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. You will be advised as to what the vector is to achieve when the vector is controller initiated and will take 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 the **approach gate**. The approach gate is an imaginary point used by ATC to vector aircraft to

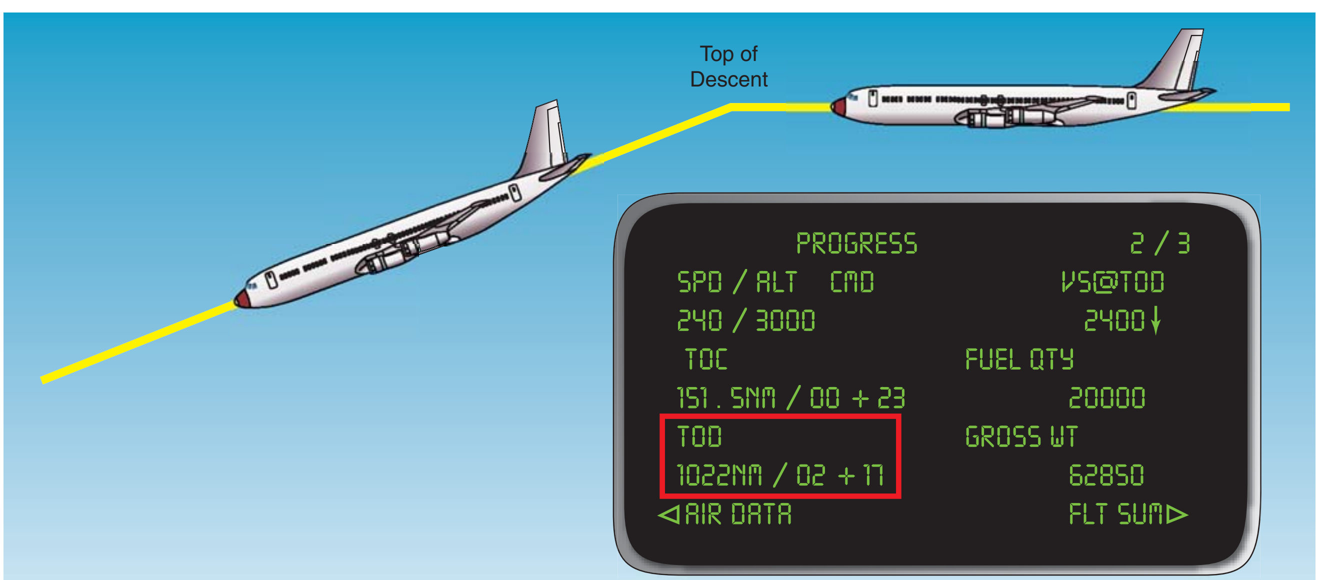


Figure 4-1. Top of Descent and FMS Display.

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.

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. 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 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.

1 2 3 4

.80/280 5

Press Alt - 1000 Ft	Time - Min	Fuel - Lbs	Dist - NAM
39	20	850	124
37	19	800	112
35	18	700	101
33	17	650	92
31	16	600	86
29	15	600	80
27	14	550	74
25	13	550	68
23	12	500	63
21	11	500	58
19	10	450	52
17	10	450	46
15	9	400	41
10	6	300	26
5	3	150	13

Note: Subtract 30 lb. of fuel and 36 seconds for each 1,000 feet that the destination airport is above sea level.

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. Suppose your cruising altitude is

17,500 feet and you must descend to the approach gate altitude for the destination airport. [Figure 4-3] Assume an approach gate altitude of 2,950 feet. In this example, you would begin your descent 14 minutes and 50 NM from your destination. Figure 4-4 includes another example of a descent planning chart. Notice in this case that 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

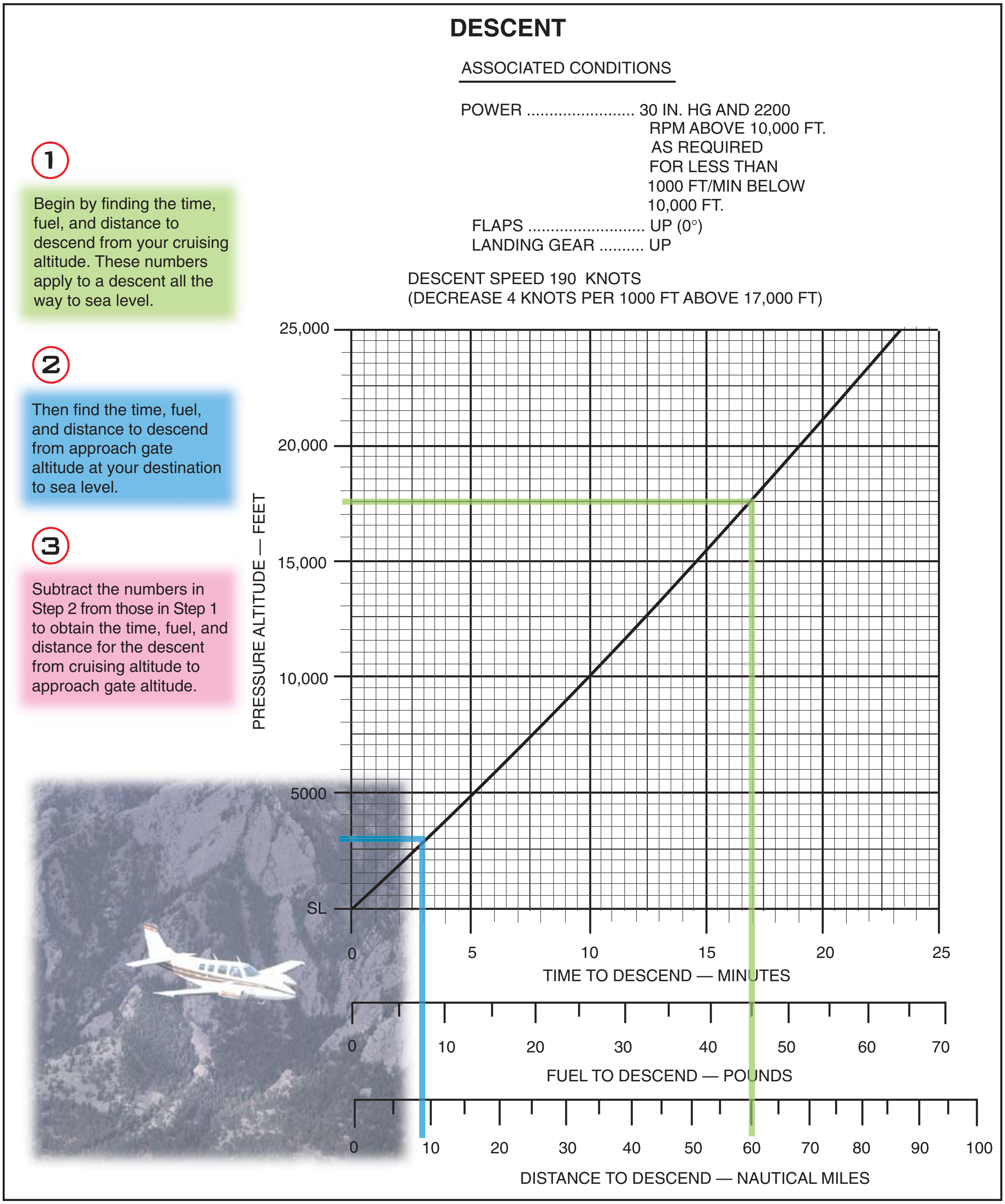


Figure 4-3. Descent Planning.

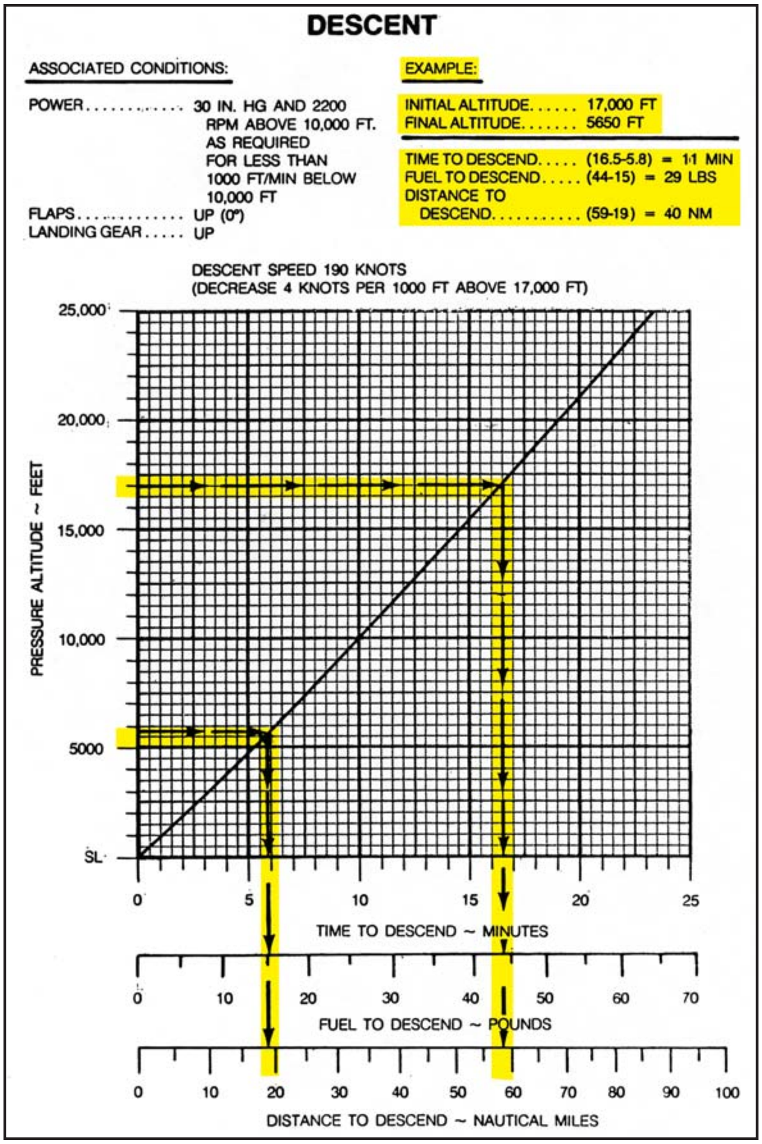


Figure 4-4. Descent Planning Chart.

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 4-5]

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, reading checklists, all of which can be distracting. By planning your descent in advance, you reduce the workload required of you during this phase of flight, which is smart workload management. [Figure 4-6] 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.

