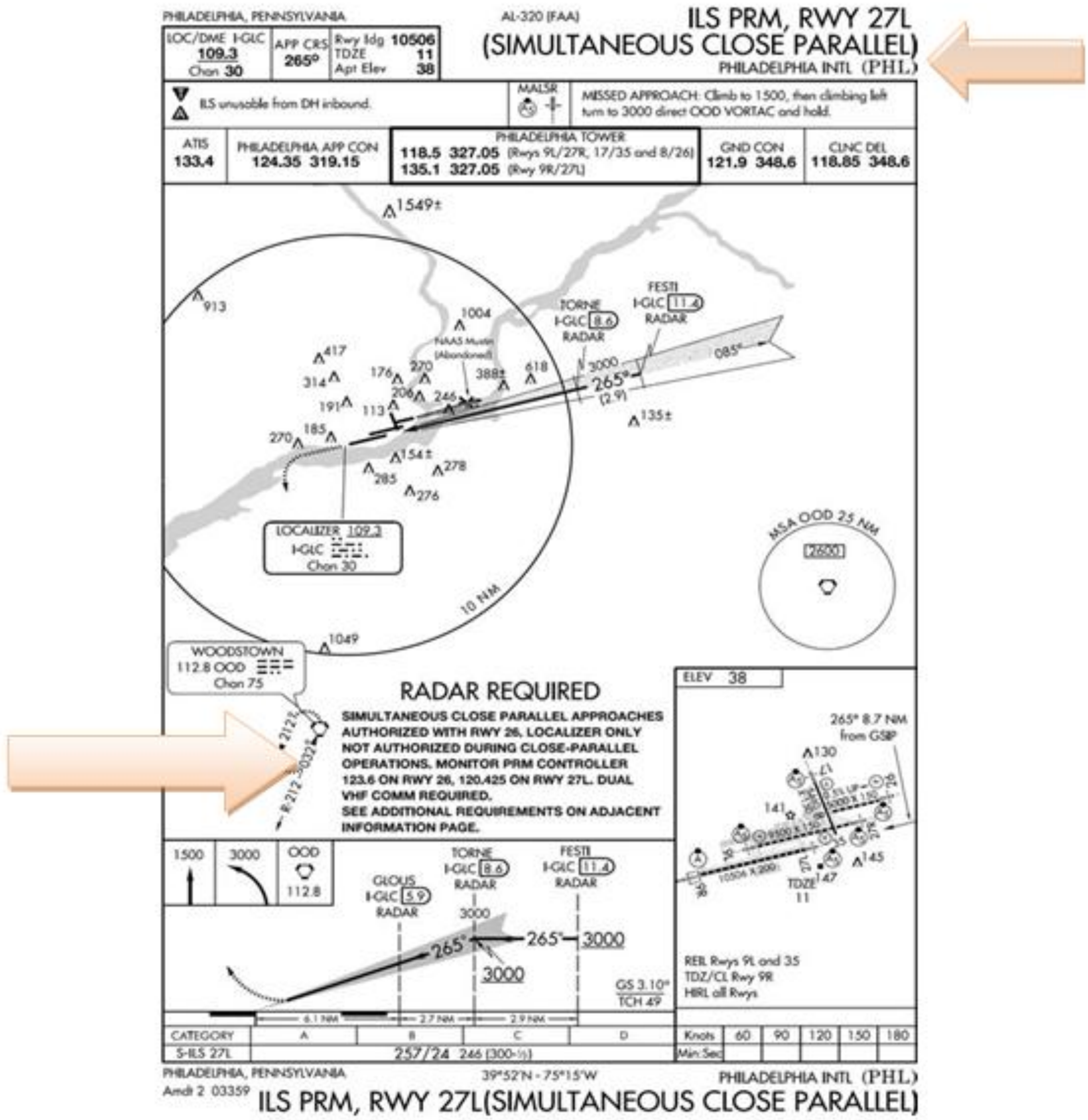
12.9.5.1.4.2.1. ATC Directed "Breakouts". ATC directed breakouts will be an air traffic controller instruction to turn and climb or descend. Pilots must always initiate the breakout in response to an air traffic controller instruction. Controllers will give a descending breakout only when there is no other reasonable option available, but in no case will the descent be below MVA which provides at least 1,000 feet required obstruction clearance.

12.9.5.1.4.2.2. If an aircraft enters the “NO TRANSGRESSION ZONE” (NTZ), the controller will breakout the threatened aircraft on the adjacent approach. The phraseology for the breakout will be: “TRAFFIC ALERT”, (aircraft call sign) Turn (left/right) IMMEDIATELY, HEADING (degrees), CLIMB/DESCEND AND MAINTAIN (altitude).”

12.9.5.1.5. ***Should a TCAS resolution advisory (RA) be received, the pilot shall immediately respond to the RA. If following an RA requires deviating from an ATC clearance, the pilot shall advise ATC as soon as practical. While following an RA, comply with the turn portion of the ATC breakout instruction unless the pilot determines safety to be a factor.***

12.9.5.1.5.1. The TCAS provides only vertical resolution of aircraft conflicts, while the ATC breakout instruction provides both vertical and horizontal guidance for conflict resolutions. Should a TCAS RA be received, the pilot should immediately respond to the RA. Adhering to these procedures assures the pilot that acceptable "breakout" separation margins will always be provided, even in the face of a normal procedural or system failure.

Figure 12.9. ILS/PRM Approach with Attention All Users Page.



ILS PRM, RWY 27L Amdt 2 03303
(SIMULTANEOUS CLOSE PARALLEL) AL-320 (FAA)
PHILADELPHIA INTL (PHL)
PHILADELPHIA, PENNSYLVANIA

ATTENTION ALL USERS OF ILS PRECISION RUNWAY MONITOR (PRM)

Special pilot training required before accepting a clearance for a simultaneous close parallel ILS/PRM approach (See Note: Special Pilot Training required**). Pilots shall notify ATC no less than 100 nautical miles from Philadelphia International Airport if they cannot meet the requirements on this information page.

1. **ATIS**. When the ATIS broadcast advises ILS/PRM approaches are in progress, pilots should brief to fly the ILS/PRM approach. If later advised to expect the ILS approach, the ILS/PRM chart may be used after completing the following briefing items:

(a) Minimums and missed approach procedures are unchanged.
(b) Monitor frequency no longer required.

2. **Dual VHF Communication required**: To avoid blocked transmissions, each runway will have two frequencies, a primary and a monitor frequency. The tower controller and monitor controller will transmit on both frequencies. Pilots will ONLY transmit on the primary frequency, but will listen to both frequencies. It is important that pilots do not select the monitor frequency audio until instructed by approach to contact the tower. The volume levels should be set about the same on both radios so that the pilots will be able to hear transmissions on at least one frequency if the other is blocked.

3. **ALL "Breakouts"** are to be hand flown to assure that the maneuver is accomplished in the shortest amount of time. Pilots, when directed by ATC to break off an approach, must assume that an aircraft is blundering toward their course and a breakout must be initiated immediately.

(a) ATC Directed "Breakouts" : ATC directed breakouts will consist of a turn and a climb or descent. Pilots must always initiate the breakout in response to an air traffic controller instruction. Controllers will give a descending breakout only when there is no ofther reasonable option available, but in no case will the descent be below minimum vectoring altitude (MVA) which provides at least 1000 feet required obstuction clearance. The MVA is 1800 feet at Philadelphia International Airport.

(b) Phraseology - "TRAFFIC ALERT" : If an aircraft enters the "NO TRANSGRESSION ZONE" (NTZ), the controller will breakout the threatened aircraft on the adjacent approach. The phraseology for the breakout will be:

"TRAFFIC ALERT, (aircraft call sign) TURN (left/right) IMMEDIATELY, HEADING (degrees), CLIMB/DESCEND AND MAINTAIN (altitude)".

**NOTE SPECIAL PILOT TRAINING REQUIRED. All pilots must complete ILS/PRM Approach Training before accepting a clearance for a simultanous close parallel ILS/PRM approach. For operations under Part 121, 129, and 135 pilots must comply with FAA approved company training. For operations under Part 91, pilots must be familiar and comply with the information as provided in the Aeronautical Informattion Manual or as provided at http://www.faa.gov/AVR/AFS/PRMtraining/.

(SIMULTANEOUS CLOSE PARALLEL) 39°52'N-75°15'W
ILS PRM, RWY 27L Amdt 2 03303
PHILADELPHIA, PENNSYLVANIA
PHILADELPHIA INTL (PHL)

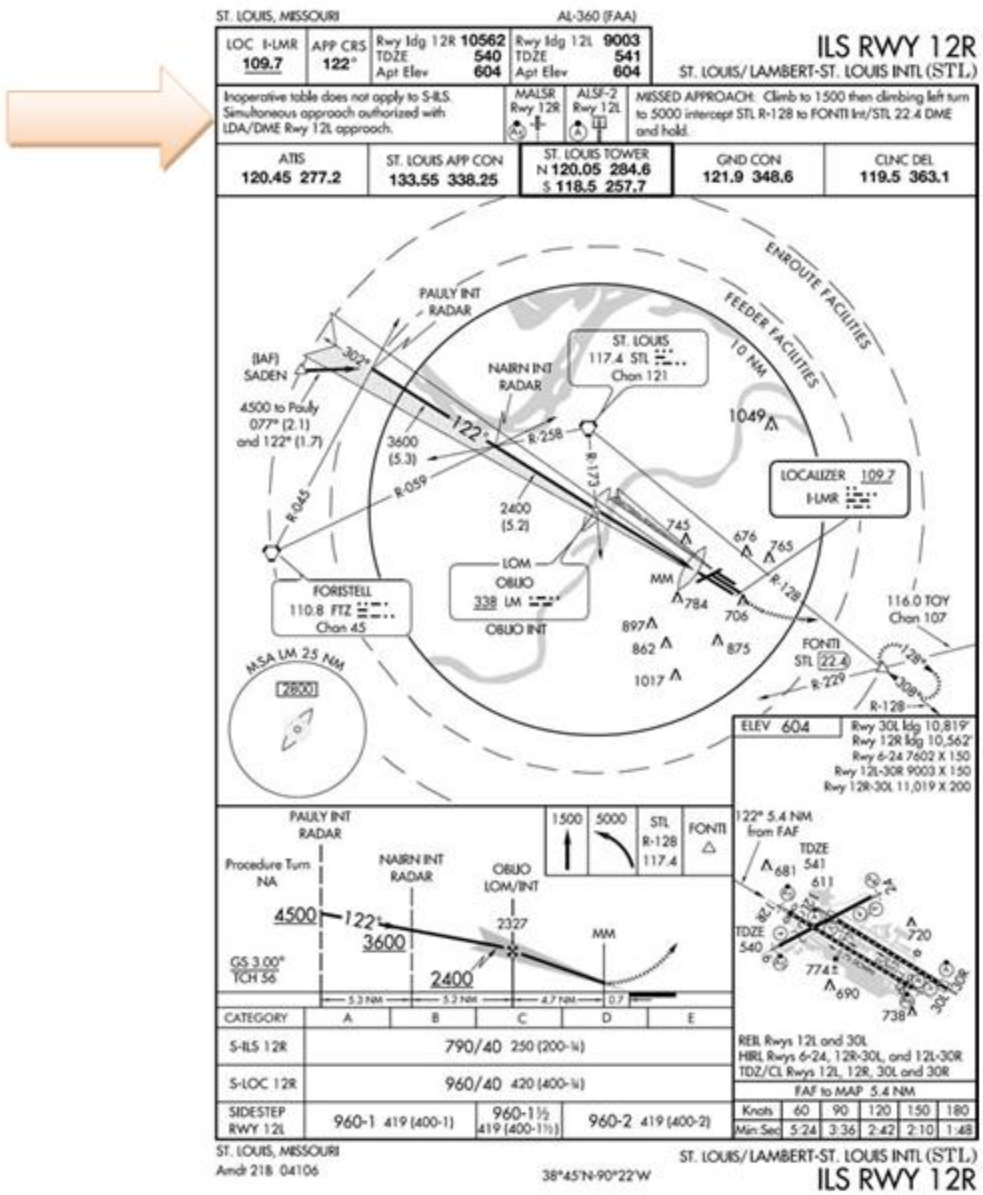
12.10. Simultaneous Offset Instrument Approaches (SOIA). Simultaneous Offset Instrument Approaches (SOIA) are procedures used to conduct simultaneous approaches to a set of parallel runways using a straight-in ILS approach to one runway and an offset LDA with glide slope instrument approach to the other runway. (Figure 12.10). The parallel runway centerlines are separated by less than 3,000 feet, but are at least 750 feet apart. Controllers monitor the approaches with a PRM system using high update radar and high-resolution ATC radar displays. The procedures and system requirements for SOIA are identical with those used for simultaneous close parallel ILS/PRM approaches until the MAP--at which time visual separation between aircraft on the adjacent approach courses must be applied. An understanding of the previous section, paragraph 12.9 is essential to conduct SOIA operations. ***When flying appropriately equipped aircraft and trained as outlined in AFI 11-202V3 and MAJCOM directives, USAF aircrews are authorized to fly SOIA approaches.***

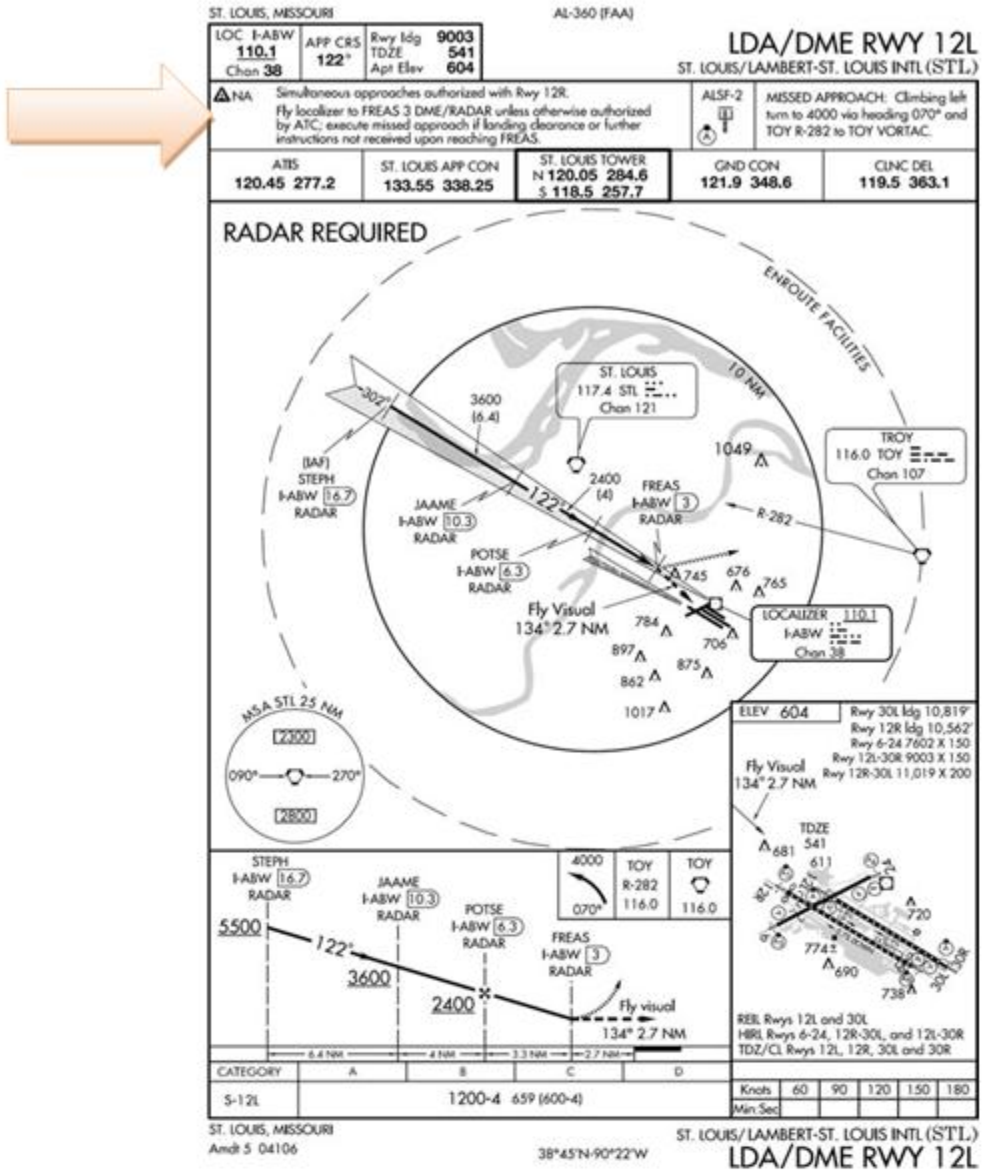
12.10.1. In SOIA, the approach course separation (instead of the runway separation) meets established approach criteria. A visual segment of the LDA approach is established between the LDA MAP and the runway threshold. Aircraft transition in visual conditions from the

LDA course to align with the runway and be stabilized by 500 feet above ground level. ***The pilot of the trailing aircraft must accept responsibility for visual separation prior to the LDA aircraft reaching the LDA MAP, or a missed approach must be executed.***

12.10.2. Final monitor controllers use the Precision Runway Monitor system to ensure prescribed separation standards are met. ***Procedures and communications phraseology are described in paragraph 12.9 ILS/PRM Approaches.*** PRM monitoring is provided to the LDA MAP or when the pilot has accepted visual separation responsibility. Final monitor controllers will not notify pilots when radar monitoring is terminated.

