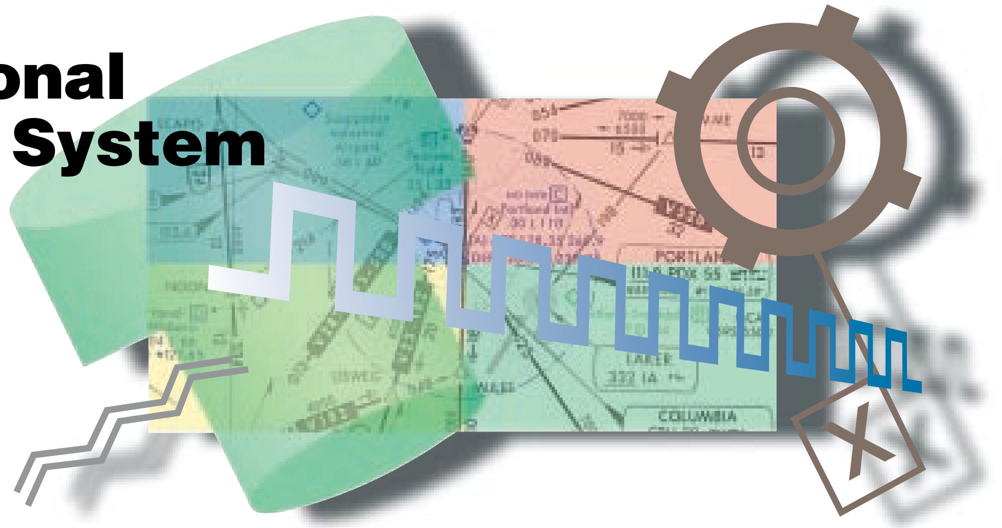
Chapter 8

The National Airspace System



Introduction

The **National Airspace System (NAS)** is the network of United States (U.S.) airspace: air navigation facilities, equipment, services, airports or landing areas, aeronautical charts, information/services, rules, regulations, procedures, technical information, manpower, and material. Included are system components shared jointly with the military. The system's present configuration is a reflection of the technological advances concerning the speed and altitude capability of jet aircraft, as well as the complexity of microchip and satellite-based navigation equipment. To conform to international aviation standards, the U.S. adopted the primary elements of the classification system developed by the **International Civil Aviation Organization (ICAO)**.

This chapter discusses airspace classification; en route, terminal, approach procedures, and operations within the NAS.

Airspace Classification

Airspace in the U.S. is designated as follows: [Figure 8-1]

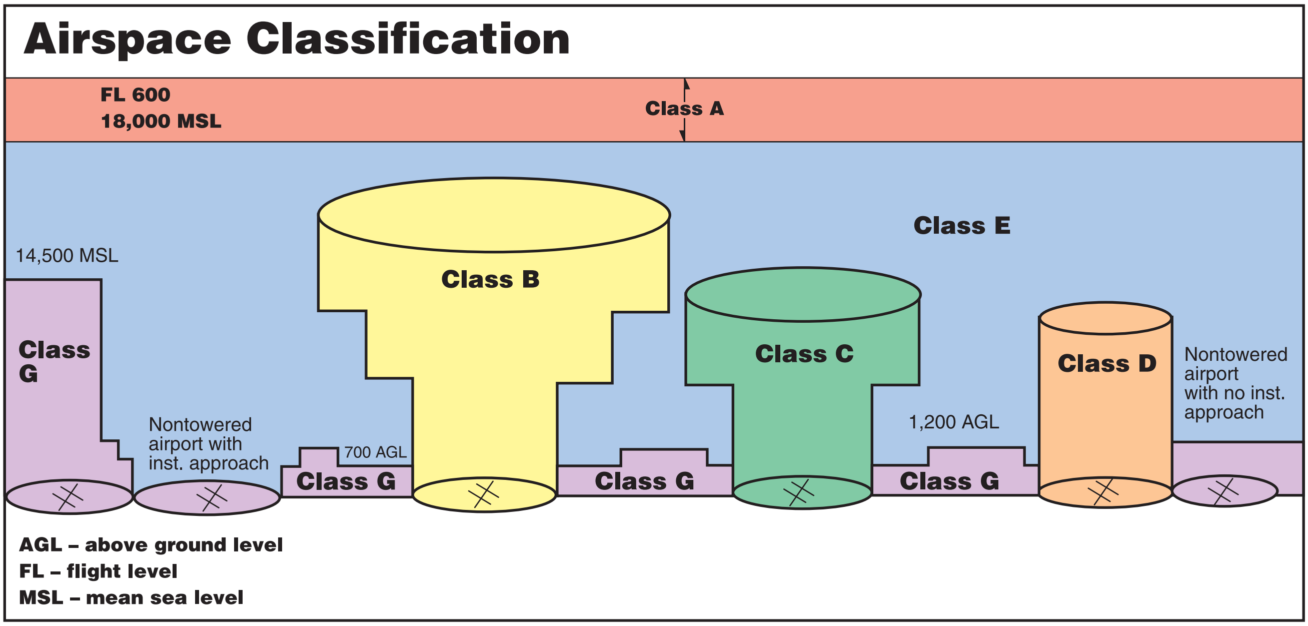
Class A—Generally, that airspace from 18,000 feet mean sea level (MSL) up to and including flight level (FL) 600, including the airspace overlying the waters within 12 nautical miles (NM) of the coast of the 48 contiguous states and Alaska. Unless otherwise authorized, all pilots must operate their aircraft under instrument flight rules (IFR).

National Airspace System (NAS): The common network of U.S. airspace — air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information, and manpower and material.

International Civil Aviation Organization (ICAO): The United Nations agency for developing the principles and techniques of international air navigation, and fostering planning and development of international civil air transport.

Class B—Generally, that airspace from the surface to 10,000 feet MSL surrounding the nation's busiest airports in terms of airport operations or passenger enplanements. The configuration of each Class B airspace area is individually tailored and consists of a surface area and two or more layers (some Class B airspace areas resemble upside-down wedding cakes), and is designed to contain all published instrument procedures once an aircraft enters the airspace. An air traffic control (ATC) clearance is required for all aircraft to operate in the area, and all aircraft that are so cleared receive separation services within the airspace.

Class C—Generally, that airspace from the surface to 4,000 feet above the airport elevation (charted in MSL) surrounding those airports that have an operational control tower, are serviced by a radar approach control, and have a certain number of IFR operations or passenger enplanements. Although the configuration of each Class C area is individually tailored, the airspace usually consists of a surface area with a 5 NM radius, an outer circle with a 10 NM radius that extends from 1,200 feet to 4,000 feet above the airport elevation and an outer area. Each person must establish two-way radio communications with the ATC facility providing air traffic services prior to entering the airspace and thereafter maintain those communications while within the airspace.



Airspace	Class A	Class B	Class C	Class D	Class E	Class G
Entry Requirements	ATC clearance	ATC clearance	Prior two-way communications	Prior two-way communications	Prior two-way communications*	Prior two-way communications*
Minimum Pilot Qualifications	Instrument Rating	Private or Student certification. Local restric-tions apply	Student certificate	Student certificate	Student certificate	Student certificate
Two-Way Radio Communications	Yes	Yes	Yes	Yes	Yes, under IFR flight plan*	Yes*
Special VFR Allowed	No	Yes	Yes	Yes	Yes	N/A
VFR Visibility Minimum	N/A	3 statute miles	3 statute miles	3 statute miles	3 statute miles**	1 statute mile†
VFR Minimum Distance from Clouds	N/A	Clear of clouds	500' below, 1,000' above, 2,000' horizontal	500' below, 1,000' above, 2,000' horizontal	500' below,** 1,000' above, 2,000' horizontal	Clear of clouds†
VFR Aircraft Separation	N/A	All	IFR aircraft	Runway Operations	None	None
Traffic Advisories	Yes	Yes	Yes	Workload permitting	Workload permitting	Workload permitting
Airport Application	N/A	• Radar • Instrument Approaches • Weather • Control Tower • High Density	• Radar • Instrument Approaches • Weather • Control Tower	• Instrument Approaches • Weather • Control Tower	• Instrument Approaches • Weather	• Control Tower

*Only if a temporary tower or control tower is present is the exception.
**Only true below 10,000 feet.
†Only true during day at or below 1,200 feet AGL (see 14 CFR part 91).

Figure 8-1. *U.S. airspace classification.*

Class D—Generally, that airspace from the surface to 2,500 feet above the airport elevation (charted in MSL) surrounding those airports that have an operational control tower. The configuration of each Class D airspace area is individually tailored and when instrument procedures are published, the airspace will normally be designed to contain the procedures. Arrival extensions for **instrument approach procedures (IAPs)** may be Class D or Class E airspace. Unless otherwise authorized, each person must establish two-way radio communications with the ATC facility providing air traffic services prior to entering the airspace and thereafter maintain those communications while in the airspace.

Class E—Generally, if the airspace is not Class A, Class B, Class C, or Class D, and it is controlled airspace, it is Class E airspace. Class E airspace extends upward from either the surface or a designated altitude to the overlying or adjacent controlled airspace. When designated as a surface area, the airspace will be configured to contain all instrument procedures. Also in this class are federal airways, airspace beginning at either 700 or 1,200 feet above ground level (AGL) used to transition to and from the terminal or en route environment, en route domestic, and offshore airspace areas designated below 18,000 feet MSL. Unless designated at a lower altitude, Class E airspace begins at 14,500 MSL over the U.S., including that airspace overlying the waters within 12 NM of the coast of the 48 contiguous states and Alaska, up to but not including 18,000 feet MSL, and the airspace above FL600.

Class G—That airspace not designated as Class A, B, C, D, or E. Class G airspace is essentially uncontrolled by ATC except when associated with a temporary control tower.

Special Use Airspace

Special use airspace is the designation for airspace in which certain activities must be confined, or where limitations may be imposed on aircraft operations that are not part of those activities. Certain special use airspace areas can create limitations on the mixed use of airspace. The special use airspace depicted on instrument charts includes the area name or number, effective altitude, time and weather conditions of operation, the controlling agency, and the chart panel location. On National Aeronautical Charting Office (NACO) en route charts, this information is available on the panel opposite the air/ground (A/G) voice communications.

Prohibited areas contain airspace of defined dimensions within which the flight of aircraft is prohibited. Such areas are established for security or other reasons associated with the national welfare. These areas are published in the Federal Register and are depicted on aeronautical charts. The area is charted as a "P" with a number (e.g., "P-123"). As the name implies, flight through this airspace is not permitted.

Restricted areas are areas where operations are hazardous to nonparticipating aircraft and contain airspace within which the flight of aircraft, while not wholly prohibited, is subject to restrictions. Activities within these areas must be confined because of their nature, or limitations imposed upon aircraft operations that are not a part of those activities, or both. Restricted areas denote the existence of unusual, often invisible, hazards to aircraft (e.g., artillery firing, aerial gunnery, or guided missiles). IFR flights may be authorized to transit the airspace and are routed accordingly. Penetration of restricted areas without authorization from the using or controlling agency may be extremely hazardous to the aircraft and its occupants. ATC facilities apply the following procedures when aircraft are operating on an IFR clearance (including those cleared by ATC to maintain visual flight rules (VFR)-On-Top) via a route that lies within joint-use restricted airspace:

1. If the restricted area is not active and has been released to the Federal Aviation Administration (FAA), the ATC facility will allow the aircraft to operate in the restricted airspace without issuing specific clearance for it to do so.
2. If the restricted area is active and has not been released to the FAA, the ATC facility will issue a clearance which will ensure the aircraft avoids the restricted airspace.

Restricted areas are charted with an "R" followed by a number (e.g., "R-5701") and are depicted on the en route chart appropriate for use at the altitude or FL being flown.

Warning areas are similar in nature to restricted areas; however, the U.S. government does not have sole jurisdiction over the airspace. A warning area is airspace of defined dimensions, extending from 3 NM outward from the coast of the U.S., containing activity that may be hazardous to nonparticipating aircraft. The purpose of such areas is to warn nonparticipating pilots of the potential danger. A warning area may be located over domestic or international waters or both. The airspace is designated with a "W" and a number (e.g., "W-123").

Instrument approach procedures (IAPs): A series of predetermined maneuvers for the orderly transfer of an aircraft under IFR from the beginning of the initial approach to a landing or to a point from which a landing may be made visually.

Special use airspace: Airspace in which certain activities are subject to restrictions that can create limitations on the mixed use of airspace. Consists of prohibited, restricted, warning, military operations, and alert areas.

Military operations areas (MOAs) consist of airspace of defined vertical and lateral limits established for the purpose of separating certain military training activities from IFR traffic. Whenever an MOA is being used, nonparticipating IFR traffic may be cleared through an MOA if IFR separation can be provided by ATC. Otherwise, ATC will reroute or restrict nonparticipating IFR traffic. MOAs are depicted on sectional, VFR terminal area, and en route low altitude charts and are named rather than numbered (e.g., "Boardman MOA").

Alert areas are depicted on aeronautical charts with an "A" and a number (e.g., "A-123") to inform nonparticipating pilots of areas that may contain a high volume of pilot training or an unusual type of aerial activity. Pilots should exercise caution in alert areas. All activity within an alert area shall be conducted in accordance with regulations, without waiver, and pilots of participating aircraft, as well as pilots transiting the area shall be equally responsible for collision avoidance.

Military Training Routes (MTRs) are routes used by military aircraft to maintain proficiency in tactical flying. These routes are usually established below 10,000 feet MSL for operations at speeds in excess of 250 knots. Some route segments may be defined at higher altitudes for purposes of route continuity. Routes are identified as IFR (IR), and VFR (VR), followed by a number. MTRs with no segment above 1,500 feet AGL are identified by four number characters (e.g., IR1206, VR1207, etc.). MTRs that include one or more segments above 1,500 feet AGL are identified by three number characters (e.g., IR206, VR207, etc.). IFR Low Altitude En Route Charts depict all IR routes and all VR routes that accommodate operations above 1,500 feet AGL. IR routes are conducted in accordance with IFR regardless of weather conditions.

Temporary flight restrictions (TFRs) are put into effect when traffic in the airspace would endanger or hamper air or ground activities in the designated area. For example, a forest fire, chemical accident, flood, or disaster-relief effort could warrant a TFR, which would be issued as a Notice to Airmen (NOTAM).

National Security Areas (NSAs) consist of airspace of defined vertical and lateral dimensions established at locations where there is a requirement for increased security and safety of ground facilities. Flight in NSAs may be temporarily prohibited by regulation under the provisions of Title 14 of the Code of Federal Regulations (14 CFR) part 99, and prohibitions will be disseminated via NOTAM.

Federal Airways

The primary navigational aid (NAVAID) for routing aircraft operating under IFR is the **federal airways** system.

Each federal airway is based on a centerline that extends from one NAVAID or intersection to another NAVAID specified for that airway. A federal airway includes the airspace within parallel boundary lines 4 NM to each side of the centerline. As in all instrument flight, courses are magnetic, and distances are in NM. The airspace of a federal airway has a floor of 1,200 feet AGL, unless otherwise specified. A federal airway does not include the airspace of a prohibited area.

Victor airways include the airspace extending from 1,200 feet AGL up to, but not including 18,000 feet MSL. The airways are designated on sectional and IFR low altitude en route charts with the letter "V" followed by a number (e.g., "V23"). Typically, Victor airways are given odd numbers when oriented north/south and even numbers when oriented east/west. If more than one airway coincides on a route segment, the numbers are listed serially (e.g., "V287-495-500"). [Figure 8-2]

Jet routes exist only in Class A airspace, from 18,000 feet MSL to FL450, and are depicted on high-altitude en route charts. The letter "J" precedes a number to label the airway (e.g., J12).

Other Routing

Preferred IFR routes have been established between major terminals to guide pilots in planning their routes of flight, minimizing route changes and aiding in the orderly management of air traffic on federal airways. Low and high altitude preferred routes are listed in the **Airport/Facility Directory (A/FD)**. To use a preferred route, reference the departure and arrival airports; if a routing exists for your flight, airway instructions will be listed.

Federal airways: Class E airspace areas that extend upward from 1,200 feet to, but not including, 18,000 feet MSL, unless otherwise specified.

Victor airways: Except in Alaska and coastal North Carolina, the VOR airways are predicated solely on VOR or VORTAC navigation aids; they are depicted in blue on aeronautical charts.

Jet routes: A route designated to serve flight operations from 18,000 feet MSL, up to and including FL450.

Preferred IFR routes: Routes established in the major terminal and en route environments to increase system efficiency and capacity.

Airport/Facility Directory (A/FD): An FAA publication containing information on all airports, communications, and NAVAIDs pertinent to IFR flight.

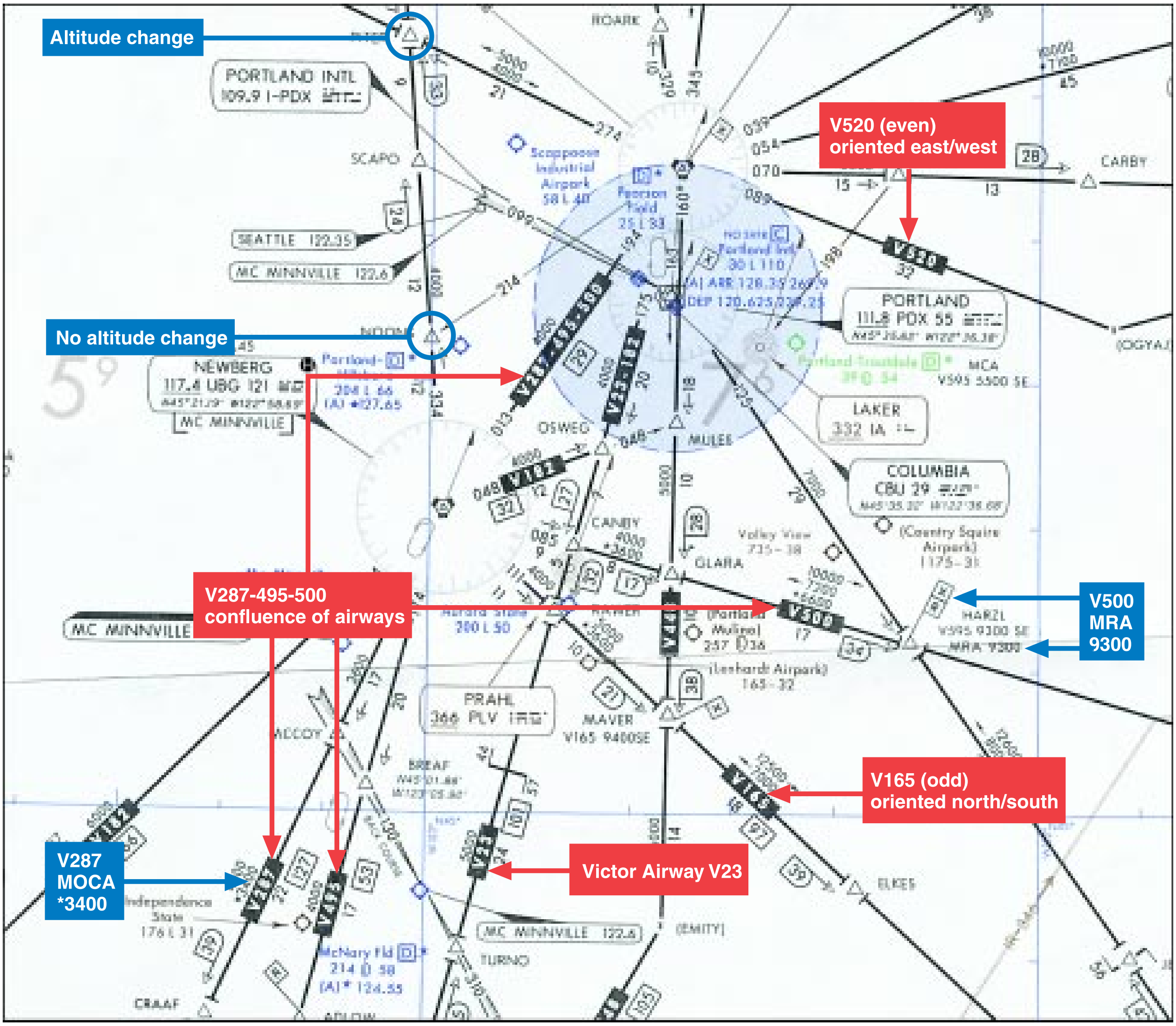


Figure 8-2. *Victor airways, and charted IFR altitudes.*

Tower En Route Control (TEC) is an ATC program that uses overlapping approach control radar services to provide IFR clearances. By using TEC, you are routed by airport control towers. Some advantages include abbreviated filing procedures, fewer delays, and reduced traffic separation requirements. TEC is dependent upon the ATC's workload and the procedure varies among locales.

The latest version of Advisory Circular (AC) 90-91, *National Route Program*, provides guidance to users of the NAS for participation in the **National Route Program (NRP)**. All flights operating at or above FL290 within the conterminous U.S. are eligible to participate in the NRP, the primary purpose of which is to allow operators to plan minimum time/cost routes that may be off the prescribed route structure.

Tower En Route Control (TEC): The control of IFR en route traffic within delegated airspace between two or more adjacent approach control facilities, designed to expedite traffic and reduce control and pilot communication requirements.

National Route Program (NRP): A set of rules and procedures designed to increase the flexibility of user flight planning within published guidelines.

Additionally, international flights to destinations within the U.S. are eligible to participate in the NRP within specific guidelines and filing requirements. NRP aircraft are not subject to route-limiting restrictions (e.g., published preferred IFR routes) beyond a 200 NM radius of their point of departure or destination.

IFR En Route Charts

The objective of IFR en route flight is to navigate within the lateral limits of a designated airway at an altitude consistent with the ATC clearance. Your ability to fly instruments in the system, safely and competently, is greatly enhanced by understanding the vast array of data available to the pilot within the instrument charts. The NACO maintains the database and produces the charts for the U.S. government.

En route high-altitude charts provide aeronautical information for en route instrument navigation (IFR) at or above 18,000 feet MSL. Information includes the portrayal of jet routes, identification and frequencies of radio aids, selected airports, distances, time zones, special use airspace, and related information. Established routes from 18,000 feet MSL to FL450 use NAVAIDs not more than 260 NM apart. Scales vary from 1 inch = 45 NM to 1 inch = 18 NM. The charts are revised every 56 days.

To effectively depart from one airport and navigate en route under instrument conditions you need the appropriate **IFR en route low-altitude chart(s)**. The IFR low altitude en route chart is the instrument equivalent of the sectional chart. When folded, the cover of the NACO en route chart displays a map of the U.S. showing the coverage areas. Cities near congested airspace are shown in black type and their associated **area chart** is listed in the box in the lower left-hand corner of the map coverage box. Also noted is the highest off-route obstruction clearance altitude. The effective date of the chart is printed on the other side of the folded chart. Information concerning MTRs are also included on the chart cover. Scales vary from 1 inch = 5 NM to 1 inch = 20 NM. The en route charts are revised every 56 days.

When the NACO en route chart is unfolded, the legend is displayed and provides information concerning airports, NAVAIDs, air traffic services, and airspace.

Area navigation (RNAV) routes, including routes using global positioning system (GPS) for navigation, are not normally depicted on IFR en route charts. However, a number of RNAV routes have been established in the high-altitude structure and are depicted on the RNAV en route high altitude charts. RNAV instrument departure procedures (DPs) and standard terminal arrival routes (STARs) are contained in the U.S. Terminal Procedures booklets. The *Graphic Notices and Supplemental Data* also contains a tabulation of RNAV routes.

In addition to the published routes, you may fly a random RNAV route under IFR if it is approved by ATC. Random RNAV routes are direct routes, based on area navigation capability, between waypoints defined in terms of latitude/longitude coordinates, degree-distance fixes, or offsets from established routes/airways at a specified distance and direction.

Radar monitoring by ATC is required on all random RNAV routes. These routes can only be approved in a radar environment. Factors that will be considered by ATC in approving random RNAV routes include the capability to provide radar monitoring, and compatibility with traffic volume and flow. ATC will radar monitor each flight; however, navigation on the random RNAV route is the responsibility of the pilot.

Reliance on RNAV systems for instrument approach operations is becoming more commonplace as new systems, such as GPS and wide area augmentation system (WAAS) are developed and deployed. In order to foster and support full integration of RNAV into the NAS, the FAA has developed a charting format for RNAV approach charts.

Airport Information

Airport information is provided in the legend, and the symbols used for the airport name, elevation, and runway length are similar to the sectional chart presentation. Instrument approaches can be found at airports with blue or green symbols, while the brown airport symbol denotes airports that do not have approved instrument approaches. Asterisks are used to indicate the part-time nature of tower operations, lighting facilities, and airspace classifications (consult the communications panel on the chart for primary radio frequencies and hours of operation). The asterisk could also indicate that approaches are not permitted during the

En route high-altitude charts: Aeronautical charts for en route instrument navigation at or above 18,000 feet MSL.

IFR en route low-altitude charts: Aeronautical charts for en route IFR navigation in the low-altitude stratum.

Area chart: Part of the low-altitude en route chart series, these charts furnish terminal data at a larger scale in congested areas.

nonoperating hours, and/or filing as an alternate is not approved during specified hours. A box after an airport name with a "C" or "D" inside indicates Class C and D airspace, respectively. D [Figure 8-3]

Charted IFR Altitudes

The **minimum en route altitude (MEA)** ensures a navigation signal strong enough for adequate reception by the aircraft navigation (NAV) receiver and adequate obstacle clearance along the airway. Communication is not necessarily guaranteed with MEA compliance. The obstacle clearance, within the limits of the airway, is typically 1,000 feet in nonmountainous areas and 2,000 feet in designated mountainous areas. MEAs can be authorized with breaks in the signal coverage; if this is the case, the NACO en route chart notes "MEA GAP" parallel to the affected airway. MEAs are usually bidirectional; however, they can be unidirectional. Arrows are used to indicate the direction to which the MEA applies.

The **minimum obstruction clearance altitude (MOCA)**, as the name suggests, provides the same obstruction clearance as an MEA; however, the NAV signal reception is only ensured within 22 NM of the closest NAVAID defining the route. The MOCA is listed below the MEA and indicated on NACO charts by a leading asterisk (e.g., "*3400"—*see* figure 8-2, V287 at bottom left in figure).

The **minimum reception altitude (MRA)** identifies an intersection from an off-course NAVAID. If the reception is line-of-sight based, signal coverage will only extend to the MRA or above. However, if the aircraft is equipped with distance measuring equipment (DME) and the chart indicates the intersection can be identified with such equipment, the pilot could define the fix without attaining the MRA. On NACO charts, the MRA is indicated by the symbol and the altitude preceded by "MRA" (e.g., "MRA 9300"). [Figure 8-2]

The **minimum crossing altitude (MCA)** will be charted when a higher MEA route segment is approached. The MCA is usually indicated when you are approaching steeply rising terrain, and obstacle clearance and/or signal reception is compromised. In this case, the pilot is required to initiate a climb so the MCA is reached by the time the intersection is crossed. On NACO charts, the MCA is indicated by the symbol, the Victor airway number, and the direction to which it applies.

The **maximum authorized altitude (MAA)** is the highest altitude at which the airway can be flown without receiving conflicting navigation signals from NAVAIDs operating on the same frequency. Chart depictions appear as "MAA-15000."

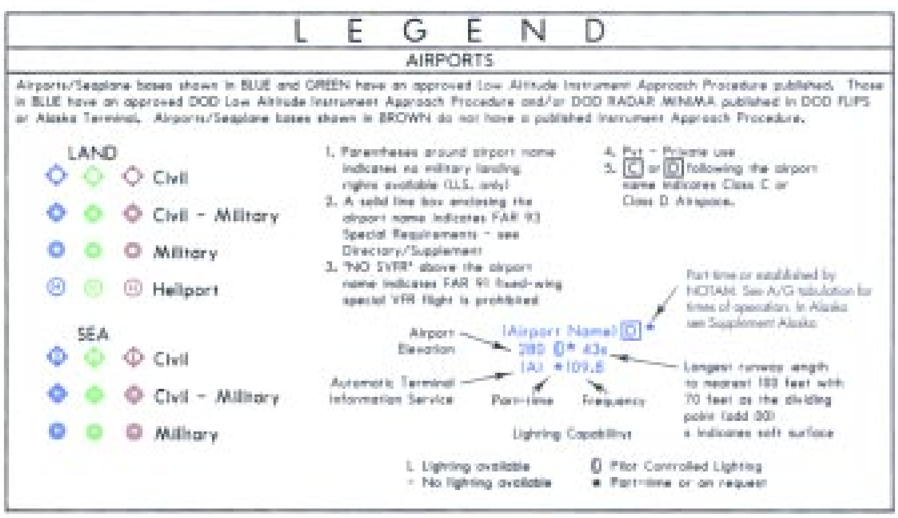


Figure 8-3. *En route airport legend.*

Minimum en route altitude (MEA): The lowest published altitude between radio fixes which ensures acceptable navigational signal coverage and meets obstacle clearance requirements between those fixes.

Minimum obstruction clearance altitude (MOCA): The lowest published altitude in effect between radio fixes on VOR airways, off-airway routes, or route segments which meets obstacle clearance requirements for the entire route segment and which ensures acceptable navigational signal coverage only within 25 statute (22 nautical) miles of a VOR.

Minimum reception altitude (MRA): The lowest altitude at which an airway intersection can be determined.

Minimum crossing altitude (MCA): The lowest altitude at certain fixes at which an aircraft must cross when proceeding in the direction of a higher MEA.

Maximum authorized altitude (MAA): A published altitude representing the maximum usable altitude or FL for an airspace structure or route segment.

When an MEA, MOCA, and/or MAA change on a segment other than a NAVAID, a sideways "T" is depicted on the chart. If there is an airway break without the symbol, you can assume the altitudes have not changed (see the upper left area of figure 8-2). When a change of MEA to a higher MEA is required, the climb may commence at the break, ensuring obstacle clearance. [Figure 8-4B]

Navigation Features

Types of NAVAIDs

Very-high frequency omnidirectional ranges (VORs) are the principal NAVAIDs that support the Victor airways. Many other navigation tools are also available to the pilot. For example, nondirectional beacons (NDBs) can broadcast signals accurate enough to provide stand-alone approaches, and DME allows the pilot to pinpoint a reporting point on the airway. Though primarily navigation tools, these NAVAIDs can also transmit voice broadcasts.

Tactical air navigation (TACAN) channels are represented as the two- or three-digit numbers following the three-letter identifier in the NAVAID boxes. The NACO terminal procedures provide a frequency-pairing table for the TACAN-only sites. On NACO charts, very-high frequencies and ultra-high frequencies (VHF/UHF) NAVAIDs (e.g., VORs) are depicted in black, while low frequencies and medium frequencies (LF/MF) are depicted as brown. [Figure 8-4A]

Identifying Intersections

Intersections along the airway route are established by a variety of NAVAIDs. An open triangle △ indicates the location of an ATC reporting point at an intersection; if the triangle is solid, ▲ a report is compulsory. [Figure 8-4B] NDBs, localizers, and off-route VORs are used to establish intersections. NDBs are sometimes colocated with intersections, in which case passage of the NDB would mark the intersection. A bearing to an off-route NDB also can provide intersection identification. The presence of a localizer course can be determined from a feathered arrowhead symbol on the en route chart. If crosshatched markings appear on the left-hand side of the arrowhead, a **back course (BC)** signal is transmitted. On NACO charts, the localizer symbol is depicted to identify an intersection.

When you travel on an airway, off-route VORs remain the most common means of identifying intersections. Arrows depicted next to the intersection indicate the NAVAID to be used for identification. Another means of identifying an intersection is with the use of DME. A hollow arrowhead indicates DME is authorized for intersection identification. If the DME mileage at the intersection is a cumulative distance of route segments, the mileage is totaled and indicated by a D-shaped symbol with a number inside. 00 Typically, the distance numbers do not appear on the initial segment. [Figure 8-4B, Route Data] Approved IFR GPS units can also be used to report intersections if the intersection name resides in a current database.

Other Route Information

DME and GPS provide valuable route information concerning such factors as mileage, position, and groundspeed. Even without this equipment, information is provided on the charts for making the necessary calculations using time and distance. The en route chart depicts point-to-point distances on the airway system. Distances from VOR to VOR are charted with a number inside of a box. $\boxed{000}$ To differentiate distances when two airways cross, the word "TO" with the three-letter VOR identifier appears next to the distance box. TO PDX $\boxed{97}$

VOR **changeover points (COPs)** are depicted on the charts by this symbol: 45 53 The numbers indicate the distance at which to change the VOR frequency. The frequency change might be required due to signal reception or conflicting frequencies. If a COP does not appear on an airway, the frequency should be changed midway between the facilities. A COP at an intersection often indicates a course change.

Occasionally an "x" will appear at a separated segment of an airway that is not an intersection. The "x" is a **mileage breakdown** or **computer navigation fix** and indicates a course change.

Back course (BC): The reciprocal of the localizer course for an ILS. When flying a back-course approach, an aircraft approaches the instrument runway from the end on which the localizer antennas are installed.

Changeover points (COPs): A point along the route where changeover in navigation guidance should occur.

Mileage breakdown or computer navigation fix: A fix indicating a course change that appears on the chart as an "x" at a break between two segments of a federal airway.

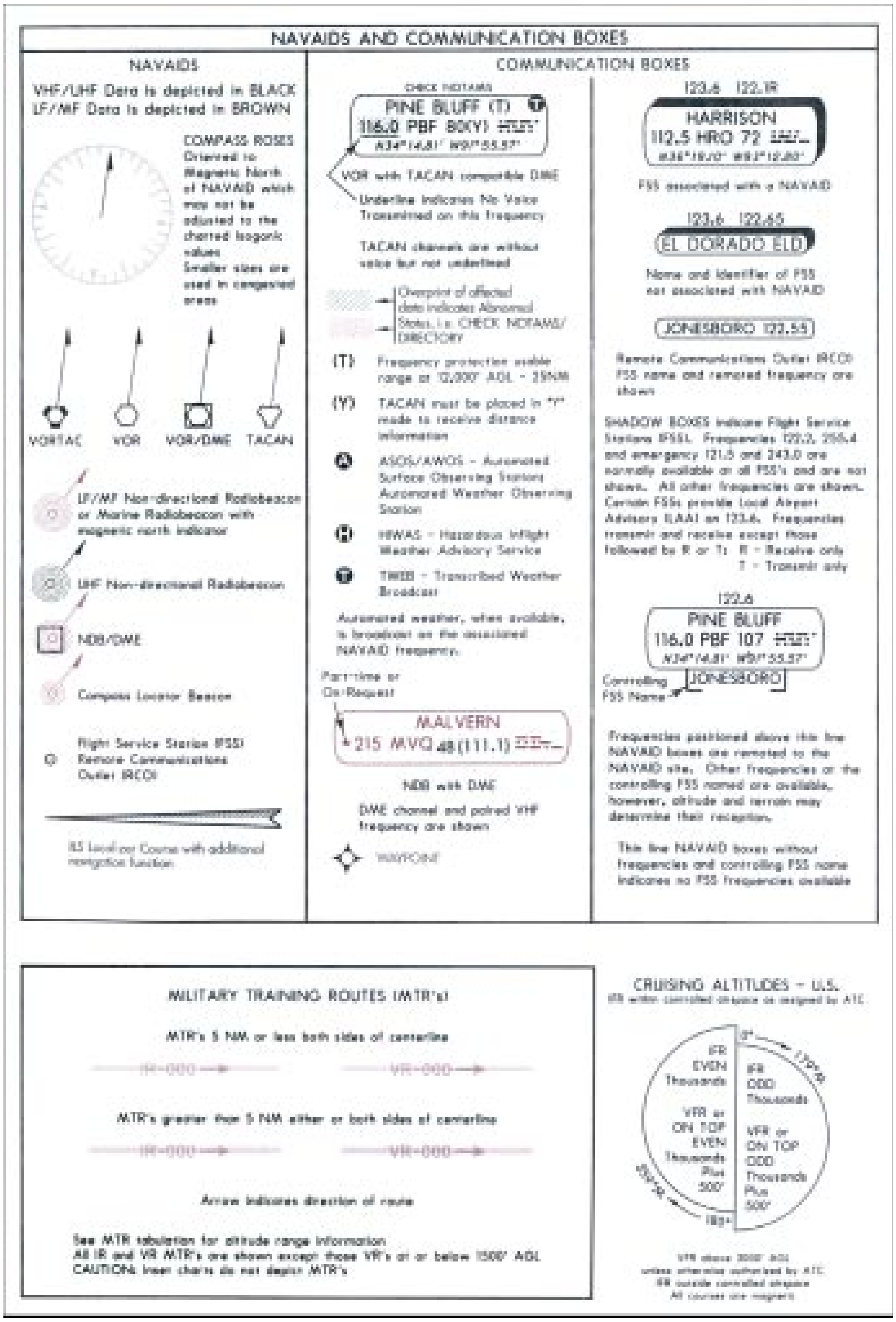


Figure 8-4A. *Legend from en route low altitude chart. (Air Traffic Services and Airspace Information section of the legend is continued on the next page.)*

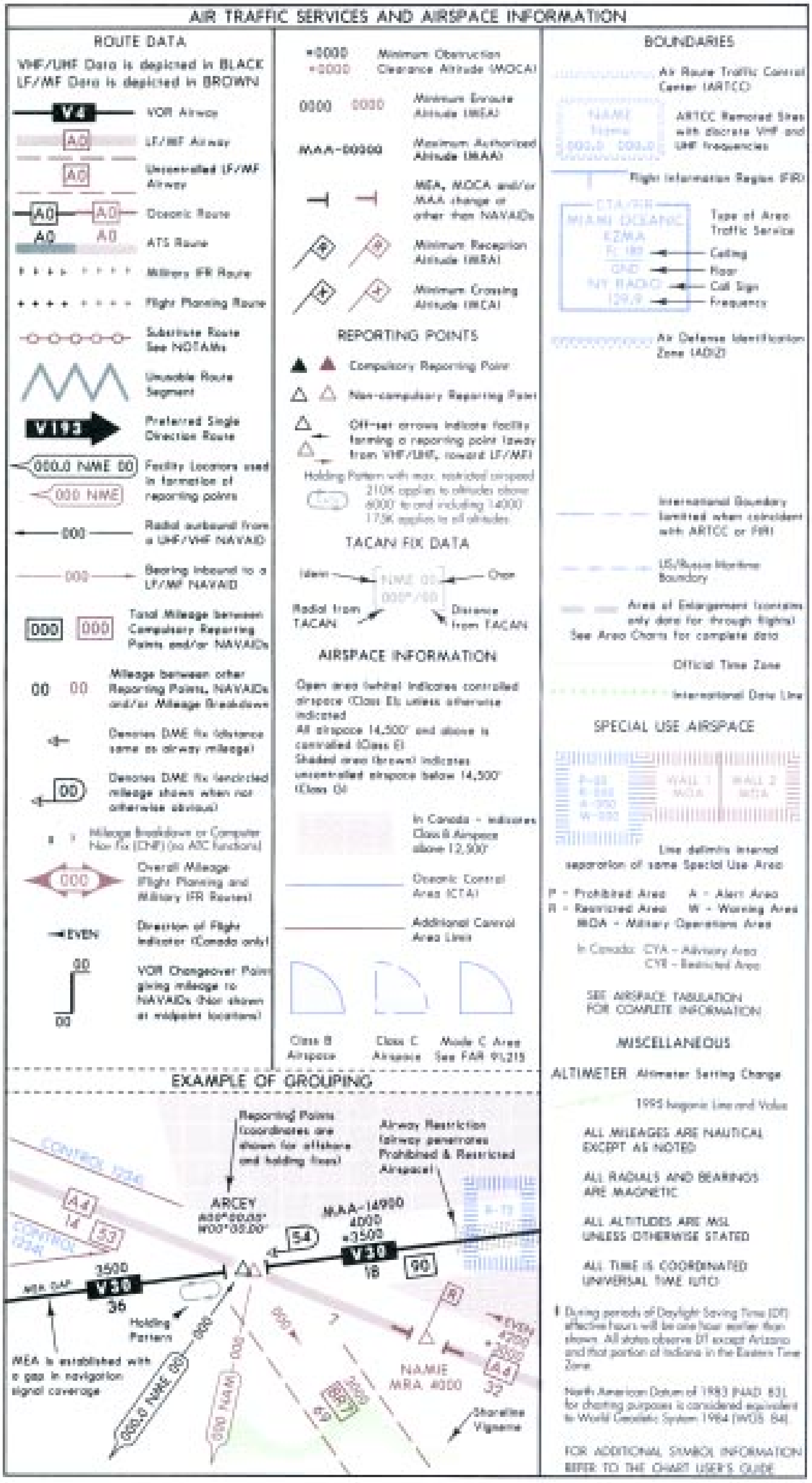


Figure 8-4B. *Legend from en route low altitude chart (continued).*

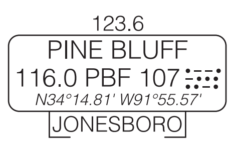
Today's computerized system of ATC has greatly reduced the need for holding en route. However, published holding patterns are still found on charts at junctures where ATC has deemed it necessary to enable traffic flow. When a holding pattern is charted, the controller may provide the holding direction and the statement "as published." [Figure 8-4B]

Boundaries separating the jurisdiction of **Air Route Traffic Control Centers (ARTCC)** are depicted on charts with blue serrations. The name of the controlling facility is printed on the corresponding side of the division line. ARTCC remote sites are depicted as blue serrated boxes and contain the center name, sector name, and the sector frequency. [Figure 8-4B]

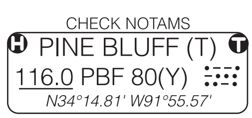
Weather Information and Communication Features

En route NAVAIDs also provide weather information and serve communication functions. When a NAVAID is shown as a shadowed box, an automated flight service station (AFSS) of the same name is directly associated with the facility. If an AFSS is located without an associated NAVAID, the shadowed box is smaller and contains only the name and identifier. The AFSS frequencies are provided on top of the box. (Frequency 122.2 and the emergency frequency 121.5 are not listed.)

A **Remote Communications Outlet (RCO)** associated with a NAVAID is designated by a fine-lined box with the controlling AFSS frequency on the top, and the name under the box, respectively. Without an associated facility, the fine-lined RCO box contains the AFSS name and remote frequency.



Hazardous Inflight Weather Advisory Service (HIWAS) and **Transcribed Weather Broadcast (TWEB)** are continuously transmitted over selected NAVAIDs and depicted in the NAVAID box. HIWAS is depicted by a white "H" in a black circle in the upper left corner of the box; TWEB broadcasts show as a white "T" in a black circle in the upper right corner.



U.S. Terminal Procedures Publications

While the en route charts provide the information necessary to safely transit broad regions of airspace, the **U.S. Terminal Procedures Publication (TPP)** enables pilots to guide their aircraft into airports. Terminal routes feed aircraft to a point where IAPs can be flown to a minimum altitude for landing. Whether for departing or arriving, these procedures exist to make the controllers' and pilots' jobs safer and more efficient. Available in booklets by region (published by the NACO), the TPP includes approach procedures, arrival and DPs, and airport diagrams.

Departure Procedures (DPs)

Departure procedures (DPs) provide obstacle clearance protection to aircraft in instrument meteorological conditions (IMC), while reducing communications and departure delays. DPs are published in text and/or charted graphic form. Regardless of the format, all DPs provide a way to depart the airport and transition to the en route structure safely. When available, pilots are strongly encouraged to file and fly a DP at night, during marginal visual meteorological conditions (VMC), and IMC.

All DPs provide obstacle clearance provided the aircraft crosses the end of the runway at least 35 feet AGL; climbs to 400 feet above airport elevation before turning; and climbs at least 200 feet per nautical mile (FPNM), unless a higher climb gradient is specified to the assigned altitude. ATC may vector an aircraft off a previously assigned DP; however, the 200 FPNM or the FPNM specified in the DP, is required.

Textual DPs are listed by airport in the IFR Take-Off Minimums and Departure Procedures Section, Section C, of the TPP. Graphic DPs are depicted in the TPP following the approach procedures for the airport. [Figure 8-5]

Air Route Traffic Control Center (ARTCC): Established to provide ATC service to aircraft operating on IFR flight plans within controlled airspace and principally during the en route phase of flight.

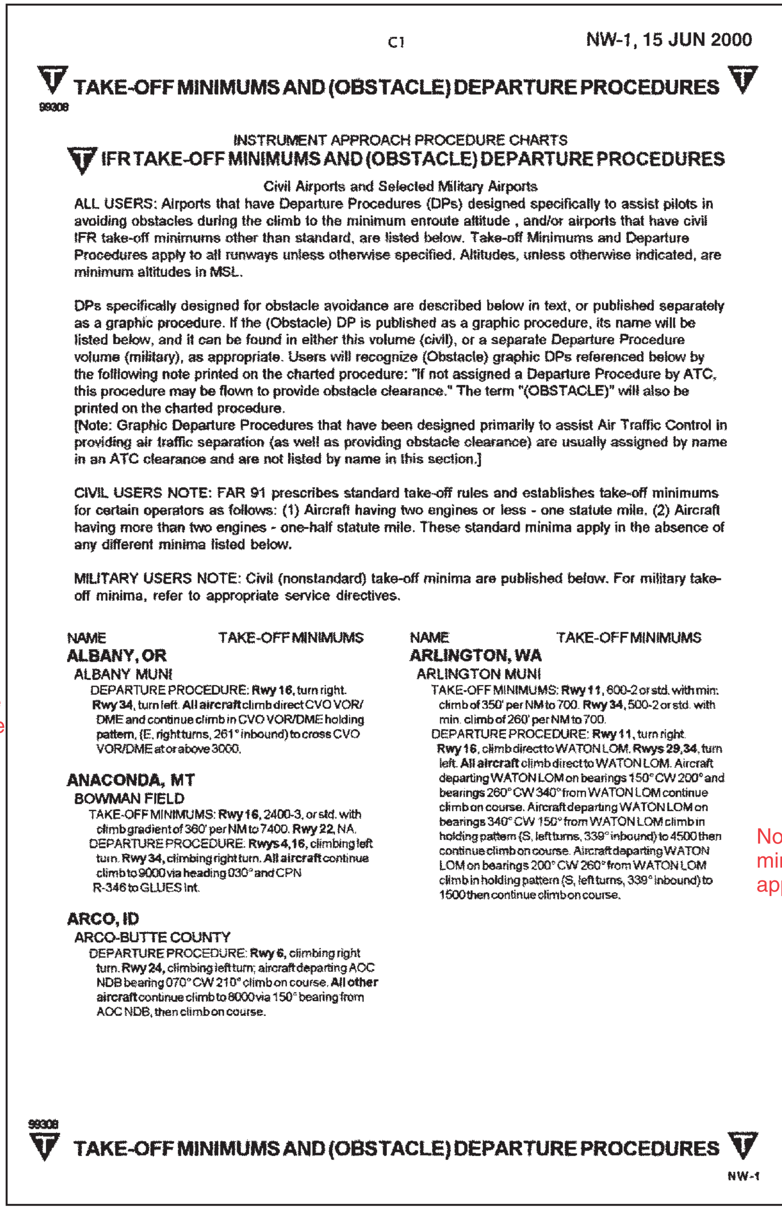
Remote Communications Outlet (RCO): An unmanned communications facility remotely controlled by air traffic personnel.

