

# CHAPTER 4

## ARRIVALS

Preparation for the arrival and approach begins long before the descent from the en route phase of flight. Planning early, while there are fewer demands on your attention, leaves you free to concentrate on precise control of the aircraft and better equipped to deal with problems that might arise during the last segment of the flight.

### TRANSITION FROM EN ROUTE

This chapter focuses on the current procedures pilots and air traffic control (ATC) use for instrument flight rule (IFR) arrivals in the National Airspace System (NAS). The objective is to provide pilots with an understanding of ATC arrival procedures and pilot responsibilities as they relate to the transition between the en route and approach phases of flight. This chapter emphasizes standard terminal arrival routes (STARs), descent clearances, descent planning, and ATC procedures, while the scope of coverage focuses on transitioning from the en route phase of flight, typically the origination point of a STAR to the STAR termination fix. This chapter also differentiates between area navigation (RNAV) STARs and STARs based on conventional navigational aids (NAVAIDs).

Optimum IFR arrival options include flying directly from the en route structure to an approach gate or initial approach fix (IAF), a visual arrival, STARs, and radar vectors. Within controlled airspace, ATC routinely uses radar vectors for separation purposes, noise abatement considerations, when it is an operational advantage, or when requested by pilots. Vectors outside of controlled airspace are provided only on pilot request. The controller tells you the purpose of the vector when the vector is controller-initiated and takes the aircraft off a previously assigned nonradar route. Typically, when operating on RNAV routes, you are allowed to remain on your own navigation.

### TOP OF DESCENT

Planning the descent from cruise is important because of the need to dissipate altitude and airspeed in order to arrive at the approach gate properly configured. Descending early results in more flight at low altitudes with increased fuel consumption, and starting down late results in problems controlling both airspeed and descent rates on the approach. Top of descent (TOD) from the en route phase of flight for high performance airplanes is often used in this process and is calculated manually or automatically through a flight management system (FMS) [Figure 4-1], based upon the altitude of

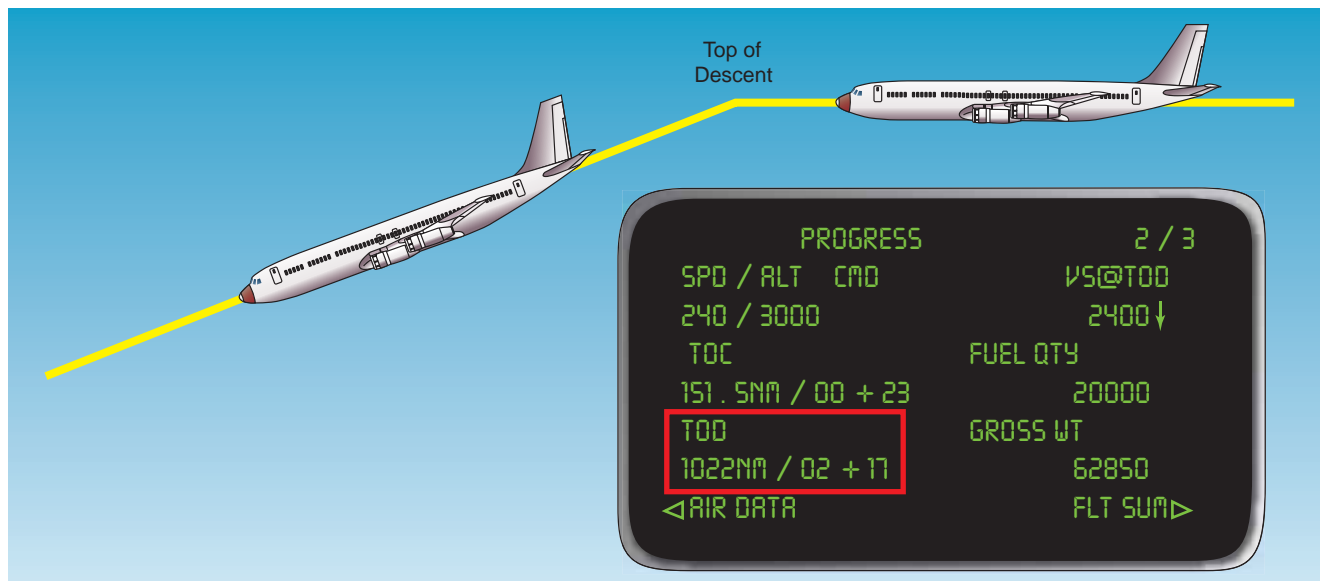


Figure 4-1. Top of Descent and FMS Display.

the approach gate. The approach gate is an imaginary point used by ATC to vector aircraft to the final approach course. The approach gate is established along the final approach course 1 nautical mile (NM) from the final approach fix (FAF) on the side away from the airport and is located no closer than 5 NM from the landing threshold. The altitude of the approach gate or initial approach fix is subtracted from the cruise altitude, and then the target rate of descent and groundspeed is applied, resulting in a time and distance for TOD, as depicted in Figure 4-1 on page 4-1.

Achieving an optimum stabilized, constant rate descent during the arrival phase requires different procedures for turbine-powered and reciprocating-engine airplanes. Controlling the airspeed and rate of descent is important for a stabilized arrival and approach, and it also results in minimum time and fuel consumption. Reciprocating-engine airplanes require engine performance and temperature management for maximum engine longevity, especially for turbocharged engines. Pilots of turbine-powered airplanes must not exceed the airplane's maximum operating limit speed above 10,000 feet, or exceed the 250-knot limit below 10,000 feet. Also, consideration must be given to turbulence that may be encountered at lower altitudes that may necessitate slowing to the turbulence penetration speed. If necessary, speed brakes should be used.

## DESCENT PLANNING

Prior to flight, calculate the fuel, time, and distance required to descend from your cruising altitude to the approach gate altitude for the specific instrument approach of your destination airport. In order to plan your descent, you need to know your cruise altitude, approach gate altitude or initial approach fix altitude, descent groundspeed, and descent rate. Update this information while in flight for changes in altitude, weather, and wind. Your flight manual or operating handbook may also contain a fuel, time, and distance to descend chart that contains the same information. The calculations should be made before the flight and "rules of thumb" updates should be applied in flight. For example, from the charted STAR you might plan a descent based on an expected clearance to "cross 40 DME West of Brown VOR at 6,000" and then apply rules of thumb for slowing down from 250 knots. These might include planning your airspeed at 25 NM from the runway threshold to be 250 knots, 200 knots at 20 NM, and 150 knots at 15 NM until gear and flap speeds are reached, never to fall below approach speed.

The need to plan the IFR descent into the approach gate and airport environment during the preflight planning stage of flight is particularly important for turbojet powered airplanes. A general rule of thumb for initial IFR descent planning in jets is the 3 to 1 formula. This means that it takes 3 NM to descend 1,000 feet. If an airplane is

at flight level (FL) 310 and the approach gate or initial approach fix is at 6,000 feet, the initial descent requirement equals 25,000 feet (31,000 - 6,000). Multiplying 25 times 3 equals 75; therefore begin descent 75 NM from the approach gate, based on a normal jet airplane, idle thrust, speed Mach 0.74 to 0.78, and vertical speed of 1,800 - 2,200 feet per minute. For a tailwind adjustment, add 2 NM for each 10 knots of tailwind. For a headwind adjustment, subtract 2 NM for each 10 knots of headwind. During the descent planning stage, try to determine which runway is in use at the destination airport, either by reading the latest aviation routine weather report (METAR) or checking the automatic terminal information service (ATIS) information. There can be big differences in distances depending on the active runway and STAR. The objective is to determine the most economical point for descent.

An example of a typical jet descent-planning chart is depicted in Figure 4-2. Item 1 is the pressure altitude from which the descent begins; item 2 is the time required for the descent in minutes; item 3 is the amount of fuel consumed in pounds during descent to sea level; and item 4 is the distance covered in NM. Item 5 shows that the chart is based on a Mach .80 airspeed until 280 knots indicated airspeed (KIAS) is obtained. The 250-knot airspeed limitation below 10,000 feet mean sea level (MSL) is not included on the chart, since its effect is minimal. Also, the effect of temperature or weight variation is negligible and is therefore omitted.

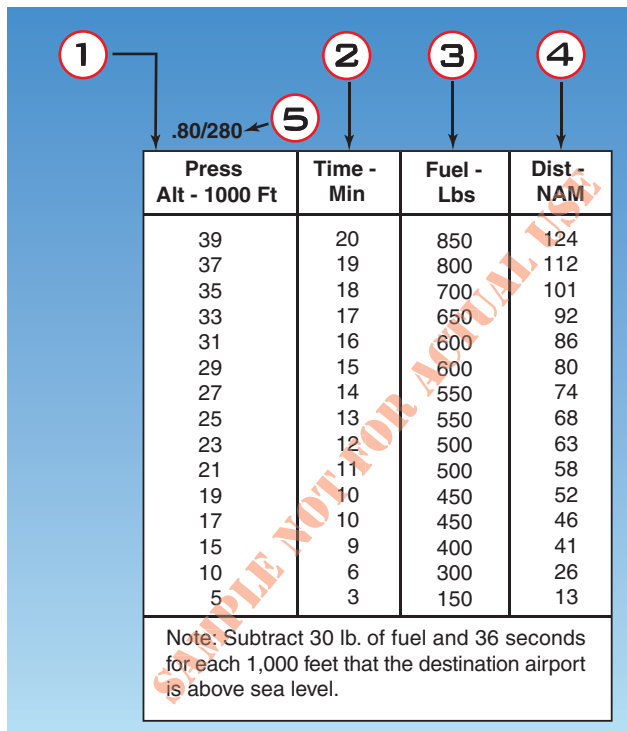


Figure 4-2. Typical Air Carrier Descent Planning Chart

Due to the increased cockpit workload, you want to get as much done ahead of time as possible. As with the

climb and cruise phases of flight, you should consult the proper performance charts to compute your fuel requirements as well as the time and distance needed for your descent. Figure 4-3 is an example of a descent-planning chart. If you are descending from 17,000 feet to a final (approach gate) altitude of 5,650, your time to descend is 11 minutes and distance to descend is 40 NM.

During the cruise and descent phases of flight, you need to monitor and manage the airplane according to the appropriate manufacturer's recommendations. The flight manuals and operating handbooks contain cruise and descent checklists, performance charts for specific cruise configurations, and descent charts that provide information regarding the fuel, time, and distance required to descend. Review this information prior to

the departure of every flight so you have an understanding of how your airplane is supposed to perform at cruise and during descent. A stabilized descent constitutes a pre-planned maneuver in which the power is properly set, and minimum control input is required to maintain the appropriate descent path. Excessive corrections or control inputs indicate the descent was improperly planned. Plan your IFR descent from cruising altitude so you arrive at the approach gate altitude or initial approach fix altitude prior to beginning the instrument approach. [Figure 4-4 on page 4-4]

Descending from cruise altitude and entering the approach environment can be a busy time during the flight. You are talking on the radio, changing radio frequencies, pulling out different charts, adjusting controls,

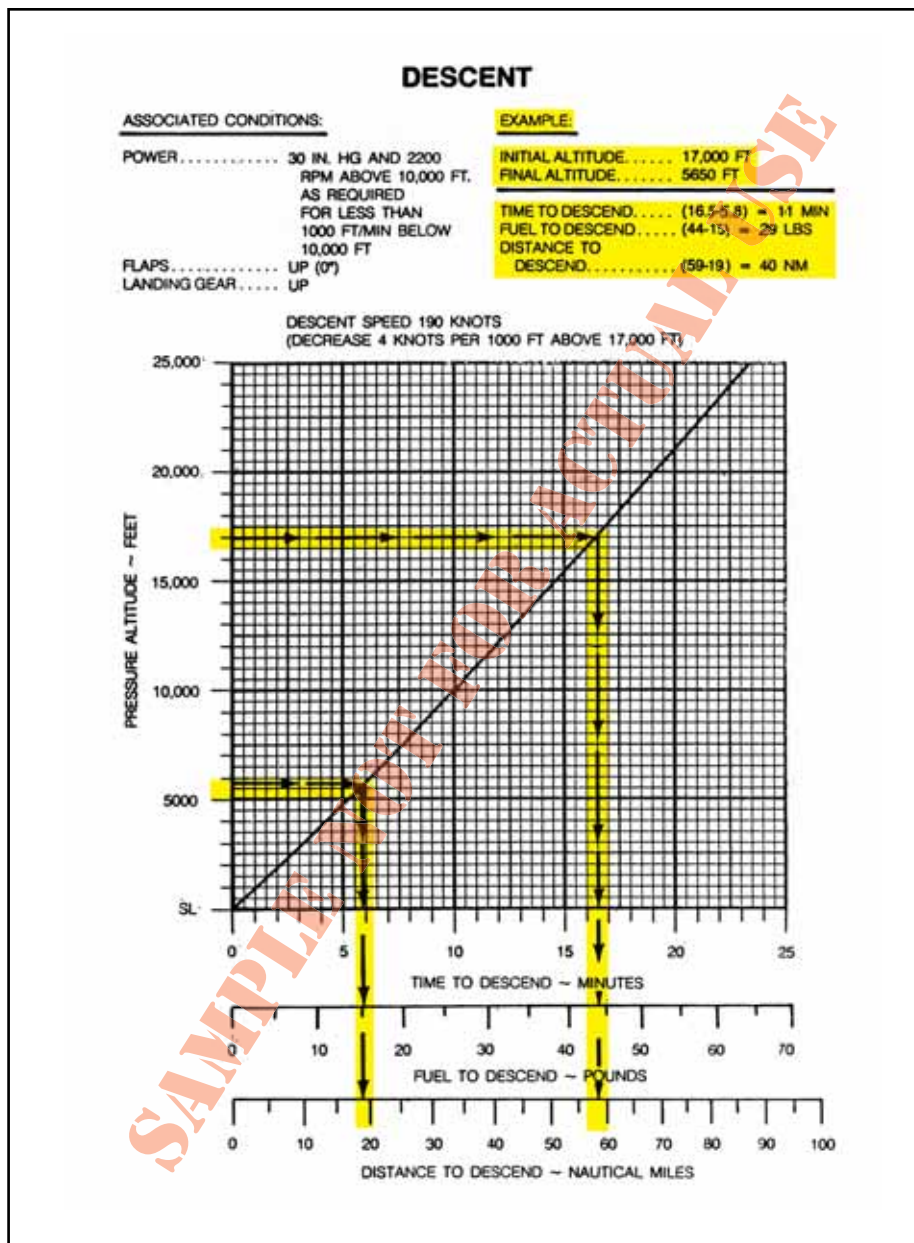


Figure 4-3. Descent Planning Chart.