Figure 12.10. SOIA Approaches.





12.11. Transponder Landing Systems (TLS). Transponder Landing Systems (TLS) (Figure 12.11) are designed to provide approach guidance utilizing existing airborne ILS, localizer, glide slope, and transponder equipment. Ground equipment consists of a transponder interrogator, sensor arrays to detect lateral and vertical position, and ILS frequency transmitters. The TLS detects the aircraft's position by interrogating its transponder. It then broadcasts ILS frequency signals to guide the aircraft along the desired approach path. The TLS ground equipment tracks one aircraft, based on its transponder code, and provides correction signals to course and glidepath based on the position of the tracked aircraft. Even though the TLS signal is received using the ILS receiver, no fixed course or glidepath is generated. The concept of operation is very similar to an air traffic controller providing radar vectors. As with radar vectors, the guidance is only valid for the intended aircraft.

12.11.1. TLS ground equipment provides approach guidance for only one aircraft at a time.

12.11.2. ***When properly trained IAW MAJCOM directives, USAF aircrews are authorized to fly TLS approaches.***

12.11.3. TLS signals are displayed on the ILS receiver in the aircraft the same as a conventional ILS. Cockpit set-up and course intercept procedures for a TLS approach are the same as a conventional ILS (i.e. set correct frequency, dial the published front course into the course select window, etc).

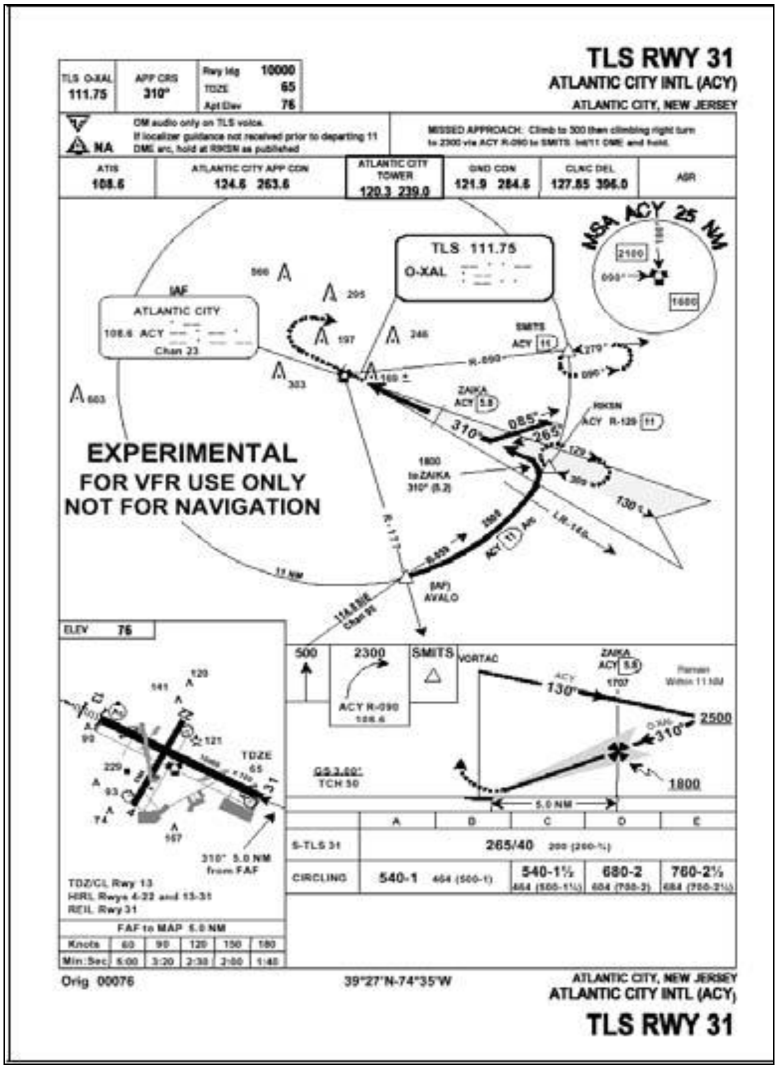
12.11.4. ***Aircrews must receive a clearance for the TLS approach.***

12.11.4.1. WARNING: If more than one aircraft is on final when another is conducting a TLS approach, the non-cleared aircraft will receive course and glide path information based on the position of the cleared aircraft.

12.11.5. ***Aircrews must complete required coordination with TLS ground equipment operator prior to commencing the approach.***

12.11.6. Navigation fixes based on conventional ground-based radio NAVAIDS or GPS are provided in the approach procedure to allow aircrews to verify TLS guidance. ***Navigation equipment must be set-up to reference these fixes during the approach.***

Figure 12.11. TLS Approach.



Chapter 13

LANDING FROM INSTRUMENT APPROACHES

13.1. Planning the Approach and Landing. A successful approach and landing in marginal weather conditions requires considerable planning, which should begin before the flight. Checking the forecast weather, winds, NOTAMs, and runway conditions at your destination and alternate will normally help you determine the runway and type of approach that is likely to be used. A study of the instrument approach procedure for the destination airport will show the approach as well as the runway layout, obstructions, type of lighting installed, and minimum data.

13.2. Transitioning From Instrument to Visual Flight Conditions. The transition from instrument to visual flight conditions varies with each approach. Pilots seldom experience a distinct transition from instrument to visual conditions during an approach in obscured weather. Obscured conditions present you with a number of problems not encountered during an approach that is either hooded or has a cloud base ceiling. At the point where the hood is pulled or the aircraft breaks out below the ceiling, the visual cues used to control the aircraft are usually clear and distinct, and there is instantaneous recognition of the position of the aircraft in relation to the runway. With obscured ceilings or partially obscured conditions, the reverse is usually true; visual cues are indistinct and easily lost, and it is difficult to discern aircraft position laterally and vertically in relation to the runway. Consider every factor that might have a bearing on the final stages of an approach and landing. The visibility, type of weather, expected visual cues, and even crew procedures and coordination are some of the tangibles requiring careful consideration. Preparation and understanding are the keys that will make the transition smooth and precise. Only through a thorough understanding of the weather environment and how it affects the availability and use of visual cues will you be prepared to transition safely and routinely. The following information deals with some of the conditions you may encounter during this phase of flight.

13.2.1. Straight-In. When flying a straight-in approach in VMC, the pilot has almost unlimited peripheral visual cues available for depth perception, vertical positioning, and motion sensing. Even so, varying length and width of unfamiliar runways can lead to erroneous perception of aircraft height above the runway surface. A relatively wide runway may give the illusion that the aircraft is below a normal glide path; conversely, a relatively narrow runway may give the illusion of being high. With an awareness of these illusions under unlimited visibility conditions, it becomes easy to appreciate a pilot's problems in a landing situation in which the approach lights and runway lights are the only visual cues available.

13.2.2. No Vertical Guidance. Instrument approach lights do not provide adequate vertical guidance to the pilot during low visibility instrument approaches. In poor visibility, especially when the runway surface is not visible, or in good visibility at night, there simply are not enough visual cues available to adequately determine vertical position or vertical motion. Studies have shown that the sudden appearance of runway lights when the aircraft is at or near minimums in conditions of limited visibility often gives the pilot the illusion of being high. They have also shown that when the approach lights become visible, pilots tend to abandon the established glide path, ignore their flight instruments and instead rely on the poor visual cues. Another similar situation occurs when a pilot flies into ground fog from above. If the pilot initially sees the runway or approach lights, these cues will tend to disappear as the pilot enters the fog bank. The loss of these visual cues will often induce the illusion or sensation of climbing. These situations of erroneous visual cues convincing the pilot that the aircraft is above normal glide path generally result in a pushover reaction, an increase in the rate of descent, and a short or hard landing.

13.2.3. Descent Rate. Since approach lights are usually sighted close to the ground in limited visibility, an increase in the rate of descent during the final approach when the aircraft is very close to the ground may create a situation in which sufficient lift cannot be generated to break the rate of descent when the pilot realizes he or she will land short.

13.2.4. Crosscheck. A recommended method to ensure against a dangerously high rate of descent and a short or hard landing is to maintain continuous crosscheck of the GSI or flight director and pay continuous attention to PAR controller instructions as well as VVI and ADI indications. The pilot should establish predetermined limitations on maximum rates of descent for the aircraft that he or she will accept when landing out of a low visibility approach. Exceeding these limits during the transition to landing should result in a go-around and missed approach in the interest of aircraft and aircrew safety.

13.2.4.1. Restrictions to Visibility. There are many phenomena, such as rain, smoke, snow, and haze, which may restrict visibility. When surface visibility restrictions do exist and the sky or clouds are totally hidden from the observer, the sky is considered totally obscured and the ceiling is the vertical visibility from the ground. If you are executing an approach in an obscured condition, you will not normally see the approach lights or runway condition as you pass the level of the obscured ceiling. You should be able to see the ground directly below; however, the transition from instrument to visual flight will occur at an altitude considerably lower than the reported vertical visibility. In partially obscured conditions, vertical visibility is not reported since the ground observer can see the sky through the obscuration. When clouds are visible with a partial obscuration, their heights and amounts are reported. The amounts (in 8ths) of the sky or clouds obscured by a partial obscuration are included in the remarks section of weather reports. Although this may help clarify the reported conditions in many cases, it still does not provide an idea of the height at which visual cues will be sighted or the slant range visibility. In some cases the partial obscuration can be associated with shallow patchy fog so you can expect to lose visual references once the fog condition is entered. Also of concern is the visual range at which you will be able to discern visual cues for runway alignment and flare. Be aware that the runway visibility or runway visual range (RVR) may not be representative of the range at which you will sight the runway. In fact, slant range visibility may be considerably less than the reported RVR. Knowledge of these various factors will aid you in making a safe, smooth transition from instrument to visual flight.

13.2.4.1.1. Shallow Fog. Fog that extends no more than 200 feet in height is considered shallow fog and is normally reported as a partial obscuration. Since the fog may be patchy, it is possible that the visual segment may vary considerably during the approach and rollout. RVR may not be representative of actual conditions in this situation if measured by transmissometer located in an area of good visibility.

One of the most serious problems with this type of fog stems from the abundance of cues available at the start of the approach. You may see the approach lighting system and possibly even some of the runway during the early stages of the approach. However, as the fog level is entered, most or all the cues become confused and disoriented. In these conditions, you should not rely entirely on visual cues for guidance. They can be brought into the crosscheck to confirm position, but instrument flight must be maintained until visual cues can be kept in view and the runway environment can provide sufficient references for alignment and flare.

13.2.4.1.2. Deep Fog. Fog that extends to a height of several hundred feet usually forms a total obscuration. You will not normally see cues during the early portion of an approach. Most likely, you will pick up cues from only the last 1,000 feet of the approach lighting system. From a US standard approach lighting system, in rapid succession you will probably see cues from the 1,000-foot roll bar, the last 1,000 feet of the centerline approach lights, red terminating bar, red wing lights, green threshold lights, and the high intensity runway edge lights. If operating at night and the strobe lights are on, these may produce a blinding effect. Care should be taken with the use of landing lights as they also may cause a blinding effect at night. The transition from an approach in a total obscuration involves the integration of visual cues within the crosscheck during the latter portion of the approach. Again, be thoroughly familiar with the approach lighting system to develop the proper perspective between these cues and the runway environment.

13.2.4.1.3. Fog Below Clouds. This fog is usually reported as a partial obscuration below a cloud ceiling. After penetrating through a ceiling, visibility usually increases when you descend below the cloud ceiling. Therefore, the transition from instrument to visual flight is sharper, with more pronounced use of visual cues after passing the ceiling. However, with fog below clouds all of the problems mentioned above with shallow fog and deep fog may be found. Night approaches may produce the sensation that the aircraft is high once the cloud base is passed. You should continue on instruments, cross-checking visual cues to confirm runway alignment. During the flare you may experience a sensation of descending below the surface of the runway. This will be especially pronounced at facilities with 300-foot wide runways. In either case, avoid abrupt or large attitude changes.

13.2.4.1.4. Advection Fog. Advection fog can present wind and turbulence problems not normally associated with other types of fog. Advection fog may possess characteristics similar to shallow, deep, or cloud base fog. It may be more difficult to maintain precise instrument flight because of turbulence. The characteristics of advection fog will be related to the wind speed increases. Wind greater than 15 knots usually lifts the fog and it forms a cloud base. The best procedure is to be aware of the conditions that might be encountered and to integrate visual cues within the crosscheck during the later portion of the approach. Also closely monitor airspeed because of the effects of turbulence and crosswinds.

13.2.4.1.5. Ice Fog. This type of fog is most common to the Arctic region; however, it can occur in other areas if the air temperature is below approximately 0° C (32° F). It consists of a suspension of ice crystals in the air and is more common around airports and cities. Condensation nuclei caused by human activity often cause the fog to form. When there is little or no wind, it is possible for an aircraft to generate enough fog during landing or takeoff to cover the runway and a portion of the field. Depending on the atmospheric conditions, ice fogs may last for several minutes or days. The piloting hazards and procedures are basically the same as with other fogs.

13.2.4.1.6. Rain. Approaches and the ensuing transition to visual flight can be very hazardous since moderate to heavy rain conditions can seriously affect the use of visual cues. Night approaches in these conditions can be even more critical as flashing strobes or runway end identifier lights may distract you. Transition to visual flight can be severely hampered by the inability to adequately maintain aircraft control and interpret the instruments as a result of gusty or turbulent conditions. The moderate or heavy rain conditions can also render the rain removal equipment ineffective, causing obscuration of visual cues at a critical time during the transition. In these conditions, be prepared for an alternate course of action and act without hesitation to prevent the development of an unsafe situation.

13.2.4.1.7. Snow. Blowing snow is accompanied by many of the same hazards as rain, such as turbulence, difficulties in reading the flight instruments, obscured visual cues, and aircraft control problems. Of special interest will be a lack of visual cues for runway identification for the visual portion of the approach. The approach and runway lights will provide some identification; however, runway markings and the contrast with relation to its surroundings may be lost in the whiteness. Therefore, depth perception may be difficult, requiring more emphasis on instruments for attitude control. It is extremely important to avoid large attitude changes during approaches in snow.

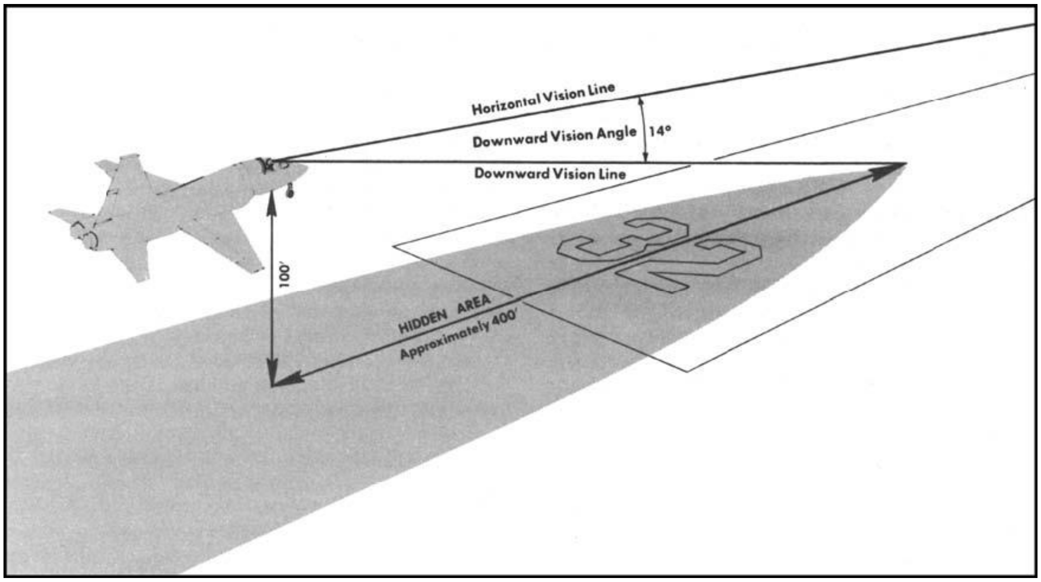
13.2.4.2. Visual Cues.

13.2.4.2.1. Runway Contact Point. Approach lights, runway markings, lights, and contrasts are the primary sources of visual cues. At some facilities, touchdown zone and centerline lights may also be available. Become familiar with the lighting and marking patterns at your destination and correlate them with the weather so you will be prepared to transition to visual flight. In minimum visibility conditions, the visual cues and references for flare and runway alignment are extremely limited compared to the normal references used during a visual approach. Therefore, the aircraft's projected runway contact point may not be within your visual segment until considerably below published minimums.

13.2.4.2.1.1. WARNING: Any abrupt attitude changes to attempt to bring the projected touchdown point into your visual segment may produce high sink rates and thrust or lift problems at a critical time. Those so-called ***duck-under maneuvers must be avoided during the low visibility approach.***

13.2.4.2.2. Duck-under. Another potential duck-under situation occurs when you attempt to land within the first 500 to 1,000 feet of the runway after breaking out of an overcast condition. In this case, you may attempt to establish a visual profile similar to the one you use most often. Establishing the visual profile usually involves reducing power and changing attitude to aim the aircraft at some spot short of the end of the runway. In this maneuver you may attempt to use as much of the available runway as possible because of a short runway or due to poor braking conditions. The duck-under is not recommended since high sink rates and poor thrust/lift relationships can develop which may cause undershoots or hard landings. Base your landing decision upon the normal touchdown point from the instrument approach, and if stopping distances are insufficient, proceed to an alternate.