Hazardous Inflight Weather Advisory Service (HIWAS): Recorded weather forecasts broadcast to airborne pilots over selected VORs.

Transcribed Weather Broadcast (TWEB): Meteorological and aeronautical data is recorded on tapes and broadcast over selected NAVAIDs.

U.S. Terminal Procedures Publication (TPP): Published by NACO in loose-leaf or perfect-bound volumes covering the conterminous U.S., Puerto Rico, and the Virgin Islands. Individual volumes in this series are entitled, *U.S. Terminal Procedures*, (name of region).

Departure procedure (DP): Preplanned IFR ATC departure/obstacle avoidance procedures, published for pilot use in textual and graphic format.



C1 NW-1, 15 JUN 2000

TAKE-OFF MINIMUMS AND (OBSTACLE) DEPARTURE PROCEDURES

99308

INSTRUMENT APPROACH PROCEDURE CHARTS

IFR TAKE-OFF MINIMUMS AND (OBSTACLE) DEPARTURE PROCEDURES

Civil Airports and Selected Military Airports

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

DPs specifically designed for obstacle avoidance are described below in text, or published separately as a graphic procedure. If the (Obstacle) DP is published as a graphic procedure, its name will be listed below, and it can be found in either this volume (civil), or a separate Departure Procedure volume (military), as appropriate. Users will recognize (Obstacle) graphic DPs referenced below by the folllowing note printed on the charted procedure: "If not assigned a Departure Procedure by ATC, this procedure may be flown to provide obstacle clearance." The term "(OBSTACLE)" will also be printed on the charted procedure.
[Note: Graphic Departure Procedures that have been designed primarily to assist Air Traffic Control in providing air traffic separation (as well as providing obstacle clearance) are usually assigned by name in an ATC clearance and are not listed by name in this section.]

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

MILITARY USERS NOTE: Civil (nonstandard) take-off minima are published below. For military take-off minima, refer to appropriate service directives.

NAME TAKE-OFF MINIMUMS

ALBANY, OR
ALBANY MUNI
DEPARTURE PROCEDURE: **Rwy 16**, turn right. **Rwy 34**, turn left. **All aircraft** climb direct CVO VOR/DME and continue climb in CVO VOR/DME holding pattern, (E, right turns, 261° inbound) to cross CVO VOR/DME at or above 3000.

ANACONDA, MT
BOWMAN FIELD
TAKE-OFF MINIMUMS: **Rwy 16**, 2400-3, or std. with climb gradient of 360' per NM to 7400. **Rwy 22**, NA.
DEPARTURE PROCEDURE: **Rwys 4, 16**, climbing left turn. **Rwy 34**, climbing right turn. **All aircraft** continue climb to 9000 via heading 030° and CPN R-346 to GLUES Int.

ARCO, ID
ARCO-BUTTE COUNTY
DEPARTURE PROCEDURE: **Rwy 6**, climbing right turn. **Rwy 24**, climbing left turn; aircraft departing AOC NDB bearing 070° CW 210° climb on course. **All other aircraft** continue climb to 8000 via 150° bearing from AOC NDB, then climb on course.

NAME TAKE-OFF MINIMUMS

ARLINGTON, WA
ARLINGTON MUNI
TAKE-OFF MINIMUMS: **Rwy 11**, 600-2 or std. with min. climb of 350' per NM to 700. **Rwy 34**, 500-2 or std. with min. climb of 260' per NM to 700.
DEPARTURE PROCEDURE: **Rwy 11**, turn right. **Rwy 16**, climb direct to WATON LOM. **Rwys 29, 34**, turn left. **All aircraft** climb direct to WATON LOM. Aircraft departing WATON LOM on bearings 150° CW 200° and bearings 260° CW 340° from WATON LOM continue climb on course. Aircraft departing WATON LOM on bearings 340° CW 150° from WATON LOM climb in holding pattern (S, left turns, 339° inbound) to 4500 then continue climb on course. Aircraft departing WATON LOM on bearings 200° CW 260° from WATON LOM climb in holding pattern (S, left turns, 339° inbound) to 1500 then continue climb on course.

99308

TAKE-OFF MINIMUMS AND (OBSTACLE) DEPARTURE PROCEDURES

NW-1

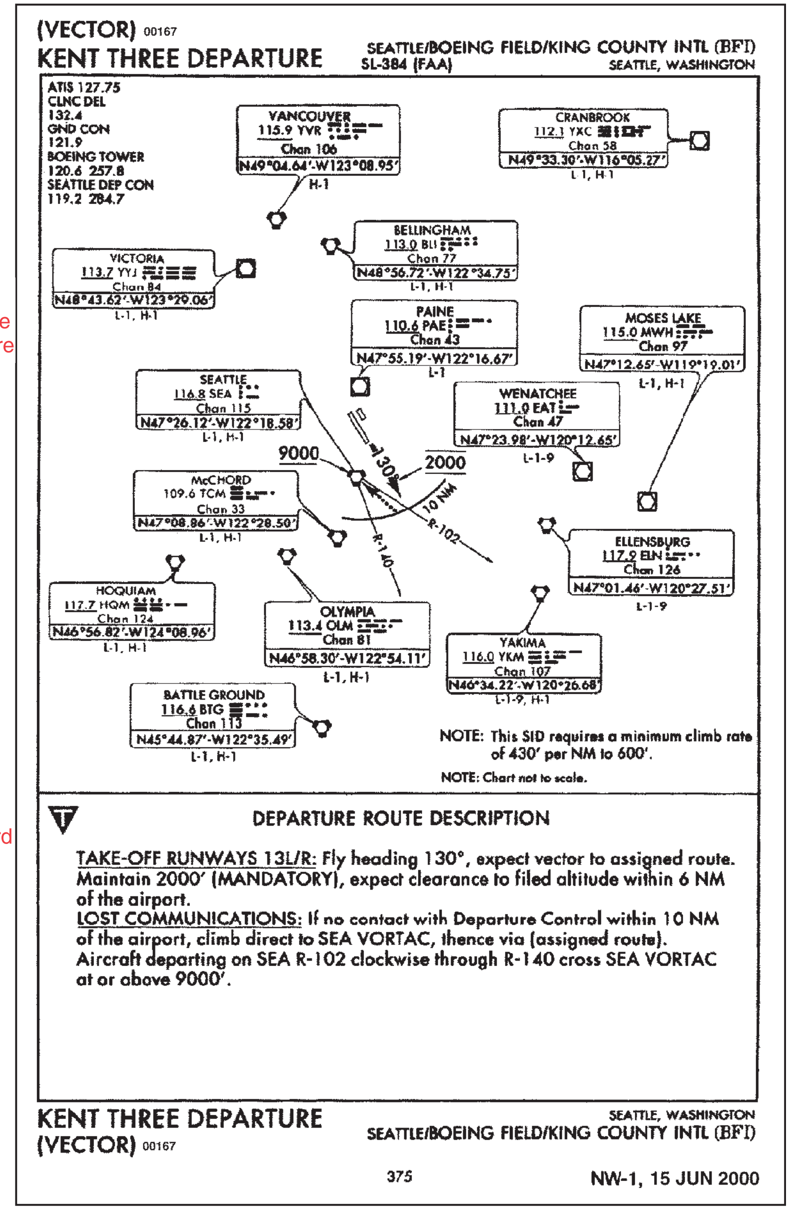


Figure 8-5. *Departure procedures.*

Standard Terminal Arrival Routes (STARs)

Standard terminal arrival routes (STARs) depict prescribed routes to transition the instrument pilot from the en route structure to a fix in the terminal area from which an instrument approach can be conducted. If you do not have the appropriate STAR in your possession, you can write "No STAR" in the flight plan. However, if the controller is busy, you might be cleared along the same route and, if necessary, the controller will have you copy the entire text of the procedure.

Textual DPs and STARs are listed alphabetically at the beginning of the NACO booklet, and graphic DPs (charts) are included after the respective airport's IAP. Figure 8-6 shows an example of a STAR, and the legend for STARs and DPs printed in NACO booklets.

Instrument Approach Procedures Charts (IAPs)

The IAPs chart provides the method to descend and land safely in low visibility conditions. The FAA has established the IAPs after thorough analyses of obstructions, terrain features, and navigational facilities. Maneuvers, including altitude changes, course corrections, and other limitations, are prescribed in the IAPs. The approach charts reflect the criteria associated with the U.S. Standard for Terminal Instrument Approach Procedures (TERPs), which prescribes standardized methods for use in designing instrument flight procedures.

In addition to the NACO, other governmental and corporate entities produce approach procedures. The U.S. military IAPs are established and published by the Department of Defense and are available to the public upon request. Special IAPs are approved by the FAA for individual operators and are not available to the general public. Foreign country standard IAPs are established and published according to the individual country's publication procedures. The information presented in the following sections will highlight features of the U.S. Terminal Procedures Publications.

The instrument approach chart is divided into five main sections, which include the margin identification, plan view, profile view, landing minimums (and notes), and airport diagram as shown in figure 8-7. An examination of each section follows.

Margin Identification

The **margin identification**, at the top and bottom of the chart, depicts the airport location and procedure identification. The approach plates are organized by city first, then airport name and state. For example, Spokane International in Spokane, Washington is alphabetically listed under "S" for Spokane.

The chart's **amendment status** appears above the procedure identification in the top margin (and below in the bottom margin), along with the volume's effective date. (The five-digit date format in the amendment, "00167" is read, "the 167th day of 2000.") At the center of the top margin is the FAA chart reference number and approving authority and, at the bottom center, the airport's latitude and longitude coordinates.

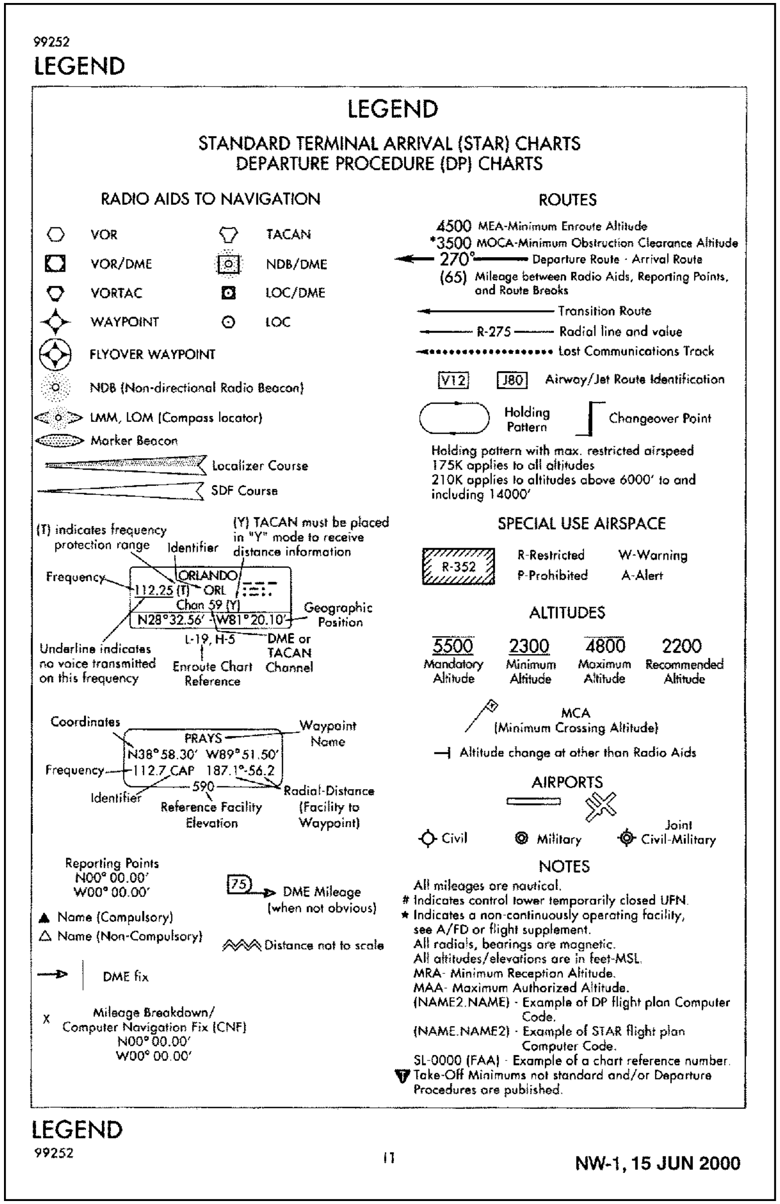
The procedure identification (top and bottom margin area of figure 8-7) is derived from the type of navigational facility providing final approach course guidance. A runway number is listed when the approach course is aligned within 30° of the runway centerline (e.g., "ILS RWY 19" or "VOR RWY 29"); this type of approach allows a straight-in landing under the right conditions. Some airports have parallel runways and simultaneous approach procedures. To distinguish between the left, right, and center runways, an "L," "R," or "C" follows the runway number (e.g., "ILS RWY 16R"). If the approach course diverges more than 30° from the runway centerline, a letter from the beginning of the alphabet is assigned (e.g., "VOR-A"). The letter designation signifies the expectation is for the procedure to culminate in a circling approach to land. In some cases, an airport might have more than one circling approach.

The navigational system required for the final approach segment can be determined by the procedure identification (top and bottom margin area of figure 8-7). The identification is derived from the type of navigational facility providing the final approach course guidance for straight-in approaches and the runway to which the course is aligned (e.g., ILS RWY 19 or RNAV RWY 29). Some airports have parallel runways and simultaneous approach procedures. To distinguish between the left, right, and center runways, an "L," "R," or "C" follows the runway number (e.g., NDB RWY 16R). For approaches that do not meet straight-in criteria, a letter from the beginning of the alphabet is assigned (e.g., VOR-A or LDA-B). The letter designation signifies the expectation is

Standard terminal arrival route (STAR): Preplanned IFR ATC arrival procedures, published for pilot use in textual and graphic format.

Margin identification: The top and bottom areas on an instrument approach chart that depict information about the procedure including airport location and procedure identification.

Amendment status: The circulation date and revision number of an instrument approach procedure, printed above the procedure identification.



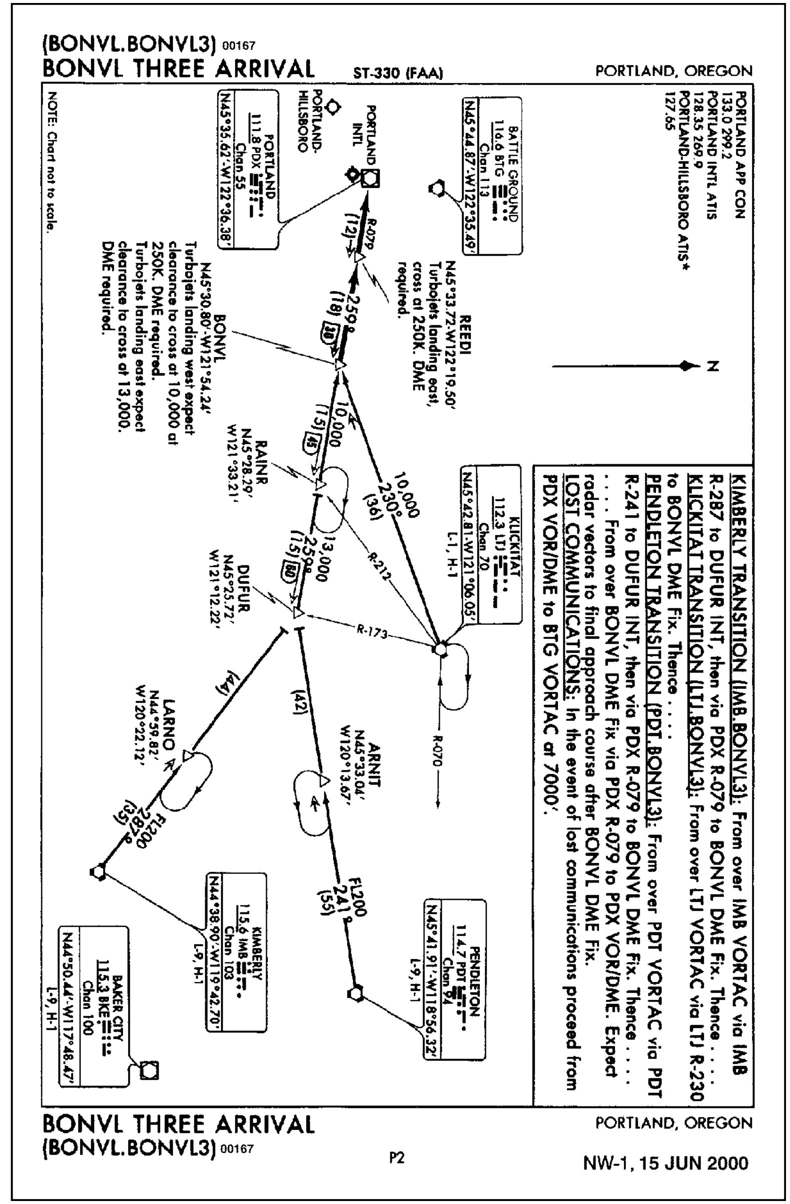


Figure 8-6. *STAR and DP chart legend.*

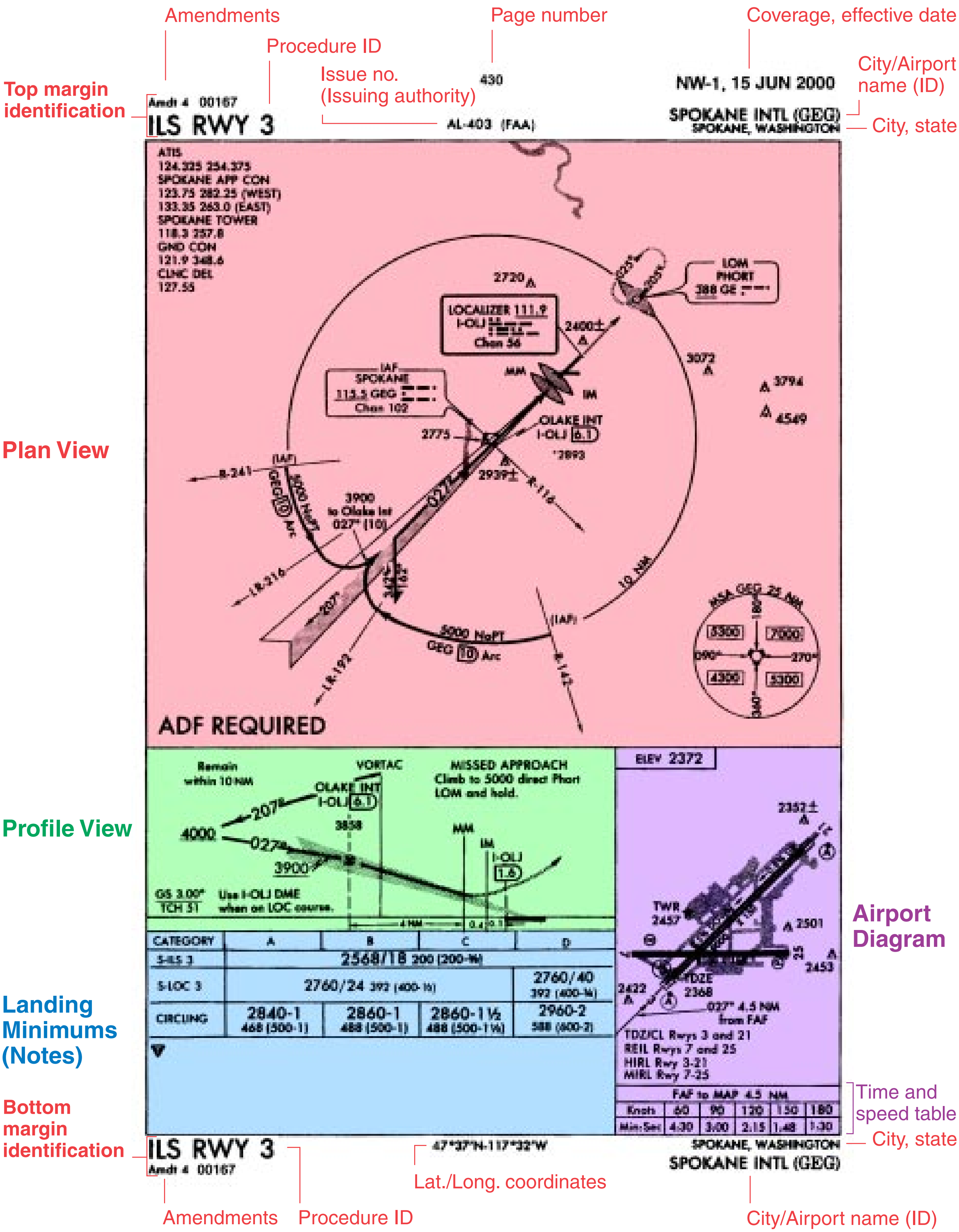


Figure 8-7. *Approach chart overview.*

for the procedure to culminate in a circling approach to land. More than one navigational system separated by a slash indicates more than one type of equipment is required to execute the final approach (e.g., VOR/DME RWY 31). More than one navigational system separated by "or" indicates either type of equipment may be used to execute the final approach (e.g., VOR or GPS RWY 15). Multiple approaches of the same type, to the same runway, using the same guidance, have an additional letter from the end of the alphabet, number or term in the title (e.g., ILS Z RWY 28, Silver ILS RWY 28, or ILS 2 RWY 28). VOR/DME RNAV approaches are identified as VOR/DME RNAV RWY (runway number). Helicopters have special IAPs, designated with COPTER in the procedure identification (e.g., COPTER LOC/DME 25L). Other types of navigation systems may be required to execute other portions of the approach prior to intercepting the final approach segment or during the missed approach.

The Plan View

The **plan view** provides a graphical overhead view of the procedure, and depicts the routes that guide the pilot from the en route segments to the initial approach fix (IAF). [Figure 8-7] During the initial approach, the aircraft has departed the en route phase of flight and is maneuvering to enter an intermediate or final segment of the instrument approach. An initial approach can be made along prescribed routes within the terminal area, which may be along an arc, radial, course, heading, radar vector, or a combination thereof. Procedure turns and high altitude teardrop penetrations are initial approach segments. Features of the plan view including the procedure turn, obstacle elevation, minimum safe altitude (MSA), and procedure track, are depicted in figure 8-8.

The majority of NACO charts contain a **reference** or **distance circle** with a 10 NM radius. Normally, approach features within the plan view are shown to scale; however, only the data within the reference circle is always drawn to scale. The circle is centered on an approach fix and has a radius of 10 NM, unless otherwise indicated. When a route segment, outside of the circle, is drawn to scale, the symbol interrupts the segment.

Dashed circles, or **concentric rings** around the distance circle, are used when the information necessary to the procedure will not fit to scale within the limits of the plan view area. They serve as a means to systematically arrange this information in its relative position outside and beyond the reference circle. These concentric rings are labeled en route facilities and **feeder facilities**. The **en route facilities ring** depicts NAVAIDs, fixes, and intersections that are part of the en route low altitude airway structure used in the approach procedure. The feeder facilities ring includes radio aids to navigation, fixes and intersections used by ATC to direct aircraft to intervening facilities/fixes between the en route structure and the IAF. Feeder routes are not part of the en route structure.

The primary airport depicted in the plan view is drawn with enough detail to show the runway orientation and final approach course alignment. Airports other than the primary approach airport are not depicted in the NACO plan view.

Known spot elevations and obstacles are indicated on the plan view in MSL altitudes. The largest dot and number combination indicates the highest elevation. An inverted "V" with a dot in the center depicts an obstacle. The highest obstacle is indicated with a bolder, larger version of the same symbol. Two interlocking inverted V's signify a group of obstacles. [Figure 8-8]

In the top left or right corner of the plan view is the communications area. Communication frequencies are generally listed in the order in which they would be used during arrival. Frequencies for weather and related facilities are included, where applicable, such as automatic terminal information service (ATIS), automated surface observing system (ASOS), automated weather observing system (AWOS) and AFSS's.

Plan view: Overhead view of an approach procedure on an IAP chart.

Reference circle (also, distance circle): The circle depicted in the plan view of an IAP chart that typically has a 10 NM radius, within which elements are drawn to scale.

Concentric rings: The dashed-line circles depicted in the plan view of IAP charts, outside of the reference circle, that show en route and feeder facilities.

Feeder facilities: NAVAIDs used by ATC to direct aircraft to intervening fixes between the en route structure and the initial approach fix.

En route facilities ring: A circle depicted in the plan view of IAP charts, which designates NAVAIDs, fixes, and intersections that are part of the en route low altitude airway structure.

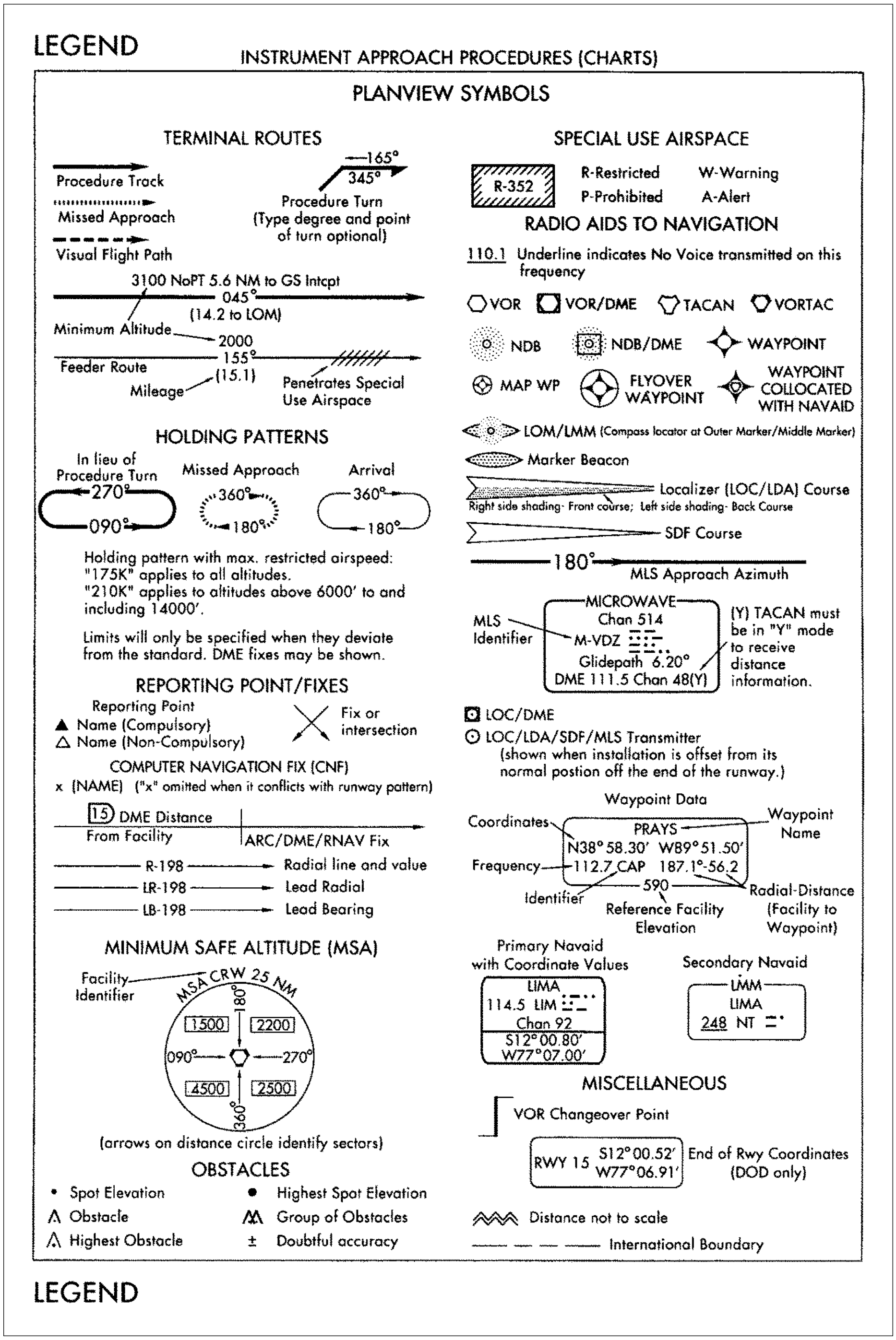
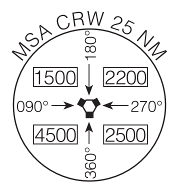


Figure 8-8. *IAP plan view symbols legend.*

The **minimum safe altitude (MSA)** circle appears in the plan view, except in approaches for which appropriate NAVAIDs (e.g., VOR or NDB) are unavailable. The MSA is provided for emergency purposes only and guarantees 1,000 feet obstruction clearance in the sector indicated with reference to the bearing in the circle. For conventional navigation systems, the MSA is normally based on the primary omnidirectional facility on which the IAP is predicated. The MSA depiction on the approach chart contains the facility identifier of the NAVAID used to determine the MSA altitudes. For RNAV approaches, the MSA is based on the runway waypoint for straight-in approaches, or the airport waypoint for circling approaches. For GPS approaches, the MSA center will be the missed approach waypoint. The MSL altitudes appear in boxes within the circle, which is typically a 25 NM radius unless otherwise indicated. The MSA circle refers to the letter identifier of the NAVAID or waypoint that describes the center of the circle. MSAs are not depicted on terminal arrival area (TAA) approach charts.



NAVAIDs, included in the plan view, are necessary for the completion of the instrument procedure and include the facility name, frequency, letter identifier, and Morse code sequence. A heavy-lined NAVAID box depicts the primary NAVAID used for the approach. An "I" in front of the NAVAID identifier (in figure 8-7, "I-OLJ") listed in the NAVAID box indicates a localizer and a TACAN channel (which signifies DME availability). The requirement for an ADF, DME or RADAR in the approach is noted in the plan view.

Intersections, fixes, radials, and course lines describe route and approach sequencing information. The main procedure, or final approach course is a thick, solid line. A DME arc, which is part of the main procedure course, is also represented as a thick, solid line. A feeder route is depicted with a medium line and provides heading, altitude, and distance information. (All three components must be designated on the chart to provide a navigable course.) Radials, such as lead radials, are shown by thin lines. The missed approach track is drawn Missed Approach using a thin dashed line with a directional arrow. A visual flight path segment appears as a thick dashed line with a directional arrow. Visual Flight Path

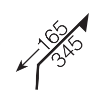
Initial approach fixes (IAFs) are charted IAF when associated with a NAVAID or when freestanding.

The missed approach holding pattern track is represented with a thin-dashed line. When colocated, the missed approach holding pattern and procedure turn holding pattern are indicated as a solid, black line. Arrival holding patterns are depicted as thin, solid lines.

Course Reversal Elements in Plan View and Profile View

Course reversals are included in an IAP, are depicted in one of three different ways, a 45°/180° procedure, a holding pattern, or a teardrop procedure. The maneuvers are required when it is necessary to reverse direction to establish the aircraft inbound on an intermediate or final approach course. Components of the required procedure are depicted in the plan view and the profile view. The maneuver must be completed within the distance and at the minimum altitude specified in the profile view. Pilots should coordinate with the appropriate ATC facility relating to course reversal during the IAP.

Procedure Turns

A **procedure turn** barbed arrow 

indicates the direction or side of the outbound course on which the procedure turn is made. Headings are provided for course reversal using the 45° procedure turn. However, the point at which the turn may be commenced, and the type and rate of turn is left to the discretion of the pilot. Some of the options are the 45° procedure turn, the racetrack pattern, the teardrop procedure turn, or the 80°/260° course reversal. The absence of the procedure turn barbed arrow in the plan view indicates that a procedure turn is not authorized for that procedure. A maximum procedure turn speed of not greater than 200 knots indicated airspeed (KIAS) should be observed when turning outbound over the IAF and throughout the procedure turn maneuver to ensure staying within the obstruction clearance area. The normal procedure turn distance is 10 NM. This may be reduced to a minimum of 5 NM where only Category A or helicopter aircraft are operated, or increased to as much as 15 NM to accommodate high performance aircraft. Descent below the procedure turn altitude begins after the aircraft is established on the inbound course.

Minimum safe altitude (MSA): The minimum altitude depicted on approach charts which provides at least 1,000 feet of obstacle clearance for emergency use within a specified distance from the listed navigation facility or waypoint.

Initial approach fix (IAF): The fixes depicted on IAP charts that identify the beginning of the initial approach segment(s).

Procedure turn: The maneuver prescribed when it is necessary to reverse direction to establish an aircraft on the intermediate approach segment or final approach course.

The procedure turn is *not* required when the symbol **"NoPT"** appears, when radar vectoring to the final approach is provided, when conducting a timed approach, or when the procedure turn is not authorized. Pilots should contact the appropriate ATC facility when in doubt if a procedure turn is required.

Holding in Lieu of Procedure Turn

A holding pattern in lieu of a procedure turn may be specified for course reversal in some procedures. In such cases, the holding pattern is established over an intermediate fix or a **final approach fix (FAF)**. The holding pattern distance or time specified in the profile view must be observed. Maximum holding airspeed limitations as set forth for all holding patterns apply. The holding pattern maneuver is completed when the aircraft is established on the inbound course after executing the appropriate entry. If cleared for the approach prior to returning to the holding fix, and the aircraft is at the prescribed altitude, additional circuits of the holding pattern are not necessary nor expected by ATC. If pilots elect to make additional circuits to lose excessive altitude or to become better established on course, it is their responsibility to advise ATC upon receipt of their approach clearance. When holding in lieu of a procedure turn, the holding pattern must be followed, *except* when RADAR VECTORING to the final approach course is provided or when NoPT is shown on the approach course.

Teardrop Procedure

When a teardrop procedure turn is depicted and a course reversal is required, unless otherwise authorized by ATC, this type of procedure must be executed. The teardrop procedure consists of departure from an IAF on the published outbound course followed by a turn toward and intercepting the inbound course at or prior to the intermediate fix or point. Its purpose is to permit an aircraft to reverse direction and lose considerable altitude within reasonably limited airspace. Where no fix is available to mark the beginning of the intermediate segment, it shall be assumed to commence at a point 10 NM prior to the FAF. When the facility is located on the airport, an aircraft is considered to be on final approach upon completion of the penetration turn. However, the final approach segment begins on the final approach course 10 NM from the facility.

Terminal Arrival Area (TAA)

The design objective of the terminal arrival area (TAA) procedure is to provide a transition method for arriving aircraft with GPS/RNAV equipment. TAAs will also eliminate or reduce the need for feeder routes, departure extensions, and procedure turns or course reversal. The TAA is controlled airspace established in conjunction with the standard or modified RNAV approach configurations.

The standard TAA has three areas: straight-in, left base, and right base. The arc boundaries of the three areas of the TAA are published portions of the approach and allow aircraft to transition from the en route structure direct to the nearest IAF. When crossing the boundary of each of these areas or when released by ATC within the area, the pilot is expected to proceed direct to the appropriate waypoint IAF for the approach area being flown. A pilot has the option in all areas of proceeding directly to the holding pattern.

The TAA has a "T" structure that normally provides a NoPT for aircraft using the approach. [Figure 8-9] The TAA provides the pilot and air traffic controller with an efficient method for routing traffic from the en route to the terminal structure. The basic "T" contained in the TAA normally aligns the procedure on runway centerline, with the missed approach point (MAP) located at the threshold, the FAF 5 NM from the threshold, and the intermediate fix (IF) 5 NM from the FAF.

In order to accommodate descent from a high en route altitude to the initial segment altitude, a hold in lieu of a procedure turn provides the aircraft with an extended distance for the necessary descent gradient. The holding pattern constructed for this purpose is always established on the center IAF waypoint. Other modifications may be required for parallel runways, or due to operational requirements. When published, the RNAV chart will depict the TAA through the use of "icons" representing each TAA associated with the RNAV procedure. These icons will be depicted in the plan view of the approach plate, generally arranged on the chart in accordance with their position relative to the aircraft's arrival from the en route structure.

NoPT (No Procedure Turn): Used with the appropriate course and altitude to denote the procedure turn is not required.

Final approach fix (FAF): The fix from which the IFR final approach to an airport is executed, which identifies the beginning of the final approach segment.

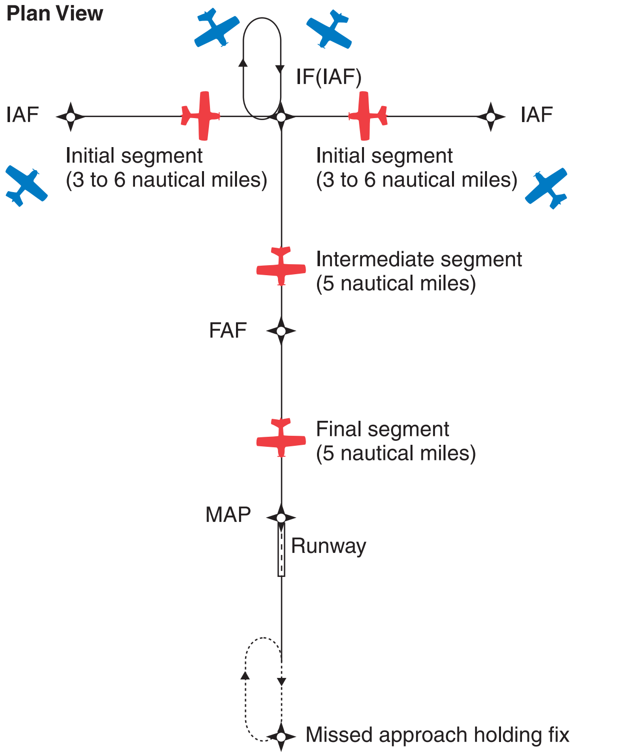


Figure 8-9. *Basic "T" Design of Terminal Arrival Area (TAA).*

The Profile View

The **profile view** is a drawing of the side view of the procedure and illustrates the vertical approach path altitudes, headings, distances, and fixes. [Figure 8-7] The view includes the minimum altitude and maximum distance for the procedure turn, altitudes over prescribed fixes, distances between fixes, and the missed approach procedure. The profile view aids in the pilot's interpretation of the IAP. The profile view is not drawn to scale. [Figures 8-10 and 8-11]

The precision approach **glide-slope intercept altitude** is a minimum altitude for glide slope interception after completion of the procedure turn, illustrated by an altitude number and "zigzag" line. It applies to precision approaches, and except where otherwise prescribed, also applies as a minimum altitude for crossing the FAF when the glide slope is inoperative or not used. Precision approach profiles also depict the glide-slope angle of descent, threshold-crossing height (TCH), and glide-slope altitude at the outer marker (OM).

In nonprecision approaches, a final descent is initiated at the FAF, or after completing the procedure turn and established inbound on the procedure course. The FAF is clearly identified by use of the Maltese cross symbol in the profile view. When the FAF is not indicated in the profile view, the MAP is based on station passage when the facility is on the airport or a specified distance (e.g., VOR/DME or GPS procedures).

Stepdown fixes in nonprecision procedures are provided between the FAF and the airport for authorizing a lower **minimum descent altitude (MDA)** after passing an obstruction. Stepdown fixes can be identified by NAVAID, NAVAID fix, waypoint, radar, and are depicted by a vertical dashed line. Normally, there is only one stepdown fix between the FAF and the MAP, but there can be several. If the stepdown fix cannot be identified for any reason, the minimum altitude at the stepdown fix becomes the MDA for the approach. However, circling minimums apply if they are higher than the stepdown fix minimum altitude, and a circling approach is required.

The **visual descent point (VDP)** is a defined point on the final approach course of a nonprecision straight-in approach procedure. A normal descent from the MDA to the runway touchdown point may be commenced, provided visual reference is established. The VDP is identified on the profile view of the approach chart by the symbol "V." [Figure 8-11]

The **missed approach point (MAP)** varies depending upon the approach flown. For the ILS, the MAP is at the decision altitude/decision height (DA/DH). In nonprecision procedures, the pilot determines the MAP by timing from FAF when the approach aid is well away from the airport, by a fix or NAVAID when the navigation facility is located on the field, or by waypoints as defined by GPS or VOR/DME RNAV. The pilot may execute the MAP early, but pilots should, unless otherwise cleared by ATC, fly the IAP as specified on the approach plate to the MAP at or above the MDA or DA/DH before executing a turning maneuver.

Profile view: Side view of an approach procedure on an IAP chart illustrating the vertical approach path altitudes, headings, distances, and fixes.

Glide-slope intercept altitude: The minimum altitude of an intermediate approach segment prescribed for a precision approach that ensures obstacle clearance.

Stepdown fix: Permits additional descent within a segment of an IAP by identifying a point at which an obstacle has been safely overflown.

Minimum descent altitude (MDA): The lowest altitude (in feet MSL) to which descent is authorized in execution of a nonprecision IAP.

Visual descent point (VDP): A defined point on the final approach course of a nonprecision straight-in approach procedure from which normal descent from the MDA to the runway touchdown point may be commenced, provided the runway environment is clearly visible to the pilot.

Missed approach point (MAP): A point prescribed in each instrument approach at which a missed approach procedure shall be executed if the required visual reference has not been established.

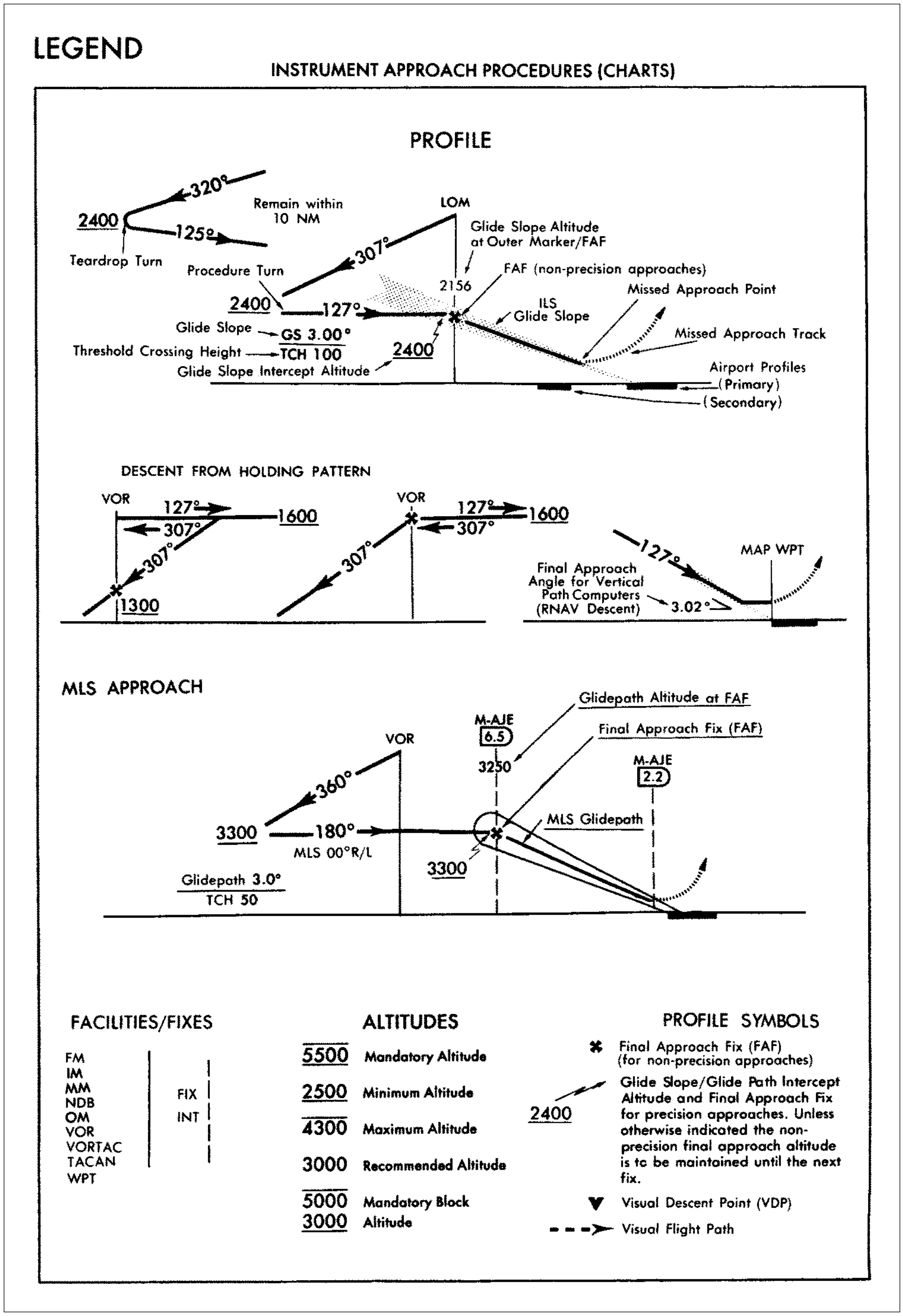


Figure 8-10. *IAP profile legend.*

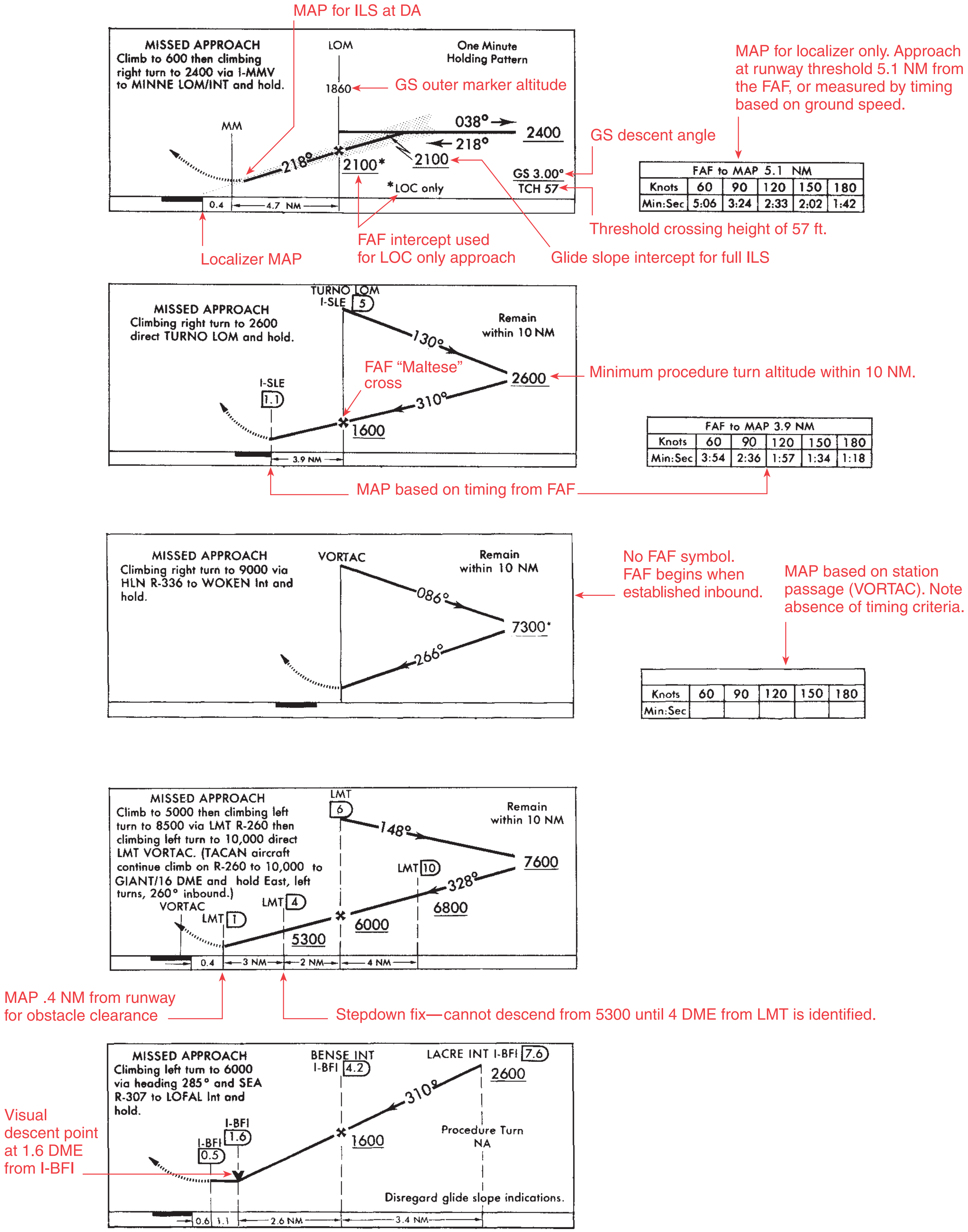


Figure 8-11. *More IAP profile view features.*

A complete description of the **missed approach procedure** appears in the profile view. [Figure 8-11] When initiating a missed approach, the pilot will be directed to climb straight ahead (e.g., "Climb to 2,500"), or commence a turning climb to a specified altitude (e.g., "Climbing left turn to 2,500"). In some cases, the procedure will direct the pilot to climb straight ahead to an initial altitude, then turn or enter a climbing turn to the holding altitude (e.g., "Climb to 900, then climbing right turn to 2,500 direct ABC VOR and hold").