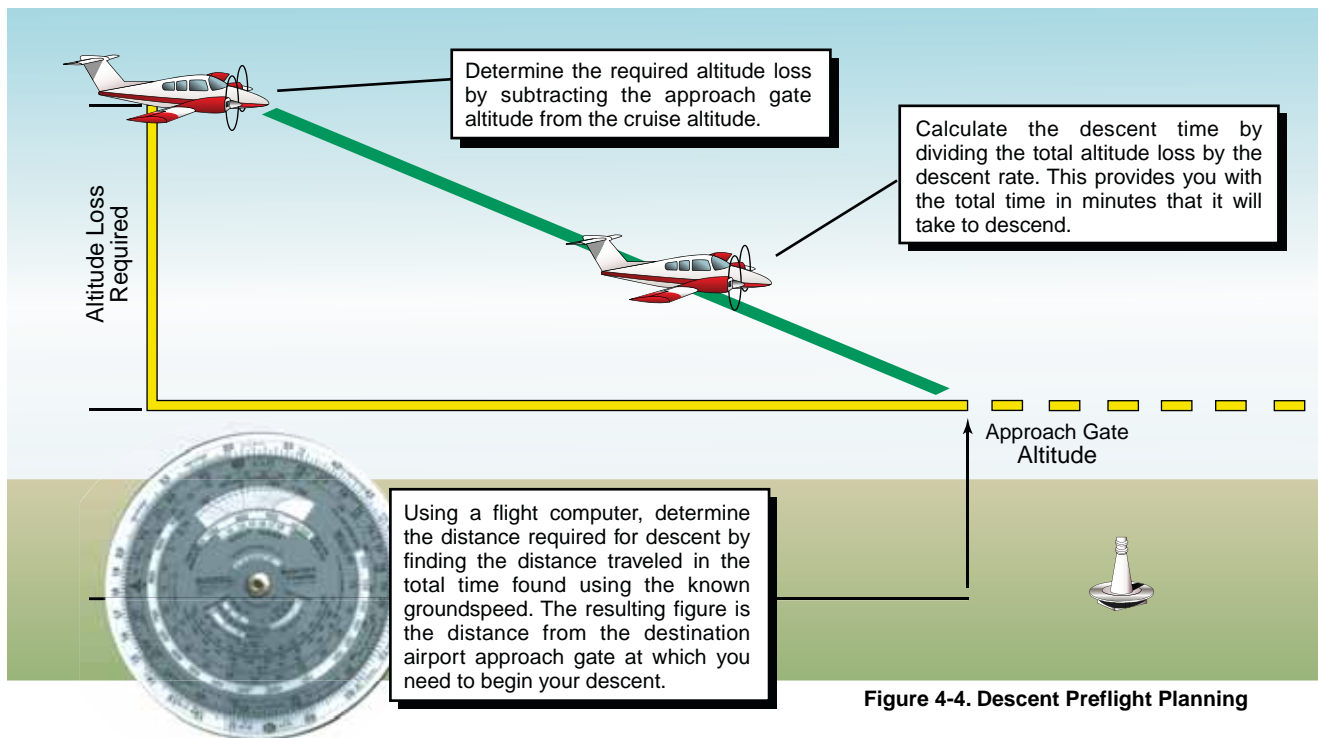


Figure 4-4. Descent Preflight Planning

reading checklists, all of which can be distracting. By planning your descent in advance, you reduce the workload required during this phase of flight, which is smart workload management. Pilots often stay as high as they can as long as they can, so planning the descent prior to arriving at the approach gate is necessary to achieve a stabilized descent, and increases situational awareness. Using the information given, calculate the distance needed to descend to the approach gate.

- Cruise Altitude: 17,000 feet MSL
- Approach Gate Altitude: 2,100 feet MSL
- Descent Rate: 1,500 feet per minute
- Descent Groundspeed: 155 knots

Subtract 2,100 feet from 17,000 feet, which equals 14,900 feet. Divide this number by 1,500 feet per minute, which equals 9.9 minutes, round this off to 10 minutes. Using your flight computer, find the distance required for the descent by using the time of 10 minutes and the groundspeed of 155 knots. This gives you a distance of 25.8 NM. You need to begin your descent approximately 26 NM prior to arriving at your destination airport approach gate.

**CRUISE CLEARANCE**

The term "cruise" may be used instead of "maintain" to assign a block of airspace to an aircraft. The block extends from the minimum IFR altitude up to and including the altitude that is specified in the cruise clearance. On a cruise clearance, you may level off at

any intermediate altitude within this block of airspace. You are allowed to climb or descend within the block at your own discretion. However, once you start descent and verbally report leaving an altitude in the block to ATC, you may not return to that altitude without an additional ATC clearance. A cruise clearance also authorizes you to execute an approach at the destination airport. When operating in uncontrolled airspace on a cruise clearance, you are responsible for determining the minimum IFR altitude. In addition, your descent and landing at an airport in uncontrolled airspace are governed by the applicable visual flight rules (VFR) and/or Operations Specifications (OpsSpecs), i.e., CFR, 91.126, 91.155, 91.175, 91.179, etc.

**HOLDING PATTERNS**

If you reach a clearance limit before receiving a further clearance from ATC, a holding pattern is required at your last assigned altitude. Controllers assign holds for a variety of reasons, including deteriorating weather or high traffic volume. Holding might also be required following a missed approach. Since flying outside the area set aside for a holding pattern could lead to an encounter with terrain or other aircraft, you need to understand the size of the protected airspace that a holding pattern provides.

Each holding pattern has a fix, a direction to hold from the fix, and an airway, bearing, course, radial, or route on which the aircraft is to hold. These elements, along with the direction of the turns, define the holding pattern.

Since the speed of the aircraft affects the size of a holding pattern, maximum holding airspeeds have been

designated to limit the amount of airspace that must be protected. The three airspeed limits are shown in Figure 3-31 in Chapter 3 of this book. Some holding patterns have additional airspeed restrictions to keep faster airplanes from flying out of the protected area. These are depicted on charts by using an icon and the limiting airspeed.

Distance-measuring equipment (DME) and IFR-certified global positioning system (GPS) equipment offer some additional options for holding. Rather than being based on time, the leg lengths for DME/GPS holding patterns are based on distances in nautical miles. These patterns use the same entry and holding procedures as conventional holding patterns. The controller or the instrument approach procedure chart will specify the length of the outbound leg. The end of the outbound leg is determined by the DME or the along track distance (ATD) readout. The holding fix on conventional procedures, or controller-defined holding based on a conventional navigation aid with DME, is a specified course or radial and distances are from the DME station for both the inbound and outbound ends of the holding pattern. When flying published GPS overlay or standalone procedures with distance specified, the holding fix is a waypoint in the database and the end of the outbound leg is determined by the ATD. Instead of using the end of the outbound leg, some FMSs are programmed to cue the inbound turn so that the inbound leg length will match the charted outbound leg length.

Normally, the difference is negligible, but in high winds, this can enlarge the size of the holding pattern. Be sure you understand your aircraft's FMS holding program to ensure that the holding entry procedures and leg lengths match the holding pattern. Some situations may require pilot intervention in order to stay within protected airspace. [Figure 4-5]

### DESCENDING FROM THE EN ROUTE ALTITUDE

As you near your destination, ATC issues a descent clearance so that you arrive in approach control's airspace at an appropriate altitude. In general, ATC issues either of two basic kinds of descent clearances.

- ATC may ask you to descend to and maintain a specific altitude. Generally, this clearance is for en route traffic separation purposes, and you need to respond to it promptly. Descend at the optimum rate for your aircraft until 1,000 feet above the assigned altitude, then descend at a rate between 500 and 1,500 feet per minute (FPM) to the assigned altitude. If at any time, other than when slowing to 250 KIAS at 10,000 feet MSL, you cannot descend at a rate of at least 500 FPM, advise ATC.
- The second type of clearance allows you to descend "... at pilot's discretion." When ATC

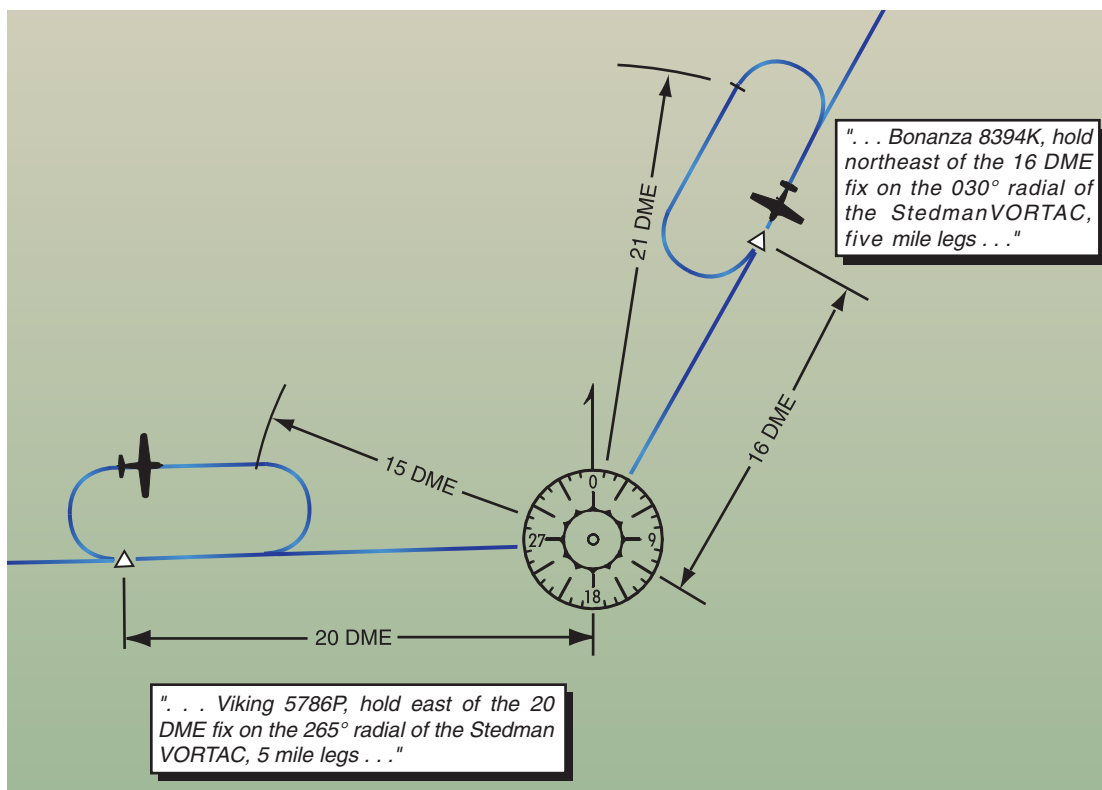


Figure 4-5. Instead of flying for a specific time after passing the holding fix, these holding patterns use distances to mark where the turns are made. The distances come from DME or IFR-certified GPS equipment.

issues a clearance to descend at pilot's discretion, you may begin the descent whenever you choose and at any rate you choose. You also are authorized to level off, temporarily, at any intermediate altitude during the descent. However, once you leave an altitude, you may not return to it.

A descent clearance may also include a segment where the descent is at your discretion—such as “*cross the Joliet VOR at or above 12,000, descend and maintain 5,000.*” This clearance authorizes you to descend from your current altitude whenever you choose, as long as you cross the Joliet VOR at or above 12,000 feet MSL. After that, you should descend at a normal rate until you reach the assigned altitude of 5,000 feet MSL.

Clearances to descend at pilot's discretion are not just an option for ATC. You may also request this type of clearance so that you can operate more efficiently. For example, if you are en route above an overcast layer, you might ask for a descent at your discretion to allow you to remain above the clouds for as long as possible. This might be particularly important if the atmosphere is conducive to icing and your aircraft's icing protection is limited. Your request permits you to stay at your cruising altitude longer to conserve fuel or to avoid prolonged IFR flight in icing conditions. This type of descent can also help to minimize the time spent in turbulence by allowing you to level off at an altitude where the air is smoother.

### **APPROACH CLEARANCE**

The approach clearance provides guidance to a position from where you can execute the approach, and it also clears you to fly that approach. If only one approach procedure exists, or if ATC authorizes you to execute the approach procedure of your choice, the clearance may be worded as simply as “... *cleared for approach.*” If ATC wants to restrict you to a specific approach, the controller names the approach in the clearance—for example, “...*cleared ILS Runway 35 Right approach.*”

When the landing will be made on a runway that is not aligned with the approach being flown, the controller may issue a circling approach clearance, such as “...*cleared for VOR Runway 17 approach, circle to land Runway 23.*”

When cleared for an approach prior to reaching a holding fix, ATC expects the pilot to continue to the holding fix, along the feeder route associated with the fix, and then to the IAF. If a feeder route to an IAF begins at a fix located along the route of flight prior to reaching the holding fix, and clearance for an approach is issued, the pilot should commence the approach via the published feeder route. The pilot is expected to commence the approach in a similar manner at the IAF, if the IAF is located along the route to the holding fix.

ATC also may clear an aircraft directly to the IAF by using language such as “*direct*” or “*proceed direct.*” Controllers normally identify an approach by its published name, even if some component of the approach aid (such as the glide slope of an ILS) is inoperative or unreliable. The controller uses the name of the approach as published but advises the aircraft when issuing the approach clearance that the component is unusable.

### **PRESENT POSITION DIRECT**

In addition to using National Aeronautical Charting Office (NACO) high and low altitude en route charts as resources for your arrival, NACO area charts can be helpful as a planning aid for situational awareness. Many pilots find the area chart helpful in locating a depicted fix after ATC clears them to proceed to a fix and hold, especially at unfamiliar airports.

Looking at Figures 4-6, and 4-7 on page 4-8, assume you are V295 northbound en route to Palm Beach International Airport. You are en route on the airway when the controller clears you present position direct to the outer marker compass locator and for the instrument landing system (ILS) approach. There is no transition authorized or charted between your present position and the approach facility. There is no minimum altitude published for the route you are about to travel.

In Figure 4-6, you are just north of HEATT Intersection at 5,000 feet when the approach controller states, “*Citation 9724J, 2 miles from HEATT, cleared present position direct RUBIN, cleared for the Palm Beach ILS Runway 9L Approach, contact Palm Beach Tower on 119.1 established inbound.*” With no minimum altitude published from that point to the RUBIN beacon, you should maintain the last assigned altitude until you reach the IAF (that's the fix, not the facility). Then, in Figure 4-7 on page 4-8, after passing the beacon outbound, commence your descent to 2,000 feet for the course reversal.

The ILS procedure relies heavily on the controller's recognition of the restriction upon you to maintain your last assigned altitude until “established” on a published segment of the approach. Refer to Appendix B, “Staying Within Protected Airspace,” for a comprehensive discussion of “established.” Prior to issuing a clearance for the approach, the controller usually assigns the pilot an altitude compatible with glide slope intercept.

### **RADAR VECTORS TO FINAL APPROACH COURSE**

Arriving aircraft usually are vectored to intercept the final approach course, except with vectors for a visual approach, at least 2 NM outside the approach gate unless one of the following exists:

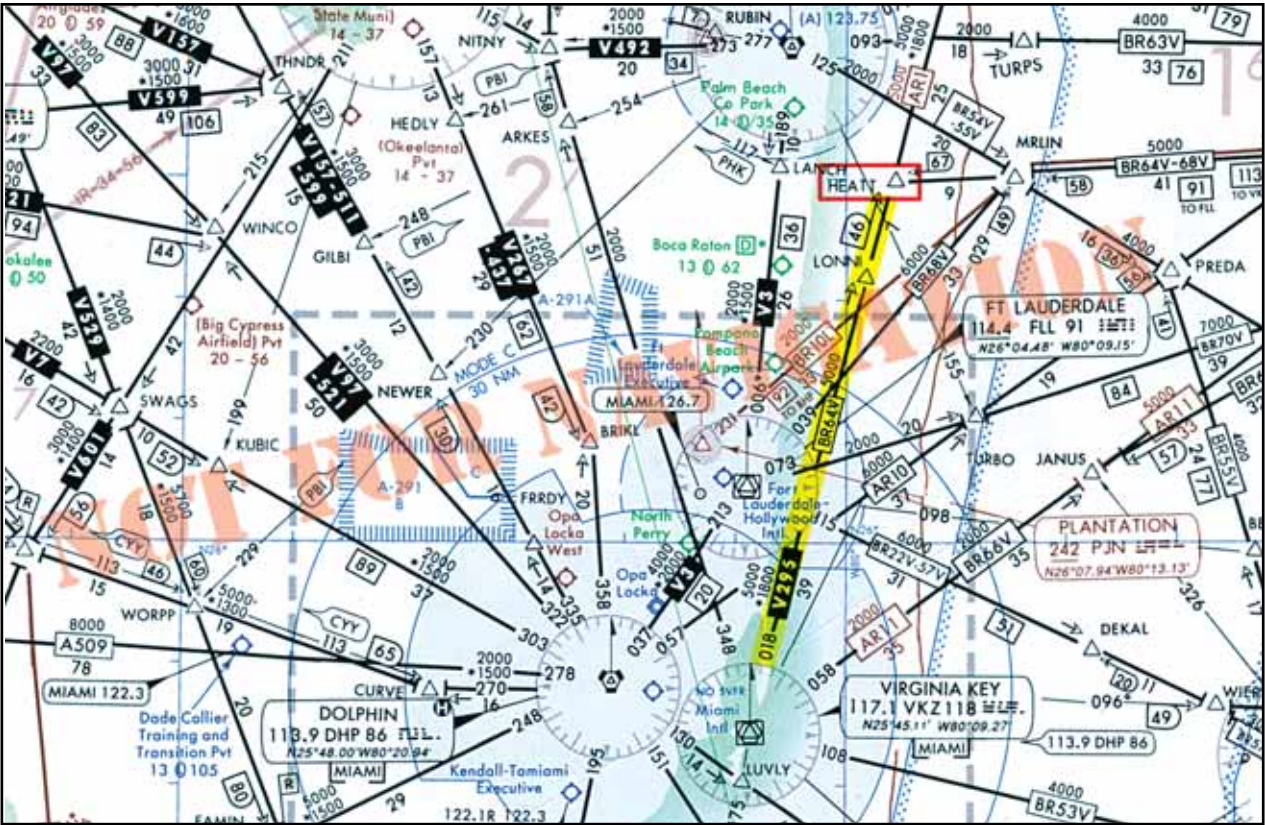


Figure 4-6. Cleared Present Position Direct from V295.