Figure 13.1. Downward Vision Angle.



13.2.4.3. Downward Vision Angle (Figure 13.1). There is an area hidden by the nose of an aircraft that cannot be seen from the cockpit. The downward vision line from the pilot's eye projected over the nose of the aircraft forms an angle with the horizontal vision line. This angle is called the "downward vision angle." An aircraft with a 14° downward vision angle 100 feet above the surface will conceal about 400 feet beneath its nose. Consider an approach in 1,600-foot visibility. This means your visual segment at 100-foot elevation with a 14° downward vision will be reduced to about 1,200 feet. Other factors, such as a nose-high pitch attitude and a slant range visibility less than the RVR, can further reduce your visual segment.

13.2.4.4. Pilot Reaction Time. At 100-foot elevation and a 3° glide slope, an aircraft is approximately 1,900 feet from the runway point of intercept (RPI). If your aircraft's final approach speed is 130 knots (215 feet per second), you have about 9 seconds to bring visual cues into the crosscheck, ascertain lateral and vertical position, determine a visual flight path, and establish appropriate corrections. More than likely, 3 to 4 seconds will be spent integrating visual cues before making a necessary control input. By this time, the aircraft will be 600 to 800 feet closer to the RPI, 40 to 60 feet lower, and possibly well into the flare. Therefore, it is absolutely essential to be prepared to use visual cues properly and with discretion during the final stages of a low visibility approach. Prior to total reliance on visual information, confirm that the instrument indications support the visual perspective.

13.2.4.5. Crew Procedures.

13.2.4.5.1. Pilot Monitoring (PM). A PM can assist the pilot flying (PF) in a number of ways. The PM can fly the approach, control airspeed, be responsible for communications, direct the checklist, perform the missed approach, establish aircraft configurations, or perform any other duties assigned by the PF. However, the PM must understand exactly what those duties and responsibilities are before the approach.

13.2.4.5.2. Technique One. One technique that has proven quite successful has been to allow highly qualified copilots to fly the approach, while the pilot makes the decision to continue or go-around at DH. The PM assumes control if a landing is to be made; if not, the copilot executes the go-around. This procedure puts fewer burdens on the pilot, allowing more time to obtain information from the visual cues for landing. If the approach is unsatisfactory or insufficient visual references are available to continue the approach at DA/DH, the copilot, since the aircraft is on instruments, is prepared to execute a missed approach on command. If the pilot executes the approach, the copilot may be allowed to control power or airspeed until DA/DH where the pilot assumes control for the landing or missed approach.

13.2.4.5.3. Technique Two. Another technique is to have the PM the approach continue to monitor flight instruments from DA/DH or minimum descent altitude to touchdown and notify the PF the approach of excessive deviations in rates of descent, glide slope, course, or airspeed. This technique will help detect duck-under maneuvers and will prevent both pilots from being deceived by a visual illusion that may be present.

13.2.4.5.4. Technique Three. A final technique is to have the autopilot fly the approach to the MDA/DA/DH and then have the PF assume control to either land or execute the go-around as required. This technique can be quite helpful especially after a long duty day and/or with instrument conditions.

13.3. Approach Lighting Systems.

13.3.1. Types of Approach Lighting Systems.

13.3.1.1. Visual Aids. Approach lighting systems are visual aids used during instrument conditions to supplement the guidance information of electronic aids such as VOR, TACAN, PAR, and ILS. The approach lights are designated high intensity (the basic type of installation) and medium intensity, according to candlepower output.

13.3.1.2. Adjustment. Most runway and approach light systems allow the tower controller to adjust the lamp brightness for different visibility conditions, or at a pilot's request. The extreme brilliance of high intensity lights penetrates fog, smoke, precipitation, etc., but may cause excessive glare under some conditions.

13.3.1.3. Depiction. The approach lighting systems now in use, along with their standard lengths, appear in the FIH.

13.3.1.4. Pilot Activation. Some airports have installed airport lighting systems that can be activated by the pilot "keying the microphone" on selected frequencies. Information concerning these systems can be found in the FIH and Terminal FLIP.

13.3.2. Runway End Identifier Lights (REIL). Runway end identifier lights are installed at many airfields to help identify the approach end of the runway. The system consists of two synchronized flashing lights, one of which is located laterally on each side of the runway threshold facing the approach area. They are effective for identifying a runway that lacks contrast with the surrounding terrain or which is surrounded by other lighting, and for approaches during reduced visibility.

13.3.3. Visual Glide Slope Indicators (VGSI).

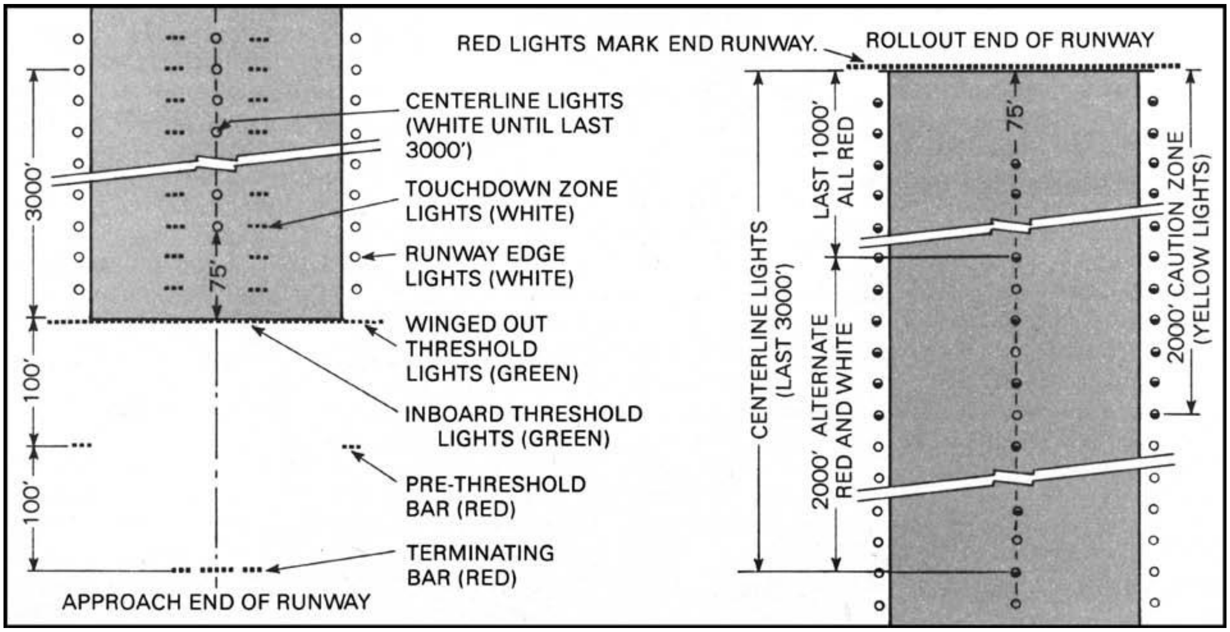
13.3.3.1. There are many different types of visual glide slope indicators in use, many in conjunction with instrument approach procedures. They provide visual glide path guidance from the instrument approach minimums to a point on the runway and can provide assistance in the transition from instrument to visual flight. Configurations are depicted in the FIH.

13.3.3.1.1. Depending upon which approach is flown, the visual glide path indicator may not guide the aircraft to the same point on the runway as the instrument approach being flown. This is depicted on many approach procedures with a note such as, “PAPI and ILS RPI not coincident.” This is common at airports with frequent jumbo-jet operations (C-5, 747, 777, etc). The VGSI at these airports is frequently adjusted to compensate for the greater vertical distance between the ground and the cockpit in these large aircraft. A smaller aircraft (KC-135, C-130, fighter, etc) that follows these VGSI indications to touchdown will touchdown beyond their normal touchdown point.

13.4. Runway Lighting Systems (Figure 13 2). Two basic runway lighting systems are used to aid the pilot in defining the usable landing area of the runway. These systems are Runway Edge Lights and Runway Centerline and Touchdown Zone Lights. For discussion of airport markings and signs used during ground operations, see AFI 11-218, *Aircraft Operations and Movement on the Ground*.

13.4.1. Runway Edge Lighting. The runway edge lighting system is a configuration of lights that defines the limits of the usable landing area. The lateral limits are defined by a row of white lights on either side of the runway. The longitudinal limits are defined at each end by the threshold lighting configuration. This configuration includes threshold lights, a pre-threshold light bar, and a terminating bar. The threshold lights emit green light toward the approach end of the runway and red light toward the rollout end of the runway.

Figure 13.2. Runway Lighting Systems.



13.4.1.1. HIRL. The High Intensity Runway Lighting (HIRL) system is the basic type of installation used by the Air Force. These elevated bi-directional lights, which extend the length of the runway, emit a white light the entire length of the runway at some military fields. Most military and all civil field HIRLs also emit a white light except in the caution zone, which is the last 2,000 feet (610m) of an instrument runway or one-half the runway length, whichever is less. The lights in the caution zone emit a yellow light in the direction of the approach end and white light in the opposite direction. The yellow lights are intended for rollout information after landing and are sometimes used in place of runway remaining markers.

13.4.1.2. MIRL. The Medium Intensity Runway Lighting (MIRL) system, which consists of elevated, omni-directional lights, may be installed on runways that are not to be used under IMC due to impaired clearance, short length, or other factors.

13.4.2. Runway Centerline and Touchdown Zone Lighting. The runway centerline and touchdown zone lighting systems are designed to facilitate landings, rollouts, and takeoffs under adverse day and night low visibility conditions. The touchdown zone lights, which define the touchdown area, are primarily a landing aid while the centerline lights are most effective for rollout and takeoff.

13.4.2.1. Touchdown Zone Lighting. The touchdown zone lighting system consists of two rows of high intensity light bars arranged on either side of the runway centerline. Each bar consists of three unidirectional white lights toward the approach area. The two rows of light bars are 3,000 feet long and extend from the threshold of the runway toward the rollout end of the runway.

13.4.2.2. Runway Centerline Lighting. The runway centerline lighting system is a straight line of lights located along the runway centerline. The system starts 75 feet (23m) from the threshold and extends down the runway to within 75 feet of the rollout end of the runway. The last 3,000 feet are color coded for landing rollout information.

The last 3,000-foot to 1,000-foot section displays alternate red and white lights, while the last 1,000-foot section displays all red lights.

13.5. Runway Markings. Runway markings are designed to make the landing area more conspicuous and to add a third dimension for night and low visibility operations. For discussion of airport and runway markings, see AFI 11-218.

13.6. Circling Approaches.

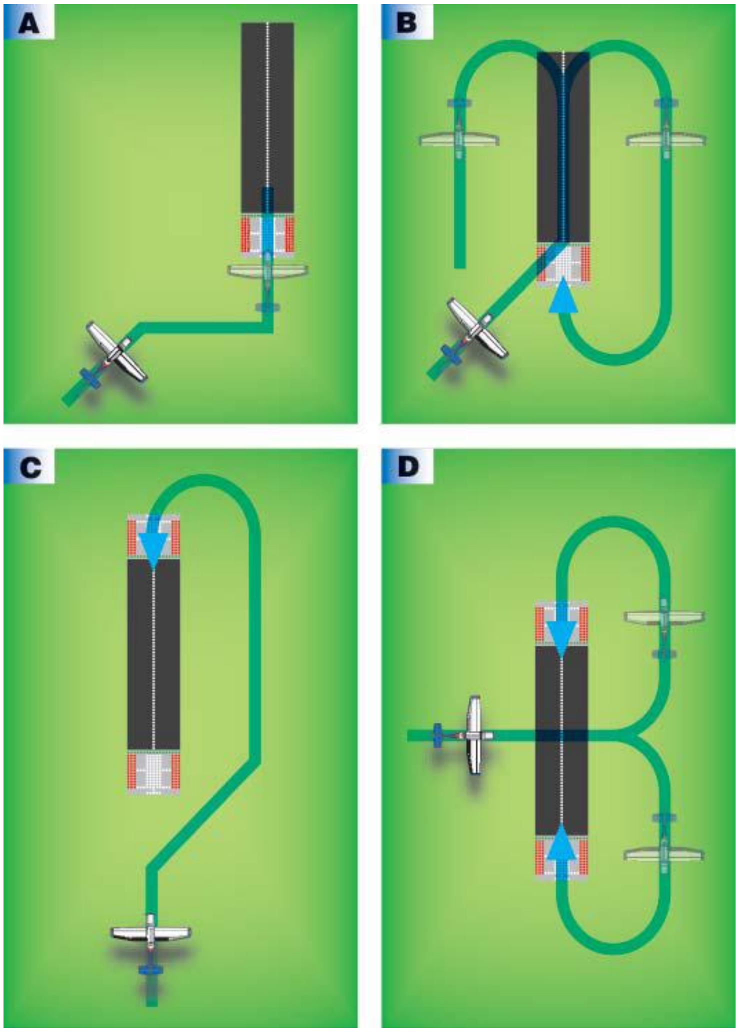
13.6.1. General Procedures. Circling to land is a visual flight maneuver. When the instrument approach is completed, it is used to align the aircraft with the landing runway. The circling MDA and weather minima to be used are those for the runway to which the instrument approach is flown (this is not always the landing runway). The circling minima listed on IAPs apply to all approach types on the IAP (RNAV (GPS), ILS, LOC, VOR, TACAN, etc.). However, since the MAP associated with the precision approach is determined by the pilot in terms of a DH and not a specific point along the final approach course, it becomes difficult to ascertain when to discontinue the approach if visual conditions are not encountered. Therefore, pilots are cautioned to ensure the aircraft is within the appropriate circling radius before abandoning the precision glideslope, if planning to circle from a precision final approach.

13.6.1.1. Circling from RNAV/GPS Approaches. Circling may be accomplished from an RNAV (GPS) approach if circling minimums are published. However, depending on the type of circling maneuver required, following RNAV (GPS) vertical guidance to the circling MDA may result in visually acquiring the airport environment too late to accomplish a safe circling maneuver. Pilots must ensure they remain within the required obstacle clearance radius and maintain situational awareness, especially in reduced visibility. In reduced visibility, pilots must maintain situational awareness and insure they remain within the required obstacle clearance radius. ***If there is any doubt as to maintaining required distance, or a loss of situational awareness, accomplish the missed approach and request an alternate approach.***

13.6.2. Instructions. If the controller has a requirement to specify the direction of the circling maneuver in relation to the airport or runway, the controller will issue instructions in the following manner: “Circle (direction given as one of eight cardinal compass points) of the airport/runway for a right/left base/downwind to runway (number).” For example, “Circle west of the airport for a right base to runway one eight.”

13.6.2.1. NOTE: Obstruction clearance areas are determined by aircraft category. Maneuver the aircraft to remain within the circling area for your aircraft category (see AFMAN 11-217V3 for radii of circling approaches). If it is necessary to maneuver at speeds in excess of the upper limit of the speed range authorized for your aircraft’s category, use the landing minima for the category appropriate to the maneuvering speed. When you request circling MDA from the controller for a circling ASR approach, state your aircraft category.

Figure 13.3. The Circling Approach.



13.6.3. Accomplishing the Approach (Figure 13.3).

13.6.3.1. Descent. After descending to circling minimum descent altitude and when the airport environment is in sight, determine if the ceiling and visibility are sufficient for performing the circling maneuver. The airport environment is considered the runways, its lights and markings, taxiways, hangars, and other buildings associated with the airport. (Since the MDA is a minimum altitude, a higher altitude may be maintained throughout the maneuver.)

13.6.3.2. Pattern. Choose a pattern that best suits the situation. Maneuver the aircraft to a position that allows you to keep as much of the airport environment in sight as possible. Consider making your turn to final into the wind if this maneuvering allows you to also keep the airport environment in sight. You may make either left or right turns to final unless you are directed by the controlling agency to turn in a specific direction or are limited by restrictions on the approach chart or IFR Supplement.

13.6.3.3. Weather -- High Ceiling/Good Visibility. If weather permits, fly the circling approach at an altitude higher than the circling MDA, up to your normal VFR traffic pattern altitude. This allows the maneuver to be flown with a more familiar perspective and better visual cues. Do not descend below circling MDA until in a position to place the aircraft on a normal glide path to the landing runway. (In order to prepare pilots for the worst situation fly practice circling approaches at the circling MDA if feasible and conditions permit.)

13.6.3.4. ***Weather -- Low Ceiling/Restricted visibility. If weather does not permit circling above the MDA, do not descend below circling MDA until the aircraft is in a position to execute a normal landing. Descend from the MDA as necessary to place the aircraft on a normal glide path to the landing runway.***

13.6.3.5. ***Missed Approach. If there is any doubt whether the aircraft can be safely maneuvered to touchdown, execute the missed approach.***

13.6.3.5.1. CAUTION: Be aware of the common tendency to maneuver too close to the runway at altitudes lower than your normal VFR pattern altitude. Using the same visual cues that you use from normal VFR pattern altitudes causes this. Select a pattern that displaces you far enough from the runway that will allow you to turn to final without overbanking or overshooting final.

13.7. Side-Step Maneuver Procedures. Where a side-step procedure is published, aircraft may make an instrument approach to a runway or airport and then visually maneuver to land on an alternate runway specified in the procedure. Landing minimums to the adjacent runway will be higher than the minimums to the primary runway, but will normally be lower than the published circling minimums.