When the missed approach procedure specifies holding at a facility or fix, the pilot proceeds according to the missed approach track and pattern depicted on the plan view. An alternate missed approach procedure may also be issued by ATC. The textual description will also specify the NAVAID(s) or radials that identify the holding fix.

The profile view also depicts minimum, maximum, recommended, and mandatory block altitudes used in approaches. The minimum altitude is depicted with the altitude underscored. $\underline{2500}$ On final approach, aircraft are required to maintain an altitude at or above the depicted altitude until reaching the subsequent fix. The maximum altitude will be depicted with the altitude overscored, $\overline{4300}$ and aircraft must remain at or below the depicted altitude. Mandatory altitude will be depicted with the altitude both underscored and overscored, $\overline{\underline{5500}}$ and altitude is to be maintained at the depicted value. Recommended altitudes are advisory altitudes and are neither over- nor underscored. When an over- or underscore spans two numbers, a mandatory block altitude is indicated, and aircraft are required to maintain altitude within the range of the two numbers. [Figures 8-10 and 8-11]

Minimums and Notes

The **minimums section** sets forth the lowest altitude and visibility requirements for the approach, whether precision or nonprecision, straight-in or circling, or radar vectored. When a fix is incorporated in a nonprecision final segment, two sets of minimums may be published, depending upon whether or not the fix can be identified. Two sets of minimums may also be published when a second altimeter source is used in the procedure. The minimums ensure that final approach obstacle clearance is provided from the start of the final segment to the runway or MAP, whichever occurs last. The same minimums apply to both day and night operations unless different minimums are specified in the Notes section. Published circling minimums provide obstacle clearance when pilots remain within the appropriate area of protection. [Figure 8-12]

Minimums are specified for various **aircraft approach categories** based upon a value 1.3 times the stalling speed of the aircraft in the landing configuration at maximum certified gross landing weight. If it is necessary to maneuver at speeds in excess of the upper limit of a speed range for a category, the minimums for the next higher category should be used. For example, an aircraft that falls into category A, but is circling to land at a speed in excess of 91 knots, should use approach category B minimums when circling to land. [Figure 8-13]

The minimums for straight-in and circling appear directly under each aircraft category. [Figure 8-12] When there is no solid division line between minimums for each category on the rows for straight-in or circling, the minimums apply to the two or more undivided categories.

The terms used to describe the minimum approach altitudes differ between precision and nonprecision approaches. Precision approaches use **decision altitude (DA)**, charted in "feet MSL," followed by the **decision height (DH)** which is referenced to the **height above threshold elevation (HAT)**. Nonprecision approaches use MDA, referenced to "feet MSL." The minimums are also referenced to HAT for straight-in approaches, or **height above airport (HAA)** for circling approaches. On NACO charts, the figures listed parenthetically are for military operations and are not used in civil aviation.

Missed approach procedure: A maneuver performed by a pilot when an instrument approach cannot be completed to a landing.

Minimums section: The area on an IAP chart that displays the lowest altitude and visibility requirements for the approach.

Aircraft approach category: A performance grouping of aircraft based on a speed of 1.3 times their stall speed in the landing configuration at maximum gross landing weight.

Decision altitude (DA): A specified altitude in the precision approach, charted in "feet MSL," at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.

Decision height (DH): A specified altitude in the precision approach, charted in "height above threshold elevation," at which a decision must be made to either continue the approach or to execute a missed approach.

Height above threshold elevation (HAT): The DA/DH or MDA above the highest runway elevation in the touchdown zone (first 3,000 feet of the runway).

Height above airport (HAA): The height of the MDA above the published airport elevation.

TERMS, LANDING MINIMA DATA

IFR LANDING MINIMA

The United States Standard for Terminal Instrument Procedures (TERPS) is the approved criteria for formulating instrument approach procedures. Landing minima are established for six aircraft approach categories (ABCDE and COPTER). In the absence of COPTER MINIMA, helicopters may use the CAT A minimums of other procedures. The standard format for RNAV minima and landing minima portrayal follows:

RNAV MINIMA

CATEGORY	A	B	C	D
GLS PA DA	1382/24 200 (200-½)			
LNAV/DA VNAV	1500/24 318 (400-½)			1500/40 318 (400-¾)
LNAV MDA	1700/24 518 (600-½)		1700/50 518 (600-1)	1700/60 518 (600-1¼)
CIRCLING	1760-1 578 (600-1)		1760-1½ 578 (600-1½)	1760-2 578 (600-2)

RNAV minimums are dependent on navigation equipment capability, as stated in the applicable AFM or AFMS and as outlined below.

GLS (Global Navigation System (GNSS) Landing System)

Must have WAAS (Wide Area Augmentation System) equipment approved for precise approach. Note: "PA" indicates that the runway environment, i.e., runway markings, runway lights, parallel taxiway, etc., meets precision approach requirements. If the GLS minimums line does not contain "PA", then the runway environment does not support precision requirements.

LNAV/VNAV (Lateral Navigation/Vertical Navigation)

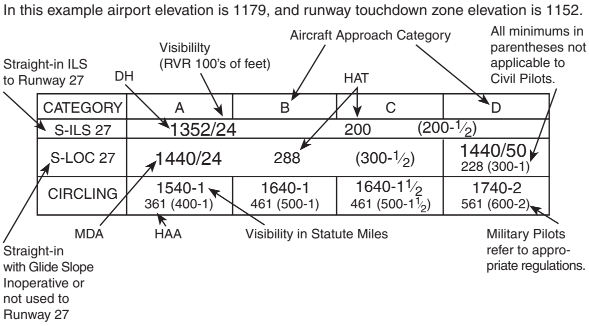
Must have WAAS equipment approved for precision approach, or RNP-0.3 system based on GPS or DME/DME, with an IFR approach approved Baro-VNAV system. Other RNAV approach systems require special appoval. Use of Baro-VNAV systems is limited by temperature, i.e., "Baro-VNAV NA below -20 C(-4 F)".
(Not applicable if chart is annotated "Baro-VNAV NA".)
NOTE: DME/DME based RNP-0.3 systems may be used only when a chart note indicates DME/DME availability, for example, "DME/DME RNP-0.3 Authorized." Specific DME facilities may be required, for example: "DME/DME RNP-0.3 Authorized. ABC, XYZ required."

LNAV (Lateral Navigation)

Must have IFR approach approved WAAS, GPS, GPS based FMS systems, or RNP-0.3 systems based on GPS or DME/DME. Other RNAV approach systems require special approval.
NOTE: DME/DME based RNP-0.3 systems may be used only when a chart note indicates DME/DME availability, for example, "DME/DME RNP-0.3 Authorized." Specific DME facilities may be required, for example: "DME/DME RNP-0.3 Authorized. ABC, XYZ required."

LANDING MINIMA FORMAT

In this example airport elevation is 1179, and runway touchdown zone elevation is 1152.



Example of a Specific Radar Approach

RADAR INSTRUMENT APPROACH MINIMUMS

OAK HARBOR, WA   Amdt. 1. NOV 20. 1986   ELEV 189
OAK HARBOR AIR PARK
RADAR - 118.2 286 0

	RWY GS/TCH/RPI	CAT	DH/ MDA-VIS	HAT/ HAA	CEIL-VIS	CAT	DH/ MDA-VIS	HAT/ HAA CEIL-VIS
ASR	25	AB	**600-1**	411	(500-1)	CD	**NA**	
	7	AB	**600-1**	450	(500-1)	CD	**NA**	
CIRCLING		AB	**640-1**	451	(500-1)	CD	**NA**	
		WHIDBEY ALTIMETER SETTING						
ASR	25	AB	**900-1**	711	(800-1)	CD	**NA**	
	7	AB	**900-1**	750	(800-1)	CD	**NA**	
CIRCLING		AB	**900-1**	711	(800-1)	CD	**NA**	

Circling NA North of Rwy 7-25
When control zone not in effect, use Whidbey altimeter setting.
A NA

Figure 8-12. *IAP landing minimums.*

Category	Maneuvering Table	Circling Approach Area Radii
A	0–90 knots	1.3 miles
B	91–120 knots	1.5 miles
C	121–140 knots	1.7 miles
D	141–165 knots	2.3 miles
E	166 knots or more	4.5 miles

Figure 8-13. *Aircraft approach categories and circling limits.*

RVR (feet)	Visibility (statute miles)
1,600	¼
2,400	½
3,200	⅝
4,000	¾
4,500	⅞
5,000	1
6,000	1¼

Figure 8-14. *RVR conversion table.*

Visibility figures are provided in statute miles or **runway visual range (RVR)**, which is reported in hundreds of feet. RVR is measured by a transmissometer, which represents the horizontal distance measured at points along the runway. It is based on the sighting of either high intensity runway lights or on the visual contrast of other targets, whichever yields the greater visual range. RVR is horizontal visual range, not slant visual range, and is used in lieu of prevailing visibility in determining minimums for a particular runway. [Figure 8-14]

Visibility figures are depicted after the DA/DH or MDA in the minimums section. If visibility in statute miles is indicated, an altitude number, hyphen, and a whole or fractional number appear; for example, 530-1, which indicates "530 feet MSL" and 1 statute mile visibility, this is the descent minimum for the approach. The RVR value is separated from the minimum altitude with a slash, such as

Runway visual range (RVR): The instrumentally-derived horizontal distance a pilot should be able to see down the runway from the approach end, based on either the sighting of high-intensity runway lights, or the visual contrast of other objects.

"1065/24," which indicates 1,065 feet MSL and an RVR of 2,400 feet. If RVR were prescribed for the procedure, but not available, a conversion table would be used to provide the equivalent visibility—in this case, of 1/2 statute mile visibility. [Figure 8-14] The conversion table is also available in the TPP.

When an **alternate airport** is required, standard IFR alternate minimums apply. Precision approach procedures require a 600-foot ceiling and 2 statute miles visibility; nonprecision approaches require an 800-foot ceiling and 2 statute miles visibility. When a black triangle with a white "A" appears in the Notes section of the approach chart, it indicates non-standard IFR alternate minimums exist for the airport. If an "NA" appears after the "A" A NA alternate minimums are not authorized. This information is found in the beginning of the TPP.

Procedural notes are included in a box located below the altitude and visibility minimums. For example, a procedural note might indicate, "Circling NA E of RWY 1-19." Some other notes might concern a local altimeter setting and the resulting change in the minimums. The use of RADAR may also be noted in this section. Additional notes may be found in the plan view.

When a triangle containing a "T" T appears in the notes area, it signifies the airport has nonstandard IFR takeoff minimums. The appropriate section in the front of the TPP would be consulted in this case.

In addition to the COPTER approaches, instrument-equipped helicopters may fly standard approach procedures. The required visibility minimum may be reduced to one-half the published visibility minimum for category A aircraft, but in no case may it be reduced to less than 1/4 mile or 1,200 feet RVR.

A couple of terms are specific to helicopters. **Height above landing (HAL)** means height above a designated helicopter landing area used for helicopter IAPs. "**Point in space approach**" refers to a helicopter IAP to a MAP more than 2,600 feet from an associated helicopter landing area.

Airport Diagram

The **airport diagram**, located on the bottom right side of the chart, includes many helpful features. IAPs for some of the larger airports devote an entire page to an airport diagram. Information concerning runway orientation, lighting, final approach bearings, airport beacon, and obstacles all serve to guide the pilot in the final phases of flight. *See* figure 8-15 for a legend of airport diagram features (*see also* figure 8-7 for an example of an airport diagram).

The diagram shows the runway configuration in solid black, while the taxiways and aprons are shaded gray. Other runway environment features are shown, such as the runway identification, dimensions, magnetic heading, displaced threshold, arresting gear, usable length, and slope.

The airport elevation is indicated in a separate box at the top of the airport diagram box. The **touch down zone elevation (TDZE)**, which is the highest elevation within the first 3,000 feet of the runway, is designated at the approach end of the procedure's runway.

Beneath the airport diagram is the **time and speed table.** The table provides the distance and the amount of time required to transit the distance from the FAF to the MAP for selected groundspeeds.

The approach lighting systems and the visual approach lights are depicted on the approach chart. White on black symbols V are used for identifying pilot-controlled lighting (PCL). Runway lighting aids are also noted (e.g., REIL, HIRL), as is the runway centerline lighting (RCL). [Figure 8-16]

Alternate airport: Designated in an IFR flight plan, provides a suitable destination if a landing at the intended airport becomes inadvisable.

Height above landing (HAL): A HAL is a height above a designated helicopter landing area used for helicopter instrument approach procedures.

Point in space approach: A type of helicopter instrument approach procedure to a missed approach point more than 2,600 feet from an associated helicopter landing area.

Airport diagram: The section of an IAP chart that shows a detailed diagram of the airport including surface features and airport configuration information.

Touch down zone elevation (TDZE): The highest elevation in the first 3,000 feet of the landing surface, TDZE is indicated on the IAP chart when straight-in landing minimums are authorized.

Time and speed table: A table depicted on an instrument approach procedure chart that identifies the distance from the FAF to the MAP, and provides the time required to transit that distance based on various ground speeds.

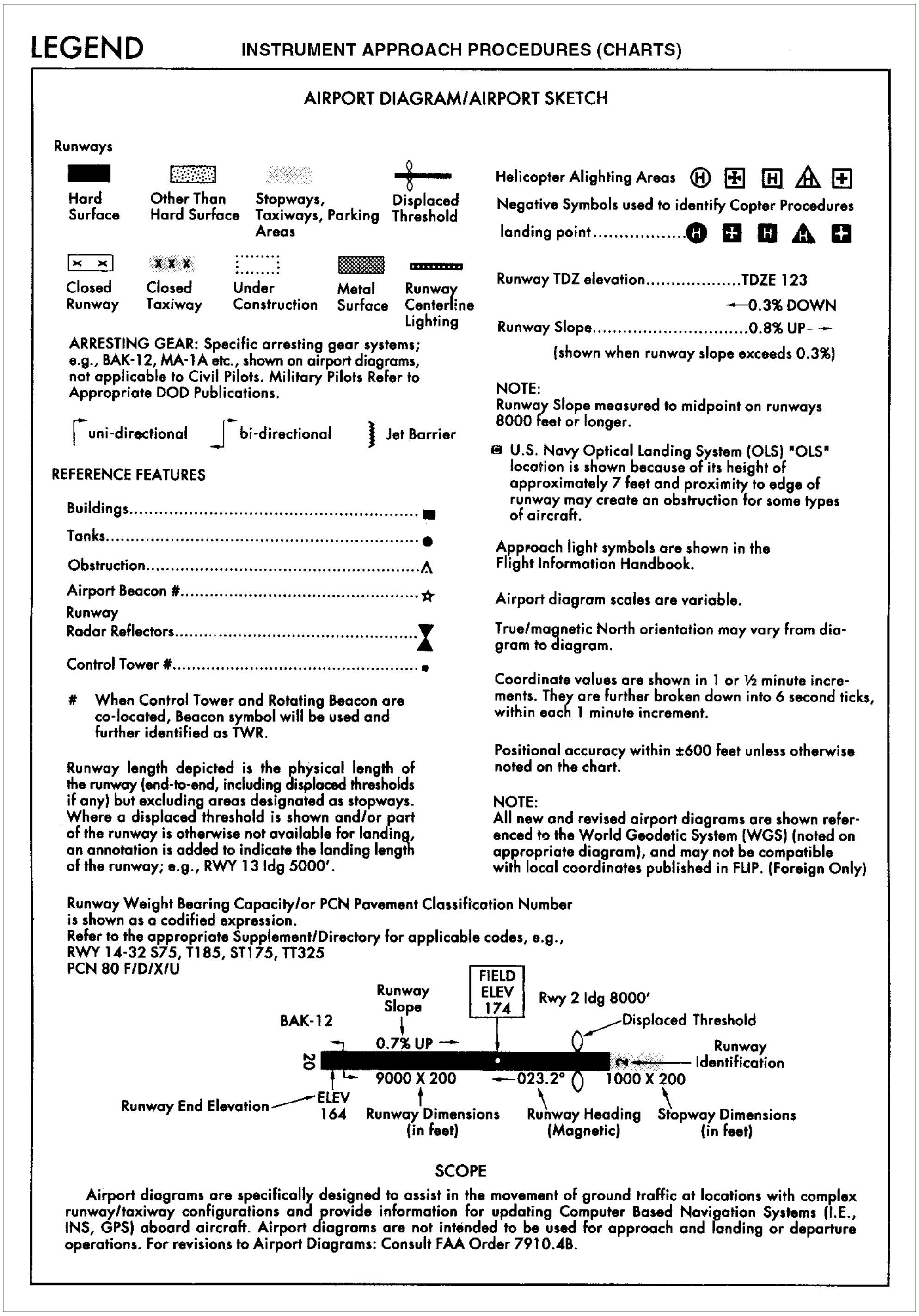


Figure 8-15. *Airport diagram legend.*

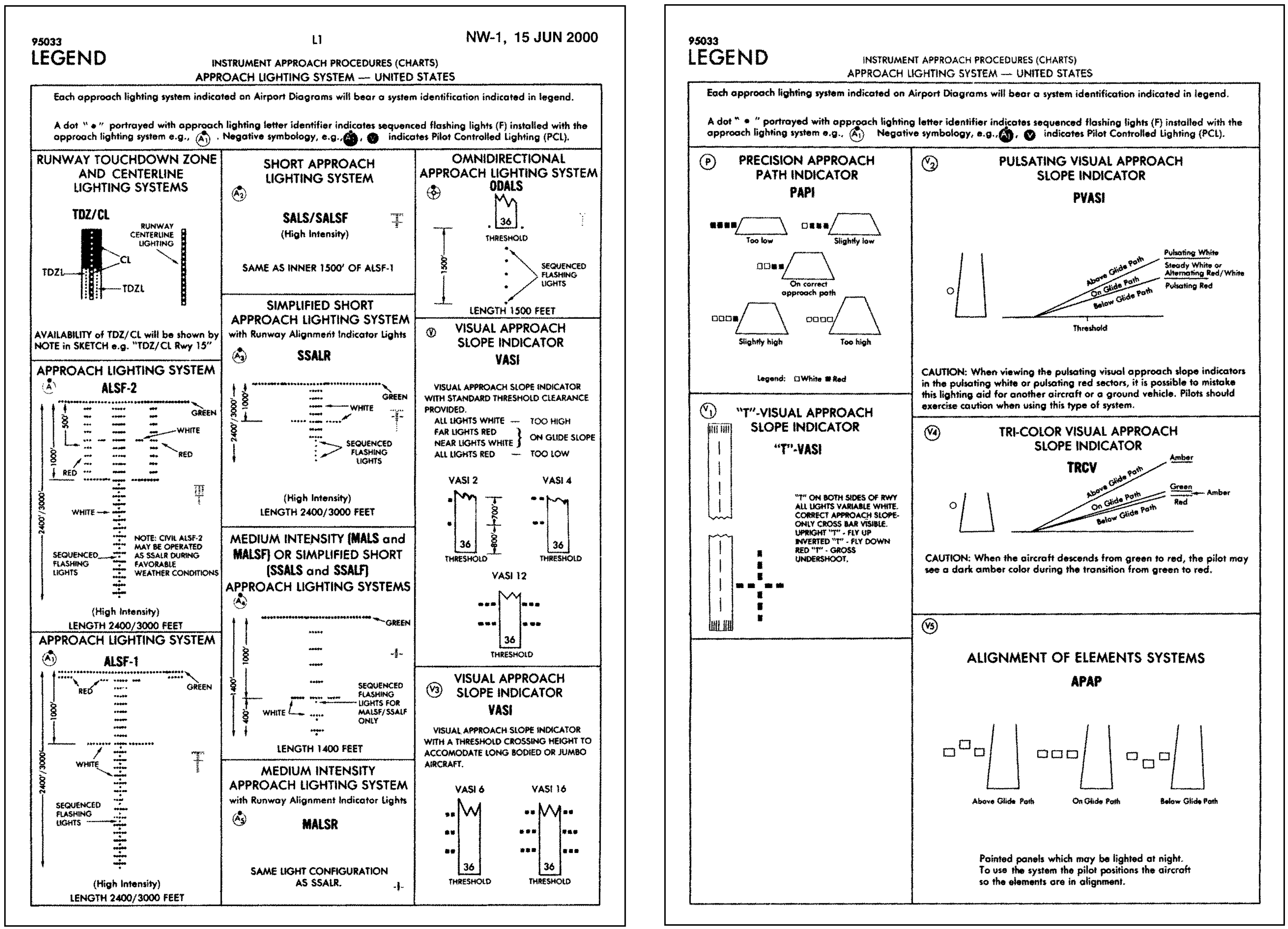


Figure 8-16. *Approach lighting legend.*

Inoperative Components

Certain procedures can be flown with **inoperative components**. According to the Inoperative Components Table, for example, an ILS approach with a malfunctioning Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR = MALS with RAIL) can be flown if the minimum visibility is increased by 1/4 mile. [Figure 8-17] A note in this section might read, "Inoperative Table does not apply to ALS or HIRL Runway 13L."

RNAV Instrument Approach Charts

Instrument approach charts are being converted to a charting format similar to the format developed for RNAV IAP. [Figure 8-18] This format avoids unnecessary duplication and proliferation of instrument approach charts. The approach minimums for unaugmented GPS, Wide Area Augmentation System (WAAS), Local Area Augmentation System (LAAS), will be published on the same approach chart as lateral navigation/vertical navigation (LNAV/VNAV). Other types of equipment may be authorized to conduct the approach based on the minima notes in the front of the TPP approach chart books. Approach charts titled "RNAV RWY XX" may be used by aircraft with navigation systems that meet the **required navigational performance (RNP)** values for each segment of the approach.

The chart may contain as many as four lines of approach minimums: **Global landing system (GLS);** WAAS and LAAS; LNAV/VNAV; LNAV; and circling. LNAV/VNAV is an instrument approach with lateral and vertical guidance with integrity limits similar to **barometric vertical navigation (BARO VNAV)**.

RNAV procedures that incorporate a final approach stepdown fix may be published without vertical navigation, on a separate chart, also titled RNAV. During a transition period when GPS procedures are undergoing revision to a new title, both RNAV and GPS approach charts and formats will be published. ATC clearance for the RNAV procedure will authorize a properly-certificated pilot to utilize any landing minimums for which the aircraft is certified.

The RNAV chart will include formatted information required for quick pilot or flightcrew reference located at the top of the chart. This portion of the chart was developed based on a study by the Department of Transportation (DOT), Volpe National Transportation Systems Center.

Chart terminology will change slightly to support the new procedure types:

1. DA replaces the term DH. DA conforms to the international convention where altitudes relate to MSL and heights relate to AGL. DA will eventually be published for other types of IAPs with vertical guidance, as well. DA indicates to the pilot that the published descent profile is flown to the DA (MSL), where a missed approach will be initiated if visual references for landing are not established. Obstacle clearance is provided to allow a momentary descent below DA while transitioning from the final approach to the missed approach. The aircraft is expected to follow the missed approach instructions while continuing along the published final approach course to at least the published runway threshold waypoint or MAP (if not at the threshold) before executing any turns.
2. MDA will continue to be used for the LNAV-only and circling procedures.
3. Threshold crossing height (TCH) has been traditionally used in precision approaches as the height of the glide slope above threshold. With publication of LNAV/VNAV minimums and RNAV descent angles, including graphically depicted descent profiles, TCH also applies to the height of the "descent angle," or glidepath, at the threshold. Unless otherwise required for larger type aircraft which may be using the IAP, the typical TCH will be 30 to 50 feet.

The minima format changes slightly:

1. Each line of minima on the RNAV IAP will be titled to reflect the RNAV system applicable (e.g., GLS, LNAV/VNAV, and LNAV.) Circling minima will also be provided.
2. The minima title box will also indicate the nature of the minimum altitude for the IAP. For example: DA will be published next to the minima line title for minimums supporting vertical guidance, and MDA will be published where the minima line supports only lateral guidance. During an approach where an MDA is used, descent below MDA is not authorized.

Inoperative components: Higher minimums are prescribed when the specified visual aids are not functioning; this information is listed in the Inoperative Components Table found in the Terminal Procedures Publications.

Required navigational performance (RNP): Navigational performance necessary to operate in a given airspace or perform a particular procedure.

Global Landing System (GLS): Global Navigation Satellite System (GNSS) that includes WAAS and/or LAAS.

Barometric vertical navigation (BARO VNAV): A navigational system which presents computed vertical guidance to the pilot referenced to a specific vertical path angle (VPA) and is based on barometric altitude.

INOP COMPONENTS

INOPERATIVE COMPONENTS OR VISUAL AIDS TABLE

Landing minimums published on instrument approach procedure charts are based upon full operation of all components and visual aids associated with the particular instrument approach chart being used. Higher minimums are required with inoperative components or visual aids as indicated below. If more than one component is inoperative, each minimum is raised to the highest minimum required by any single component that is inoperative. ILS glide slope inoperative minimums are published on instrument approach charts as localizer minimums. This table may be amended by notes on the approach chart. Such notes apply only to the particular approach category(ies) as stated. See legend page for description of components indicated below.

(1) ILS, MLS, and PAR

Inoperative Component or Aid	Approach Category	Increase Visibility
ALSF 1 & 2, MALSR, & SSALR	ABCD	¼ mile

(2) ILS with visibility minimum of 1,800 RVR.

ALSF 1 & 2, MALSR, & SSALR	ABCD	To 4000 RVR
TDZI RCLS	ABCD	To 2400 RVR
RVR	ABCD	To ½ mile

(3) VOR, VOR/DME, VORTAC, VOR (TAC), VOR/DME (TAC), LOC, LOC/DME, LDA, LDA/DME, SDF, SDF/DME, GPS, RNAV, and ASR

Inoperative Visual Aid	Approach Category	Increase Visibility
ALSF 1 & 2, MALSR, & SSALR	ABCD	½ mile
SSALS, MALS, & ODALS	ABC	¼ mile

(4) NDB

ALSF 1 & 2, MALSR	C	½ mile
& SSALR	ABD	¼ mile
MALS, SSALS, ODALS	ABC	¼ mile

CORRECTIONS, COMMENTS AND/OR PROCUREMENT

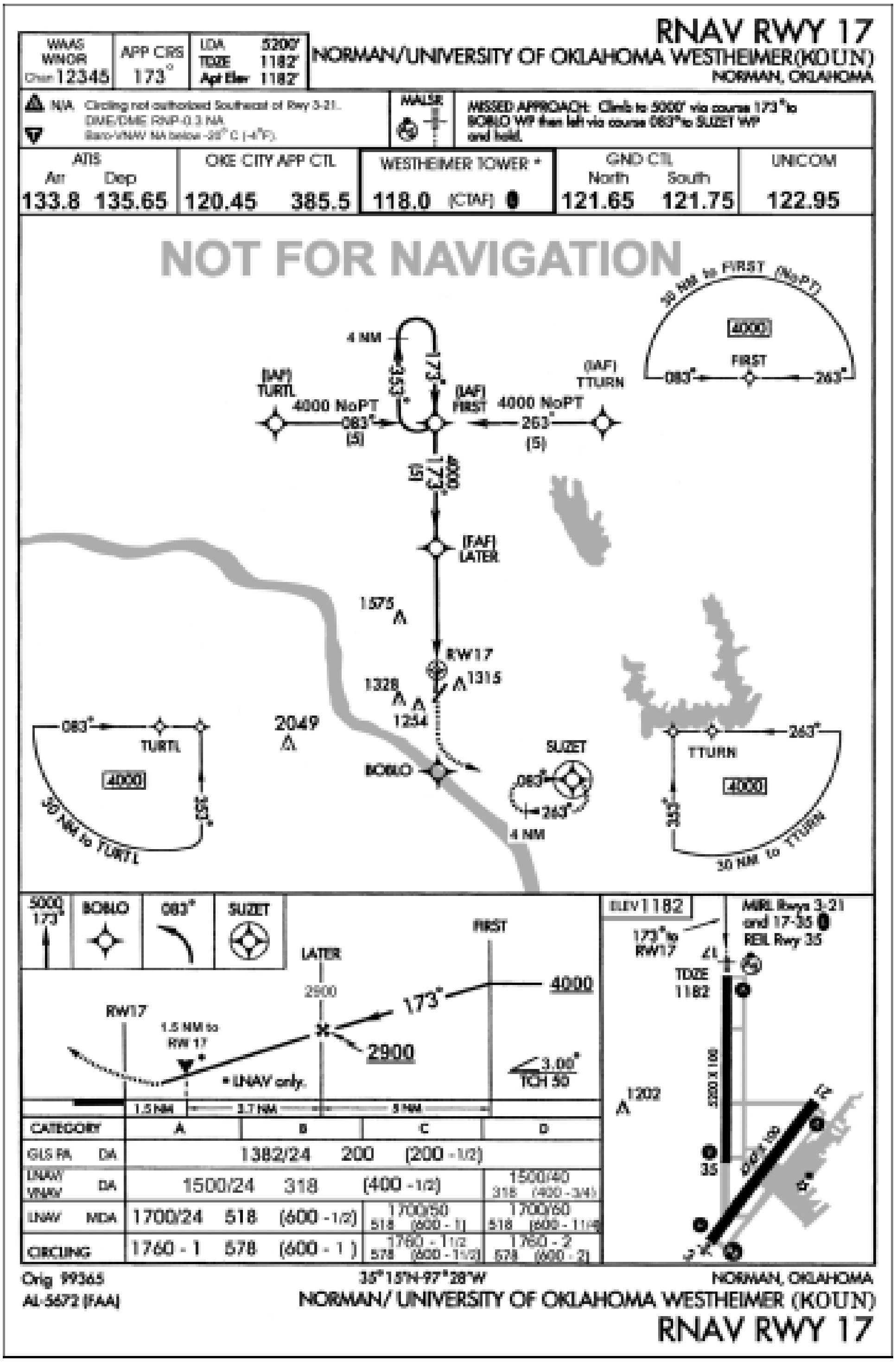
FOR CHARTING ERRORS CONTACT:
National Ocean Service/NOAA
N/ACC1, SSMC-4, Sta. #2335
1305 East-West Highway
Silver Spring, MD 20910-3281
Telephone Toll-Free (800) 626-3677
Internet/E-Mail: Aerochart@NOAA.GOV

FOR CHANGES, ADDITIONS, OR RECOMMENDATIONS ON PROCEDURAL ASPECTS:
Contact Federal Aviation Administration, ATA 110
800 Independence Avenue, S.W.
Washington, D.C. 20591
Telephone Toll-Free (800) 457-6656

TO PURCHASE CHARTS CONTACT:
National Ocean Service
NOAA, N/ACC3
Distribution Division
Riverdale, MD 20737
Telephone (800) 638-8972

Requests for the creation or revisions to Airport Diagrams should be in accordance with FAA Order 7910.4B.

Figure 8-17. *IAP inoperative components table.*



CATEGORY	A	B	C	D
GLS PA DA	1382/24 200 (200 -1/2)			
LNAV/VNAV DA	1500/24 318 (400 -1/2)			1500/40 318 (400 -3/4)
LNAV MDA	1700/24 518 (600 -1/2)		1700/50 518 (600 - 1)	1700/60 518 (600 - 1 1/4)
CIRCLING	1760 - 1 578 (600 - 1)		1760 - 1 1/2 578 (600 - 1 1/2)	1760 - 2 578 (600 - 2)

Figure 8-18. *RNAV Approach Chart.*

3. Where two or more systems share the same minima, each line of minima will be displayed separately.

The following chart symbology will change slightly: [Figure 8-18]

1. Descent profile
2. VDP
3. Missed approach symbology
4. Waypoints

For more information concerning government charts, the NACO can be contacted by telephone, or via their internet address at:

National Aeronautical Charting Office
Telephone 800-626-3677
http://acc.nos.noaa.gov/

Chapter 9

The Air Traffic Control System

Introduction

This chapter will cover the communication equipment, communication procedures, and air traffic control (ATC) facilities and services available for a flight under instrument flight rules (IFR) in the National Airspace System (NAS).

Communication Equipment

Navigation/Communication (NAV/COM) Equipment

Civilian pilots communicate with ATC on frequencies in the very high frequency (VHF) range between 118.000 and 136.975 MHz. To derive full benefit from the ATC system, radios capable of 25 kHz spacing are required (e.g., 134.500, 134.575, 134.600, etc.). If ATC assigns a frequency that cannot be selected on your radio, ask for an alternative frequency.

Figure 9-1 illustrates a typical radio panel installation, consisting of a communications transceiver on the left and a navigational receiver on the right. Many radios allow the pilot to have one or more frequencies stored in memory and one frequency active for transmitting and receiving (called **simplex** operation). It is possible to communicate with some automated flight service stations (AFSS) by transmitting on 122.1 MHz (selected on the communication radio) and receiving on a VHF omnidirectional range (VOR) frequency (selected on the navigation radio). This is called **duplex** operation.

An audio panel allows you to adjust the volume of the selected receiver(s) and to select the desired transmitter. [Figure 9-2] The audio panel has two positions for receiver selection, cabin speaker and headphone (some units might have a center "off" position). Use of a hand-held microphone and the cabin speaker introduces the distraction of reaching for and hanging up the microphone. A headset with a boom microphone is recommended for clear communications. Position the microphone close to your lips because ambient cockpit noise may interfere with the controller understanding your transmissions. Headphones will deliver the received signal directly to your ears; therefore, ambient noise does not interfere with your ability to understand the transmission. [Figure 9-3]

Switching the transmitter selector between COM1 and COM2 changes both the transmitter and receiver frequencies. It should be necessary to select a receiver, communication or navigation, only when you want to monitor one communications frequency while communicating on another. One example is listening to automatic terminal information service (ATIS) on one receiver while communicating with ATC on the other. Monitoring a navigation receiver to check for proper identification is another reason to use the switch panel.

Most audio switch panels also include a marker beacon receiver; all marker beacons transmit on 75 MHz, so there is no frequency selector.

Simplex: Transmitting and receiving on the same frequency.

Duplex: Transmitting on one frequency and receiving on a separate frequency.

Figure 9-1. *Typical NAV/COM installation.*

Figure 9-2. *Audio panel.*

Figure 9-3. *Boom microphone, headset, and push-to-talk switch.*

Figure 9-4. *Combination GPS-Com unit.*

Figure 9-4 illustrates an increasingly popular form of **NAV/COM** radio; it contains a global positioning system (GPS) receiver and a communications transceiver. Using its navigational capability, this unit can determine when your flight crosses an airspace boundary or fix and can automatically select the appropriate communications frequency for that location in the communications radio.

Radar and Transponders

ATC **radars** have a limited ability to display primary returns, which is energy reflected from an aircraft's metallic structure. Their ability to display secondary returns (transponder replies to ground interrogation signals) makes possible the many advantages of automation.

A transponder is a radar beacon transmitter/receiver installed in the instrument panel. ATC beacon transmitters send out interrogation signals continuously as the radar antenna rotates. When an interrogation is received by your transponder, a coded reply is sent to the ground station where it is displayed on the controller's scope. A "Reply" light on your transponder panel flickers every time you receive and reply to a radar interrogation. **Transponder codes** are assigned by ATC.

When a controller asks you to "**ident**" and you push the ident button, your return on the controller's scope is intensified for precise identification of your flight. When requested, briefly push the ident button to activate this feature. It is good practice to verbally confirm you have changed codes or pushed the ident button.

Mode C (Altitude Reporting)

Primary radar returns indicate only range and bearing from the radar antenna to the target; secondary radar returns can display altitude **Mode C** on the control scope if the aircraft is equipped with an encoding altimeter or blind encoder. In either case, when the transponder's function switch is in the ALT position the aircraft's **pressure altitude** is sent to the controller. Adjusting the altimeter's **Kollsman window** has no effect on the altitude read by the controller.

Transponders must be ON at all times when operating in controlled airspace; altitude reporting is required by regulation in Class B and Class C airspace and inside of a 30-mile circle surrounding the primary airport in Class B airspace. Altitude reporting should also be ON at all times.

NAV/COM: Combined communication and navigation radio.

Radar: Radio Detection And Ranging.

Transponder code: One of 4,096 four-digit discrete codes ATC will assign to distinguish between aircraft.

Ident: Push the button on the transponder to identify your return on the controller's scope.

Mode C: Altitude reporting transponder mode.

Pressure altitude: Altitude above the standard 29.92" Hg plane.

Kollsman window: Adjustment for altimeter setting.

Communication Procedures

Clarity in communication is essential for a safe instrument flight. This requires pilots and controllers to use terms that are understood by both — the *Pilot/Controller Glossary* in the *Aeronautical Information Manual* (AIM) is the best source of terms and definitions. The AIM is revised twice a year and new definitions are added, so the Glossary should be reviewed frequently. Because clearances and instructions are comprised largely of letters and numbers, a phonetic pronunciation guide has been developed for both. [Figure 9-5]

Air traffic controllers must follow the guidance of the *Air Traffic Control Manual* when communicating with pilots. The manual presents the controller with different situations and prescribes precise terminology that must be used. This is advantageous for pilots, because once they have recognized a pattern or format they can expect future controller transmissions to follow that format. Controllers are faced with a wide variety of communication styles based on pilot experience, proficiency, and professionalism.

Pilots should study the examples in the AIM, listen to other pilots communicate, and apply the lessons learned to their own communications with ATC. Pilots should ask for clarification of a clearance or instruction. If necessary, use plain English to ensure understanding, and expect the controller to reply in the same way. A safe instrument flight is the result of cooperation between controller and pilot.

Communication Facilities

The controller's primary responsibility is separation of aircraft operating under IFR. This is accomplished with ATC facilities which include the AFSS, airport traffic control tower (ATCT), terminal radar approach control (TRACON), and air route traffic control center (ARTCC).

Automated Flight Service Stations (AFSS)

Your first contact with ATC will probably be through AFSS, either by radio or telephone. AFSS's provide pilot briefings, receives and processes flight plans, relays ATC clearances, originates Notices to Airmen (NOTAMs), and broadcasts aviation weather. Some facilities provide **En Route Flight Advisory Service (EFAS)**, take weather observations, and advise United States (U.S.) Customs and Immigration of international flights.

En Route Flight Advisory Service (EFAS): An en route weather-only AFSS service.

Character	Morse Code	Telephony	Phonic (Pronunciation)
A	• —	Alfa	(AL-FAH)
B	— • • •	Bravo	(BRAH-VOH)
C	— • — •	Charlie	(CHAR-LEE) or (SHAR-LEE)
D	— • •	Delta	(DELL-TAH)
E	•	Echo	(ECK-OH)
F	• • — •	Foxtrot	(FOKS-TROT)
G	— — •	Golf	(GOLF)
H	• • • •	Hotel	(HOH-TEL)
I	• •	India	(IN-DEE-AH)
J	• — — —	Juliett	(JEW-LEE-ETT)
K	— • —	Kilo	(KEY-LOH)
L	• — • •	Lima	(LEE-MAH)
M	— —	Mike	(MIKE)
N	— •	November	(NO-VEM-BER)
O	— — —	Oscar	(OSS-CAH)
P	• — — •	Papa	(PAH-PAH)
Q	— — • —	Quebec	(KEH-BECK)
R	• — •	Romeo	(ROW-ME-OH)
S	• • •	Sierra	(SEE-AIR-RAH)
T	—	Tango	(TANG-GO)
U	• • —	Uniform	(YOU-NEE-FORM) or (OO-NEE-FORM)
V	• • • —	Victor	(VIK-TAH)
W	• — —	Whiskey	(WISS-KEY)
X	— • • —	Xray	(ECKS-RAY)
Y	— • — —	Yankee	(YANG-KEY)
Z	— — • •	Zulu	(ZOO-LOO)
1	• — — — —	One	(WUN)
2	• • — — —	Two	(TOO)
3	• • • — —	Three	(TREE)
4	• • • • —	Four	(FOW-ER)
5	• • • • •	Five	(FIFE)
6	— • • • •	Six	(SIX)
7	— — • • •	Seven	(SEV-EN)
8	— — — • •	Eight	(AIT)
9	— — — — •	Nine	(NIN-ER)
0	— — — — —	Zero	(ZEE-RO)

Figure 9-5. *Phonetic pronunciation guide.*

Telephone contact with Flight Service can be obtained by dialing 1-800-WX-BRIEF anywhere in the United States—you will be connected to the nearest AFSS based on the area code from which you are calling. There are a variety of methods of making radio contact: direct transmission, remote communications outlets (RCOs), ground communication outlets (GCOs), and by using duplex transmissions, through navigational aids (NAVAIDs). The best source of information on frequency usage is the *Airport/Facility Directory* (A/FD), and the legend panel on sectional charts also contains contact information.

The briefer will send your flight plan to the host computer at the ARTCC (Center). After processing your flight plan, the computer will send **flight strips** to the tower, to the radar facility that will handle your departure route, and to the Center controller whose sector you will first enter. Figure 9-6 shows a typical strip. These strips will be delivered approximately 30 minutes prior to your proposed departure time. Strips will be delivered to en route facilities 30 minutes before you are expected to enter their airspace. If you fail to open your flight plan, it will "time out" 2 hours after your proposed departure time.

When departing an airport in Class G airspace, you will receive your IFR clearance from the AFSS by radio or telephone. It will contain either a **"clearance void" time**, in which case you must be airborne prior to that time, or a "release" time—you should not be airborne prior to release time. You can help the controller by stating how soon you expect to be airborne. If your void time is, for example, 10 minutes past the hour and you are airborne at exactly 10 minutes past the hour, your clearance is void—you must be airborne prior to the void time. You may ask for a specific void time when filing your flight plan.

Air Traffic Control Towers

Several controllers in the tower cab will be involved in handling your instrument flight. Where there is a dedicated clearance delivery position, that frequency will be found in the A/FD and on the instrument approach chart for the departure airport. Where there is no clearance delivery position, the ground controller will perform this function. At the busiest airports, pre-taxi clearance is required; the frequency for pre-taxi clearance can be found in the A/FD. Taxi clearance should be requested not more than 10 minutes before proposed taxi time.

It is recommended that you read your IFR clearance back to the clearance delivery controller. Instrument clearances can be overwhelming if you try to copy them verbatim, but they follow a format that allows you to be prepared when you say "Ready to copy." The format is: Clearance limit (usually the destination airport); Route, including any departure procedure; initial Altitude; Frequency (for departure control); and Transponder code. With the exception of the transponder code, you will know most of these items before engine start. One technique for clearance copying is writing C-R-A-F-T.

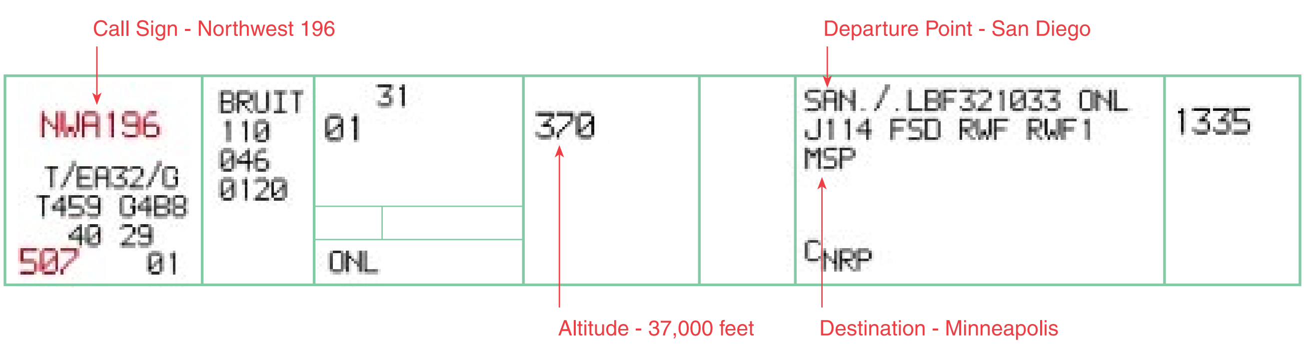


Figure 9-6. *Flight strip.*

Flight strips: Paper strips containing instrument flight information.