1. When the reported ceiling is at least 500 feet above the minimum vectoring altitude or minimum IFR altitude and the visibility is at least 3 NM (report may be a pilot report if no weather is reported for the airport), aircraft may be vectored to intercept the final approach course closer than 2 NM outside the approach gate but no closer than the approach gate.
2. If specifically requested by a pilot, ATC may vector aircraft to intercept the final approach course inside the approach gate but no closer than the FAF.

For a precision approach, aircraft are vectored at an altitude that is not above the glide slope/glidepath or below the minimum glide slope intercept altitude specified on the approach procedure chart. For a nonprecision approach, aircraft are vectored at an altitude that allows descent in accordance with the published procedure.

When a vector will take the aircraft across the final approach course, pilots are informed by ATC and the reason for the action is stated. In the event that ATC is not able to inform the aircraft, the pilot is not expected to turn inbound on the final approach course unless an approach clearance has been issued. An example of ATC phraseology in this case is, "...expect vectors across final for spacing."

The following ATC arrival instructions are issued to an IFR aircraft before it reaches the approach gate:

1. Position relative to a fix on the final approach course. If none is portrayed on the controller's radar display or if none is prescribed in the instrument approach procedure, ATC issues position information relative to the airport or relative to the navigation aid that provides final approach guidance.
2. Vector to intercept the final approach course if required.
3. Approach clearance except when conducting a radar approach. ATC issues the approach clearance only after the aircraft is established on a segment of a published route or instrument approach procedure, or in the following examples as depicted in Figure 4-8 on page 4-9.

Aircraft 1 was vectored to the final approach course but clearance was withheld. It is now at 4,000 feet and established on a segment of the instrument approach procedure. "Seven miles from X-RAY. Cleared ILS runway three six approach."

Aircraft 2 is being vectored to a published segment of the final approach course, 4 NM from LIMA at 2,000 feet. The minimum vectoring altitude for this area is 2,000 feet. *“Four miles from LIMA. Turn right heading three four zero. Maintain two thousand until established on the localizer. Cleared ILS runway three six approach.”*

There are many times when it is desirable to position an aircraft onto the final approach course prior to a published, charted segment of an instrument approach procedure (IAP). Sometimes IAPs have no initial segment and require vectors. *“RADAR REQUIRED”* will be charted in the planview. Sometimes a route will intersect an extended final approach course making a long intercept desirable.

When ATC issues a vector or clearance to the final approach course beyond the published segment, controllers assign an altitude to maintain until the aircraft is established on a segment of a published route or IAP. This ensures that both the pilot and controller know precisely what altitude is to be flown and precisely where descent to appropriate minimum altitudes or step-down altitudes can begin.

Most aircraft are vectored onto a localizer or final approach course between an intermediate fix and the approach gate. These aircraft normally are told to maintain an altitude until established on a segment of the approach.

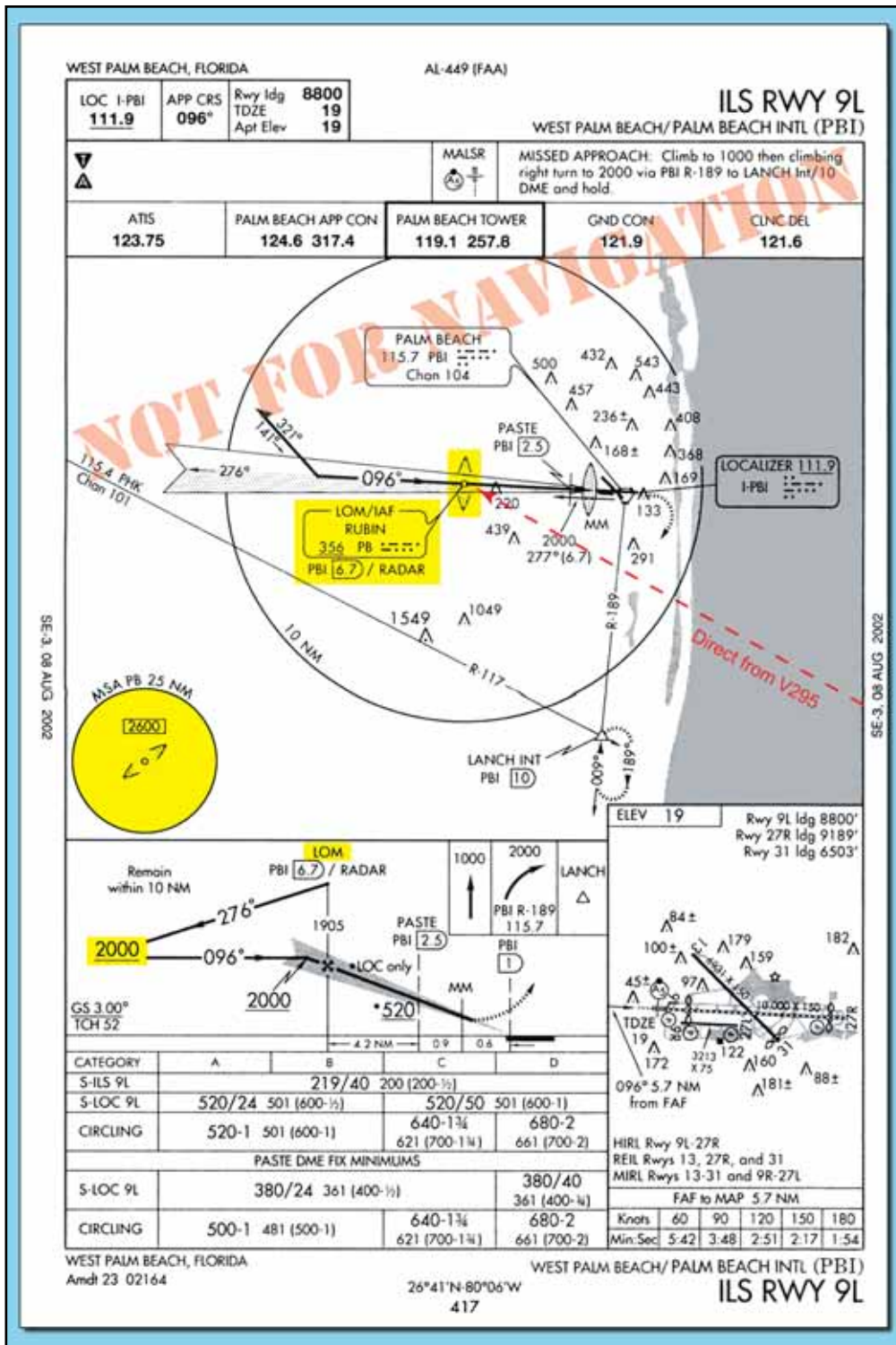
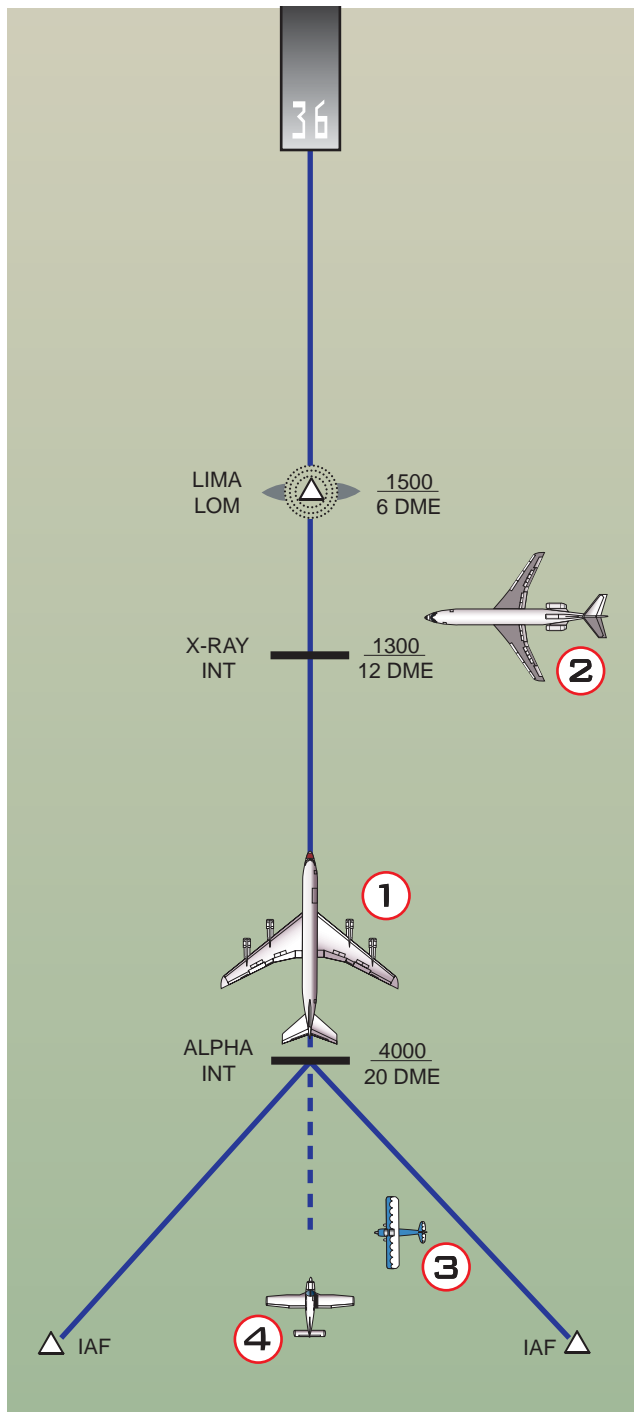


Figure 4-7. Cleared for the Palm Beach ILS Approach.

When an aircraft is assigned a route that will establish the aircraft on a published segment of an approach, the controller must issue an altitude to maintain until the aircraft is established on a published segment of the approach.

Aircraft 4 is established on the final approach course beyond the approach segments, 8 NM from Alpha at 6,000 feet. The minimum vectoring altitude for this area



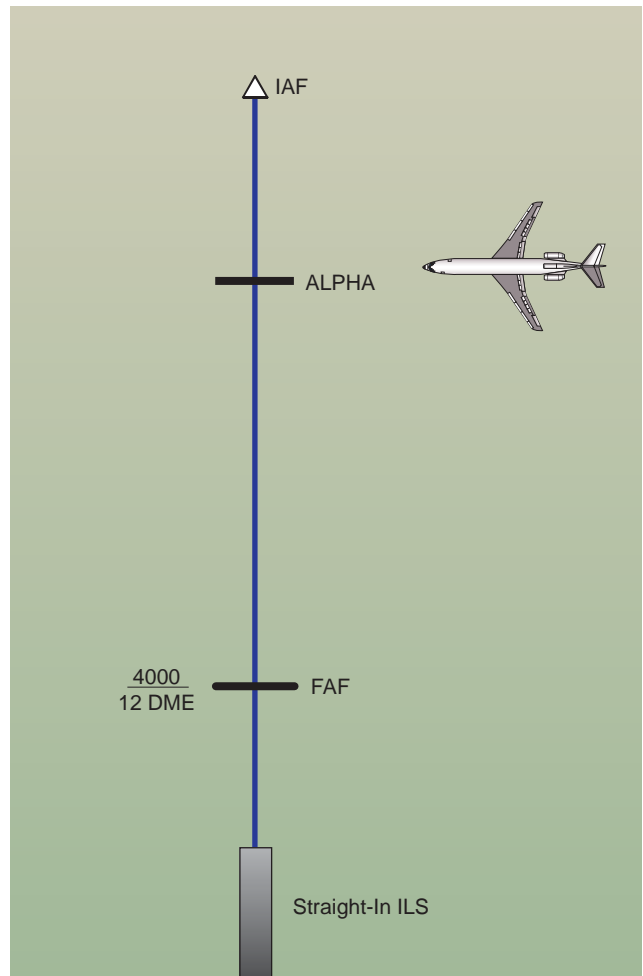


**Figure 4-8. Arrival Instructions When Established.**

is 4,000 feet. “Eight miles from Alpha. Cross Alpha at or above four thousand. Cleared ILS runway three six approach.”

If an aircraft is not established on a segment of a published approach and is not conducting a radar approach, ATC will assign an altitude to maintain until the aircraft is established on a segment of a published route or instrument approach procedure, as depicted in Figure 4-9.

The aircraft is being vectored to a published segment of the ILS final approach course, 3 NM from Alpha at



**Figure 4-9. Arrival Instructions When Not Established.**

4,000 feet. The minimum vectoring altitude for this area is 4,000 feet. “Three miles from Alpha. Turn left heading two one zero. Maintain four thousand until established on the localizer. Cleared ILS runway one eight approach.”

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

ATC tries to make frequency changes prior to passing the FAF, although when radar is used to establish the FAF, ATC informs the pilot to contact the tower on the local control frequency after being advised that the aircraft is over the fix. For example, “Three miles from final approach fix. Turn left heading zero one zero. Maintain two thousand until established on the localizer. Cleared ILS runway three six approach. I will advise when over the fix.”

“Over final approach fix. Contact tower one one eight point one.”