13.7.1. Phraseology. Examples of ATC phraseology used to clear aircraft for these procedures are: "Cleared for ILS runway seven left approach. Side-step to runway seven right."

13.7.2. Begin Side-step. Pilots are normally expected to commence the side-step maneuver as soon as possible after the runway or runway environment is in sight. Typically this occurs inside the FAF. Beginning the side-step maneuver prior to the FAF could cause a conflict with other traffic, especially when using parallel runways. Compliance with minimum altitudes associated with stepdown fixes is expected even after the side-step maneuver is initiated.

13.7.3. Lose Visual. As in a circling approach, if you lose visual reference during the maneuver, follow the missed approach specified for the approach procedure just flown, unless otherwise directed. An initial climbing turn toward the landing runway will ensure that the aircraft remains within the obstruction clearance area.

Chapter 14

MISSED APPROACH

14.1. Planning. Performing a missed approach successfully is the result of thorough planning. You should familiarize yourself with the missed approach departure instructions during preflight planning. The missed approach departure instruction is designed to return the aircraft to an altitude providing en route obstruction clearance. In some cases the aircraft may be returned to the initial segment of the approach.

14.2. Missed Approach Point (MAP). The missed approach point for a nonprecision straight-in approach is located along the final approach course and no farther from the FAF than the runway threshold (or over an on-airport navigation facility for a no-FAF procedure and some selected FAF procedures). To determine the location of the MAP, compare the distance from the FAF to the MAP adjacent to the timing block. It may not be the same point as depicted in the profile view. If there is not a timing block, the MAP should be clearly portrayed on the IAP.

14.2.1. NOTE: The MAP depicted on the IAP is for the non-radar approach with the lowest HAT. For example, on an ILS approach designed by the FAA, the MAP printed will be for the ILS DA/DH. The MAP for the localizer will probably be at the approach end of the runway and the only way to determine this is by the distance listed on the timing block.

14.2.2. Circling. The MAP for a circling approach is also located along the final approach course. It will be no farther from the FAF than the first portion of the usable landing surface (or over an on-airport navigation facility for a no-FAF procedure).

14.2.3. Precision. The missed approach point for any precision approach is the point at which the DA/DH is reached. This is normally the point depicted on the IAP as the start of a climbing dashed line.

14.2.4. Obstacle Clearance. The published missed approach procedure provides obstacle clearance only when the missed approach is conducted on the missed approach segment from or above the missed approach point. If the aircraft initiates a missed approach at a point prior to the missed approach point, from below MDA or DH, or on a circling approach, obstacle clearance is not necessarily provided by following the published missed approach procedure. During pre-approach planning, the pilot should assess the actions to be taken in the event of a balked landing beyond the missed approach point or below the MDA or DA(H) based on the anticipated weather conditions and available aircraft performance. If balked landing occurs at a position where it is no longer possible to fly the published missed approach and alternative missed approach instructions are not available from ATC, obstacle clearance is the pilot's responsibility. When a missed approach is initiated in this situation, the pilot must consider other factors such as the aircraft's geographical location with respect to the prescribed missed approach point, direction of flight and/or minimum turning altitudes in the prescribed missed approach procedure, aircraft performance, visual climb restrictions, charted obstacles, takeoff obstacle departure procedure, takeoff visual climb requirements as expressed by nonstandard takeoff minima, or other factors not specifically expressed by the approach procedures. If the pilot executes any procedure other than the published missed, they should advise ATC as soon as possible with current actions and intentions.

14.2.4.1. Note: For copter only approaches, the missed approach is based on a climb gradient of at least 400 feet per mile; twice the angle used for fixed-wing instrument approach procedures. If a 90 knot (no wind) missed approach is performed, then this climb gradient equates to a 600 foot per minute minimum rate of climb.

14.2.5. Initiation. ***When the missed approach is initiated prior to the MAP, the pilot shall, unless otherwise cleared by ATC, fly the IAP as specified on the approach plate to the MAP at or above the DA/DH before executing a turning maneuver.***

14.2.6. Delayed Decision. ***If on arrival at the MAP or DH/DA (or at any time thereafter) any of the requirements in*** **paragraph 12.1.2.2** ***are not met, the pilot shall immediately execute the appropriate missed approach procedure, ATC issued climb out instructions or other ATC clearance.*** Missed approach obstacle clearance is predicated on beginning the missed approach procedure at the MAP from DA/DH and then climbing 200 ft/NM or greater. Initiating a go-around after passing the published MAP may result in loss of obstacle clearance. See 14.2.4.

14.2.7. Radar Approach. When flying a radar approach, missed approach departure instructions will be given if weather reports indicate that any portion of the final approach will be conducted in IFR conditions. At USAF bases where missed approach instructions are published in base flying regulations, controllers may not issue missed approach instructions to locally assigned aircraft.

14.3. Missed Approach/Departure Instructions. A clearance for an approach includes clearance for the missed approach published on the IAP, unless ATC issues alternate missed approach instructions.

14.3.1. Multiple Approaches. Prior to the FAF, the controller is required to issue appropriate departure instructions to be followed upon completion of approaches that are not to full stop landings. The pilot should tell the controller how the approach will terminate prior to beginning the approach. The controller will state, "After completion of your low approach/touch-and-go/stop-and-go/option, climb and maintain (altitude), turn right/left heading (degrees)." These instructions are often referred to as "climb out instructions" and are designed to return you to the traffic pattern. ***At locations where ATC radar service is provided, the pilot should conform to radar vectors when provided by ATC in lieu of the published missed approach procedure. Unless otherwise instructed, initiate an immediate climb to the assigned altitude. Delay any turns until past the departure end of the runway, if visible, and 400 feet AGL. If the departure end is not visible, climb on runway heading until 400 feet AGL before beginning your turn. If you are unable to comply with previously issued climb out instructions, comply with the published missed approach procedure and inform ATC immediately.*** This will ensure ATC is aware of your intentions and can issue alternative instructions if necessary.

14.3.1.1. When practicing instrument approaches under VFR IAW AFI 11-202V3, you are expected to comply with climb out instructions and are NOT automatically cleared for the published missed approach procedure if you cannot comply with the climb out instructions. ***When practicing instrument approaches under VFR, the pilot must request and receive a specific clearance to execute the published missed approach procedure.***

14.3.2. Circling Approaches. Executing climb out instructions in conjunction with a circling approach is more complicated. ***If upon reaching the missed approach point the airport environment is not in sight, execute the climb out instructions from the missed approach point. If the circling maneuver has begun and the airport environment is visually lost, begin an initial climbing turn toward the landing runway to ensure the aircraft remains within the obstruction clearance area. Continue this turn until established on the climb out instructions.***

14.4. Actual Missed Approach. If you have been cleared to land (full stop), ATC expects you to land; therefore, ***if you have been cleared to land and must subsequently execute a missed approach, the pilot shall notify ATC as soon as possible and execute the published missed approach unless issued alternate climb out instructions.***

14.4.1. Various Terms. There are various terms in the missed approach departure instruction written on the IAP that have specific meanings with respect to climbing to an altitude, executing a turn for obstruction avoidance and other reasons. Here are some examples:

14.4.1.1. “Climb and maintain” means a normal climb along the prescribed course.

14.4.1.2. “Climb and maintain (altitude), turn right (heading)” means climbing right turn as soon as safety permits, normally to clear obstructions. This instruction may be given with the turn direction stated first.

14.4.1.3. “Climb and maintain 2,400” means climb to 2,400 feet before ATC will issue a turn instruction, normally to clear obstructions. ATC may state: “Climb and maintain 2,400, then turn right (heading),” to accomplish the same.

14.4.2. Accomplishing the Missed Approach.

14.4.2.1. When to do the Missed Approach. ***The pilot shall perform the missed approach when the missed approach point, decision height (DH), or decision altitude (DA) is reached and any of the 3 following conditions exists:***

14.4.2.1.1. ***The runway environment is not in sight.***

14.4.2.1.2. ***You are unable to make a safe landing.***

14.4.2.1.3. ***You are directed by the controlling agency.***

14.4.2.2. Fly the Aircraft. When you decide to execute the missed approach, fly the aircraft in accordance with the flight manual missed approach procedures.

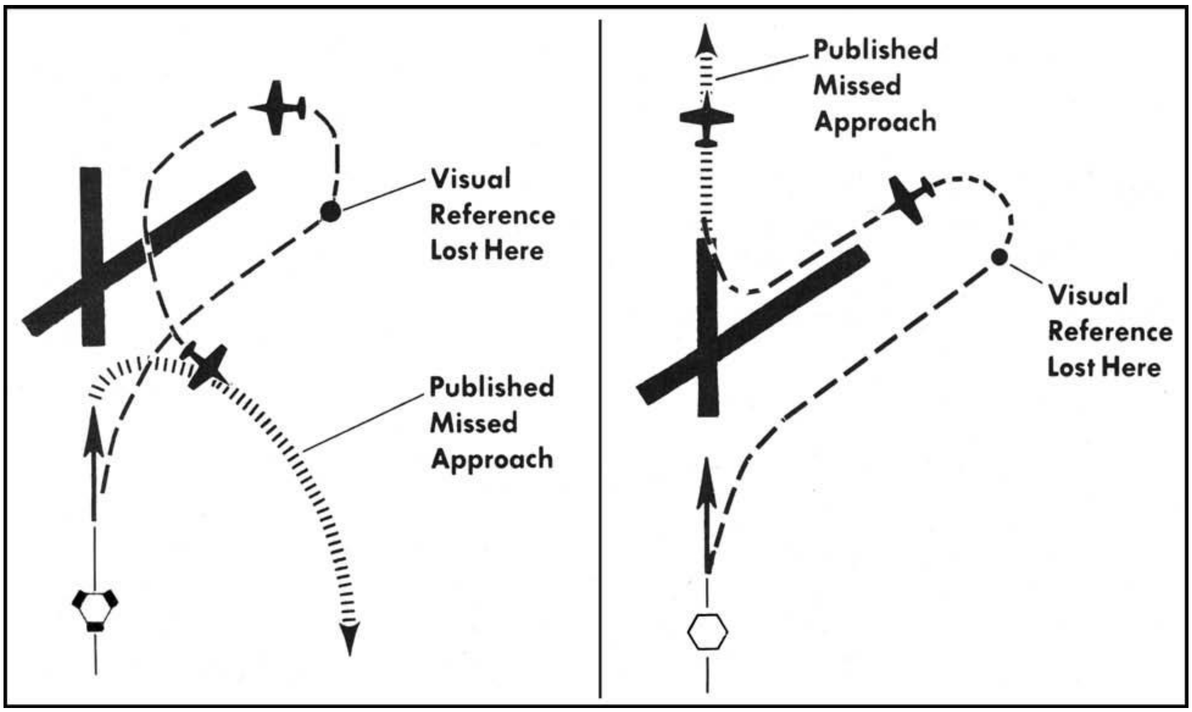
14.4.2.3. Transition. Transition from the approach to the missed approach in a positive manner using precise attitude and power control changes. Establish the missed approach attitude, power setting, and configuration prescribed in the flight manual. Crosscheck the vertical velocity indicator and altimeter for positive climb indications before retracting the gear and wing flaps. Since aircraft control will require almost total attention, you should have the first heading, course, and altitude in mind before reaching the missed approach point.

14.4.2.3.1. If you decide to execute a missed approach prior to reaching the missed approach point, ***continue along the IAP routing at or above the DA/DH until reaching the missed approach point.*** You may climb to the missed approach altitude while following the IAP routing. ***Do not initiate any turns on the missed approach***

until reaching the missed approach point. If ATC issues you a vector on the missed approach, consider this your new clearance.

14.4.2.4. Lose Visual Reference. ***If visual reference is lost while circling to land, the pilot shall follow the missed approach specified for the approach procedure just flown, unless otherwise directed.*** An initial climbing turn toward the landing runway will ensure that the aircraft remains within the circling obstruction clearance area. Continue to turn until established on the missed approach course (Figure 14.1). An immediate climb must be initiated to ensure climb gradient requirements are met.

Figure 14.1. Missed Approach from the Circling Approach.



14.4.3. Climb Gradient. ***The pilot shall ensure that the aircraft can achieve the published climb gradient. When the gradient is not published, climb at least 200 feet per nautical mile in order to clear obstructions. See AFI 11-202V3, for engine out performance requirements.***

14.4.4. Request clearance. As soon as practical after initiating the missed approach, advise ATC and request clearance for specific action; that is, to an alternate airport, another approach, or holding. Do not sacrifice aircraft control for the sake of a voice transmission.

14.4.5. Obstacle Clearance. Terrain clearance is provided within established boundaries of the approach course and the missed approach path. It is essential that you follow the procedure depicted on the IAP chart or the instructions issued by the controller. Be aware of the minimum safe altitudes found on the IAP charts. Remember that the missed approach climb gradient begins at the published MAP.

Chapter 15

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) PROCEDURES

15.1. Introduction. The ICAO is composed of over 180 member nations and is a part of the United Nations. Unlike the FAA, whose regulations are directive, ICAO is an advisory organization that jointly agrees on procedural criteria. Although the ICAO does not have any enforcement authority, ICAO member nations do undertake an obligation to adopt the annexes and procedures adopted as standard by the ICAO. These are published in a document called Procedures for Air Navigation Services-Aircraft Operations (PANS-OPS), in the Annexes to the Convention, and Standards and Recommended Practices (SARPS). Member nations are required to publish their exceptions to PANS-OPS and SARPS in their individual Aeronautical Information Publication (AIP). Most nations do this and follow the ICAO publication of aeronautical information SARPS in Annex 15. These procedures are intended to be strictly adhered to by flight crews in order to achieve and maintain an acceptable level of safety in flight operations. USAF aircrews will find pertinent information extracted from the AIPs in FLIP AP and the Foreign Clearance Guide (FCG).

15.1.1. The ICAO Convention does contain an exemption for state aircraft. However, there should be a due regard exercised for the safety of navigation of civil aircraft. ***USAF crews shall comply with guidance in AFI 11-202V3 regarding compliance with ICAO procedures.***

15.1.1.1. NOTE: Although an ICAO signatory, the United States uses none of the PANS-OPS procedures. We use the Federal Aviation Regulations for procedural guidance instead as an equivalent to an AIP.

15.1.2. The Continuum of Safety. Even more so than in the United States, international flying requires good judgment on the part of the pilot. The Air Force expects and encourages you to apply it. No book of hard and fast rules could ever hope to cover all the various situations you may encounter everywhere in the world. The global mission of the USAF means that you may well be required to operate in countries without a well developed aviation system, or into airfields where the ICAO rules have been ignored, replaced or poorly applied. The PIC must necessarily be the final judge of what is safe and prudent for any given mission on any given day. A thorough review of all flight planning documents prior to departure is critical.

15.1.2.1. While English is the standard language of aviation, in many parts of the world you will hear native languages being spoken over ATC frequencies. Knowing, and using, standard terms from FLIP GP, AIM, the ICAO nation's AIP, and the Pilot-Controller glossary reduces the chance of misinterpreting a clearance or misunderstanding information from controllers with heavy accents. At all times, and especially when working with ATC controllers whose native language is not English, ***USAF pilots shall use standard aviation terminology and phraseology***. ***USAF pilots are required to clarify with ATC any clearance that is not completely understood.***

15.1.2.2. While most terminology has been standardized between the FAA and ICAO, there are minor differences that should be known to aircrews. Five of the most common verbiage differences include:

15.1.2.2.1. “Position and Hold” (FAA) – “Line up and Wait” (ICAO)

15.1.2.2.2. “Say Altitude” (FAA) – “Verify Level” (ICAO)

15.1.2.2.3. “Hold Short Line” (FAA) – “Holding Point” (ICAO)

15.1.2.2.4. “Back Taxi” (FAA) – “Back Track” (ICAO)

15.1.2.2.5. “Airport” (FAA) – “Aerodrome” (ICAO)

15.1.2.3. SID STAR Phraseology. Approximately half of the world’s aircraft operations experience SID and STAR altitude (level) restrictions that are automatically cancelled with a new altitude assignment; the remainder experience SID and STAR altitude (level) restrictions that continue to apply until explicitly cancelled, potentially causing confusion amongst aircrews. ICAO signatories are attempting to alleviate this confusion with new standardized phraseology. The following verbiage may be expected while operating under ICAO rules:

15.1.2.3.1. “Climb (level) via SID”, meaning “Climb following the level restrictions or requirements published on the SID.”

15.1.2.3.2. “Open Climb (level)”, meaning “Climb to (level) without stopping at any vertical restriction on the SID and without being required to meet any vertical requirement on the SID.”

15.1.2.3.3. “Descend (level) via STAR”, meaning “Descend following the level restrictions or requirements published on the STAR.”

15.1.2.3.4. “Open Descent (level)”, meaning “Descend to (level) without stopping at any vertical restrictions on the STAR and without being required to meet any vertical requirements on the STAR.”

15.1.2.4. Aircrew should familiarize themselves with country and area specific requirements prior to flying into an unfamiliar region. ICAO publications can be found online at **http://dcaa.slv.dk:8000/icaodocs**/. AIP information is available at **http://www.faa.gov/air_traffic/publications/ifim**/.

15.1.3. Applicability. Procedures described in this chapter apply only in airspace not under FAA control. These procedures are ICAO standard procedures and may be modified by each country (as the U.S. has).

15.1.3.1. When determining whether to apply FAA or ICAO procedures in flying an instrument procedure, the nationality of the air traffic controller or who produced the procedure is not relevant. The geographic location of the aircraft is the determining factor, unless local procedures (detailed in FLIP and/or local directives) are in place. Regardless of the nationality of the air traffic controller and/or the origin of the instrument procedure you are using, ***if you are flying outside US National Airspace, apply ICAO instrument procedures unless otherwise published***.

