AMERICAN FLYERS

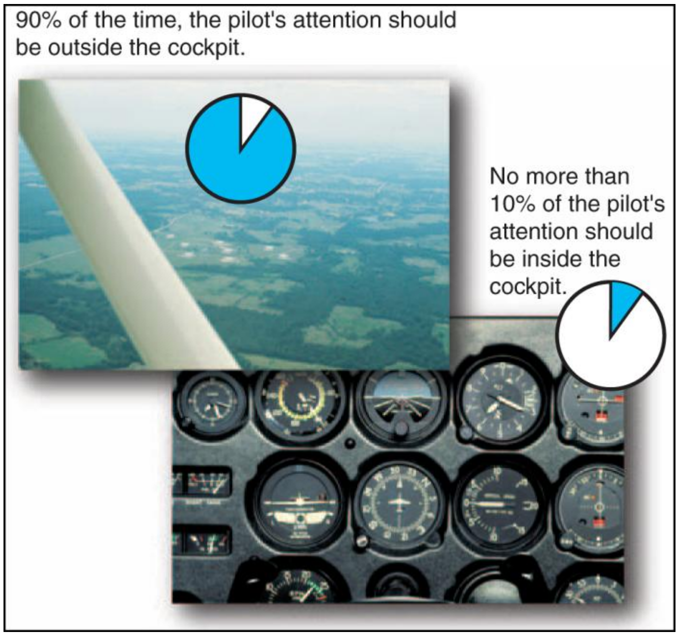
FIRC Stage 6

Chapter 1

Overview

Integrated flight instruction is flight instruction during which students are taught to perform flight maneuvers both by outside visual references and by reference to flight instruments *from the first time each maneuver is introduced.* No distinction in the pilot's operation of the flight controls is permitted, regardless of whether outside references or instrument indications are used for the performance of a maneuver.

Integrated flight instruction was introduced on a national scale in 1959 when an amendment to the Civil Air Regulations established certain instruction and competency in the use of flight instruments as prerequisites for the issuance of private pilot certificates. The objective of this training was, and still is, the formation of firm habit patterns for the observance of and reliance on flight instruments from the student's first piloting experience. Such habits have proven to produce more capable and safer pilots for the efficient operation of today's airplanes. Although the ability to fly in instrument weather is not the objective of this type of primary training, it does greatly facilitate any subsequent instrument flight training.



Integrated Method of Flight Instruction

Procedures and Instructor Qualifications

The conduct of integrated flight instruction is simple: the use of an airplane equipped with flight instruments and an easy means of simulating instrument flight conditions, such as an extended-visor cap, are needed. The student's first briefing on the function of the flight controls should include the instrument indications to be expected as well as the outside references which should be used to control the attitude of the airplane.

Each new flight maneuver should be introduced using either outside references or instrument indications as the instructor prefers. Then the student's visor should be raised or lowered, whichever is appropriate, and the same maneuver performed again, this time by the use of the other set of references. This practice should continue throughout the student's instruction for all flight maneuvers, except those which require the use of ground references. To fully achieve the benefits of this type of training, the use of visual and instrument references must be constantly integrated throughout the training.

Development of Habit Patterns

General aviation accident reports provide ample support for the belief that habitual reference to flight instruments is important to safety. The safety record of pilots who hold instrument ratings is significantly better than that of pilots with comparable flight time who have never received formal instrument flight training. Student pilots who have been required to perform all normal flight maneuvers by reference to instruments, as well as by outside references will develop from the start the habit of continuously monitoring their own, and the airplane's performance. This habit would be much more difficult for a student to develop after prolonged piloting experience without it, as veteran pilots who begin formal training for an instrument rating can readily testify.

Accuracy of Flight Control

The greatest benefit of using the integrated method of flight instruction during pilot training is that students are more precise in their performance of maneuvers by visual references. This applies to all flight operations, not just when flight by reference to instruments is required. Notable among students' achievements are better monitoring of power settings and more accurate maintenance of desired headings, altitudes, and airspeeds. As the habit of monitoring their own performance by reference to instruments is developed, students will begin to make corrections without prompting. The habitual attention to instrument indications leads to superior cross-country navigation, better coordination, improved landings because of more accurate airspeed control, and a generally better overall pilot competency.

Emergency Capability

The use of integrated flight instruction helps develop the student's ability to maintain proper control of an airplane in flight for limited periods if outside references are lost. It also presents the instructor with an opportunity to introduce the dangers of spatial disorientation. Impress upon your student through demonstrations in flight that total reliance on flight instrument crosscheck and interpretation is essential to avoiding disaster. This ability could save the pilot's life and those of the passengers in an actual emergency.

During the conduct of integrated flight training, the flight instructor must emphasize to the students that their introduction to the use of flight instruments does not prepare them for intentional operations in marginal or instrument weather conditions. The possible consequences, both to themselves and to others, of experiments with flight operations in weather conditions worse than those required for VFR operations before they are instrument rated should be constantly impressed on the students.

Precautions

During the conduct of integrated flight instruction, the instructor must be especially vigilant for other air traffic while the student is operating under the hood. The instructor must guard against having attention diverted to the student's performance for extended periods. Utilizing radar traffic advisories during training will enhance safety. Remember though, that traffic advisories are provided on a workload-permitting basis and that radar does not pick up every traffic conflict. The responsibility for collision avoidance remains with the instructor even when radar advisories are being provided.

It is important to note that integrated instruction is not without its critics. There are pilots both within and outside the FAA that worry that students will develop poor collision avoidance techniques by spending too much time referring to the instrument panel and not enough time looking for traffic. Also of concern is the possibility that the student may conclude that they have developed sufficient instrument flight skills to tackle limited visual conditions or even instrument weather. This is a valid concern and cannot be ignored by the instructor.

Students quickly learn that it is easier to control aircraft performance by concentrating on the instrument panel. Not only does this validate the concerns mentioned above, but it also makes ground reference maneuvers more difficult for the student to perform. The instructor should carefully observe the student's performance of maneuvers during the early stages of integrated flight instruction to ensure that this habit does not develop. If it is detected, the instructor should make the student concentrate on maneuvering by outside references with the gyroscopic instruments caged or covered.

Collision avoidance too, must be continually stressed. It is known that most midair collisions occur in VFR weather conditions; the pilots involved in these collisions may not have been searching for other traffic. Teach your student to always ask for radar traffic advisories but to keep in mind that collision avoidance is always the responsibility of the pilot.

During the conduct of integrated flight instruction, the instructor should make it clear that the use of instruments is being taught to prepare students to accurately monitor their own and their airplane's performance, not to qualify them for IFR operations. The instructor must avoid any indication, by word or action, that the proficiency sought is intended solely for use in difficult weather situations.

Instructor Qualifications

It is essential that a flight instructor be thoroughly familiar with the functions, characteristics, and use of all standard flight instruments. It is also the personal responsibility of each flight instructor to maintain familiarity with current pilot training techniques and certification requirements. This may be done by constant use of new periodicals and technical publications, personal contacts with Federal Aviation Administration inspectors and designated pilot examiners, and by participation in pilot and flight instructor symposiums and clinics. The application of outmoded instructional procedures or the preparation of student pilots using obsolete certification requirements is inexcusable.

Reference for Straight and Level Flight

Chapter 2

Single-Pilot Instrument Techniques

Likely at this point in your career you have heard almost everything there is to say about various IFR teaching techniques. The next few pages will introduce you to some often overlooked concepts in IFR training programs

Consider the following questions: Is it possible the CFI doesn't always know what factors are contributing to his or her performance and decision-making? Do CFIs simply pass along the same advice they received from their instructor? And do CFIs actually follow that advice? It seems an accepted fact that a proficient pilot usually reacts to situations instinctively and subconsciously; if this is so, how is this skill transferred from instructor to student?

The brain processes information and determines appropriate reactions at the speed of light. It is very possible the instructor thinks he or she is flying the way they were taught when actually pursuing a different course of action without realizing it. This is what happens when students learn in spite of the instruction instead of because of it. When these student advance to become instructors, they will probably teach the same way they were taught even though they subconsciously found a different and more effective method to use.

Aviate, Aviate, Aviate

Knowing that a student may unintentionally learn from the instructor, and the instructor may be inadvertently teaching unintended material, let us examine a procedural adage often relayed from instructor to student: "Aviate. Navigate. Communicate."

Is "Aviate, navigate and communicate" really effective? Maybe not. Perhaps "Aviate, Aviate, Aviate" is more efficacious. Consider this: there is no such thing as single-pilot IFR for the airlines. Why? Because whoever is flying, whether it is the PIC or SIC, flying the aircraft is all they do. The pilot flying does not change frequencies on the radio, set the OBS, put the gear up or down, or even talk to ATC! The pilot not flying is the one who handles these chores. The pilot flying may have 20,000 hours logged and may be flying 1,000 hours a year, up to 200 of which may be actual instrument. What is learned from all this experience is that you cannot fly on instruments in hard IFR unless you are looking at them. The flight instruments are the sole concern of the pilot flying, distractions are ignored or delegated to the pilot not flying.