Where a terminal arrival area (TAA) has been established to support RNAV approaches, as depicted in

Figure 4-10, ATC informs the aircraft of its position relative to the appropriate IAF and issues the approach clearance, as shown in the following examples:

Aircraft 1 is in the straight-in area of the TAA. *“Seven miles from CENTR, Cleared RNAV Runway One Eight Approach.”*

Aircraft 2 is in the left base area of the TAA. *“Fifteen miles from LEFTT, Cleared RNAV Runway One Eight Approach.”*

Aircraft 3 is in the right base area of the TAA. *“Four miles from WRITE, Cleared RNAV Runway One Eight Approach.”*

IFR en route descent procedures should include a review of minimum, maximum, mandatory, and recommended altitudes that normally precede the fix or NAVAID facility to which they apply. The initial descent gradient for a low altitude instrument approach procedure does not exceed 500 feet per NM (approximately 5 degrees), and for a high altitude approach, the maximum

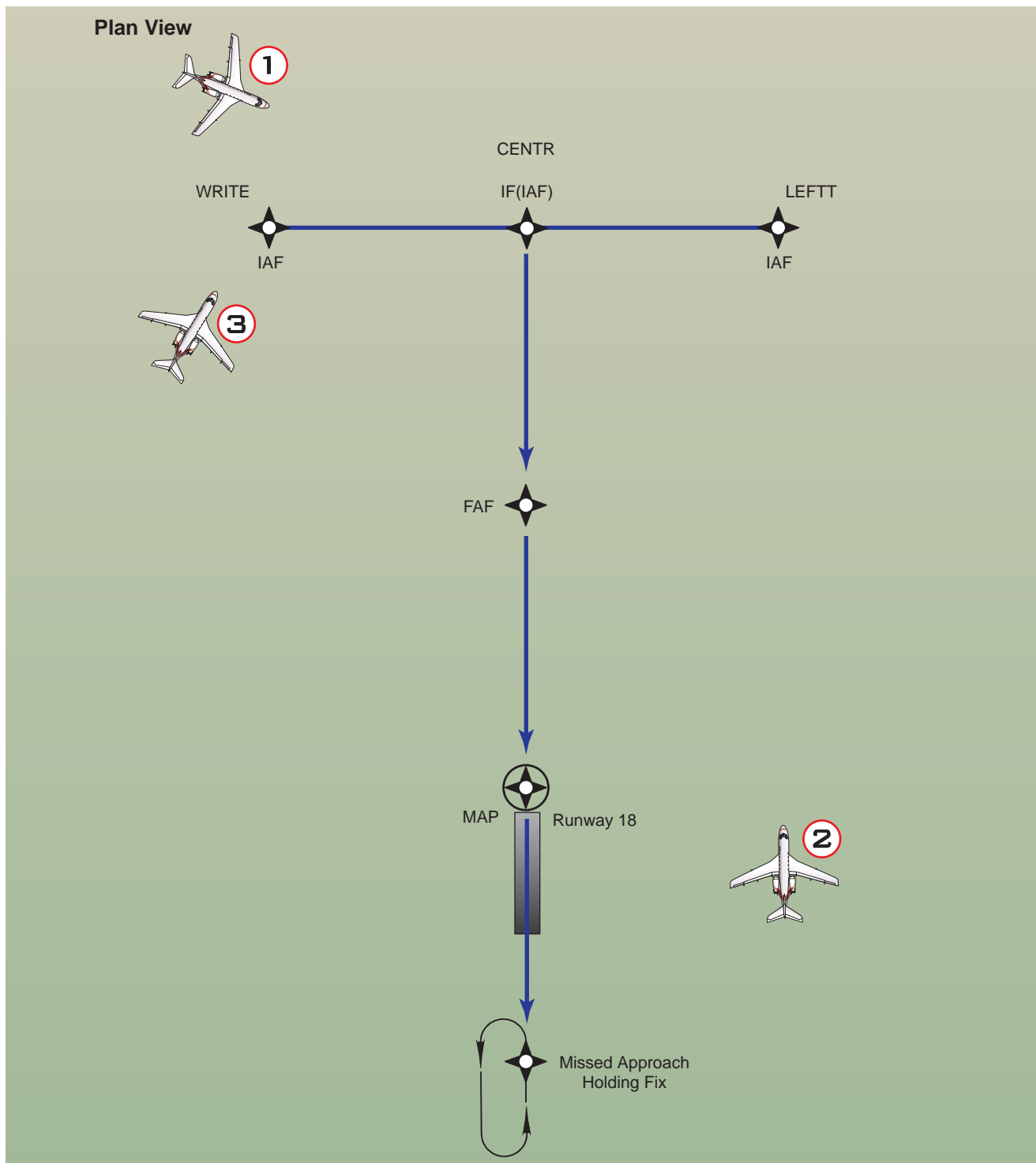


Figure 4-10. Basic “T” Design Terminal Arrival Area.

allowable initial gradient is 1,000 feet per NM (approximately 10 degrees).

Remember during arrivals, when cleared for an instrument approach, maintain the last assigned altitude until you are established on a published segment of the approach, or on a segment of a published route. If no altitude is assigned with the approach clearance and you are already on a published segment, you can descend to its minimum altitude.

### **HIGH PERFORMANCE AIRPLANE ARRIVALS**

Procedures are established for the control of IFR high performance airplane arrivals, and are generally applied regardless of air traffic activity or time of day. This includes all turbojets and turboprops over 12,500 pounds. These procedures reduce fuel consumption and minimize the time spent at low altitudes. The primary objective is to ensure turbine-powered airplanes remain at the highest possible altitude as long as possible within reasonable operating limits and consistent with noise abatement policies.

### **AIRSPEED**

During the arrival, expect to make adjustments in speed at the controller's request. When you fly a high-performance airplane on an IFR flight plan, ATC may ask you to adjust your airspeed to achieve proper traffic sequencing and separation. This also reduces the amount of radar vectoring required in the terminal area. When operating a reciprocating engine or turboprop airplane within 20 NM from your destination airport, 150 knots is usually the slowest airspeed you will be assigned. If your aircraft cannot maintain the assigned airspeed, you must advise ATC. Controllers may ask you to maintain the same speed as the aircraft ahead of or behind you on the approach. You are expected to maintain the specified airspeed  $\pm 10$  knots. At other times, ATC may ask you to increase or decrease your speed by 10 knots, or multiples thereof. When the speed adjustment is no longer needed, ATC will advise you to "...*resume normal speed.*" Keep in mind that the maximum speeds specified in Title 14 of the Code of Federal Regulations (14 CFR) Part 91.117 still apply during speed adjustments. It is your responsibility, as pilot in command, to advise ATC if an assigned speed adjustment would cause you to exceed these limits. For operations in Class C or D airspace at or below 2,500 feet above ground level (AGL), within 4 NM of the primary airport, ATC has the authority to request or approve a faster speed than those prescribed in Part 91.117.

Pilots operating at or above 10,000 feet MSL on an assigned speed adjustment that is greater than 250 KIAS are expected to reduce speed to 250 KIAS to comply with Part 91.117(a) when cleared below 10,000 feet MSL, within domestic airspace. This speed adjustment is made without notifying ATC. Pilots are expected to

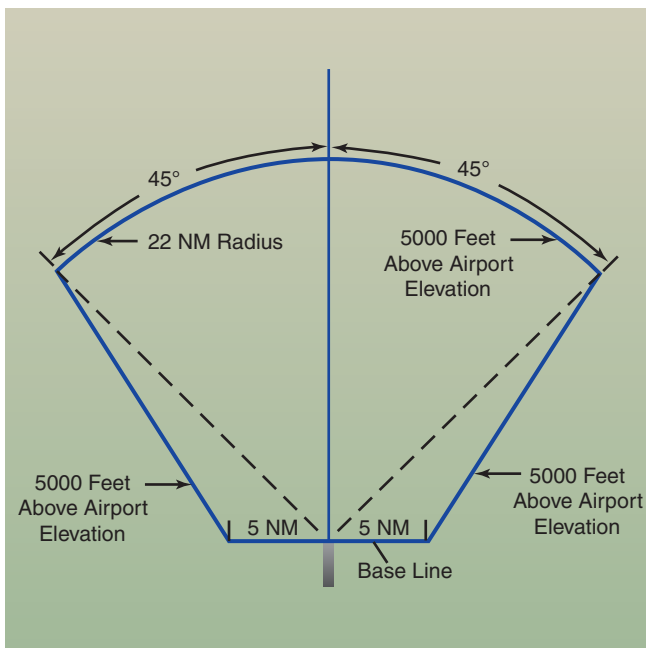
comply with the other provisions of Part 91.117 without notifying ATC. For example, it is normal for faster aircraft to level off at 10,000 feet MSL while slowing to the 250 KIAS limit that applies below that altitude, and to level off at 2,500 feet above airport elevation to slow to the 200 KIAS limit that applies within the surface limits of Class C or D airspace. Controllers anticipate this action and plan accordingly.

Speed restrictions of 250 knots do not apply to aircraft operating beyond 12 NM from the coastline within the United States (U.S.) Flight Information Region, in offshore Class E airspace below 10,000 feet MSL. In airspace underlying a Class B airspace area designated for an airport, pilots are expected to comply with the 200 KIAS limit specified in Part 91.117(c). (See Parts 91.117(c) and 91.703.)

Approach clearances cancel any previously assigned speed adjustment. Pilots are expected to make speed adjustments to complete the approach unless the adjustments are restated. Pilots complying with speed adjustment instructions should maintain a speed within plus or minus 10 knots or 0.02 Mach number of the specified speed.

Although standardization of these procedures for terminal locations is subject to local considerations, specific criteria apply in developing new or revised arrival procedures. Normally, high performance airplanes enter the terminal area at or above 10,000 feet above the airport elevation and begin their descent 30 to 40 NM from touchdown on the landing runway. Unless pilots indicate an operational need for a lower altitude, descent below 5,000 feet above the airport elevation is typically limited to the descent area where final descent and glide slope intercept can be made without exceeding specific obstacle clearance and other related arrival, approach, and landing criteria. Your descent should not be interrupted by controllers just to ensure that you cross the boundaries of the descent area at precisely 5,000 feet above the airport elevation. A typical descent area is shown in Figure 4-11 on page 4-12.

Arrival delays typically are absorbed at a metering fix. This fix is established on a route prior to the terminal airspace, 10,000 feet or more above the airport elevation. The metering fix facilitates profile descents, rather than controllers using delaying vectors or a holding pattern at low altitudes. Descent restrictions normally are applied prior to reaching the final approach phase to preclude relatively high descent rates close in to the destination airport. At least 10 NM from initial descent from 10,000 feet above the airport elevation, the controller issues an advisory that details when to expect to commence the descent. ATC typically uses the phraseology, "*Expect descent in (number) miles.*" If cleared for a visual or contact approach, ATC usually restricts



**Figure 4-11. Typical Descent Area for Straight-In Approach.**

you to at least 5,000 feet above the airport elevation until entering the descent area. Standard ATC phraseology is, “Maintain (altitude) until (specified point; e.g., abeam landing runway end), cleared for visual approach or expect visual or contact approach clearance in (number of miles, minutes or specified point).”

Once the determination is made regarding the instrument approach and landing runway you will use, with its associated descent area, ATC will not permit a change to another navigational aid that is not aligned with the landing runway. When altitude restrictions are required for separation purposes, ATC avoids assigning an altitude below 5,000 above the airport elevation.

There are numerous exceptions to the high performance airplane arrival procedures previously outlined. For example, in a nonradar environment, the controller may clear the flight to use an approach based on a NAVAID other than the one aligned with the landing runway, such as a circling approach. In this case, the descent to a lower altitude usually is limited to the descent area with the circle-to-land maneuver confined to the traffic pattern. Also in a nonradar environment, contact approaches may be approved from 5,000 above the airport elevation while the flight is within a descent area, regardless of landing direction.

Descent areas are established for all straight-in instrument approach procedures at an airport and may be established for runways not served by an instrument approach procedure to accommodate visual and contact approaches. More than one runway (descent area) may be used simultaneously for arriving high performance airplanes if there is an operational advantage for the pilot

or ATC, provided that the descent area serves the runway of intended landing.

### CONTROLLED FLIGHT INTO TERRAIN

Inappropriate descent planning and execution during arrivals has been a contributing factor to many fatal aircraft accidents. Since the beginning of commercial jet operations, more than 9,000 people have died worldwide because of controlled flight into terrain (CFIT). CFIT is described as an event in which a normally functioning aircraft is inadvertently flown into the ground, water, or an obstacle. Of all CFIT accidents, 7.2 percent occurred during the descent phase of flight.

The basic causes of CFIT accidents involve poor flight crew situational awareness. One definition of situational awareness is an accurate perception by pilots of the factors and conditions currently affecting the safe operation of the aircraft and the crew. The causes of CFIT are the flight crews’ lack of vertical position awareness or their lack of horizontal position awareness in relation to the ground, water, or an obstacle. More than two-thirds of all CFIT accidents are the result of an altitude error or lack of vertical situational awareness. CFIT accidents most often occur during reduced visibility associated with instrument meteorological conditions (IMC), darkness, or a combination of both.

The inability of controllers and pilots to properly communicate has been a factor in many CFIT accidents. Heavy workloads can lead to hurried communication and the use of abbreviated or non-standard phraseology. The importance of good communication during the arrival phase of flight was made evident in a report by an air traffic controller and the flight crew of an MD-80. The controller reported that he was scanning his radarscope for traffic and noticed that the MD-80 was descending through 6,400 feet. He immediately instructed a climb to at least 6,500 feet. The pilot responded that he had been cleared to 5,000 feet and then climbed to... The pilot reported that he had “heard” a clearance to 5,000 feet and read back 5,000 feet to the controller and received no correction from the controller. After almost simultaneous ground proximity warning system (GPWS) and controller warnings, the pilot climbed and avoided the terrain. The recording of the radio transmissions confirmed that the airplane was cleared to 7,000 feet and the pilot mistakenly read back 5,000 feet then attempted to descend to 5,000 feet. The pilot stated in the report: “I don’t know how much clearance from the mountains we had, but it certainly makes clear the importance of good communications between the controller and pilot.”

ATC is not always responsible for safe terrain clearance for the aircraft under its jurisdiction. Many times ATC will issue en route clearances for pilots to proceed off airway direct to a point. Pilots who accept this

type of clearance also are accepting responsibility for maintaining safe terrain clearance. Know the height of the highest terrain and obstacles in the operating area. Know your position in relation to the surrounding high terrain.

The following are excerpts from CFIT accidents related to descending on arrival: "...delayed the initiation of the descent..."; "Aircraft prematurely descended too early..."; "...late getting down..."; "During a descent...incorrectly cleared down..."; "...aircraft prematurely let down..."; "...lost situational awareness..."; "Premature descent clearance..."; "Prematurely descended..."; "Premature descent clearance while on vector..."; "During initial descent..." [Figure 4-12]

Practicing good communication skills is not limited to just pilots and controllers. In its findings from a 1974 air carrier accident, the National Transportation Safety Board (NTSB) wrote, "...the extraneous conversation conducted by the flight crew during the descent was symptomatic of a lax atmosphere in the cockpit that continued throughout the approach." The NTSB listed the probable cause as "...the flight crew's lack of altitude awareness at critical points during the approach due to poor cockpit discipline in that the crew did not follow prescribed procedures." In 1981, the FAA issued Parts 121.542 and 135.100, Flight Crewmember Duties, commonly referred to as "sterile cockpit rules." The provisions in this rule can help pilots, operating under any regulations, to avoid altitude and course deviations during arrival. In part, it states: (a) No certificate holder shall require, nor may any flight crewmember perform, any duties during a critical phase of flight except those duties required for the safe operation of the aircraft. Duties such as company required calls made for such purposes as ordering galley supplies and confirming passenger connections, announcements made to passengers promoting the air carrier or pointing out sights of interest, and filling out company payroll and related records are not required for the safe operation of the aircraft. (b) No flight crewmember may engage in, nor

may any pilot in command permit, any activity during a critical phase of flight that could distract any flight crewmember from the performance of his or her duties or which could interfere in any way with the proper conduct of those duties. Activities such as eating meals, engaging in nonessential conversations within the cockpit and nonessential communications between the cabin and cockpit crews, and reading publications not related to the proper conduct of the flight are not required for the safe operation of the aircraft. (c) For the purposes of this section, critical phases of flight include all ground operations involving taxi, takeoff and landing, and all other flight operations conducted below 10,000 feet, except cruise flight.

## ARRIVAL NAVIGATION CONCEPTS

Today, the most significant and demanding navigational requirement is the need to safely separate aircraft. In a nonradar environment, ATC does not have an independent means to separate air traffic and must depend entirely on information relayed from flight crews to determine the actual geographic position and altitude. In this situation, precise navigation is critical to ATC's ability to provide separation.

Even in a radar environment, precise navigation and position reports, when required, are still the primary means of providing separation. In most situations, ATC does not have the capability or the responsibility for navigating an aircraft. Because they rely on precise navigation by the flight crew, flight safety in all IFR operations depends directly on your ability to achieve and maintain certain levels of navigational performance. ATC uses radar to monitor navigational performance, detect possible navigational errors, and expedite traffic flow. In a nonradar environment, ATC has no independent knowledge of the actual position of your aircraft or its relationship to other aircraft in adjacent airspace. Therefore, ATC's ability to detect a navigational error and resolve collision hazards is seriously degraded when a deviation from a clearance occurs.