15.1.3.2. US National Airspace is defined as airspace controlled by the FAA. This airspace is defined geographically as overlying the 50 United States, the District of Columbia, the Commonwealth of Puerto Rico, and the several territories and possessions (ex. Marianas Islands, etc.) of the United States. By Presidential proclamation in December 1988, this airspace also overlies the waters up to 12 miles from the coast.

15.1.3.2.1. IAW ICAO Article 12 and Annexes 2 and 11, the United States has accepted responsibility for providing air traffic services within airspace overlying the high seas beyond 12 miles from the coast (also known as international airspace). These flight information regions of international airspace are: Oakland Oceanic, Anchorage Oceanic, Anchorage Continental, Anchorage Arctic, Miami Oceanic, Houston Oceanic, and New York Oceanic. Although the FAA in these areas is providing air traffic services, they are considered international airspace and ICAO rules apply.

15.1.4. Finding Current Information and Procedures. Changes to ICAO standard procedures can be numerous and may even vary from airfield to airfield within a country. FLIP Area Planning (AP) generally contains a comprehensive consolidation of procedural requirements, but a thorough review of all applicable preflight planning sources is essential to ensuring compliance with ICAO, host nation, and USAF requirements. Other preflight planning sources include, but are not limited to: NOTAMS, the ASRR, Specific Theatre Information Files (STIF), and MAJCOM/Unit Flight Crew Information File (FCIF).

15.1.5. Terminal IAPs. There are many different kinds of approaches published in the DoD FLIP books for regions outside the United States. You may find approaches designed using U.S. TERPS at overseas bases. You may also find approaches designed under the civil PANS-OPS criteria. Or you may find procedures that use host nation criteria that are different from PANS-OPS. Aircraft executing maneuvers other than those intended by the host nation approach design could exceed the boundaries of the protected airspace or may cause overflight of unauthorized areas. ***All ICAO procedures must be flown as they are depicted***.

15.1.5.1. NOTE: For procedures designed in accordance with host nation or PANS-OPS criteria, the original foreign procedures may have been modified or edited as a result of the DoD TERPS review, which is conducted before these procedures are published in DoD FLIP.

15.2. Definitions. Here are a few ICAO definitions that differ from those commonly used in the United States.

15.2.1. PANS-OPS. PANS-OPS is a two-part document. The first volume is for pilots, and is similar to the FAA's AIM. The second volume contains the ICAO "TERPS." The document is intended for the use of the international civilian aviation community, not the military. There have been a number of editions of PANS-OPS published since the creation of the ICAO, each with significant changes in the details of instrument approach procedure design. This means that you may find approaches in different parts of the world that have been designed with entirely different rules.

15.2.2. Aircraft Categories. Aircraft approach categories play a much bigger role in the design of ICAO instrument procedures than they do in the U. S. In addition to affecting final approach minimums, PANS-OPS references maximum speeds by category for such operations as holding, departures, and the intermediate segments of instrument approaches. To make matters even more confusing, these additional "category" restrictions specify speeds that are completely different from the familiar approach speeds on final. The appropriate PANS-OPS "category" speeds appear in tables later in this chapter.

15.2.3. Track. The projection on the earth's surface of the path of an aircraft, the direction of which path at any point is usually expressed in degrees from North, specifying true or magnetic. This means you must apply any known winds/drift to maintain the ground path. Obstacle clearance in ICAO procedures is provided under the assumption that pilots will maintain the depicted track.

15.2.4. Bank Angle. Procedures are based on average achieved bank angle of 25 degrees, or the bank angle giving a rate of turn of 3 degrees per second, whichever is less.

15.2.5. Established on Course. Established on course is defined as being within half full-scale deflection for an ILS or VOR/DME and within ± 5° of the required bearing for an NDB. ***Do not consider yourself "established on course" until you are within these limits.*** ICAO obstacle clearance surfaces assume that the pilot does not normally deviate from the centerline more than one-half scale deflection after being established on track. Despite the fact that there is a range of "acceptable" variation, make every attempt to fly the aircraft on the course centerline and on the glide path. Allowing a more than half-scale deflection (or a more than half-scale fly-up deflection on glideslope) combined with other system tolerances could place the aircraft near the edge or at the bottom of the protected airspace where loss of protection from obstacles can occur.

15.3. Departure Procedures.

15.3.1. Screen Heights. It may be difficult or impossible to accurately determine screen height used for a particular departure procedure. For PANS-OPS, the origin of the OIS begins at 16 ft (5 m) above the DER. See Chapter 7 for guidelines to determine screen height.

15.3.2. Climb Gradient. ICAO does not apply the FAA 24% ROC formula and has retained the traditional 48 ft/nm (0.8%) ROC for departures. ICAO obstacle clearance during departures is based on a 2.5% gradient obstacle clearance (152 feet/NM) and an increasing 0.8% obstacle clearance (48 feet/NM). This equates to a minimum climb gradient of 3.3% (200 feet/NM). Minimum climb gradients exceeding 3.3% will be specified to an altitude/height after which the 3.3% will be used.

15.3.3. Basic Rules for All Departures. Unless the procedure specifies otherwise, ***you must climb on runway heading at a minimum of 200 feet/NM (3.3%) until reaching 400 feet above the DER. Continue to climb at a minimum of 200 feet/NM until reaching a safe enroute altitude.***

15.3.4. Omnidirectional Departures. The PANS-OPS "Omnidirectional Departure" is somewhat similar to the FAA's "Diverse Departure." It is a departure procedure without any track guidance provided. There are some very important differences, though, because an Omnidirectional Departure may be published even though obstacles penetrate the 40:1 Obstacle Identification Surface. If this is the case, PANS-OPS gives the departure designer a number of ways to publish departure restrictions. These restrictions may be published singly, or in any combination.

15.3.4.1. Standard case. Where no obstacles penetrate the 40:1 OIS, then no departure restrictions will be published. Upon reaching 400 feet above DER, you may turn in any direction.

15.3.4.2. Specified turn altitude. The procedure may specify a 3.3% climb to an altitude where a safe omnidirectional turn can be made.

15.3.4.3. Specified climb gradient. The procedure may specify a minimum climb gradient of more than 3.3% to an altitude before turns are permitted.

15.3.4.4. Sector departure. The procedure may identify sectors for which either a minimum turn altitude or a minimum climb gradient is specified. (For example, "Climb straight ahead to 2000 feet before commencing a turn to the east/sector 180°- 270°).

15.3.5. Departures with Track Guidance (SIDs). PANS-OPS uses the term Standard Instrument Departure (SID) to refer to departures using track guidance. Minimum climb gradients may apply. There are two basic types: straight and turning.

15.3.5.1. Straight departures. Whenever possible, a straight departure will be specified. A departure is considered "straight" if the track is aligned within 15° of the runway centerline.

15.3.5.2. Turning departures. Where a departure route requires a turn of more than 15°, a turning departure may be constructed. Turns may be specified at an altitude/height, at a fix or at a facility. If an obstacle prohibits turning before the departure end of the runway or prior to reaching an altitude/height, an earliest turning point or a minimum turning altitude/height will be specified. When it is necessary, after a turn, to fly a heading to intercept a specified radial/bearing, the procedure will specify the turning point, the track to be made good and the radial/bearing to be intercepted.

15.3.5.2.1. Turning departures are designed with maximum speed limits. These maximum speeds may be published by category or by a note. For example, these procedures may be annotated, "Departure limited to CAT C Aircraft" or "Departure turn limited to 220 KIAS maximum." ***You must comply with the speed limit published on the departure to remain within protected airspace. If you require a higher speed, ATC may approve the higher speed or assign an alternative departure procedure.***

15.3.5.2.2. If the departure is limited to specific aircraft categories, the applicable speeds are found in Table 15.1.

Table 15.1. Maximum Airspeed on Departure.

Aircraft Category	Max Airspeed (KIAS)
A	120
B	165
C	265
D	290
E	300

15.4. Low Altitude Approach Procedures.

15.4.1. Procedural Tracks. Procedural Track approaches are the most common way of transitioning from the enroute structure. These approaches are often much more complicated than a comparable U.S. approach, and may include multiple NAVAIDs, fixes and course changes, but they are flown essentially the same as described in Chapter 11.

15.4.2. Reversal Procedures and Racetrack Procedures. If the instrument approach cannot be designed as a procedural track arrival, then a reversal procedure or a racetrack or a holding pattern is required.

15.4.2.1. Reversal Procedures. ICAO "Reversal Procedures" are similar in concept to FAA "Procedure Turns." The ICAO recognizes three distinctly different methods of performing a "reversal procedure," each with its own airspace characteristics: the 45°/180° Procedure Turn (Figure 15.1), the 80°/260° Procedure Turn (Figure 15.2), and the Base Turn (Figure 15.3).

15.4.2.1.1. Entry is restricted to a specific direction or sector. To remain within the airspace provided requires strict adherence to the directions and timing specified.

15.4.2.1.1.1. NOTE: The protected airspace for "reversal procedures" does not permit a racetrack or holding maneuver to be conducted unless so specified. ***You may not enter an ICAO procedure turn using the "Holding Technique" described in* Chapter 11.** Instead, refer to the entry procedures below.

15.4.2.1.2. The 45°/180° Procedure Turn. This procedure starts at a facility or fix and consists of:

15.4.2.1.2.1. A straight leg with track guidance; this straight leg may be timed or limited by a radial or DME distance;

15.4.2.1.2.2. A 45° turn; commenced at the designated radial or DME fix, or at the completion of the published timing requirement;

15.4.2.1.2.3. A straight leg without track guidance. This straight leg is timed; it is 1 minute from the start of the turn for categories A and B aircraft and 1 minute 15 seconds from the start of the turn for categories C, D and E aircraft;

15.4.2.1.2.4. A 180° turn in the opposite direction to intercept the inbound

15.4.2.1.2.4.1. NOTE: You must adjust the time or distance on the outbound track to ensure the reversal is initiated at a point specified on the IAP if so depicted, or the maneuver is completed within the specified "remain within" distance.

15.4.2.1.3. The 80°/260° Procedure Turn. This procedure starts at a facility or fix and consists of:

15.4.2.1.3.1. A straight leg with track guidance; this straight leg may be timed or limited by a radial or DME distance;

15.4.2.1.3.2. An 80° turn; commenced at the designated radial or DME fix, or at the completion of the published timing requirement, followed immediately by;

15.4.2.1.3.3. A 260° turn in the opposite direction to intercept the inbound track.

15.4.2.1.3.3.1. NOTE: You must adjust the time or distance on the outbound track to ensure the reversal is initiated at a point specified on the IAP if so depicted, or the maneuver is completed within the specified "remain within" distance.

15.4.2.1.3.4. While executing this procedure, comply with the speeds in paragraph 15.4.2.2.8.1 or as published on the procedure. Also, comply with the bank angle restrictions of paragraph 15.2.4.

15.4.2.1.4. The Base Turn. This procedure consists of intercepting and maintaining a specified outbound track, timing from the facility or proceeding to a specified fix, followed by a turn to intercept the inbound track.

15.4.2.1.4.1. NOTE: The base turn procedure is not optional. ***You may not fly one of the "procedure turns" described above instead of the depicted base turn.*** More than one track may be depicted depending on aircraft category.

Figure 15.1. 45°/180° Course Reversal.

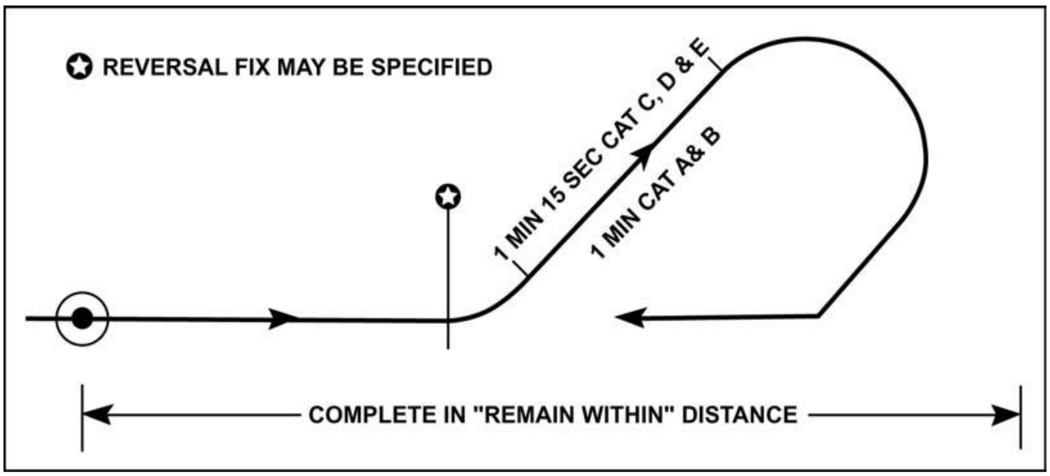


Figure 15.2. 80°/260° Course Reversal.

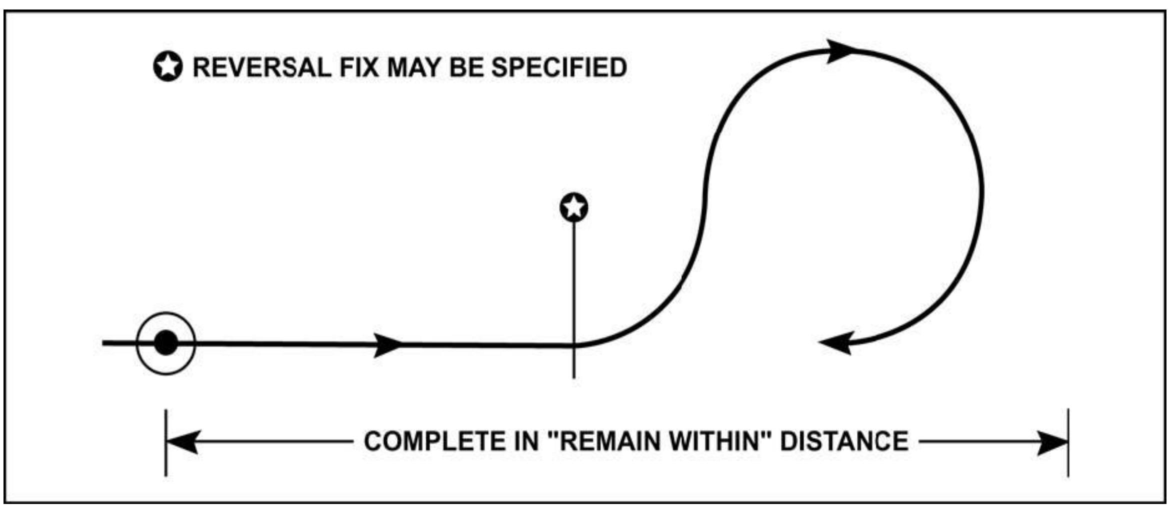
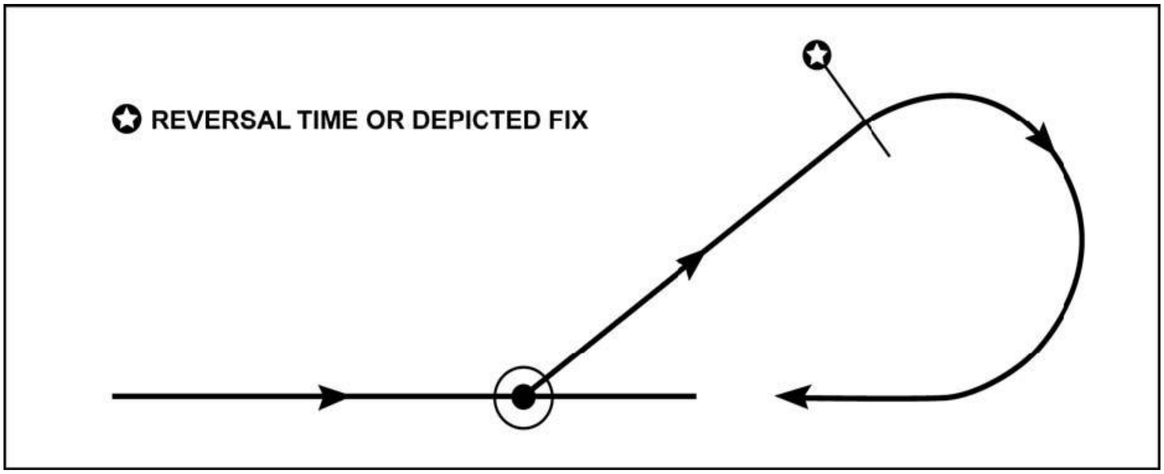


Figure 15.3. Base Turns.



15.4.2.2. Reversal Procedure Entry (Figure 15.4). Of all the differences between FAA and ICAO procedures, the entry into the three course reversal maneuvers has historically been the area of greatest confusion for USAF pilots. A short discussion is in order:

15.4.2.2.1. The 30° Entry Sector. The reason PANS-OPS specifies this entry sector is because, unlike in the U. S., the course reversal protected airspace may not include any airspace except that on the outbound side of the procedure turn fix. In the U.S., protected airspace includes a large "entry zone" surrounding the fix.