Where does that leave the pilot who flies without the aid of a copilot? Can single-pilot IFR be as safe as an airline operation with two pilots? Of course it can, otherwise the FAA would not allow it. However, in order to ensure the highest level of safety during single-pilot IFR operations, the pilot must learn to never stop being the PIC in order to accomplish SIC duties. This pilot needs to work smarter, not harder.

Even with a sophisticated autopilot or FMS, the duties of flying or managing flight are enough to require a pilot's full and complete attention. How then can other tasks be accomplished? These are the items that must become instinctive so as to not distract from flying the aircraft. Additionally, the pilot needs to get assistance from whatever resources might exist, including ATC. ATC as a source of information and assistance will be a theme present throughout the rest of this chapter.

Stacking the Deck

Every pilot can and must "stack the deck" in their favor during any flight but especially during single-pilot IFR operations. The amount of resources available to pilots, even before they climb into their airplane, is immense.

Investigations into accidents occurring during IFR operations have revealed the following common denominators as factors that increase risk during flight: IFR operations into unfamiliar airports (referred to as *strange-field let downs*) during low IFR weather or at night, circling-to-land maneuvers during low IFR weather or at night, and using unfamiliar cockpit automation.

It would therefore follow that a pilot who wishes to reduce the risk factor of a flight will avoid strange-field let downs or circle-to-land maneuvers during low IFR weather or at night, and will not use cockpit automation that is unfamiliar. Though these situations of higher risk occur during flight, with all the myriad of resources available, the opportunity to make decisions that will reduce risk occurs before you ever fly.

Good planning is the first and perhaps most important step in stacking the deck. Through advance planning, most decisions can be made ahead of time resulting in a more relaxed and confident flight; this idea is definitely one to impart to your students.

Pilots should be proactive instead of reactive; show your students how to seek advice from FSS, ATC or even local pilots regarding the clearance most likely to be issued for an upcoming trip. Have your student mentally "pre-fly" the trip and anticipate any complex maneuvering or navigation setups. If an FTD or PCATD is available, suggest that your student use it to pre-fly the more complicated segments of the trip.

ATIS

ATIS was designed to help the pilot determine ahead of time (more advance planning) how the arrival will be accomplished. However, when the pilot flying is the only pilot in the cockpit, he or she can not ignore the controller in order to copy the ATIS. So can this chore be accomplished while continuing to fly the aircraft?

Some CFIs tell their students to monitor both frequencies simultaneously. These instructors may have been taught that method while they were students and apparently have forgotten that it never worked very well. It can be a difficult task to successfully listen to, and comprehend, two different conversations at the same time, especially when the airspace is busy.

As an alternative, get ATC involved. Teach your students to anticipate a position approximately 15 minutes prior to where the change to approach control might occur. That is a good place to call the current controller and tell ATC that you are switching to ATIS and will report when you are back on the frequency.

ATC will respond in one of two ways. The controller might say: "Frequency change approved, call me when you are back on my frequency." This allows the pilot to listen to just the ATIS and will facilitate acquiring the necessary data quickly. The other response might be: "Negative, I will be handing you off to approach control shortly." Simply make your request to the next controller.

Remember though, you are preparing your student for single-pilot operations, and procedures must be modified accordingly. Simply instruct your student to contact approach control with the aircraft identification and altitude followed by the phrase, "Negative ATIS." Approach will then respond in one of two ways. ATC might say, "Current weather is..." And provide your student with the appropriate information, negating the need to check ATIS. Alternately he or she might only say which phonetic designator is current, and a request to change frequency to pick up the ATIS information must be made again.

Strange-field Let Downs

Professional pilots flying for the scheduled airlines avoid strange-field let downs for good reason. It is worth noting that the majority of accidents that happen during IFR operations (especially single-pilot IFR), occur during the approach phase at an airport the pilot has never flown into before. Seldom do these accidents happen during approaches at home. A possible explanation for this is that perhaps chart reference is kept to a minimum during the familiar approaches because the pilot has memorized the pertinent information. This means less time spent looking at the approach chart and more time the pilot can spend on controlling heading, altitude and airspeed. Conversely, the more time spent seeking data from the chart, the less time and concentration the pilot has to give to controlling the aircraft.

Advance planning includes teaching your student to avoid strange-field let downs. Handing your student an approach chart during a flight lesson and announcing, "Lets try this one," is unfair and unrealistic. It won't happen that way in the real world and shouldn't happen that way in training. Tell your student, at least a day before the lesson, which approaches will be flown during the lesson so he or she can study the charts ahead of time. Suggest pre-flying the approaches in an FTD or on a PCATD if one is available. The fact that this time cannot be logged is irrelevant. What is relevant is that the student is provided with an opportunity to prepare for the lesson. Preparation on the student's part will make the lesson a much more productive and positive learning experience.

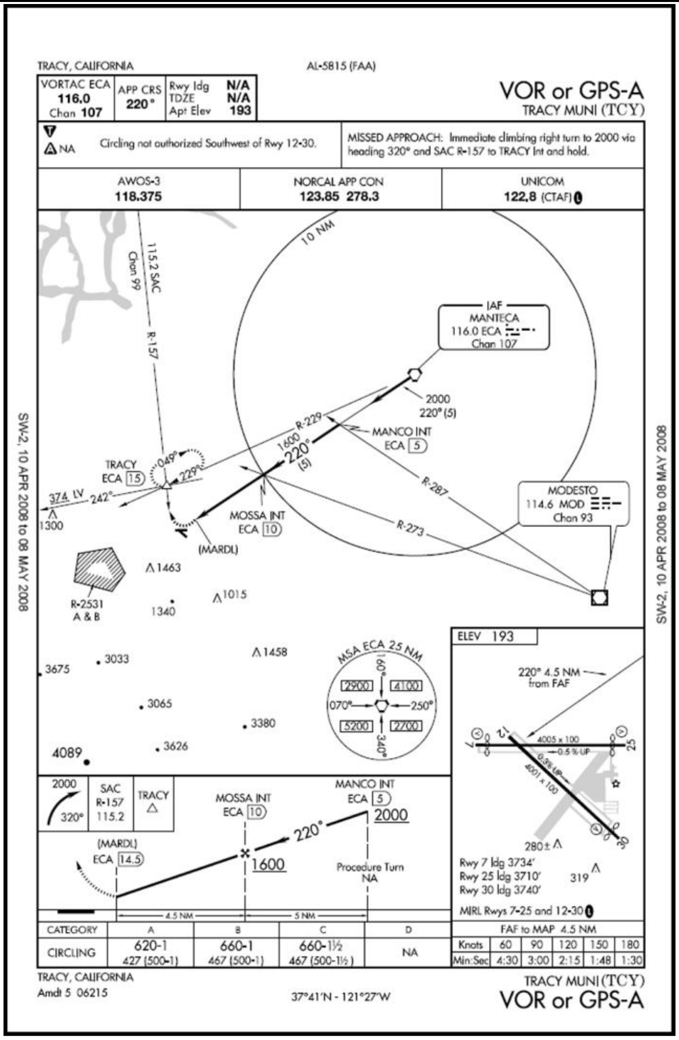
This concept is especially significant when preparing your student for a flight test. Any time spent practicing approaches not likely to be used during the check ride is time not used to the student's advantage. The more times a pilot flies the approaches likely to be used, the more likely he or she is to successfully execute those approaches for the examiner. Does this mean teaching the test? No, you are only trying to prepare the student to acceptably perform the instrument approaches most likely to be encountered on the practical test.

Pre-fly approaches in a Flight Training Device

Adding Notes to Your Charts

Advance planning includes noting anything unusual about the trip, including terminal areas. For example, the VOR approach into Tracy, California involves an unusually complex navigation radio setup if the aircraft is not DME equipped. Manteca VOR provides the course guidance but Modesto VOR makes up the two cross-bearings required during the approach. The missed approach requires the use of the Sacramento VOR 157 degree radial. Since Modesto is required to identify the final approach fix, Sacramento can not be tuned in until after commencing the final descent. Once Sacramento is finally tuned in, the pilot may be unable to identify the Morse code because of the low altitude and the distance from Sacramento. This means the pilot must identify Sacramento and make sure it is usable before tuning in Modesto and beginning the approach. In the unlikely event Sacramento is off the air, the pilot should discuss an alternative missed approach procedure with Stockton Approach Control before commencing the procedure.

Preflight planning might also include adding a note to the approach chart showing the reciprocal of 157 degrees since the procedure requires the pilot to fly the radial northwest bound to Tracy intersection. Although figuring reciprocals may be easy for you, a student will not likely find it a simple task, especially while flying the aircraft. Adding a note showing 019 degrees for the outbound heading of the teardrop entry into the missed approach hold will also help reduce your student's workload. Teach your students to add whatever notes may be helpful to their approach charts. After all, that is how approach charts came into being: Capt. Jeppesen kept a book of notes for himself showing what he considered to be "need-to-know" information for each of the airports he flew into.