Clearance void time: Used by ATC to advise an aircraft that the departure clearance is automatically canceled if takeoff is not made prior to a specified time. The pilot must obtain a new clearance or cancel the IFR flight plan if not off by the specified time.

Memory aid for IFR clearance format:

C learance limit
R oute (including DP, if any)
A ltitude
F requency
T ransponder code

Assume you have filed an IFR flight plan from Seattle, Washington to Sacramento, California via V-23 at 7,000 feet. You note traffic is taking off to the north from Seattle-Tacoma (Sea-Tac) airport and, by monitoring the clearance delivery frequency, you note the departure procedure being assigned to southbound flights. Your clearance limit will be the destination airport, so you can write "SAC" after the letter C. Write "SEATTLE TWO – V23" after R for Route, because you heard departure control issue this departure to other flights (you could also call the tower on the telephone to ask what departure is in use). Write "7" after the A, the departure control frequency printed on the approach charts for Sea-Tac after F, and leave the space after T blank—the transponder code is generated by computer and can seldom be determined in advance. Now call clearance delivery and report ready to copy.

As the controller reads the clearance, check it against what you have already written down; if there is a change, draw a line through that item and write in the changed item. Chances are the changes will be minimal, and you will have "copied" most of your clearance before keying the microphone. Still, it is worthwhile to develop your own clearance shorthand to cut down on the verbiage that must be copied (*see* appendix 1).

You are required to have either the text or a graphic representation of a departure procedure (DP) (if one is available), and should review it before you accept your clearance. This is another reason to find out ahead of time which DP is in use. If the DP includes an altitude or a departure control frequency, those items will not be included in the clearance delivered to you from the tower cab.

The last clearance received supersedes all previous clearances. For instance, if the DP says "Climb and maintain 2,000 feet, expect higher in 6 miles" and upon contacting the departure controller you hear "Climb and maintain 8,000 feet," the 2,000-foot restriction has been canceled. This rule applies in both terminal and Center airspace.

If you report ready to copy your IFR clearance before the strip has been received from the Center computer, you will be advised "**clearance on request**" and the controller will call you when it has been received. Use this time for taxi and pretakeoff checks.

The "local" controller is responsible for operations in the **Class D airspace** and on the active runways. At some towers, designated as IFR towers, the local controller has **vectoring** authority. At visual flight rules (VFR) towers, the local controller accepts inbound IFR flights from the terminal radar facility and cannot provide vectors. The local controller also coordinates flights in the local area with radar controllers. Although Class D airspace normally extends 2,500 feet above field elevation, towers frequently release the top 500 feet to the radar controllers to facilitate overflights. Accordingly, when your flight is vectored over an airport at an altitude that appears to enter the tower controller's airspace, there is no need for you to contact the tower controller—all coordination is handled by ATC.

The departure radar controller may be in the same building as the control tower, but it is more likely that the departure radar position is remotely located. The tower controller will not issue a takeoff clearance until the departure controller issues a release.

Terminal Radar Approach Control (TRACON)

TRACONs are considered terminal facilities because they provide the link between the departure airport and the en route structure of the NAS. Terminal airspace normally extends 30 nautical miles (NM) from the facility, with a vertical extent of 10,000 feet; however, dimensions vary widely. Class B and Class C airspace dimensions are provided on aeronautical charts. At terminal radar facilities the airspace is divided into sectors, each with one or more controllers, and each sector is assigned a discrete radio frequency. All terminal facilities are approach controls, and should be addressed as "Approach" except when directed to do otherwise ("Contact departure on 120.4").

Terminal radar antennas are located on or adjacent to the airport. Figure 9-7 shows a typical configuration. Terminal controllers can assign altitudes lower than published procedural altitudes called **minimum vectoring altitudes (MVAs)**. These altitudes are not published and accessible to pilots, but are displayed at the controller's position, as shown in figure 9-8. However, if you are assigned an altitude that seems to be too low, query the controller before descending.

Clearance on request: Clearance has not been received.

Class D airspace: Airspace controlled by an operating control tower.

Vectoring: Navigational guidance by assigning headings.

Minimum vectoring altitude (MVA): An IFR altitude, lower than the minimum en route altitude (MEA), that provides terrain and obstacle clearance.

Terrain Clearance Responsibility

Terrain clearance responsibility is yours as pilot in command, until you reach the controller's MVA; but even then, if the altitude assigned seems too low, query the controller before descending.

Figure 9-7. *Combined radar and beacon antenna.*

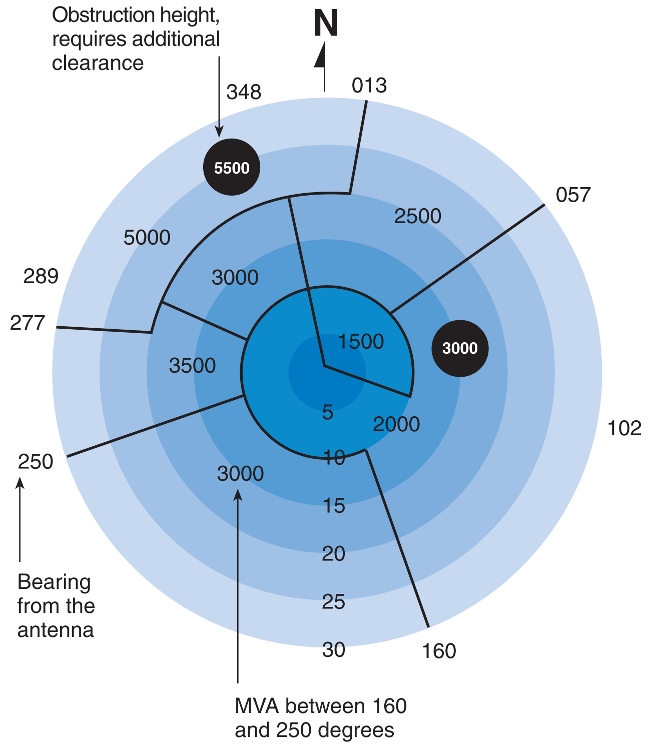


Figure 9-8. *Minimum Vectoring Altitude Chart.*

When you receive and accept your clearance and report ready for takeoff, a controller in the tower contacts the TRACON for a release—you will not be released until the departure controller can fit your flight into the departure flow. You may have to hold for release. When you receive takeoff clearance, the departure controller is aware of your flight and is waiting for your call. All of the information the controller needs is on the departure strip or the computer screen, so you need not repeat any portion of your clearance to that controller; simply establish contact with the facility when instructed to do so by the tower controller. The terminal facility computer will pick up your transponder and initiate tracking as soon as it detects the assigned code; for this reason, the transponder should remain on standby until takeoff clearance has been received.

Your aircraft will appear on the controller's radar as a target with an associated data block that moves as your aircraft moves through the airspace. The data block includes aircraft identification, aircraft type, altitude, and airspeed.

A TRACON controller uses Airport Surveillance Radar (ASR) to detect primary targets and Automated Radar Terminal Systems (ARTS) to receive transponder signals; the two are combined on the controller's scope. [Figure 9-9]

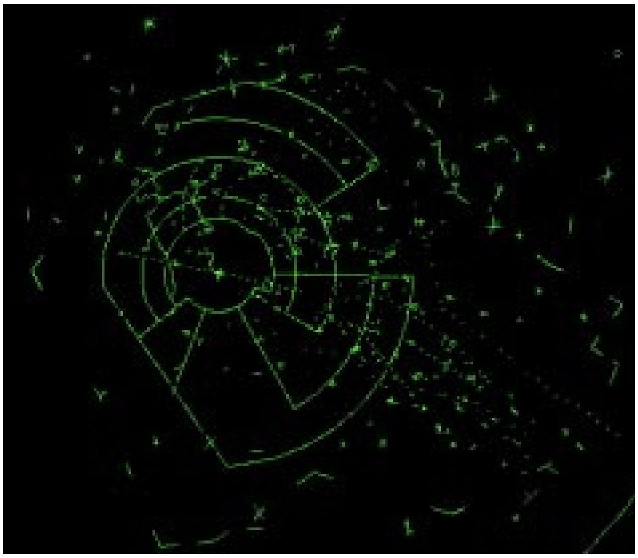
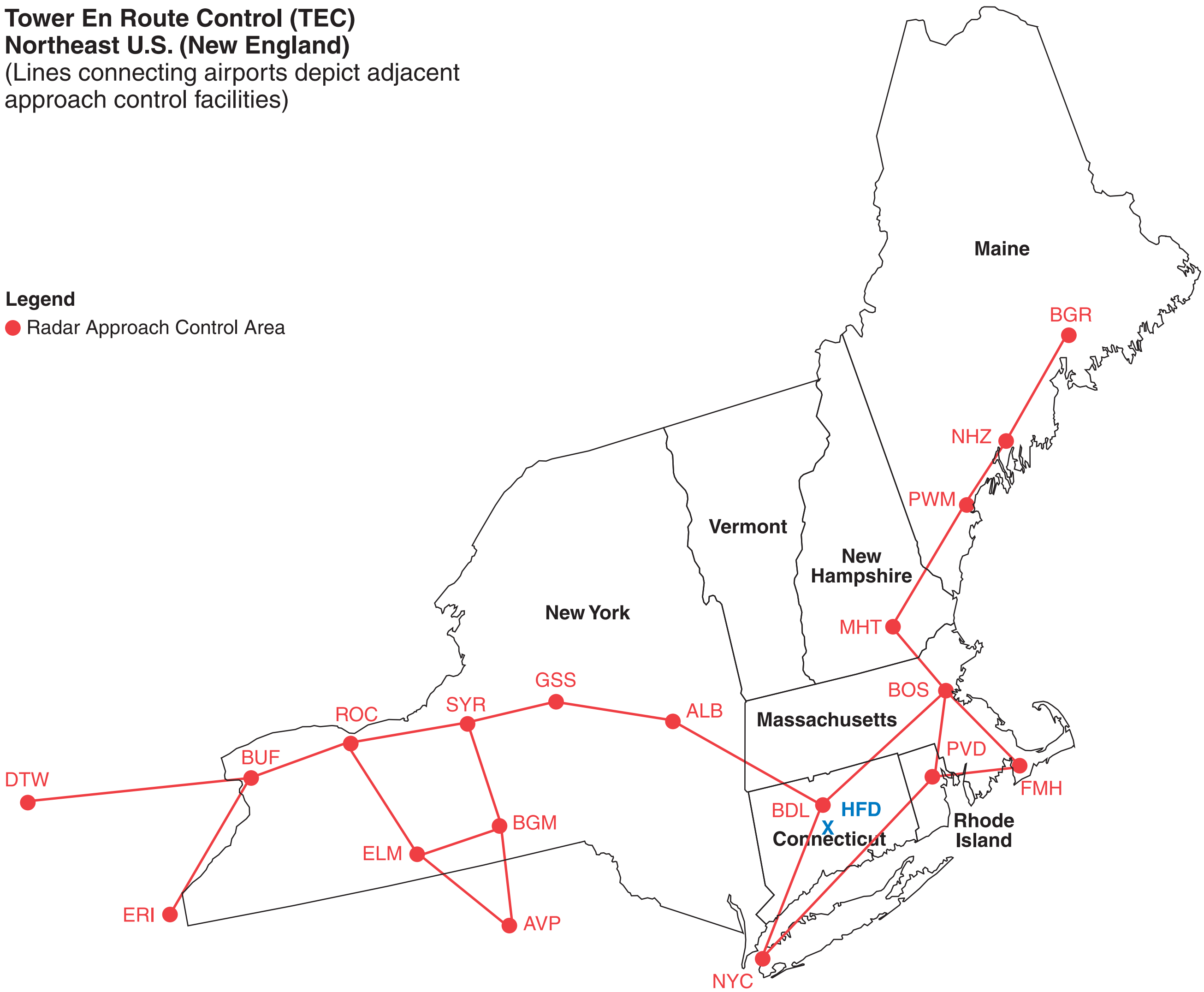


Figure 9-9. *What the approach controller sees.*

Tower En Route Control (TEC)
Northeast U.S. (New England)
(Lines connecting airports depict adjacent approach control facilities)

Legend
● Radar Approach Control Area



New York/Kennedy	....	SAX V249 SBJ V30 ETX (Non jet/Non turboprop)	8000	Allentown
	....	DIXIE V229 ACY (Props only)	6000	Atlantic City
	....	DIXIE V1 HOWIE (Jets only)	8000	Atlantic City
	....	DIXIE V1 V308 OTT (Props only)	6000	Andrews AFB
	....	DIXIE V16 ENO V268 SWANN (Props only)	6000	Baltimore
	....	COL	2000	Belmar
	....	BDR MAD V475 V188 TMU	9000	Block Island
	....	BDR V229 HFD V3 WOONS	9000	Boston
	....	BDR V229 HFD HFD053 DREEM	9000	Boston (North)
	....	BDR BDR014 JUDDS V419 BRISS	9000	Bradley
	....	BDR BDR014 JUDDS V419 BRISS (Jets only)	10000	Bradley

Figure 9-10. *A portion of the New York area Tower En Route list. (From the A/FD.)*

At facilities with ASR-3 equipment, radar returns from precipitation are not displayed as varying levels of intensity, and controllers must rely on pilot reports and experience to provide weather avoidance information. With ASR-9 equipment, the controller can select up to six levels of intensity. Level 1 precipitation does not require avoidance tactics, but the presence of levels 2 or 3 should cause pilots to investigate further. The returns from higher levels of intensity may obscure aircraft data blocks, and controllers may select the higher levels only on pilot request. When you are uncertain about the weather ahead, ask the controller if the facility can display intensity levels—pilots of small aircraft should avoid intensity levels 3 or higher.

Tower En Route Control (TEC)

At many locations, instrument flights can be conducted entirely in terminal airspace. These TEC routes are generally for aircraft operating below 10,000 feet, and they can be found in the A/FD. Pilots desiring to use TEC should include that designation in the remarks section of the flight plan.

Pilots are not limited to the major airports at the city pairs listed in the A/FD. For example, a tower en route flight from an airport in New York (NYC) airspace could terminate at any airport within approximately 30 miles of Bradley International (BDL) airspace, such as Hartford (HFD). [Figure 9-10]

A valuable service provided by the automated radar equipment at terminal radar facilities is the Minimum Safe Altitude Warnings (MSAW). This equipment predicts your aircraft's position in 2 minutes based on present path of flight—the controller will issue a safety alert if the projected path will encounter terrain or an obstruction. An unusually rapid descent rate on a **nonprecision approach** can trigger such an alert.

Air Route Traffic Control Centers (ARTCC)

Air route traffic control center facilities are responsible for maintaining separation between IFR flights in the en route structure. Center radars (Air Route Surveillance Radar) acquire and track transponder returns using the same basic technology as terminal radars. [Figure 9-11]

Figure 9-11. *Center radar displays.*

Earlier Center radars display weather as an area of slashes (light precipitation) and H's (moderate rainfall), as illustrated in figure 9-12. Because the controller cannot detect higher levels of precipitation, pilots should be wary of areas showing moderate rainfall. Newer radar displays show weather as three levels of blue. Controllers can select the level of weather to be displayed. Weather displays of higher levels of intensity can make it difficult for controllers to see aircraft data blocks, so pilots should not expect ATC to keep weather displayed continuously.

Center airspace is divided into sectors in the same manner as terminal airspace; additionally, most Center airspace is divided by altitudes into high and low sectors. Each sector has a dedicated team of controllers and a selection of radio frequencies, because each Center has a network of remote transmitter/receiver sites. You will find all Center frequencies in the back of the A/FD in the format shown in figure 9-13; they are also found on en route charts.

Each ARTCC's area of responsibility covers several states; as you fly from the vicinity of one remote communication site toward another, expect the same controller to talk to you on different frequencies.

Nonprecision approach: An instrument approach without vertical guidance.

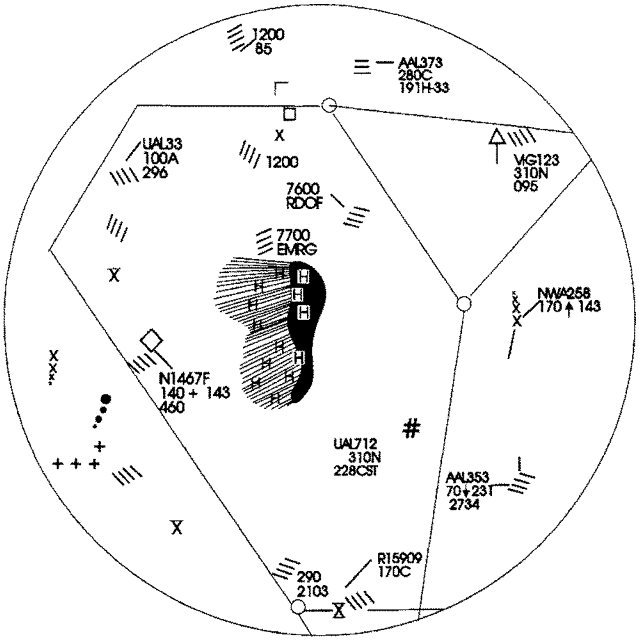


Figure 9-12. *A Center controller's scope.*

®**FORT WORTH CENTER** **134.4** **H–2–3–4, L–4–6–13–14–15–17 (KZFW)**
Abilene–134.25 127.45
Ardmore–132.975 128.1
Big Spring–133.7
Blue Ridge–127.6 124.87
Brownwood–127.45
Clinton-Sherman–132.45 128.4 126.3
Cumby–132.85 132.02 **126.57**
Dublin–135.375 **128.32** 127.15
El Dorado–133.875 128.2
Frankston–135.25 **134.025**
Gainsville–134.15 126.77
Hobbs–133.1
Keller–135.275 134.15 133.25
Lubbock–133.35 127.7 126.45
Marshall–135.1 **128.125**
McAlester–135.45 132.2
Midland (Site A)–133.1 **132.075**
Mineral Wells–135.6 127.0
Monroe–135.1
Oklahoma City–133.9 **132.45**
Paducah–134.55 133.5 **133.35** 126.45
Paris–127.6
Plainview–126.45
San Angelo–132.075 126.15
Scurry–135.75 126.725
Shreveport–135.1 **132.275**
Texarkana–134.475 133.95 **126.57**
Tyler–135.25 **134.025**
Waco–133.3
Wichita Falls–(Site Nr1) - 134.55 132.925
Wichita Falls (Site Nr2) - 133.5 **127.95**

Figure 9-13. *Center symbology.*

Center Approach/Departure Control

The majority of airports with instrument approaches do not lie within terminal radar airspace, and when operating to or from these airports you will communicate directly with the Center controller. If you are departing a tower-controlled airport, the tower controller will provide instructions for contacting the appropriate Center controller. When you depart an airport without an operating control tower, your clearance will include instructions such as "Upon entering controlled airspace, contact Houston Center on 126.5." You are responsible for terrain clearance until you reach the controller's MVA. Simply hearing "Radar contact" is not sufficient to relieve you of this responsibility.

If obstacles in the departure path require a steeper-than-standard climb gradient (200 feet per NM), you should be so advised by the controller. However, you should check the departure airport listing in the A/FD to determine if there are trees or wires in the departure path just to be sure; when in doubt, ask the controller for the required climb gradient.

A common clearance in these situations is "When able, proceed direct to the Astoria VOR…" The words "when able" mean to proceed when you can do so while maintaining terrain and obstruction clearance—they do not mean to proceed as soon as a signal suitable for navigation is received from the NAVAID. Using the standard climb gradient, you will be 2 miles from the departure end of the runway before it is safe to turn (400 feet above ground level (AGL)). When a Center controller issues a heading, a direct route, or says "direct when able," the controller becomes responsible for terrain and obstruction clearance.

Another common Center clearance is "Leaving (altitude) fly (heading) or proceed direct when able." This keeps the terrain/obstruction clearance responsibility in the cockpit until above the minimum IFR altitude. A controller cannot issue an IFR clearance until you are above the minimum IFR altitude unless you are able to climb in VFR conditions.

On a Center controller's scope, 1 NM is about 1/28 of an inch; when a Center controller is providing Approach/Departure control services at an airport many miles from the radar antenna, estimating headings and distances is very difficult. Controllers providing vectors to final must set the range on their scopes to not more than 125 NM; this is to provide the greatest possible accuracy for intercept headings. Accordingly, at locations more distant from a Center radar antenna, pilots should expect a minimum of vectoring.

Control Sequence

The IFR system is flexible and accommodating if you have done your homework, have as many frequencies as possible written down before they are needed, and have an alternate in mind if your flight cannot be completed as planned. Familiarize yourself with all the facilities and services available on your route of flight. [Figure 9-14] Always know where the nearest VFR conditions can be found, and be prepared to head in that direction if your situation deteriorates.

A typical IFR flight, with departure and arrival at airports with control towers, would use the ATC facilities and services in the following sequence:

1. AFSS: Obtain a weather briefing for your departure, destination and alternate airports, and en route conditions, then file your flight plan by calling 1-800-WX-BRIEF.
2. ATIS: Preflight complete, listen for present conditions and the approach in use.
3. Clearance Delivery: Prior to taxiing, obtain your departure clearance.
4. Ground Control: Noting that you are IFR, receive taxi instructions.
5. Tower: Pretakeoff checks complete, receive clearance to takeoff.
6. Departure Control: Once your transponder "tags up" with the ARTS, the tower controller will instruct you to contact Departure to establish radar contact.
7. ARTCC: After departing the departure controller's airspace, you will be handed off to Center who will coordinate your flight while en route. You may be in contact with multiple ARTCC facilities; they will coordinate the hand-offs.
8. EFAS/HIWAS: Coordinate with ATC before leaving their frequency to obtain inflight weather information.
9. ATIS: Coordinate with ATC before leaving their frequency to obtain ATIS information.
10. Approach Control: Center will hand you off to approach control where you will receive additional information and clearances.
11. Tower: Once cleared for the approach, you will be instructed to contact tower control; your flight plan will be canceled by the tower controller upon landing.

A typical IFR flight, with departure and arrival at airports without operating control towers, would use the ATC facilities and services in the following sequence:

1. AFSS: Obtain a weather briefing for your departure, destination and alternate airports, and en route conditions, then file your flight plan by calling 1-800-WX-BRIEF. Provide the latitude/longitude description for small airports to ensure that Center is able to locate your departure and arrival locations.

2. AFSS or UNICOM: ATC clearances can be filed and received on the UNICOM frequency if the licensee has made arrangements with the controlling ARTCC; otherwise, you need to file with AFSS via telephone. Be sure your preflight preparations are complete before filing. Your clearance will include a clearance void time. You must be airborne prior to the void time.

3. ARTCC: After takeoff, establish contact with Center. You may be in contact with multiple ARTCC facilities; they will coordinate the hand-offs.

4. EFAS/HIWAS: Coordinate with ATC before leaving their frequency to obtain in-flight weather information.

5. Approach Control: Center will hand you off to approach control where you will receive additional information and clearances. If you are able to land under visual meteorological conditions (VMC), you may cancel your IFR clearance before landing.

Letters of Agreement (LOA)

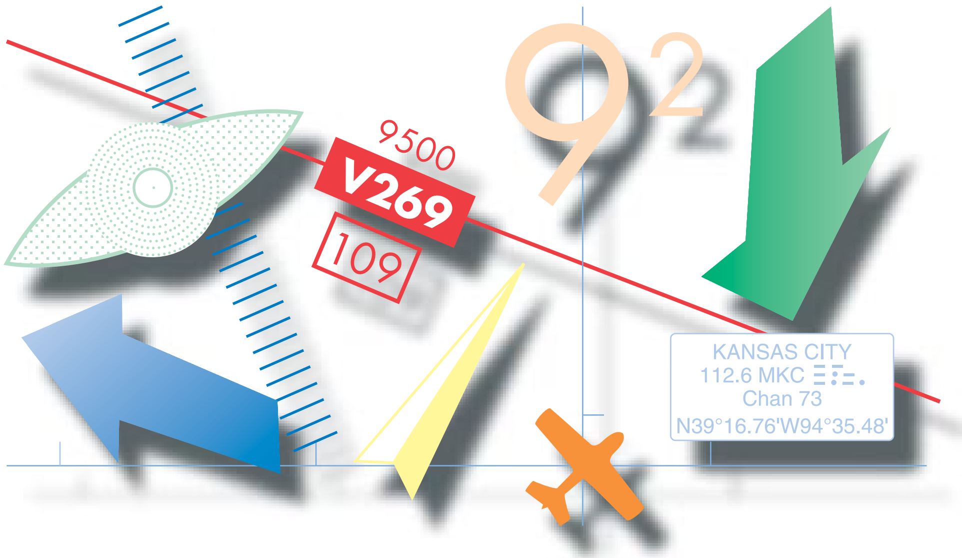
The ATC system is indeed a system and very little happens by chance. As your flight progresses, controllers in adjoining sectors or adjoining Centers coordinate its handling by telephone or by computer. Where there is a boundary between the airspace controlled by different facilities, the location and altitude at which you will be handed off is determined by Letters of Agreement (LOA) negotiated between the two facility managers. This information is not available to you in any Federal Aviation Administration (FAA) publication. For this reason, it is good practice to note on your en route chart the points at which hand-offs occur as you fly over them. Each time you are handed off to a different facility, the controller knows your altitude and where you are—this was part of the hand-off procedure.

Communications Facility	Description	Frequency
Airport Advisory Area "[AFSS name] RADIO"	AFSS personnel provide traffic advisories to pilots operating within 10 miles of the airport.	123.6 MHz.
UNICOM "[airport name] UNICOM"	Airport advisories from an airport without an operating control tower or AFSS.	Listed in A/FD under the city name; also on sectional charts in airport data block.
Air Route Traffic Control Center (ARTCC) "CENTER"	En route radar facilities that maintain separation between IFR flights, and between IFR flights and known VFR flights. Centers will provide VFR traffic advisories on a workload permitting basis.	Listed in A/FD, and on instrument en route charts.
Approach/Departure Control "[airport name] APPROACH" (unless otherwise advised)	Positions at a terminal radar facility responsible for handling of IFR flights to and from the primary airport (where Class B airspace exists).	Listed in A/FD; also on sectional charts in the communications panel, and on terminal area charts.
Automatic Terminal Information Service (ATIS)	Continuous broadcast of audio tape prepared by ATC controller containing wind direction and velocity, temperature, altimeter setting, runway and approach in use, and other information of interest to pilots.	Listed in A/FD under the city name; also on sectional charts in airport data block and in the communications panel, and on terminal area charts.
Clearance Delivery "[airport name] CLEARANCE"	Control tower position responsible for transmitting departure clearances to IFR flights.	Listed on instrument approach procedure charts.
Common Traffic Advisory Frequency (CTAF)	CTAF provides a single frequency for pilots in the area to use for contacting the facility and/or broadcasting their position and intentions to other pilots.	Listed in A/FD; also on sectional charts in the airport data block (followed by a white C on a blue or magenta background). At airports with no tower, CTAF is 122.9, the "MULTICOM" frequency.
Automated Flight Service Station (AFSS) "[facility name] RADIO"	Provides information and services to pilots, using remote communications outlets (RCOs) and ground communications outlets (GCOs).	Listed in A/FD and sectional charts, both under city name and in a separate listing of AFSS frequencies. On sectional charts, listed above the VOR boxes, or in separate boxes when remote.
Ground Control "[airport name] GROUND"	At tower-controlled airports, a position in the tower responsible for controlling aircraft taxiing to and from the runways.	Listed in A/FD under city name.
Hazardous Inflight Weather Advisory Service (HIWAS)	Continuous broadcast of forecast hazardous weather conditions on selected NAVAIDs. No communication capability.	Black circle with white "H" in VOR frequency box; notation in A/FD airport listing under "Radio Aids to Navigation."
MULTICOM "[airport name] TRAFFIC"	Intended for use by pilots at airports with no radio facilities. Pilots should use self-announce procedures given in the AIM.	122.9 MHz. A/FD shows 122.9 as CTAF; also on sectional charts 122.9 is followed by a white C on a dark background, indicating CTAF.
Tower "[airport name] TOWER"	"Local" controller responsible for operations on the runways and in Class B, C, or D airspace surrounding the airport.	Listed in A/FD under city name; also on sectional and terminal control area charts in the airport data block and communications panel.
En Route Flight Advisory Service (EFAS) "FLIGHT WATCH"	For in-flight weather information.	122.0 MHz (0600-2200 local time)

Figure 9-14. *ATC facilities, services, and radio call signs.*

Chapter 10

IFR Flight



Introduction

No single procedure can be outlined that is applicable to the planning and preparation involved with all flights conducted under instrument flight rules (IFR). Once you understand the overall operation of IFR flight, the many procedural details can be put into the appropriate sequence. This chapter explains the sources for flight planning, the conditions associated with instrument flight, and the procedures used for each phase of IFR flight: departure, en route, and approach. The chapter concludes with an example IFR flight, which applies many of the procedures learned earlier in the chapter.

Sources of Flight Planning Information

In addition to current IFR en route charts, area charts, and United States (U.S.) Terminal Procedures Publications (TPP) published by the National Aeronautical Charting Office (NACO), the Federal Aviation Administration (FAA) publishes the *Aeronautical Information Manual* (AIM), the *Airport/Facility Directory* (A/FD), and the *Notices to Airmen Publication* (NTAP) for flight planning in the National Airspace System (NAS). Pilots should also consult the Pilot's Operating Handbook/Airplane Flight Manual (POH/AFM) for flight planning information pertinent to the aircraft to be flown.

Preflight Planning Reference

In addition to approach procedures, the U.S. Terminal Procedures (TPP) booklets contain a wealth of flight planning information including IFR takeoff and alternate minimums, standard terminal arrival procedures, and departure procedures.

Aeronautical Information Manual (AIM)

The AIM provides the aviation community with basic flight information and air traffic control (ATC) procedures used in the U.S. NAS. An international version called the *Aeronautical Information Publication* contains parallel information, as well as specific information on the international airports used by the international community.

Airport/Facility Directory (A/FD)

The A/FD contains information on airports, communications, and navigation aids pertinent to IFR flight. It also includes very-high frequency omnidirectional range (VOR) receiver checkpoints, automated flight service station (AFSS), weather service telephone numbers, and air route traffic control center (ARTCC) frequencies. Various special notices essential to IFR flight are also included, such as land and hold short (LAHSO) data, the civil use of military fields, continuous power facilities, and special flight procedures.

In the major terminal and en route environments, preferred routes have been established to guide pilots in planning their routes of flight, to minimize route changes, and to aid in the orderly management of air traffic using the federal airways. The A/FD lists both high and low altitude preferred routes.

Notices to Airmen Publication (NTAP)

The NTAP is a publication containing current Notices to Airmen (NOTAMs) which are essential to the safety of flight, as well as supplemental data affecting the other operational publications listed. It also includes current Flight Data Center (FDC) NOTAMs, which are regulatory in nature, issued to establish restrictions to flight or to amend charts or published instrument approach procedures (IAPs).

POH/AFM

The POH/AFM contain operating limitations, performance, normal and emergency procedures, and a variety of other operational information for the respective aircraft. Aircraft manufacturers have done considerable testing to gather and substantiate the information in the aircraft manual. Pilots should refer to it for information relevant to a proposed flight.

A review of the contents of all the publications listed will help you determine which material should be referenced for each flight and those you would consult less frequently. As you become more familiar with these publications, you will be able to plan your IFR flights quickly and easily.

IFR Flight Plan

As specified in Title 14 of the Code of Federal Regulations (14 CFR) part 91, no person may operate an aircraft in **controlled airspace** under IFR unless that person has filed an IFR flight plan. Flight plans may be submitted to the nearest AFSS or air traffic control tower (ATCT) either in person, by telephone (1-800-WX-BRIEF), by computer (using the direct user access terminal system (DUATS)), or by radio if no other means are available. Pilots should file

Form Approved OMB No. 2120-0026

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION **FLIGHT PLAN**	(FAA USE ONLY) ☐ PILOT BRIEFING ☐ VNR ☐ STOPOVER	TIME STARTED	SPECIALIST INITIALS

1. TYPE	2. AIRCRAFT IDENTIFICATION	3. AIRCRAFT TYPE/ SPECIAL EQUIPMENT	4. TRUE AIRSPEED	5. DEPARTURE POINT	6. DEPARTURE TIME PROPOSED (Z)	6. DEPARTURE TIME ACTUAL (Z)	7. CRUISING ALTITUDE
VFR X IFR DVFR	N1230A	C182/G	140 KTS	DTW	1300		4000

8. ROUTE OF FLIGHT

DCT LFD DCT CMI

9. DESTINATION (Name of airport and city)	10. EST. TIME ENROUTE HOURS	10. EST. TIME ENROUTE MINUTES	11. REMARKS
CMI-WILLARD AIRPORT SAVOY, IL	01	42	

12. FUEL ON BOARD HOURS	12. FUEL ON BOARD MINUTES	13. ALTERNATE AIRPORT(S)	14. PILOT'S NAME, ADDRESS & TELEPHONE NUMBER & AIRCRAFT HOME BASE	15. NUMBER ABOARD
04	20	ALN	WARREN SMITH, 123 MAIN STREET DETROIT, MI 48123 217-555-1212 DTW 17. DESTINATION CONTACT/TELEPHONE (OPTIONAL)	2

16. COLOR OF AIRCRAFT	
BLUE/WHITE	CIVIL AIRCRAFT PILOTS. FAR Part 91 requires you file an IFR flight plan to operate under instrument flight rules in controlled airspace. Failure to file could result in a civil penalty not to exceed $1,000 for each violation (Section 901 of the Federal Aviation Act of 1958, as amended). Filing of a VFR flight plan is recommended as a good operating practice. See also Part 99 for requirements concerning DVFR flight plans.

FAA Form 7233-1 (8-82) CLOSE VFR FLIGHT PLAN WITH __________ FSS ON ARRIVAL

Figure 10-1. *Flight plan form.*

Controlled airspace: An airspace of defined dimensions within which ATC service is provided to IFR and visual flight rules (VFR) flights in accordance with the airspace classification. Includes Class A, Class B, Class C, Class D, and Class E airspace.

IFR flight plans at least 30 minutes prior to estimated time of departure to preclude possible delay in receiving a departure clearance from ATC. The AIM provides guidance for completing and filing FAA Form 7233-1, Flight Plan. These forms are available at flight service stations (FSS's), and are generally found in flight planning rooms at airport terminal buildings. [Figure 10-1]

Filing in Flight

IFR flight plans may be filed from the air under various conditions, including:

1. A flight outside of controlled airspace before proceeding into IFR conditions in controlled airspace.
2. A VFR flight expecting IFR weather conditions en route in controlled airspace.

In either of these situations, the flight plan may be filed with the nearest AFSS or directly with the ARTCC. A pilot who files with the AFSS submits the information normally entered during preflight filing, except for "point of departure," together with present position and altitude. AFSS then relays this information to the ARTCC. The ARTCC will then clear the pilot from present position or from a specified navigation fix.

A pilot who files direct with the ARTCC reports present position and altitude, and submits only the flight plan information normally relayed from the AFSS to the ARTCC. Be aware that traffic saturation frequently prevents ARTCC personnel from accepting flight plans by radio. In such cases, you will be advised to contact the nearest AFSS to file your flight plan.

Canceling IFR Flight Plans

You may cancel your IFR flight plan any time you are operating in VFR conditions outside Class A airspace by stating "cancel my IFR flight plan" to the controller or air-to-ground station with which you are communicating. After canceling your IFR flight plan, you should change to the appropriate air-to-ground frequency, appropriate transponder code as directed, and VFR altitude/flight level.

ATC separation and information services (including radar services, where applicable) are discontinued. If you desire VFR radar advisory service, you must specifically request it. Be aware that other procedures may apply if you cancel your IFR flight plan within areas such as Class C or Class B airspace.

If you are operating on an IFR flight plan to an airport with an operating control tower, your flight plan is canceled automatically upon landing. If you are operating on an IFR flight plan to an airport without an operating control tower, you must cancel the flight plan. This can be done by telephone after landing if there is no operating FSS, or other means of direct communications with ATC. If there is no FSS and air-to-ground communications with ATC are not possible below a certain altitude, you may cancel your IFR flight plan while still airborne and able to communicate with ATC by radio. If you follow this procedure, be certain the remainder of your flight can be conducted under VFR. It is essential that you cancel your IFR flight plan expeditiously. This allows other IFR traffic to utilize the airspace.

Clearances

An ATC **clearance** allows an aircraft to proceed under specified traffic conditions within controlled airspace for the purpose of providing separation between known aircraft.

Examples

A flight filed for a short distance at a relatively low altitude in an area of low traffic density might receive a clearance as follows:

> "Cessna 1230 Alpha, cleared to Doeville airport direct, cruise 5,000."

The term "cruise" in this clearance means you are authorized to fly at any altitude from the minimum IFR altitude up to and including 5,000 feet. You may level off at any altitude within this block of airspace. A climb or descent within the block may be made at your discretion. However, once you have reported leaving an altitude within the block, you may not return to that altitude without further ATC clearance.

When ATC issues a **cruise clearance** in conjunction with an unpublished route, an appropriate crossing altitude will be specified to ensure terrain clearance until the aircraft reaches a fix, point, or route where the altitude information is available. The crossing altitude ensures IFR obstruction clearance to the point at which the aircraft enters a segment of a published route or IAP.

Clearance: Allows an aircraft to proceed under specified traffic conditions within controlled airspace, for the purpose of providing separation between known aircraft.

Cruise clearance: Used in an ATC clearance to allow a pilot to conduct flight at any altitude from the minimum IFR altitude up to and including the altitude specified in the clearance. Also authorizes a pilot to proceed to and make an approach at the destination airport.

Once a flight plan is filed, ATC will issue the clearance with appropriate instructions, such as the following:

> "Cessna 1230 Alpha is cleared to Skyline airport via the Crossville 055 radial, Victor 18, maintain 5,000. Clearance void if not off by 1330."

You may receive a more complex clearance, such as:

> "Cessna 1230 Alpha is cleared to Wichita Mid-continent airport via Victor 77, left turn after takeoff, proceed direct to the Oklahoma City VORTAC. Hold west on the Oklahoma City 277 radial, climb to 5,000 in holding pattern before proceeding on course. Maintain 5,000 to CASHION intersection. Climb to and maintain 7,000. Departure control frequency will be 121.05. Squawk 0412."

Suppose you are awaiting departure clearance at a busy metropolitan terminal (your first IFR departure from this airport). On an average day, the tower at this airport controls departures at a rate of one every 2 minutes to maintain the required traffic flow. Sequenced behind you are a number of aircraft ready for departure, including jet transports.

Clearance delivery may issue you the following "abbreviated clearance" which includes a **departure procedure (DP)**:

> "Cessna 1230 Alpha, cleared to La Guardia as filed, RINGOES 8 departure Phillipsburg transition, maintain 8,000. Departure control frequency will be 120.4, Squawk 0700."

This clearance may be readily copied in shorthand as follows:

> "CAF RNGO8 PSB M80 DPC 120.4 SQ 0700."

The information contained in this DP clearance is abbreviated using clearance shorthand (*see* appendix 1). You should know the locations of the specified navigation facilities, together with the route and point-to-point time, before accepting the clearance.

Clearance delivery: Control tower position responsible for transmitting departure clearances to IFR flights.

Departure procedure (DP): Preplanned IFR ATC departure/obstacle avoidance procedures, published for pilot use in textual and graphic format.

The DP enables you to study and understand the details of your departure before filing an IFR flight plan. It provides the information necessary for you to set up your communication and navigation equipment and be ready for departure before requesting IFR clearance from the tower.

Once the clearance is accepted, you are required to comply with ATC instructions. You may request a clearance different from that issued if you consider another course of action more practicable or if your aircraft equipment limitations or other considerations make acceptance of the clearance inadvisable.

Pilots should also request clarification or amendment, as appropriate, any time a clearance is not fully understood or considered unacceptable because of safety of flight. *The pilot is responsible for requesting an amended clearance* if ATC issues a clearance that would cause a pilot to deviate from a rule or regulation or would place the aircraft in jeopardy.

Clearance Separations

ATC will provide the pilot on an IFR clearance with separation from other IFR traffic. This separation is provided:

1. Vertically—by assignment of different altitudes.
2. Longitudinally—by controlling time separation between aircraft on the same course.
3. Laterally—by assignment of different flightpaths.
4. By radar—including all of the above.

ATC does *not* provide separation for an aircraft operating:

1. Outside controlled airspace;
2. On an IFR clearance:
   a. With "VFR-On-Top" authorized instead of a specific assigned altitude.
   b. Specifying climb or descent in "VFR conditions."
   c. At any time in VFR conditions, since uncontrolled VFR flights may be operating in the same airspace.

In addition to heading and altitude assignments, ATC will occasionally issue speed adjustments to maintain the required separations. For example:

> "Cessna 30 Alpha, slow to 100 knots."

See and Avoid

An IFR clearance does **not** relieve the pilot in command of responsibility to see and avoid traffic while operating in visual conditions.

Pilots who receive speed adjustments are expected to maintain that speed plus or minus 10 knots. If for any reason the pilot is not able to accept a speed restriction, the pilot should advise ATC.

At times, ATC may also employ visual separation techniques to keep aircraft safely separated. A pilot who obtains visual contact with another aircraft may be asked to maintain visual separation or to follow the aircraft. For example:

> "Cessna 30 Alpha, maintain visual separation with that traffic, climb and maintain 7,000."

The pilot's acceptance of instructions to maintain visual separation or to follow another aircraft is an acknowledgment that he or she will maneuver the aircraft, as necessary, to maintain safe separation. It is also an acknowledgment that the pilot accepts the responsibility for wake turbulence avoidance.

In the absence of radar contact, ATC will rely on **position reports** to assist in maintaining proper separation. Using the data transmitted by the pilot, the controller follows the progress of your flight. ATC must correlate your reports with all the others to provide separation; therefore, the accuracy of your reports can affect the progress and safety of every other aircraft operating in the area on an IFR flight plan.

Departure Procedures (DPs)

DPs are designed to expedite clearance delivery, to facilitate transition between takeoff and en route operations, and to ensure adequate obstacle clearance. They furnish pilots' departure routing clearance information in both graphic and textual form. To simplify clearances, DPs have been established for the most frequently used departure routes in areas of high traffic activity. A DP will normally be used where such departures are available, since this is advantageous to both users and ATC. [Figure 10-2]

DPs can be found in section C of each booklet published regionally by the NACO, **TPP**, along with "IFR Take-off Minimums." The following points are important to remember if you file IFR out of terminal areas where DPs are in use.

1. Pilots of IFR aircraft operating from locations where DP procedures are effective may expect an ATC clearance containing a DP. The use of a DP requires pilot possession of at least the textual description of the approved DP.
2. If you do not possess a preprinted DP or for any other reason do not wish to use a DP, you are expected to advise ATC. Notification may be accomplished by filing "NO DP" in the remarks section of the filed flight plan, or by advising ATC.
3. If you accept a DP in your clearance, you must comply with it.

Radar Controlled Departures

On your IFR departures from airports in congested areas, you will normally receive navigational guidance from departure control by radar vector. When your departure is to be vectored immediately following takeoff, you will be advised before takeoff of the initial heading to be flown. This information is vital in the event you experience a loss of two-way radio communications during departure.

The radar departure is normally simple. Following takeoff, you contact departure control on the assigned frequency when advised to do so by the control tower. At this time departure control verifies radar contact, and gives headings, altitude, and climb instructions to move you quickly and safely out of the terminal area. Fly the assigned headings and altitudes until the controller tells you your position with respect to the route given in your clearance, whom to contact next, and to "resume your own navigation."

Departure control will vector you to either a navigation facility or an en route position appropriate to your departure clearance, or you will be transferred to another controller with further radar surveillance capabilities. [Figure 10-2]

A radar controlled departure does not relieve you of your responsibilities as pilot in command. You should be prepared before takeoff to conduct your own navigation according to your ATC clearance, with navigation receivers checked and properly tuned. While under radar control, monitor your instruments to ensure that you are continuously oriented to the route specified in your clearance, and record the time over designated checkpoints.

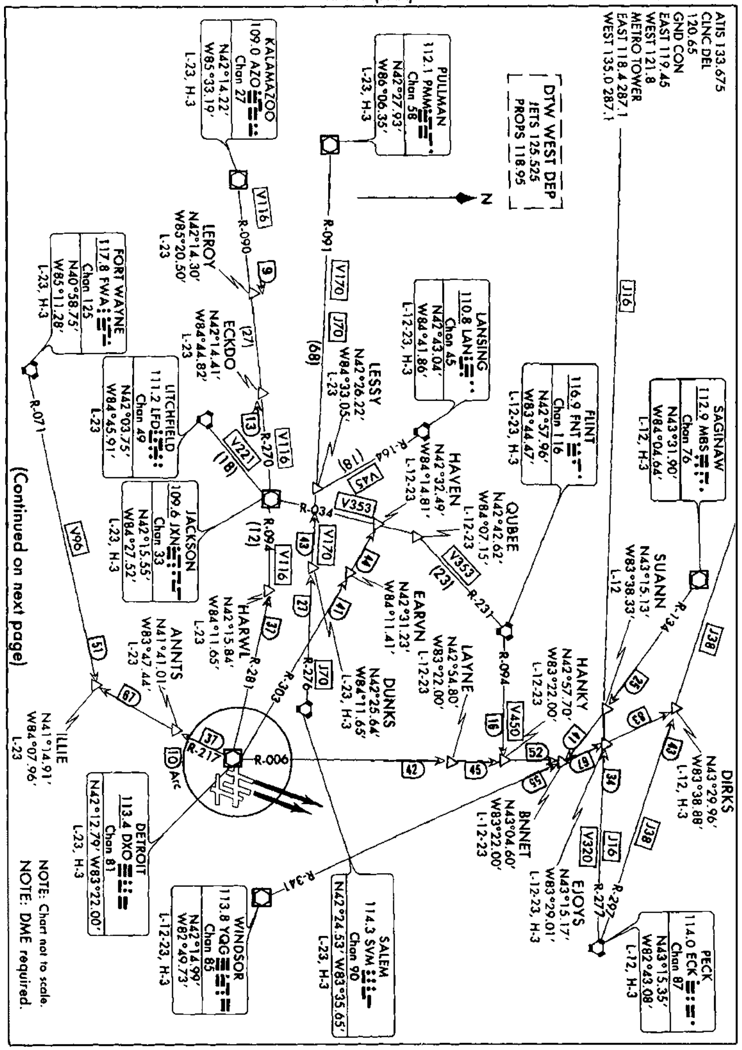
Position report: A report over a known location as transmitted by the pilot to ATC.