15.4.2.2.2. ***Unless the procedure specifies particular entry restrictions, the 45°/180°, 80°/260°, and base turn reversal procedures must be entered from a track within ± 30° of the outbound reversal track*** (Figure 15.5). There is a special rule for base turns: for base turns where the ± 30° entry sector does not include the reciprocal of the inbound track, the entry sector is expanded to include the reciprocal. (Figure 15.6). If the aircraft's arrival track is not within the entry sector:

15.4.2.2.2.1. Comply with the published entry restrictions or arrival routing; or

15.4.2.2.2.2. If there is a suitable arrival holding pattern published, enter holding prior to the reversal procedure; or

15.4.2.2.2.3. If there is no published routing or suitable holding pattern, use good judgment while maneuvering the aircraft into the entry sector.

15.4.2.2.2.4. For racetrack entry, see paragraph 15.4.2.3.

15.4.2.2.3. What if you Arrive From Outside the Entry Sector?

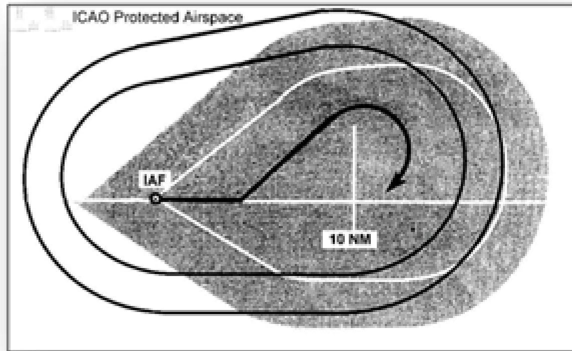
15.4.2.2.3.1. Arrival Routing. There is often some form of published arrival routing into the course reversal IAF, such as a STAR, feeder routing, or arrival airway. This arrival routing may not fall into the 30-degree entry sector. Such arrival routes will be blended into the reversal approach, and protected airspace is provided to allow the pilot to turn onto the outbound reversal track. Pilots need not request "maneuvering airspace" to perform an alignment maneuver. Such requests are often met with confusion by ATC. You should remain within protected airspace on the published arrival routing, whether or not that happens to align you with the 30° entry sector.

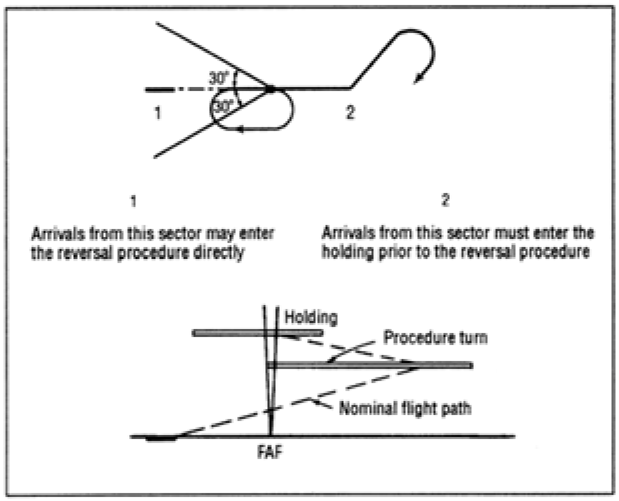
15.4.2.2.3.2. Using the Arrival Holding Pattern. On most ICAO course reversals, a holding pattern is published at or near the IAF to accommodate arrivals from outside the 30-degree sector and not on a published arrival routing. PANS-OPS directs pilots arriving from outside the entry sector to enter holding prior to the reversal procedure. In most cases, the holding pattern will align you for the approach.

15.4.2.2.3.3. Off-airway Arrivals. What if there is no suitable Holding Pattern? The danger arises when attempting to perform the course reversal when arriving into the IAF from a direction not anticipated by the approach designer, such as when you request to proceed direct to the fix from a point off the arrival airway. Sometimes there is no holding pattern published for your alignment, or there is a holding pattern that does not turn you into the entry sector. In this case, you will need to maneuver into the entry sector somehow. You must understand how small the protected airspace is, especially when compared to an FAA procedure turn. You may be operating completely outside of protected airspace while proceeding to the IAF, and terrain and obstacle clearance may be totally up to you. Use good judgment, consider the published minimum safe/sector altitudes, and do not rely solely on ATC to keep you safe.

Figure 15.4. Comparison of FAA and ICAO Protected Airspace for a Procedure Turn.

FAA protected airspace for a procedure turn is shown in white, with ICAO airspace in gray. Note that there is no primary protected airspace to the West of the IAF under PANS-OPS criteria





1. Arrivals from within the entry sector will be in protected airspace immediately upon passing the IAF.

2. If there is a suitable holding pattern, you can arrive from outside the entry sector and use a turn in holding to align with the entry sector.

Figure 15.5. Procedure Turn Entry (45°/180° or 80°/260°).

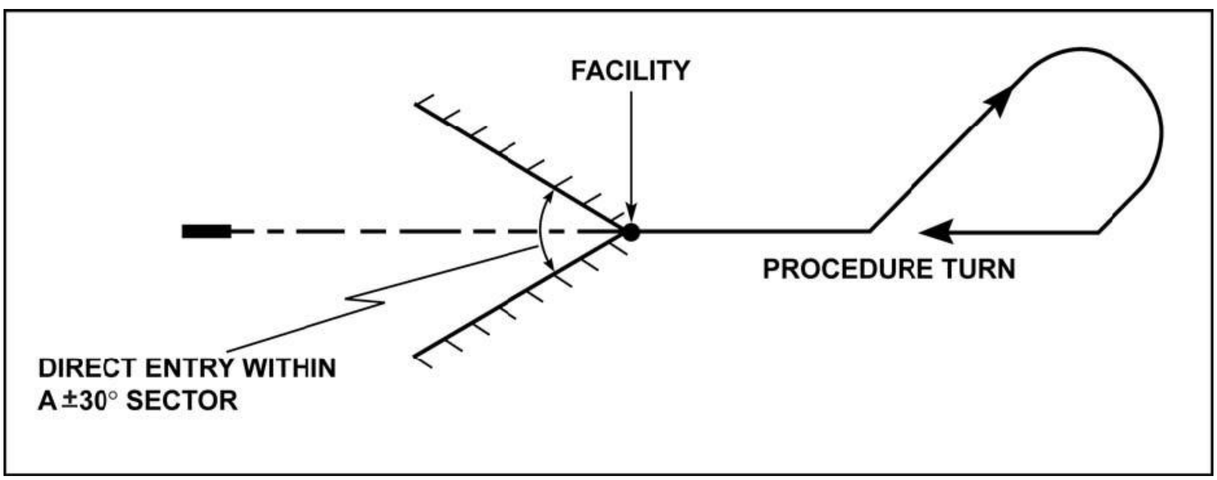
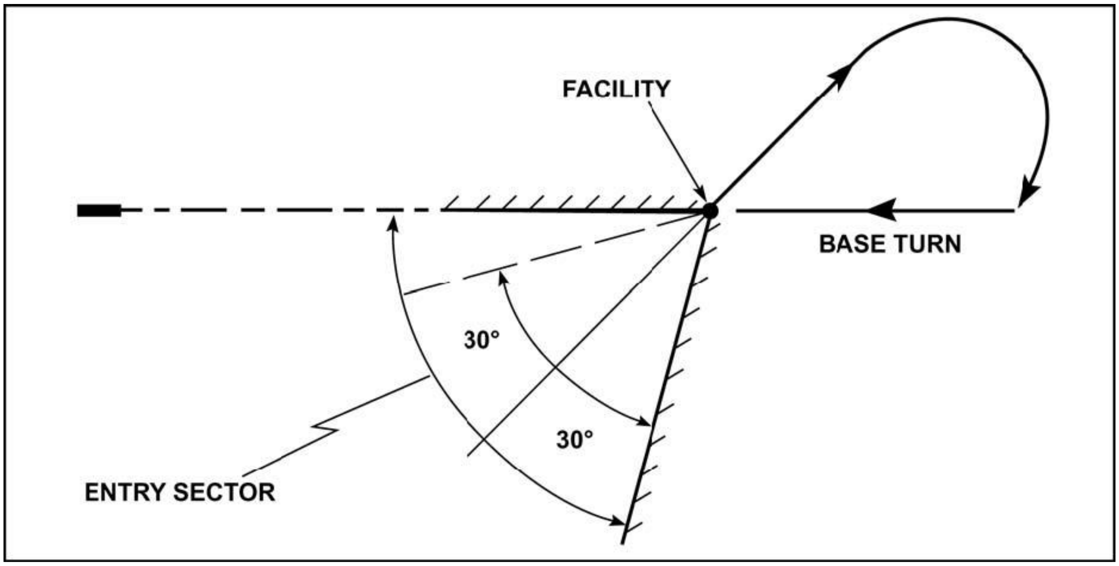


Figure 15.6. Base Turn Entry.



15.4.2.2.4. Timing. Begin timing to comply with published times or "remain within" distances when outbound abeam the facility or fix. If the abeam position cannot be determined while in a turn, start timing after completing the turn.

15.4.2.2.5. Descent. A descent can be depicted at any point along a course reversal. When a descent is depicted at the IAF, start descent when abeam or past the IAF and on a parallel or intercept heading to the depicted outbound track. For descents past the IAF, be established on a segment of the IAP before beginning a descent to the altitude associated with that segment.

15.4.2.2.6. NOTE: According to the ICAO's definition, "established on a segment" is considered being within half full-scale deflection for an ILS or VOR and within ± 5° of the required bearing for the NDB.

15.4.2.2.7. Remaining Within Protected Airspace. To ensure that you remain within protected airspace while executing ICAO course reversals, you must ***comply with the following***:

15.4.2.2.7.1. Fly no faster than the maximum speed for your category in Table 15.2 or the maximum airspeed published on the procedure, whichever is lower;

15.4.2.2.7.2. ***Comply with the entry sector requirements of* paragraph 15 4.2 *(i.e. 30° entry sector);***

15.4.2.2.7.3. ***Begin the course reversal at the fix specified in the procedure;***

15.4.2.2.7.4. ***Comply with the bank angle restrictions in* paragraph 15 2.4**;

15.4.2.2.7.5. ***Begin required timing at the appropriate location;***

15.4.2.2.7.6. ***Apply drift corrections to track the published ground track.***

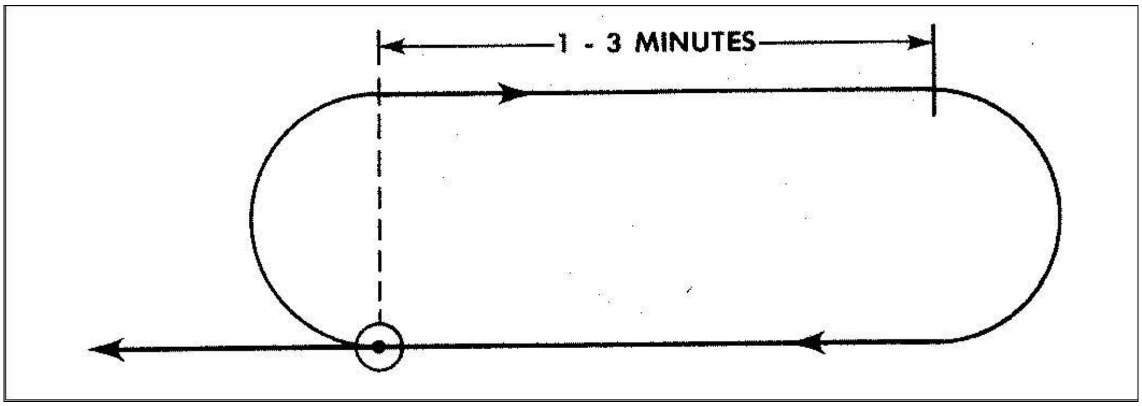
15.4.2.2.8. ***Airspeed Restrictions. Before reaching the IAF, reduce to maneuvering airspeed. Use holding speed if maneuvering speed is not specified for your aircraft.***

Table 15.2. Maximum Approach Speeds.

CATEGORY	MAXIMUM SPEED
A	110
B	140
C	240
D	250
E	250

15.4.2.2.8.1. Additional speed restrictions may be charted on individual IAPs and must be complied with. ***However, the maximum speeds by category, as shown above, will not be exceeded without approval of the appropriate ATC agency.***

Figure 15.7. Racetrack Procedure.



15.4.2.3. The Racetrack (Figure 15.7). The ICAO "Racetrack Procedure" is similar in concept to an FAA "Holding In Lieu of Procedure Turn." This maneuver consists of a holding pattern with outbound leg lengths of 1 to 3 minutes, specified in 30-second increments. As an alternative to timing, a DME distance or an intersecting radial or bearing may limit the outbound leg.

15.4.2.3.1. Racetrack Entry Procedure. Normally a racetrack procedure is used when aircraft arrive overhead the fix from various directions. Entry procedures for a racetrack are the same as entry procedures for holding patterns with several exceptions:

15.4.2.3.1.1. The teardrop offset should be planned using 30° from the inbound course.

15.4.2.3.1.2. The teardrop entry from sector 2 is limited to 1 1/2 minutes wings level on the 30-degree teardrop track, after which the pilot is expected to turn to a heading to parallel the outbound track for the remainder of the outbound time. If the outbound time is only 1 minute, the time on the 30 degree teardrop track will be 1 minute also.

15.4.2.3.1.3. Parallel entries may not return directly to the facility without first intercepting the inbound track.

15.4.2.3.1.4. All maneuvering will be done as much as practical on the maneuvering side of the inbound track.

15.4.2.3.1.4.1. NOTE: When necessary due to airspace limitations, entry into the racetrack procedure may be restricted to specified routes. When so restricted, the entry routes will be depicted on the IAP. Racetrack procedures are used where sufficient distance is not available in a straight segment to accommodate the required loss of altitude and when entry into a reversal maneuver is not practical. They may also be specified as alternatives to reversal procedures to increase operational flexibility.

15.4.2.3.2. Shuttle Procedure. A "Shuttle" is a descent or climb conducted in a holding pattern. A shuttle is normally specified where the descent required between the end of the initial approach and the beginning of the final approach exceeds standard ICAO approach design limits.

15.4.2.3.3. Alternate Procedures: There may be alternate procedures specified to any of the procedures described above. IAPs will contain the appropriate depiction and the words "alternative procedure." Pilots should be prepared to execute either procedure. ***Prior to accepting clearance for an approach that depicts an alternative procedure, determine which procedure the controlling agency expects***.

15.4.2.3.4. Circling Procedures. ICAO circling protected airspace is typically larger than US TERPS and the ROC is higher. One important distinction to make is between the terms "runway environment" and "airport environment**."** ***While circling using an ICAO-designed procedure, you must maintain visual contact with the runway environment (as defined in*** **paragraph 12.1.2.2*****) throughout the entire circling maneuver.*** In the United States, you are only required to maintain visual contact with the airport environment while circling to land, but cannot descend out of the circling MDA until the runway environment is in sight. Use Table 15.3 to determine maximum airspeeds for circling.

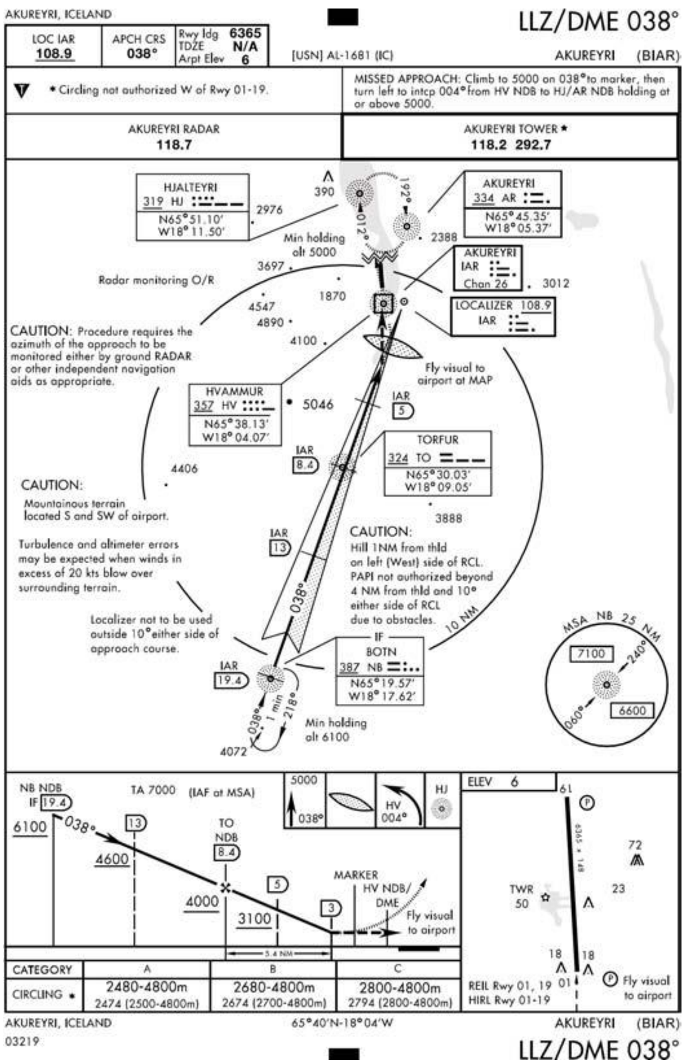
Table 15.3. Maximum Airspeeds for Circling Approaches.