VOR or GPS-A (TCY)

Chapter 3

Attitude Flying: Overview

Up to this point we have been discussing how to reduce the workload for single-pilot IFR operations by planning ahead. Now let's look at another area that is not often covered adequately. Whenever the instrument student has difficulty holding a heading within ten degrees or an altitude within 100 feet or an airspeed within ten knots, the instructor may conclude that the student is not scanning or cross-checking the instruments. But could it be that the student is in fact scanning, perhaps even the way the instructor taught it? Could the problem be with the scan itself? Often too little attention is paid to this skill. We all know how important scanning is but we may not know the best method to teach it.

The pilot must have an objective in mind. They may be looking at the appropriate instrument at the appropriate time, but if they do not know what to look for, then they will not know if they have accomplished what needs to be done.

In a simple fixed-gear training aircraft, there are five main flight configurations. If these are mastered, the student will need to spend less time on configuring the aircraft and thus have more time to attend to the flight instruments. The five configurations are: climb, level cruise, cruise descent, level approach, and approach descent.

Attitude Plus Power Equals Performance

By setting established attitudes and power settings for each configuration, the pilot can obtain the desired performance in each situation without chasing needles. The following table provides a sample of attitudes and power settings and the resulting performance for a typical training aircraft for each configuration.

The power required to accomplish a given performance on any given flight will be a function of density altitude and gross weight, but the numbers shown below represent a good starting point. Use this concept to work up a performance chart like the one below for the airplane you will be using for your lessons. Adjust the power settings and attitudes as necessary to achieve the performance values you wish to use.

	CLIMB	CRUISE LEVEL	CRUISE DESCENT	APPROACH LEVEL	APPROACH DESCENT
ATTITUDE	5° UP	LEVEL	1° DOWN	1° UP	LEVEL
POWER	FULL	2250 RPM	2000 RPM	2000 RPM	1700 RPM
VERT VELOC	+500 FPM +/-	0	-500 FPM	0	-500 FPM
AIRSPEED	85 KTS	100 KTS	100 KTS	85 KTS	85 KTS

Sample Performance Chart

Level Cruise Configuration

Choose a calm day and start with the cruise setting first. After leveling off from your initial climb, set the power setting you intend to use for cruise, maintain a constant altitude, trim the aircraft, adjust the attitude indicator to show the wings level, and note the indicated airspeed on your performance chart.

	CLIMB	CRUISE LEVEL	CRUISE DESCENT	APPROACH LEVEL	APPROACH DESCENT
ATTITUDE		LEVEL			
POWER		2300 RPM			
VERT VELOC		0			
AIRSPEED		?			

Level Cruise Setting

Cruise Descent Configuration

Next, determine an attitude and power setting that will maintain the indicated cruise airspeed but in a 500 fpm or cruise descent. Since the aircraft is already trimmed to maintain cruise airspeed, a gradual power reduction of 250 rpm will normally yield the appropriate pitch-down attitude to maintain the airspeed. Use elevator input as necessary to reduce pitch oscillations as lift, weight, thrust and drag seek equilibrium. For a constant speed propeller, use a gradual power reduction of five inches of manifold pressure. Once the cruise descent is stabilized, note and record the power setting and attitude (probably between one and two degrees pitch down and 250 rpm or five inches less than cruise level).

The rule of thumb is that a power change of approximately 250 rpm or five inches of manifold pressure will change the vertical velocity by 500 fpm if the airspeed is kept constant.

	CLIMB	CRUISE LEVEL	CRUISE DESCENT	APPROACH LEVEL	APPROACH DESCENT
ATTITUDE		LEVEL	?		
POWER		2300 RPM	**2050 RPM**		
VERT VELOC		0	**500 FPM**		
AIRSPEED		105	**105**		

Cruise Descent Setting

Level Approach Configuration

The level approach is the next configuration to work out. The adjustment here may be simply trading airspeed for vertical velocity. Try adjusting the pitch attitude to one degree nose-high while keeping power constant (however you will have to adjust the throttle slightly for the increased load on a fixed pitch propeller). The objective is to bring the vertical velocity to zero and end up with a usable approach speed. Once you determine the attitude and airspeed for this configuration add them to your chart.

	CLIMB	CRUISE LEVEL	CRUISE DESCENT	APPROACH LEVEL	APPROACH DESCENT
ATTITUDE		LEVEL	1.5° DOWN	?	
POWER		2300 RPM	2050 RPM	**2050 RPM**	
VERT VELOC		0	-500 FPM	**0**	
AIRSPEED		105	105	?	

Level Approach Setting

Approach Descent Configuration

Use the rule of thumb to come up with the following values for the approach descent:

	CLIMB	CRUISE LEVEL	CRUISE DESCENT	APPROACH LEVEL	APPROACH DESCENT
ATTITUDE		LEVEL	1.5° DOWN	1°UP	**LEVEL**
POWER		2300 RPM	2050 RPM	2050 RPM	**1800 RPM**
VERT VELOC		0	-500 FPM	0	**-500 FPM**
AIRSPEED		105	105	90	**90**

Approach Descent Setting

Climb Configuration

In the event of a missed approach, the climb configuration would follow the approach descent. The objective here is to use a climb speed equal to the approach speed so that retrimming is not necessary. However, you also want at least a 500 fpm rate of climb and may have to settle for a slightly slower airspeed. Start with a five-degree pitch-up attitude and adjust as necessary to achieve the proper performance.

	CLIMB	CRUISE LEVEL	CRUISE DESCENT	APPROACH LEVEL	APPROACH DESCENT
ATTITUDE	?	LEVEL	1.5° DOWN	1°UP	LEVEL
POWER	**FULL**	2300 RPM	2050 RPM	2050 RPM	1800 RPM
VERT VELOC	**+500 FPM**	0	-500 FPM	0	-500 FPM
AIRSPEED	?	105	105	90	90

Climb Setting

Teaching the Five Configurations

After you have established the five configurations, discuss them with your student during the preflight briefing. Then let your student practice the attitudes and power settings in flight without the hood so he or she can put these seemingly abstract calculations into a tangible experience.

For retractable gear aircraft, the level approach will have two configurations: gear up and gear down. Approach descent will always be with gear down to avoid landing with the gear in the wrong position.

A more complex version of this method was developed by the military for their flight training programs during World War II to accommodate the complexities of the fighters, bombers, freight haulers and troop

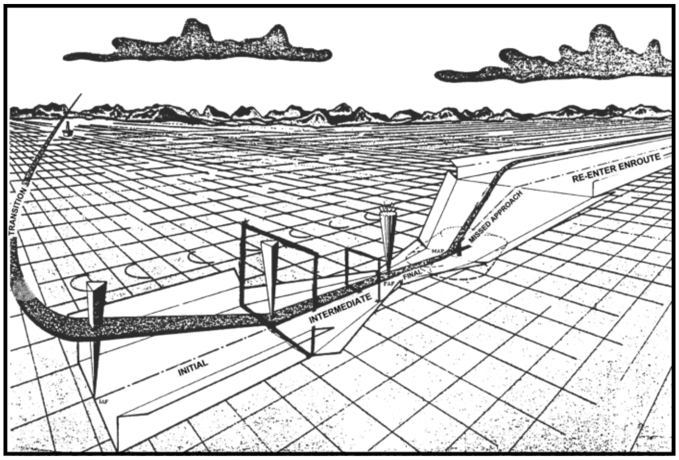
transports in use at the time. The essence of this system was contained in the phrase that simplified the heart of the computations, and it is known today as then: "Attitude plus power equals performance."
This method teaches the instrument student to set an attitude and power setting. By concentrating on the attitude indicator and holding it constant, the student will find that the performance indicators (airspeed and vertical velocity) will settle down very close to the desired values. Any discrepancies can be eliminated with minute adjustments to the attitude and/or the power setting. With this technique, the student will be able to fly the aircraft on instruments within practical test standards and without chasing needles.

Chapter 4

Preflight Planning: Overview

An IFR flight consists of three basic phases: departure, en route, and approach. The departure takes the aircraft from the departure airport, out of the terminal areas, and into the en route structure, consisting primarily of the airway system, through which we navigate to the approach corridor. This corridor leads us to the ultimate goal of every IFR flight--a normal, safe landing at our destination airport.

IFR flying begins with proper planning. We have to know how we are going to get to our destination, what conditions our aircraft is likely to encounter along the way, and what information and equipment we will need for our flight.



Approach Corridor

Weather Data

The Weather Briefing

While computerized weather data and briefs are commonplace, teach your students to augment their computer-based data with a weather briefing by phone. Train your student to ask very specific questions. What information should be requested? Use a form as a guide.