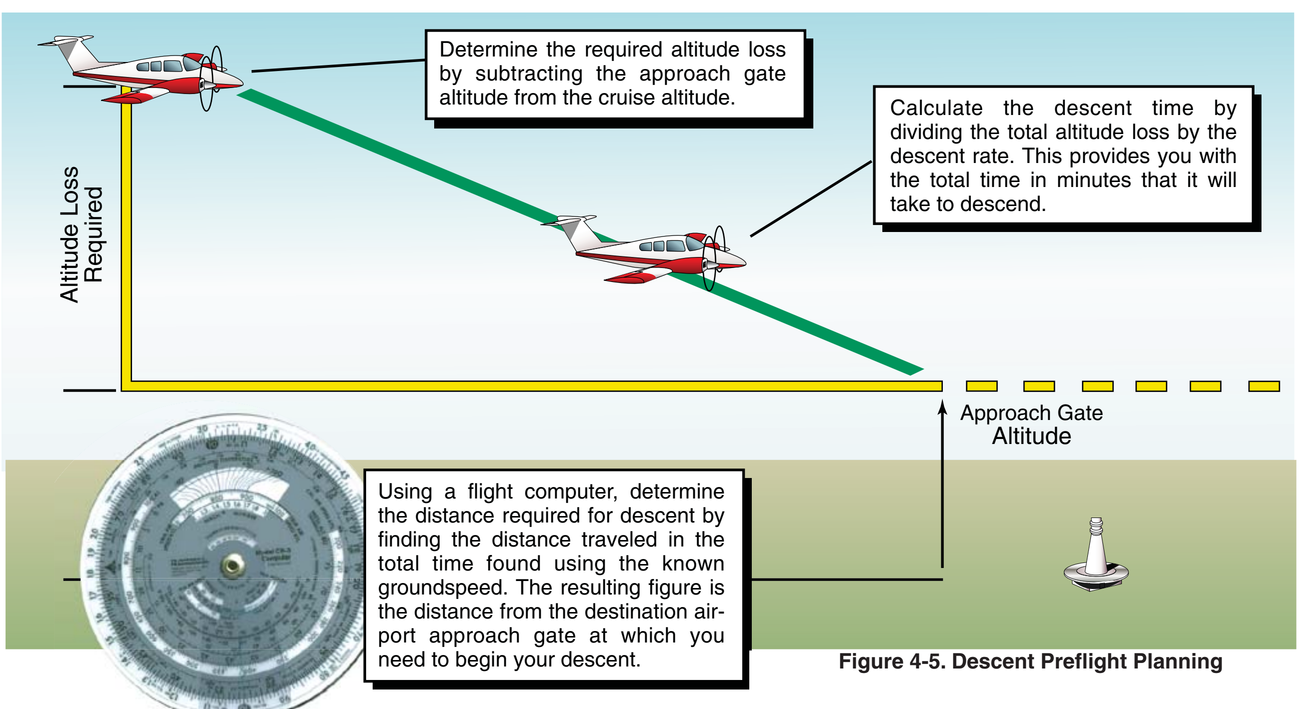


Figure 4-5. Descent Preflight Planning

- 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.

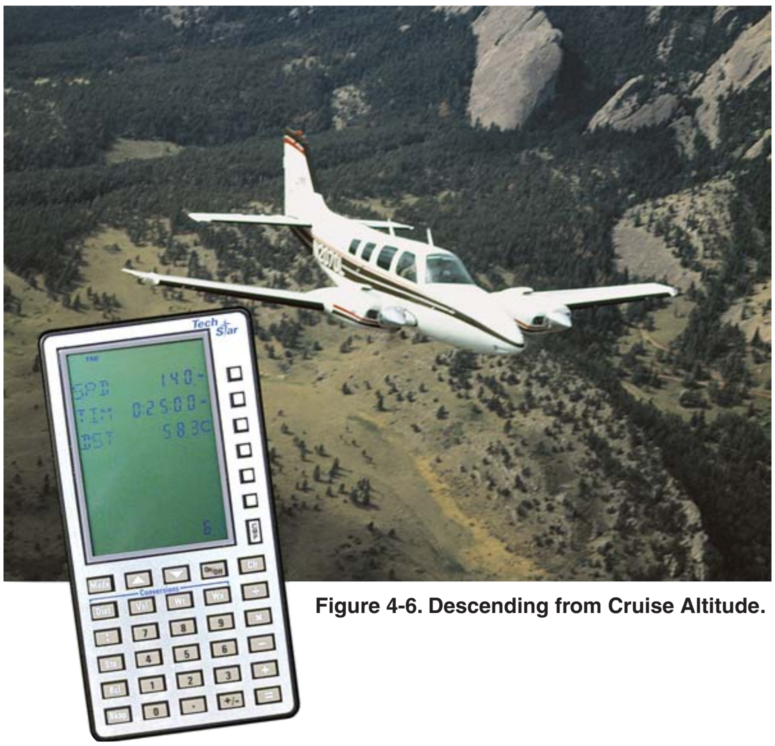


Figure 4-6. Descending from Cruise Altitude.

CLEARED FOR APPROACH

Assume you are flying en route northwest bound on Victor 187 preparing for arrival at Great Falls International Airport as depicted in figure 4-7 (which shows en route and approach chart excerpts). The Great Falls VHF omnidirectional range/tactical air navigation (VORTAC) serves as the initial approach fix for the very high frequency omnidirectional range (VOR) runway 03 approach. Center gives you the altimeter setting, and clears you as follows: *"Gulfstream 5732S, expect VOR Runway 03 approach, Great Falls International. Contact Great Falls Approach on 128.6."* Approximately 20 NM from the VOR, Great Falls Approach clears you as follows: *"Gulfstream 5732S, cleared to the Great Falls VOR, cleared for the VOR Runway 03 approach, contact Great Falls Tower on 118.7 established inbound."* When cleared for an instrument approach, you can legally commence a descent to the minimum altitude for the segment of the approach on which you are located. Since you are still in the en route phase of flight, you would leave your last assigned altitude for the minimum en route altitude (MEA) or minimum obstruction clearance altitude (MOCA) shown on the airway, then maintain that until established on a segment of the approach depicted on the approach chart. In the figure 4-7 en route chart illustration, refer to the MEA of 11,000 and the MOCA of 10,300. Both the MEA and MOCA provide the same obstruction clearance. The only difference is that radio navigation signal coverage is provided along the entire airway segment at the MEA, but the MOCA provides radio navigation signal coverage only within 22 NM of the VOR. This means that when cleared for the approach while still on the airway, you can descend from the MEA to the MOCA when within 22 NM from the Great Falls VORTAC.

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.

RADAR OUT OF SERVICE

If a pilot left the airway structure upon arrival, the radar is out of service, and the aircraft is established on a terminal route transition for the approach, what altitude should be used? Whenever it is necessary or just convenient to leave the airway and proceed from the en route phase into the intermediate phase for an instrument approach, transitions from the IAF are used. What are the minimum altitudes for these transitions? The minimum altitudes are for the specific transition only, and are treated as MEAs. In figure 4-7, if positioned on the Great Falls (GTF) 7 distance measuring equipment (DME) arc southeast of the VOR, the pilot would maintain the minimum altitude of 6,000 feet MSL until the next segment of the approach.

PRESENT POSITION DIRECT

Looking at figures 4-8 and 4-9, 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.

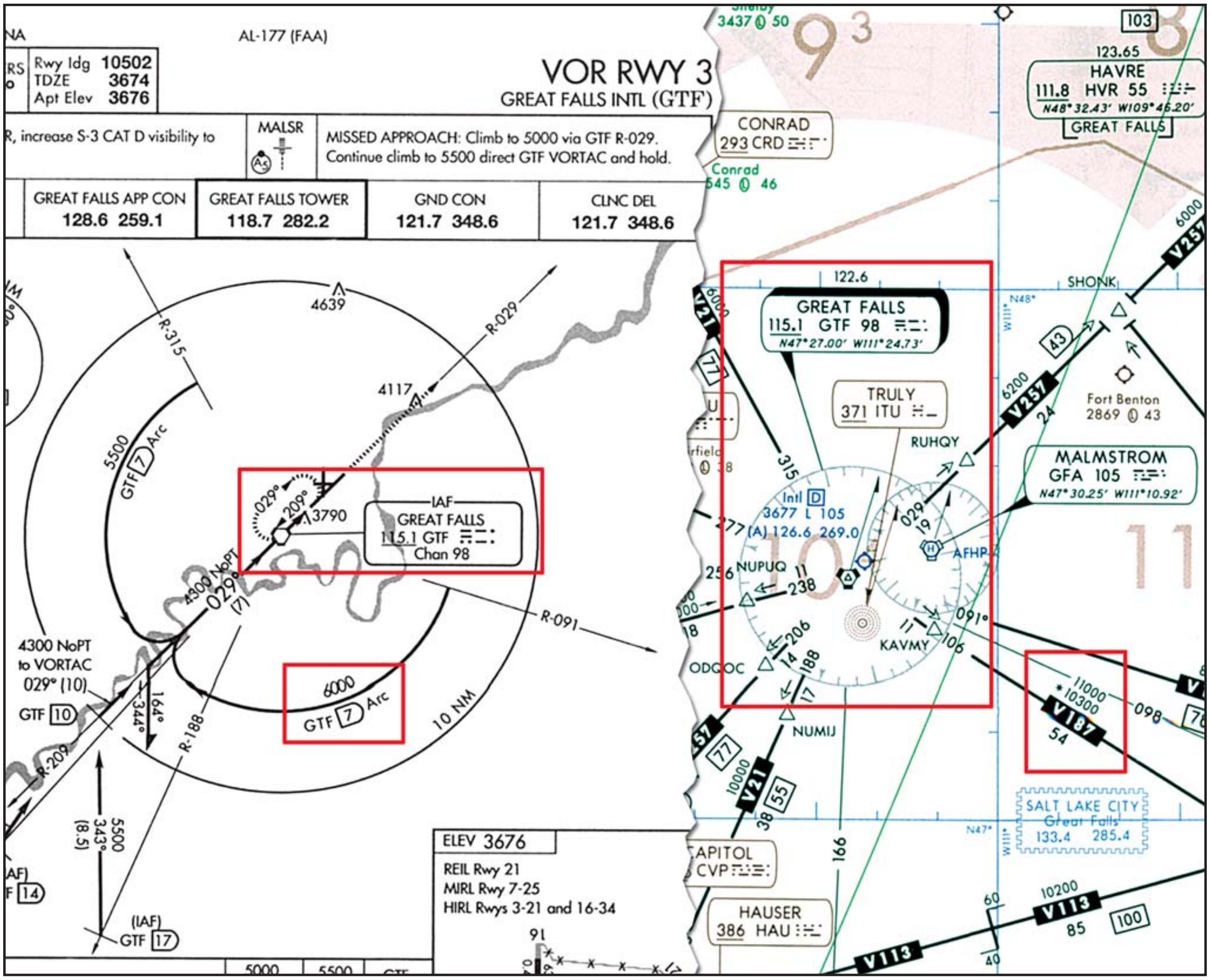


Figure 4-7. Cleared for the Great Falls VOR Approach.

In figure 4-8, 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 4-9, after passing the beacon outbound, commence your descent to 2,000 feet for the course reversal.

It is in circumstances like this that you may be tempted to use the minimum safe altitude (MSA) shown in the planview, although the MSA is for emergency use only, and is not an operational altitude unless you are specifically cleared to that altitude. 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. To be "**established**" means to be stable or fixed on a route, route segment, altitude, heading, etc.

The International Civil Aviation Organization (ICAO) definition of established is considered as being within half full scale deflection for the ILS and VOR, or within ±5° of the required bearing for the nondirectional radio beacon (NDB). Generally, the controller assigns an altitude compatible with glide slope intercept prior to being cleared for the approach.

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:

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.