TPP: Booklets published in regional format by the NACO that include DPs, standard terminal arrivals (STARs), IAPs, and other information pertinent to IFR flight.

Obstacle Avoidance

When departing from airports without operating control towers in IFR conditions, adhere to the published obstacle departure procedure (DP), if applicable.

(VECTOR) 00167
PALACE TWO DEPARTURE SL-119 (FAA) DETROIT METROPOLITAN WAYNE COUNTY (DTW) DETROIT, MICHIGAN



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(VECTOR) 00167
PALACE TWO DEPARTURE SL-119 (FAA) DETROIT METROPOLITAN WAYNE COUNTY (DTW) DETROIT, MICHIGAN

DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAYS 3L AND 3C: **Climb runway heading to 1100 feet before turning. Thence . . . .**

TAKE-OFF ALL OTHER RUNWAYS: Thence. . . .
. . . . Climb on assigned heading for vectors to join the assigned Airway or Radial then proceed to the assigned departure fix, thence via the assigned route. Jets maintain 10,000 feet, cross the DXO 10 DME Arc at or above 5,000 feet for noise abatement. If unable to comply, advise ATC prior to departure. Props maintain 4000 feet or lower assigned altitude.
Expect clearance to filed altitude/flight level ten (10) minutes after departure.

SPECIAL INSTRUCTIONS: When using this departure, file the appropriate depicted departure fix and route. Aircraft landing/overflying Lansing (LAN) or overflying Flint (FNT) at 8,000 feet or below, file via EARVN. Aircraft landing Flint (FNT) at 8,000 feet or below, file via LAYNE.ANNTS, Jets only. Jets use Departure Control Frequency 125.525. Props use Departure Control Frequency 118.95.

PALACE TWO DEPARTURE DETROIT METROPOLITAN WAYNE COUNTY (DTW) DETROIT, MICHIGAN
(VECTOR) 00167

Figure 10-2. *Departure procedure (DP).*

Departures from Airports Without an Operating Control Tower

When you are departing from airports that have neither an operating tower nor an FSS, you should telephone your flight plan to the nearest ATC facility at least 30 minutes before your estimated departure time. If weather conditions permit, you could depart VFR and request IFR clearance as soon as radio contact is established with ATC. If weather conditions make it undesirable to fly VFR, you could again telephone and request clearance. In this case, the controller would probably issue a short-range clearance pending establishment of radio contact, and might restrict your departure time to a certain period. For example:

> "Clearance void if not off by 0900."

This would authorize you to depart within the allotted period and proceed in accordance with your clearance. In the absence of any specific departure instructions, you would be expected to proceed on course via the most direct route.

En Route Procedures

Procedures en route will vary according to the proposed route, the traffic environment, and the ATC facilities controlling the flight. Some IFR flights are under radar surveillance and controlled from departure to arrival and others rely entirely on pilot navigation.

Where ATC has no jurisdiction, it does not issue an IFR clearance. It has no control over the flight; nor does the pilot have any assurance of separation from other traffic.

ATC Reports

All pilots are required to report unforecast weather conditions or other information related to safety of flight to ATC. Pilots of aircraft operated in controlled airspace under IFR, are also required to immediately report to ATC any of the following equipment malfunctions occurring in flight:

1. Loss of VOR, tactical air navigation (TACAN) or automatic direction finder (ADF) receiver capability.
2. Complete or partial loss of instrument landing system (ILS) receiver capability.
3. Impairment of air-to-ground communications capability.

VFR Departures

When departing VFR to receive an IFR clearance airborne, consider obstacle clearance, airspace, VFR cloud clearance requirements, and an alternate plan of action if an IFR clearance cannot be received.

In each report, pilots are expected to include aircraft identification, equipment affected, and degree to which IFR operational capability in the ATC system is impaired. The nature and extent of assistance desired from ATC must also be stated.

Position Reports

Unless in radar contact with ATC, you are required to furnish a position report over certain reporting points. Position reports are required over each compulsory reporting point (shown on the chart as solid triangle figures ▲) along the route being flown regardless of altitude, including those with a VFR-On-Top clearance. Along direct routes, reports are required of all IFR flights over each point used to define the route of flight. Reports at reporting points (shown as open triangle figures △) are made only when requested by ATC.

Position reports should include the following items:

1. Identification.
2. Position.
3. Type of flight plan, if your report is made to an AFSS.
4. The estimated time of arrival (ETA) over next reporting point.
5. The name only of the next succeeding (required) reporting point along the route of flight.
6. Pertinent remarks.

En route position reports are submitted normally to the ARTCC controllers via direct controller-to-pilot communications channels, using the appropriate ARTCC frequencies listed on the en route chart.

Whenever an initial Center contact is to be followed by a position report, the name of the reporting point should be included in the callup. This alerts the controller that such information is forthcoming. For example:

> "Cleveland Center, Cessna 1230 Alpha at HARWL intersection."

Additional Reports

In addition to other required reports, the following reports should be made to ATC:

1. When vacating any previously assigned altitude or flight level (FL) for a newly assigned altitude or FL.
2. When an altitude change will be made, when operating on a VFR-On-Top clearance.
3. When an approach has been missed (request clearance for specific action (e.g., to altermate airport, another approach, etc.)).

(The following reports are not required if in radar contact with ATC:)

4. The time and altitude or FL reaching a holding fix or point to which cleared.
5. When leaving any assigned holding fix or point.
6. When leaving final approach fix (FAF) inbound on final approach.
7. A corrected estimate at any time it becomes apparent that an estimate previously submitted is in error in excess of 3 minutes.

Planning the Descent and Approach

ATC arrival procedures and cockpit workload are affected by weather conditions, traffic density, aircraft equipment, and radar availability.

When landing at airports with approach control services and where two or more IAPs are published, you will be provided in advance of arrival with information on the type of approach to expect or if you will be vectored for a visual approach. This information will be broadcast either on automated terminal information service (ATIS) or by a controller. It will not be furnished when the visibility is 3 miles or better and the ceiling is at or above the highest initial approach altitude established for any low altitude IAP for the airport.

The purpose of this information is to help you in planning arrival actions; however, it is not an ATC clearance or commitment and is subject to change. Fluctuating weather, shifting winds, blocked runway, etc., are conditions that may result in changes to the approach information you previously received. It is important to advise ATC immediately if you are unable to execute the approach, or if you prefer, another type of approach.

If the destination is an airport without an operating control tower, and has automated weather data with broadcast capability, you should monitor the automated surface observing system/automated weather observing system (ASOS/AWOS) frequency to ascertain the current weather for the airport. You should advise ATC once you have received the broadcast weather and state your intentions.

Once you know which approach you will execute, you should plan for the descent prior to the initial approach fix (IAF) or transition route depicted on the IAP. When flying the transition route, maintain the last assigned altitude until you hear "cleared for the approach" and have intercepted a segment of the approach. You may "request lower" to bring your transition route closer to the required altitude for the initial approach altitude. When ATC uses the phrase, "at pilot's discretion" in the altitude information of a clearance, you have the option to start a descent at any rate, and you may level off temporarily at any intermediate altitude. However, once you have vacated an altitude, you may not return to that altitude. When ATC has *not* used the term "at pilot's discretion" nor imposed any descent restrictions, you should initiate descent promptly upon acknowledgment of the clearance.

Descend at an optimum rate (consistent with the operating characteristics of the aircraft) to 1,000 feet above the assigned altitude. Then attempt to descend at a rate of between 500 and 1,500 feet per minute (fpm) until the assigned altitude is reached. If at anytime you are unable to descend at a rate of at least 500 fpm, advise ATC. Advise ATC if it is necessary to level off at an intermediate altitude during descent. An exception to this is when leveling off at 10,000 feet mean sea level (MSL) on descent, or 2,500 feet above airport elevation (prior to entering a Class B, Class C, or Class D surface area) when required for speed reduction.

Standard Terminal Arrival Routes (STARs)

Standard terminal arrival routes (as described in Chapter 8) have been established to simplify clearance delivery procedures for arriving aircraft at certain areas having high density traffic. A STAR serves a purpose parallel to that of a DP for departing traffic. [Figure 10-3] The following points regarding STARs are important to remember:

1. All STARs are contained in the TPP, along with the IAP charts for your destination airport. The AIM also describes STAR procedures.

Standard terminal arrival route (STAR): A preplanned IFR ATC arrival procedure published for pilot use in graphic and/or textual form.

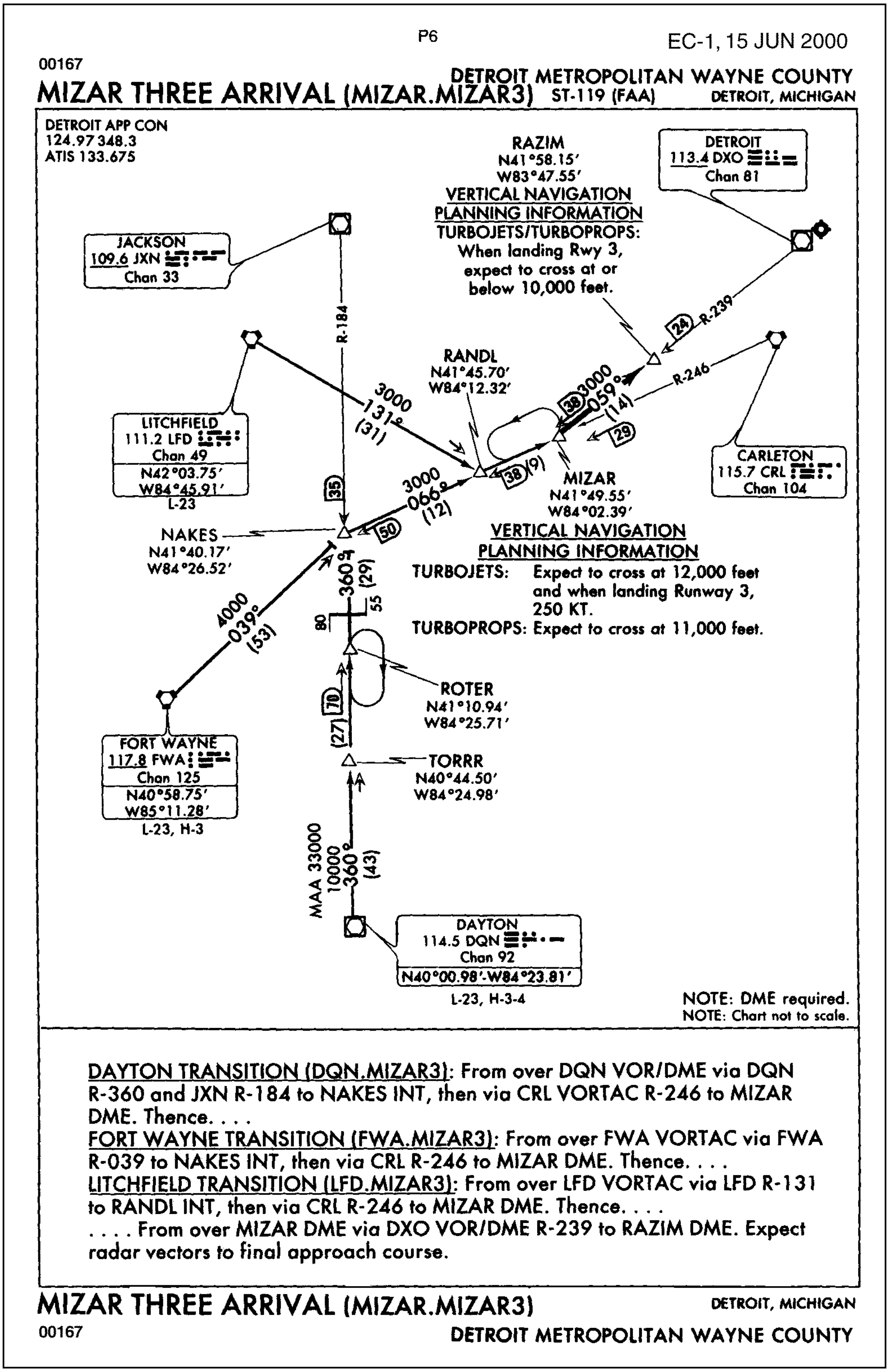


Figure 10-3. *Standard terminal arrival route (STAR).*

2. If your destination is a location for which STARs have been published, you may be issued a clearance containing a STAR whenever ATC deems it appropriate. You must possess at least the approved textual description.
3. It is your responsibility to either accept or refuse an issued STAR. If you do not wish to use a STAR, you should advise ATC by placing "NO STAR" in the remarks section of your filed flight plan or by advising ATC.
4. If you accept a STAR in your clearance, you must comply with it.

Substitutes for Inoperative or Unusable Components

The basic ground components of an ILS are the localizer, glide slope, outer marker, middle marker, and inner marker (when installed). A **compass locator** or precision radar may be substituted for the outer or middle marker. Distance measuring equipment (DME), VOR, or nondirectional beacon (NDB) fixes authorized in the standard IAP or surveillance radar may be substituted for the outer marker.

Additionally, IFR-certified global positioning system (GPS) equipment, operated in accordance with Advisory Circular (AC) 90-94, *Guidelines for Using Global Positioning System Equipment for IFR En Route and Terminal Operations and for Nonprecision Instrument Approaches in the U.S. NAS*, may be substituted for ADF and DME equipment, except for when flying NDB IAP. Specifically, GPS can be substituted for ADF and DME equipment when:

1. Flying a DME arc;
2. Navigating TO/FROM an NDB;
3. Determining the aircraft position over an NDB;
4. Determining the aircraft position over a fix made up of a crossing NDB bearing;
5. Holding over an NDB;
6. Determining aircraft position over a DME fix.

Holding Procedures

Depending upon traffic and weather conditions, holding may be required. **Holding** is a predetermined maneuver which keeps aircraft within a specified airspace while awaiting further clearance from ATC. A standard holding pattern uses right turns, and a nonstandard holding pattern uses left turns. The ATC clearance will always specify left turns when a nonstandard pattern is to be flown.

Standard Holding Pattern (No Wind)

The **standard holding pattern** is a racetrack pattern. [Figure 10-4] The aircraft follows the specified course inbound to the holding fix, turns 180° to the right, flies a parallel straight course outbound for 1 minute, turns 180° to the right, and flies the inbound course to the fix.

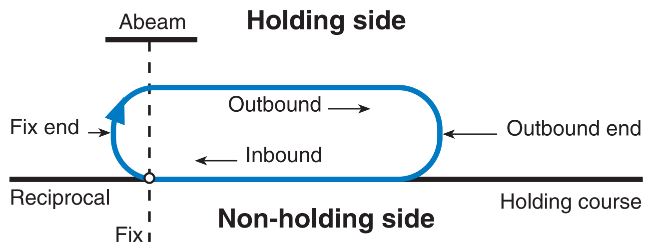


Figure 10-4. *Standard holding pattern—no wind.*

Standard Holding Pattern (With Wind)

In compliance with the holding pattern procedures given in the AIM, the symmetrical racetrack pattern cannot be tracked when a wind exists. Pilots are expected to:

1. Compensate for the effect of a known wind except when turning.
2. Adjust outbound timing so as to achieve a 1-minute (1-1/2 minutes above 14,000 feet) inbound leg.

Figure 10-5 illustrates the holding track followed with a left crosswind. The effect of wind is counteracted by applying drift corrections to the inbound and outbound legs and by applying time allowances to the outbound leg.

Compass locator: A low-power, low- or medium-frequency (L/MF) radio beacon installed at the site of the outer or middle marker of an ILS.

Holding: A predetermined maneuver that keeps aircraft within a specified airspace while awaiting further clearance from ATC.

Standard holding pattern: A holding pattern in which all turns are made to the right.

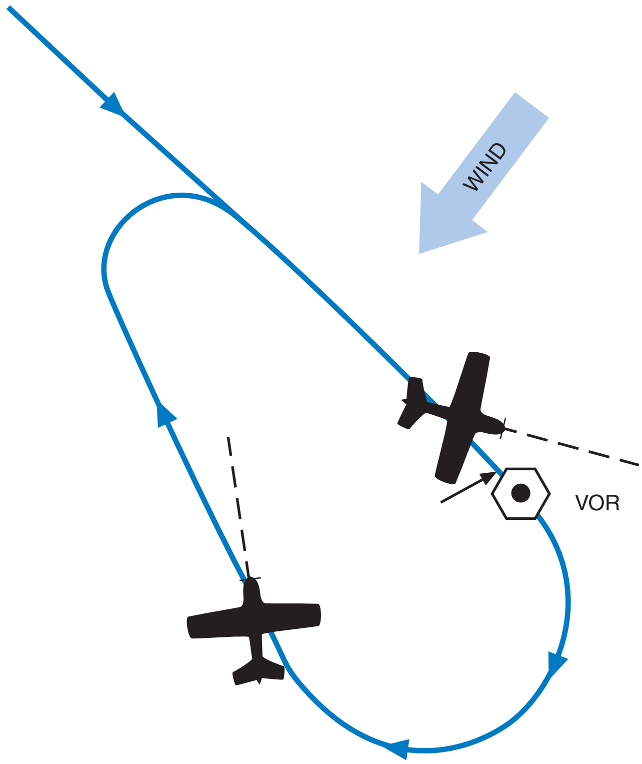


Figure 10-5. *Drift correction in holding pattern.*

Holding Instructions

If you arrive at your clearance limit before receiving clearance beyond the fix, ATC expects you to maintain the last assigned altitude and begin holding in accordance with the depicted holding pattern. If no holding pattern is depicted, you are expected to begin holding in a standard holding pattern on the course upon which you approached the fix. You should immediately request further clearance. Normally, when no delay is anticipated, ATC will issue holding instructions at least 5 minutes before your estimated arrival at the fix. Where a holding pattern is not depicted, the ATC clearance will specify the following:

1. Direction of holding from the fix in terms of the eight cardinal compass points (i.e., N, NE, E, SE, etc.).
2. Holding fix (the fix may be omitted if included at the beginning of the transmission as the clearance limit).
3. Radial, course, bearing, airway, or route on which the aircraft is to hold.
4. Leg length in miles if DME or area navigation (RNAV) is to be used (leg length will be specified in minutes on pilot request or if the controller considers it necessary).
5. Direction of turn if left turns are to be made, the pilot requests or the controller considers it necessary.
6. Time to **expect-further-clearance (EFC)** and any pertinent additional delay information.

ATC instructions will also be issued whenever:

1. It is determined that a delay will exceed 1 hour.
2. A revised EFC is necessary.
3. In a terminal area having a number of navigation aids and approach procedures, a clearance limit may not indicate clearly which approach procedures will be used. On initial contact, or as soon as possible thereafter, approach control will advise you of the type of approach you may anticipate.
4. Ceiling and/or visibility is reported as being at or below the highest "circling minimums" established for the airport concerned. ATC will transmit a report of current weather conditions and subsequent changes, as necessary.
5. Aircraft are holding while awaiting approach clearance, and pilots advise that reported weather conditions are below minimums applicable to their operation. In this event, ATC will issue suitable instructions to aircraft desiring either to continue holding while awaiting weather improvement or proceed to another airport.

Standard Entry Procedures

The entry procedures given in the AIM evolved from extensive experimentation under a wide range of operational conditions. The standardized procedures should be followed to ensure that you remain within the boundaries of the prescribed holding airspace.

Reduce airspeed to holding speed within 3 minutes of your ETA at the holding fix. The purpose of the speed reduction is to prevent overshooting the holding airspace limits, especially at locations where adjacent holding patterns are

Holding (With Wind)
To compensate for the effects of wind while holding, triple the outbound correction in the opposite direction of your inbound wind correction angle. For example, if you are holding an 8° left wind correction for the inbound course, correct 24° to the right on the outbound leg.

Expect-further-clearance (EFC):
The time a pilot can expect to receive clearance beyond a clearance limit.

close together. The exact time at which you reduce speed is not important as long as you arrive at the fix at your preselected holding speed within 3 minutes of your submitted ETA. If it takes more than 3 minutes for you to complete a speed reduction and ready yourself for identification of the fix, adjustment of navigation and communications equipment, entry to the pattern, and reporting, make the necessary time allowance.

All aircraft may hold at the following altitudes and maximum holding airspeeds:

Altitude (MSL)	*Airspeed (KIAS)*
MHA – 6,000 feet	200
6,001 – 14,000 feet	230
14,001 feet and above	265

The following are exceptions to the maximum holding airspeeds:

1. Holding patterns from 6,001 to 14,000 feet may be restricted to a maximum airspeed of 210 knots indicated airspeed (KIAS). This nonstandard pattern will be depicted by an icon.
2. Holding patterns may be restricted to a maximum airspeed of 175 KIAS. This nonstandard pattern will be depicted by an icon. Holding patterns restricted to 175 KIAS will generally be found on IAPs applicable to category A and B aircraft only.
3. Holding patterns at Air Force airfields only—310 KIAS maximum, unless otherwise depicted.
4. Holding patterns at Navy airfields only—230 KIAS maximum, unless otherwise depicted.
5. Advise ATC if you need to exceed a maximum holding speed.

You may want to use the maximum endurance speed when executing a holding pattern in order to save fuel. However, there are several reasons why you would not want to use the maximum endurance speed for holding. You should use a speed for holding patterns that will give you good aircraft control without increasing workload, minimizing fuel burn (as much as possible), and provides a safe margin above stall.

While other entry procedures may enable the aircraft to enter the holding pattern and remain within protected airspace, the parallel, teardrop and direct entries are the procedures for entry, and holding recommended by the FAA. [Figure 10-6]

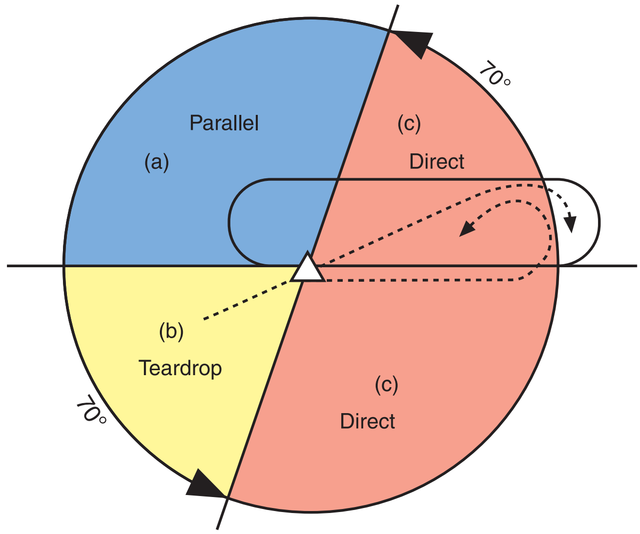


Figure 10-6. *Holding pattern entry procedures.*

1. Parallel procedure: When approaching the holding fix from anywhere in sector (a), turn to a heading to parallel the holding course outbound on the nonholding side for approximately 1 minute, turn in the direction of the holding pattern through more than 180°, and return to the holding fix or intercept the holding course inbound.
2. Teardrop procedure: When approaching the holding fix from anywhere in sector (b), fly to the fix, turn outbound using course guidance when available, or to a heading for a 30° teardrop entry within the pattern (on the holding side) for approximately 1 minute, then turn in the direction of the holding pattern to intercept the inbound holding course.
3. Direct entry procedure: When approaching the holding fix from anywhere in sector (c), fly directly to the fix and turn to follow the holding pattern.

Pilots should make all turns during entry and while holding at:

1. 3° per second, or
2. 30° bank angle, or
3. a bank angle provided by a flight director system.

Time Factors

The holding pattern entry time reported to ATC is the initial time of arrival over the fix. Upon entering a holding pattern, the initial outbound leg is flown for 1 minute at or below 14,000 feet MSL, and for 1-1/2 minutes above 14,000 feet MSL. Timing for subsequent outbound legs should be adjusted as necessary to achieve proper inbound leg time. Pilots should begin outbound timing over or abeam the fix, whichever occurs later. If the abeam position cannot be determined, start timing when the turn to outbound is completed. [Figure 10-7]

EFC times require no time adjustment since the purpose for issuance of these times is to provide for possible loss of two-way radio communications. You will normally receive further clearance prior to your EFC. If you do not receive it, request a revised EFC time from ATC.

Time leaving the holding fix must be known to ATC before succeeding aircraft can be cleared to the airspace you have vacated. Leave the holding fix:

1. When ATC issues either further clearance en route or approach clearance;
2. As prescribed in part 91 (for IFR operations; two-way radio communications failure, and responsibility and authority of the pilot in command); or
3. After you have canceled your IFR flight plan, if you are holding in VFR conditions.

DME Holding

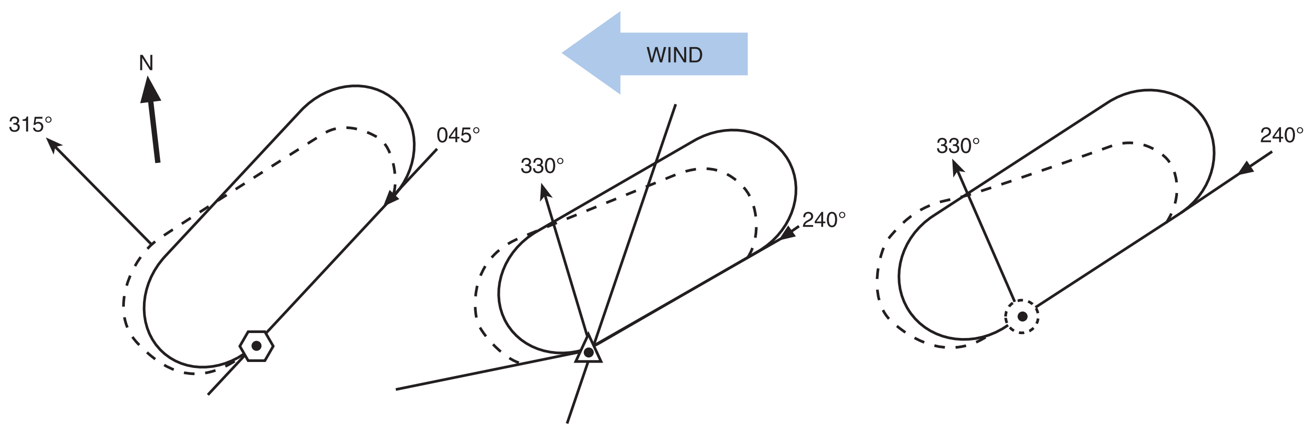
The same entry and holding procedures apply to DME holding except distances (nautical miles) are used instead of time values. The length of the outbound leg will be specified by the controller, and the end of this leg is determined by the DME readout.

Approaches

Compliance with Published Standard Instrument Approach Procedures

Compliance with the approach procedures shown on the approach charts provides necessary navigation guidance information for alignment with the final approach courses, as well as obstruction clearance. Under certain conditions, a course reversal maneuver or procedure turn may be necessary. However, this procedure is not authorized when:

1. The symbol "**NoPT**" appears on the approach course on the plan view of the approach chart.
2. Radar vectoring is provided to the final approach course.
3. A holding pattern is published in lieu of a procedure turn.
4. Executing a timed approach from a holding fix.
5. Otherwise directed by ATC.



VOR: Outbound timing starts when TO/FROM indicator reverses.

Airway Intersection: Outbound timing starts at completion of outbound turn, since 330° magnetic bearing cannot be determined.

Compass Locator: Outbound timing starts when ADF relative bearing is 90° minus drift correction angle.

Figure 10-7. *Holding—outbound timing.*

NoPT: No procedure turn.

Instrument Approaches to Civil Airports

Unless otherwise authorized, when an instrument letdown to an airport is necessary, pilots should use a standard IAP prescribed for that airport. IAPs are depicted on IAP charts and are found in the TPP.

ATC approach procedures depend upon the facilities available at the terminal area, the type of instrument approach executed, and the existing weather conditions. The ATC facilities, navigation aids (NAVAIDs), and associated frequencies appropriate to each standard instrument approach are given on the approach chart. Individual charts are published for standard approach procedures associated with the following types of facilities:

1. Nondirectional beacon (NDB)
2. Very-high frequency omnirange (VOR)
3. Very-high frequency omnirange with distance measuring equipment (VORTAC or VOR/DME)
4. Localizer (LOC)
5. Instrument landing system (ILS)
6. Localizer-type directional aid (LDA)
7. Simplified directional facility (SDF)
8. Area navigation (RNAV)
9. Global positioning system (GPS)

An IAP can be flown in one of two ways: as a full approach or with the assistance of radar vectors. When the IAP is flown as a full approach, pilots conduct their own navigation using the routes and altitudes depicted on the instrument approach chart. A full approach allows the pilot to transition from the en route phase, to the instrument approach, and then to a landing with minimal assistance from ATC. This type of procedure may be requested by the pilot but is most often used in areas without radar coverage. A full approach also provides the pilot with a means of completing an instrument approach in the event of a communications failure.

When an approach is flown with the assistance of radar vectors, ATC provides guidance in the form of headings and altitudes which positions the aircraft to intercept the final approach. From this point, the pilot resumes navigation, intercepts the final approach course, and completes the approach using the IAP chart. This is often a more expedient method of flying the approach, as opposed to the full approach, and allows ATC to sequence arriving traffic. A pilot operating in radar contact can generally expect the assistance of radar vectors to the final approach course.

Approach to Airport Without an Operating Control Tower

Figure 10-8 shows an approach procedure at an airport without an operating control tower. As you approach such a facility, you should monitor the AWOS/ASOS if available for the latest weather conditions. When direct communication between the pilot and controller is no longer required, the ARTCC or approach controller will clear you for an instrument approach and advise "change to advisory frequency approved." If you are arriving on a "cruise" clearance, ATC will not issue further clearance for approach and landing.

If an approach clearance is required, ATC will authorize you to execute your choice of standard instrument approach (if more than one is published for the airport) with the phrase "Cleared for the approach" and the communications frequency change required, if any. From this point on, you will have no contact with ATC. Accordingly, you must close your IFR flight plan before landing, if in VFR conditions, or by telephone after landing.

Unless otherwise authorized by ATC, you are expected to execute the complete IAP shown on the chart.

Approach to Airport With an Operating Tower, With No Approach Control

When you approach an airport with an operating control tower, but no approach control, ATC will clear you to an approach/outer fix with the appropriate information and instructions as follows:

1. Name of the fix;
2. Altitude to be maintained;
3. Holding information and expected approach clearance time, if appropriate; and
4. Instructions regarding further communications, including:
    a. facility to be contacted.
    b. time and place of contact.
    c. frequency/ies to be used.

If the tower has ATIS, you should monitor that frequency for such information as ceiling, visibility, wind direction and velocity, altimeter setting, instrument approach, and runways in use prior to initial radio contact with approach control. If there is no ATIS, ATC will, at the time of your first radio contact or shortly thereafter, provide weather information from the nearest reporting station to your destination.

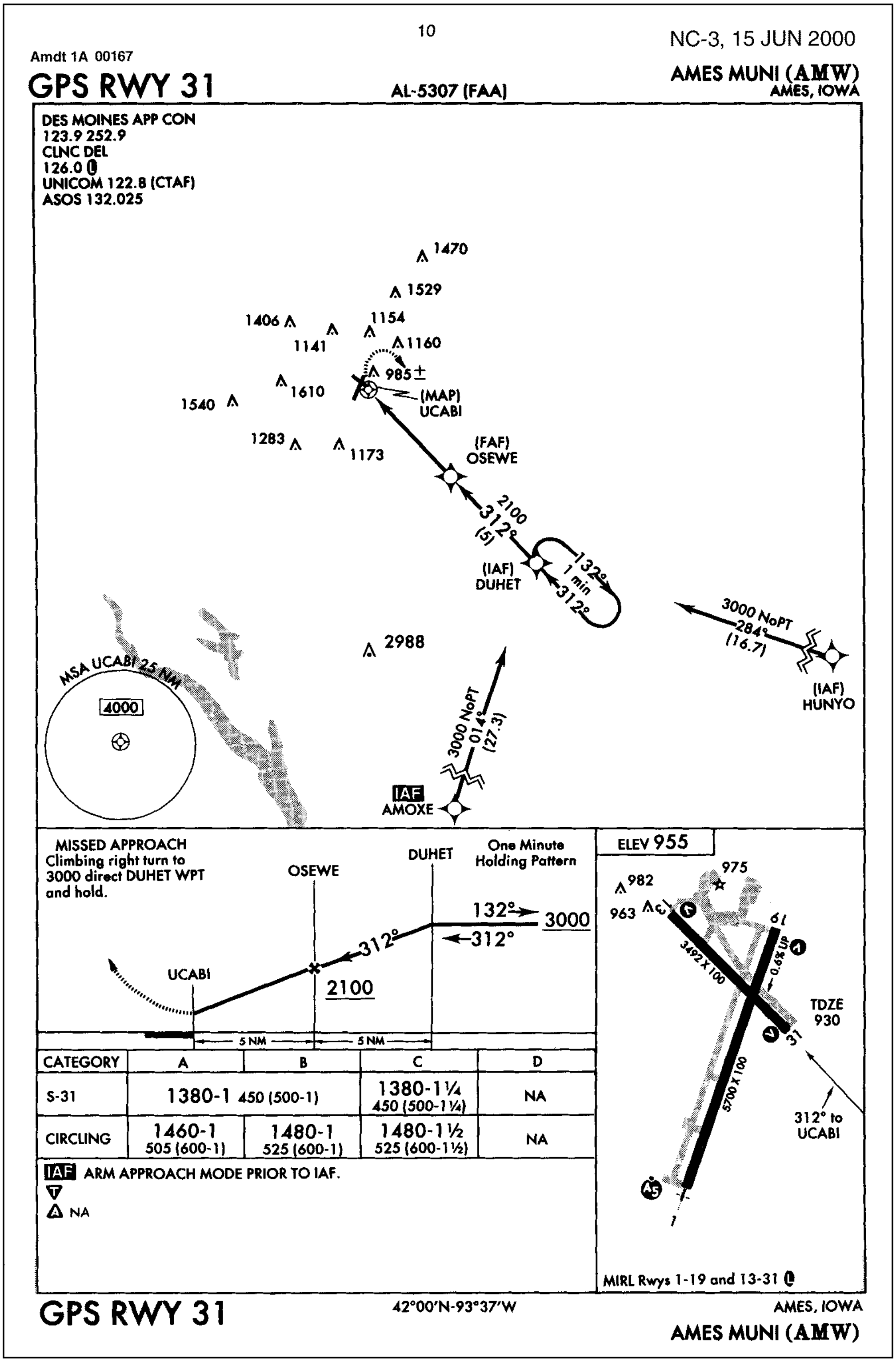


Figure 10-8. *Ames, Iowa (AMW) GPS Rwy 31 approach: an approach procedure at an airport without an operating control tower.*

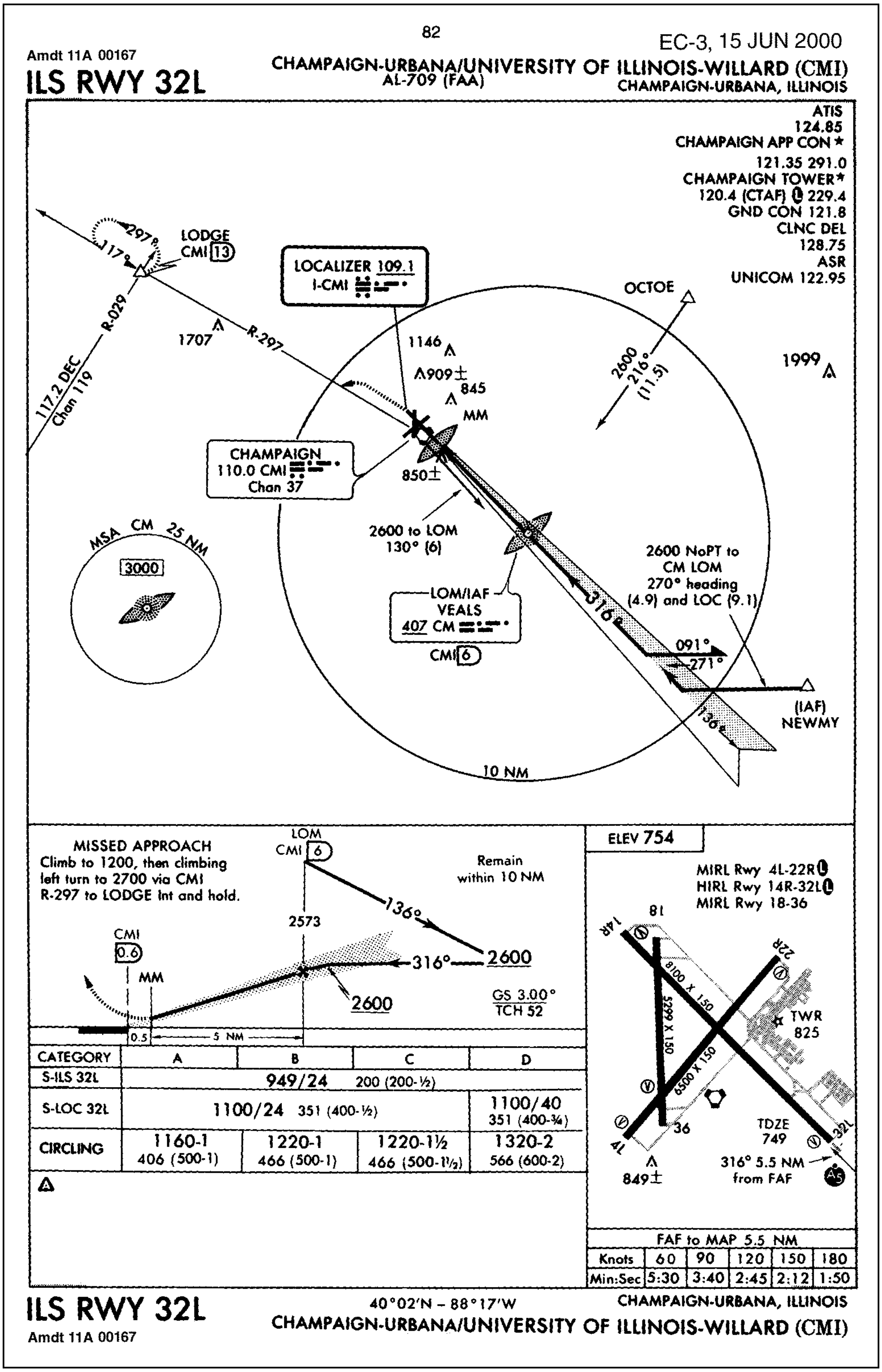


Figure 10-9. *Champaign, IL (CMI) ILS Rwy 32L approach: an instrument procedure chart with maximum ATC facilities available.*

Approach to an Airport With an Operating Tower, With an Approach Control

Where radar is approved for approach control service, it is used to provide vectors in conjunction with published IAPs. Radar vectors can provide course guidance and expedite traffic to the final approach course of any established IAP.

Figure 10-9 shows an IAP chart with maximum ATC facilities available.

Approach control facilities that provide this radar service operate in the following manner:

1. Arriving aircraft are either cleared to an outer fix most appropriate to the route being flown with vertical separation and, if required, given holding information; or,
2. When radar hand-offs are effected between ARTCC and approach control, or between two approach control facilities, aircraft are cleared to the airport, or to a fix so located that the hand-off will be completed prior to the time the aircraft reaches the fix.
   a. When the radar hand-offs are utilized, successive arriving flights may be handed-off to approach control with radar separation in lieu of vertical separation.
   b. After hand-off to approach control, aircraft are vectored to the appropriate final approach course.
3. Radar vectors and altitude/flight levels will be issued as required for spacing and separating aircraft; therefore, you must not deviate from the headings issued by approach control.
4. You will normally be informed when it becomes necessary to vector you across the final approach course for spacing or other reasons. If you determine that approach course crossing is imminent and you have not been informed that you will be vectored across it, you should question the controller. You should not turn inbound on the final approach course unless you have received an approach clearance. Approach control will normally issue this clearance with the final vector for interception of the final approach course, and the vector will be such as to enable you to establish your aircraft on the final approach course prior to reaching the final approach fix. In the event you are already inbound on the final approach course, you will be issued approach clearance prior to reaching the final approach fix.
5. After you are established inbound on the final approach course, radar separation will be maintained between you and other aircraft, and you will be expected to complete the approach using the NAVAID designated in the clearance (ILS, VOR, NDB, GPS, etc.) as the primary means of navigation.
6. After passing the final approach fix inbound, you are expected to proceed direct to the airport and complete the approach, or to execute the published **missed approach** procedure.
7. Radar service is automatically terminated when the landing is completed or the tower controller has your aircraft in sight, whichever occurs first.

Radar Approaches

With a radar approach, the pilot is "talked down" while a controller monitors the progress of the flight with radar. This is an option should the pilot experience an emergency or distress situation. These approaches require a radar facility and a functioning airborne radio.

Initial radar contact for either a surveillance or **precision approach radar (PAR)** is made with approach control. Pilots must comply promptly with all instructions when conducting either type of procedure. They can determine the radar approach facilities (surveillance and/or precision) available at a specific airport by referring to the appropriate En route Low Altitude Chart and IAP chart. Surveillance and precision radar minimums are listed alphabetically by airport on pages with the heading, "Radar Instrument Approach Minimums," in each TPP. Note that both straight-in and circling minimums are listed. [Figure 10-10]

When your instrument approach is being radar monitored, the radar advisories serve only as a secondary aid. Since you have selected a NAVAID such as the ILS or VOR as the primary aid for the approach, the minimums listed on the approach chart apply.

Missed approach: A maneuver conducted by a pilot when an instrument approach cannot be completed to a landing.

Precision approach radar (PAR): An instrument approach in which ATC issues azimuth and elevation instructions for pilot compliance, based on aircraft position in relation to the final approach course, glide slope, and distance from the end of the runway as displayed on the controller's radar scope.

FORT HUACHUCA/SIERRA VISTA, AZ Amdt. 20A, NOV 14, 1999 ELEV**4716**

SIERRA VISTA MUNI-LIBBY AAF

RADAR 1 - 134.45 327.15

	RWY GS/TCH/RPI	CAT	DH/ MDA-VIS	HAT/ HAA	CEIL-VIS	CAT	DH/ MDA-VIS	HAT/ HAA	CEIL-VIS
PAR	8	ABCDE	**4916**-¾	200	(200-¾)				
	26	ABCDE	**4826**-¾	200	(200-¾)				
ASR	26	ABCDE	**4900**-1	274	(200-1)				
CIRCLING		A	**5100**-1	384	(400-1)	B	**5180**-1	464	(500-1)
		C	**5180**-1½	464	(500-1½)	DE	**5280**-2	564	(600-2)
ASR	8	AB	**5440**-1	724	(800-1)	C	**5440**-2	724	(800-2)
		D	**5440**-2¼	724	(800-2¼)	E	**5440**-2½	724	(800-2½)
CIRCLING		AB	**5440**-1	724	(800-1)	C	**5440**-2	724	(800-2)
		D	**5440**-2¼	724	(800-2¼)	E	**5440**-2½	724	(800-2½)

PAR/ASR opr 1500-2300 Monday-Friday, except for holidays.
No NOTAM maintenance period 1500-1900 on the first Thursday of the month.
Circling not authorized south of ruways 8 and 29.

NA

SW-1

RADAR INSTRUMENT APPROACH MINIMUMS

Figure 10-10. *Radar instrument approach minimums for Ft. Huachuca, AZ (FHU).*

At a few FAA radar locations and military airfields, instrument approaches have been established on NAVAIDs whose final approach course from the final approach fix to the runway coincides with the PAR course. At such locations, your approach will be monitored and you will be given radar advisories whenever the reported weather is below basic VFR minimums (1,000 and 3), at night, or at your request. Before starting the final approach, you will be advised of the frequency on which the advisories will be transmitted. If for any reason radar advisories cannot be furnished, you will be advised.

Surveillance Approach

On an **airport surveillance radar approach (ASR)**, the controller will vector you to a point where you can begin a descent to the airport or to a specific runway. During the initial part of the approach, you will be given communications failure/ missed approach instructions. Before you begin your descent, the controller will give you the published straight-in **minimum descent altitude (MDA)**. You will not be given the circling MDA unless you request it and tell the controller your aircraft category.

During the final approach, the controller will provide navigational guidance in azimuth only. Guidance in elevation is not possible, but you will be advised when to begin descent to the MDA, or if appropriate, to the intermediate "stepdown fix" MDA and subsequently to the prescribed MDA. In addition, you will be advised of the location of the missed approach point (MAP) and your position each mile from the runway, airport, or MAP as appropriate. If you so request, the controller will issue recommended altitudes each mile, based on the descent gradient established for the procedure, down to the last mile that is at or above the MDA.

You will normally be provided navigational guidance until you reach the MAP. The controller will terminate guidance and instruct you to execute a missed approach at the MAP, if at that point you do not have the runway or airport in sight, or if you are on a point-in-space approach in a helicopter, the prescribed visual reference with the surface is not established. If at any time during the approach the controller considers that safe guidance cannot be provided for the remainder of the approach, the approach will be terminated, and you will be instructed to execute a missed approach. Guidance termination and missed approach will be effected upon pilot request, and the controller may terminate guidance

Airport surveillance radar approach (ASR): An instrument approach in which ATC issues instructions for pilot compliance, based on aircraft position in relation to the final approach course, and the distance from the end of the runway as displayed on the controller's radar scope.

Minimum descent altitude (MDA): The lowest altitude to which descent is authorized on final approach, or during circle-to-land maneuvering in execution of a nonprecision approach.

when the pilot reports the runway, airport/heliport, or visual surface route (point-in-space approach) in sight or otherwise indicates that continued guidance is not required. Radar service is automatically terminated at the completion of the radar approach.

Precision Approach

The installations that have PAR are joint civil/military airports and usually provide service to civilian pilots flying IFR only with prior permission, except in an emergency.

A PAR serves the same purpose as an ILS, except that guidance information is presented to the pilot through aural rather than visual means. If a PAR is available, it is normally aligned with an ILS. During a PAR approach, pilots are provided highly accurate guidance in both azimuth and elevation.

The precision approach begins when your aircraft is within range of the precision radar and contact has been established with the PAR controller. Normally this occurs approximately 8 miles from touchdown, a point to which you are vectored by surveillance radar or are positioned by a nonradar approach procedure. You will be given headings to fly, to direct you to, and to keep your aircraft aligned with, the extended centerline of the landing runway.

Before intercepting the glidepath, you will be advised of communications failure/missed approach procedures and told not to acknowledge further transmissions. You will be told to anticipate glidepath interception approximately 15 to 30 seconds before it occurs and when to start your descent. The published **decision altitude/decision height (DA/DH)** will be given only if you request it.