METARs

These reports are measurements made of the weather as it has occurred at a specific station and time. Be sure to check METARs for: the destination and departure airport to determine if it has weather good enough that a return could be accomplished should a malfunction occur on, or shortly after, takeoff; the alternate, if one is required, to determine if the weather is at, or above, alternate minimums; en route stations, because the weather there will influence the pilot's judgment if an emergency should occur while in flight.

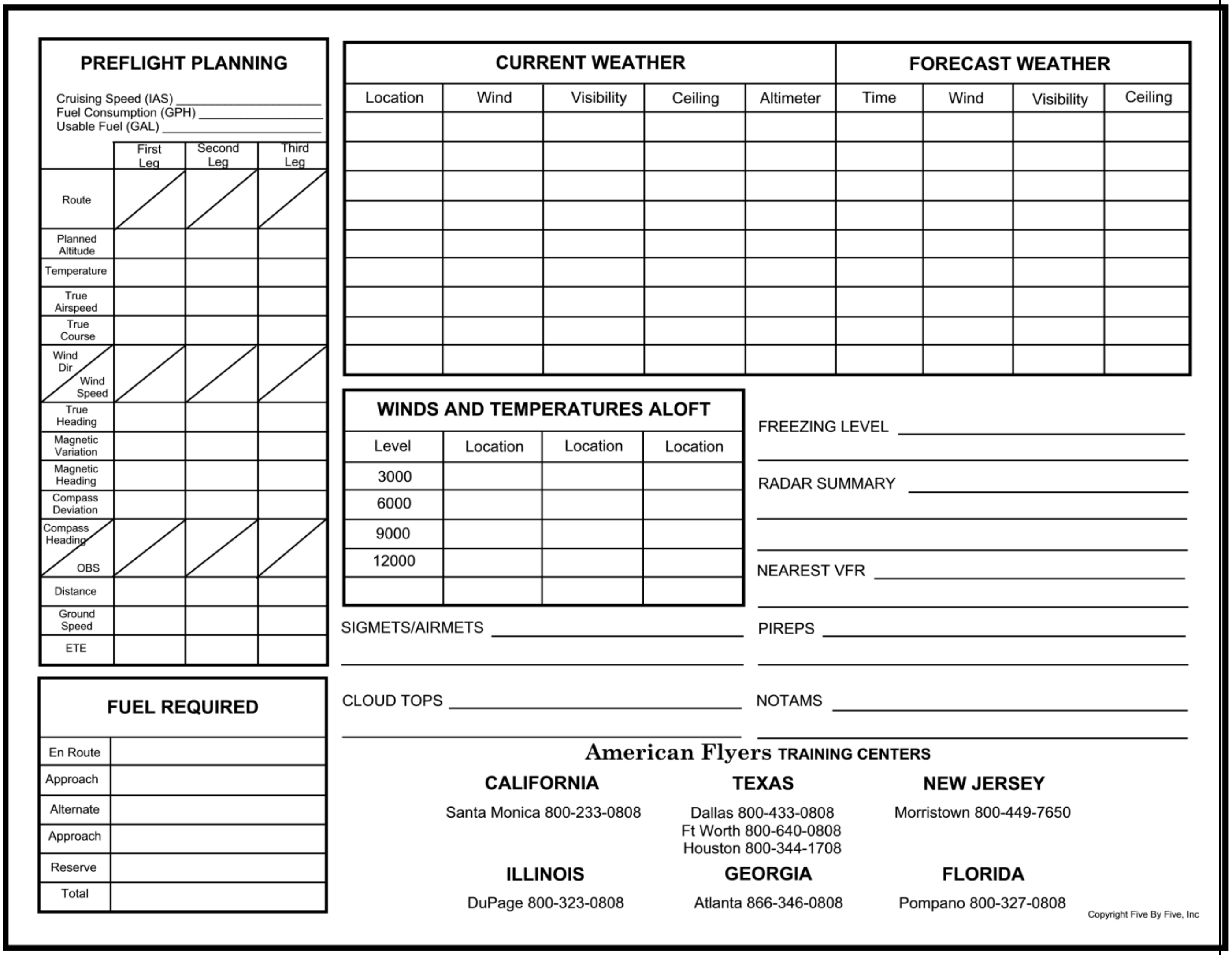
When the weather appears marginal, the METARs for the past two or three hours should be compared to determine the actual trend of the weather and to compare this to the forecasts. Do not hurry through this information. Get all the key items such as sky cover and ceiling, visibility, or RVR if listed, altimeter setting and surface winds. Should a communications failure occur, this may well be the last information upon which the selection of an approach is made.

TAFs

Get the Terminal Aerodrome Forecasts for the same stations. TAFs are not available for all stations, and area forecasts (FAs) may have to be used.

The destination forecast should be compared to the actual trend in the METARs and Pilot Reports (PIREP). The forecast for the departure airport is of interest because of the possibility of having to return. TAFs for en route stations are needed for possible emergencies and also for the possibility of their being used as an alternate.

FAs for the en route portion of the flight should be requested for an overall picture of the weather and also to answer an important question: Which way to the closest VFR weather? This is to determine the best escape route should a complete electrical failure occur.



PREFLIGHT PLANNING

Cruising Speed (IAS) ____________
Fuel Consumption (GPH) ____________
Usable Fuel (GAL) ____________

	First Leg	Second Leg	Third Leg
Route			
Planned Altitude			
Temperature			
True Airspeed			
True Course			
Wind Dir / Wind Speed			
True Heading			
Magnetic Variation			
Magnetic Heading			
Compass Deviation			
Compass Heading / OBS			
Distance			
Ground Speed			
ETE			

FUEL REQUIRED

En Route	
Approach	
Alternate	
Approach	
Reserve	
Total	

CURRENT WEATHER					FORECAST WEATHER			
Location	Wind	Visibility	Ceiling	Altimeter	Time	Wind	Visibility	Ceiling

WINDS AND TEMPERATURES ALOFT

Level	Location	Location	Location
3000			
6000			
9000			
12000			

FREEZING LEVEL ____________

RADAR SUMMARY ____________

NEAREST VFR ____________

SIGMETS/AIRMETS ____________

PIREPS ____________

CLOUD TOPS ____________

NOTAMS ____________

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CALIFORNIA
Santa Monica 800-233-0808

TEXAS
Dallas 800-433-0808
Ft Worth 800-640-0808
Houston 800-344-1708

NEW JERSEY
Morristown 800-449-7650

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Forecast Reliability

The accuracy of a forecast is limited by what is known and what can be measured. These result in a reliability factor. The reliability factor of weather forecasts is inversely proportional to the length of time that has passed since the forecast was issued.

Good weather forecasts are likely to be correct for up to twelve hours. A forecast for bad weather is not likely to be correct for the same period of time. Ceiling and visibility forecasts are not reliable beyond two or three hours. In other words, a twelve-hour forecast of good weather has a reliability factor of about 80 percent, whereas a twelve-hour forecast of bad weather is only about 45 percent reliable.

In cases where distinct weather systems are involved, such as fronts and precipitation, there is a tendency to forecast too little bad weather. Errors in forecasting the time of a specific weather occurrence are more prevalent than errors in forecasting the occurrence itself.

Some high-reliability forecasts that are usually about seventy-five percent accurate concern the passage of fast-moving cold fronts and are accurate within plus or minus two hours; the passage of slow-moving warm fronts, within plus or minus five hours. Rapidly lowering ceilings in pre-warm front conditions are accurate to within plus or minus two hundred feet and have a time accuracy of plus or minus four hours. In areas where radar is available, the forecast of thunderstorms is accurate to within one or two hours.

Some very low-reliability forecasts include the location of severe turbulence, the location and occurrence of heavy icing, the location and occurrence of tornadoes, ceilings of 100 feet or less, and the location of immature thunderstorms.

Icing and turbulence are by nature local and often transient occurrences. Since an aircraft is about the only instrument that can measure these phenomena, there is no other way to verify the forecasts. This fact lends more importance to the obtaining of pilot reports.

Icing and turbulence forecasts are made for a relatively large volume of airspace compared to their localized extent. The occurrence of these hazards can be forecast with between fifty to seventy-five percent accuracy, but the intensity and the exact location are less reliable. This means that when flying through a volume of air space for which these hazards have been forecast, the probability of an actual encounter is not fifty to seventy-five percent, but about five to fifteen percent. The regions of actual icing and turbulence are small compared to the overall volume specified in the forecast. Nevertheless, the possibility of the hazard exists, and good judgment must be used by the pilot.

Alternates

Referring to the information in the forecasts, the pilot can determine if an alternate airport needs to be designated on the flight plan. The regulations state that if the first airport of intended landing has a standard instrument approach procedure and for at least one hour before and one hour after the estimated time of arrival the weather reports or forecasts indicate the ceiling will be at least two thousand feet above the airport elevation and the visibility will be at least three statute miles, then an alternate airport need not be designated.

According to the latest FAA interpretation, *chance of* or *occasional* in a report constitute a valid forecast for a given event and must be considered when determining the need for an alternate. Note that if the first airport of intended landing does not have a standard instrument approach procedure, an alternate airport must be designated regardless of reported or forecast weather conditions.