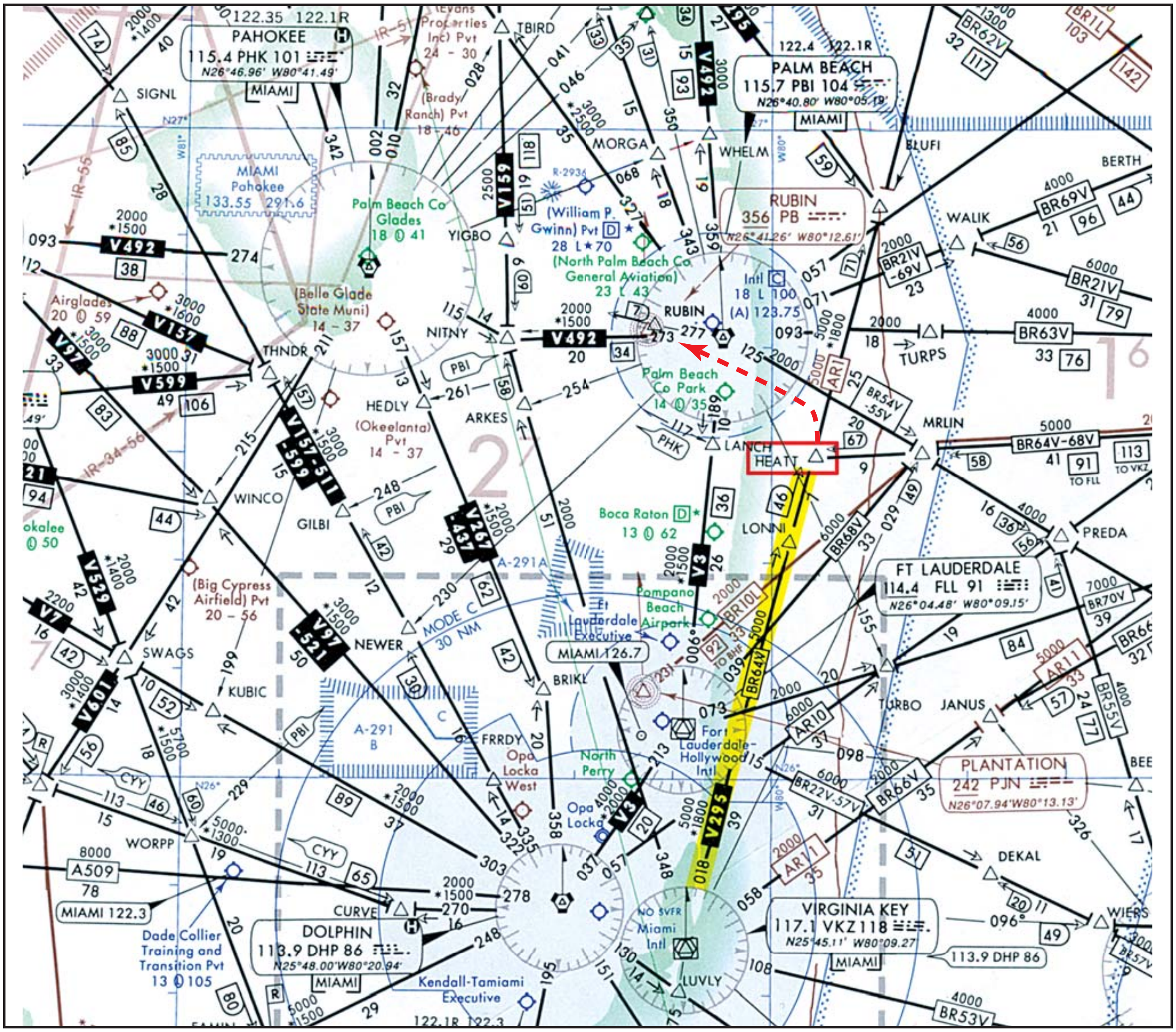


Figure 4-8. Cleared Present Position Direct from V295.

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.

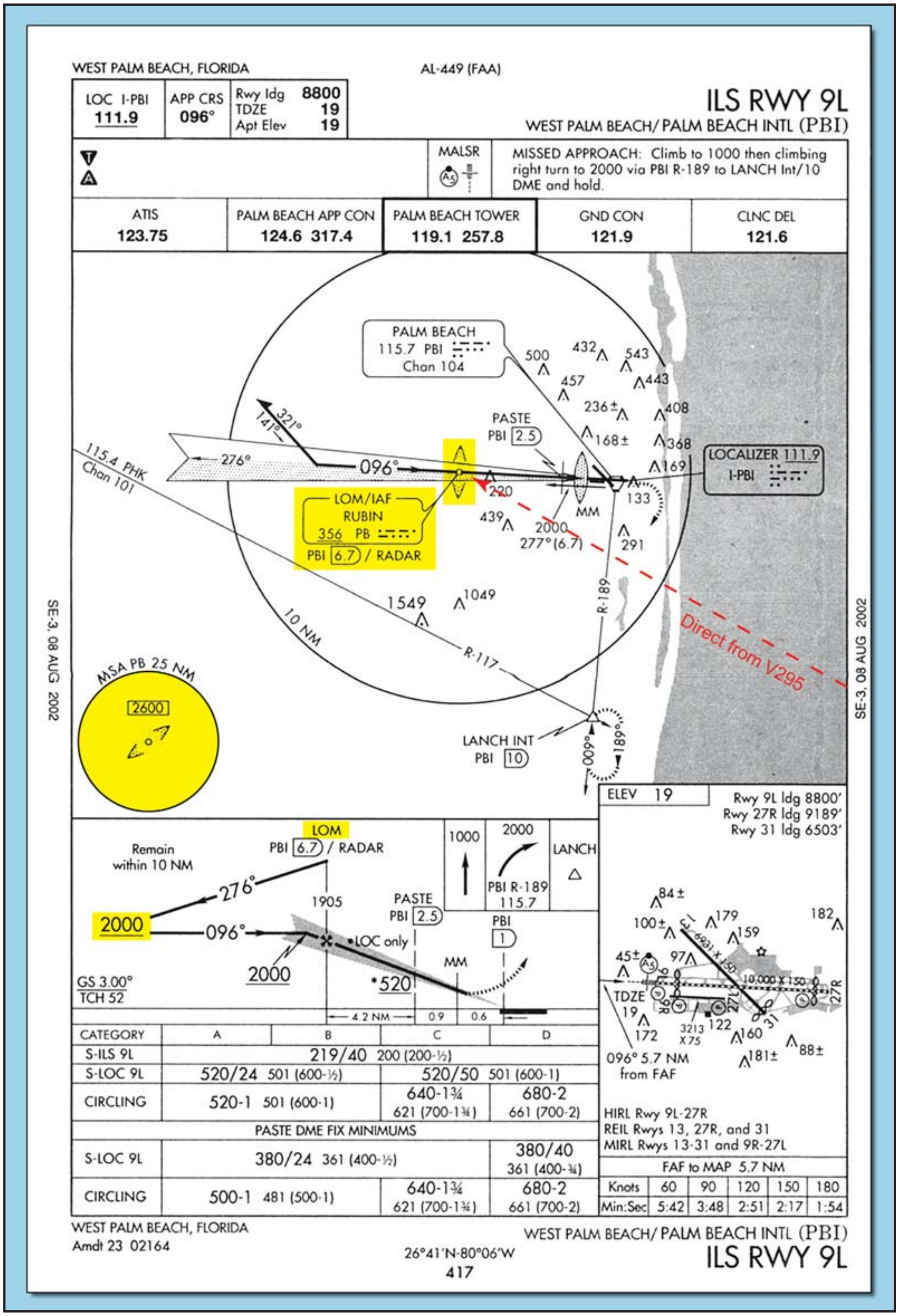
2. Vector to intercept the final approach course if required.

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 4-10.

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; sometimes a route will intersect an extended final approach course making a long intercept desirable.



CATEGORY	A	B	C	D
S-ILS 9L	219/40 200 (200-½)			
S-LOC 9L	520/24 501 (600-½)		520/50 501 (600-1)	
CIRCLING	520-1 501 (600-1)		640-1¾ 621 (700-1¾)	680-2 661 (700-2)
PASTE DME FIX MINIMUMS				
S-LOC 9L	380/24 361 (400-½)			380/40 361 (400-¾)
CIRCLING	500-1 481 (500-1)		640-1¾ 621 (700-1¾)	680-2 661 (700-2)

FAF to MAP 5.7 NM					
Knots	60	90	120	150	180
Min:Sec	5:42	3:48	2:51	2:17	1:54

Figure 4-9. Cleared for the Palm Beach ILS Approach.

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. This procedure is appropriate only when that aircraft, once established, will be on a published segment of the approach procedure.

If a pilot will intercept the localizer, final approach course, or arc prior to a published segment of an approach, the altitude assignment must be stated in a

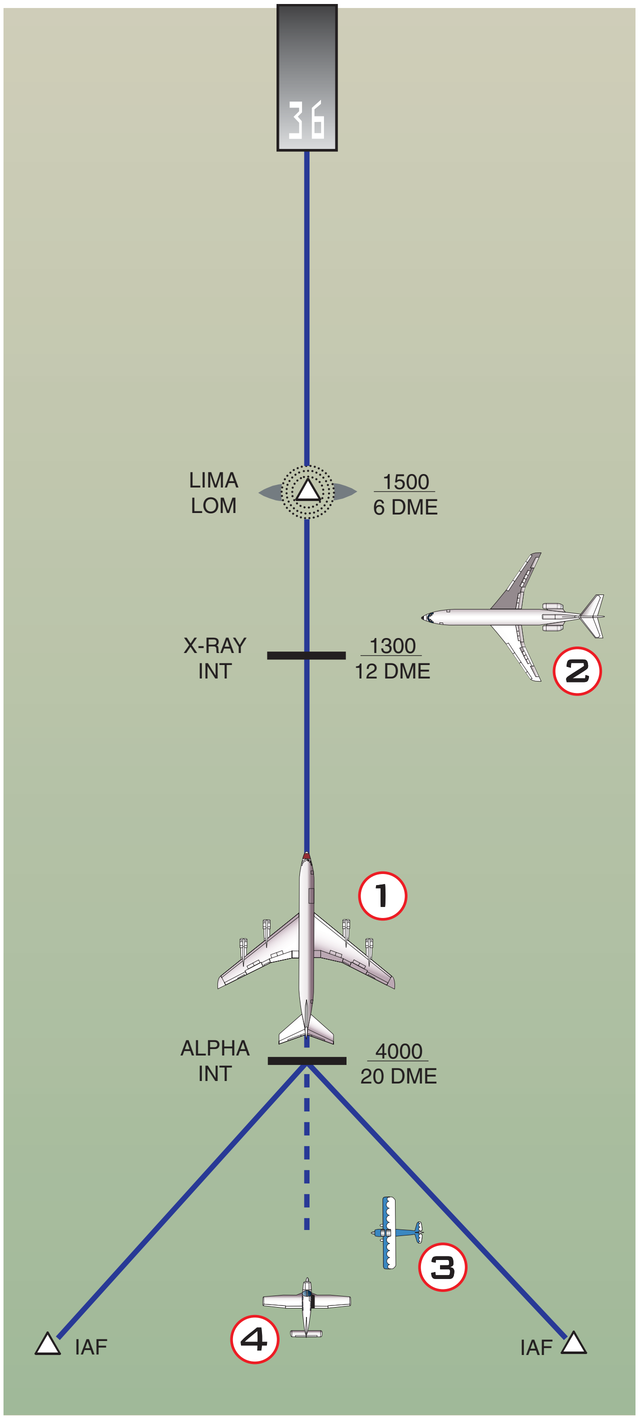


Figure 4-10. Arrival Instructions When Established.

different way. Aircraft 3 provides one example of ATC phraseology for altitude assignment when an aircraft is established on an IAP course prior to a published segment:

Aircraft 3 is being vectored to intercept the final approach course beyond the approach segments, 5 NM from Alpha at 5,000 feet. The minimum vectoring altitude for this area is 4,000 feet. *"Five miles from Alpha. Turn right heading three three zero. Cross Alpha at or above four thousand. Cleared ILS runway three six 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 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 4-11.