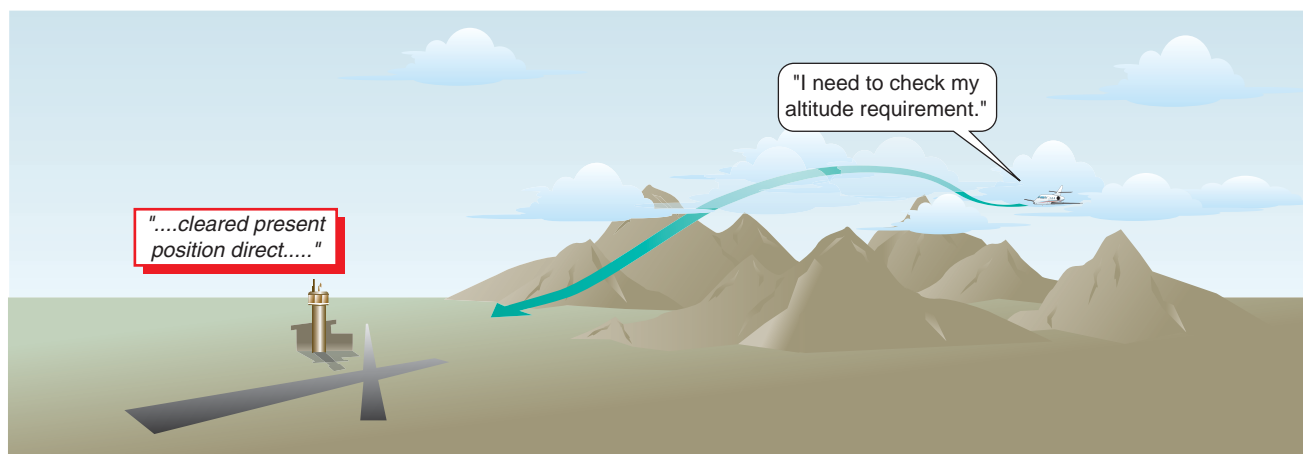


Figure 4-12. Altitude Management When Cleared Direct.

The concept of navigation performance, previously discussed in this book, involves the precision that must be maintained for both the assigned route and altitude. Required levels of navigation performance vary from area to area depending on traffic density and complexity of the routes flown. The level of navigation performance must be more precise in domestic airspace than in oceanic and remote land areas since air traffic density in domestic airspace is much greater. For example, there are two million flight operations conducted within Chicago Center's airspace each year. The minimum lateral distance permitted between co-altitude aircraft in Chicago Center's airspace is 8 NM (3 NM when radar is used). The route ATC assigns an aircraft has protected airspace on both sides of the centerline, equal to one-half of the lateral separation minimum standard. For example, the overall level of lateral navigation performance necessary for flight safety must be better than 4 NM in Center airspace. When STARs are reviewed subsequently in this chapter, you will see how the navigational requirements become more restrictive in the arrival phase of flight where air traffic density increases and procedural design and obstacle clearance become more limiting.

The concept of navigational performance is fundamental to the code of federal regulations, and is best

defined in Parts 121.103 and 121.121, which state that each aircraft must be navigated to the degree of accuracy required for air traffic control. The requirements of Part 91.123 related to compliance with ATC clearances and instructions also reflect this fundamental concept. Commercial operators must comply with their Operations Specifications (OpsSpecs) and understand the categories of navigational operations and be able to navigate to the degree of accuracy required for the control of air traffic. In the broad concept of air navigation, there are two major categories of navigational operations consisting of Class I navigation and Class II navigation. Class I navigation is any en route flight operation conducted in controlled or uncontrolled airspace that is entirely within operational service volumes of ICAO standard NAVAIDs (VOR, VOR/DME, NDB). Class II navigation is any en route operation that is not categorized as Class I navigation and includes any operation or portion of an operation that takes place outside the operational service volumes of ICAO standard NAVAIDs. For example, your aircraft equipped only with VORs conducts Class II navigation when your flight operates in an area outside the operational service volumes of federal VORs. Class II navigation does not automatically require the use of long-range, specialized navigational systems if special navigational techniques are used to supplement

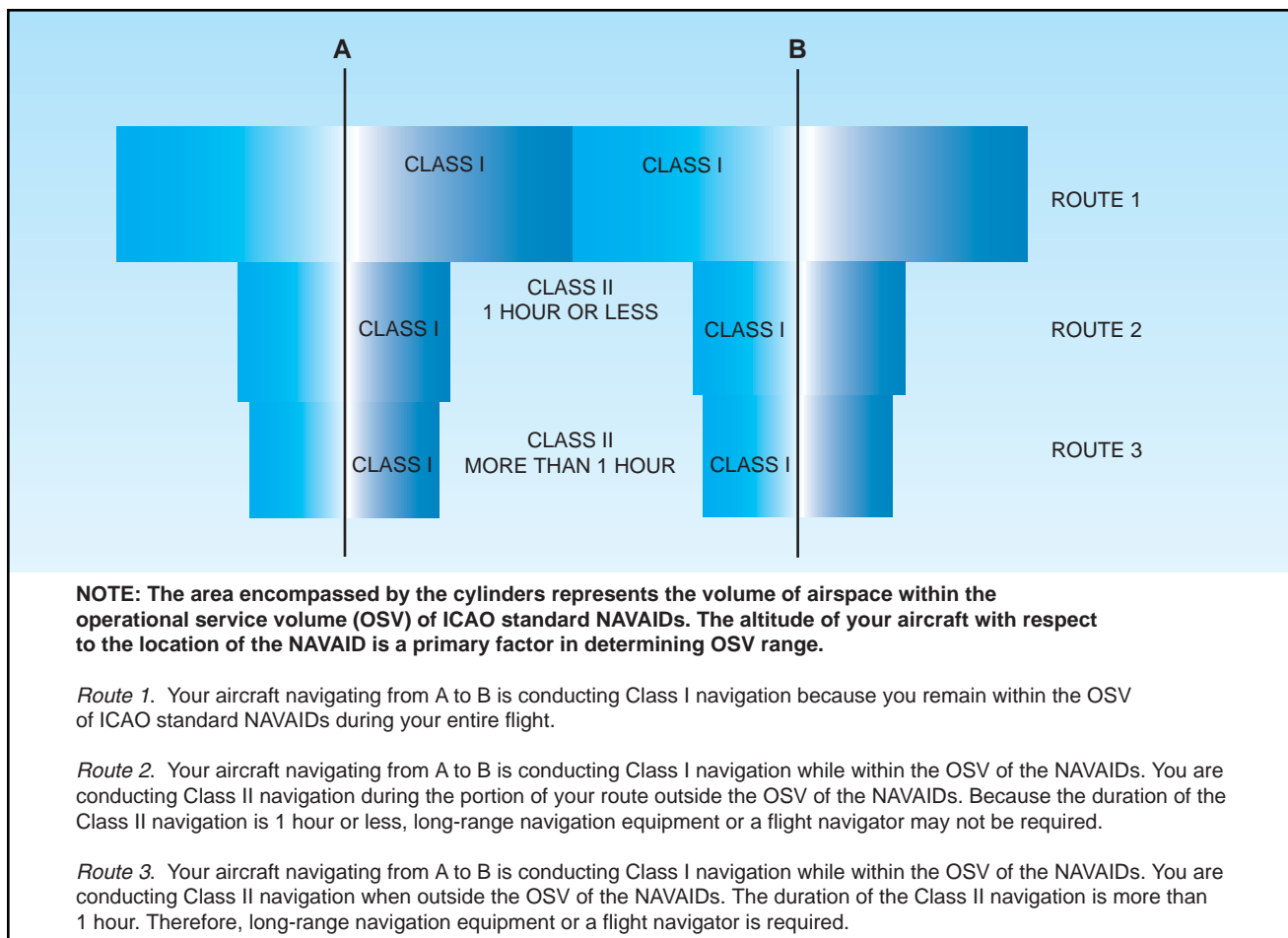


Figure 4-13. Class I and II Navigation.

conventional NAVAIDs. Class II navigation includes transoceanic operations and operations in desolate and remote land areas such as the Arctic. The primary types of specialized navigational systems approved for Class II operations include inertial navigation system (INS), Doppler, and global positioning system (GPS). Figure 4-13 provides several examples of Class I and II navigation.

A typical limitations entry in a commercial operator's pilot handbook states, "The area navigation system used for IFR Class I navigation meets the performance/accuracy criteria of AC 20-130A for en route and terminal area navigation." The subject of AC 20-130A is *Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors*.

## STANDARD TERMINAL ARRIVAL ROUTES

A standard terminal arrival route (STAR) provides a critical form of communication between pilots and ATC. Once a flight crew has accepted a clearance for a STAR, they have communicated with the controller what route, and in some cases what altitude and airspeed, they will fly during the arrival, depending on the type of clearance. The STAR provides a common method for leaving the en route structure and navigating to your destination. It is a preplanned instrument flight rule ATC arrival procedure published for pilot use in graphic and textual form that simplifies clearance delivery procedures.

When the repetitive complex departure clearances by controllers turned into standard instrument departures (SIDs) in the late 1970s, the idea caught on quickly. Eventually, most of the major airports in the U.S. developed standard departures with graphics for printed publication. The idea seemed so good that the standard arrival clearances also started being published in text and graphic form. The new procedures were named standard terminal arrival routes, or STARs.

The principal difference between SIDs or departure procedures (DPs) and STARs is that the DPs start at the airport pavement and connect to the en route structure. STARs on the other hand, start at the en route structure but don't make it down to the pavement; they end at a fix or NAVAID designated by ATC, where radar vectors commonly take over. This is primarily because STARs serve multiple airports. STARs greatly help to facilitate the transition between the en route and approach phases of flight. The objective when connecting a STAR to an instrument approach procedure is to ensure a seamless lateral and vertical transition. The STAR and approach procedure should connect to one another in such a way as to maintain the overall descent and deceleration

profiles. This often results in a seamless transition between the en route, arrival, and approach phases of flight, and serves as a preferred route into high volume terminal areas. [Figure 4-14 on page 4-16]

STARs provide a transition from the en route structure to an approach gate, outer fix, instrument approach fix, or arrival waypoint in the terminal area, and they usually terminate with an instrument or visual approach procedure. STARs are included at the front of each *Terminal Procedures Publication* regional booklet.

For STARs based on conventional NAVAIDs, the procedure design and obstacle clearance criteria are essentially the same as that for en route criteria, covered in Chapter 3, *En Route Operations*. STAR procedures typically include a standardized descent gradient at and above 10,000 feet MSL of 318 feet per NM, or 3 degrees. Below 10,000 feet MSL the maximum descent rate is 330 feet per NM, or approximately 3.1 degrees. In addition to standardized descent gradients, STARs allow for deceleration segments at any waypoint that has a speed restriction. As a general guideline, deceleration considerations typically add 1 NM of distance for each ten knots of speed reduction required.

## INTERPRETING THE STAR

STARs use much of the same symbology as departure and approach charts. In fact, a STAR may at first appear identical to a similar graphic DP, except the direction of flight is reversed and the procedure ends at an approach fix. The STAR officially begins at the common NAVAID, intersection, or fix where all the various transitions to the arrival come together. A STAR transition is a published segment used to connect one or more en route airways, jet routes, or RNAV routes to the basic STAR procedure. It is one of several routes that bring traffic from different directions into one STAR. This way, arrivals from several directions can be accommodated on the same chart, and traffic flow is routed appropriately within the congested airspace.

To illustrate how STARs can be used to simplify a complex clearance and reduce frequency congestion, consider the following arrival clearance issued to a pilot flying to Seattle, Washington, depicted in Figure 4-15 on page 4-17: "*Cessna 32G, cleared to the Seattle/Tacoma International Airport as filed. Maintain 12,000. At the Ephrata VOR intercept the 221° radial to CHINS Intersection. Intercept the 284° radial of the Yakima VOR to RADDY Intersection. Cross RADDY at 10,000. Continue via the Yakima 284° radial to AUBRN Intersection. Expect radar vectors to the final approach course.*"

Now consider how this same clearance is issued when a STAR exists for this terminal area. "*Cessna 32G,*

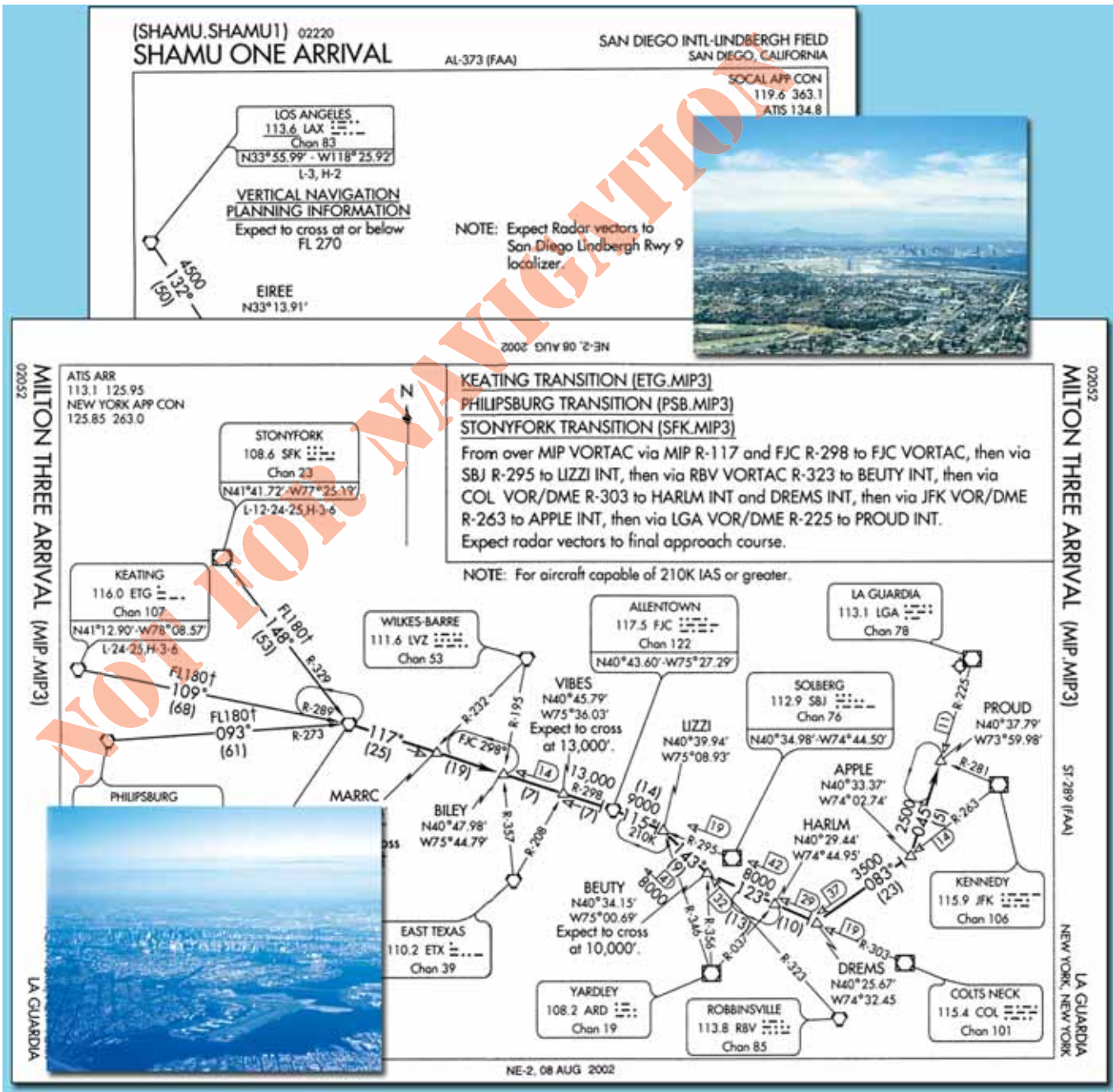


Figure 4-14. Arrival Charts.