Regulations state that the weather forecast for the alternate airport at the estimated time of arrival must indicate that the ceiling and visibility will be at or above the alternate minimums published in the standard instrument approach procedure for that airport. If no alternate minimums are published, a ceiling of at least six hundred feet and visibility of at least two statute miles must be present for a precision approach; for a non-precision approach, at least eight hundred feet and two miles. If the airport designated as the alternate has no instrument approach, the weather forecast must indicate that descent from MEA and landing can be accomplished under basic VFR.

Remember this is only for flight planning purposes. When en route to the alternate the actual published minimums for the approach apply.

Radar Summary and Pilot Reports

No preflight planning is complete without the Radar Summary and Pilot Reports. As previously mentioned, an aircraft is the only tool available to measure certain weather phenomena. PIREPs are the most reliable source of information on cloud tops, icing, thunderstorms, and turbulence. Once airborne, the pilot can get up-to-date pilot reports and contribute to the information available to other pilots on frequency 122.0 MHz, the En route Weather Advisory Service.

The Route Log

Only with a complete weather briefing can a pilot can make the go or no-go decision. If the decision is to go, a route log should be prepared in order to compute en route times and other information required for the flight plan. The type and complexity of the route log will vary with the pilot's proficiency and the type of equipment. Its use will reduce chart reference--a must for single-pilot IFR. It will provide the information needed to make required reports and it will furnish the data necessary should a communications failure occur.

Here's a tip for filling out the ground speed estimate on your flight log. Please refer to the second Figure below. On any given course, if the wind is on the nose of the aircraft, the full value of the wind is subtracted from the true airspeed.

For example, if the true airspeed is one hundred knots and we have a twenty knot headwind, the groundspeed will be eighty knots. If a quartering headwind, one-half the value of the wind is subtracted. If it is a direct crosswind, one-fourth of the value of the wind is subtracted. For a quartering tail wind, one-half the value of the wind is added to the true airspeed. When using this method to calculate groundspeed during an approach, a direct crosswind can be disregarded because of the short distances involved.

AMERICAN FLYERS

TACH IN ______________
TACH OUT ______________
TOTAL ______________

HOBBS IN ____________
HOBBS OUT ____________
TOTAL ____________

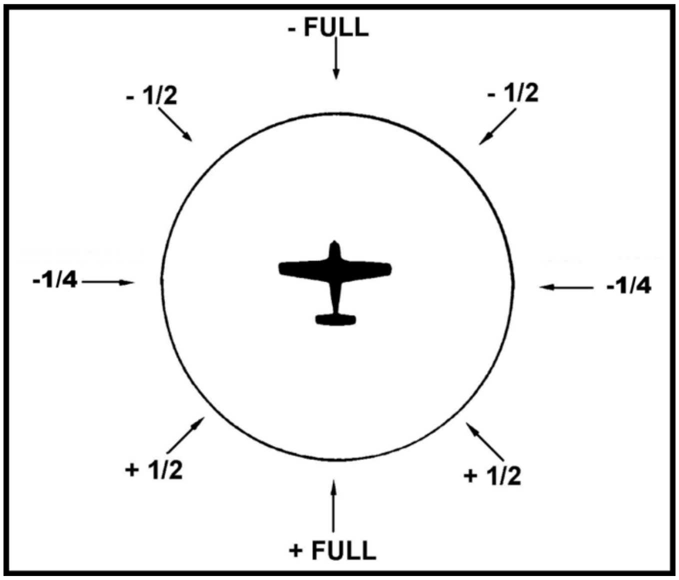
CHECK POINT	NAV FREQ	MAG CRS/HDG	LEG DIST	TIME			GROUND SPEED	COMMUNICATION FREQUENCIES				
				ETE	ETA	ATA		FSS/CTR	APP	TWR	GRD	ATIS
DEPT:												
											DEPARTURE	
											ARRIVAL	
DEST												
		TOTAL										

1. Copy ATIS
2. Set Gyros & Altimeter
3. VOR Test
4. ADF Test
5. Request Clearance
6. Set Up Nav Radios
7. Transponder Test & Set
8. Request Taxi
9. Systems Check
10. Departure Procedures
11. Transponder to ALT
12. Note Time Off _______

CLEARANCE:

1. TYPE	2. A/C REG NUMBER	3. A/C TYPE SPECIAL EQUIPMENT	4. TRUE AIRSPEED	5. DEPARTURE POINT	6. DEPARTURE TIME	7. CRUISE ALT
8. ROUTE OF FLIGHT						
9. DESTINATION	10. ESTIMATED TIME ENROUTE: HOURS	MINUTES	11. REMARKS			
12. FUEL ON BOARD	13. ALTERNATE AIRPORT	14. PILOTS NAME, ADDRESS, TELEPHONE & A/C HOME BASE				15. NUMBER ABOARD
16. COLOR OF A/C	17. DESTINATION CONTACT & TELEPHONE (OPTIONAL)					

Route Log



Ground Speed Made Easy

The Flight Plan

The FAA Flight Plan should be filed at least thirty minutes prior to the estimated time of departure. If the departure is delayed for longer than one hour, the pilot should notify ATC. Most of the boxes on the flight plan are self-explanatory. The pilot should make sure to use the proper suffix in box three so that ATC has the information needed to use all the features of the navigation equipment and transponder capabilities available on the aircraft. These suffixes are listed in the AIM. Box ten, the estimated time en route, should be the time the pilot estimates it will take to fly from the departure airport to the destination airport.

All flight plans are filed through a Flight Service Station. To minimize delay the IFR clearance should be obtained prior to departure. An IFR-to-VFR on top, a pop-up, or a tower en route clearance can be obtained directly from ATC without going through the normal filing procedure.

A flight plan requesting clearance to VFR conditions on top should be filed following normal procedures. In block nine of the flight plan form, indicate the destination as *VFR-on-top*. This would be appropriate when there is a low overcast at the departure airport with the cloud tops at three thousand feet and clear above to the destination. A clearance in this case might read, *Cleared to VFR conditions on top via Direct Joliet VOR; if not on top by five thousand, maintain five thousand and advise.* When in the clear on top, the pilot cancels IFR and proceeds to their destination VFR. Never accept this kind of clearance without the phrase, *if not on top by ... maintain ... and advise.*

Be certain that the pilot report, or other information used to determine the height of cloud tops, is accurate. In our example, if the flight was not on top at five thousand, a holding clearance to absorb a thirty minute delay while additional flight plan information is processed would not be uncommon.

The "pop-up," or obtaining an IFR clearance from an ATC facility without having previously filed, is useful if you suspect that a VFR destination airport's weather may turn to IFR. The best procedure to follow is to file an IFR flight plan prior to departure, or if already en route, file with flight service by radio at least thirty minutes prior to the time you will need an IFR clearance. In this case the departure point will be the fix over which you plan to pick up your IFR. At certain high-density facilities during peak traffic times, controllers may be unable to accommodate these pick-up requests, so it is best to check this with flight service prior to departure.

At some locations, tower en route clearances can be obtained without a flight plan simply by requesting clearance directly from ground control at the departure airport. Tower en route describes a flight that proceeds from one approach control facility to another without entering airspace which is the responsibility of an en route center. Listings of these routes, along with the maximum altitudes, are available in the airport/facility directory or Jeppesen supplement. Due to workload or locally established procedures, ATC may be unable to honor tower en route requests without a flight plan. Again, the best procedure is to file with flight service at least thirty minutes before departure.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
FLIGHT PLAN

(FAA USE ONLY) ☐ PILOT BRIEFING ☐ VNR ☐ STOPOVER | TIME STARTED | SPECIALIST INITIALS

1. TYPE: VFR / IFR / DVFR
2. AIRCRAFT IDENTIFICATION
3. AIRCRAFT TYPE/ SPECIAL EQUIPMENT
4. TRUE AIRSPEED KTS
5. DEPARTURE POINT
6. DEPARTURE TIME: PROPOSED (Z) / ACTUAL (Z)
7. CRUISING ALTITUDE
8. ROUTE OF FLIGHT
9. DESTINATION (Name of airport and city)
10. EST. TIME ENROUTE: HOURS / MINUTES
11. REMARKS
12. FUEL ON BOARD: HOURS / MINUTES
13. ALTERNATE AIRPORT(S)
14. PILOT'S NAME, ADDRESS & TELEPHONE NUMBER & AIRCRAFT HOME BASE
15. NUMBER ABOARD
16. COLOR OF AIRCRAFT
17. DESTINATION CONTACT/TELEPHONE (OPTIONAL)

CIVIL AIRCRAFT PILOTS, FAR 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

Flight Plan

The Airplane

To complete our flight planning, we need to know that the airplane is legal to fly and calculate how it will perform.