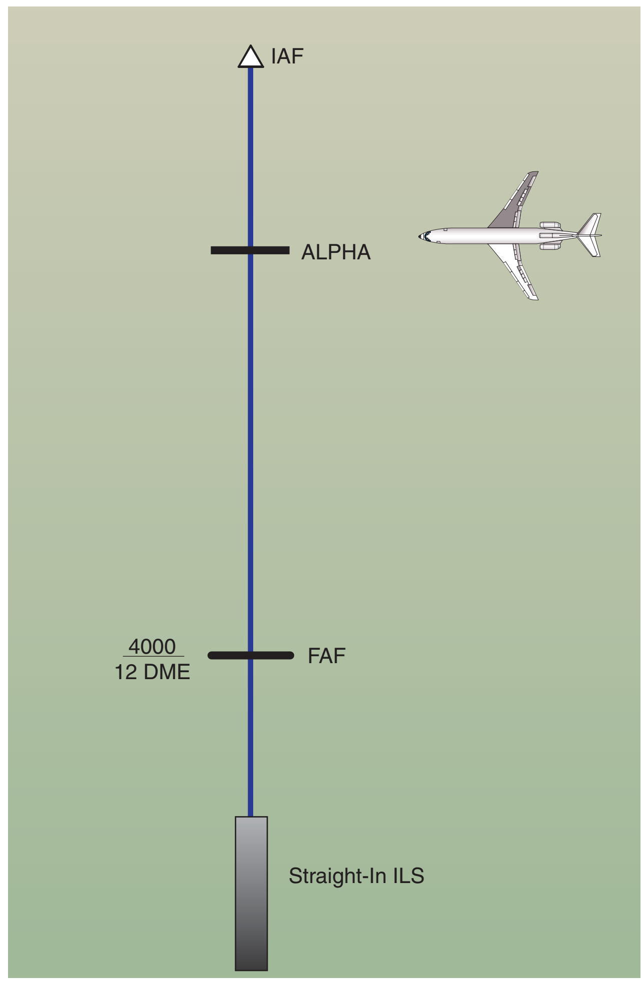


Figure 4-11. Arrival Instructions When Not Established.

The aircraft is being vectored to a published segment of the ILS final approach course, 3 NM from Alpha at 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 4-12,

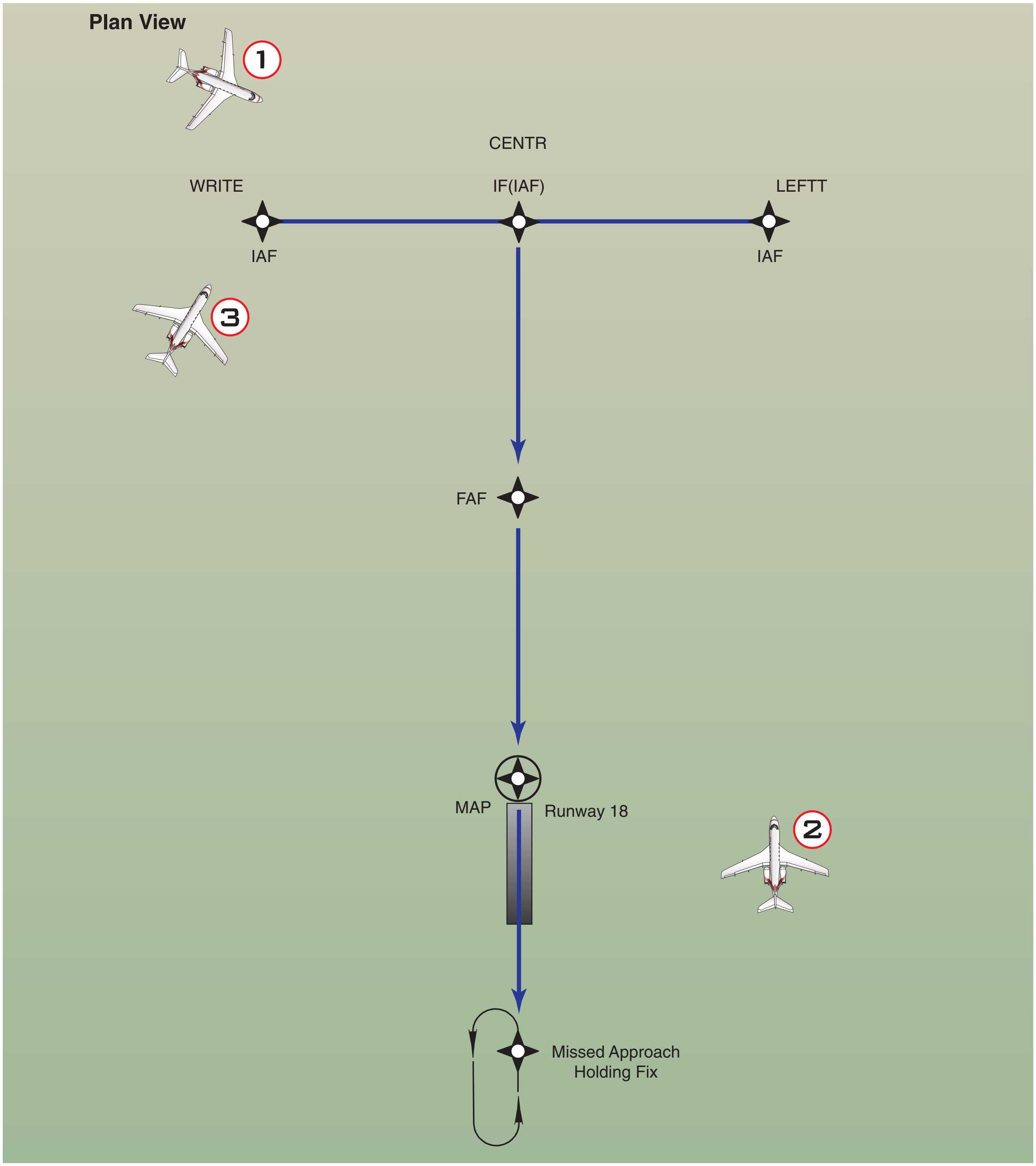


Figure 4-12. Basic "T" Design Terminal Arrival Area.

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."*

For military aircraft, IFR en route descent procedures 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 military low altitude instrument approach procedure does not exceed 500 feet per NM (approximately 5°), and for a high altitude approach, the maximum allowable initial gradient is 1,000 feet per NM (approximately 10°).

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. If 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 turbojet airplanes and all turboprop airplanes over 12,500 pounds. These procedures benefit pilots by reducing fuel consumption and minimizing 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 indicated airspeed 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 within 20 NM of your destination airport, 150 knots is usually the lowest speed you will be assigned. If your aircraft cannot maintain the assigned airspeed, you must advise ATC. In this case, the controller may ask you to maintain the same airspeed as those aircraft ahead of you or behind you on the approach. ATC expects you to maintain the specified airspeed within ±10 knots. At other times, ATC may ask you to increase or decrease your speed by 10 knots, or multiples thereof. When ATC no longer requires the speed adjustment, they 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 higher speed than those prescribed in Part 91.117.

In many countries, there is a standard speed limit of 250 knots indicated air speed (IAS) below 10,000 feet for the entire country. In most countries that standard does not exist for all locations, but the maximum and minimum speed limits can be changed by ATC. In some countries, if you are flying in an airplane that can't go as fast as 160 knots IAS, you must inform ATC immediately.

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

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 knot speed 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 between 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 4-13.

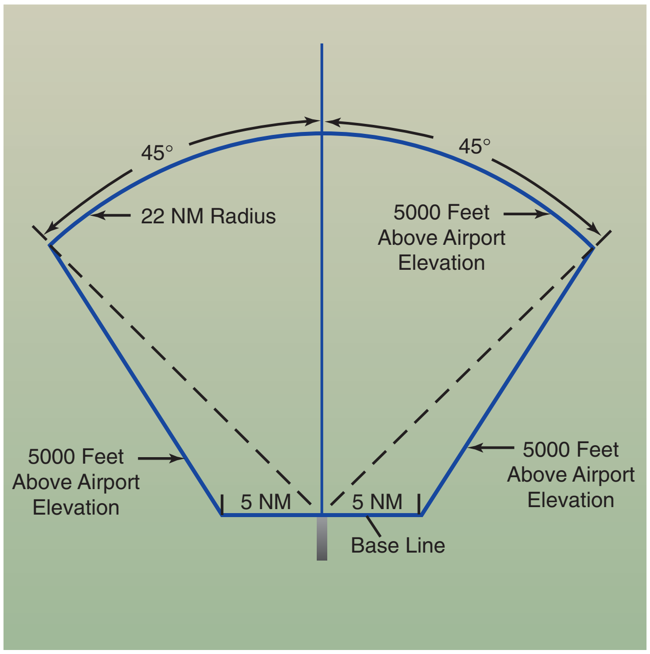


Figure 4-13. Typical Descent Area for Straight-In Approach.

Arrival delays typically are absorbed at a metering fix along an established route prior to entering terminal airspace, at or above 10,000 feet above the airport elevation to facilitate a profile descent, 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 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 radar scope 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 4-14]

STERILE COCKPIT CONCEPT

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 non-safety related 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 which 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.

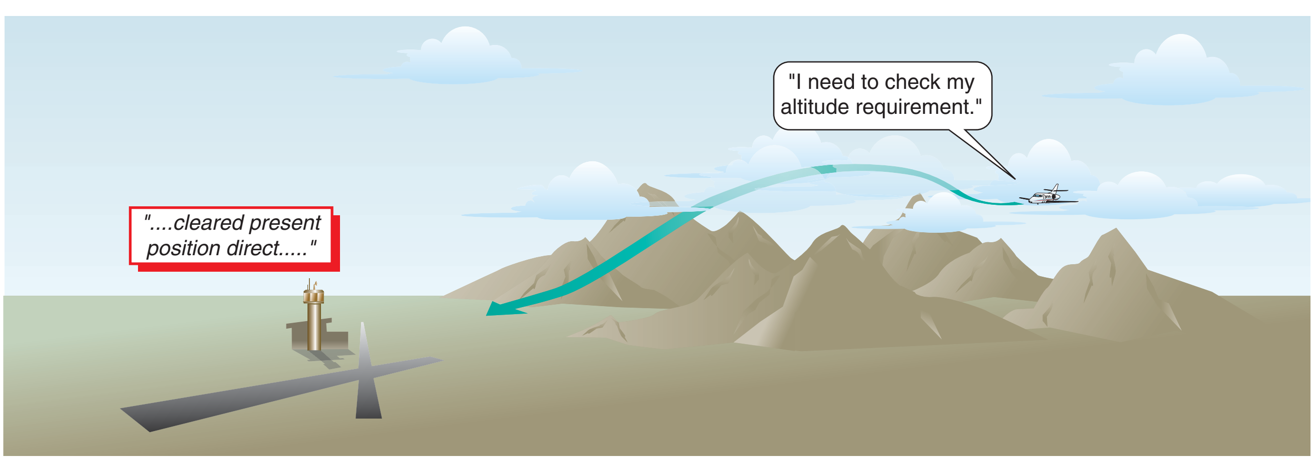


Figure 4-14. Altitude Management When Cleared Direct.

(c) For the purposes of this section, critical phases of flight includes 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.