APPROACH CATEGORY	MAXIMUM SPEED
A	100
B	135
C	180
D	205
E	240

15.4.3. Localizer (LLZ) (Figure 15.8). PANS-OPS abbreviates the localizer facility as LLZ. The accuracy of the signal generated by the LZZ is the same as a LOC. PANS-OPS normally requires the LLZ final approach track alignment to remain within 5° of the runway centerline. However, in certain cases, the alignment can exceed 5°. Where required, PANS-OPS allows an increase of the final approach track to 15° for categories C, D, and E. For aircraft categories A and B, the maximum angle formed by the final approach track and the runway centerline is 30°.

15.4.3.1. NOTE: Prior to flying a LDA or LLZ, compare the final approach course with the runway heading. The aerodrome sketch should provide a visual indication of the angle formed between the final approach track and the runway centerline.

Figure 15.8. LLZ Approach.



15.4.4. Constant Descent Final Approach (CDFA). Member States of the European Union are beginning to publish non-precision approaches as CDFAs. These procedures differ from traditional nonprecision approaches in that instead of being flown as "dive and drive" (descend from the FAF at 1200-1500 fpm to the MDA and then drive to the MAP), they are intended to be flown as a continuous descent, without level off, to the Decision Altitude (Height), annotated as DA(H). The CDFA technique simplifies the final segment of the non-precision approach by incorporating techniques similar to those used when flying a precision approach procedure. CDFA instrument procedures include tabular information in the minima section with ground speed in knots and descent angle. Flying the resulting VVI will result in arriving at the DA(H) at the VDP.

15.4.4.1. NOTE: Unlike the DH on a precision approach procedure which accounts for height-loss (dip under) on a missed approach, that is not the case for a DA(H). The airspace below the DA(H) does not guarantee obstacle clearance. A technique to avoid descending through the DA(H) is to create a derived DA by adding a buffer (e.g. 50 feet) to the minimum.

15.4.4.2. If the visual references required to land have not been acquired when the aircraft reaches the DA(H), the vertical (climbing) portion of the missed approach is initiated at an altitude above the DA(H) sufficient to prevent the aircraft from descending through the DA(H). At no time is the aircraft flown in level flight at or near the DA(H). Any turns on the missed approach shall not begin until the aircraft reaches the MAP. Likewise, if the aircraft reaches the MAP before descending to near the DA(H), the missed approach shall be initiated at the MAP.

15.4.5. Timing for Missed Approach and FAF to MAP. Some host nations use non-standard timing for determining the MAP on a procedure. This means timing may go from the FAF to the runway threshold or from a step-down fix to the runway threshold. When these host nation procedures are published in DoD FLIP, these non-standard timing blocks will be converted to the US standard of FAF to MAP. This can induce some errors due to rounding of numbers. For this reason, when using timing to determine the MAP on a DoD procedure produced by a host nation, it is imperative that crews correctly determine the timing based on groundspeed, and then fly that groundspeed to avoid exaggerating errors already induced due to the conversion from host nation to DoD format.

15.5. Holding.

15.5.1. Bank Angle. Make all turns at a bank angle IAW paragraph 15.2.4. ICAO procedures do not allow correcting for winds by adjusting bank angle. The “triple-drift” technique described in Chapter 8 is a good way to correct for winds without varying your bank angle.

15.5.2. Tracks. All procedures depict tracks. ***Attempt to maintain the track by allowing for known winds and applying corrections to heading and timing during entry and while flying in the holding pattern.***

15.5.3. Limiting Radial. When holding away from a NAVAID, where the distance from the holding fix to the NAVAID is short, a limiting radial may be specified. A limiting radial may also be specified where airspace conservation is essential. If you encounter the limiting radial first, initiate a turn onto the radial until you turn inbound. Do not exceed the limiting DME distance, if published.

15.5.4. Holding Entry Procedure. ***The ICAO holding entry procedure is a mandatory procedure. All timing, distances, and limiting radials must be complied with. Enter the holding pattern based on your heading (±5°) relative to the three entry sectors depicted in*** **Figure 15.9** ***Upon reaching the holding fix, follow the appropriate procedure for your entry sector:***

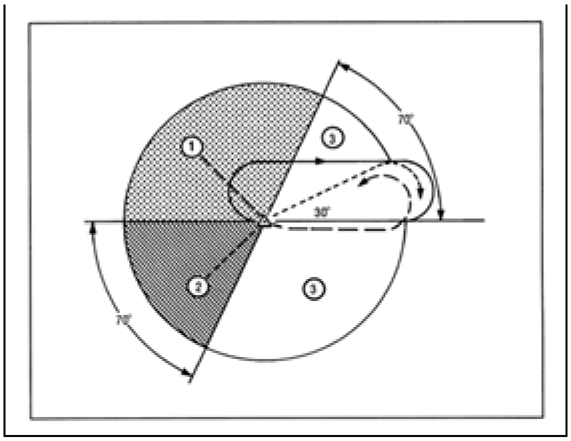
15.5.4.1. ***Sector 1 (Parallel). Turn onto an outbound heading for the appropriate time or distance, and then turn towards the holding side to intercept the inbound track or to return to the fix.***

15.5.4.2. ***Sector 2 (Offset). Turn to a heading to make good a track making an angle of 30° from the reciprocal of the inbound track on the holding side. Fly outbound for the appropriate period of time described in*** **paragraph 15.4.2.3.1.2**, ***until the***

appropriate limiting DME is attained, or where a limiting radial (paragraph 15.5.3) is also specified, either until the limiting DME is attained or until the limiting radial is encountered, whichever occurs first, then turn right to intercept the inbound holding track.

15.5.4.3. ***Sector 3 (Direct). Turn and follow the holding pattern.***

Figure 15.9. ICAO Holding Pattern Entry Sectors.



1. Sector 1: make a parallel entry.

2. Sector 2: make a teardrop entry. The teardrop is defined as the 30° offset track.

3. Sector 3: make a direct entry

15.5.5. Airspeeds. There is little standardization of maximum holding airspeeds in PANS-OPS. There are three completely different tables of holding airspeeds that an approach designer could have used, depending on which edition of PANS-OPS was used when the holding pattern was constructed. Many countries publish their own holding pattern airspeeds. This information is supposed to be published in FLIP, but it may be quite difficult or impossible for to you to actually find it. Some holding pattern airspeeds are published on IAPs. You must understand, though, that the concept is the same as in the United States: maximum holding airspeeds are defined by PANS-OPS (or the host country) and have no relation to the holding speed specified in the aircraft flight manual. Table 15.4 reproduces the airspeeds from PANS-OPS and is the most common table used.

Table 15.4. ICAO Holding Airspeeds.

ALTITUDE	AIRSPEED	AIRSPEED
	Normal Conditions	Turbulence*
Up to 14,000 Feet Inclusive (CAT A and B)	170	170
Up to 14,000 Feet Inclusive (CAT C thru E)	230	280
Above 14,000-20,000	240	280 or .8 Mach, whichever is less
Above 20,000-34,000	265	280 or .8 Mach, whichever is less
Above 34,000	.83 Mach	.83 Mach
*The speeds published for turbulence conditions shall be used for holding only after		

prior clearance with ATC, unless the relevant publications indicate that the holding area can accommodate aircraft flying at these high holding speeds.

15.5.6. Holding Pattern Lengths. On the second and subsequent arrivals over the fix, turn and fly an outbound track that will most appropriately position the aircraft for the turn onto the inbound track. Continue outbound until the appropriate limiting distance or time. ICAO outbound legs are the limiting factor for both timed and fixed distance holding patterns. The standard times are: 1 minute outbound at or below 14,000 feet MSL, or 1 1/2 minutes outbound above 14,000 feet MSL.

15.5.7. Wind Corrections. Attempt to correct both heading and timing to compensate for the effects of wind to ensure the inbound track is regained before passing the holding fix inbound. Indications available from the NAVAID and estimated or known winds should be used in making these corrections. If a limiting radial is published and encountered prior to the outbound limits, it must be followed until a turn inbound is initiated at the appropriate distance/time.

15.6. ICAO Altimeter Setting Procedures. There are three different methods of reporting the altimeter measurements and four different units of measure used to express altimeter settings. For aircraft that have only one type of altimeter scale, or for areas where the altimeter setting is not converted for you, the FIH contains conversion tables. It is critical that crewmembers understand how to apply the conversions prior to flight into airspace using other than inches of mercury QNH for altimeter settings. Refer to FLIP AP for specific altimeter setting procedures for each country.

15.6.1. Methods of Reporting Altimeter Settings.

15.6.1.1. QNH Settings. A QNH altimeter setting represents the pressure that would, in theory, exist at sea level at that location by measuring the surface pressure and correcting it to sea level pressure for a standard day. ***Set the reported QNH when descending through, or operating below, the published MSL Transition Level***. With the proper QNH set, the altimeter will indicate your height above MSL. All DOD approach criteria are based upon using QNH altimeter settings. Some also provide QFE altitudes in parenthesis.

15.6.1.2. QNE Settings. QNE is used to indicate your height above an imaginary plane called the “standard datum plane,” also known as “FL 0”. The established altimeter setting at FL 0 is 29.92 inches of Mercury (IN HG), or 1013.2 millibars or hectopascals. ***Set QNE (29.92) when climbing through, or operating above the Transition Altitude.***

15.6.1.3. QFE Settings. QFE is the altimeter setting issued to aircraft to indicate the AGL height above the airport. With the proper QFE set, your altimeter should indicate “0” on the ground. The Royal Air Force and the Royal Navy in the United Kingdom, and in many parts of the Pacific and Eastern Europe commonly use QFE.

15.6.2. Units of Measure for Altimeter Settings.

15.6.2.1. Inches of Mercury. The unit of measure used in the US is inches of mercury.

15.6.2.1.1. WARNING: In some areas, controllers will use shorthand to issue an altimeter setting, which can cause confusion for crews. For example, “992” could mean 29.92 inches or 992 mb. Insure you are using the correct units of measure when setting your altimeter.

15.6.2.1.2. NOTE: Most USAF altimeters have the ability to display either inches of mercury or millibars/hectopascals by use of two different barometric scales in the window of the altimeter. Insure you are using the proper scale to set the altimeter setting.

15.6.2.2. Millibars and Hectopascals. In most other parts of the world, the metric system is used and you will hear the term "millibars (MB)" or "hectopascals (HPa)." Both MB and HPa equal the same unit of pressure per square centimeter, and thus can be used interchangeably.

15.6.2.3. Millimeters of Mercury. This is primarily used in Eastern Europe and nations of the former USSR, and is not to be confused with millibars, which is a different unit of measure.

15.6.2.3.1. WARNING: Do not set a millimeters value from ATC on your altimeter using the millibars scale that is part of your altimeter because they are NOT equivalent.

15.6.3. Transition Altitude. The altitude in the vicinity of an airport at or below which the vertical position of an aircraft is determined from an altimeter set to QNH or QFE as appropriate. Transition altitude is normally specified for each airfield by the country in which the airfield exists. Transition altitude will not normally be below 3,000 feet HAA and must be published on the appropriate charts.

15.6.4. Transition Level. The lowest flight level available for use above the transition altitude. Transition level is usually passed to the aircraft during the approach or landing clearances. The transition layer may be published, or it may be supplied by ATC via the ATIS or during arrival. Half flight levels may be used: for example, "FL 45."

15.6.5. Transition Layer. That area between the transition altitude and transition level. Aircraft are not normally assigned altitudes within the transition layer.

15.6.6. Transition Between Flight Levels and Altitudes. The vertical position of an aircraft at or below transition altitude shall be expressed in altitude (QNH or QFE as appropriate). Vertical position at or above the transition level shall be expressed in terms of flight levels (QNE). When passing through the transition layer, vertical position shall be expressed in terms of flight levels (QNE) when climbing and in terms of altitudes (QNH or QFE as appropriate) when descending. After an approach clearance has been issued and the descent to land is commenced, the vertical positioning of an aircraft above the transition level may be by reference to altitude (QNH or QFE as appropriate) provided that level flight above the transition altitude is not indicated or anticipated. This is intended for turbo jet aircraft where an uninterrupted descent from high altitude is desired and for airfields equipped to reference altitudes throughout the descent.

15.6.7. Altimeter Errors. The allowable altimeter errors at a ground checkpoint in ICAO are different than in the US and vary by airport elevation and atmospheric pressure. ***Use Tables* 15.5*, *15.6*, and *15.7 *to determine allowable altimeter errors. If your aircraft flight manual***

is more restrictive than the values shown in these tables, comply with the guidance in your aircraft flight manual.

Table 15.5. Allowable Altimeter Errors at Ground Checkpoint for Airports Up to 3500 Feet Elevation With Atmospheric Pressure at or Above Standard.

Airport Elevation	Atmospheric Pressure	Altimeter Range	Allowable Difference
3500 Feet or Below	At or Above Standard	0-30,000 Feet	±60 Feet
3500 Feet or Below	At or Above Standard	0-50,000 Feet	±80 Feet

Table 15.6. Allowable Altimeter Errors at Ground Checkpoint for Airports Above 3500 Feet Elevation or Atmospheric Pressure Lower Than Standard (Altimeter Range 0-30,000 Feet).

Airport Elevation	Allowable Difference
2000 Feet	±60 Feet
3000 Feet	±70 Feet
4000 Feet	±75 Feet
5000 Feet	±80 Feet
6000 Feet	±85 Feet
7000 Feet	±95 Feet
8000 Feet	±105 Feet
9000 Feet	±115 Feet
10000 Feet	±125 Feet
11000 Feet	±135 Feet
12000 Feet	±145 Feet
13000 Feet	±155 Feet
14000 Feet	±165 Feet
15000 Feet	±175 Feet

Table 15.7. Allowable Altimeter Errors at Ground Checkpoint for Airports Above 3500 Feet Elevation or Atmospheric Pressure Lower Than Standard (Altimeter Range 0-50,000 Feet).

Airport Elevation	Allowable Difference
2000 Feet	±100 Feet
3000 Feet	±105 Feet
4000 Feet	±115 Feet
5000 Feet	±125 Feet
6000 Feet	±135 Feet
7000 Feet	±145 Feet
8000 Feet	±155 Feet
9000 Feet	±165 Feet
10000 Feet	±175 Feet
11000 Feet	±185 Feet
12000 Feet	±195 Feet

13000 Feet	±205 Feet
14000 Feet	±215 Feet
15000 Feet	±225 Feet

15.6.8. Altimeter Use in Flight. ***Prior to take-off at least one altimeter will be set to the latest QNH/QFE altimeter setting*. *Set the altimeter to QNE (29.92) climbing through transition altitude. Prior to commencing the initial approach to an airfield, the number of the transition level should be obtained from the appropriate air traffic services unit. Obtain the latest QNH/QFE before descending below the transition level***.

15.7. Units of Measure for Altitudes.

15.7.1. Some countries, particularly in Eastern Europe and nations of the former USSR, use meters to define altitudes. Most USAF aircraft do not have altimeters that can display meters. FLIP AP contains information on units of measure for each country. The FIH has a conversion chart for feet to meters. It is imperative to correctly convert from feet to meters when flying in these areas.

15.7.1.1. WARNING: In some areas you may be required to fly altitudes or flight levels in meters and use an altimeter setting other than inches of mercury QNH. For example, altitude in meters using millibars QFE. Misapplication of conversions in these areas can cause mid-air collision or collision with the ground. Crews must insure they are thoroughly familiar with their aircraft system limitations and conversions prior to flight in these areas.

Chapter 16

CATEGORY II AND III ILS

16.1. Category II ILS Approach (Airport, Aircraft, and Aircrew Certification Required) (Figure 16 1). A Category II ILS approach provides the capability of flying to minima as low as a DH of 100 feet and an RVR of 1200. The DH for a Category II approach is identified by a pre-selected height on the aircraft radar altimeter. This figure is enclosed in parentheses on the IAP and is prefaced by RA (Radar Altimeter), example: (RA 113).

16.1.1. Check flight directors, barometric and radar altimeters, and any other Category II equipment. Set the DH on the radar altimeter (if required for the approach).

16.1.1.1. On certain Category II ILS approaches, the terminology "RA-NA" will be annotated in the minimums section of the procedure. This indicates that the DA must be determined solely from the barometric altimeter, not the radar altimeter.

16.1.2. Brief Category I procedures as a backup approach if appropriate.

16.1.3. Announce the illumination of any Category II system fault identification light.

16.1.3.1. If any required Category II component fails prior to 300 feet AGL, the system is capable of a Category I approach only unless the failure can be corrected prior to 300 feet AGL.

16.1.3.2. Any failure of a required Category II component below 300 feet AGL requires the pilot to execute an immediate missed approach unless visual cues are sufficient to complete the approach and landing.

16.1.4. PM will make appropriate advisory altitude calls on the approach, including a call 100 feet above the DH.

16.1.4.1. NOTE: Tolerances for continuing the approach from 100 feet above DH are: airspeed ±5 knots of computed final approach speed or the speed directed by the flight manual for Category II approaches, and deviation from glide slope and localizer not to exceed one-half dot.

16.1.5. From 100 feet above the DH to the Category II DH, the PM will concentrate primarily on outside references to determine if visual cues are sufficient to complete the landing visually.