How much usable fuel is available and what is the consumption rate? Remember to enter the total amount of usable fuel on board the airplane in terms of time. For IFR flights the minimum amount of fuel that must be aboard must be enough to fly to the first airport of intended landing, then to the listed alternate airport, and then for 45 minutes at normal cruising speed. If your flight will not require an alternate airport, you must have enough fuel to fly to the destination airport and then for 45 minutes at normal cruising speed.

What will the true airspeed be at your selected altitude?

Check weight and balance before every flight. The effects of improper loading can be disastrous, particularly when you're IFR.

There are several other things we need to check to determine if our aircraft is legal for the flight. Does it have the necessary documents aboard? Below is an easy-to-remember checklist that outlines the documents that must be aboard an airplane: The Airworthiness certificate, the federal Registration certificate, the Radio license, the Operating limitations, a current Weight and balance, and the Equipment list.

If used under IFR, the aircraft must have certain additional inspections completed. It should have a maintenance inspection appropriate to the type of operation, a VOR accuracy check within the preceding thirty days, and a static system and altimeter check within the preceding 24 calendar months.

Also, for IFR or VFR, the emergency locator transmitter battery must be within certain time parameters.

Documents

ARROWE

- Airworthiness certificate.
- Registration certificate.
- Radio station license (International flight only).
- Operating limitations.
- Weight and balance data.
- Equipment list.

The following maintenance checks must be documented in the aircraft's log:

- VOR accuracy check within the last 30 days.
- Static system and altimeter tests within the last 24 months.
- Transponder test within the last 24 months.

The Pilot

When it has been determined that the aircraft is legal and ready, a check on the pilot-in-command is in order. While 14 CFR does not require the logging of all flight time, the pilot must meet certain currency requirements. These requirements are cumulative and are the minimum times that must be logged.

For daytime currency, in order to act as pilot-in-command carrying passengers, the pilot must have made three takeoffs and landings within the preceding ninety days. Note that if this requirement is not met, the pilot can solo the airplane to perform the three takeoffs and landings, log them, and then legally carry passengers. This requirement must be met in the category and class of aircraft being used. Meeting this requirement in a twin-engine airplane doesn't meet the requirements if a single engine airplane is being used. If the airplane is a tail-wheel, the landings must be made to a full stop in a tail-wheel airplane.

For nighttime currency, in order to act as a pilot-in-command carrying passengers, three takeoffs and landings to a full stop within the preceding ninety days, at night, are required. These also must be in the category and class of aircraft being used. A pilot meeting the night currency requirement is also day-current.

In order to act as pilot-in-command of an aircraft operating under instrument flight rules, the pilot must have performed and logged under actual or simulated instrument conditions, either in flight in the appropriate category of aircraft for the instrument privileges sought or in an approved flight simulator or flight training device that is representative of the aircraft category for the instrument privileges sought, at least six instrument approaches, holding procedures, and intercepting and tracking courses through the use of navigation systems.

If this experience is accomplished in an approved flight simulator or flight training device, the experience must be certified by an authorized instructor. The experience may also be attained under the hood with an appropriately rated safety pilot. The date, airport and type of approach must be recorded, and if done with a safety pilot while under the hood, the name of the safety pilot should be recorded.

If a pilot should find that instrument currency has lapsed, they can make themselves current again by acquiring the needed experience and approaches in any of the approved methods. However, should a pilot go for period of an additional six consecutive months without being current, that pilot cannot use his or her instrument rating without an Instrument Proficiency Check. This check can be conducted by any valid instrument flight instructor and must include tasks so indicated in the appropriate PTS. Completing a proficiency check makes the pilot instrument current for six months. The instrument proficiency check should not be looked upon as that which must be avoided at all costs. It is a short, economical way for a pilot to ensure their currency for six months. In most cases a proficiency check takes less time and less work than does the acquisition of six approaches.

In order to act as pilot-in-command on any flight, the pilot must have completed a Flight Review or equivalent within the preceding 24 calendar months.

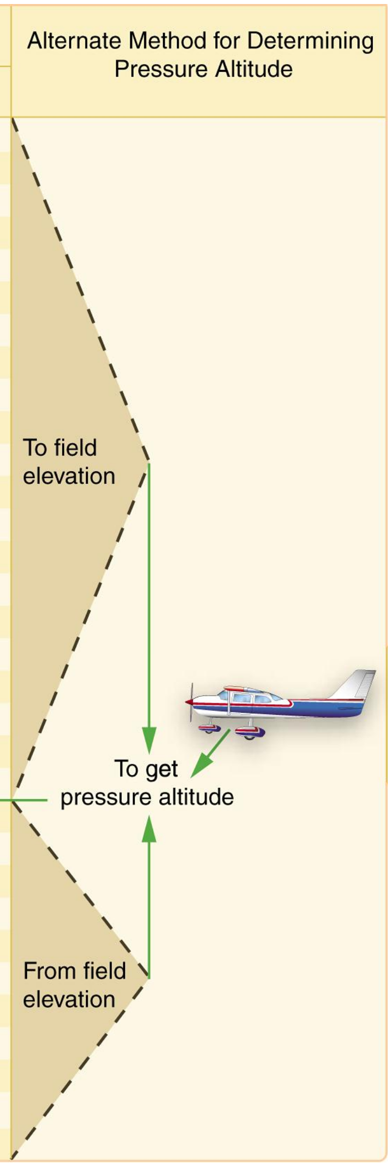
Now that preflight planning is complete and the airplane and pilot are legal, there is still a very important item to be checked. Every pilot knows the importance of having up-to-date approach charts, but that cannot be ensured unless the FDC NOTAMS are checked. FDC stands for Flight Data Center, these NOTAMS deal with procedure changes on instrument approaches. Changes such as the raising or lowering of an MDA or an altitude for a segment of an approach will appear in these NOTAMS until the approach chart can be revised.

Chapter 5

Preflight Instrument Checks

With all the required documents aboard and all of the inspections completed and logged, that airplane still may not be ready for instrument flight. Instruments must be checked for accuracy and normal operation. The altimeter must be set to the current atmospheric pressure and the indicated altitude must be within 75 feet of the field elevation in order to be considered safe for use in IFR operations. Check the airspeed indicator for normal readings while parked and while taxiing. Check the turn needle and ball during taxiing turns for normal readings; make sure the heading indicator is reading properly. The attitude indicator should settle down within a few minutes after engine start. Up to five degrees of bank indication due to precession during taxi turns is considered normal.

Method for Determining Pressure Altitude	
Altimeter setting	Altitude correction
28.0	1,825
28.1	1,725
28.2	1,630
28.3	1,535
28.4	1,435
28.5	1,340
28.6	1,245
28.7	1,150
28.8	1,050
28.9	955
29.0	865
29.1	770
29.2	675
29.3	580
29.4	485
29.5	390
29.6	300
29.7	205
29.8	110
29.9	20
29.92	0
30.0	–75
30.1	–165
30.2	–255
30.3	–350
30.4	–440
30.5	–530
30.6	–620
30.7	–710
30.8	–805
30.9	–895
31.0	–965



Field Elevation Versus Pressure

IFR Clearance

All instrument clearances come in four parts: the Clearance Limit, the En route routing, the Altitude, and Remarks (CLEAR).

Some ATC facilities will issue an abbreviated IFR departure clearance. These may contain a departure procedure (DP), whether or not one was requested on the flight plan. A DP will be issued any time ATC deems it appropriate. Preferred IFR routes beginning with a fix indicate that departing aircraft will normally be routed to that fix via a DP or radar vectors.

If a STAR has been filed in the flight plan, it is considered part of the flight plan route and isn't normally stated in the departure clearance. *Cleared as Filed* doesn't necessarily include the altitude requested in the flight plan. An en route altitude should be stated in the clearance. For example: *Cessna 201 cleared to Peoria as filed. Canal Two departure, expect four thousand.*

Sometimes the flight will be cleared to a clearance limit short of the destination. In most cases this is due to airspace jurisdiction. At the time of issuance there is no intention of holding the flight at that point. Instead, it is the responsibility of the controller to issue further clearance prior to the time the flight reaches the fix.

However, if due to frequency congestion further clearance hasn't been received, the pilot is expected to slow to holding pattern airspeed, and upon reaching the clearance limit, enter the published holding pattern. If no holding pattern is depicted, the hold should be accomplished on the route on which the fix was reached. This is not to be confused with the action taken by the pilot if this should occur with a two-way radio communication failure.