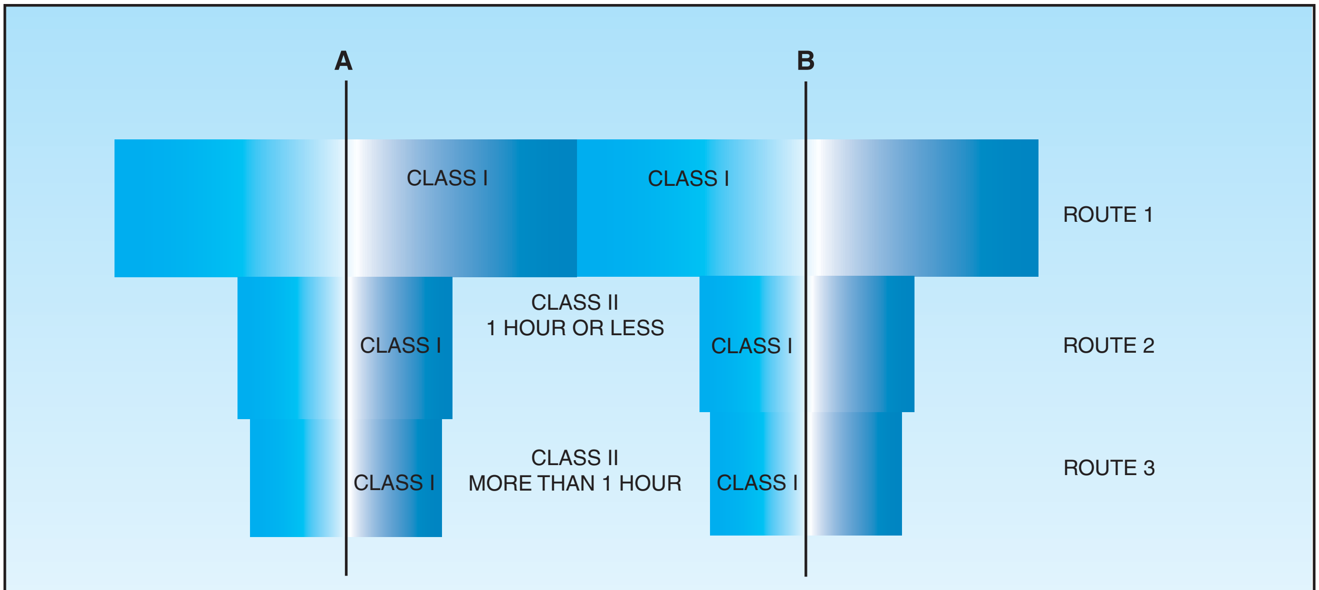
The concept of navigation performance, previously discussed in this book, involves the precision that must be maintained for both the assigned route and altitude. Required levels of navigation performance vary from area to area depending on traffic density and complexity of the routes flown. The level 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 federal aviation 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/DMEs. Class II navigation does not automatically require the use of long-range, specialized navigational systems if special navigational techniques are used to supplement 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), OMEGA, Doppler, and global positioning system (GPS). Figure 4-15 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



NOTE: The area encompassed by the cylinders represents the volume of airspace within the operational service volume (OSV) of ICAO standard NAVAIDs. The altitude of your aircraft with respect to the location of the NAVAID is a primary factor in determining OSV range.

Route 1. Your aircraft navigating from A to B is conducting Class I navigation because you remain within the OSV of ICAO standard NAVAIDs during your entire flight.

Route 2. Your aircraft navigating from A to B is conducting Class I navigation while within the OSV of the NAVAIDs. You are conducting Class II navigation during the portion of your route outside the OSV of the NAVAIDs. Because the duration of the Class II navigation is 1 hour or less, long-range navigation equipment or a flight navigator may not be required.

Route 3. Your aircraft navigating from A to B is conducting Class I navigation while within the OSV of the NAVAIDs. You are conducting Class II navigation when outside the OSV of the NAVAIDs. The duration of the Class II navigation is more than 1 hour. Therefore, long-range navigation equipment or a flight navigator is required.

Figure 4-15. Class I and II Navigation.

method for departing 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 4-16]

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°. Below 10,000 feet MSL the maximum descent rate is 330 feet per NM, or approximately 3.1°. In addition to

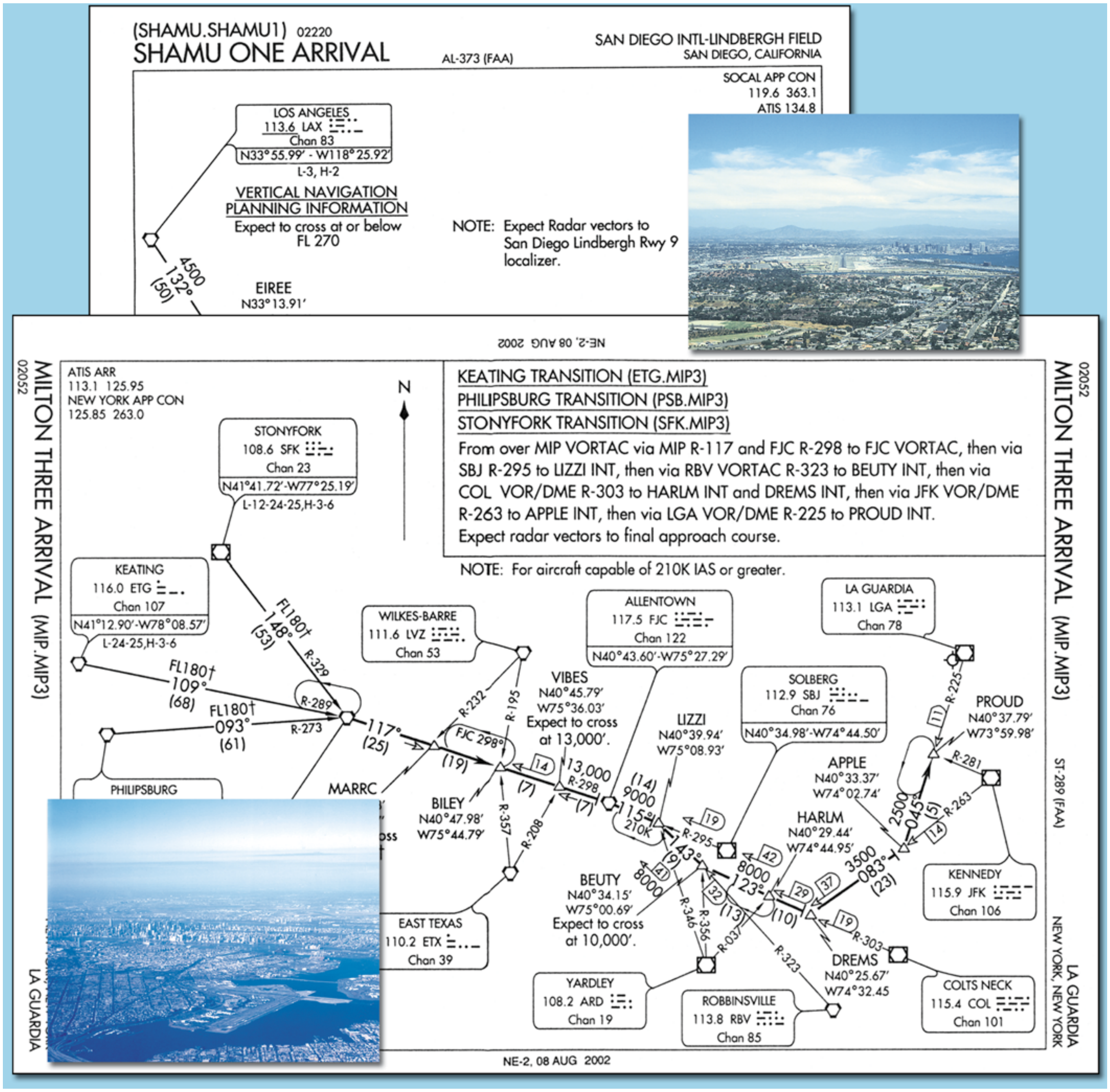


Figure 4-16. Arrival Charts.

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 4-17: *"Cessna 32G, cleared to the Seattle/Tacoma International Airport as filed. Maintain 12,000. At the Ephrata VOR intercept the 221° radial to CHINS*

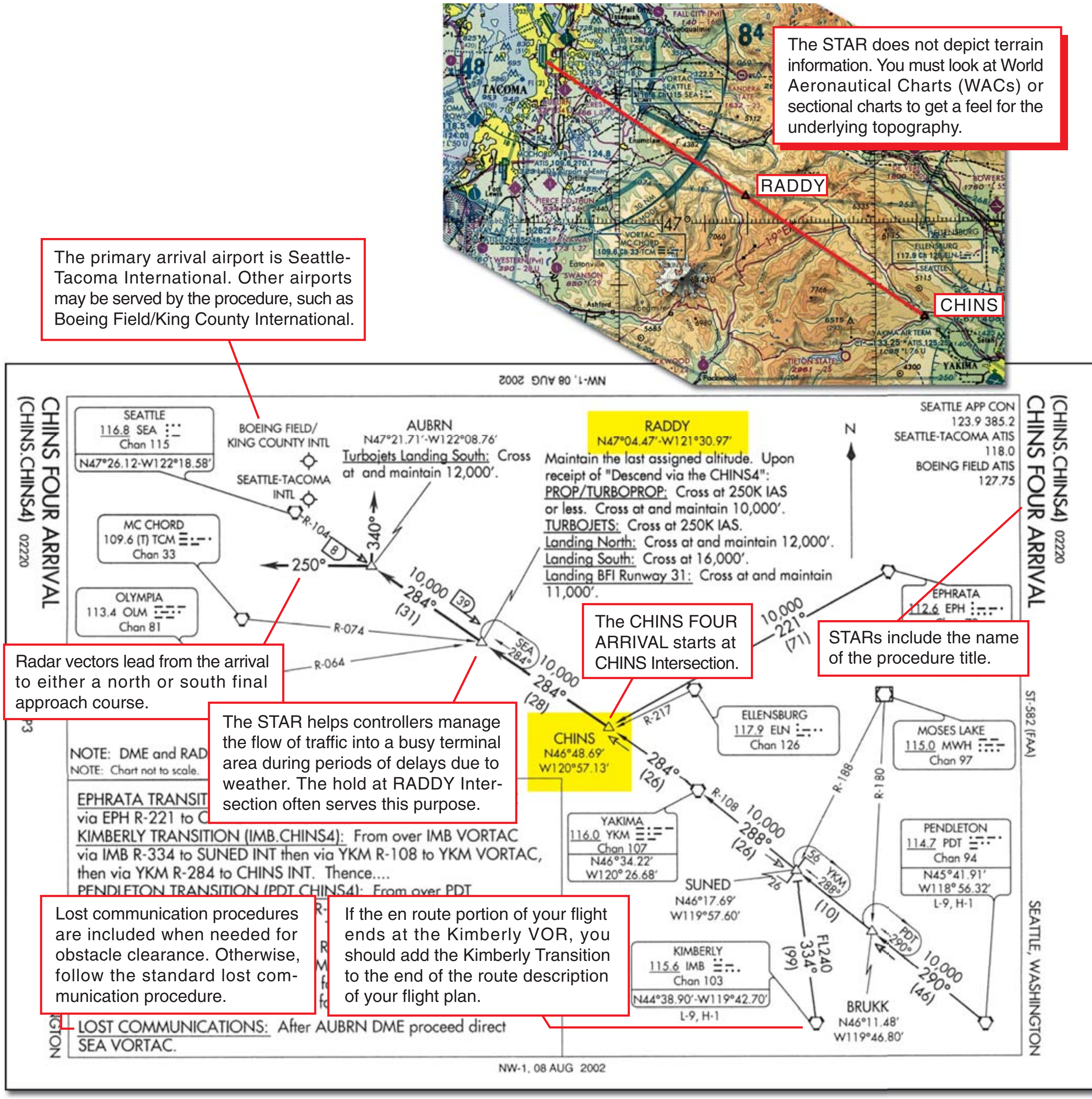


Figure 4-17. STAR Interpretation.

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, 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 4-18]

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.

Studying the STARs for an airport may allow you to perceive the specific topography of the area. Note the initial fixes and where they correspond to fixes on the NACO en route or area chart. Arrivals may incorporate stepdown 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 4-19 by referring to the legend at the beginning of the NACO *Terminal Procedures Publication*.