During the final approach, the controller will give elevation information as "slightly/well above" or " slightly/well below" glidepath, and course information as "slightly/well right" or "slightly/well left" of course. Extreme accuracy in maintaining and correcting headings and rate of descent is essential. The controller will assume the last assigned heading is being maintained and will base further corrections on this assumption. Range from touchdown is given at least once each mile. If your aircraft is observed by the controller to proceed outside of specified safety zone limits in azimuth and/or elevation and continue to operate outside these prescribed limits, you will be directed to execute a missed approach or to fly a specified course unless you have the runway environment in sight. You will be provided navigational guidance in azimuth and elevation to the DA/DH. Advisory course and glidepath information will be furnished by the controller until your aircraft passes over the runway threshold, at which point you will be advised of any deviation from the runway centerline. Radar service is automatically terminated at the completion of the approach.

No-Gyro Approach Under Radar Control

If you should experience failure of your heading indicator or other stabilized compass, or for other reasons need more positive radar guidance, ATC will provide a no-gyro vector or approach on request. Before commencing such an approach, you will be advised as to the type of approach (surveillance or precision approach and runway number) and the manner in which turn instructions will be issued. All turns are executed at standard rate, except on final approach—then, at half-standard rate. The controller tells you when to start and stop turns, recommends altitude information and provides guidance and information essential for the completion of your approach. You can execute this approach in an emergency with an operating communications receiver and primary flight instruments.

Timed Approaches From a Holding Fix

Timed approaches from a holding fix are conducted when many aircraft are waiting for an approach clearance. Although the controller will not specifically state "timed approaches are in progress," the assigning of a time to depart the FAF inbound (nonprecision approach), or the outer marker or fix used in lieu of the outer marker inbound (precision approach), indicates that timed approach procedures are being utilized.

In lieu of holding, the controller may use radar vectors to the final approach course to establish a distance between aircraft that will ensure the appropriate time sequence between the FAF and outer marker, or fix used in lieu of the outer marker and the airport. Each pilot in the approach sequence will be given advance notice as to the time they should leave the holding point on approach to the airport. When a time to leave the holding point is received, the pilot should adjust the flightpath in order to leave the fix as closely as possible to the designated time.

Decision altitude (DA): A specified altitude in the precision approach, charted in "feet MSL," at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.

Decision height (DH): A specified altitude in the precision approach, charted in "height above threshold elevation," at which a decision must be made to either continue the approach or to execute a missed approach.

Timed approaches may be conducted when the following conditions are met:

1. A control tower is in operation at the airport where the approaches are conducted.
2. Direct communications are maintained between the pilot and the Center or approach controller until the pilot is instructed to contact the tower.
3. If more than one missed approach procedure is available, none require a course reversal.
4. If only one missed approach procedure is available, the following conditions are met:
   a. Course reversal is not required; and,
   b. Reported ceiling and visibility are equal to or greater than the highest prescribed circling minimums for the IAP.
5. When cleared for the approach, pilots should not execute a procedure turn.

Approaches to Parallel Runways

Procedures permit ILS instrument approach operations to dual or triple parallel runway configurations. Parallel approaches are an ATC procedure that permits parallel ILS approaches to airports with parallel runways separated by at least 2,500 feet between centerlines. Wherever parallel approaches are in progress, pilots are informed that approaches to both runways are in use.

Simultaneous approaches are permitted to runways:

1. With centerlines separated by 4,300 to 9,000 feet;
2. That are equipped with final monitor controllers;
3. That require radar monitoring to ensure separation between aircraft on the adjacent parallel approach course.

The approach procedure chart will include the note "simultaneous approaches authorized RWYS 14L and 14R," identifying the appropriate runways. When advised that simultaneous parallel approaches are in progress, pilots must advise approach control immediately of malfunctioning or inoperative components.

Parallel approach operations demand heightened pilot situational awareness. The close proximity of adjacent aircraft conducting simultaneous parallel approaches mandates strict compliance with all ATC clearances and approach procedures. Pilots should pay particular attention to the following approach chart information: name and number of the approach, localizer frequency, inbound course, glide-slope intercept altitude, DA/DH, missed approach instructions, special notes/procedures, and the assigned runway location and proximity to adjacent runways. Pilots also need to exercise strict radio discipline, which includes continuous monitoring of communications and the avoidance of lengthy, unnecessary radio transmissions.

Side-Step Maneuver

ATC may authorize a side-step maneuver to either one of two parallel runways that are separated by 1,200 feet or less, followed by a straight-in landing on the adjacent runway. Aircraft executing a side-step maneuver will be cleared for a specified nonprecision approach and landing on the adjacent parallel runway. For example, "Cleared ILS runway 7 left approach, side-step to runway 7 right." Pilots are expected to commence the side-step maneuver as soon as possible after the runway or runway environment is in sight. Landing minimums to the adjacent runway will be based on nonprecision criteria and therefore higher than the precision minimums to the primary runway, but will normally be lower than the published circling minimums.

Circling Approaches

Landing minimums are listed on the approach chart under "CIRCLING." Circling minimums apply when it is necessary to circle the airport or maneuver for landing, or when no straight-in minimums are specified on the approach chart. [Figure 10-11]

The circling minimums published on the instrument approach chart provide a minimum of 300 feet of obstacle clearance in the circling area. During a **circling approach**, you should maintain visual contact with the runway of intended landing and fly no lower than the circling minimums until you are in position to make a final descent for a landing. Remember—circling minimums are just that—minimums. If the ceiling allows it, fly at an altitude that more nearly approximates your VFR traffic pattern altitude. This will make any maneuvering safer and bring your view of the landing runway into a more normal perspective.

Circling approach: A maneuver initiated by the pilot to align the aircraft with a runway for landing when a straight-in landing from an instrument approach is not possible or is not desirable.

Approach Category	Radius (miles)
A	1.3
B	1.5
C	1.7
D	2.3
E	4.5

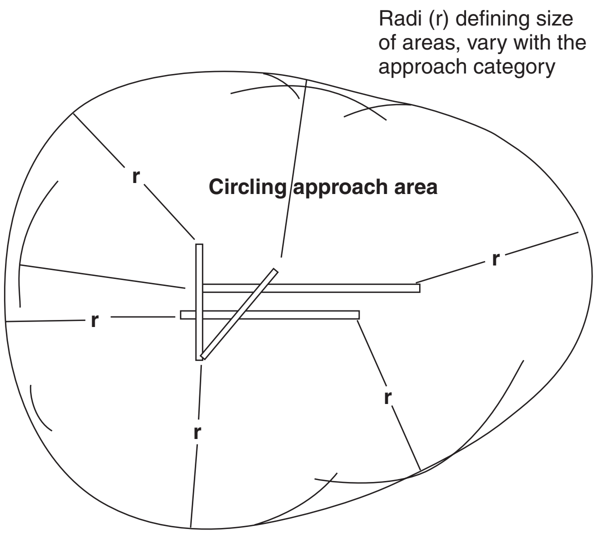


Figure 10-11. *Circling approach area radii.*

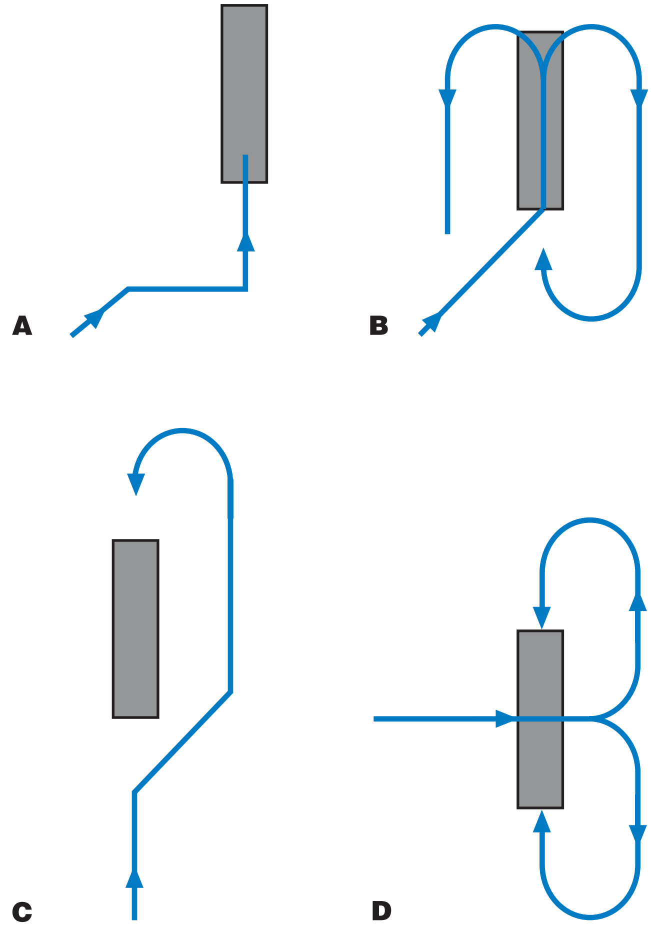


Figure 10-12. *Circling approaches.*

Figure 10-12 shows patterns that can be used for circling approaches. Pattern "A" can be flown when your final approach course intersects the runway centerline at less than a 90° angle, and you sight the runway early enough to establish a base leg. If you sight the runway too late to fly pattern "A," you can circle as shown in "B." You can fly pattern "C" if it is desirable to land opposite the direction of the final approach, and the runway is sighted in time for a turn to downwind leg. If the runway is sighted too late for a turn to downwind, you can fly pattern "D." Regardless of the pattern flown, the pilot must maneuver the aircraft so as to remain within the designated circling area. Refer to section A ("Terms and Landing Minima Data") in the front of each TPP, for a description of circling approach categories.

Sound judgment and knowledge of your capabilities and the performance of your aircraft are the criteria for determining the pattern to be flown in each instance, since you must consider all factors: airport design, ceiling and visibility, wind direction and velocity, final approach course alignment, distance from the final approach fix to the runway, and ATC instructions.

IAP Minimums

Pilots may not operate an aircraft at any airport below the authorized MDA or continue an approach below the authorized DA/DH unless:

1. The aircraft is continuously in a position from which a descent to a landing on the intended runway can be made at a normal descent rate using normal maneuvers;
2. The flight visibility is not less than that prescribed for the approach procedure being used; and
3. At least one of the following visual references for the intended runway is visible and identifiable to the pilot:
   a. Approach light system
   b. Threshold
   c. Threshold markings
   d. Threshold lights

e. Runway end identifier lights (REIL)

f. Visual approach slope indicator (VASI)

g. Touchdown zone or touchdown zone markings

h. Touchdown zone lights

i. Runway or runway markings

j. Runway lights

Missed Approaches

A missed approach procedure is formulated for each published instrument approach and allows the pilot to return to the airway structure while remaining clear of obstacles. The procedure is shown on the approach chart in text and graphic form. Since the execution of a missed approach occurs when your cockpit workload is at a maximum, the procedure should be studied and mastered before beginning the approach.

When a MAP is initiated, a climb pitch attitude should be established while setting climb power. You should configure the aircraft for climb, turn to the appropriate heading, advise ATC that you are executing a missed approach, and request further clearances.

If the missed approach is initiated prior to reaching the MAP, unless otherwise cleared by ATC, continue to fly the IAP as specified on the approach plate to the MAP at or above the MDA or DA/DH before beginning a turn.

If visual reference is lost while circling-to-land from an instrument approach, execute the appropriate MAP. You should make the initial climbing turn toward the landing runway and then maneuver to intercept and fly the missed approach course.

Pilots should immediately execute the missed approach procedure:

1. Whenever the requirements for operating below DA/DH or MDA are not met when the aircraft is below MDA, or upon arrival at the MAP and at any time after that until touchdown;
2. Whenever an identifiable part of the airport is not visible to the pilot during a circling maneuver at or above MDA;
3. When so directed by ATC.

Missed Approach Caution

Acceleration forces and poor visual cues can cause sensory illusions during the execution of a missed approach. A well-developed instrument cross-check is necessary to safely carry out the procedure.

The missed approach procedures are related to the location of the FAF. When the FAF is not located on the field, the missed approach procedure will specify the distance from the facility to the MAP. The airport diagram on the IAP shows the time from the facility to the missed approach at various groundspeeds, which you must determine from airspeed, wind, and distance values. This time determines when you report and execute a missed approach if you do not have applicable minimums. Missed approach instructions will be provided prior to starting the final approach of either an ASR or PAR approach.

Landing

According to part 91, no pilot may land when the flight visibility is less than the visibility prescribed in the standard IAP being used. ATC will provide the pilot with the current visibility reports appropriate to the runway in use. This may be in the form of **prevailing visibility**, **runway visual value (RVV)**, or **runway visual range (RVR)**. However, only the pilot can determine if the flight visibility meets the landing requirements indicated on the approach chart. If the flight visibility meets the minimum prescribed for the approach, then the approach may be continued to a landing. If the flight visibility is less than that prescribed for the approach, then the pilot must execute a missed approach, regardless of the reported visibility.

The landing minimums published on IAP charts are based on full operation of all components and visual aids associated with the instrument approach chart being used. Higher minimums are required with inoperative components or visual aids. For example, if the ALSF-1 approach lighting system were inoperative, the visibility minimums for an ILS must be increased by one-quarter mile. If more than one component is inoperative, each minimum is raised to the highest minimum required by any single component that is inoperative. ILS glide-slope inoperative minimums are published on instrument approach charts as localizer minimums. Consult the "Inoperative Components or Visual Aids Table" (printed on the inside front cover of each TPP), for a complete description of the effect of inoperative components on approach minimums.

Prevailing visibility: The greatest horizontal visibility equaled or exceeded throughout at least half the horizon circle (which is not necessarily continuous).

Runway visibility value (RVV): The visibility determined for a particular runway by a transmissometer.

Runway visual range (RVR): An instrumentally derived value, based on standard calibrations, that represents the horizontal distance a pilot will see down the runway from the approach end.

Instrument Weather Flying

Flying Experience

The more experience, the better — both VFR and IFR. Night flying promotes both instrument proficiency and confidence. Progressing from night flying under clear, moonlit conditions to flying without moonlight, natural horizon, or familiar landmarks, you learn to trust your instruments with a minimum dependence upon what you can see outside the aircraft. The more VFR experience you have in terminal areas with high traffic activity, the more capable you can become in dividing your attention between aircraft control, navigation, communications, and other cockpit duties. It is your decision to go ahead with an IFR flight or to wait for more acceptable weather conditions.

Recency of Experience

Your currency as an instrument pilot is an equally important consideration. You may not act as pilot in command of an aircraft under IFR or in weather conditions less than VFR minimums unless you have met the requirements of part 61. Remember, these are minimum requirements. Whether they are adequate preparation for you, personally, is another consideration.

Airborne Equipment and Ground Facilities

Regulations specify minimum equipment for filing an IFR flight plan. It is your responsibility to decide on the adequacy of your aircraft and navigation/communication (NAV/COM) equipment for the proposed IFR flight. Performance limitations, accessories, and general condition are directly related to the weather, route, altitude, and ground facilities pertinent to your flight, as well as to the cockpit workload you can expect.

Weather Conditions

In addition to the weather conditions that might affect a VFR flight, an IFR pilot must consider the effects of other weather phenomena (e.g., thunderstorms, turbulence, icing, and visibility).

Turbulence

In-flight turbulence can range from occasional light bumps to extreme airspeed and altitude variations in which aircraft control is difficult. To reduce the risk factors associated with turbulence, pilots must learn methods of avoidance, as well as piloting techniques for dealing with an inadvertent encounter.

Turbulence avoidance begins with a thorough preflight weather briefing. Many reports and forecasts are available to assist the pilot in determining areas of potential turbulence. These include the Severe Weather Warning (WW), **SIGMET** (WS), **Convective SIGMET** (WST), **AIRMET** (WA), Severe Weather Outlook (AC), Center Weather Advisory (CWA), Area Forecast (FA), and Pilot Reports (UA or **PIREPs**). Since thunderstorms are always indicative of turbulence, areas of known and forecast thunderstorm activity will always be of interest to the pilot. In addition, clear air turbulence (CAT) associated with jet streams, strong winds over rough terrain, and fast moving cold fronts are good indicators of turbulence.

Pilots should be alert while in flight for the signposts of turbulence. For example, clouds with vertical development such as cumulus, towering cumulus, and cumulonimbus are indicators of atmospheric instability and possible turbulence. Standing lenticular clouds lack vertical development but indicate strong mountain wave turbulence. While en route, pilots can monitor hazardous in-flight weather advisory service (HIWAS) broadcast for updated weather advisories, or contact the nearest AFSS or En Route Flight Advisory Service (EFAS) for the latest turbulence-related PIREPs.

To avoid turbulence associated with strong thunderstorms, circumnavigate cells by at least 20 miles. Turbulence may also be present in the clear air above a thunderstorm. To avoid this, fly at least 1,000 feet above the tops for every 10 knots of wind at that level, or fly around the storm. Finally, do not underestimate the turbulence underneath a thunderstorm. Never attempt to fly under a thunderstorm even if you can see through to the other side. The possible results of turbulence and wind shear under the storm could be disastrous.

When you encounter moderate to severe turbulence, aircraft control will be difficult, and it will take a great deal of concentration to maintain an instrument scan. [Figure 10-13] Pilots should immediately reduce power and slow the aircraft to the recommended turbulence penetration speed as described in the POH/AFM. To minimize the load factor

SIGMET: A weather advisory issued concerning weather significant to the safety of all aircraft.

Convective SIGMET: Weather advisory concerning convective weather significant to the safety of all aircraft.

AIRMET: In-flight weather advisory issued as an amendment to the area forecast, concerning weather phenomena of operational interest to all aircraft which are potentially hazardous to aircraft with limited capability due to lack of equipment, instrumentation, or pilot qualifications.

Pilot report (PIREP): Report of meteorological phenomena encountered by aircraft in flight.

imposed on the aircraft, the wings should be kept level and the aircraft's pitch attitude should be held constant, while the altitude of the aircraft is allowed to fluctuate up and down. Maneuvering to maintain a constant altitude will only increase the stress on the aircraft. If necessary, the pilot should advise ATC of the fluctuations and request a block altitude clearance. In addition, the power should remain constant at a setting that will maintain the recommended turbulence penetration airspeed.

Figure 10-13. *Maintaining an instrument scan in severe turbulence may be difficult.*

The best source of information on the location and intensity of turbulence are PIREPs. Therefore, pilots are encouraged to familiarize themselves with the turbulence reporting criteria found in the AIM, which also describes the procedure for volunteering PIREPs relating to turbulence.

Structural Icing

The very nature of IFR requires flight in visible moisture such as clouds. At the right temperatures, this moisture can freeze on the aircraft causing increased weight, degraded performance, and unpredictable aerodynamic characteristics. Understanding, avoidance, and early recognition followed by prompt action are the keys to avoiding this potentially hazardous situation.

Structural icing refers to the accumulation of ice on the exterior of the aircraft and is broken down into three classifications: **rime ice**, **clear ice**, and **mixed ice**. For ice to form, there must be moisture present in the air, and the air must be cooled to a temperature of 0 °C (32 °F) or less. Aerodynamic cooling can lower the surface temperature of an airfoil and cause ice to form on the airframe even though the ambient temperature is slightly above freezing.

Rime ice forms if the droplets are small and freeze immediately when contacting the aircraft surface. This type of ice usually forms on areas such as the leading edges of wings or struts. It has a somewhat rough-looking appearance and a milky-white color.

Clear ice is usually formed from larger water droplets or freezing rain that can spread over a surface. This is the most dangerous type of ice since it is clear, hard to see, and can change the shape of the airfoil.

Mixed ice is a mixture of clear ice and rime ice. It has the bad characteristics of both types and can form rapidly. Ice particles become imbedded in clear ice, building a very rough accumulation. The table in figure 10-14 lists the temperatures at which the various types of ice will form.

Outside Air	Temperature Range	Icing Type
0 °C to	-10 °C	Clear
-10 °C to	-15 °C	Mixed clear and rime
-15 °C to	-20 °C	Rime

Figure 10-14. *Temperature ranges for ice formation.*

Structural icing is a condition that can only get worse. Therefore, during an inadvertent icing encounter, it is important the pilot act to prevent additional ice accumulation. Regardless of the level of **anti-ice** or **deice** protection offered by the aircraft, the first course of action should be to get out of the area of visible moisture. This might mean descending to an altitude below the cloud bases, climbing to an altitude that is above the cloud tops, or turning to a different course. If this is not possible, then the pilot must move to an altitude where the temperature is above freezing. Report icing conditions to ATC and request new routing or altitude if icing will be a hazard. Refer to the AIM for information on reporting icing intensities.

Rime ice: Rough, milky, opaque ice formed by the instantaneous freezing of small supercooled water droplets.

Clear ice: Glossy, clear, or translucent ice formed by the relatively slow freezing of large supercooled water droplets.

Mixed ice: A mixture of clear ice and rime ice.

Anti-ice: System designed to prevent the accumulation of ice on an aircraft structure.

Deice: System designed to remove ice accumulation from an aircraft structure.

Fog

Instrument pilots must learn to anticipate conditions leading to the formation of fog and take appropriate action early in the progress of the flight. Before a flight, close examination of current and forecast weather should alert the pilot to the possibility of fog formation. When fog is a consideration, pilots should plan adequate fuel reserves and alternate landing sites. En route, the pilot must stay alert for fog formation through weather updates from EFAS, ATIS, and ASOS/AWOS sites.

Two conditions will lead to the formation of fog. Either the air is cooled to saturation, or sufficient moisture is added to the air until saturation occurs. In either case, fog can form when the temperature/dewpoint spread is 5° or less. Pilots planning to arrive at their destination near dusk with decreasing temperatures should be particularly concerned about the possibility of fog formation.

Volcanic Ash

Volcanic eruptions create volcanic ash clouds containing an abrasive dust that poses a serious safety threat to flight operations. Adding to the danger is the fact that these ash clouds are not easily discernible from ordinary clouds when encountered at some distance from the volcanic eruption.

When an aircraft enters a volcanic ash cloud, dust particles and smoke may become evident in the cabin, often along with the odor of an electrical fire. Inside the volcanic ash cloud, the aircraft may also experience lightning and St. Elmo's fire on the windscreen. The abrasive nature of the volcanic ash can pit the windscreens, thus reducing or eliminating forward visibility. The pitot-static system may become clogged, causing instrument failure. Severe engine damage is probable in both piston and jet-powered aircraft.

Every effort must be made to avoid volcanic ash. Since volcanic ash clouds are carried by the wind, pilots should plan their flights to remain upwind of the ash-producing volcano. Visual detection and airborne radar are not considered a reliable means of avoiding volcanic ash clouds. Pilots witnessing volcanic eruptions or encountering volcanic ash should immediately pass this information along in the form of a pilot report. The National Weather Service monitors volcanic eruptions and estimates ash trajectories. This information is passed along to pilots in the form of SIGMETs.

Like many other hazards to flight, the best source of volcanic information comes from PIREPs. Pilots who witness a volcanic eruption or encounter volcanic ash in flight should immediately inform the nearest agency. Volcanic Ash Forecast Transport and Dispersion (VAFTAD) charts are also available; these depict volcanic ash cloud locations in the atmosphere following an eruption, and also forecast dispersion of the ash concentrations over 6- and 12-hour time intervals. *See* AC 00-45, *Aviation Weather Services*.

Thunderstorms

A thunderstorm packs just about every weather hazard known to aviation into one vicious bundle. Turbulence, hail, rain, snow, lightning, sustained updrafts and downdrafts, and icing conditions are all present in thunderstorms. Do not take off in the face of an approaching thunderstorm or fly an aircraft that is not equipped with thunderstorm detection in clouds or at night in areas of suspected thunderstorm activity. [Figure 10-15]

Figure 10-15. *A thunderstorm packs just about every weather hazard known to aviation into one vicious bundle.*

Thunderstorm Avoidance

Aircraft without airborne weather detection equipment should not operate in IMC near areas of suspected thunderstorm activity.

There is no useful correlation between the external visual appearance of thunderstorms and the severity or amount of turbulence or hail within them. All thunderstorms should be considered hazardous, and thunderstorms with tops above 35,000 feet should be considered extremely hazardous.

Weather radar, airborne or ground based, will normally reflect the areas of moderate to heavy precipitation (radar does not detect turbulence). The frequency and severity of turbulence generally increases with the radar reflectivity closely associated with the areas of highest liquid water content of the storm. A flightpath through an area of strong or very strong radar echoes separated by 20 to 30 miles or less may not be considered free of severe turbulence.

The probability of lightning strikes occurring to aircraft is greatest when operating at altitudes where temperatures are between -5 °C and +5 °C. In addition, an aircraft flying in the clear air near a thunderstorm is also susceptible to lightning strikes. Thunderstorm avoidance is always the best policy.

Wind Shear

Wind shear can be defined as a change in wind speed and/or wind direction in a short distance. It can exist in a horizontal or vertical direction and occasionally in both. Wind shear can occur at all levels of the atmosphere but is of greatest concern during takeoffs and landings. It is typically associated with thunderstorms and low-level temperature inversions; however, the jet stream and weather fronts are also sources of wind shear.

As figure 10-16 illustrates, while an aircraft is on an instrument approach, a shear from a tailwind to a headwind will cause the airspeed to increase and the nose to pitch up with a corresponding balloon above the glidepath. A shear from a headwind to a tailwind will have the opposite effect and the aircraft will sink below the glidepath.

A headwind shear followed by a tailwind/downdraft shear is particularly dangerous because the pilot has reduced power and lowered the nose in response to the headwind shear. This leaves the aircraft in a nose-low, power-low configuration when the tailwind shear occurs, which makes recovery more difficult, particularly near the ground. This type of wind shear scenario is likely while making an approach in the face of an oncoming thunderstorm. Pilots should be alert for indications of wind shear early in the approach phase and be ready to initiate a missed approach at the first indication. It may be impossible to recover from a wind shear encounter at low altitude.

To inform pilots of hazardous wind shear activity, some airports have installed a Low-Level Wind Shear Alert System (LLWAS) consisting of a centerfield wind indicator and several surrounding boundary-wind indicators. With this system, controllers are alerted of wind discrepancies (an indicator of wind shear possibility) and provide this information to pilots. A typical wind shear alert issued to a pilot would be:

> "Wind shear alert, Centerfield wind 230 at 8, south boundary wind 170 at 20."

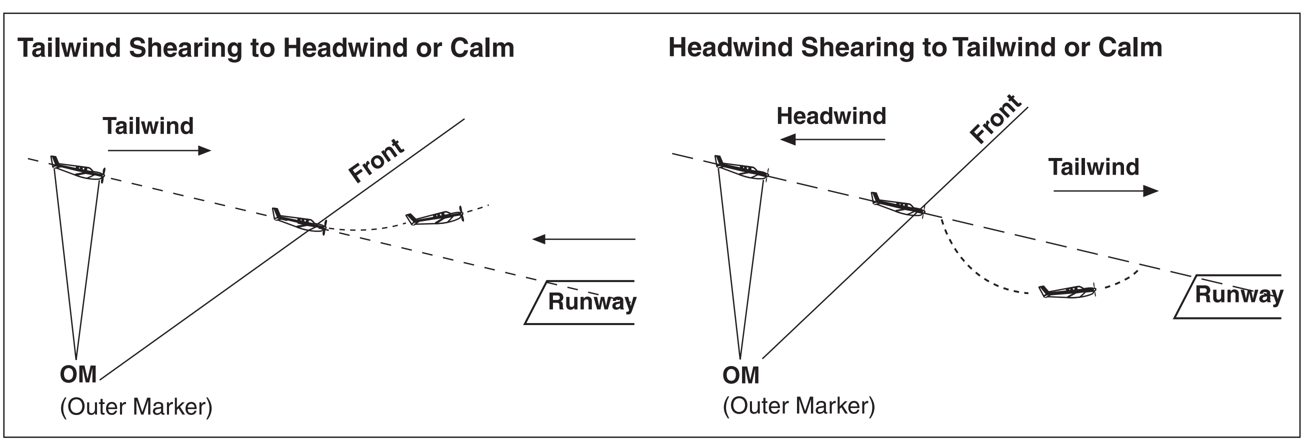


Figure 10-16. *Glide-slope deviations due to wind shear encounter.*

Pilots encountering wind shear are encouraged to pass along pilot reports. Refer to AIM for additional information on wind shear PIREPs.

VFR-On-Top

Pilots on IFR flight plans operating in VFR weather conditions may request **VFR-On-Top** in lieu of an assigned altitude. This permits them to select an altitude or flight level of their choice (subject to any ATC restrictions).

Pilots desiring to climb through a cloud, haze, smoke, or other meteorological formation and then either cancel their IFR flight plan or operate VFR-On-Top may request a climb to VFR-On-Top. The ATC authorization will contain either a top report (or a statement that no top report is available), and a request to report upon reaching VFR-On-Top. Additionally, the ATC authorization may contain a clearance limit, routing, and an alternative clearance if VFR-On-Top is not reached by a specified altitude.

A pilot on an IFR flight plan, operating in VFR conditions, may request to climb/descend in VFR conditions. When operating in VFR conditions with an ATC authorization to "maintain VFR-On-Top/maintain VFR conditions" pilots on IFR flight plans must:

1. Fly at the appropriate VFR altitude as prescribed in part 91.
2. Comply with the VFR visibility and distance-from-cloud criteria in part 91.
3. Comply with IFRs applicable to this flight (e.g., minimum IFR altitudes, position reporting, radio communications, course to be flown, adherence to ATC clearance, etc.).

Pilots operating on a VFR-On-Top clearance should advise ATC before any altitude change to ensure the exchange of accurate traffic information.

ATC authorization to "maintain VFR-On-Top" is not intended to restrict pilots to operating only above an obscuring meteorological formation (layer). Rather, it permits operation above, below, between layers, or in areas where there is no meteorological obscuration. It is imperative pilots understand, however, that clearance to operate "VFR-On-Top/VFR conditions" does not imply cancellation of the IFR flight plan.

Pilots operating VFR-On-Top/VFR conditions may receive traffic information from ATC on other pertinent IFR or VFR aircraft. However, when operating in VFR weather conditions, it is the pilot's responsibility to be vigilant to see-and-avoid other aircraft.

This clearance must be requested by the pilot on an IFR flight plan. VFR-On-Top is not permitted in certain areas, such as Class A airspace. Consequently, IFR flights operating VFR-On-Top must avoid such airspace.

VFR Over-The-Top

VFR Over-The-Top must not be confused with VFR-On-Top. VFR-On-Top is an IFR clearance that allows the pilot to fly VFR altitudes. VFR Over-The-Top is strictly a VFR operation in which the pilot maintains VFR cloud clearance requirements while operating on top of an undercast layer. This situation might occur when the departure airport and the destination airport are reporting clear conditions, but a low overcast layer is present in between. The pilot could conduct a VFR departure, fly over the top of the undercast in VFR conditions, then complete a VFR descent and landing at the destination. VFR cloud clearance requirements would be maintained at all times, and an IFR clearance would not be required for any part of the flight.

Conducting an IFR Flight

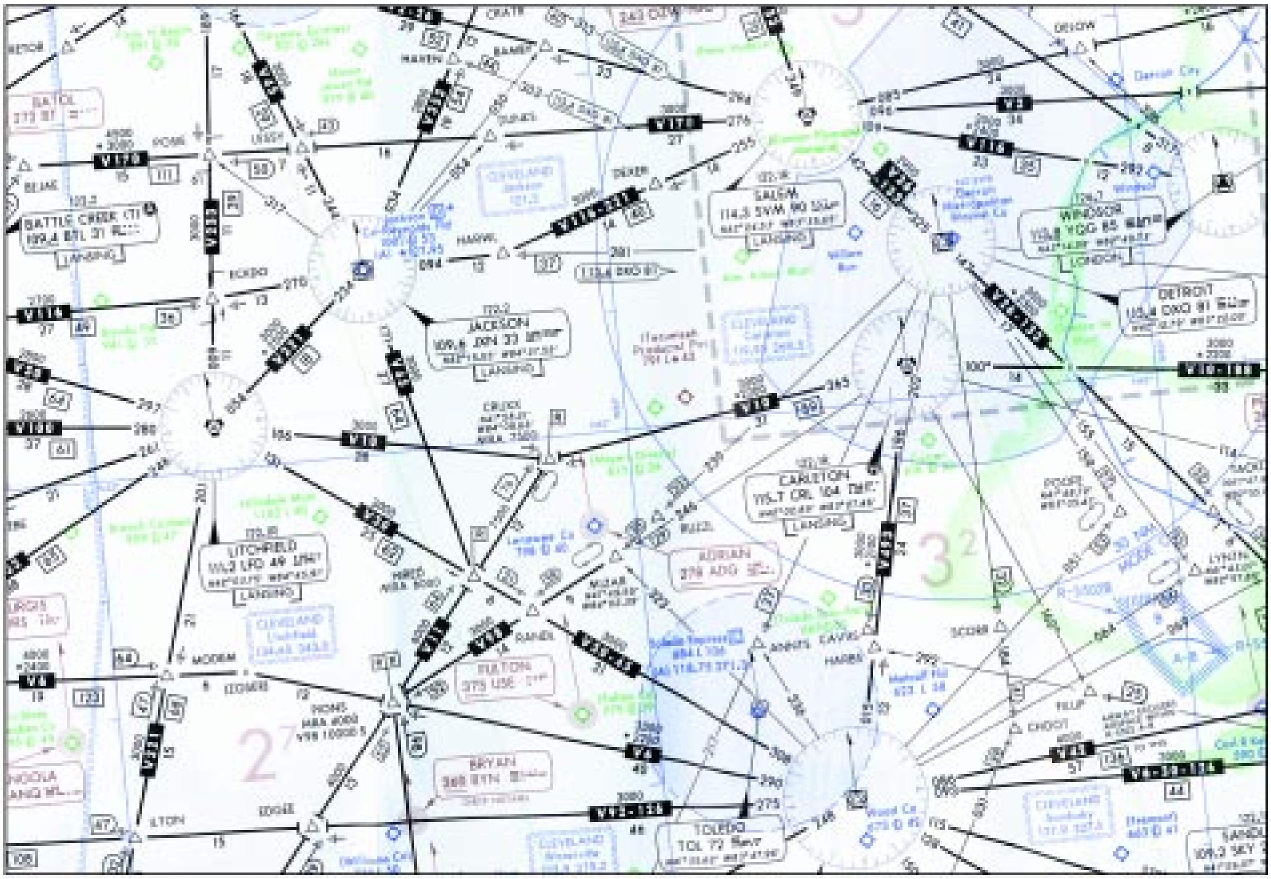
To illustrate some of the concepts introduced in this chapter, follow along on a typical IFR flight from the Detroit Metropolitan Airport (DTW) to the University of Illinois — Willard Airport located near Champaign, IL (CMI). [Figure 10-17] For this trip, a Cessna 182 with a call sign of N1230A will be flown. The aircraft is equipped with dual navigation and communication radios, DME, ADF, a transponder, and a GPS system approved for IFR en route operations to be used during the flight.

Preflight

The success of the flight depends largely upon the thoroughness of the preflight planning. The evening before the flight, pay close attention to the weather forecast and begin planning the flight.

VFR-On-Top: ATC authorization for an IFR aircraft to operate in VFR conditions at any appropriate VFR altitude.

VFR Over-The-Top: A VFR operation in which an aircraft operates in VFR conditions on top of an undercast.



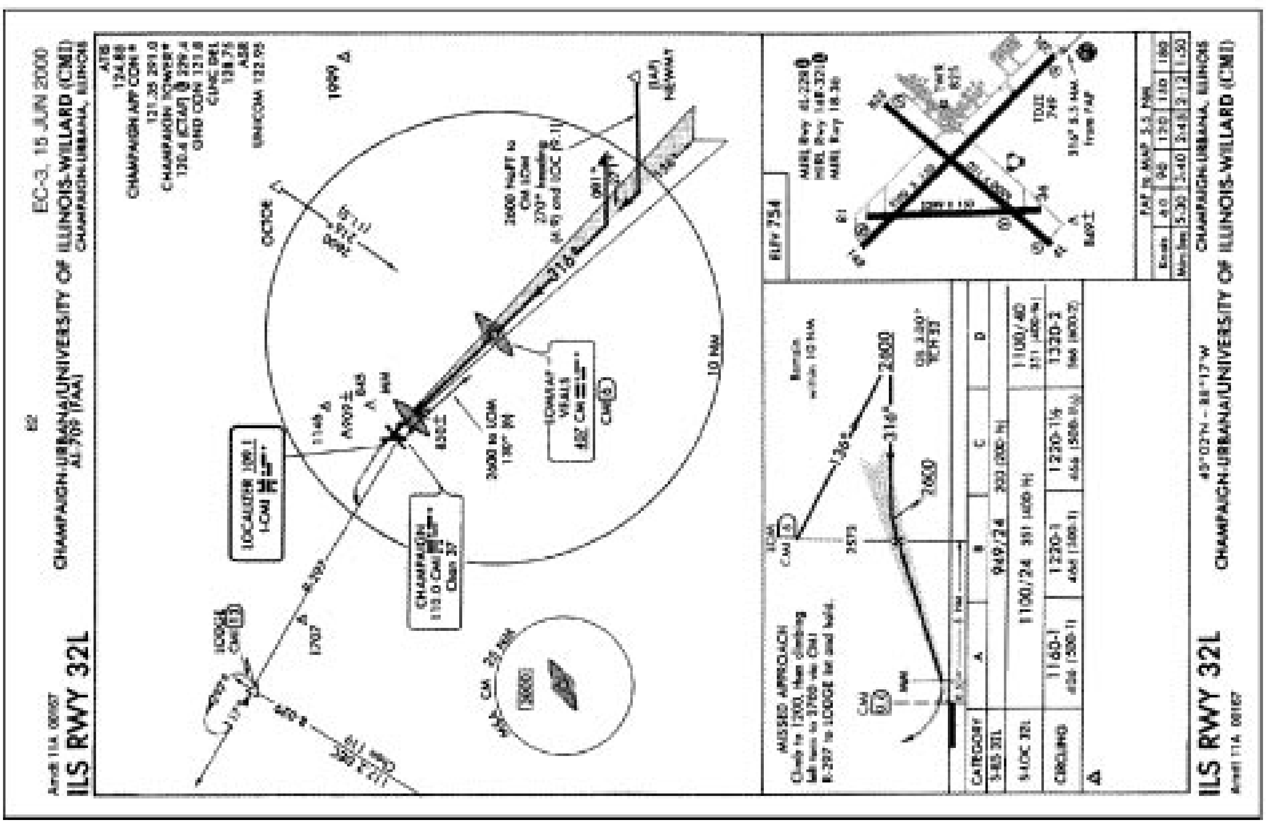


Figure 10-17. *Route planning.*

The Weather Channel indicates a large low-pressure system has settled in over the Midwest, pulling moisture up from the Gulf of Mexico and causing low ceilings and visibility, with little chance for improvement over the next couple of days. To begin planning, gather all the necessary charts and materials, and verify everything is current. This includes en route charts, approach charts, DPs, STAR charts, as well as an A/FD, some navigation logs, and the aircraft's POH/AFM. The charts cover both the departure and arrival airports, as well as any contingency airports that will be needed if you cannot complete the flight as planned. This is also a good time to consider your recent flight experience, proficiency as a pilot, fitness, and personal weather minimums to fly this particular flight.

To begin planning, go to the A/FD to become familiar with the departure and arrival airport and check for any preferred routing between DTW and CMI. Next, review the approach plates and any DP or STAR that pertain to the flight. Finally, review the en route charts for potential routing, paying close attention to the minimum en route and obstacle clearance altitudes.

After this review, you decide your best option is to fly the Palace Two DP (*see* figure 10-2) out of DTW direct to HARWL intersection, V116 to Jackson VOR (JXN), V221 to Litchfield VOR (LFD), then direct to CMI using the GPS. You also decide that an altitude of 4,000 feet will meet all the regulatory requirements and falls well within the performance capabilities of your aircraft.

Next, call 1-800-WX-BRIEF to obtain an outlook-type weather briefing for your proposed flight. This provides forecast conditions for your departure and arrival airports as well as the en route portion of the flight including forecast winds aloft. This also is a good opportunity to check the available NOTAMs.

The weather briefer confirms the predictions of the weather channel giving forecast conditions that are at or near minimum landing minimums at both DTW and CMI for your proposed departure time. The briefer also informs you of some NOTAM information for CMI indicating that the localizer back-course approach to runway 14 right is scheduled to be out of service for tomorrow, and that runway 4/22 is closed.

Somewhat leery of the weather, you continue flight planning and begin to transfer some preliminary information onto the navigation log, listing each fix along the route and the appropriate distances, frequencies, and altitudes. Consolidating this information onto an organized navigation log keeps your workload to a minimum during the flight. With your homework complete, now it is time to get a good night's sleep and see what tomorrow brings.

The next morning you awaken to light drizzle and low ceilings. You use the computer to print a standard weather briefing for the proposed route. A check of current conditions indicates low IFR conditions at both the departure airport and at the destination, with visibility of one-quarter mile:

```
SURFACE WEATHER OBSERVATIONS

METAR KDTW 111147Z VRB04KT 1/4SM FG –RN
VV1600 06/05 A2944 RMK AO2 SLP970

METAR KCMI 111145Z 27006KT 1/4SM FG OVC001
08/07 A2962 RMK AO2 SLP033
```

The small temperature/dewpoint spread is causing the low visibility and ceilings. As the temperatures increase, conditions should improve later in the day. A check of the terminal forecast confirms this theory:

```
TERMINAL FORECASTS

TAF KDTW 101146Z 101212 VRB04KT 1/4SM FG
OVC001 TEMPO 1316 3/4SM VV1800

FM1600 VRB05KT 2SM BR OVC007 TEMPO 1720
3SM DZ BKN009

FM2000 24008KT 3SM BR OVC015 TEMPO 2202
3SM BR OVC025

FM0200 25010KT P6SM OVC025

FM0800 27013KT P6SM BKN030 PROB40 1012
2SM -RN OVC030

TAF KCMI 101145Z 101212 2706KT 1/4SM FG
VV1600 BECMG 1317 3SM BR OVC004

FM1700 2910KT 3SM BR OVC005

FM0400 2710KT 5SM SCT080 TEMPO 0612 P6SM
SKC
```

In addition to the terminal forecast, the area forecast also indicates gradual improvement along the route. Since the terminal forecast only provides information for a 5-mile radius around a terminal area, checking the area forecast provides a better understanding of the overall weather picture along the route and alerts you to potential hazards:

```
SYNOPSIS AND VFR CLOUDS/WEATHER FORECASTS

CHIC FA 111045

SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 120500

CLDS/WX VALID UNTIL 112300...OTLK VALID
112300-120500

ND SD NE KS MN IA MO WI LM LS MI LH IL IN
KY

SEE AIRMET SIERRA FOR IFR CONDS AND MTN
OBSCN.

TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND
IFR CONDS.

NON MSL HGTS DENOTED BY AGL OR CIG.

SYNOPSIS...AREA OF LOW PRESSURE CNTD OVR
AL RMNG GENLY STNRY BRNGNG MSTR AND WD
SPRD IFR TO GRT LKS RGN. ALF...LOW PRES
TROF ACRS CNTR PTN OF THE CHI FA WILL
GDLY MOV EWD DURG PD...KITE...

MO

CIG BKN020 TOPS TO FL180. VIS 1-3SM BR.
SWLY WND. 18Z BRK030. OTLK...MVFR CIG.

WI LS LM MI LH IN

CIG OVC001-OVC006 TOPS TO FL240. VIS
1/4-3/4SM FG. SWLY WND. 16Z CIG OVC010
VIS 2SM BR. OCNL VIS 3-5SM -RN BR OVC009.
OTLK...MVFR CIG VIS

IL

NRN 1/2 CIG OVC001 TOPS LYRD TO FL250.
VIS 1/4-1SM FG BR. WLY WND THRUT THE PD.
16Z CIG OVC006. SCT -SHRN. OTLK...IFR.
SRN 1/2...CIG SCT-BKN015 TOPS TO FL250.
WLY WND THRUT THE PD. 17Z AGL BRK040.
OTLK...MVFR CIG VIS.
```

At this time, there are no SIGMETs or PIREPs reported. However, you note several AIRMETs, one for IFR conditions and one for turbulence that covers the entire route and another for icing conditions which covers an area just north of the route:

```
AIRMET TURB...MN WI MI LM IN IL IA MO OH

FROM MSP TO TVC TO CLE TO FAM TO BUM TO
MSP

OCNL MOD TURB BLW 080. CONDS CONTG BYD
11Z THRU 17Z.

AIRMET ICE...WI MI MN

FROM MBS TO MSN TO INL TO AFW TO MBS

LGT-OCNL MOD RIME ICGIC BTN 040 AND 100.
CONDS CONTG BYD 11Z THRU 18Z.

FRZLVL...SFC-040 NRN MN SLPG 050-100 RMNDR
FA AREA FM NW TO SE.

AIRMET IFR...IA MO IL IN WI LM LS MI LH
MN

FROM INL TO AFW TO PIT TO BNA TO ICT TO
INL

OCNL CIG BLW 010/VIS BLW 3SM PCPN/BR/FG.
CONDS CONTG BYD 09Z THRU 15Z. RMNDR...NO
WDSPRD IFR EXP.
```

A recheck of NOTAMs confirms that the localizer back-course approach for runway 14R at Champaign is out of service and that runway 22/4 is closed. You also learn of another NOTAM that was not mentioned in the telephone briefing, concerning the Palace-Two departure. If you use runway 21 for the departure, you should confirm that you are able to adhere to the climb restriction. This Palace-Two Departure NOTAM (below) is a good example of why it is important to check the second column of airport identifiers for the NOTAM location. If you only looked at the first column of identifiers, you might mistakenly think this NOTAM applied to USD rather than DTW:

```
USD 11/004 DTW PALACE TWO DEPARTURE: PROP
AIRCRAFT DEPARTING RWY 21 WESTBOUND CROSS
DXO 3.5 DME AT OR ABOVE 2500 MSL. IF
UNABLE TO MAKE THE CLIMB RESTRICTION ADVISE
DTW TOWER PRIOR TO DEPARTURE.

CMI 12/006 CMI RWY 22R/4L CLSD

CMI 12/008 CMI LOCBAC 14R OTS
```

Flight Planner

AIRCRAFT	N	TIME OFF	1308	BLOCK START	1258	BLOCK END	1455
ATIS CODE	KILO	SKY 7OVC	3 MILES	TEMP	+8C	WIND	090@8
En Route		ALTIMETER	29.87	RUNWAY	3C	EST GPH	11

Preflight

PLANNED TRUE COURSE	PLANNED ALTITUDE	PREDICTED WIND DIRECTION	PREDICTED WIND VELOCITY	TEMP	PLAN TAS	WIND CORR ANGLE -L +R	TRUE HEADING / -E +W VAR	MAG HEADING / ± DEV
275	4000	116	23	+02	140	-3L	272 / +6	278 / +2
269	4000	116	23	+02	140	-4L	265 / +5	270 / +2
229	4000	116	23	+02	140	-9L	220 / +5	225 / +2
236	4000	116	23	+02	140	-8L	228 / +4	232 / +2
230	4000	116	23	+02	140	-9L	221 / +0	221 / +2

En Route

Checkpoints	COMPASS HEADING	DIST LEG / REM	GS EST / ACT	ETE / ATE	ETA / ATA	FUEL USED / FUEL REM.	VOR FREQ / IDENT	VOR BEARING / TO/FROM	TRANSPONDER CODES "SQUAWKS"
DEPARTURE DTW									
HARWL	ZV 280°	38 / 230	161	14		3gAL	113.4	281 FROM	0321
JXN	V116 272°	12 / 218	160	05		1gAL	109.6	274 TO	
LFD	V221 227°	18 / 200	147	07		2gAL	111.2	234 TO	
CMI	DCT 234°	200 / 0	150	0/120		15gAL	GPS / DCT	239 TO	
TOTALS →		268		0/146		21gAL			
ALTERNATE CMI									
ALN	DCT 223°	107 / 107	148	00:43		8gAL			
RESERVE				00:45					
ARRIVAL	TOTALS →			3+14		29gAL			

Terminal Information

Field	Elevation	Runways	Radio Frequencies
DTW	640	3/21 9/27	133.67 ATIS 120.68 CLNC 119.45G (184(T)) 118.95 DEP
ALN	544	1/129 17/35	125.8 ATIS 124.2 APR 126.0T 120.2 GND
CMI	754	32L-14R	124.85 ATIS 121.35(A) 120.4(T) 21.8(G)

Notes: MINIMUM FUEL REQUIRED = 50 GALLONS

CMI: LOC BAC 14R 05 RWY 22R/4L CLOSED

Pilot Report FLIGHT WATCH 122.0 OR NEAREST FLIGHT SERVICE STATION	**1** AIRCRAFT	**2** POSITION	**3** TIME (Z)
	4 CONDITIONS	**5** CLOUDS	**6** ALTITUDE

FLIGHT PLAN & WEATHER LOG ON REVERSE SIDE

 ASA-FP-2

Figure 10-18. *Navigation log.*

Weather Briefing

LOCATION	TERMINAL AERODROME FORECASTS
DTW	AFTER 8AM 7OVC/3 WIND 090@8
CMI	AFTER 10AM 6OVC/4 WIND 140@9
ALN	20OVC/3 WIND 140@8

LOCATION	WINDS & TEMPERATURES ALOFT FORECASTS			
	ALT 3	ALT 6	ALT 9	ALT
EWA	110@20	130@30	135@35	

LOCATION	PIREPS/SIGNIFICANT WEATHER/NOTAMS
CMI	14R LOC BAC OS RWY 22/4 CLSD

Weight and Balance

	WEIGHT	X ARM	= MOMENT
EMPTY WEIGHT AIRCRAFT	1802		139988
FRONT PASSENGERS	378	81	30618
REAR PASSENGERS	—	—	—
FUEL GAL x 6#/GAL=	420	95	39900
BAGGAGE	55	142	7810
TOTAL GROSS WEIGHT	2655	TOTAL MOMENT	218316

CG = TOTAL MOMENT / TOTAL WEIGHT: 82.2

GROSS WEIGHT AND CG WITHIN LIMITS? YES

Figure 10-18. *Navigation log. (continued)*

The good news is that the weather is substantially better south of your route, making Alton Regional Airport a good alternate with current conditions and a forecast of marginal VFR.

```
METAR KALN 111049Z 25010KT 2SM BKN014
OVC025 03/M03 A2973

TAF KSTL 101045Z 101212 2510KT 2SM BR
OVC020 BECMG 1317 3SM BR OVC025
FM1700 2710KT 4SM BR OVC030
FM0400 2714KT 5SM OVC050 TEMPO 0612 P6SM
OCV080
```

At this point, with weather minimums well below personal minimums, you make the decision to delay your departure for a couple of hours to wait for improved conditions; this gives you more time to continue with your preflight planning.