Departure Procedures

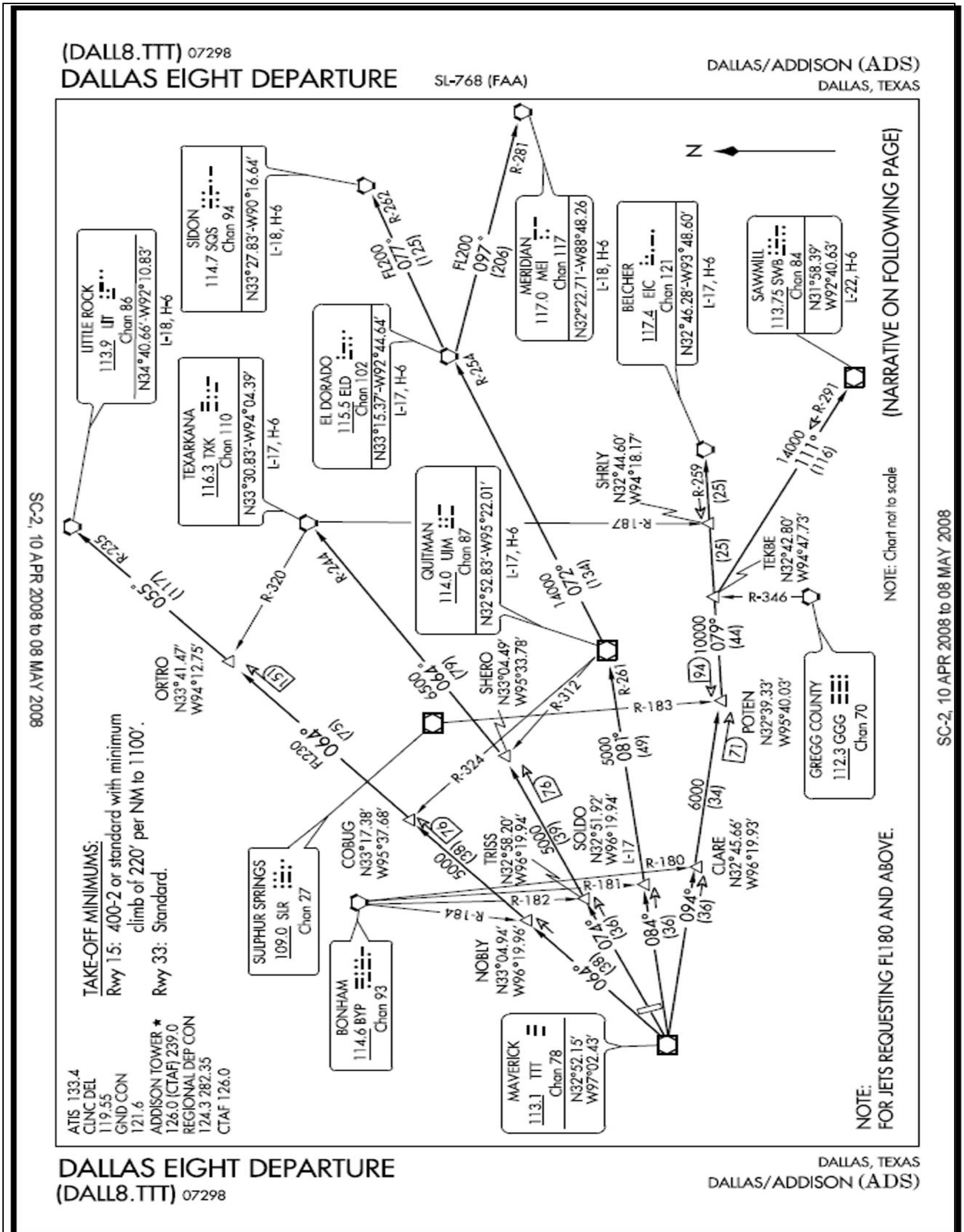
A Departure Procedure (DP) is a coded ATC departure procedure and may be issued by ATC without a pilot's request. The use of DPs simplifies clearance delivery. In order to accept a DP, you must have either the textual or graphic description. NOS publishes DPs and STARS in the approach chart books.

The departure procedure describes the route to fly from take-off to the departure fix. There may be one or more transitions from the departure fix to en route fixes. To specify a DP in your flight plan, list the DP identifier for the appropriate departure and transition. If you don't have the DP charts, specify "No DPs" in the remarks section of your flight plan.

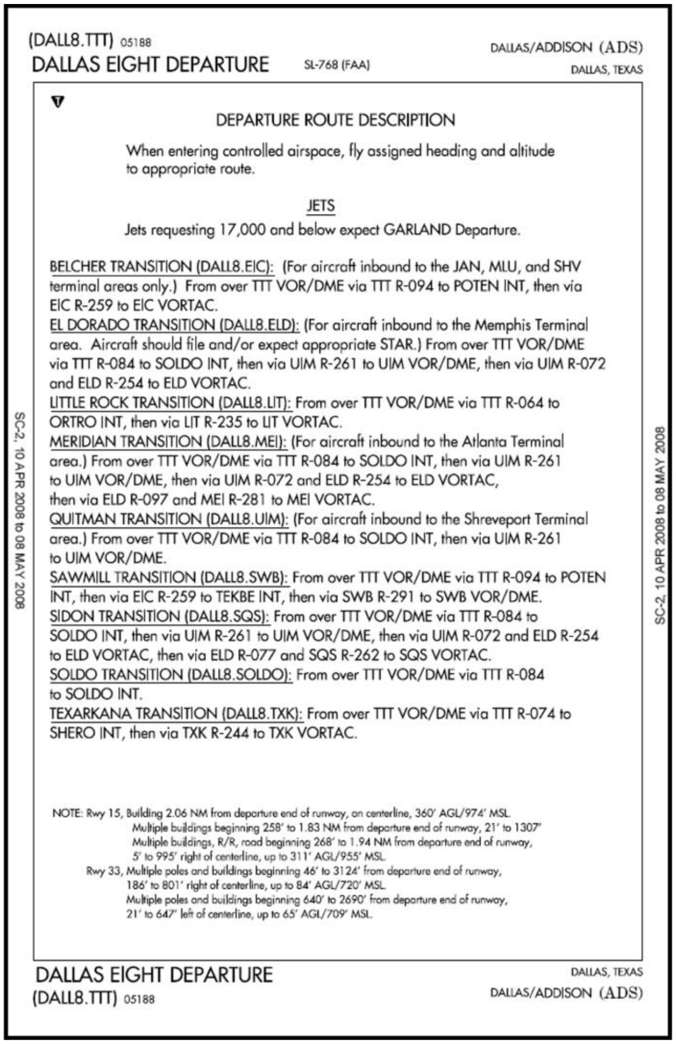
The main purpose of a DP is to simplify clearance delivery. As mentioned before, a DP will be issued to a pilot any time ATC deems it appropriate. If the pilot has used the remarks section of the flight plan to indicate no DPs or STARs, the only effect it will have is to tell the controller that any DPs will have to be issued in narrative form. A DP shows a visual and narrative description of both parts of the procedure: the departure and the transition. Once a pilot has been cleared to use a departure procedure, the printed procedure is mandatory until ATC clears the pilot to deviate.

Some DPs have minimum crossing altitudes and minimum en route altitudes for various legs. Before accepting a DP, the pilot should make sure that the aircraft has the capability to comply with these altitudes. A minimum climb performance of 152 feet per mile is required after crossing the fix until reaching the MEA or assigned altitude.

The DP charts are simple and should be used in conjunction with the area and en route charts; the symbols used are very similar. Notice that the departure frequencies are conveniently posted, as is the narrative description of the procedure. The plan view not only depicts the departure routing, but also the key airways and fixes that facilitate the transition into the en route structure.



Dallas Eight Departure (ADS)


(DALL8.TTT) 05188
DALLAS EIGHT DEPARTURE SL-768 (FAA)
DALLAS/ADDISON (ADS)
DALLAS, TEXAS

DEPARTURE ROUTE DESCRIPTION

When entering controlled airspace, fly assigned heading and altitude to appropriate route.

JETS

Jets requesting 17,000 and below expect GARLAND Departure.

BELCHER TRANSITION (DALL8.EIC): (For aircraft inbound to the JAN, MLU, and SHV terminal areas only.) From over TTT VOR/DME via TTT R-094 to POTEN INT, then via EIC R-259 to EIC VORTAC.
EL DORADO TRANSITION (DALL8.ELD): (For aircraft inbound to the Memphis Terminal area. Aircraft should file and/or expect appropriate STAR.) From over TTT VOR/DME via TTT R-084 to SOLDO INT, then via UIM R-261 to UIM VOR/DME, then via UIM R-072 and ELD R-254 to ELD VORTAC.
LITTLE ROCK TRANSITION (DALL8.LIT): From over TTT VOR/DME via TTT R-064 to ORTRO INT, then via LIT R-235 to LIT VORTAC.
MERIDIAN TRANSITION (DALL8.MEI): (For aircraft inbound to the Atlanta Terminal area.) From over TTT VOR/DME via TTT R-084 to SOLDO INT, then via UIM R-261 to UIM VOR/DME, then via UIM R-072 and ELD R-254 to ELD VORTAC, then via ELD R-097 and MEI R-281 to MEI VORTAC.
QUITMAN TRANSITION (DALL8.UIM): (For aircraft inbound to the Shreveport Terminal area.) From over TTT VOR/DME via TTT R-084 to SOLDO INT, then via UIM R-261 to UIM VOR/DME.
SAWMILL TRANSITION (DALL8.SWB): From over TTT VOR/DME via TTT R-094 to POTEN INT, then via EIC R-259 to TEKBE INT, then via SWB R-291 to SWB VOR/DME.
SIDON TRANSITION (DALL8.SQS): From over TTT VOR/DME via TTT R-084 to SOLDO INT, then via UIM R-261 to UIM VOR/DME, then via UIM R-072 and ELD R-254 to ELD VORTAC, then via ELD R-077 and SQS R-262 to SQS VORTAC.
SOLDO TRANSITION (DALL8.SOLDO): From over TTT VOR/DME via TTT R-084 to SOLDO INT.
TEXARKANA TRANSITION (DALL8.TXK): From over TTT VOR/DME via TTT R-074 to SHERO INT, then via TXK R-244 to TXK VORTAC.