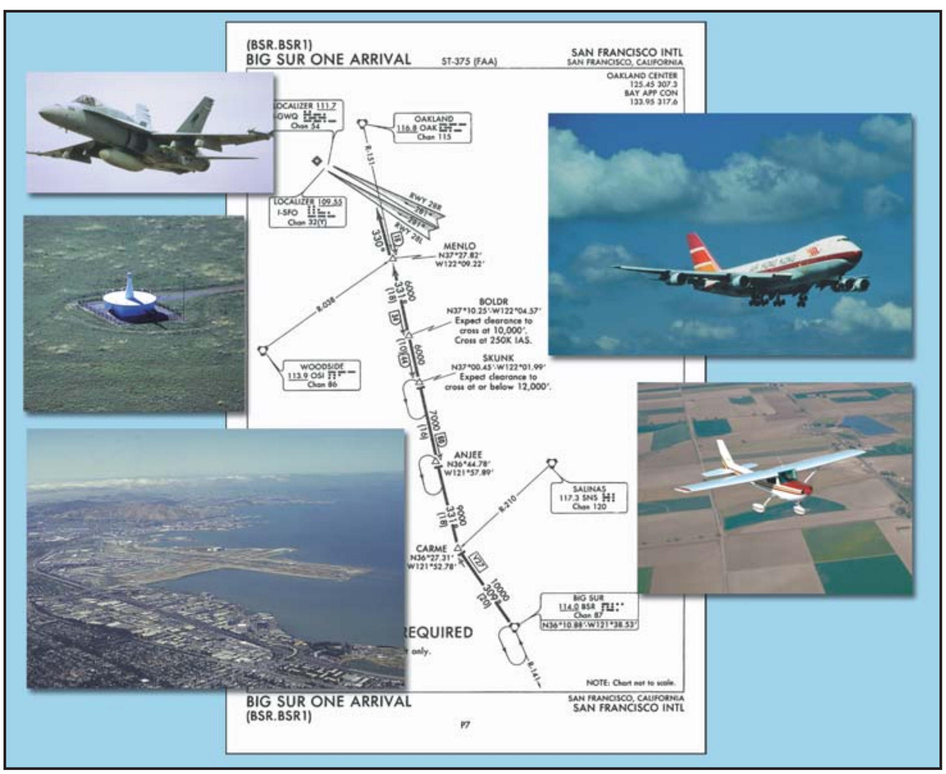


Figure 4-18. Reducing Pilot/Controller Workload.

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. The vertical navigation planning information from the RAMMS THREE ARRIVAL at Denver, Colorado, is used by pilots of larger and faster airplanes to plan their descents. [Figure 4-20]

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

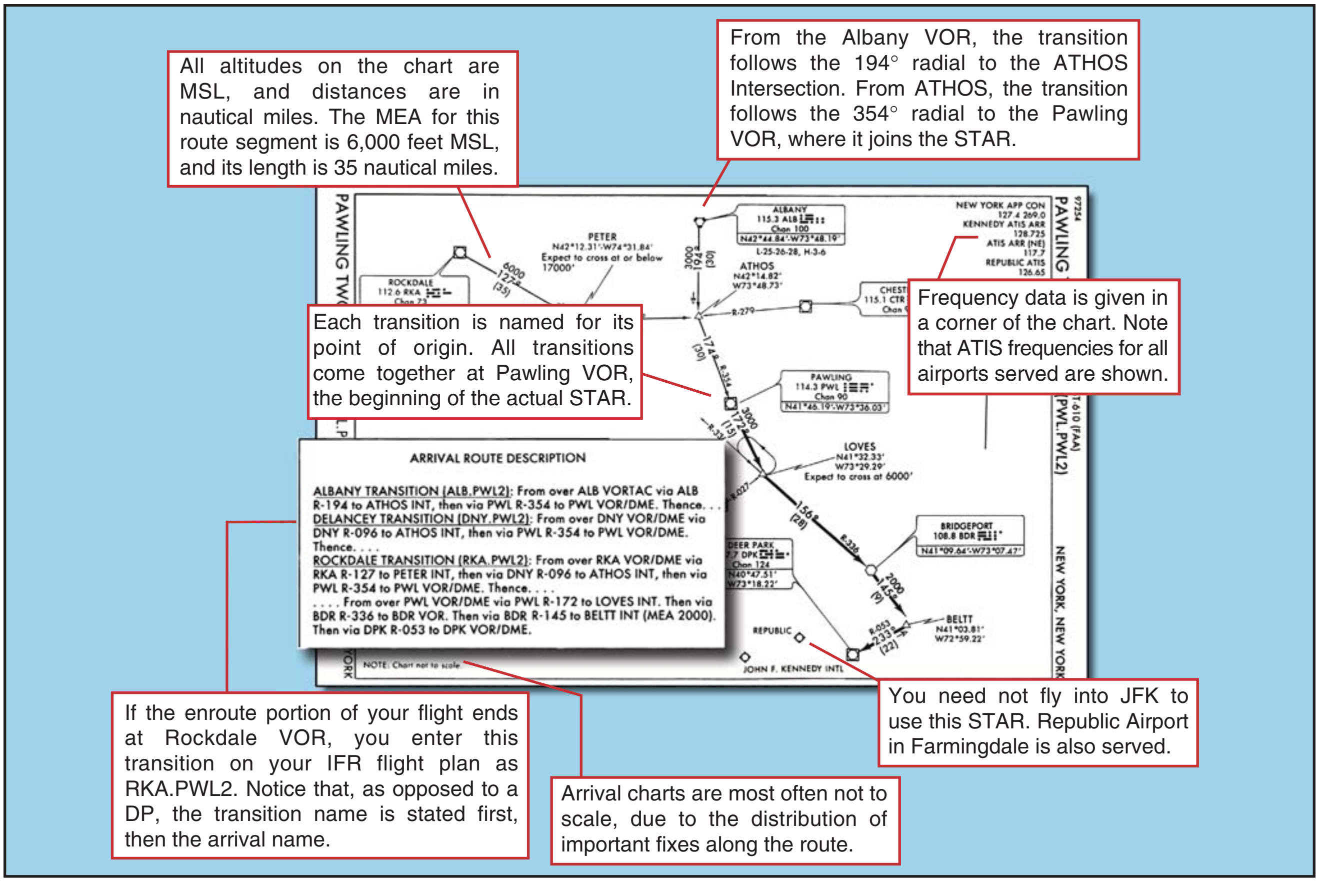


Figure 4-19. STAR Symbology.

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 4-21]

For STAR procedures charted with radar vectors to the final approach, look for routes from the STAR terminating fixes to the IAF. If there is no route depicted, it is very important that you 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 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 prelanding items early, you free yourself to concentrate on the approach.

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 4-22 on page 4-22] 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 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.

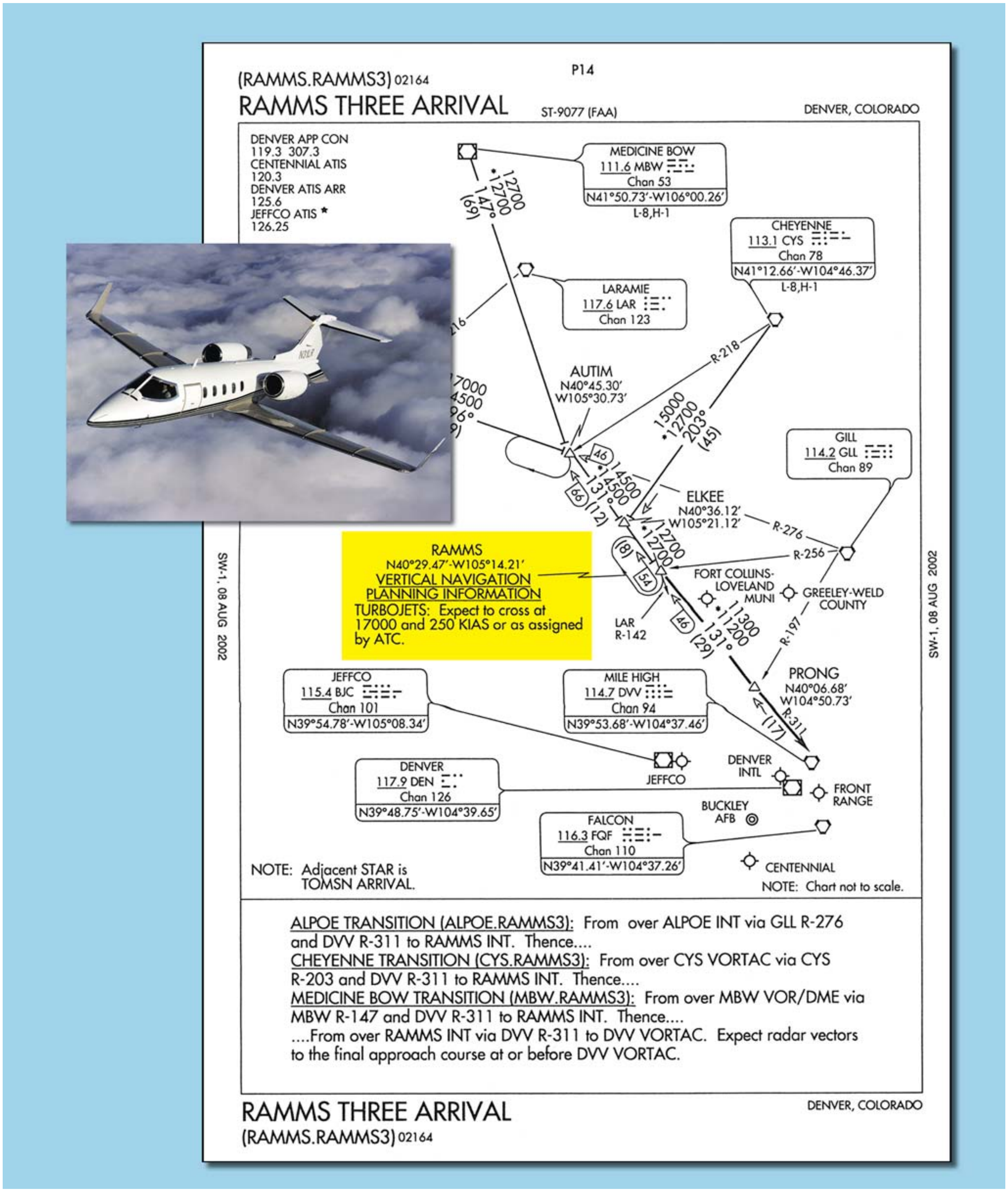


Figure 4-20. Vertical Navigation Planning.

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 4-23]

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.