You can now complete your navigation log. [Figure 10-18] Use the POH/AFM to compute a true airspeed, cruise power setting, and fuel burn based on the forecast temperatures aloft and your cruising pressure altitude. Also, compute weight-and-balance information, and determine your takeoff and landing distance. You will have a slight tailwind if weather conditions require a straight-in landing on the ILS to runway 32L at CMI. Therefore, compute your landing distance assuming a 10-knot tailwind, and determine if the runway length is adequate to allow a downwind landing. Continuing in your navigation log, determine your estimated flight time and fuel burn using the winds aloft forecast and considering Alton, IL, as your alternate airport. With full tanks, you can make the flight nonstop, with adequate fuel for your destination, alternate, and a 1-hour and 10-minute reserve.

A look at the surface analysis chart provides the big picture and shows where you will find the pressure systems. The weather depiction chart shows areas of IFR conditions; you can use this to find areas of improving conditions. This is good information should you need to divert to VFR conditions. The radar depicts precipitation along the route, and the latest satellite photo confirms what the weather depiction chart showed.

With the navigation log finished, you can now complete the flight plan in preparation for filing with flight service. [Figure 10-19]

A couple of hours have passed, and a look out the window shows the weather appears to be improving. Calling AFSS for an update weather briefing, you learn that conditions have indeed improved. Detroit Metro airport is now 700 overcast with 3 miles visibility and Champaign is now 400 overcast with 2 miles visibility. The alternate, Alton Regional Airport, continues to report adequate weather conditions with 2,000 overcast and 3 miles visibility in light rain.

Several pilot reports have been submitted for light icing conditions; however, all the reports are north of the route of flight corresponding to the AIRMET that was issued earlier. You inquire about cloud tops, but the briefer states no pilot reports have included cloud tops, at this time; however, the area forecast was predicting cloud tops to flight level 240. Since the weather conditions appear to be improving and you have the weather briefer on the telephone, file your flight plan using the completed form.

Form Approved OMB No. 2120-0026

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION **FLIGHT PLAN**	(FAA USE ONLY) ☐ PILOT BRIEFING ☐ VNR ☐ STOPOVER	TIME STARTED	SPECIALIST INITIALS

1. TYPE	2. AIRCRAFT IDENTIFICATION	3. AIRCRAFT TYPE/ SPECIAL EQUIPMENT	4. TRUE AIRSPEED	5. DEPARTURE POINT	6. DEPARTURE TIME PROPOSED (Z)	6. DEPARTURE TIME ACTUAL (Z)	7. CRUISING ALTITUDE
VFR ☐ / X IFR / DVFR ☐	N1230A	C182/G	140 KTS	DTW	1300		4000

8. ROUTE OF FLIGHT

DCT LFD DCT CMI

9. DESTINATION (Name of airport and city)	10. EST. TIME ENROUTE HOURS	10. EST. TIME ENROUTE MINUTES	11. REMARKS
CMI-WILLARD AIRPORT SAVOY, IL	01	42	

12. FUEL ON BOARD HOURS	12. FUEL ON BOARD MINUTES	13. ALTERNATE AIRPORT(S)	14. PILOT'S NAME, ADDRESS & TELEPHONE NUMBER & AIRCRAFT HOME BASE	15. NUMBER ABOARD
04	20	ALN	WARREN SMITH, 123 MAIN STREET DETROIT, MI 48123 217-555-1212 DTW 17. DESTINATION CONTACT/TELEPHONE (OPTIONAL)	2

16. COLOR OF AIRCRAFT	
BLUE/WHITE	CIVIL AIRCRAFT PILOTS. FAR Part 91 requires you file an IFR flight plan to operate under instrument flight rules in controlled airspace. Failure to file could result in a civil penalty not to exceed $1,000 for each violation (Section 901 of the Federal Aviation Act of 1958, as amended). Filing of a VFR flight plan is recommended as a good operating practice. See also Part 99 for requirements concerning DVFR flight plans.

FAA Form 7233-1 (8-82) CLOSE VFR FLIGHT PLAN WITH ____________ FSS ON ARRIVAL

Figure 10-19. *Flight plan form.*

Analyzing the latest weather, you decide to proceed with the trip. The weather minimums are now well above your personal minimums. With the absence of icing reported along the route and steadily rising temperatures, you are confident you will be able to avoid structural icing. However, make a note to do an operational check of the pitot heat during preflight and to take evasive action immediately should you encounter even light icing conditions in flight. This may require returning to DTW or landing at an intermediate spot before reaching CMI. Your go/no-go decision will be constantly reevaluated during the flight. With these thoughts you grab your flight bag and head for the airport.

At the airport you pull Cessna 1230A out of the hangar and conduct a thorough preflight inspection. A quick check of the logbooks indicates all airworthiness requirements have been met to conduct this IFR flight including an altimeter, static, and transponder test within the preceding 24-calendar months. In addition, a log on the clipboard indicates the VOR system has been checked within the preceding 30 days. Turn on the master switch and pitot heat, and quickly check the heating element before it becomes too hot. Then complete the rest of the walk-around procedure. Since this will be a flight in actual IFR conditions, place special emphasis on IFR equipment during the walk-around, including the alternator belt and antennas. After completing the preflight, you organize your charts, pencils, paper, and navigation log in the cockpit for quick, easy access. You are ready to fly!

Departure

After starting the engine, tune in ATIS and copy the information to your navigation log. The conditions remain the same as the updated weather briefing with the ceiling at 700 overcast, and visibility at 3 miles. Call clearance delivery, and receive your clearance:

> "Departure Clearance, Cessna 1230A IFR to Champaign with information Kilo, ready to copy."

> "Cessna 1230A is cleared to Champaign via the PALACE 2 departure, HARWL, Victor 116 Jackson, Victor 221 Litchfield, then direct. Climb and maintain 4,000. Squawk 0321."

Read back the clearance and review the DP. Although a departure frequency was not given in the clearance, you note that in the description of the DPs, it instructs propeller-driven aircraft to contact departure control frequency on 118.95. Since you are anticipating a departure from runway three center, you also note the instruction to climb to 1,100 prior to turning. The NOTAM received earlier applies only to runway 21 departures and will not be a factor. After tuning in the appropriate frequencies and setting up your navigation equipment for the departure routing, you contact ground control (noting that you are IFR), and receive the following clearance:

> "Cessna 1230A taxi to runway 3 center via taxiways Sierra 4, Sierra, Foxtrot, and Mike. Hold short of runway 3 right at taxiway Foxtrot."

Read back the clearance including the hold short instruction and your aircraft call sign. After a review of the taxi instructions on your airport diagram, begin your taxi and check your flight instruments for proper indications as you go. As you are holding short of runway three right at Foxtrot, ground control calls with the following clearance:

> "Cessna 30A taxi to runway 3 center via Foxtrot and Mike."

Continue taxi to runway three center and complete your before takeoff checklist and engine runup, then call the tower and advise them you are ready for takeoff. The tower gives the following clearance:

> "Cessna 30A cleared for takeoff runway 3 center. Turn left heading 270. Caution wake turbulence for departing DC9."

Taxi into position, note your time off on the navigation log, verify your heading indicator and magnetic compass are in agreement, the transponder is in the ALT position, all the necessary lights are on, and start the takeoff roll. Since you will be operating in the clouds, also turn on your pitot heat prior to departure. The takeoff roll will be substantially shorter than that of the DC9, so you are able to stay clear of its wake turbulence.

En Route

After departure, climb straight ahead to 1,100 feet as directed by the Palace 2 Departure, then turn left to the assigned heading of 270 and continue your climb to 4,000 feet. As you roll out of the turn, tower contacts you:

> "Cessna 30A contact Departure."

Acknowledge the clearance and contact departure on the frequency designated by the DP. Provide your altitude so the departure controller can check your encoded altitude against your indicated altitude:

> "Detroit Departure Cessna 1230A climbing through 2,700 heading 270."

Departure replies:

> "Cessna 30A proceed direct to HARWL intersection and resume your own navigation. Contact Cleveland Center on 125.45."

Acknowledge the clearance, contact Cleveland Center, and proceed direct to HARWL intersection, using your IFR-approved GPS equipment, complete the appropriate checklists, and then on to Jackson and Litchfield VORs. At each fix you note your arrival time on the navigation log to monitor your progress. Upon reaching Litchfield VOR, proceed direct to CMI again using the GPS to navigate:

Cleveland replies:

> "Cessna 30A radar contact. Fort Wayne altimeter 29.87. Traffic at your 2:00 position and 4 miles is a Boeing 727 descending to 5,000."

Even when on an IFR flight plan, pilots are still responsible for seeing and avoiding other aircraft. Since you are in IFR conditions at the time the traffic advisory is issued, you should notify ATC:

> "Roger, altimeter setting 29.87. Cessna 30A is in IMC."

At this point you decide to get an update of the weather at the destination and issue a pilot report. To find the nearest AFSS, locate a nearby VOR and check above the VOR information box for a frequency. In this case, the nearest VOR is Goshen (GSH) which lists a receive-only frequency of 121.1. Request a frequency change from Cleveland Center and then attempt to contact Terre Haute 122.1 while listening over the Goshen VOR frequency of 113.7:

> "Terre Haute Radio Cessna 1230A receiving on frequency 113.7, over."

> "Cessna 30A, this is Terre Haute, go ahead."

"Terre Haute Radio, Cessna 30A is currently 20 miles southeast of the Goshen VOR at 4,000 feet en route to Champaign, IL. Requesting an update of en route conditions and current weather at CMI, as well as ALN."

"Cessna 30A, Terre Haute Radio, current weather at Champaign is 300 overcast with 3 miles visibility in light rain. The winds are from 140 at 7 and the altimeter is 29.86. Weather across your route is generally IFR in light rain with ceilings ranging from 300 to 1,000 overcast with visibilities between 1 and 3 miles. Alton weather is much better with ceilings now at 2,500 and visibility 6 miles. Checking current NOTAMs at CMI shows the localizer back-course approach out of service and runway 4/22 closed."

"Roger, Cessna 30A copies the weather. I have a PIREP when you are ready to copy."

"Cessna 30A go ahead with your PIREP."

"Cessna 30A is a Cessna 182 located on the Goshen 130 degree radial at 20 miles level at 4,000 feet. I am currently in IMC conditions with a smooth ride. Outside air temperature is plus 1-degree Celsius. Negative icing."

"Cessna 30A thank you for your PIREP."

With the weather check and PIREP complete, return to Cleveland Center:

"Cleveland Center, Cessna 30A is back on your frequency."

"Cessna 30A, Cleveland Center roger, contact Chicago Center now on frequency 135.35."

"Roger, contact Chicago Center frequency 135.35, Cessna 30A."

"Chicago Center, Cessna 1230A level at 4,000 feet."

"Cessna 30A, Chicago Center radar contact."

A review of the weather provided by AFSS shows some deterioration of the CMI weather. In fact, the weather is right at your personal minimums. To further complicate matters, the only approach available is the ILS to runway 32L and the current weather does not allow for a circling approach. With the current winds at 140° and 7 knots, it means you will be flying the approach and landing with a tailwind. Re-evaluating your go/no-go decision, you decide to continue toward CMI. If the weather deteriorates further by the time you receive the CMI ATIS, you will proceed to the alternate of ALN which continues to report good weather.

Continuing toward Champaign, you discover a small trace of mixed ice beginning to form on the leading edge of the wing and notice the outside air temperature has dropped to 0 °C. You decide the best option is to climb to a higher altitude and request a climb to 5,000 feet from Chicago Center. Although this is the wrong altitude for your direction of flight, Chicago Center approves the request and you begin an immediate climb. Reaching 5,000 you are now between two cloud layers. A check of the outside air temperature shows a reading of 2 °C indicating a temperature inversion. Pass this information to Chicago Center in the form of a pilot report.

Arrival

You are now approximately 50 miles northeast of CMI. Ask the Center controller for permission to leave the Center frequency, tune in the ATIS frequency, and you learn there has been no change in the weather since you talked to AFSS. ATIS is advertising ILS runway 32L as the active approach. After returning to Center, you begin reviewing the approach chart, placing special emphasis on the missed approach procedure. If the weather improves, you will want to circle for a landing on runway 14 right, so you should also review the circle to land minimums. You should complete the appropriate checklists.

Chicago Center hands you off to Champaign approach control and you contact approach:

"Champaign Approach, Cessna 1230A level 5,000 feet with information TANGO."

"Cessna 30A, Champaign Approach, descend and maintain 3,000 feet, turn left heading 240 for radar vectors to the ILS approach to runway 32 left."

"Descend to 3,000, turn left to 240, radar vectors to ILS 32l, Cessna 30A."

Turn to 240° and begin your descent to 3,000. Since you are now on radar vectors, begin to configure your navigation radios for the approach. Tune in the ILS frequency of 109.1 on the number one navigation radio, and set in the final approach course of 316° on the OBS. Then set in the VOR frequency of 110.0 on your number two navigation radio, and set in the 297° radial on the OBS in anticipation of a missed approach. Finally, tune in the VEALS compass locator frequency of 407 on your ADF, identify each navigation signal, then tune in Champaign tower on your number two communication radio. You are ready to fly the approach when approach contacts you:

> "Cessna 30A your position is 7 miles from VEALS, turn right heading 290 maintain 3,000 feet until intercepting the localizer, cleared for the ILS runway 32 left approach."

Read back the clearance and concentrate on flying the aircraft. Intercept the localizer and descend to 2,600 as depicted on the approach chart. Champaign approach control hands you off to Champaign tower:

> "Cessna 30A contact Tower on 120.4."

> "120.4, Cessna 30A."

> "Champaign Tower, Cessna 1230A outside VEALS on the ILS runway 32 left."

> "Cessna 30A Champaign Tower, the weather is improving at Champaign. The ceiling is now 600 overcast and the visibility is 4 miles. Plan to circle north of the field, cleared to land runway 14 right."

> "Circle north, cleared to land runway 14 right, Cessna 30A."

Intercepting the Course

If you are on a vector to intercept the localizer and the controller has not yet issued an approach clearance, do not proceed inbound upon localizer intercept, but do query the controller: "Cessna 1230 Alpha is intercepting." The controller will then either issue the approach clearance or clarify why the flight is being vectored through the localizer.

Continue the approach, complete the appropriate checklists, cross the outer marker, and begin your descent on the glide slope. At 1,600 feet MSL you break out of the clouds and make visual contact with the airport. Even though circling minimums are 1,160 feet, you decide to conduct your circling approach at an altitude of 1,500 since the ceiling and visibility will allow it. You circle north of the field on a left downwind for runway 14 right and begin the descent abeam the touchdown to allow a normal descent to landing. As you touch down on the runway, Champaign Tower gives further instructions:

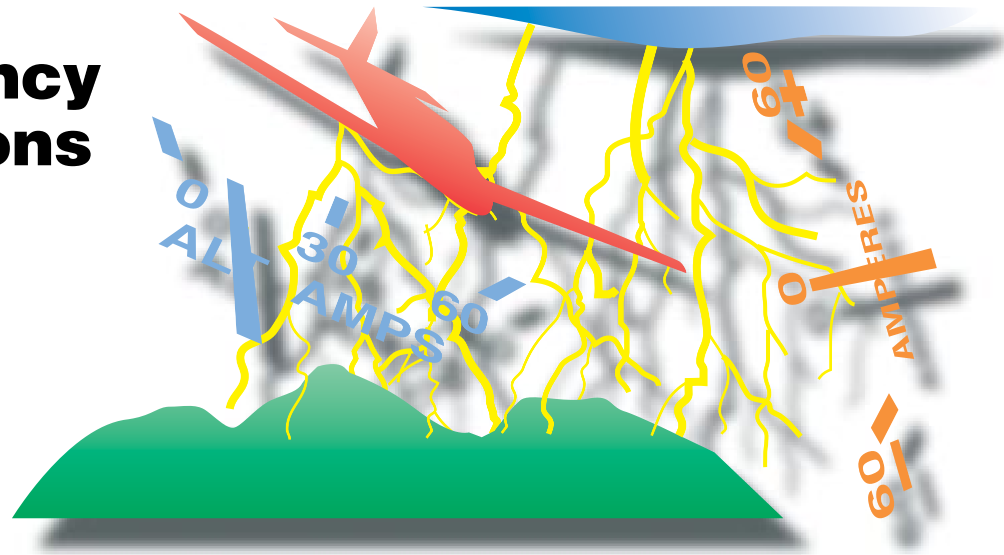
> "Cessna 30A turn left at taxiway Bravo and taxi to the ramp on this frequency."

> "Roger, Cessna 30A."

As you taxi clear of the runway and complete the appropriate checklists, there is a great sense of accomplishment in having completed the flight successfully. Tower cancels your IFR flight plan with no further action on your part. Your thorough preflight planning has made this a successful trip.

Chapter 11

Emergency Operations



Introduction

Changing weather conditions, air traffic control (ATC), the aircraft, and the pilot are all variables that make instrument flying an unpredictable and challenging operation. The safety of the flight depends upon the pilot's ability to manage these variables while maintaining positive aircraft control and adequate situational awareness. This chapter will discuss the recognition and suggested remedies for such abnormal and **emergency** events related to unforecasted, adverse weather, aircraft system malfunctions, communication/navigation system malfunctions, and loss of situational awareness.

Unforecast Adverse Weather

Inadvertent Thunderstorm Encounter

A pilot should avoid flying through a thunderstorm of any intensity. However, certain conditions may be present that could lead to an inadvertent thunderstorm encounter. For example, flying in areas where thunderstorms are embedded in large cloud masses may make thunderstorm avoidance difficult, even when the aircraft is equipped with thunderstorm detection equipment. Therefore, pilots must be prepared to deal with an inadvertent thunderstorm penetration. At the very least, a thunderstorm encounter will subject the aircraft to turbulence that could be severe. The pilot, as well as the passengers, should tighten seat belts and shoulder harnesses and secure any loose items in the cabin.

As with any emergency, the first order of business during an inadvertent thunderstorm encounter must be to fly the aircraft. The pilot workload will be high; therefore, increased concentration is necessary to maintain an instrument scan. Once you enter a thunderstorm, it is better to maintain a course straight through the thunderstorm rather than turning around. A straight course will most likely get you out of the hazard in the least amount of time, and turning maneuvers will only increase structural stress on the aircraft.

Reduce power to a setting that will maintain a speed at the recommended turbulence penetration speed as described in the Pilot's Operating Handbook/Airplane Flight Manual (POH/AFM), and try to minimize additional power adjustments. Concentrate on keeping the aircraft in a level attitude while allowing airspeed and altitude to fluctuate. Similarly, if using the autopilot, disengage the altitude hold and speed hold modes, as they will only increase the aircraft's maneuvering—thereby increasing structural stress.

During a thunderstorm encounter, the potential for icing also exists. As soon as possible, turn on anti-icing/deicing equipment and carburetor heat, if equipped. Icing can be rapid at any altitude and may lead to power failure and/or loss of airspeed indication.

Lightning will also be present in a thunderstorm and can temporarily blind a pilot. To reduce this risk, turn up cockpit lights to the highest intensity, concentrate on the flight instruments, and resist the urge to look outside.

Emergency: A distress or urgent condition.

Inadvertent Icing Encounter

Because icing is unpredictable in nature, pilots may find themselves in icing conditions even though they have done everything to avoid it. In order to stay alert to this possibility while operating in visible moisture, pilots should monitor the outside air temperature (OAT).

Proper utilization of the anti-icing/deicing equipment is critical to the safety of the flight. If the anti-icing/deicing equipment is used before sufficient ice has accumulated, the equipment may not be able to remove all of the ice accumulation. Refer to the POH/AFM for the proper use of anti-icing/deicing equipment.

Prior to entering visible moisture with temperatures at 5° above freezing or cooler, activate the appropriate anti-icing/deicing equipment in anticipation of ice accumulation—early ice detection is critical. This may be particularly difficult during night flight. You may need to use a flashlight to check for ice accumulation on the wings. At the first indication of ice accumulation, you must act to get out of the icing conditions.

There are four options for action once ice has begun to accumulate on the aircraft:

1. Move to an altitude with significantly colder temperatures;
2. Move to an altitude with temperatures that are above freezing;
3. Fly to an area clear of visible moisture; or
4. Change heading and fly to an area of known nonicing conditions.

If none of these options are available, you must consider an immediate landing at the nearest suitable airport. Anti-icing/deicing equipment is not designed to allow aircraft to operate in icing conditions indefinitely. Anti-icing/deicing equipment will simply give you more time to get out of the icing conditions.

Precipitation Static

Precipitation static, often referred to as P-static, occurs when accumulated static electricity is discharged from the extremities of the aircraft. This discharge has the potential to create problems for the instrument pilot. These problems range from the serious, such as the complete loss of very-high frequency (VHF) communications and erroneous magnetic compass readings, to the annoyance of high-pitched audio squealing, and **St. Elmo's Fire**. [Figure 11-1]

Figure 11-1. *St. Elmo's Fire.*

Precipitation static is caused when an aircraft encounters airborne particles during flight (e.g., rain or snow), and develops a negative charge. It can also result from atmospheric electric fields in thunderstorm clouds. When a significant negative voltage level is reached, the aircraft will discharge it, which can create electrical disturbances.

To reduce the problems associated with P-static, the pilot should ensure the aircraft's static wicks are properly maintained and accounted for. Broken or missing static wicks should be replaced before an instrument flight. [Figure 11-2]

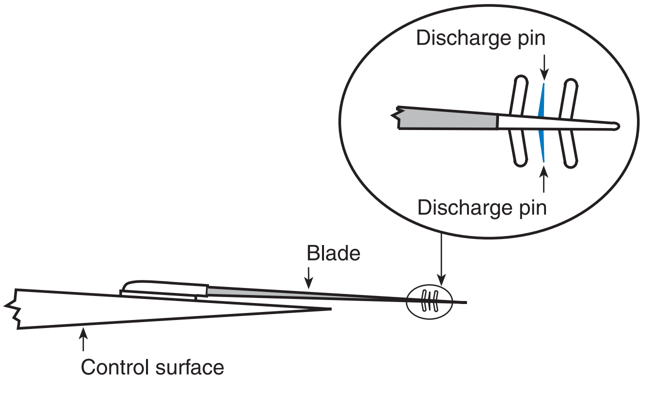


Figure 11-2. *One example of a static wick installed on aircraft control surface to bleed off static charges built up during flight.*

Precipitation static: A form of radio interference caused by rain, snow, or dust particles hitting the antenna and inducing a small radio-frequency voltage into it.

St. Elmo's Fire: A corona discharge which lights up the aircraft surface areas where maximum static discharge occurs.

Aircraft System Malfunctions

Preventing aircraft system malfunctions that might lead to an inflight emergency begins with a thorough preflight inspection. In addition to those items normally checked prior to a visual flight rule (VFR) flight, pilots intending to fly under instrument flight rules (IFR) should pay particular attention to the alternator belt, antennas, static wicks, anti-icing/deicing equipment, pitot tube, and static ports.

During taxi, verify the operation and accuracy of all flight instruments. In addition, during the runup, verify that the operation of the pneumatic system is within acceptable parameters. It is critical that all systems are determined to be operational before departing into IFR conditions.

Alternator/Generator Failure

Depending upon the aircraft being flown, an alternator failure is indicated in different ways. Some aircraft use an **ammeter** that indicates the state of charge or discharge of the battery. [Figure 11-3] A positive indication on the ammeter indicates a charge condition; a negative indication reveals a discharge condition. Other aircraft use a **loadmeter** to indicate the load being carried by the alternator. [Figure 11-4] If the alternator were to fail, then a zero load indication is shown on the loadmeter. Sometimes an indicator light is also installed in the aircraft to alert the pilot to an alternator failure. Review the appropriate POH/AFM for information on the type of systems installed in your aircraft.

Figure 11-3. *Ammeter.*

Ammeter: An instrument installed in series with an electrical load to measure the amount of current flowing through the load.

Loadmeter: A type of ammeter installed between the generator output and the main bus in an aircraft electrical system.

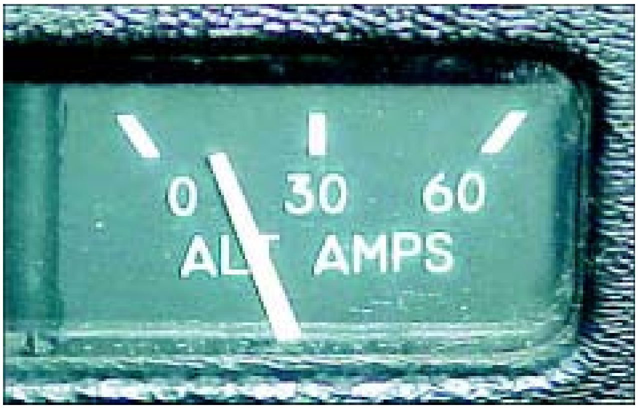


Figure 11-4. *Loadmeter.*

Once an alternator failure has been detected, the pilot must reduce the electrical load on the battery and land as soon as practical. Depending upon the electrical load and condition of the battery, there may be sufficient power available for an hour or more of flight—or for only a matter of minutes. You should also be familiar with what systems on the aircraft are electric and which continue to operate without electrical power. The pilot can attempt to troubleshoot the alternator failure by following the established alternator failure procedure published in the POH/AFM. If the alternator cannot be reset, advise ATC of the situation and inform them of the impending electrical failure.

Instrument Failure

System or instrument failure is usually identified by a warning indicator or an inconsistency between the indications on the attitude indicator and the supporting performance instruments. Aircraft control must be maintained while identifying the failed component(s). Expedite the cross-check and include all the flight instruments. The problem may be individual instrument failure or a system failure that affects several instruments.

One method of identification involves an immediate comparison of the attitude indicator with the rate-of-turn indicator and vertical speed indicator (VSI). Along with providing pitch-and-bank information, this technique compares the static system with the suction or pressure system and the electrical system. Identify the failed component(s) and use the remaining functional instruments to maintain aircraft control.

Attempt to restore the inoperative components(s) by checking the appropriate power source, changing to a backup or alternate system, and resetting the instrument if possible. Covering the failed instrument(s) may enhance your ability to maintain aircraft control and navigate the aircraft. Usually the next step is to advise ATC of the problem and, if necessary, declare an emergency before the situation deteriorates beyond your ability to recover.

Pneumatic System Failure

One possible cause of instrument failure is a loss of the suction or pressure source. This pressure or suction is supplied by a vacuum pump mechanically driven off the engine. Occasionally, these pumps fail, leaving the pilot with inoperative attitude and heading indicators. [Figure 11-5] Many small aircraft are not equipped with a warning system for vacuum failure; therefore, the pilot should monitor the system's vacuum/pressure gauge. This can be a hazardous situation with the potential to lead the unsuspecting pilot into a dangerous unusual attitude—which would require a partial panel recovery. It is important pilots practice instrument flight without reference to the attitude and heading indicators in preparation for such a failure.

Pitot/Static System Failure

A pitot or static system failure can also cause erratic and unreliable instrument indications. When a static system problem occurs, it will affect the airspeed indicator, altimeter, and the VSI. In most aircraft, provisions have been made for the pilot to select an alternate static source. Check the POH/AFM for the location and operation of the alternate static source. In the absence of an alternate static source, in an unpressurized aircraft, the pilot could break the glass on the VSI. The VSI is not required for instrument flight and breaking the glass will provide the altimeter and the airspeed indicator a source of static pressure. This procedure could cause additional instrument errors.

Communication/Navigation System Malfunction

Avionics equipment has become very reliable, and the likelihood of a complete communications failure is remote. However, each IFR flight should be planned and executed in anticipation of a two-way radio failure. At any given point during a flight, the pilot must know exactly what route to fly, what altitude to fly, and when to continue beyond a **clearance limit**. Title 14 of the Code of Federal Regulations (14 CFR) part 91 describes the procedures to be followed in case of a two-way radio communications failure. If the pilot is operating

Figure 11-5. *Vacuum failure—inoperative attitude and heading indicators.*

Clearance limit: The fix, point, or location to which an aircraft is cleared when issued an air traffic clearance.

in VFR conditions at the time of the failure, the pilot should continue the flight under VFR and land as soon as practicable. If the failure occurs in IFR conditions, or if VFR conditions cannot be maintained, the pilot must continue the flight:

1. Along the route assigned in the last ATC clearance received;
2. If being radar vectored, by the direct route from the point of radio failure to the fix, route, or airway specified in the vector clearance;
3. In the absence of an assigned route, by the route that ATC has advised may be expected in a further clearance; or
4. In the absence of an assigned route or a route that ATC has advised may be expected in a further clearance, by the route filed in the flight plan.

The pilot should maintain the highest of the following altitudes or flight levels for the route segment being flown:

1. The altitude or flight level assigned in the last ATC clearance received;
2. The minimum altitude (converted, if appropriate, to minimum flight level as prescribed in part 91 for IFR operations); or
3. The altitude or flight level ATC has advised may be expected in a further clearance.

In addition to route and altitude, the pilot must also plan the progress of the flight to leave the clearance limit:

1. When the clearance limit is a fix from which an approach begins, commence descent or descent and approach as close as possible to the expect-further-clearance time if one has been received; or if one has not been received, as close as possible to the estimated time of arrival as calculated from the filed or amended (with ATC) estimated time en route.
2. If the clearance limit is not a fix from which an approach begins, leave the clearance limit at the expect-further-clearance time if one has been received; or if none has been received, upon arrival over the clearance limit, and proceed to a fix from which an approach begins and commence descent or descent and approach as close as possible to the estimated time of arrival as calculated from the filed or amended (with ATC) estimated time en route.

While following these procedures, set the transponder to code 7600 and use all means possible to re-establish two-way radio communication with ATC. This includes monitoring navigational aids (NAVAIDs), attempting radio contact with other aircraft, and attempting contact with a nearby automated flight service station (AFSS).

Loss of Situational Awareness (SA)

Situational awareness (SA) is not simply a mental picture of where you are; rather, it is an overall assessment of each element of the environment and how it will affect your flight. On one end of the SA spectrum is a pilot who is knowledgeable of every aspect of the flight; consequently, this pilot's decision making is proactive. With good SA, this pilot is able to make decisions well ahead of time and evaluate several different options. On the other end of the SA spectrum is a pilot who is missing important pieces of the puzzle: "I knew exactly where I was when I ran out of fuel." Consequently, this pilot's decision making is reactive. With poor SA, this pilot lacks a vision of future events and is forced to make decisions quickly, often with limited options.

During a typical IFR flight, a pilot will operate at varying levels of SA. For example, a pilot may be cruising to his/her destination with a high level of SA when ATC issues an unexpected standard terminal arrival route (STAR). Since the pilot was not expecting the STAR and is not familiar with it, SA is lowered. However, after becoming familiar with the STAR and resuming normal navigation, the pilot returns to a higher level of SA.

Factors that reduce SA include: distractions, unusual or unexpected events, complacency, high workload, unfamiliar situations, and inoperative equipment. In some situations, a loss of SA may be beyond a pilot's control. For example, with a pneumatic system failure and associated loss of the attitude and heading indicators, a pilot may find his/her aircraft in an unusual attitude. In this situation, established procedures must be used to regain SA.

As a pilot, you should be alert to a loss of SA any time you find yourself in a reactive mindset. To regain SA, you must re-assess your situation and work toward understanding. This may mean you need to seek additional information from other sources, such as the navigation instruments or ATC.

Appendix 1

Clearance Shorthand

The following shorthand system is recommended by the Federal Aviation Administration (FAA). Applicants for the Instrument Rating may use any shorthand system, in any language, which ensures accurate compliance with air traffic control (ATC) instructions. No shorthand system is required by regulation and no knowledge of shorthand is required for the FAA Knowledge Test; however, because of the vital need for reliable communication between the pilot and controller, clearance information should be unmistakably clear.

The following symbols and contractions represent words and phrases frequently used in clearances. Most of them are used regularly by ATC personnel. By practicing this shorthand, omitting the parenthetical words, you will be able to copy long clearances as fast as they are read.

Example: CAF ~~M~~→ RH RV V18 ↑40 SQ 0700 DPC 120.4
Cleared as filed, maintain runway heading for radar vector to Victor 18, climb to 4,000, squawk 0700, departure control frequency is 120.4.

Words and Phrases	**Shorthand**
Above	ABV
Above (Altitude, Hundreds of Feet)	$\underline{70}$
Adjust speed to 250 knots	250 K
Advise	ADZ
After (Passing)	<
Airway (Designation)	V26
Airport	A
Alternate Instructions	( )
Altitude 6,000-17,000	60-170
And	&
Approach	AP
Approach Control	APC
Area Navigation	RNAV
Arriving	↓
At	@
At or Above	$\underline{\uparrow}$
At or Below	$\overline{\downarrow}$
(ATC) Advises	CA
(ATC) Clears or Cleared	C
(ATC) Requests	CR
Back Course	BC
Bearing	BR
Before (Reaching, Passing)	>
Below	BLO
Below (Altitude, Hundreds of Feet)	$\overline{70}$
Center	CTR
Clearance Void if Not Off By (time)	v<
Cleared as Filed	CAF
Cleared to Airport	A
Cleared to Climb/Descend at Pilot's Discretion	PD
Cleared to Cross	X
Cleared to Depart From the Fix	D
Cleared to the Fix	F
Cleared to Hold and Instructions Issued	H
Cleared to Land	L
Cleared to the Outer Marker	O
Climb to (Altitude, Hundreds of Feet)	↑70
Contact Approach	CT
Contact (Denver) Approach Control	(den
Contact (Denver) Center	(DEN
Course	CRS

Cross	X
Cruise	→
Delay Indefinite	DLI
Depart (direction, if specified)	T→ ( )
Departure Control	DPC
Descend To (Altitude, Hundreds of Feet)	↓70
Direct	DR
Direction (Bound)	
Eastbound	EB
Westbound	WB
Northbound	NB
Southbound	SB
Inbound	IB
Outbound	OB
DME Fix (Mile)	21
Each	EA
Enter Control Area	△
Estimated Time of Arrival	ETA
Expect	EX
Expect-Further-Clearance	EFC
Fan Marker	FM
Final	F
Final Approach	FA
Flight Level	FL
Flight Planned Route	FPR
For Further Clearance	FFC
For Further Headings	FFH
From	FM
Ground	GND
GPS Approach	GPS
Heading	HDG
Hold (Direction)	H-W
Holding Pattern	
ILS Approach	ILS
Increase Speed 30 Knots	+30 K
Initial Approach	I
Instrument Departure Procedure	DP
Intersection	XN
Join or Intercept Airway/ Jet Route/Track or Course	≥
Left Turn After Takeoff	↰
Locator Outer Marker	LOM
Magnetic	M
Maintain	~~M~~→
Maintain VFR Conditions On Top	<u>VFR</u>
Middle Compass Locator	ML
Middle Marker	MM
Missed Approach	MA
Nondirectional Beacon Approach	NDB
Out of (Leave) Control Area	△
Outer Marker	OM
Over (Station)	<u>OKC</u>
On Course	OC
Precision Approach Radar	PAR
Procedure Turn	PT
Radar Vector	RV
Radial (080° Radial)	080R
Reduce Speed 20 Knots	-20 K
Remain This Frequency	RTF
Remain Well to Left Side	LS
Remain Well to Right Side	RS
Report Crossing	RX
Report Departing	RD
Report Leaving	RL
Report on Course	R-CRS
Report Over	RO

Report Passing	RP
Report Reaching	RR
Report Starting Procedure Turn	RSPT
Reverse Course	RC
Right Turn After Takeoff	↱
Runway Heading	RH
Runway (Number)	RY18
Squawk	SQ
Standby	STBY
Straight-in Approach	SI
Surveillance Radar Approach	ASR
Takeoff (Direction)	T→N
Tower	Z
Turn Left	TL
Turn Right	TR
Until	/
Until Advised (By)	UA
Until Further Advised	UFA
VFR Conditions On Top	OTP
Via	VIA
Victor (Airway Number)	V14
Visual Approach	VA
VOR	⊙
VOR Approach	VR
VORTAC	Ⓣ
While in Control Area	△

Appendix 2

Instrument Training Lesson Guide

Introduction

Flight instructors may use this guide in the development of lesson plans. The lessons are arranged in a logical learning sequence and use the building-block technique. Each lesson includes ground training appropriate to the flight portion of the lesson. It is vitally important that the flight instructor brief the student on the objective of the lesson and how it will be accomplished. Debriefing the student's performance is also necessary to motivate further progress. To ensure steady progress, student pilots should master the objective of each lesson before advancing to the next lesson. Lessons should be arranged to take advantage of each student's knowledge and skills.

Flight instructors must monitor progress closely during training to guide student pilots in how to properly divide their attention. The importance of this division of attention or "cross-check" cannot be overemphasized. Cross-check and proper instrument interpretation are essential components of "attitude instrument flying" that enables student pilots to accurately visualize the aircraft's attitude at all times.

When possible, each lesson should incorporate radio communications, basic navigation, and emergency procedures so the student pilot is exposed to the entire IFR experience with each flight. Cross-reference the Instrument Training Lesson Guide with this handbook and the Instrument Practical Test Standards for a comprehensive instrument rating training program.

Lesson 1—Ground and flight evaluation of student's knowledge and performance

Aircraft systems
Aircraft performance
Preflight planning
Use of checklists
Basic flight maneuvers
Radio communications procedures
Navigation systems

Lesson 2—Preflight preparation and flight by reference to instruments

Ground Training

Instrument system preflight procedures
Attitude instrument flying
Fundamental instrument skills
Instrument cross-check techniques

Flight Training

Aircraft and instrument preflight inspection
Use of checklists
Fundamental instrument skills
Basic flight maneuvers
Instrument approach (demonstrated)
Postflight procedures

Lesson 3—Flight instruments and human factors

Ground Training

Human factors
Flight instruments and systems
Aircraft systems
Navigation instruments and systems

Flight Training

Aircraft and instrument preflight inspection
Radio communications
Checklist procedures
Attitude instrument flying
Fundamental instrument skills
Basic flight maneuvers
Spatial disorientation demonstration
Navigation systems
Postflight procedures

Lesson 4—Attitude instrument flying

Ground Training

Human factors
Flight instruments and systems
Aircraft systems
Navigation instruments and systems
Attitude instrument flying
Fundamental instrument skills
Basic flight maneuvers

Flight Training

Aircraft and instrument preflight inspection
Checklist procedures
Radio communications
Attitude instrument flying
Fundamental instrument skills
Basic flight maneuvers
Spatial disorientation
Navigation
Postflight procedures

Lesson 5—Aerodynamic factors and basic flight maneuvers

Ground Training

Basic aerodynamic factors
Basic instrument flight patterns
Emergency procedures

Flight Training

Aircraft and instrument preflight inspection
Checklist procedures
Radio communications
Basic instrument flight patterns
Emergency procedures
Navigation
Postflight procedures

Lesson 6—Partial-panel operations

Ground Training

ATC system
Flight instruments
Partial-panel operations

Flight Training

Aircraft and instrument preflight inspection
Checklist procedures
Radio communications
Basic instrument flight patterns
Emergency procedures
Partial-panel practice
Navigation
Postflight procedures

Lesson 7—Recovery from unusual attitudes

Ground Training

Attitude instrument flying
ATC system
NAS overview

Flight Training

Preflight
Aircraft and instrument preflight inspection
Checklist procedures
Radio communications
Instrument takeoff
Navigation
Partial-panel practice
Recovery from unusual attitudes
Postflight procedures

Lesson 8—Navigation systems

Ground Training

ATC clearances
Departure procedures
IFR en route charts

Flight Training

Aircraft and instrument preflight inspection
Checklist procedures
Radio communications
Intercepting and tracking
Holding
Postflight procedures

Lesson 9—Review and practice

Ground Training

Aerodynamic factors
Flight instruments and systems
Attitude instrument flying
Navigation systems
NAS
ATC
Emergency procedures

Flight Training

Aircraft and instrument preflight inspection
Checklist procedures
Radio communications
Review and practice as determined by the flight instructor
Instrument takeoff
Radio communications
Navigation systems
Emergency procedures
Postflight procedures

Lessons 10 through 19—Orientation, intercepting, tracking, and holding using each navigation system installed in the aircraft

Ground Training

Preflight planning
Navigation systems
NAS
ATC
Emergencies

Flight Training

Aircraft and instrument preflight inspection
Checklist procedures
Radio communications
Departure procedures
En route navigation
Terminal operations
Partial-panel operation
Instrument approach
Missed approach
Approach to a landing
Postflight procedures

Lessons 20 and 21—Cross-country flights

Ground Training

Preflight planning
Aircraft performance
Navigation systems
NAS
ATC
Emergencies

Flight Training

Emergency procedures
Partial-panel operation
Aircraft and instrument preflight inspection
Checklist procedures
Radio communications
Departure procedures
En route navigation
Terminal operations
Instrument approach
Missed approach
Approach to a landing
Postflight procedures

Lessons 22 and 23—Review and practice

Ground Training

Human factors
Aerodynamic factors
Flight instruments and systems
Attitude instrument flying
Basic flight maneuvers
Navigation systems
NAS
ATC
Emergency operations

Flight Training

Aircraft and instrument preflight inspection
Checklist procedures
Radio communications
Review and practice as determined by the flight instructor
Instrument takeoff
Partial-panel operations
Unusual attitude recoveries
Radio communications
Navigation systems
Emergency procedures
Postflight procedures

Lessons 24 and subsequent—Practical test preparation

Ground Training

Title 14 of the Code of Federal Regulations (14 CFR) parts 61, 71, 91, 95, and 97
Instrument Flying Handbook
Practical test standards
Administrative requirements
Equipment requirements
Applicant's requirements

Flight Training

Review and practice until the student can consistently perform all required tasks in accordance with the appropriate practical test standards.

NOTE: It is the recommending instructor's responsibility to ensure that the applicant meets part 61 requirements and is prepared for the practical test, including: training, knowledge, experience, and the appropriate instructor endorsements.

Glossary

absolute altitude. The actual distance between an aircraft and the terrain over which it is flying.

absolute pressure. Pressure measured from the reference of zero pressure, or a vacuum.

a.c. Alternating current.

acceleration error. A magnetic compass error that shows up when the aircraft accelerates while flying on an easterly or westerly heading, causing the compass card to rotate toward North.

accelerometer. A part of an inertial navigation system (INS) that accurately measures the force of acceleration in one direction.

ADF. *See* automatic direction finder.

ADI. *See* attitude director indicator.

ADM. *See* aeronautical decision making.

adverse yaw. A flight condition at the beginning of a turn in which the nose of the aircraft starts to move in the direction opposite the direction the turn is being made, caused by the induced drag produced by the downward-deflected aileron holding back the wing as it begins to rise.

aeronautical decision making (ADM). A systematic approach to the mental process used by pilots to consistently determine the best course of action in response to a given set of circumstances.