16.1.6. ***Continue the approach at DH only if the following conditions are met:***

16.1.6.1. Runway environment (as defined in para 12.1.2.2.) is in sight.

16.1.6.2. Airspeed is within ± 5 knots of the computed final approach speed or as directed by the flight manual.

16.1.6.3. Localizer or glide slope deviations do not exceed one-half dot.

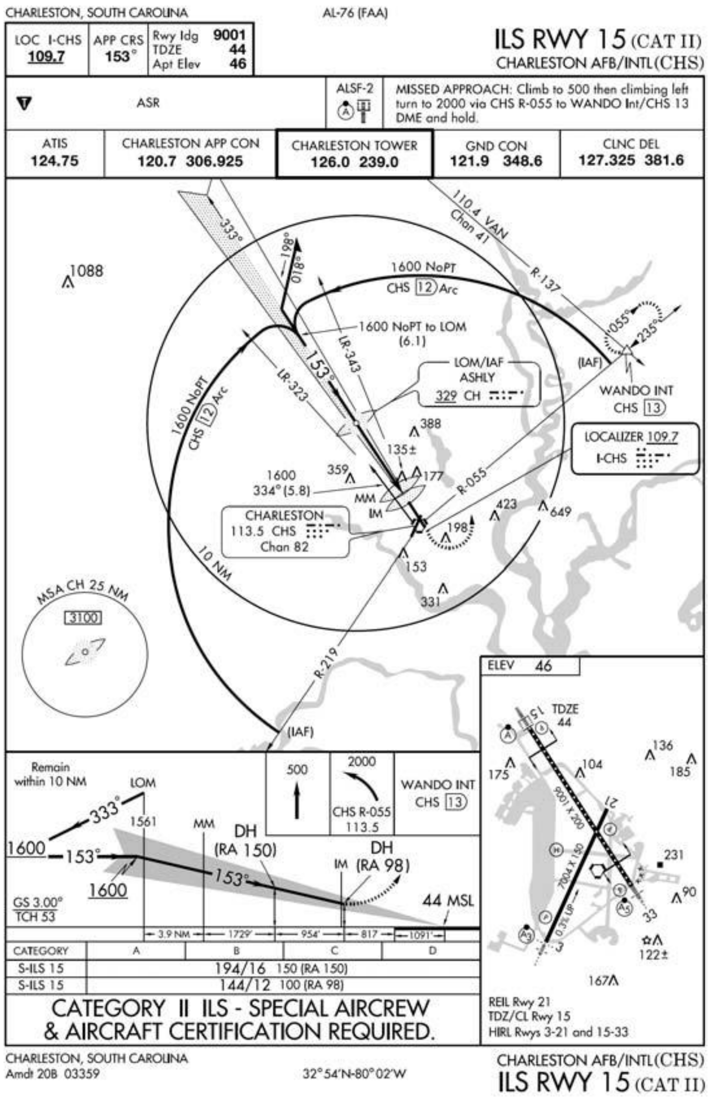
16.1.6.4. The aircraft's position is within, and tracking to remain within, the extended lateral confines of the runway.

16.1.6.5. The aircraft is stabilized with reference to attitude and airspeed.

16.1.7. Go around at DH if the runway environment is not in sight or if any of the above tolerances are exceeded.

16.1.7.1. NOTE: These procedures are intended for use by Category II ILS certified aircrews only. ***Individual MAJCOM directives and aircraft manuals have established minimum equipment requirements and restrictions that must be complied with prior to initiating a Category II ILS approach.***

Figure 16.1. Category II ILS.



16.2. Category III ILS (Airport, Aircraft, & Aircrew Certification Required) (Figure 16.2).

16.2.1. Definitions.

16.2.1.1. ILS Category III. A precision instrument approach and landing without a DH, or a DH below 100 feet (30 meters) and controlling runway visual range not less than 700 feet (240 meters).

16.2.1.1.1. ILS Category IIIa. An ILS approach procedure that provides for approach without a DH or RVR not less than 700 feet.

16.2.1.1.2. ILS Category IIIb. An ILS approach procedure that provides for approach without DH and with RVR not less than 150 feet.

16.2.1.1.3. ILS Category IIIc. An ILS approach procedure that provides for approach without DH and without RVR minimum.

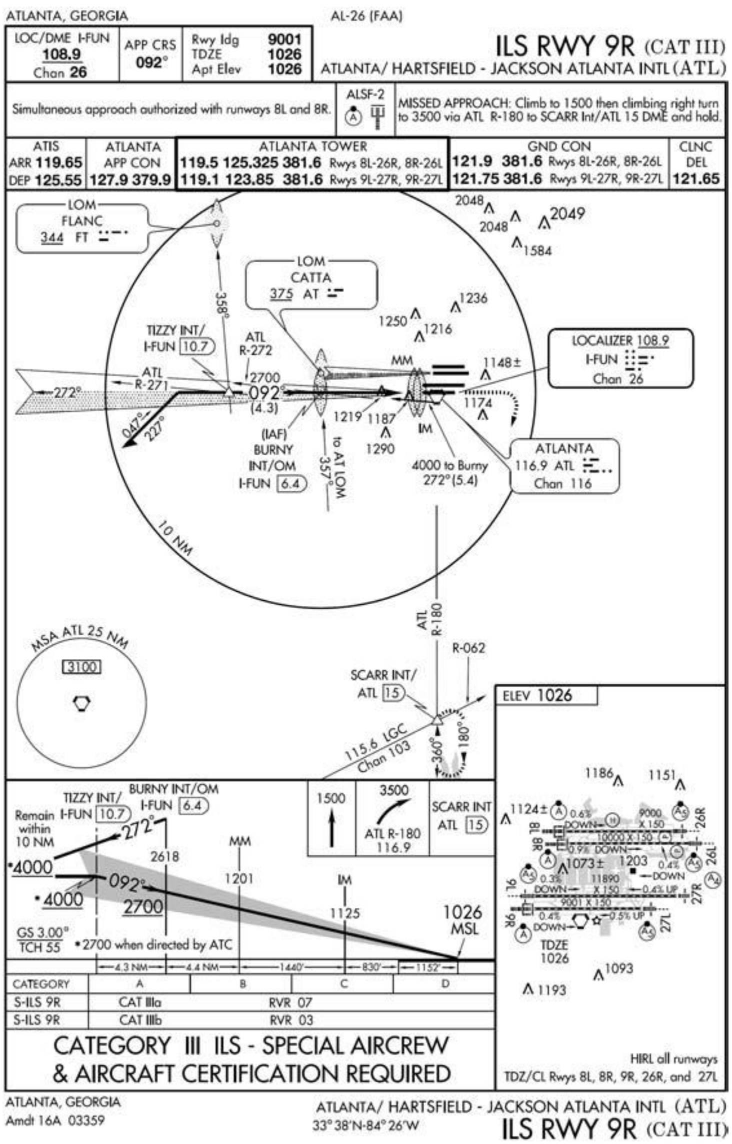
16.2.1.2. Alert Height (AH). A height defined as 100 feet above the highest elevation in the touchdown zone, above which a Category III approach would be discontinued and a missed approach initiated if a failure occurred in one of the required redundant operational systems in the airplane or in the relevant ground equipment. Below this height, the approach, flare, touchdown, and rollout may be safely accomplished following any individual failure in the associated Category III systems.

16.2.2. Operational Concepts. The weather conditions encountered in Category III operations range from adequate visual references for manual rollout in Category IIIa, to inadequate visual references even for taxi operations in Category IIIc. To maintain a high level of safety during approach and landing operations in very low visibilities, the airborne system and ground support system requirements established for Category III operations should be compatible with the limited visual references that are available. The primary mode of Category III operations is automatic approach to touchdown using automatic landing systems that does not require pilot intervention. However, pilot intervention should be anticipated in the unlikely event that the pilot detects or strongly suspects inadequate aircraft performance as well as when it is determined that an automatic touchdown cannot be safely accomplished within the touchdown zone.

16.2.2.1. Fail Operational Category III Operations. Aircraft certification is based on the total airborne system being operative down to AH height of 100 feet. The aircraft will accomplish an automatic landing and rollout using the remaining automatic systems following failure of one system below AH. Equipment failures above AH must result in a go-around or reversion to another approach if those requirements can be met. For Category IIIa fail-operational approach and landing without a rollout control system, visual reference with the touchdown zone is required and should be verified prior to the minimum height specified by the operator for the particular aircraft type. These visual cues combined with controlling transmissometer RVR report of visibility at or above minima are necessary to verify that the initial landing rollout can be accomplished visually. A go-around should be accomplished if there is no visual reference prior to the specified minimum height or upon receiving a report of controlling RVR below minima prior to this height. For Category IIIa fail-operational approach and landing with a rollout control system, the availability of visual reference is not a specific requirement for continuation of an approach to touchdown. The design of the cockpit instrumentation, system comparators, and warning systems should be adequate in combination to assure that the pilot can verify that the aircraft will safely touchdown within the touchdown zone and safely rollout if the controlling RVR is reported at or above approved minima. The aircraft may go-around safely from any altitude to touchdown. Use manual go-around after touchdown.

16.2.3. Procedures. See individual MAJCOM directives and aircraft manuals for minimum equipment requirements, restrictions, and procedures used when initiating Category III ILS approaches.

Figure 16.2. Category III ILS.



PHILIP M. BREEDLOVE, Lt Gen, USAF
DCS, Operations, Plans and Requirements

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

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Abbreviations and Acronyms

AC—Advisory Circular

ADF—Automatic Direction Finding

ADI—Attitude Director Indicator

AFFSA—Air Force Flight Standards Agency

AGL—Above Ground Level

AH—Alert Height

AIM—Aeronautical Information Manual

AIP—Aeronautical Information Publication

AMI—Airspeed Mach Indicator

AMU—Areas of Magnetic Unreliability

ANG—Air National Guard

ANP—Actual Navigation Performance

AP—Area Planning

ARTCC—Air Route Traffic Control Center

ASR—Aircraft Surveillance Radar

ASRR—Airfield Suitability Report

ATC—Air Traffic Control

ATCSCC—Air Traffic Control System Command Center

ATD—Along Track Distance

ATIS—Automatic Terminal Information Service

AZ—Azimuth

BARO-VNAV—Barometric Vertical Navigation

BC—Back Course

BDHI—Bearing Distance Heading Indicator

BRNAV—Basic Area Navigation

CADC—Central Air Data Computer

CAS—Calibrated Airspeed

CDFA—Constant Descent Final Approach

CDI—Course Deviation Indicator

CDM—Climb Dive Marker

CDU—Control Display Unit

CFIT—Controller Flight Into Terrain

CI—Course Indicator

CNS/ATM—Communication Navigation Systems / Air Traffic Management

CONUS—Continental United States

CRT—Cathode Ray Tube

CSW—Course Selector Window

CTAF—Common Traffic Advisory Frequency

CVFP—Charted Visual Flight Procedure

DA—Decision Altitude

DA(H)—Decision Altitude (Height)

DAFIF—Digital Aeronautical Flight Information File

DER—Departure End of Runway

DF—Direct to Fix

DG—Directional Gyro

DH—Decision Height

DINS—DoD Internet NOTAM System

DME—Distance Measuring Equipment

DME/P—Precision Distance Measuring Equipment

DoD—Department of Defense

DP—Departure Procedure

DR—Dead Reckoning

DVA—Diverse Vector Area

EFB—Electronic Flight Bag

EFC—Expect Further Clearance

EL—Elevation Angle

EPR—Engine Pressure Ratio

ETA—Estimated Time of Arrival

ETD—Estimated Time of Departure

ETE—Estimated Time En Route

FAA—Federal Aviation Administration

FAF—Final Approach Fix

FAR—Federal Aviation Regulations

FAWP—Final Approach Way Point

FBO—Fixed Base Operator

FCG—Foreign Clearance Guide

FCIF—Flight Crew Information File

FDC—Flight Data Center

FDE—Fault Detection and Exclusion

FDS—Flight Director System

FIH—Flight Information Handbook

FIR—Flight Information Region

FL—Flight Level

FLIP—Flight Information Publication

FMA—Final Monitor Aids

FMS—Flight Management System

INS—Inertial Navigation System

FMSP—Flight Management System Procedure

FOV—Field of View

fpm—Feet Per Minute

FPM—Flight Path Marker

FSS—Flight Service Station

GCA—Ground Controlled Approach

GCCS—Global Command and Control System

GEO—Geostationary Satellite

GLONASS—Global Orbiting Navigation Satellite System

GLS—GNSS Landing System

GNSS—Global Navigation Satellite System

GP—General Planning

GPS—Global Positioning System

GS—Groundspeed

GSI—Glide Slope Indicator

GSP—Glide Slope Pointer

HAA—Height Above Aerodrome

HAT—Height Above Touchdown

HDD—Head Down Display

Hg—Mercury

HILO—Holding In Lieu of Procedure Turn

HIRL—High Intensity Runway Lighting

HMD—Helmet Mounted Display

HSI—Horizontal Situation Indicator

HUD—Head-Up-Display

Hz—Hertz (cycles per second)

IAF—Initial Approach Fix

IAP—Instrument Approach Procedure

IAS—Indicated Airspeed

IAW—In Accordance With

IAWP—Initial Approach Way Point

ICAO—International Civil Aviation Organization

IF—Intermediate Fix

IFF—Identification, Friend or Foe

IFIS—Integrated Flight Instrument System

IFR—Instrument Flight Rules

IFRB—International Frequency Registration Board

ILS—Instrument Landing System

ILS/PRM—ILS Precision Runway Monitor

IM—Inner Marker

IMC—Instrument Meteorological Conditions

NoPT—No Procedure Turn Required

NOTAM—Notices to Airmen

IRC—Instrument Refresher Course

IRU—Inertial Reference Unit

ISA—International Standard Atmospheric

ITO—Instrument Takeoff

JCS—Joint Chiefs of Staff

kHz—Kilohertz

KIAS—Knots Indicated Airspeed

KTAS—Knots True Airspeed

LAAS—Local Area Augmentation System

LDA—Localizer Type Directional Aid

LLZ—Localizer (ICAO)

LNAV—Lateral Navigation

LOC—Localizer

LOM—Locator Outer Marker

LORAN—Long-Range Aid to Navigation

MAHWP—Missed Approach Holding Way Point

MAJCOM—Major Command

MAP—Missed Approach Point

MAWP—Mission Approach Waypoint

MCA—Minimum Crossing Altitude

MDA—Minimum Descent Altitude

MDS—Mission Design Series

MEA—Minimum En Route Altitude

mHz—MilliHertz

MHz—Megahertz

MIRL—Medium Intensity Runway Lighting

MLS—Microwave Landing System

MM—Middle Marker

MMLS—Mobile Microwave Landing System

MOA—Military Operations Area

MOCA—Minimum Obstruction Clearance Altitude

MRA—Minimum Reception Altitude

MSL—Mean Sea Level

MVA—Minimum Vectoring Altitude

NACO—National Aeronautical Charting Office

NAS—National Airspace System

NATO—North Atlantic Treaty Organization

NAVAID—Navigational Aid

NDB—Nondirectional Beacon

NGA—National Geospatial-Intelligence Agency

NM—Nautical Miles

STAR—Standard Terminal Arrival

NRP—National Route Plan

NTAP—Notices to Airmen Publication

NTZ—No Transgression Zone

NVG—Night Vision Goggles

OBS—Omni Bearing Selector

ODP—Obstacle Departure Procedure

OEI—One Engine Inoperative

OIS—Obstacle Identification Surface

OM—Outer Marker

PANS-OPS—Procedures for Air Navigation Services-Aircraft Operations

PAPI—Precision Approach Path Indicator

PAR—Precision Approach Radar

PF—Pilot Flying

PIC—Pilot in Command

PM—Pilot Monitoring

PPS—Precise Positioning

PRN—Pseudo Random Noise

PT—Procedure Turn

RA—Resolution Advisory

Radar—Radio Detecting and Ranging

RAIM—Random Autonomous Integrity Monitoring

REIL—Runway End Identifier Lights

RMI—Radio Magnetic Indicator

RNAV—Area Navigation

RNP—Required Navigation Performance

ROA—Remotely Operated Aircraft

ROC—Required Obstacle Clearance

RPI—Runway Point of Intercept

RVR—Runway Visual Range

RVSM—Reduced Vertical Separation Minimums

SAAAR—Special Aircraft and Aircrew Authorization Required

SARPS—Standards and Recommended Practices

SAS—Stability Augmentation System

SDF—Simplified Directional Facility

SDP—Special Departure Procedure

SDP—Standard Datum Plane

SID—Standard Instrument Departure

SM—Statute Miles

SOIA—Simultaneous Offset Instrument Approaches

SPS—Standard Positioning Service

STIF—Special Theater Information Files

SVN—Satellite Vehicle Number

TAA—Terminal Arrival Areas

TACAN—Tactical Air Navigation

TAS—True Airspeed

TCAS—Traffic Collision Alert System

TCH—Threshold Crossing Height

TCN—Terminal Change Notice

TDZE—Touchdown Zone Elevation

TERPs—Terminal Instrument Procedures

TF—-Track to Fix

TFR—-Temporary Flight Restriction

TLS—Transponder Landing System

TO—Technical Order

TSO—Technical Standard Order

UHF—Ultra High Frequency

UIR—Upper Information Regions

USA—United States Army

USAF—United States Air Force

USN—United States Navy

USNS—US NOTAM System

UTC—Universal Time Coordinated

VASI—Visual Approach Slope Indicator

VDP—Visual Descent Point

VFR—Visual Flight Rules

VGSI—Vertical Glide Slope Information

VHF—Very High Frequency

VMC—Visual Meteorological Conditions

VNAV—Vertical Navigation

VOR—VHF Omnidirectional Range

VORTAC—VHF Omnidirectional Range/Tactical Air Navigation

VOT—VOR Test Facility

VV—Velocity Vector

VVI—Vertical Velocity Indicator

WAAS—Wide-Area Augmentation System

WP—Waypoint

WRS—Wide-Area Ground Reference Station

WMS—Wide area Master Station