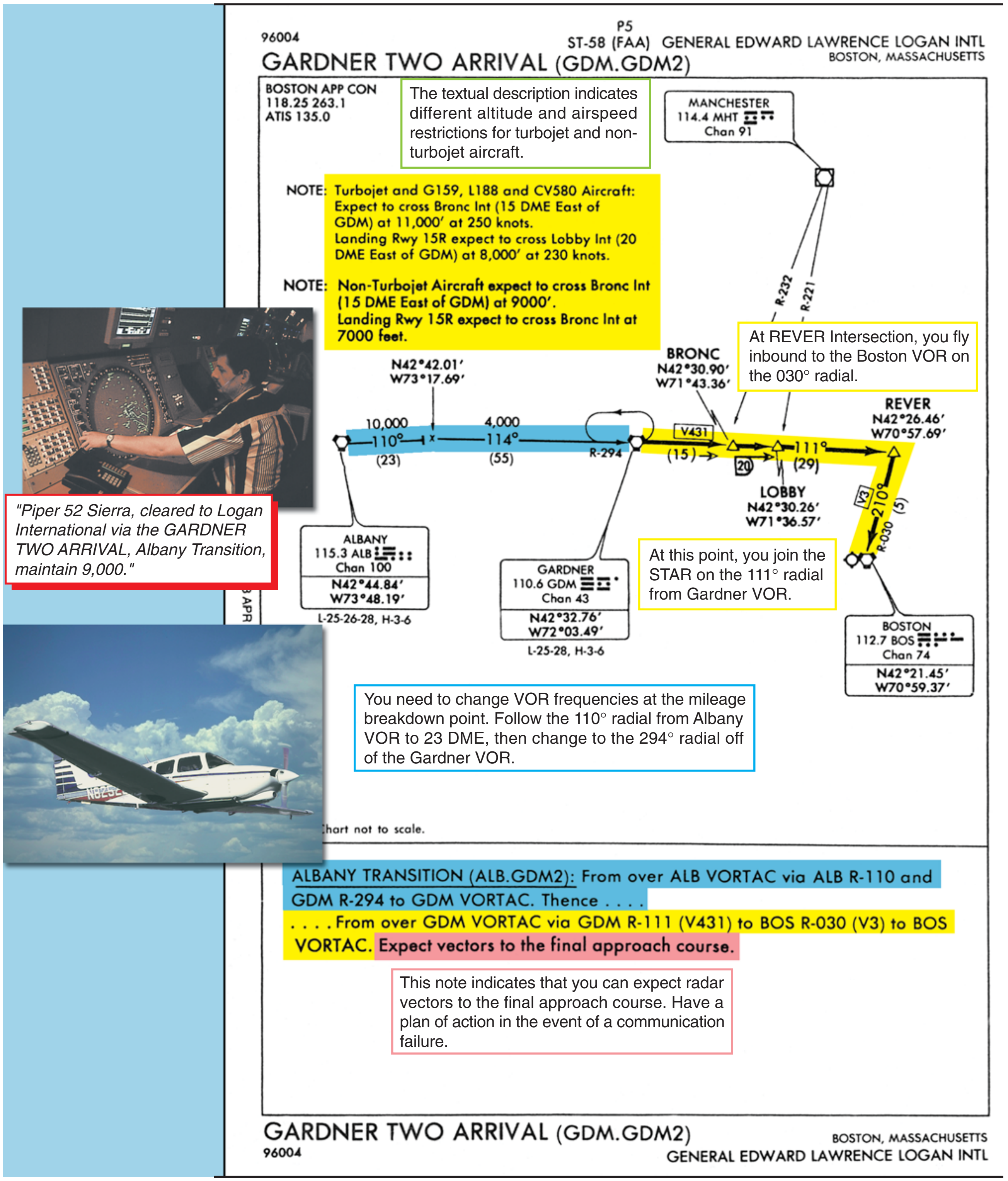


Figure 4-21. Arrival Clearance.

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

An RNAV STAR or STAR transition typically includes flyby waypoints, with flyover waypoints used only

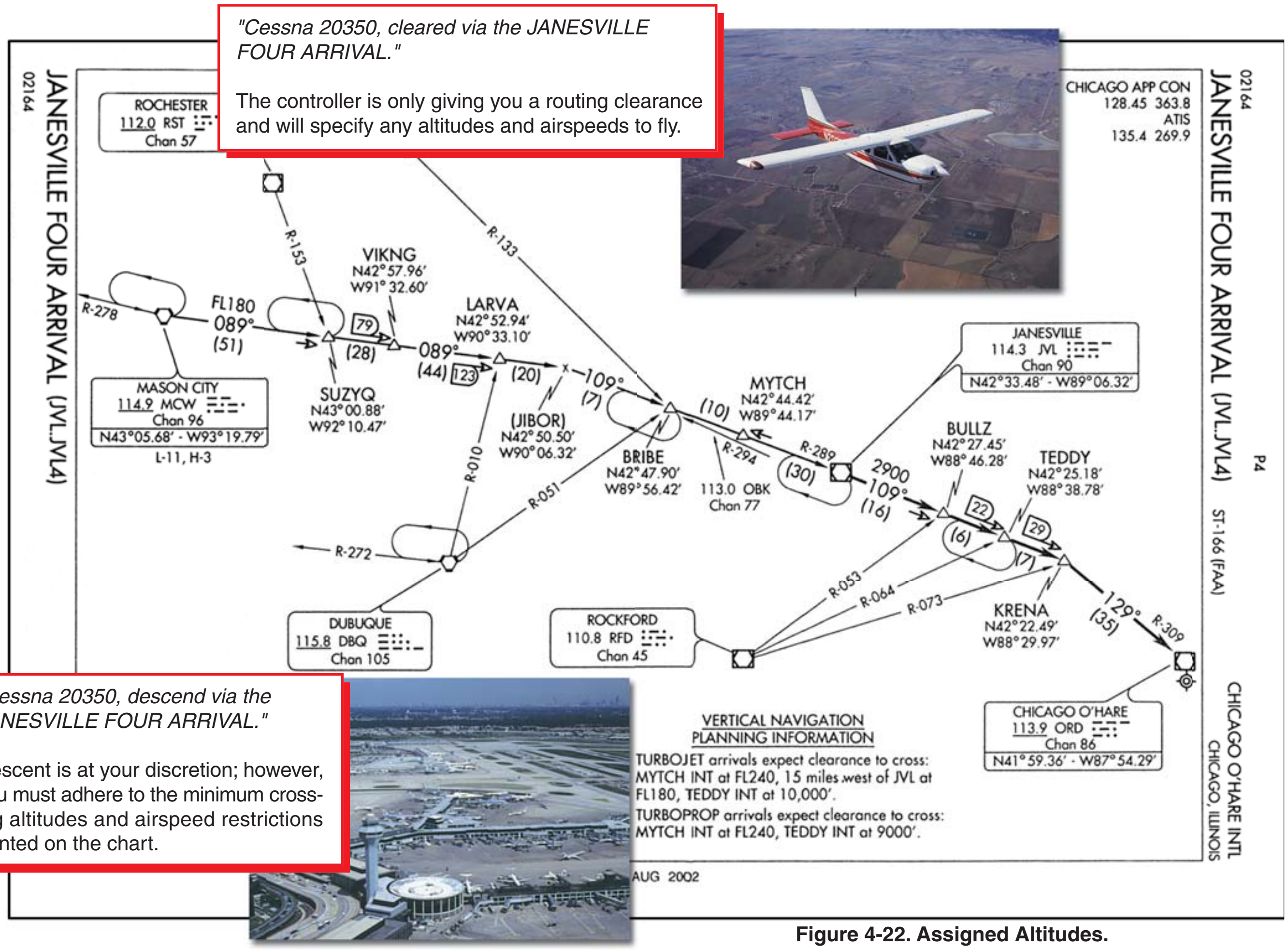


Figure 4-22. Assigned Altitudes.

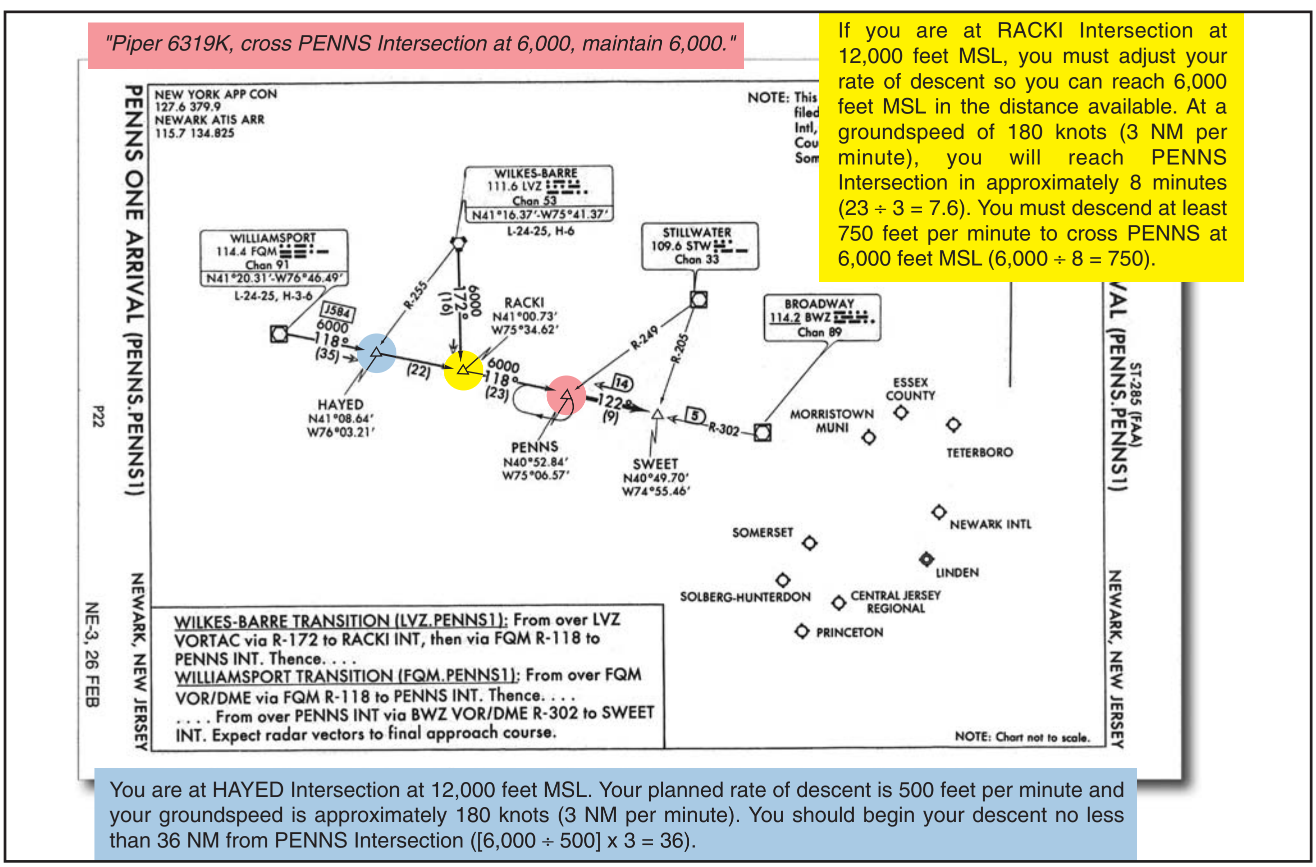


Figure 4-23. Altitude Restrictions.

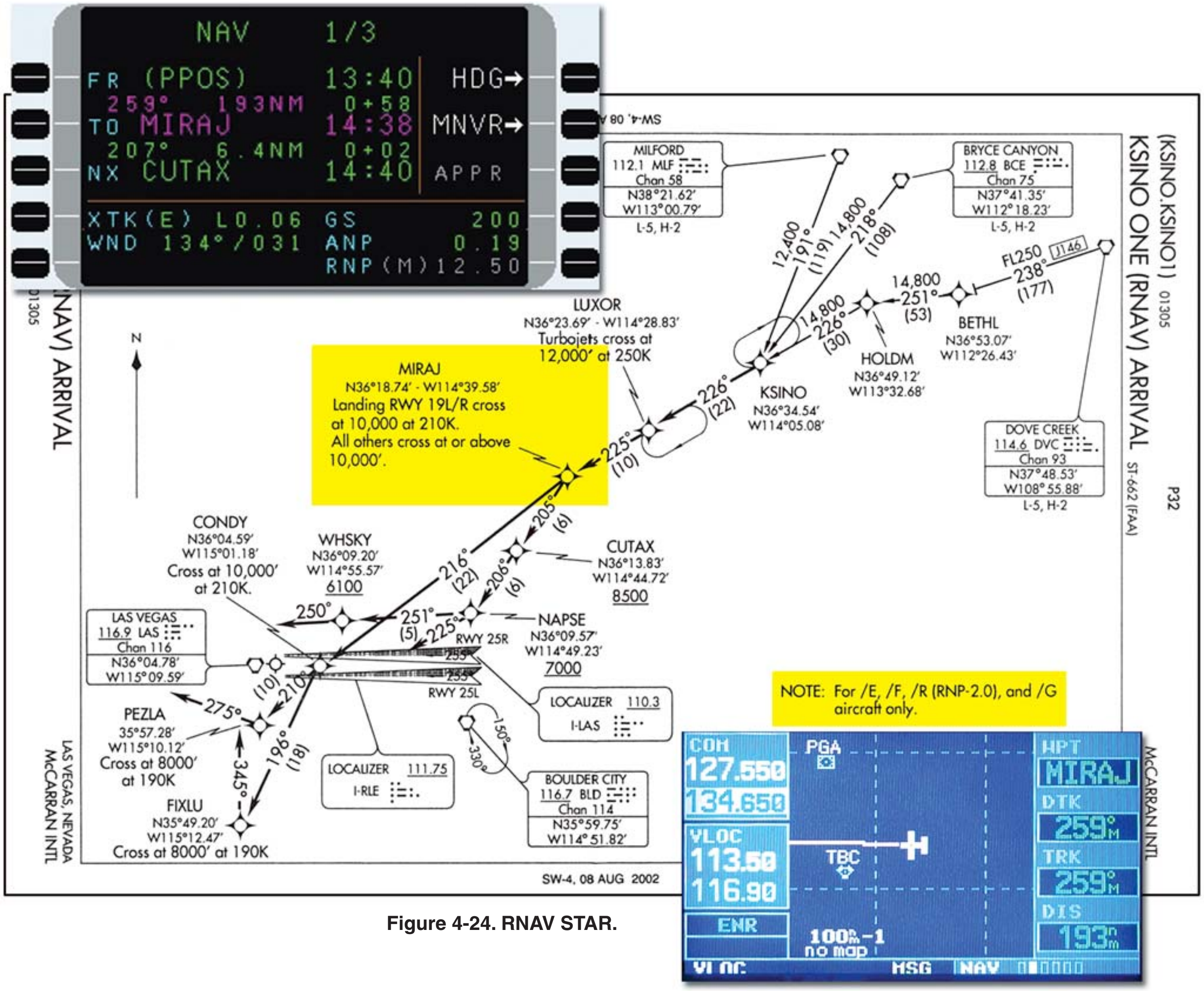


Figure 4-24. RNAV STAR.