A/FD. *See* Airport/Facility Directory.

agonic line. An irregular imaginary line across the surface of the Earth along which the magnetic and geographic poles are in alignment, and along which there is no magnetic variation.

aircraft approach category. A performance grouping of aircraft based on a speed of 1.3 times their stall speed in the landing configuration at maximum gross landing weight.

AIRMET. In-flight weather advisory issued as an amendment to the area forecast, concerning weather phenomena of operational interest to all aircraft and is potentially hazardous to aircraft with limited capability due to lack of equipment, instrumentation, or pilot qualifications.

airport diagram. The section of an instrument approach procedure chart that shows a detailed diagram of the airport including surface features and airport configuration information.

Airport/Facility Directory (A/FD). An FAA publication containing information on all airports, communications, and NAVAIDs.

airport surface detection equipment (ASDE). Radar equipment specifically designed to detect all principal features and traffic on the surface of an airport, presenting the entire image on the control tower console; used to augment visual observation by tower personnel of aircraft and/or vehicular movements on runways and taxiways.

airport surveillance radar (ASR). Approach control radar used to detect and display an aircraft's position in the terminal area.

airport surveillance radar approach. An instrument approach in which ATC issues instructions for pilot compliance based on aircraft position in relation to the final approach course, and the distance from the end of the runway as displayed on the controller's radar scope.

air route surveillance radar (ARSR). Air route traffic control center (ARTCC) radar used primarily to detect and display an aircraft's position while en route between terminal areas.

air route traffic control center (ARTCC). Provides ATC service to aircraft operating on IFR flight plans within controlled airspace and principally during the en route phase of flight.

airways. Based on a centerline that extends from one navigation aid or intersection to another navigation aid (or through several navigation aids or intersections); used to establish a known route for en route procedures between terminal areas.

alert area. An area in which there is a high volume of pilot training or an unusual type of aeronautical activity.

almanac data. Information the GPS receiver can obtain from one satellite which describes the approximate orbital positioning of all satellites in the constellation. This information is necessary for the GPS receiver to know what satellites to look for in the sky at a given time.

ALS. *See* approach lighting system.

alternate airport. Designated in an IFR flight plan, provides a suitable destination if a landing at the intended airport becomes inadvisable.

alternate static source valve. A valve in the instrument static air system that supplies reference air pressure to the altimeter, airspeed indicator, and vertical speed indicator if the normal static pickup should become clogged or iced over. This valve is accessible to the pilot in flight.

altimeter setting. Station pressure (the barometric pressure at the location the reading is taken) which has been corrected for the height of the station above sea level.

amendment status. The circulation date and revision number of an instrument approach procedure, printed above the procedure identification.

ammeter. An instrument installed in series with an electrical load to measure the amount of current flowing through the load.

aneroid. The sensitive component in an altimeter or barometer that measures the absolute pressure of the air. It is a sealed, flat capsule made of thin disks of corrugated metal soldered together and evacuated by pumping all of the air out of it.

aneroid barometer. An instrument that measures the absolute pressure of the atmosphere by balancing the weight of the air above it against the spring action of the aneroid.

angle of attack. The acute angle formed between the chord line of an airfoil and the direction of the air that strikes the airfoil.

anti-ice. System designed to prevent the accumulation of ice on an aircraft structure.

approach lighting system (ALS). Provides lights that will penetrate the atmosphere far enough from touchdown to give directional, distance, and glidepath information for safe transition from instrument to visual flight.

area chart. Part of the low-altitude en route chart series, these charts furnish terminal data at a larger scale for congested areas.

area navigation (RNAV). Allows a pilot to fly a selected course to a predetermined point without the need to overfly ground-based navigation facilities, by using waypoints.

ARSR. *See* air route surveillance radar.

ARTCC. *See* air route traffic control center.

ASDE. *See* airport surface detection equipment.

ASR. *See* airport surveillance radar.

ATC. Air Traffic Control.

atmospheric propagation delay. A bending of the electromagnetic (EM) wave from the satellite that creates an error in the GPS system.

attitude director indicator (ADI). An aircraft attitude indicator that incorporates flight command bars to provide pitch and roll commands.

attitude indicator. The basis for all instrument flight, this instrument reflects the airplane's attitude in relation to the horizon.

attitude instrument flying. Controlling the aircraft by reference to the instruments rather than outside visual cues.

autokinesis. Nighttime visual illusion that a stationary light is moving, which becomes apparent after several seconds of staring at the light.

automatic direction finder (ADF). Electronic navigation equipment that operates in the low- and medium-frequency bands. Used in conjunction with the ground-based nondirectional beacon (NDB), the instrument displays the number of degrees clockwise from the nose of the aircraft to the station being received.

back course (BC). The reciprocal of the localizer course for an ILS. When flying a back-course approach, an aircraft approaches the instrument runway from the end at which the localizer antennas are installed.

barometric scale. A scale on the dial of an altimeter to which the pilot sets the barometric pressure level from which the altitude shown by the pointers is measured.

BC. *See* back course.

block altitude. A block of altitudes assigned by ATC to allow altitude deviations; for example, "Maintain block altitude 9 to 11 thousand."

cage. The black markings on the ball instrument indicating its neutral position.

calibrated. The instrument indication was compared with a standard value to determine the accuracy of the instrument.

calibrated orifice. A hole of specific diameter used to delay the pressure change in the case of a vertical speed indicator.

CDI. Course deviation indicator.

changeover points (COPs). A point along the route or airway segment between two adjacent navigation facilities or waypoints where changeover in navigation guidance should occur.

circling approach. A maneuver initiated by the pilot to align the aircraft with a runway for landing when a straight-in landing from an instrument approach is not possible or is not desirable.

Class A airspace. Airspace from 18,000 feet MSL up to and including FL600, including the airspace overlying the waters within 12 NM of the coast of the 48 contiguous states and Alaska; and designated international airspace beyond 12 NM of the coast of the 48 contiguous states and Alaska within areas of domestic radio navigational signal or ATC radar coverage, and within which domestic procedures are applied.

Class B airspace. Airspace from the surface to 10,000 feet MSL surrounding the nation's busiest airports in terms of IFR operations or passenger numbers. The configuration of each Class B airspace is individually tailored and consists of a surface area and two or more layers, and is designed to contain all published instrument procedures once an aircraft enters the airspace. For all aircraft, an ATC clearance is required to operate in the area, and aircraft so cleared receive separation services within the airspace.

Class C airspace. Airspace from the surface to 4,000 feet above the airport elevation (charted in MSL) surrounding those airports having an operational control tower, serviced by radar approach control, and having a certain number of IFR operations or passenger numbers. Although the configuration of each Class C airspace area is individually tailored, the airspace usually consists of a 5 NM radius core surface area that extends from the surface up to 4,000 feet above the airport elevation, and a 10 NM radius shelf area that extends from 1,200 feet to 4,000 feet above the airport elevation.

Class D airspace. Airspace from the surface to 2,500 feet above the airport elevation (charted in MSL) surrounding those airports that have an operational control tower. The configuration of each Class D airspace area is individually tailored, and when instrument procedures are published, the airspace will normally be designed to contain the procedures.

Class E airspace. Airspace that is not Class A, Class B, Class C, or Class D, and it is controlled airspace.

Class G airspace. Airspace that is uncontrolled, except when associated with a temporary control tower, and has not been designated as Class A, Class B, Class C, Class D, or Class E airspace.

clean configuration. An aircraft in a clean configuration is one in which all flight control surfaces have been placed so as to create minimum drag; in most aircraft this means flaps and gear retracted.

clearance. Allows an aircraft to proceed under specified traffic conditions within controlled airspace, for the purpose of providing separation between known aircraft.

clearance delivery. Control tower position responsible for transmitting departure clearances to IFR flights.

clearance limit. The fix, point, or location to which an aircraft is cleared when issued an air traffic clearance.

clearance on request. After filing a flight plan, the IFR clearance has not yet been received but it is pending.

clearance void time. Used by ATC to advise an aircraft that the departure clearance is automatically canceled if takeoff is not made prior to a specified time. The pilot must obtain a new clearance or cancel the IFR flight plan if not off by the specified time.

clear ice. Glossy, clear, or translucent ice formed by the relatively slow freezing of large supercooled water droplets.

compass course. A true course corrected for variation and deviation errors.

compass locator. A low-power, low- or medium-frequency (L/MF) radio beacon installed at the site of the outer or middle marker of an ILS.

compass rose. A small circle graduated in 360° increments printed on navigational charts to show the amount of compass variation at different locations, or on instruments to indicate direction.

computer navigation fix. A point used to define a navigation track for an airborne computer system such as GPS or FMS.

concentric rings. The dashed-line circles depicted in the plan view of IAP charts, outside of the reference circle, that show en route and feeder facilities.

cone of confusion. A cone-shaped volume of airspace directly above a VOR station where no signal is received causing the CDI to fluctuate.

control and performance. A method of attitude instrument flying in which one instrument is used for making attitude changes, and the other instruments are used to monitor the progress of the change.

controlled airspace. An airspace of defined dimensions within which ATC service is provided to IFR and VFR flights in accordance with the airspace classification. Includes Class A, Class B, Class C, Class D, and Class E airspace.

control pressures. The amount of physical exertion on the control column necessary to achieve the desired aircraft attitude.

convective. Unstable, rising air—cumiliform clouds.

convective SIGMET. Weather advisory concerning convective weather significant to the safety of all aircraft, including thunderstorms, hail, and tornadoes.

coordinated. Using the controls to maintain or establish various conditions of flight with (1) a minimum disturbance of the forces maintaining equilibrium, or (2) the control action necessary to effect the smoothest changes in equilibrium.

COPs. *See* changeover points.

Coriolis illusion. An abrupt head movement, while in a prolonged constant-rate turn that has ceased stimulating the motion sensing system, can create the illusion of rotation or movement in an entirely different axis.

crew resource management (CRM). The effective use of all available resources—human resources, hardware, and information.

critical areas. Areas where disturbances to the ILS localizer and glide-slope courses may occur when surface vehicles or aircraft operate near the localizer or glide-slope antennas.

CRM. *See* crew resource management.

cross-check. The first fundamental skill of instrument flight, also known as "scan"; the continuous and logical observation of instruments for attitude and performance information.

cruise clearance. Used in an ATC clearance to allow a pilot to conduct flight at any altitude from the minimum IFR altitude up to and including the altitude specified in the clearance. Also authorizes a pilot to proceed to and make an approach at the destination airport.

current induction. An electrical current is induced into, or generated in, any conductor that is crossed by lines of flux from any magnet.

DA. *See* decision altitude.

d.c. Direct current.

dark adaptation. Physical and chemical adjustments of the eye that make vision possible in relative darkness.

deceleration error. A magnetic compass error that shows up when the aircraft decelerates while flying on an easterly or westerly heading, causing the compass card to rotate toward South.

decision altitude (DA). A specified altitude in the precision approach, charted in feet MSL, at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.

decision height (DH). A specified altitude in the precision approach, charted in height above threshold elevation, at which a decision must be made to either continue the approach or to execute a missed approach.

deice. System designed to remove ice accumulation from an aircraft structure.

density altitude. Pressure altitude corrected for nonstandard temperature. Density altitude is used for computing the performance of an aircraft and its engines.

departure procedure (DP). Preplanned IFR ATC departure, published for pilot use, in textual and graphic format.

deviation. A magnetic compass error caused by local magnetic fields within the aircraft. Deviation error is different on each heading.

DGPS. Differential global positioning system.

DH. *See* decision height.

direct indication. The true and instantaneous reflection of aircraft pitch-and-bank attitude by the miniature aircraft, relative to the horizon bar of the attitude indicator.

direct user access terminal system (DUATS). Provides current FAA weather and flight plan filing services to certified civil pilots, via a personal computer, modem, and telephone access to the system. Pilots can request specific types of weather briefings and other pertinent data for planned flights.

distance circle. *See* reference circle.

distance measuring equipment (DME). A pulse-type electronic navigation system that shows the pilot, by an instrument-panel indication, the number of nautical miles between the aircraft and a ground station or waypoint.

DME. *See* distance measuring equipment.

DME arc. Flying a track that is a constant distance from the station or waypoint.

DOD. Department of Defense.

doghouse. A mark on the dial of a turn-and-slip indicator that has the shape of a doghouse.

double gimbal. A type of mount used for the gyro in an attitude instrument. The axes of the two gimbals are at right angles to the spin axis of the gyro, allowing free motion in two planes around the gyro.

DP. *See* departure procedure.

DUATS. *See* direct user access terminal system.

duplex. Transmitting on one frequency and receiving on a separate frequency.

eddy currents. Current induced in a metal cup or disc when it is crossed by lines of flux from a moving magnet.

EFAS. *See* En route Flight Advisory Service.

EFC. *See* expect-further-clearance.

elevator illusion. The feeling of being in a climb or descent, caused by the kind of abrupt vertical accelerations that result from up- or downdrafts.

emergency. A distress or urgent condition.

emphasis error. Giving too much attention to a particular instrument during the cross-check, instead of relying on a combination of instruments necessary for attitude and performance information.

EM wave. Electromagnetic wave.

encoding altimeter. A special type of pressure altimeter used to send a signal to the air traffic controller on the ground, showing the pressure altitude the aircraft is flying.

en route facilities ring. A circle depicted in the plan view of IAP charts, which designates NAVAIDs, fixes, and intersections that are part of the en route low altitude airway structure.

En route Flight Advisory Service (EFAS). An en route weather-only AFSS service.

en route high-altitude charts. Aeronautical charts for en route instrument navigation at or above 18,000 feet MSL.

en route low-altitude charts. Aeronautical charts for en route IFR navigation below 18,000 feet MSL.

inverter. A solid-state electronic device that converts electrical current from d.c. into a.c. to operate a.c. gyro-instruments.

expect-further-clearance (EFC). The time a pilot can expect to receive clearance beyond a clearance limit.

FAF. *See* final approach fix.

false horizon. Inaccurate visual information for aligning the aircraft caused by various natural and geometric formations that disorient the pilot from the actual horizon.

federal airways. Class E airspace areas that extend upward from 1,200 feet to, but not including, 18,000 feet MSL, unless otherwise specified.

feeder facilities. NAVAIDs used by ATC to direct aircraft to intervening fixes between the en route structure and the initial approach fix.

final approach fix (FAF). The fix from which the IFR final approach to an airport is executed, and which identifies the beginning of the final approach segment. An FAF is designated on government charts by the Maltese cross symbol for nonprecision approaches, and the lightning bolt symbol for precision approaches.

fixating. Staring at a single instrument, thereby interrupting the cross-check process.

FL. *See* flight level.

flight configurations. Adjusting the aircraft controls surfaces (including flaps and landing gear) in a manner that will achieve a specified attitude.

flight level (FL). A measure of altitude used by aircraft flying above 18,000 feet with the altimeter set at 29.92" Hg.

flight management system (FMS). Provides pilot and crew with highly accurate and automatic long-range navigation capability, blending available inputs from long- and short-range sensors.

flightpath. The line, course, or track along which an aircraft is flying or is intended to be flown.

flight patterns. Basic maneuvers, flown by reference to the instruments rather than outside visual cues, for the purpose of practicing basic attitude flying. The patterns simulate maneuvers encountered on instrument flights such as holding patterns, procedure turns, and approaches.

flight strips. Paper strips containing instrument flight information, used by ATC when processing flight plans.

FMS. *See* flight management system.

fundamental skills. Instrument cross-check, instrument interpretation, and aircraft control.

glide slope (GS). Part of the ILS that projects a radio beam upward at an angle of approximately 3° from the approach end of an instrument runway. The glide slope provides vertical guidance to aircraft on the final approach course for the aircraft to follow when making an ILS approach along the localizer path.

glide-slope intercept altitude. The minimum altitude of an intermediate approach segment prescribed for a precision approach that ensures obstacle clearance.

global positioning system (GPS). Navigation system that uses satellite rather than ground-based transmitters for location information.

goniometer. As used in radio frequency (RF) antenna systems, a direction-sensing device consisting of two fixed loops of wire oriented 90° from each other, which sense received signal strength separately and send those signals to two rotors (also oriented 90°) in the sealed direction-indicating instrument. The rotors are attached to the direction-indicating needle of the instrument and rotated by a small motor until minimum magnetic field is sensed near the rotors.

GPS. *See* global positioning system.

GPS Approach Overlay Program. An authorization for pilots to use GPS avionics under IFR for flying designated existing nonprecision instrument approach procedures, with the exception of LOC, LDA, and SDF procedures.

graveyard spiral. The illusion of the cessation of a turn while actually still in a prolonged coordinated, constant-rate turn, which can lead a disoriented pilot to a loss of control of the aircraft.

great circle route. The shortest distance across the surface of a sphere (the Earth) between two points on the surface.

groundspeed. Speed over the ground; either closing speed to the station or waypoint, or speed over the ground in whatever direction the aircraft is going at the moment, depending upon the navigation system used.

GS. *See* glide slope.

HAA. *See* height above airport.

HAL. *See* height above landing.

HAT. *See* height above touchdown elevation.

hazardous attitudes. Five aeronautical decision-making attitudes that may contribute to poor pilot judgment are: antiauthority, impulsivity, invulnerability, macho, and resignation.

Hazardous Inflight Weather Advisory Service (HIWAS). Recorded weather forecasts broadcast to airborne pilots over selected VORs.

head-up display (HUD). A special type of flight viewing screen that allows the pilot to watch the flight instruments and other data while looking through the windshield of the aircraft for other traffic, the approach lights, or the runway.

height above airport (HAA). The height of the MDA above the published airport elevation.

height above landing (HAL). The height above a designated helicopter landing area used for helicopter instrument approach procedures.

height above touchdown elevation (HAT). The DA/DH or MDA above the highest runway elevation in the touchdown zone (first 3,000 feet of the runway).

HF. High frequency.

HIWAS. *See* Hazardous Inflight Weather Advisory Service.

holding. A predetermined maneuver that keeps aircraft within a specified airspace while awaiting further clearance from ATC.

holding pattern. A racetrack pattern, involving two turns and two legs, used to keep an aircraft within a prescribed airspace with respect to a geographic fix. A standard pattern uses right turns; nonstandard patterns use left turns.

homing. Flying the aircraft on any heading required to keep the needle pointing directly to the 0° relative bearing position.

horizontal situation indicator (HSI). A flight navigation instrument that combines the heading indicator with a CDI, in order to provide the pilot with better situational awareness of location with respect to the courseline.

HSI. *See* horizontal situation indicator.

HUD. *See* head-up display.

human factors. A multidisciplinary field encompassing the behavioral and social sciences, engineering, and physiology, to consider the variables that influence individual and crew performance for the purpose of optimizing human performance and reducing errors.

hypoxia. A state of oxygen deficiency in the body sufficient to impair functions of the brain and other organs.

IAF. *See* initial approach fix.

IAP. *See* instrument approach procedures.

ICAO. *See* International Civil Aviation Organization.

ident. Push the button on the transponder to identify your return on the controller's scope.

IFR. *See* instrument flight rules.

ILS. *See* instrument landing system.

ILS categories. Categories of instrument approach procedures allowed at airports equipped with the following types of instrument landing systems:

ILS Category I: Provides for approach to a height above touchdown of not less than 200 feet, and with runway visual range of not less than 1,800 feet.

ILS Category II: Provides for approach to a height above touchdown of not less than 100 feet and with runway visual range of not less than 1,200 feet.

ILS Category IIIA: Provides for approach without a decision height minimum and with runway visual range of not less than 700 feet.

ILS Category IIIB: Provides for approach without a decision height minimum and with runway visual range of not less than 150 feet.

ILS Category IIIC: Provides for approach without a decision height minimum and without runway visual range minimum.

IMC. *See* instrument meteorological conditions.

indirect indication. A reflection of aircraft pitch-and-bank attitude by the instruments other than the attitude indicator.

induced drag. Drag caused by the same factors that produce lift; its amount varies inversely with airspeed. As airspeed decreases, the angle of attack must increase, and this increases induced drag.

inertial navigation system (INS). A computer-based navigation system that tracks the movement of an aircraft via signals produced by onboard accelerometers. The initial location of the aircraft is entered into the computer, and all subsequent movement of the aircraft is sensed and used to keep the position updated. An INS does not require any inputs from outside signals.

initial approach fix (IAF). The fix depicted on IAP charts where the IAP begins unless otherwise authorized by ATC.

inoperative components. Higher minimums are prescribed when the specified visual aids are not functioning; this information is listed in the Inoperative Components Table found in the U.S. Terminal Procedures Publications.

INS. *See* inertial navigation system.

instrument approach procedures (IAP). A series of predetermined maneuvers for the orderly transfer of an aircraft under IFR from the beginning of the initial approach to a landing or to a point from which a landing may be made visually.

instrument flight rules (IFR). Rules and regulations established by the Federal Aviation Administration to govern flight under conditions in which flight by outside visual reference is not safe. IFR flight depends upon flying by reference to instruments in the cockpit, and navigation is done by reference to electronic signals.

instrument landing system (ILS). An electronic system that provides both horizontal and vertical guidance to a specific runway, used to execute a precision instrument approach procedure.

instrument meteorological conditions (IMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling less than the minimums specified for visual meteorological conditions, requiring operations to be conducted under IFR.

instrument takeoff. Using the instruments rather than outside visual cues to maintain runway heading and execute a safe takeoff.

International Civil Aviation Organization (ICAO). The United Nations agency for developing the principles and techniques of international air navigation, and fostering planning and development of international civil air transport.

inversion illusion. The feeling that the aircraft is tumbling backwards, caused by an abrupt change from climb to straight-and-level flight while in situations lacking visual reference.

inverter. A solid-state electronic device that converts d.c. into a.c. current of the proper voltage and frequency to operate a.c. gyro instruments.

isogonic lines. Lines drawn across aeronautical charts to connect points having the same magnetic variation.

jet route. A route designated to serve flight operations from 18,000 feet MSL, up to and including FL450.

jet stream. A high-velocity narrow stream of winds, usually found near the upper limit of the troposphere, which flows generally from west to east.

Kollsman window. A barometric scale window of a sensitive altimeter used to adjust the altitude for the altimeter setting.

LAAS. *See* local area augmentation system.

lag. The delay that occurs before an instrument needle attains a stable indication.

land as soon as possible. Land without delay at the nearest suitable area, such as an open field, at which a safe approach and landing is assured.

land as soon as practical. The landing site and duration of flight are at the discretion of the pilot. Extended flight beyond the nearest approved landing area is not recommended.

land immediately. The urgency of the landing is paramount. The primary consideration is to ensure the survival of the occupants. Landing in trees, water, or other unsafe areas should be considered only as a last resort.

LDA. *See* localizer-type directional aid.

lead radial. The radial at which the turn from the DME arc to the inbound course is started.

leans, the. An abrupt correction of a banked attitude, entered too slowly to stimulate the motion sensing system in the inner ear, can create the illusion of banking in the opposite direction.

lines of flux. Invisible lines of magnetic force passing between the poles of a magnet.

LMM. *See* locator middle marker.

load factor. The ratio of a specified load to the total weight of the aircraft. The specified load is expressed in terms of any of the following: aerodynamic forces, inertia forces, or ground or water reactions.

loadmeter. A type of ammeter installed between the generator output and the main bus in an aircraft electrical system.

LOC. *See* localizer.

local area augmentation system (LAAS). A differential global positioning system (DGPS) that improves the accuracy of the system by determining position error from the GPS satellites, then transmitting the error, or corrective factors, to the airborne GPS receiver.

localizer (LOC). The portion of an ILS that gives left/right guidance information down the centerline of the instrument runway for final approach.

localizer-type directional aid (LDA). A NAVAID used for nonprecision instrument approaches with utility and accuracy comparable to a localizer but which is not a part of a complete ILS and is not aligned with the runway. Some LDAs are equipped with a glide slope.

locator middle marker (LMM). NDB compass locator, colocated with a MM.

locator outer marker (LOM). NDB compass locator, colocated with an OM.

LOM. *See* locator outer marker.

long range navigation (LORAN). An electronic navigational system by which hyperbolic lines of position are determined by measuring the difference in the time of reception of synchronized pulse signals from two fixed transmitters. LORAN A operates in the 1750 to 1950 kHz frequency band. LORAN C and D operate in the 100 to 110 kHz frequency band.

LORAN. *See* long range navigation.

lubber line. The reference line used in a magnetic compass or heading indicator.

MAA. *See* maximum authorized altitude.

magnetic bearing (MB). The direction to or from a radio transmitting station measured relative to magnetic north.

magnetic heading (MH). The direction an aircraft is pointed with respect to magnetic north.

mandatory altitude. An altitude depicted on an instrument approach chart with the altitude value both underscored and overscored. Aircraft are required to maintain altitude at the depicted value.

mandatory block altitude. An altitude depicted on an instrument approach chart with two altitude values underscored and overscored. Aircraft are required to maintain altitude between the depicted values.

MAP. *See* missed approach point.

margin identification. The top and bottom areas on an instrument approach chart that depict information about the procedure, including airport location and procedure identification.

marker beacon. A low-powered transmitter that directs its signal upward in a small, fan-shaped pattern. Used along the flightpath when approaching an airport for landing, marker beacons indicate both aurally and visually when the aircraft is directly over the facility.

maximum altitude. An altitude depicted on an instrument approach chart with the altitude value overscored. Aircraft are required to maintain altitude at or below the depicted value.

maximum authorized altitude (MAA). A published altitude representing the maximum usable altitude or flight level for an airspace structure or route segment.

MB. *See* magnetic bearing.

MCA. *See* minimum crossing altitude.

MDA. *See* minimum descent altitude.

MEA. *See* minimum en route altitude.

MH. *See* magnetic heading.

microwave landing system (MLS). A precision instrument approach system operating in the microwave spectrum which normally consists of an azimuth station, elevation station, and precision distance measuring equipment.

mileage breakdown. A fix indicating a course change that appears on the chart as an "x" at a break between two segments of a federal airway.

military operations area (MOA). MOAs consist of airspace established for the purpose of separating certain military training activities from IFR traffic.

Military Training Route (MTR). Airspace of defined vertical and lateral dimensions established for the conduct of military training at airspeeds in excess of 250 KIAS.

minimum altitude. An altitude depicted on an instrument approach chart with the altitude value underscored. Aircraft are required to maintain altitude at or above the depicted value.

minimum crossing altitude (MCA). The lowest altitude at certain fixes at which an aircraft must cross when proceeding in the direction of a higher MEA.

minimum descent altitude (MDA). The lowest altitude (in feet MSL) to which descent is authorized on final approach, or during circle-to-land maneuvering in execution of a nonprecision approach.

minimum en route altitude (MEA). The lowest published altitude between radio fixes which ensures acceptable navigational signal coverage and meets obstacle clearance requirements between those fixes.

minimum obstruction clearance altitude (MOCA). The lowest published altitude in effect between radio fixes on VOR airways, off-airway routes, or route segments which meets obstacle clearance requirements for the entire route segment and which ensures acceptable navigational signal coverage only within 25 statute (22 nautical) miles of a VOR.

minimum reception altitude (MRA). The lowest altitude at which an airway intersection can be determined.

minimum safe altitude (MSA). The minimum altitude depicted on approach charts which provides at least 1,000 feet of obstacle clearance for emergency use within a specified distance from the listed navigation facility.

minimum vectoring altitude (MVA). An IFR altitude lower than the minimum en route altitude (MEA) that provides terrain and obstacle clearance.

minimums section. The area on an IAP chart that displays the lowest altitude and visibility requirements for the approach.

missed approach. A maneuver conducted by a pilot when an instrument approach cannot be completed to a landing.

missed approach point (MAP). A point prescribed in each instrument approach at which a missed approach procedure shall be executed if the required visual reference has not been established.

mixed ice. A mixture of clear ice and rime ice.

MLS. *See* microwave landing system.

MM. Middle marker.

MOA. *See* military operations area.

MOCA. *See* minimum obstruction clearance altitude.

mode C. Altitude reporting transponder mode.

MRA. *See* minimum reception altitude.

MSA. *See* minimum safe altitude.

MTR. *See* Military Training Route.

MVA. *See* minimum vectoring altitude.

NACO. *See* National Aeronautical Charting Office.

NAS. *See* National Airspace System.

National Airspace System (NAS). The common network of U.S. airspace—air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information; and manpower and material.

National Aeronautical Charting Office (NACO). A Federal agency operating under the FAA, responsible for publishing charts such as the terminal procedures and en route charts.

National Route Program (NRP). A set of rules and procedures designed to increase the flexibility of user flight planning within published guidelines.

National Security Area (NSA). National Security Areas consist of airspace of defined vertical and lateral dimensions established at locations where there is a requirement for increased security and safety of ground facilities. Pilots are requested to voluntarily avoid flying through the depicted NSA. When it is necessary to provide a greater level of security and safety, flight in NSAs may be temporarily prohibited. Regulatory prohibitions are disseminated via NOTAMs.

NM. Nautical mile.

NAV/COM. Combined communication and navigation radio.

NOAA. National Oceanic and Atmospheric Administration.

no-gyro approach. A radar approach that may be used in case of a malfunctioning gyro-compass or directional gyro. Instead of providing the pilot with headings to be flown, the controller observes the radar track and issues control instructions "turn right/left" or "stop turn," as appropriate.

nonprecision approach. A standard instrument approach procedure in which only horizontal guidance is provided.

no procedure turn (NoPT). Used with the appropriate course and altitude to denote the procedure turn is not required.

NRP. *See* National Route Program.

NSA. *See* National Security Area.

NWS. National Weather Service.

OM. Outer marker.

omission error. Failing to anticipate significant instrument indications following attitude changes; for example, concentrating on pitch control while forgetting about heading or roll information, resulting in erratic control of heading and bank.

optical illusion. A misleading visual image of features on the ground associated with landing, which causes a pilot to misread the spatial relationships between the aircraft and the runway.

orientation. Awareness of the position of the aircraft and of oneself in relation to a specific reference point.

overcontrolling. Using more movement in the control column than is necessary to achieve the desired pitch-and-bank condition.

overpower. Using more power than required for the purpose of achieving a faster rate of airspeed change.

P-static. *See* precipitation static.

PAPI. *See* precision approach path indicator.

PAR. *See* precision approach radar.

parasite drag. Drag caused by the friction of air moving over the aircraft structure; its amount varies directly with the airspeed. The higher the airspeed, the greater the parasite drag.

PIC. *See* pilot in command.

pilot in command (PIC). The pilot responsible for the operation and safety of an aircraft.

pilot report (PIREP). Report of meteorological phenomena encountered by aircraft.

Pilot's Operating Handbook/Airplane Flight Manual (POH/AFM). FAA-approved documents published by the airframe manufacturer that list the operating conditions for a particular model of aircraft.

PIREP. *See* pilot report.

pitot pressure. Ram air pressure used to measure airspeed.

pitot-static head. A combination pickup used to sample pitot pressure and static air pressure.

plan view. The overhead view of an approach procedure on an instrument approach chart. The plan view depicts the routes that guide the pilot from the en route segments to the IAF.

POH/AFM. *See* Pilot's Operating Handbook/Airplane Flight Manual.

point in space approach. A type of helicopter instrument approach procedure to a missed approach point more than 2,600 feet from an associated helicopter landing area.

position error. Error in the indication of the altimeter, ASI, and VSI caused by the air at the static system entrance not being absolutely still.

position report. A report over a known location as transmitted by an aircraft to ATC.

precession. The characteristic of a gyroscope that causes an applied force to be felt, not at the point of application, but 90° from that point in the direction of rotation.

precipitation static (P-static). A form of radio interference caused by rain, snow, or dust particles hitting the antenna and inducing a small radio-frequency voltage into it.

precision approach. A standard instrument approach procedure in which both vertical and horizontal guidance is provided.

precision approach path indicator (PAPI). Similar to the VASI but consisting of one row of lights in two- or four-light systems. A pilot on the correct glide slope will see two white lights and two red lights. *See* VASI.

precision approach radar (PAR). A type of radar used at an airport to guide an aircraft through the final stages of landing, providing both horizontal and vertical guidance. The radar operator directs the pilot to change heading or adjust the descent rate to keep the aircraft on a path that allows it to touch down at the correct spot on the runway.

preferred IFR routes. Routes established in the major terminal and en route environments to increase system efficiency and capacity. IFR clearances are issued based on these routes, listed in the A/FD except when severe weather avoidance procedures or other factors dictate otherwise.

pressure altitude. Altitude above the standard 29.92" Hg plane.

prevailing visibility. The greatest horizontal visibility equaled or exceeded throughout at least half the horizon circle (which is not necessarily continuous).

primary and supporting. A method of attitude instrument flying using the instrument that provides the most direct indication of attitude and performance.

procedure turn. A maneuver prescribed when it is necessary to reverse direction to establish an aircraft on the intermediate approach segment or final approach course.

profile view. Side view of an IAP chart illustrating the vertical approach path altitudes, headings, distances, and fixes.

prohibited area. Designated airspace within which flight of aircraft is prohibited.

propeller/rotor modulation error. Certain propeller RPM settings or helicopter rotor speeds can cause the VOR course deviation indicator (CDI) to fluctuate as much as ±6°. Slight changes to the RPM setting will normally smooth out this roughness.

rabbit, the. High-intensity flasher system installed at many large airports. The flashers consist of a series of brilliant blue-white bursts of light flashing in sequence along the approach lights, giving the effect of a ball of light traveling towards the runway.

radar. Radio Detection And Ranging.

radar approach. The controller provides vectors while monitoring the progress of the flight with radar, guiding the pilot through the descent to the airport/heliport or to a specific runway.

radials. The courses oriented FROM the station.

radio or radar altimeter. An electronic altimeter that determines the height of an aircraft above the terrain by measuring the time needed for a pulse of radio-frequency energy to travel from the aircraft to the ground and return.

radio magnetic indicator (RMI). An electronic navigation instrument that combines a magnetic compass with an ADF or VOR. The card of the RMI acts as a gyro-stabilized magnetic compass, and shows the magnetic heading the aircraft is flying.

radio wave. An electromagnetic wave (EM wave) with frequency characteristics useful for radio transmission.

RAIM. *See* receiver autonomous integrity monitoring.

random RNAV routes. Direct routes, based on area navigation capability, between waypoints defined in terms of latitude/longitude coordinates, degree-distance fixes, or offsets from established routes/airways at a specified distance and direction.

ranging signals. Transmitted from the GPS satellite, these allow the aircraft's receiver to determine range (distance) from each satellite.

RB. *See* relative bearing.

RBI. *See* relative bearing indicator.

RCO. *See* remote communications outlet.

receiver autonomous integrity monitoring (RAIM). A system used to verify the usability of the received GPS signals and warns the pilot of any malfunction in the navigation system. This system is required for IFR-certified GPS units.

recommended altitude. An altitude depicted on an instrument approach chart with the altitude value neither underscored nor overscored. The depicted value is an advisory value.

reference circle (also, distance circle). The circle depicted in the plan view of an IAP chart that typically has a 10 NM radius, within which the elements are drawn to scale.

regions of command. The "regions of normal and reversed command" refers to the relationship between speed and the power required to maintain or change that speed in flight.

REIL. *See* runway end identifier lights.

relative bearing (RB). The angular difference between the aircraft heading and the direction to the station, measured clockwise from the nose of the aircraft.

relative bearing indicator (RBI). Also known as the fixed-card ADF, zero is always indicated at the top of the instrument and the needle indicates the relative bearing to the station.

relative wind. Direction of the airflow produced by an object moving through the air. The relative wind for an airplane in flight flows in a direction parallel with and opposite to the direction of flight; therefore, the actual flightpath of the airplane determines the direction of the relative wind.

remote communications outlet (RCO). An unmanned communications facility remotely controlled by air traffic personnel.

restricted area. Airspace designated under 14 CFR part 73 within which the flight of aircraft, while not wholly prohibited, is subject to restriction.

reverse sensing. When the VOR needle appears to be indicating the reverse of normal operation.

RF. Radio frequency.

rigidity. The characteristic of a gyroscope that prevents its axis of rotation tilting as the Earth rotates.

rime ice. Rough, milky, opaque ice formed by the instantaneous freezing of small supercooled water droplets.

RMI. *See* radio magnetic indicator.

RNAV. *See* area navigation.

runway end identifier lights (REIL). This system consists of a pair of synchronized flashing lights, located laterally on each side of the runway threshold, to provide rapid and positive identification of the approach end of a runway.

runway visibility value (RVV). The visibility determined for a particular runway by a transmissometer.

runway visual range (RVR). The instrumentally-derived horizontal distance a pilot should be able to see down the runway from the approach end, based on either the sighting of high-intensity runway lights, or the visual contrast of other objects.

RVR. *See* runway visual range.

RVV. *See* runway visibility value.

SA. *See* selective availability.

St. Elmo's Fire. A corona discharge which lights up the aircraft surface areas where maximum static discharge occurs.

satellite ephemeris data. Data broadcast by the GPS satellite containing very accurate orbital data for that satellite, atmospheric propagation data, and satellite clock error data.

scan. The first fundamental skill of instrument flight, also known as "cross-check"; the continuous and logical observation of instruments for attitude and performance information.

SDF. *See* simplified directional facility.

selective availability (SA). A method by which the Department of Defense (DOD) can, in the interest of national security, create a significant clock and ephemeris error in the satellites, resulting in a navigation error.

sensitive altimeter. A form of multipointer pneumatic altimeter with an adjustable barometric scale that allows the reference pressure to be set to any desired level.

SIGMET. A weather advisory issued concerning weather significant to the safety of all aircraft.

signal-to-noise ratio. An indication of signal strength received compared to background noise, which is a measure of how adequate the received signal is.

simplex. Transmitting and receiving on the same frequency.

simplified directional facility (SDF). A NAVAID used for nonprecision instrument approaches. The final approach course is similar to that of an ILS localizer except that the SDF course may be offset from the runway, generally not more than 3°, and the course may be wider than the localizer, resulting in a lower degree of accuracy.

situational awareness. Knowing where you are in regard to location, air traffic control, weather, regulations, aircraft status, and other factors that may affect flight.

skidding turn. An uncoordinated turn in which the rate of turn is too great for the angle of bank, pulling the aircraft to the outside of the turn.

slant range. The horizontal distance from the aircraft antenna to the ground station, due to line-of-sight transmission of the DME signal.

slaved-compass. A system whereby the heading gyro "slaved to," or continuously corrected to bring its direction readings into agreement with a remotely-located magnetic direction sensing device (usually a flux valve or flux gate compass).

slipping turn. An uncoordinated turn in which the aircraft is banked too much for the rate of turn, so the horizontal lift component is greater than the centrifugal force, pulling the aircraft toward the inside of the turn.

small airplane. An airplane of 12,500 pounds or less maximum certificated takeoff weight.

somatogravic illusion. The feeling of being in a nose-up or nose-down attitude, caused by a rapid acceleration or deceleration while in flight situations that lack visual reference.

spatial disorientation. The state of confusion due to misleading information being sent to the brain from various sensory organs, resulting in a lack of awareness of the aircraft position in relation to a specific reference point.

special use airspace. Airspace in which flight activities are subject to restrictions that can create limitations on the mixed use of airspace. Consists of prohibited, restricted, warning, military operations, and alert areas.

SSV. *See* standard service volume.

standard holding pattern. A holding pattern in which all turns are made to the right.

standard-rate turn. A turn in which an aircraft changes its direction at a rate of 3° per second (360° in 2 minutes) for low- or medium-speed aircraft. For high-speed aircraft, the standard-rate turn is 1-1/2° per second (360° in 4 minutes).

standard service volume (SSV). Defines the limits of the volume of airspace which the VOR serves.

standard terminal arrival route (STAR). A preplanned IFR ATC arrival procedure published for pilot use in graphic and/or textual form.

STAR. *See* standard terminal arrival route.

static longitudinal stability. The aerodynamic pitching moments required to return the aircraft to the equilibrium angle of attack.

static pressure. Pressure of the air that is still, or not moving, measured perpendicular to the surface of the aircraft.

steep turns. In instrument flight, anything greater than standard rate; in visual flight, anything greater than a 45° bank.

stepdown fix. Permits additional descent within a segment of an IAP by identifying a point at which an obstacle has been safely overflown.

strapdown system. An INS in which the accelerometers and gyros are permanently "strapped down" or aligned with the three axes of the aircraft.

stress. The body's response to demands placed upon it.

suction relief valve. A relief valve in an instrument vacuum system to maintain the correct low pressure inside the instrument case for the proper operation of the gyros.

synchro. A device used to transmit indications of angular movement or position from one location to another.

TAA. *See* terminal arrival area.

TACAN. *See* tactical air navigation.

tactical air navigation (TACAN). An electronic navigation system used by military aircraft, providing both distance and direction information.

TDZE. *See* touch down zone elevation.

TEC. *See* Tower En route Control.

technique. The manner or style in which the procedures are executed.

temporary flight restriction (TFR). Restrictions to flight imposed in order to:

1. Protect persons and property in the air or on the surface from an existing or imminent flight associated hazard;

2. Provide a safe environment for the operation of disaster relief aircraft;

3. Prevent an unsafe congestion of sightseeing aircraft above an incident;

4. Protect the President, Vice President, or other public figures; and,

5. Provide a safe environment for space agency operations.

Pilots are expected to check appropriate NOTAMs during flight planning when conducting flight in an area where a temporary flight restriction is in effect.

tension. Maintaining an excessively strong grip on the control column; usually results in an overcontrolled situation.

terminal arrival area (TAA). The objective of the TAA procedure design is to provide a new transition method for arriving aircraft equipped with FMS and/or GPS navigational equipment. The TAA contains a "T" structure that normally provides a NoPT for aircraft using the approach.

TFR. *See* temporary flight restriction.

thrust (aerodynamic force). The forward aerodynamic force produced by a propeller, fan, or turbojet engine as it forces a mass of air to the rear, behind the aircraft.

time and speed table. A table depicted on an instrument approach procedure chart that identifies the distance from the FAF to the MAP, and provides the time required to transit that distance based on various groundspeeds.

timed turn. A turn in which the clock and the turn coordinator are used to change heading a definite number of degrees in a given time.

Title 14 of the Code of Federal Regulations (14 CFR). The federal aviation regulations governing the operation of aircraft, airways, and airmen.

touchdown zone elevation (TDZE). The highest elevation in the first 3,000 feet of the landing surface, TDZE is indicated on the instrument approach procedure chart when straight-in landing minimums are authorized.

Tower En route Control (TEC). The control of IFR en route traffic within delegated airspace between two or more adjacent approach control facilities, designed to expedite traffic and reduce control and pilot communication requirements.

TPP. *See* U.S. Terminal Procedures Publication.

tracking. Flying a heading that will maintain the desired track to or from the station regardless of crosswind conditions.

Transcribed Weather Broadcast (TWEB). Meteorological and aeronautical data is recorded on tapes and broadcast over selected NAVAIDs. Generally, the broadcast contains route-oriented data with specially prepared NWS forecasts, in-flight advisories, and winds aloft; plus selected current information such as weather reports (METAR/SPECI), NOTAMs, and special notices.

transponder. The airborne portion of the ATC radar beacon system.

transponder code. One of 4,096 four-digit discrete codes ATC will assign to distinguish between aircraft.

trend. Instruments showing an immediate indication of the direction of aircraft movement.

trim. Adjusting the aerodynamic forces on the control surfaces so that the aircraft maintains the set attitude without any control input.

TWEB. *See* Transcribed Weather Broadcast.

uncaging. Unlocking the gimbals of a gyroscopic instrument, making it susceptible to damage by abrupt flight maneuvers or rough handling.

underpower. Using less power than required for the purpose of achieving a faster rate of airspeed change.

U.S. Terminal Procedures Publication (TPP). Booklets published in regional format by the NACO that include DPs, STARs, IAPs, and other information pertinent to IFR flight.

unusual attitude. An unintentional, unanticipated, or extreme aircraft attitude.

user-defined waypoints. Waypoint location and other data which may be input by the user; this is the only GPS database that may be altered (edited) by the user.

variation. The compass error caused by the difference in the physical locations of the magnetic north pole and the geographic north pole.

VASI. *See* visual approach slope indicator.

VDP. *See* visual descent point.

vectoring. Navigational guidance by assigning headings.

venturi tube. A specially-shaped tube attached to the outside of an aircraft to produce suction to operate gyro instruments.

very-high frequency omnidirectional range (VOR). Electronic navigation equipment in which the cockpit instrument identifies the radial or line from the VOR station measured in degrees clockwise from magnetic north, along which the aircraft is located.

vestibular. The central cavity of the bony labyrinth of the ear, or the parts of the membranous labyrinth that it contains.

VFR. *See* visual flight rules.

VFR-On-Top. ATC authorization for an IFR aircraft to operate in VFR conditions at any appropriate VFR altitude.

VFR Over-The-Top. A VFR operation in which an aircraft operates in VFR conditions on top of an undercast.

Victor airways. Based on a centerline that extends from one VOR or VORTAC navigation aid or intersection, to another navigation aid (or through several navigation aids or intersections); used to establish a known route for en route procedures between terminal areas.

visual approach slope indicator (VASI). A system of lights arranged to provide visual descent guidance information during the approach to the runway. A pilot on the correct glide slope will see red lights over white lights.

visual descent point (VDP). A defined point on the final approach course of a nonprecision straight-in approach procedure from which normal descent from the MDA to the runway touchdown point may be commenced, provided the runway environment is clearly visible to the pilot.

visual flight rules (VFR). Flight rules adopted by the FAA governing aircraft flight using visual references. VFR operations specify the amount of ceiling and the visibility the pilot must have in order to operate according to these rules. When the weather conditions are such that the pilot can not operate according to VFR, he or she must use instrument flight rules (IFR).

visual meteorological conditions (VMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling meeting or exceeding the minimums specified for VFR.

VMC. *See* visual meteorological conditions.

VOR. *See* very-high frequency omnidirectional range.

VORTAC. A facility consisting of two components, VOR and TACAN, which provides three individual services: VOR azimuth, TACAN azimuth, and TACAN distance (DME) at one site.

VOR test facility (VOT). A ground facility which emits a test signal to check VOR receiver accuracy. Some VOTs are available to the user while airborne, while others are limited to ground use only.

WAAS. *See* wide area augmentation system.

warning area. An area containing hazards to any aircraft not participating in the activities being conducted in the area. Warning areas may contain intensive military training, gunnery exercises, or special weapons testing.

waypoint. A designated geographical location used for route definition or progress-reporting purposes and is defined in terms of latitude/longitude coordinates.

WCA. *See* wind correction angle.

wide area augmentation system (WAAS). A differential global positioning system (DGPS) that improves the accuracy of the system by determining position error from the GPS satellites, then transmitting the error, or corrective factors, to the airborne GPS receiver.

wind correction angle (WCA). The angle between the desired track and the heading of the aircraft necessary to keep the aircraft tracking over the desired track.

work. A physical measurement of force used to produce movement.

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