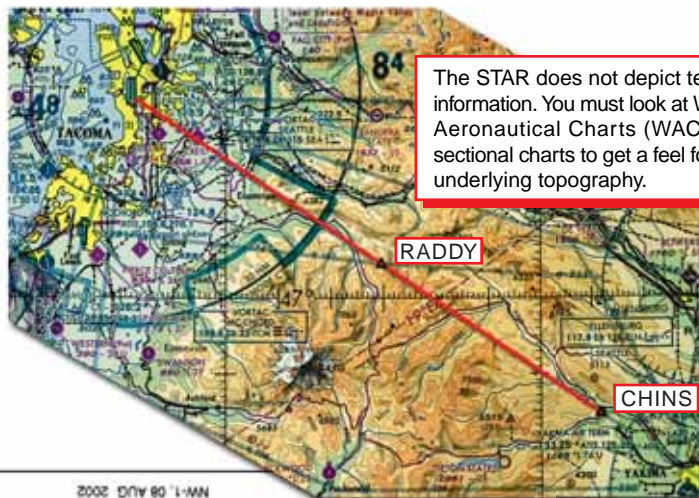
cleared to Seattle/Tacoma International Airport as filed, then CHINS FOUR ARRIVAL, Ephrata Transition. Maintain 10,000 feet." A shorter transmission conveys the same information.

Safety is enhanced when both pilots and controllers know what to expect. Effective communication increases with the reduction of repetitive clearances, decreasing congestion on control frequencies. To accomplish this, STARs are developed according to the following criteria:

- STARs must be simple, easily understood and, if possible, limited to one page.

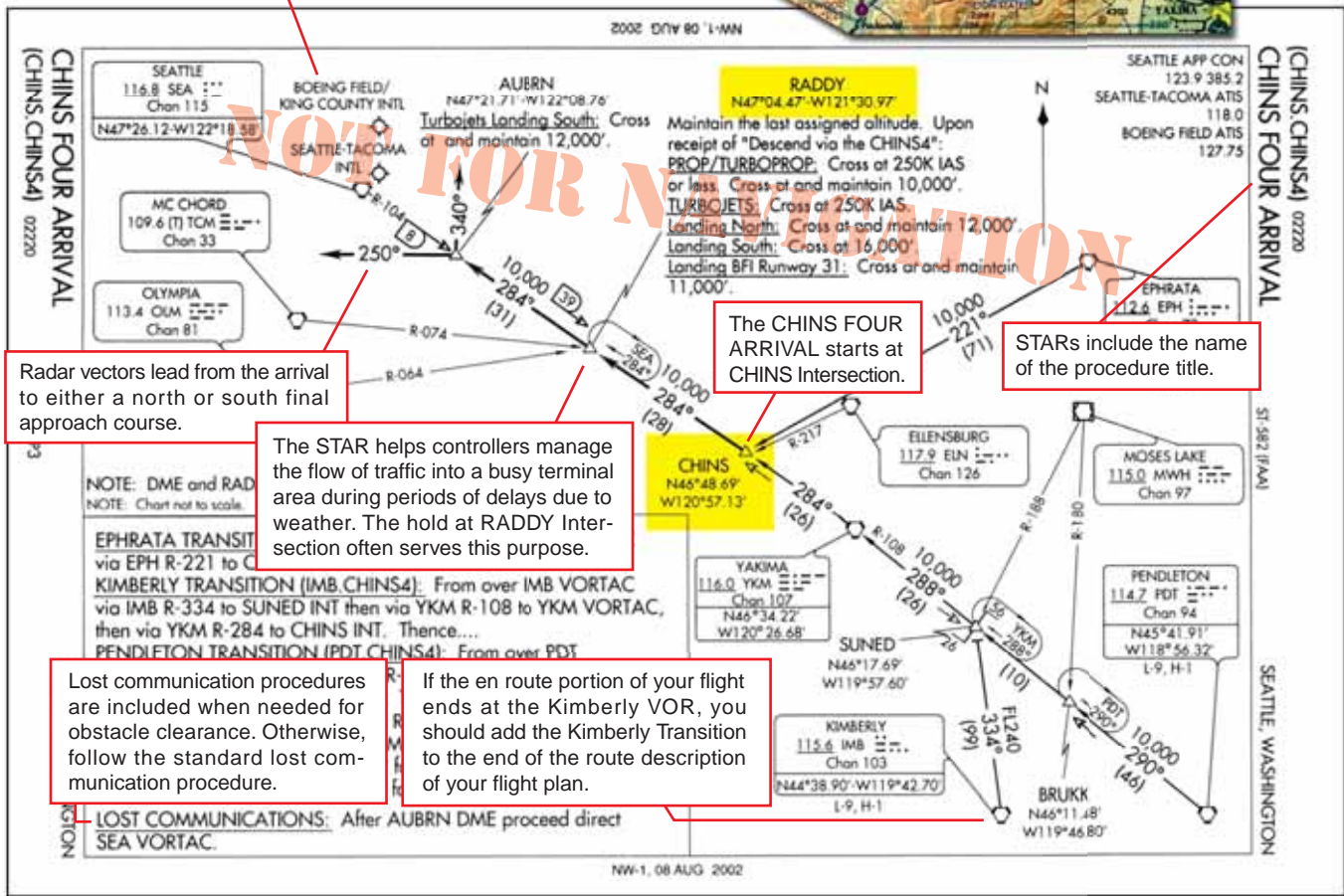
- A STAR transition should be able to accommodate as many different types of aircraft as possible.
- VORTACs are used wherever possible, with some exceptions on RNAV STARs, so that military and civilian aircraft can use the same arrival.
- DME arcs within a STAR should be avoided since not all aircraft in the IFR environment are so equipped.
- Altitude crossing and airspeed restrictions are included when they are assigned by ATC a majority of the time. [Figure 4-16 on page 4-18]





The STAR does not depict terrain information. You must look at World Aeronautical Charts (WACs) or sectional charts to get a feel for the underlying topography.

The primary arrival airport is Seattle-Tacoma International. Other airports may be served by the procedure, such as Boeing Field/King County International.



Radar vectors lead from the arrival to either a north or south final approach course.

The STAR helps controllers manage the flow of traffic into a busy terminal area during periods of delays due to weather. The hold at RADDY Intersection often serves this purpose.

The CHINS FOUR ARRIVAL starts at CHINS Intersection.

STARs include the name of the procedure title.

Lost communication procedures are included when needed for obstacle clearance. Otherwise, follow the standard lost communication procedure.

If the en route portion of your flight ends at the Kimberly VOR, you should add the Kimberly Transition to the end of the route description of your flight plan.

Figure 4-15. STAR Interpretation.

STARs usually are named according to the point at which the procedure begins. In the U.S., typically there are en route transitions before the STAR itself. So the STAR name is usually the same as the last fix on the en route transitions where they come together to begin the basic STAR procedure. A STAR that commences at the CHINS Intersection becomes the CHINS ONE ARRIVAL. When a significant portion of the arrival is revised, such as an altitude, a route, or data concerning the NAVAID, the number of the arrival changes. For example, the CHINS ONE ARRIVAL is now the CHINS FOUR ARRIVAL due to modifications in the procedure.

fixes and where they correspond to fixes on the NACO en route or area chart. Arrivals may incorporate step-down fixes when necessary to keep aircraft within airspace boundaries, or for obstacle clearance. Routes between fixes contain courses, distances, and minimum altitudes, alerting you to possible obstructions or terrain under your arrival path. Airspeed restrictions also appear where they aid in managing the traffic flow. In addition, some STARs require that you use DME and/or ATC radar. You can decode the symbology on the PAWLING TWO ARRIVAL depicted in Figure 4-17 on page 4-18 by referring to the legend at the beginning of the NACO Terminal Procedures Publication.

Studying the STARs for an airport may allow you to perceive the specific topography of the area. Note the initial

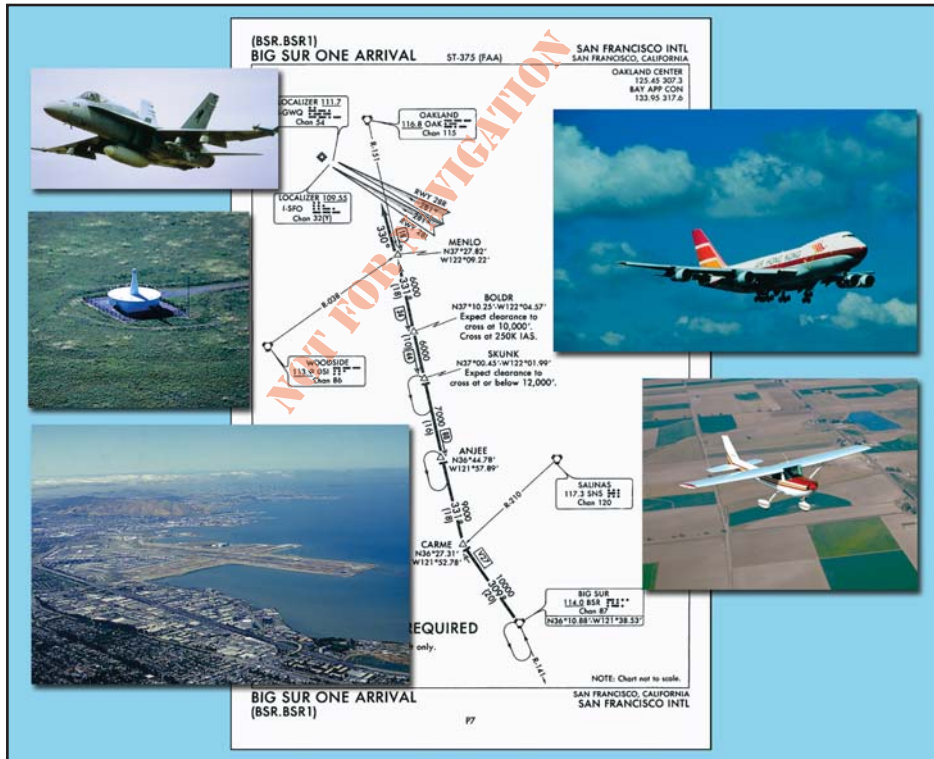


Figure 4-16. Reducing Pilot/Controller Workload.

## VERTICAL NAVIGATION PLANNING

Included within certain STARs is information on vertical navigation planning. This information is provided to reduce the amount of low altitude flying time for high performance airplanes, like jets and turboprops. An expected altitude is given for a key fix along the route. By knowing an intermediate altitude in advance when flying a high performance airplane, you can plan the power or thrust settings and airplane configurations that result in the most efficient descent in terms of time and fuel requirements. Pilots of high performance airplanes use the vertical navigation planning information from the RAMMS FIVE ARRIVAL at Denver, Colorado, to plan their descents. [Figure 4-18]

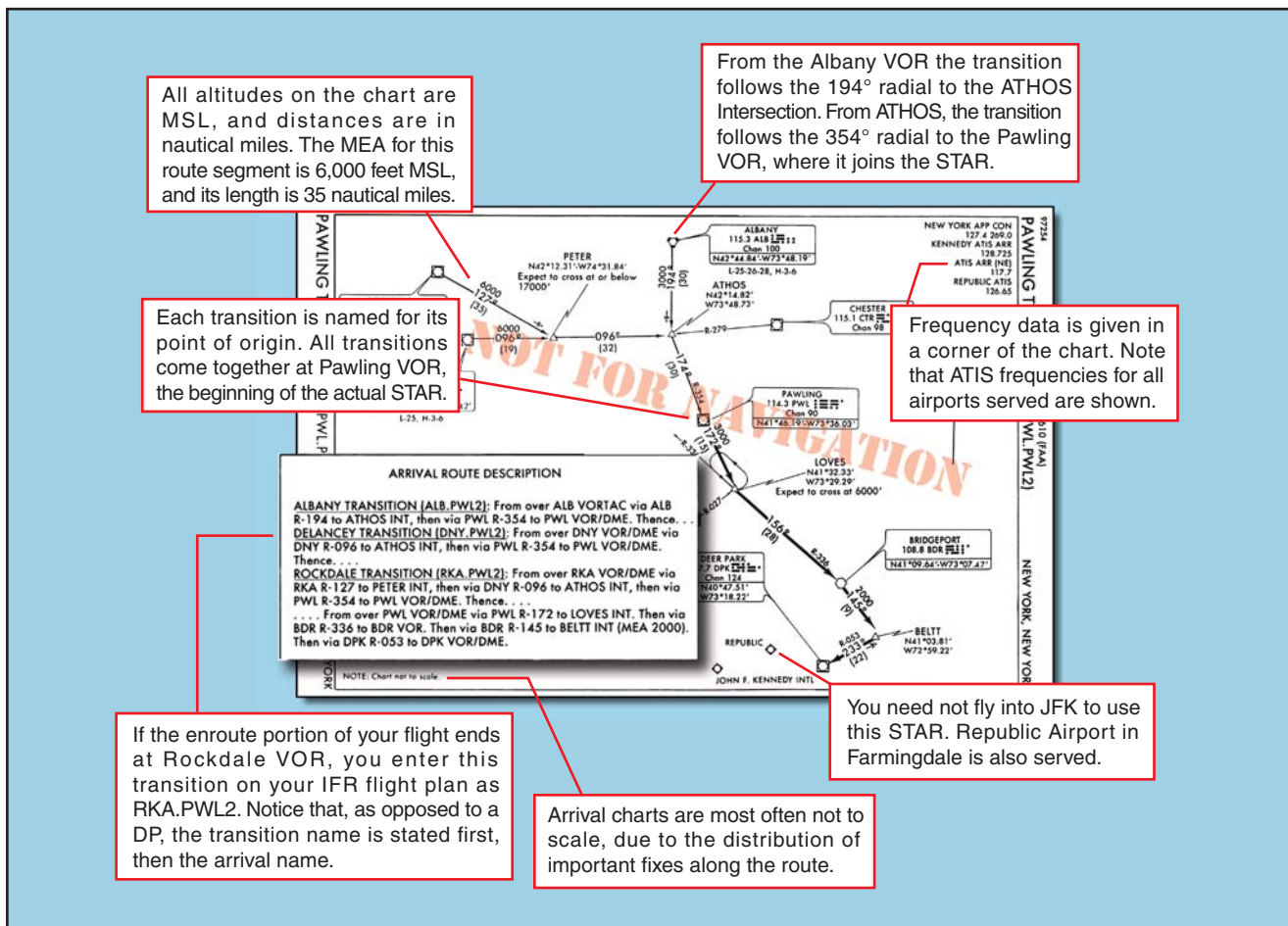


Figure 4-17. STAR Symbology.

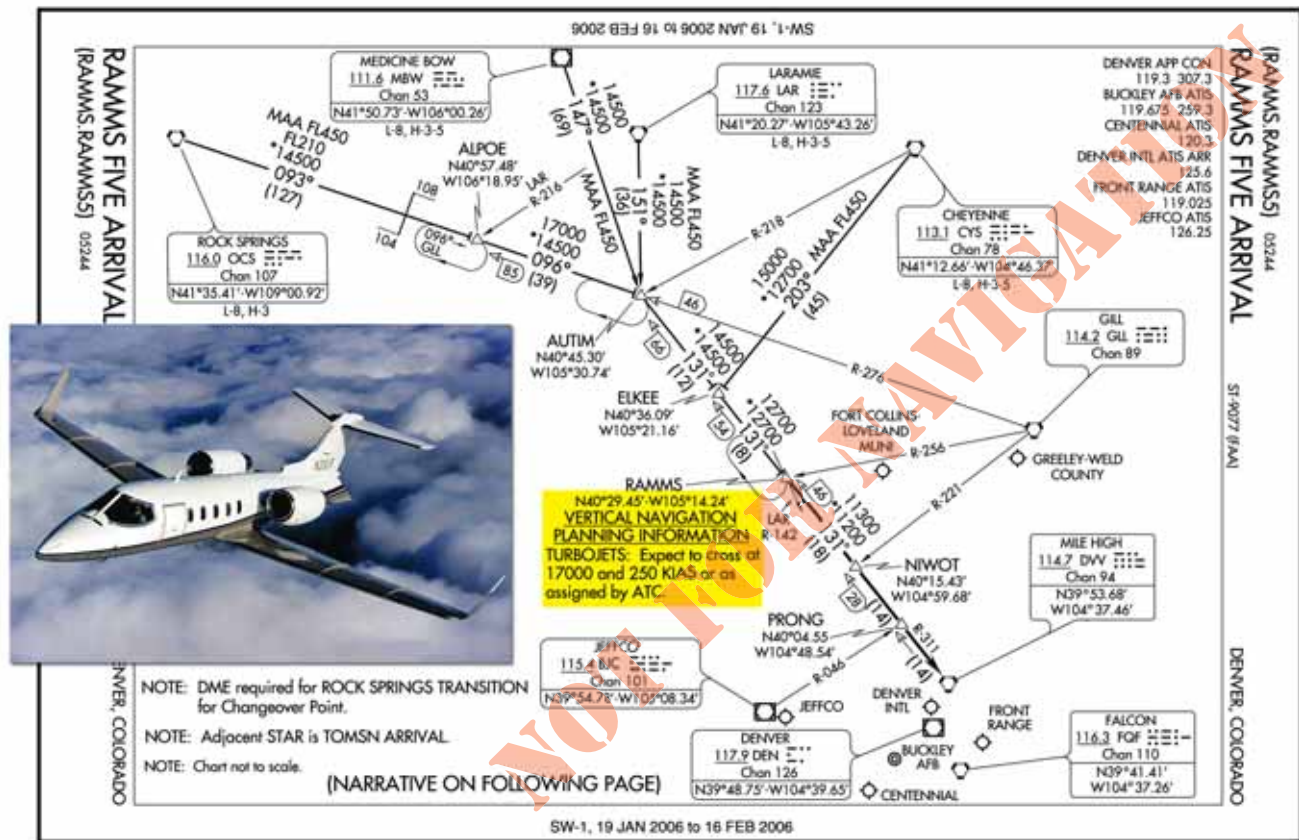


Figure 4-18. Vertical Navigation Planning.