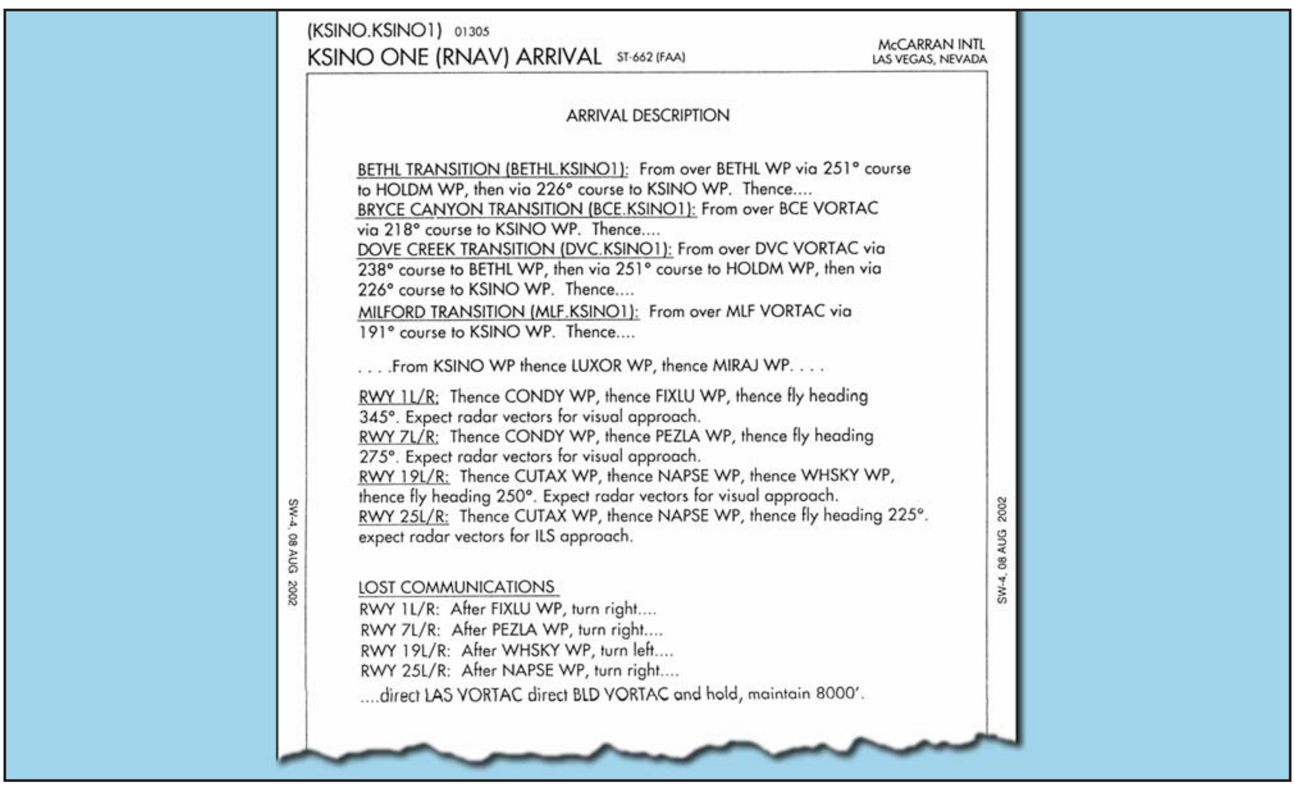
when operationally required. These waypoints may be assigned crossing altitudes and speeds to optimize the descent and deceleration profiles. RNAV STARs often are designed, coordinated, and approved by a joint effort between air carriers, commercial operators, and the ATC facilities that have jurisdiction for the affected airspace.

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. RNAV STARs are developed using RNP 2.0 criteria and are annotated for use by /E, /F, /G, and /R RNP 2.0 en route equipped aircraft only, as depicted with the KSINO ONE (RNAV) ARRIVAL in figure 4-24. Note that the FMS inset (upper left) and GPS inset (lower right) depict present position direct to MIRAJ waypoint on a track of 259°, 193 NM out. Figure 4-25 includes the arrival description from this procedure. Figure 4-26 depicts typical RNAV STAR leg (segment) types you can expect to see when flying these procedures.

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:

SPECIAL AIRPORTS	COMMENTS
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.
Tatlina AFS, AK	Unique approach; mountainous terrain.
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.
Anniston, AL	Traffic complexity.
Key West Florida Int'l., Airport	Lake effect upon thermals on short final to 4,800-foot runway.
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.


(KSINO.KSINO1) 01305

KSINO ONE (RNAV) ARRIVAL ST-662 (FAA)

McCARRAN INTL
LAS VEGAS, NEVADA

ARRIVAL DESCRIPTION

BETHL TRANSITION (BETHL.KSINO1): From over BETHL WP via 251° course to HOLDM WP, then via 226° course to KSINO WP. Thence....
BRYCE CANYON TRANSITION (BCE.KSINO1): From over BCE VORTAC via 218° course to KSINO WP. Thence....
DOVE CREEK TRANSITION (DVC.KSINO1): From over DVC VORTAC via 238° course to BETHL WP, then via 251° course to HOLDM WP, then via 226° course to KSINO WP. Thence....
MILFORD TRANSITION (MLF.KSINO1): From over MLF VORTAC via 191° course to KSINO WP. Thence....

. . . .From KSINO WP thence LUXOR WP, thence MIRAJ WP. . . .

RWY 1L/R: Thence CONDY WP, thence FIXLU WP, thence fly heading 345°. Expect radar vectors for visual approach.
RWY 7L/R: Thence CONDY WP, thence PEZLA WP, thence fly heading 275°. Expect radar vectors for visual approach.
RWY 19L/R: Thence CUTAX WP, thence NAPSE WP, thence WHSKY WP, thence fly heading 250°. Expect radar vectors for visual approach.
RWY 25L/R: Thence CUTAX WP, thence NAPSE WP, thence fly heading 225°. expect radar vectors for ILS approach.

LOST COMMUNICATIONS
RWY 1L/R: After FIXLU WP, turn right....
RWY 7L/R: After PEZLA WP, turn right....
RWY 19L/R: After WHSKY WP, turn left....
RWY 25L/R: After NAPSE WP, turn right....
....direct LAS VORTAC direct BLD VORTAC and hold, maintain 8000'.

SW-4, 08 AUG 2002

SW-4, 08 AUG 2002

Figure 4-25. RNAV STAR Arrival Description.

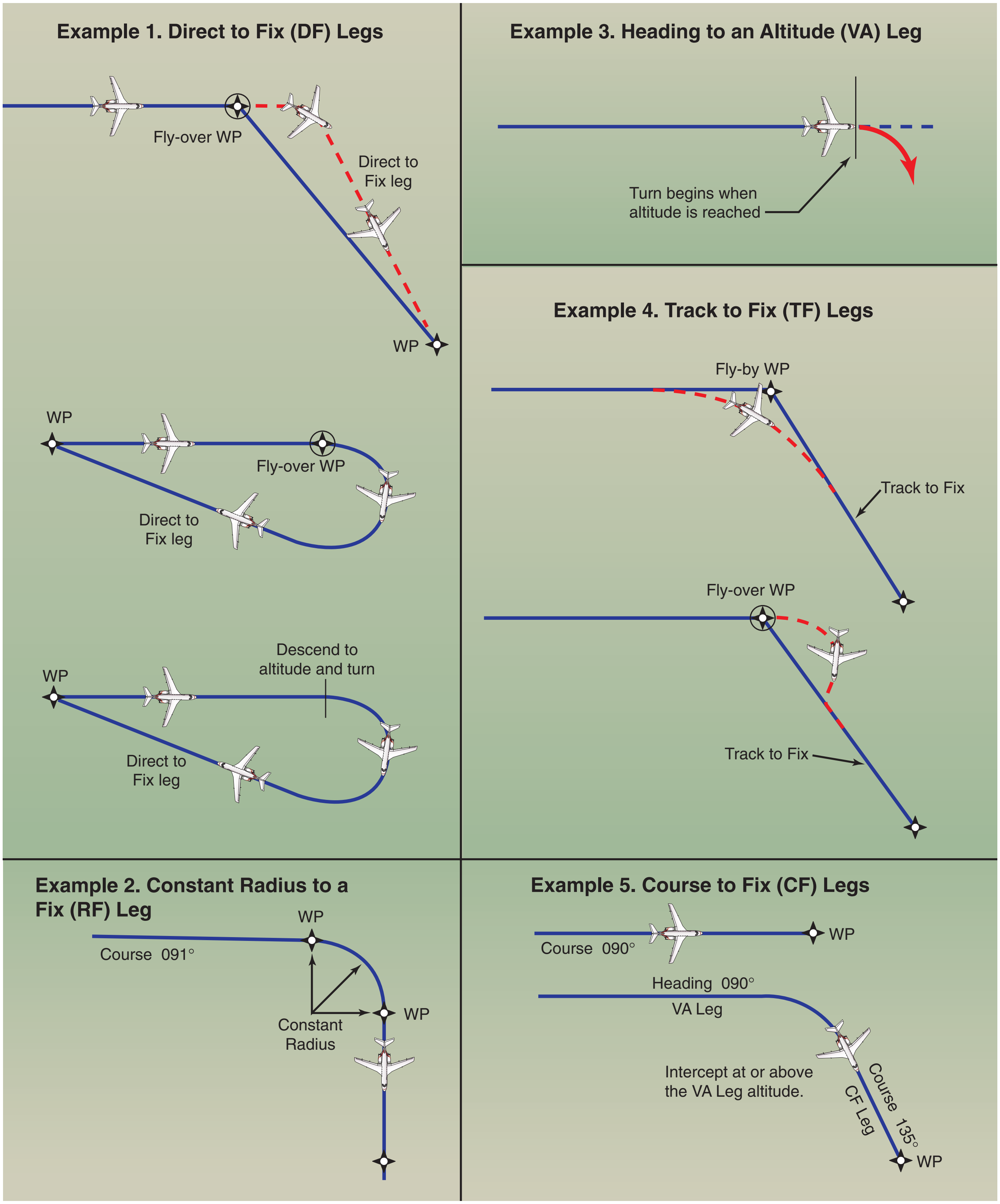


Figure 4-26. RNAV STAR Leg (Segment) Types.