## ARRIVAL PROCEDURES

You may accept a STAR within a clearance or you may file for one in your flight plan. As you near your destination airport, ATC may add a STAR procedure to your original clearance. Keep in mind that ATC can assign a STAR even if you have not requested one. If you accept the clearance, you must have at least a textual description of the procedure in your possession. If you do not want to use a STAR, you must specify “No STAR” in the remarks section of your flight plan. You may also refuse the STAR when it is given to you verbally by ATC, but the system works better if you advise ATC ahead of time.

## PREPARING FOR THE ARRIVAL

As mentioned before, STARs include navigation fixes that are used to provide transition and arrival routes from the en route structure to the final approach course. They also may lead to a fix where radar vectors will be provided to intercept the final approach course. You may have noticed that minimum crossing altitudes and airspeed restrictions appear on some STARs. These expected altitudes and airspeeds are not part of your clearance until ATC includes them verbally. A STAR is simply a published routing; it does not have the force of a clearance until issued specifically by ATC. For example, MEAs printed on STARs are not valid unless stated within an ATC clearance or in cases of

lost communication. After receiving your arrival clearance, you should review the assigned STAR procedure.

Obtain the airport and weather information as early as practical. It is recommended that you have this information prior to flying the STAR. If you are landing at an airport with approach control services that has two or more published instrument approach procedures, you will receive advance notice of which instrument approaches to expect. This information is broadcast either by ATIS or by a controller. It may not be provided when the visibility is 3 statute miles (SM) or better and the ceiling is at or above the highest initial approach altitude established for any instrument approach procedure for the airport. [Figure 4-19 on page 4-20]

For STAR procedures charted with radar vectors to the final approach, look for routes from the STAR terminating fixes to the IAF. **If no route is depicted, you should have a predetermined plan of action to fly from the STAR terminating fix to the IAF in the event of a communication failure.**

## REVIEWING THE APPROACH

Once you have determined which approach to expect, review the approach chart thoroughly before you enter the terminal area. Check your fuel level and make sure

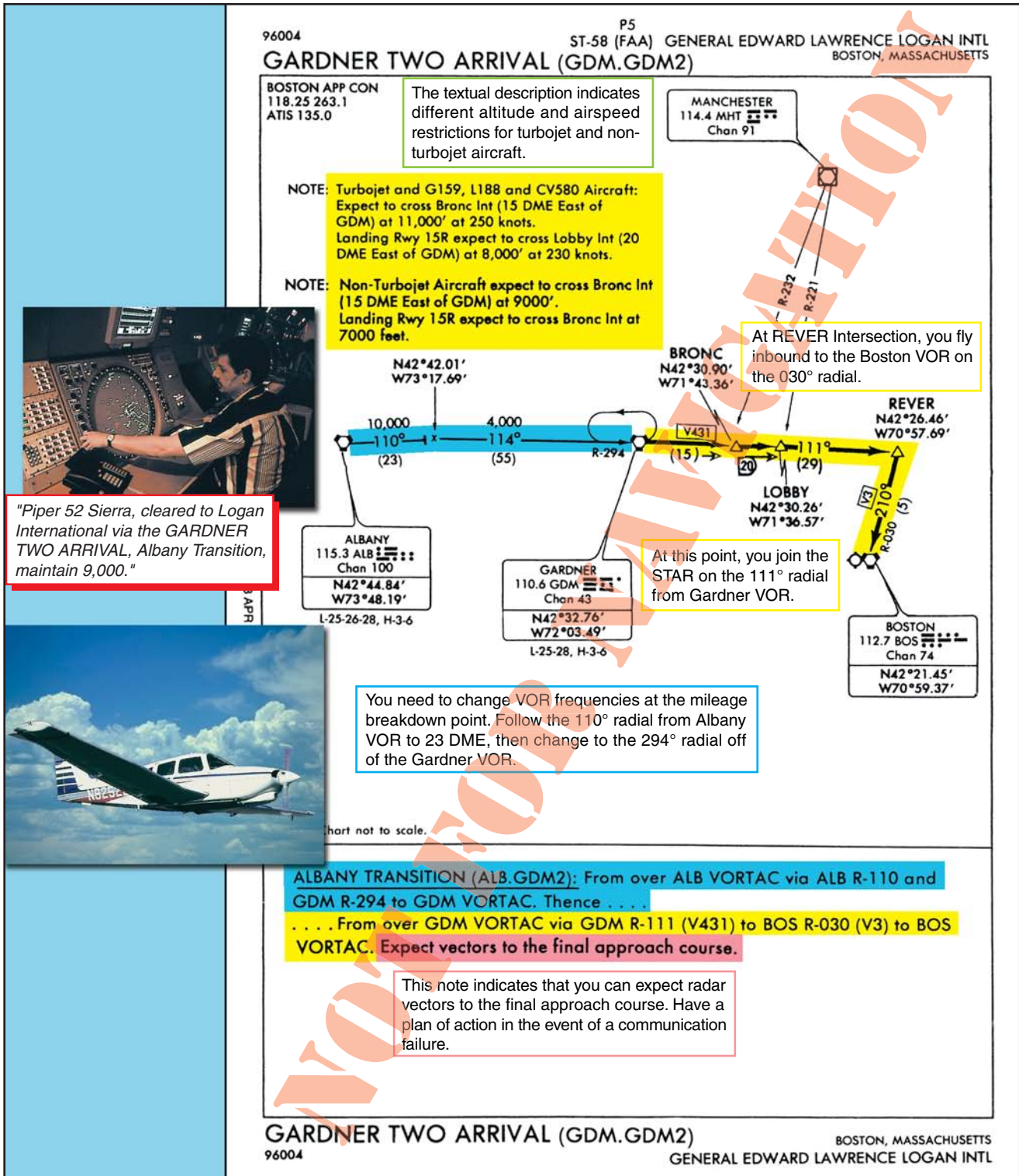


Figure 4-19. Arrival Clearance.

a prolonged hold or increased headwinds have not cut into your fuel reserves because there is always a chance you will have to make a missed approach or go to an alternate. By completing landing checklists early, you free yourself to concentrate on the approach.

In setting up for the expected approach procedure when using an RNAV, GPS, or FMS system, it is important to understand how multiple approaches to

the same runway are coded in the database. When more than one RNAV procedure is issued for the same runway, there must be a way to differentiate between them within the equipment's database, as well as to select which procedure you want to use. (Multiple procedures may exist to accommodate GPS receivers and FMSs, both with and without VNAV capability.) Each procedure name incorporates a letter of the alphabet, starting with Z and working backward through Y, X, W, and so

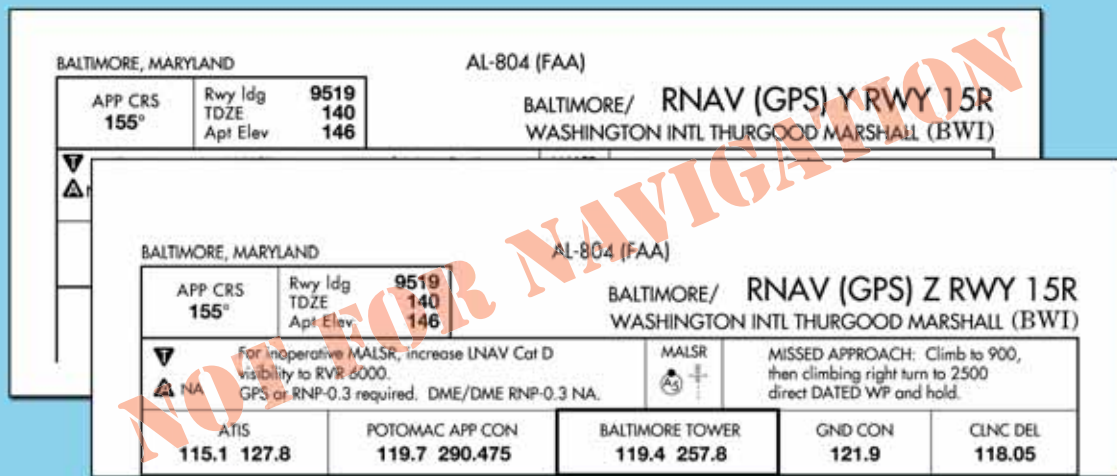


Figure 4-20. Here are two RNAV (GPS) approaches to Runway 15R at Baltimore. A controller issuing a clearance for one of these approaches would speak the identifying letter—for example, "...cleared for the RNAV (GPS) Yankee approach, Runway 15R..."

on. (Naming conventions for approaches are covered in more depth in the next chapter.) [Figure 4-20]

### ALTITUDE

Upon your arrival in the terminal area, ATC either clears you to a specific altitude, or they give you a

"descend via" clearance that instructs you to follow the altitudes published on the STAR. [Figure 4-21 ] You are not authorized to leave your last assigned altitude unless specifically cleared to do so. If ATC amends the altitude or route to one that is different from the published procedure, the rest of the charted

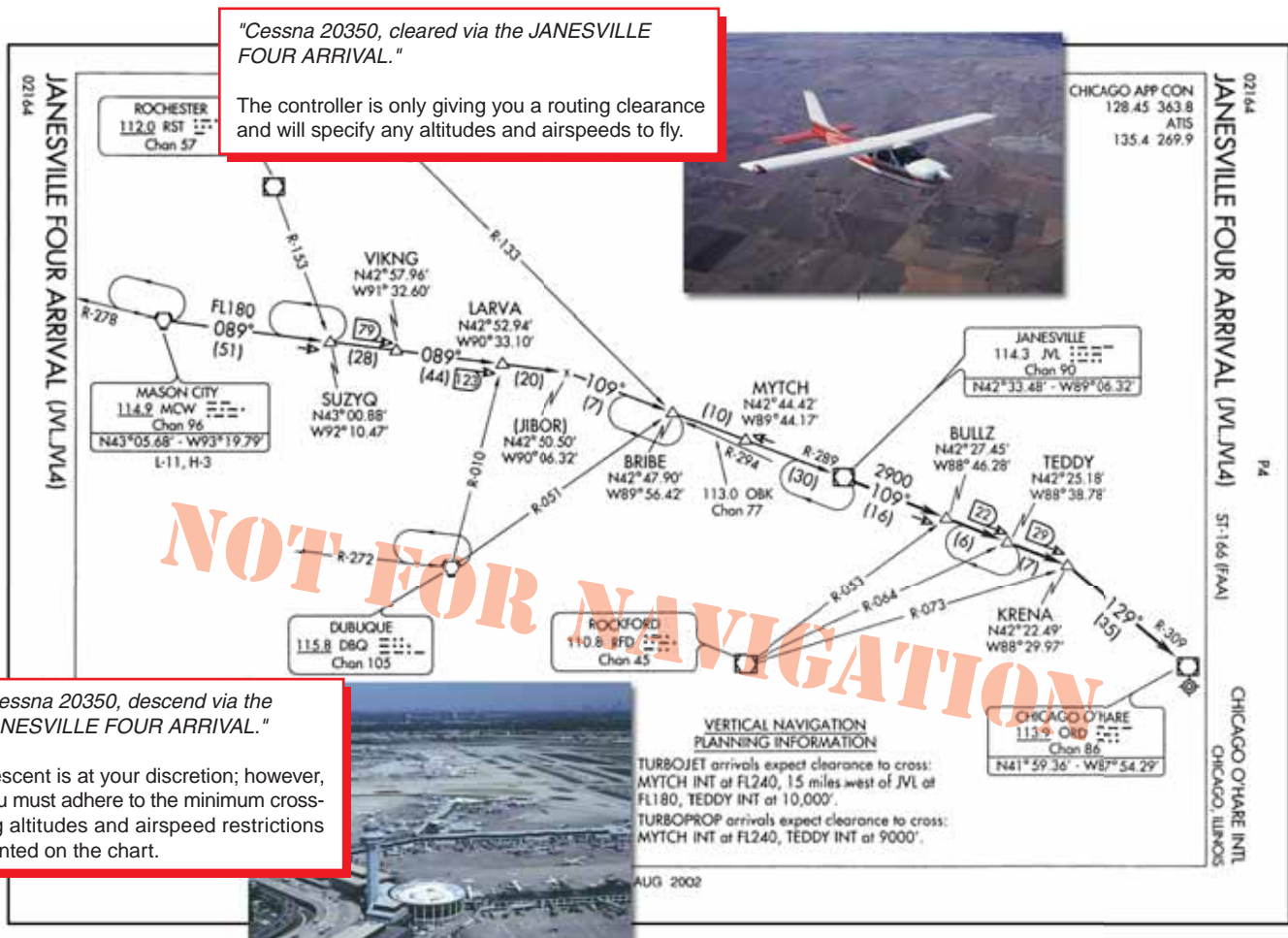


Figure 4-21. Assigned Altitudes.

descent procedure is canceled. ATC will assign you any further route, altitude, or airspeed clearances, as necessary. Notice the JANESVILLE FOUR ARRIVAL depicts only one published arrival route, with no named transition routes leading to the basic STAR procedure beginning at the Janesville VOR/DME. Vertical navigation planning information is included for turbojet and turboprop airplanes at the bottom of the chart. Additionally, note that there are several ways to identify the BRIBE reporting point using alternate formation radials, some of which are from off-chart NAVAIDS. ATC may issue a descent clearance that includes a crossing altitude restriction. In the PENNS ONE ARRIVAL, the ATC clearance authorizes you to descend at your discretion, as long as you cross the PENNS Intersection at 6,000 feet MSL. [Figure 4-22]

In the United States, Canada, and many other countries, the common altitude for changing to the standard altimeter setting of 29.92 inches of mercury (or 1013.2 hectopascals or millibars) when climbing to the high altitude structure is 18,000 feet. When descending from high altitude, the altimeter should be changed to the local altimeter setting when passing through FL 180, although in most countries throughout the world the change to or from the standard altimeter setting is not done at the same altitude for each instance.

For example, the flight level where you change your altimeter setting to the local altimeter setting is specified by ATC each time you arrive at a specific airport. This information is shown on STAR charts outside the U.S. with the words: TRANS LEVEL: BY ATC. When departing from that same airport (also depicted typically on the STAR chart), the altimeter should be set to the standard setting when passing through 5,000 feet, as an example. This means that altimeter readings when flying above 5,000 feet will actually be flight levels, not feet. This is common for Europe, but very different for pilots experienced with flying in the United States and Canada.

### RNAV STARS OR STAR TRANSITIONS

STARs designated RNAV serve the same purpose as conventional STARs, but are only used by aircraft equipped with FMS or GPS. An RNAV STAR or STAR transition typically includes flyby waypoints, with fly-over waypoints used only when operationally required. These waypoints may be assigned crossing altitudes and speeds to optimize the descent and deceleration profiles. RNAV STARs often are designed, coordinated, and approved by a joint effort between air carriers, commercial operators, and the ATC facilities that have jurisdiction for the affected airspace.

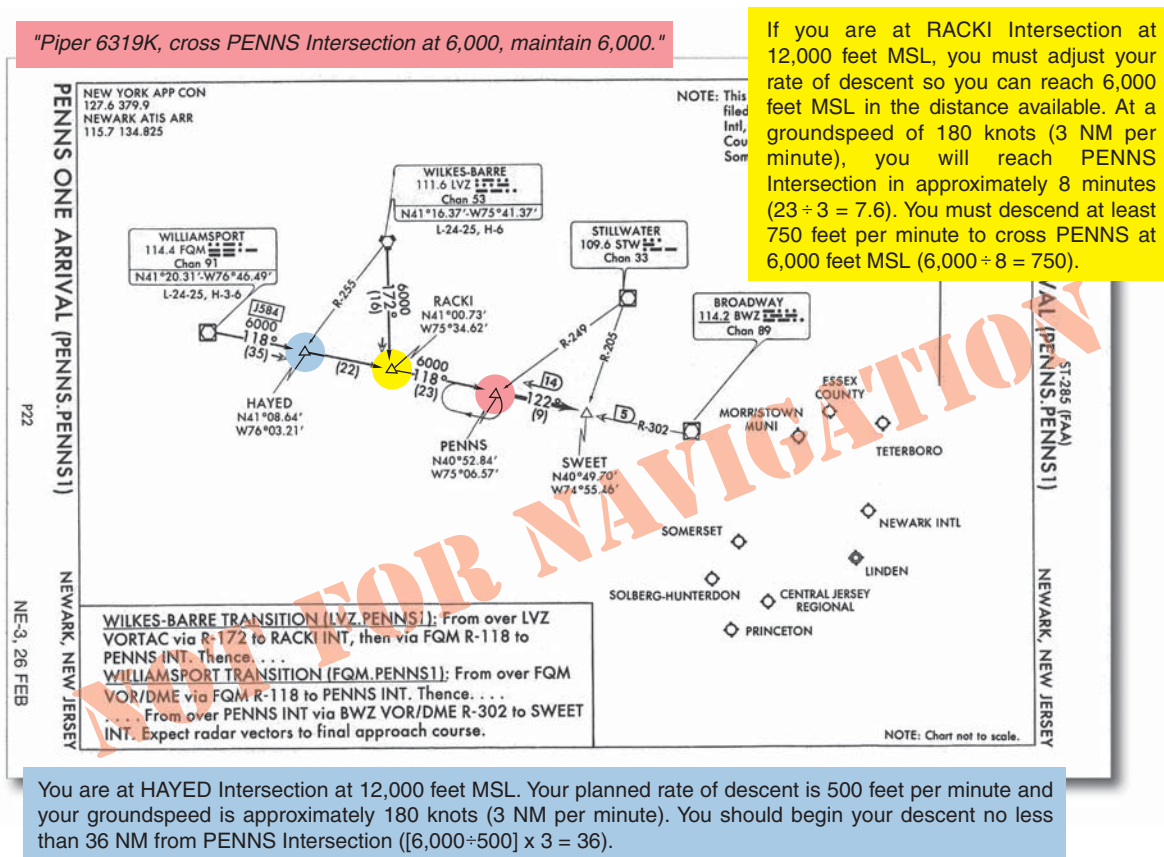


Figure 4-22. Altitude Restrictions.

RNAV STAR procedure design, such as minimum leg length, maximum turn angles, obstacle assessment criteria, including widths of the primary and secondary areas, use the same design criteria as RNAV DPs. Likewise, RNAV STAR procedures are designated as either Type A or Type B, based on the aircraft navigation equipment required, flight crew procedures, and the process and criteria used to develop the STAR. The Type A or Type B designation appears in the notes on the chart. Type B STARs have higher equipment requirements and, often, tighter RNP tolerances than Type A. For Type B STARs, pilots are required to use a CDI/flight director, and/or autopilot in LNAV mode while operating on RNAV courses. (These requirements are detailed in Chapter 2 of this book, under “RNAV Departure Procedures.”) Type B STARs are generally designated for high-traffic areas. Controllers may clear you to use an RNAV STAR in various ways.

If your clearance simply states, “*cleared Hadly One arrival*,” you are to use the arrival for lateral routing only.

- A clearance such as “*cleared Hadly One arrival, descend and maintain flight level two four zero*,” clears you to descend only to the assigned altitude, and you should maintain that altitude until cleared for further vertical navigation.

- If you are cleared using the phrase “*descend via*,” the controller expects you to use the equipment for both lateral and vertical navigation, as published on the chart.
- The controller may also clear you to use the arrival with specific exceptions—for example, “*Descend via the Haris One arrival, except cross Bruno at one three thousand then maintain one zero thousand*.” In this case, the pilot should track the arrival both laterally and vertically, descending so as to comply with all altitude and airspeed restrictions until reaching Bruno, and then maintain 10,000 feet until cleared by ATC to continue to descend.
- Pilots might also be given direct routing to intercept a STAR and then use it for vertical navigation. For example, “*proceed direct Mahem, descend via the Mahem Two arrival*.”

[Figure 4-23 on page 4-24]

Figure 4-24 on page 4-25 depicts typical RNAV STAR leg (segment) types you can expect to see when flying these procedures.

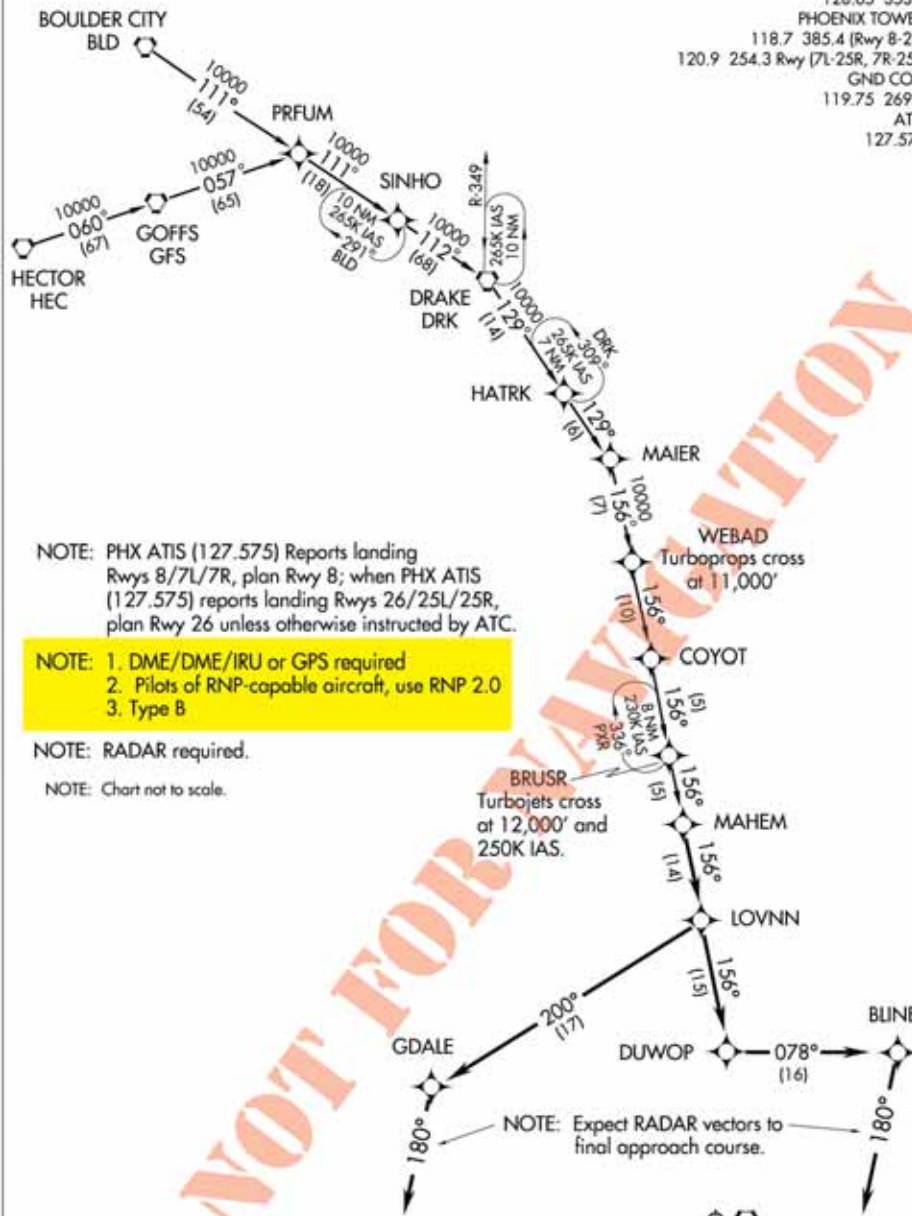
(MAHEM.MAHEM2) 05356

ST-322 (FAA)

### MAHEM TWO ARRIVAL (RNAV)

PHOENIX SKY HARBOR INTL  
PHOENIX, ARIZONA

PHOENIX APP CON  
128.65 353.8  
PHOENIX TOWER  
118.7 385.4 (Rwy 8-26)  
120.9 254.3 Rwy (7L-25R, 7R-25L)  
GND CON  
119.75 269.2  
ATIS  
127.575



NOTE: PHX ATIS (127.575) Reports landing Rwy 8/7L/7R, plan Rwy 8; when PHX ATIS (127.575) reports landing Rwy 26/25L/25R, plan Rwy 26 unless otherwise instructed by ATC.

- NOTE: 1. DME/DME/IRU or GPS required
- 2. Pilots of RNP-capable aircraft, use RNP 2.0
- 3. Type B

NOTE: RADAR required.

NOTE: Chart not to scale.

NOTE: Expect RADAR vectors to final approach course.

(NARRATIVE ON FOLLOWING PAGE)

### MAHEM TWO ARRIVAL (RNAV)

(MAHEM.MAHEM2) 05356

PHOENIX, ARIZONA  
PHOENIX SKY HARBOR INTL

SW-4, 19 JAN 2006 to 16 FEB 2006

SW-4, 19 JAN 2006 to 16 FEB 2006

Figure 4-23. The notes show that this is a Type B RNAV STAR.



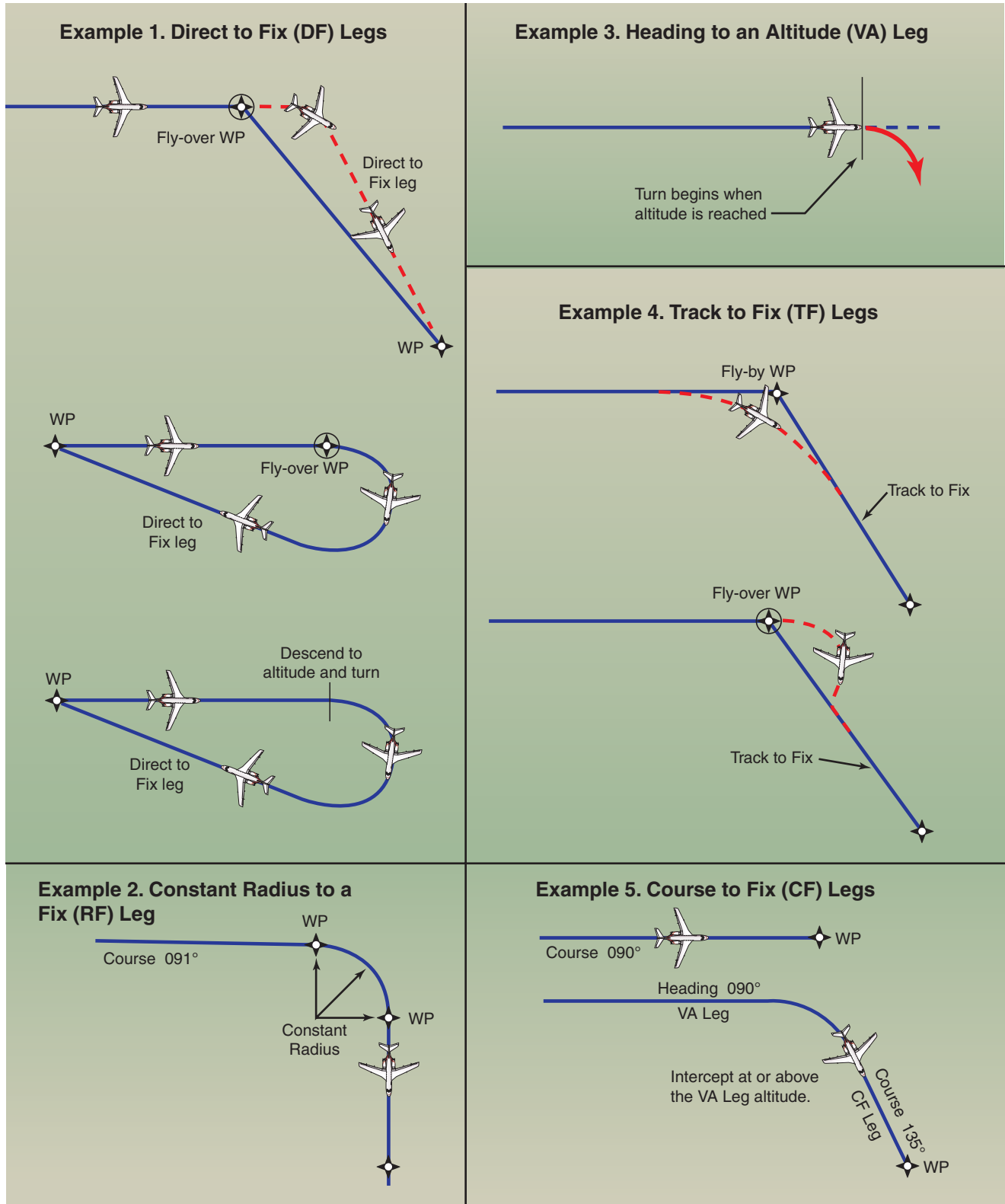


Figure 4-24. RNAV STAR Leg (Segment) Types.

### SPECIAL AIRPORT QUALIFICATION

It is important to note an example of additional resources that are helpful for arrivals, especially into unfamiliar airports requiring special pilot or navigation qualifications. The operating rules governing domestic and flag air carriers require pilots in command to be qualified over the routes and into airports where scheduled operations are conducted, including areas, routes,

and airports in which special pilot qualifications or special navigation qualifications are needed. For Part 119 certificate holders who conduct operations under Parts 121.443, there are provisions in OpsSpecs under which operators can comply with this regulation. The following are examples of special airports in the U.S, along with associated comments:

<b>SPECIAL AIRPORTS</b>	<b>COMMENTS</b>
Kodiak, AK	Airport is surrounded by mountainous terrain. Any go-around beyond ILS or GCA MAP will not provide obstruction clearance.
Petersburg, AK	Mountainous terrain in immediate vicinity of airport, all quadrants.
Cape Newenham AFS, AK	Runway located on mountain slope with high gradient factor; nonstandard instrument approach.
Washington, DC (National)	Special arrival/departure procedures.
Shenandoah Valley, VA (Stanton-Waynesboro-Harrisonburg)	Mountainous terrain.
Aspen, CO	High terrain; special procedures.
Gunnison, CO	VOR only; uncontrolled; numerous obstructions in airport area; complex departure procedures.
Missoula, MT	Mountainous terrain; special procedures.
Jackson Hole, WY	Mountainous terrain; all quadrants; complex departure procedures.
Hailey, ID (Friedman Memorial)	Mountainous terrain; special arrival/departure procedures.
Hayden, Yampa Valley, CO	Mountainous terrain; no control tower; special engine-out procedures for certain large airplanes.
Lihue, Kauai, HI	High terrain; mountainous to 2,300 feet within 3 miles of the localizer.
Ontario, CA	Mountainous terrain and extremely limited visibility in haze conditions.