NOTE: Rwy 15, Building 2.06 NM from departure end of runway, on centerline, 360' AGL/974' MSL.
Multiple buildings beginning 258' to 1.83 NM from departure end of runway, 21' to 1307'
Multiple buildings, R/R, road beginning 268' to 1.94 NM from departure end of runway, 5' to 995' right of centerline, up to 311' AGL/955' MSL.
Rwy 33, Multiple poles and buildings beginning 46' to 3124' from departure end of runway, 186' to 801' right of centerline, up to 84' AGL/720' MSL.
Multiple poles and buildings beginning 640' to 2690' from departure end of runway, 21' to 647' left of centerline, up to 65' AGL/709' MSL.

SC-2, 10 APR 2008 to 08 MAY 2008

DALLAS EIGHT DEPARTURE
(DALL8.TTT) 05188
DALLAS, TEXAS
DALLAS/ADDISON (ADS)

Dallas Eight Departure Description

Non-standard Departure Procedures

When making an IFR departure, it is very important that the pilot have the approach charts for the airport of departure readily available, not just for the airport diagram or communication frequencies, but for another very important reason: non-standard departure procedures.

Whenever the surrounding terrain or the availability of airport facilities dictate takeoff minimums or departure procedures other than standard, the NOS charts show the symbol "T" contained within a solid blue triangle. These procedures are described in a supplementary listing that accompanies the chart subscription. A pilot has to determine before departure whether obstacles can be avoided visually or if the published procedure should be followed.

Referring to the TAKE-OFF MINIMUMS/DEPARTURE PROCEDURES excerpt below, it can be seen that Bar Harbor, Maine is a typical example. When departing on runway 17, the pilot must perform a climbing right turn via a heading of 220 degrees to 2100 feet before proceeding on course. Departing on runway 22, climb via heading 224 degrees to 1100 feet before proceeding east or southeast. Departing on runway 35, climb via heading 349 degrees to 600 before proceeding on course.

At airports where departure procedures are standard, there is a good rule of thumb to follow with regard to how high to climb after takeoff before making any turns. The circle to land MDA for any runway will provide at least 300 feet of obstacle clearance for a distance of 1.3 miles from the end of the specified runway. If the pilot climbs to this altitude before proceeding on course, he or she should have adequate obstacle clearance within 1.3 miles of the runway. However, the pilot is always responsible to verify there are no obstructions along the expected flight path before becoming established on a published airway.

When departing an airport where there is no published approach, and hence no departure procedures, the pilot must determine what action will be necessary to ensure a safe departure. The FAA has prescribed Standard IFR Takeoff Minimums for commercial carriers, these are: one statue mile of visibility for aircraft having two engines or less, and one-half statute mile for aircraft having more than two engines. While these minima do not apply to non-commercial flights operating under 14 CFR part 91 however, safe practice would dictate their use.

When departing an airport without an operating control tower, ATC may assign a clearance which contains a provision for the clearance to be void if not airborne by a specific time. A pilot who does not depart prior to this clearance void time must advise ATC as soon as possible of their intentions. ATC will normally advise the pilot of the time allotted to notify ATC that the aircraft did not depart prior to the clearance void time. This time cannot exceed 30 minutes. Failure of an aircraft to contact ATC within 30 minutes after the clearance void time will result in the aircraft being considered overdue and search and rescue procedures initiated.

AUBURN-LEWISTON MUNI(CONT.)

72'AGL/312' MSL. Tree 1146' from departure end of runway, 378' left of centerline, 77' AGL/317' MSL. Tree 1520' from departure end of runway, 170' right of centerline, 62' AGL/302' MSL.

AUGUSTA, ME

AUGUSTA STATE

TAKE-OFF MINIMUMS: **Rwys 8, 35,** 300-1. **Rwy 26,** 400-1 or std. with a min. climb of 250' per NM to 700.

BANGOR, ME

BANGOR INTL (BGR)

AMDT 1 08101 (FAA)

NOTE: **Rwy 15,** trees beginning 1694' from departure end of runway, 629' left of centerline, up to 80' AGL/289' MSL. **Rwy 33,** trees beginning 1071' from departure end of runway, 759' right of centerline, up to 80' AGL/259' MSL.

BAR HARBOR, ME

HANCOCK COUNTY-BAR HARBOR

DEPARTURE PROCEDURE: **Rwy 17,** climbing right turn via heading 220° to 2100 before proceeding on course. **Rwy 22,** climb via heading 224° to 1100 before proceeding east or southeast bound. **Rwy 35,** climb via heading 349° to 600 before proceeding on course.

NOTE: **Rwy 4,** road 324' from departure end of runway, 524' left of centerline, 15' AGL/79' MSL. Multiple trees beginning 119' from departure end of runway, 231' right of centerline, up to 60' AGL/193' MSL. **Rwy 17,** bush 116' from departure end of runway, 164' left of centerline, 10' AGL/47' MSL. Tree 245' from departure end of runway, 346' right of centerline, 44' AGL/82' MSL. **Rwy 22,** multiple poles and trees beginning 562' from departure end of runway, 329' left of centerline, up to 60' AGL/135' MSL. Terrain, multiple poles and trees beginning 450' left of departure end of runway, up to 60' AGL/142' MSL. **Rwy 35,** terrain and multiple trees beginning 35' from departure end of runway, 340' left of centerline, up to 60' AGL/217' MSL. Glideslope antenna and multiple trees beginning 657' from departure end of runway, 565' right of centerline up to 60' AGL/146' MSL.

BARRE-MONTPELIER, VT

EDWARD F. KNAPP STATE

TAKE-OFF MINIMUMS: **Rwy 17,** 400-1. **Rwy 23,** 500-2 or std. with a min. climb of 400' per NM to 2600 .

DEPARTURE PROCEDURE: **Rwy 5,** climb runway heading to 2100, then climbing right turn to 3900 direct MPV VOR/DME. **Rwy 17,** climb direct to MPV VOR/DME, climb in holding pattern (N, right turns, 160° inbound) to 3500 before proceeding on course. **Rwy 23,** climbing left turn to 3500 direct MPV VOR/DME. **Rwy 35,** climb runway heading to 1600, then climbing right turn to 3900 direct MPV VOR/DME.

BEDFORD, MA

LAURENCE G. HANSCOM FIELD

TAKE-OFF MINIMUMS: **Rwy 23,** 300-1½ or std. w/ min. climb of 420' per NM to 500.

NOTE: **Rwy 5,** multiple trees 246' from departure end of runway, 114' right of centerline, 90' AGL/217' MSL. Multiple trees 45' from departure end of runway, 11' left of centerline, 87' AGL/214' MSL. Light on pole 575' from departure end of runway, 405' right of centerline, 55' AGL/182' MSL. Pole 835' from departure end of runway, 364' right of centerline, 50' AGL/177' MSL. Light on pole 868' from departure end of runway, 348' right of centerline, 50' AGL/177' MSL. Terrain 535' from departure end of runway, 536' left of centerline, 165' MSL. Terrain 157' from departure end of runway, 532' left of centerline, 145' MSL. Bush 171' from departure end of runway, 309' left of centerline, 13' AGL/140' MSL. Light on pole 1912' from departure end of runway, 505' right of centerline, 59' AGL/177' MSL. Fence 153' from departure end of runway, 249' right of centerline, 5' AGL/132' MSL. **Rwy 11,** tree 2695' from departure end of runway, 925' left of centerline, 65' AGL/192' MSL. **Rwy 23,** numerous trees 918' from departure end of runway, 647' right of centerline, up to 81' AGL/228' MSL. Numerous trees 1081' from departure end of runway, 378' left of centerline, up to 80' AGL/286' MSL. Tree 4587' from departure end of runway, 127' right of centerline, 100' AGL/306' MSL. Multiple trees 6358' from departure end of runway, 1046' right of centerline, 80' AGL/385' MSL. Multiple trees 6378' from departure end of runway, 205' left of centerline, 40' AGL/315' MSL. Multiple trees 8764' from departure end of runway, 977' left of centerline, 65' AGL/379' MSL. **Rwy 29,** numerous trees 2676' from departure end of runway, 229' right of centerline, 196' AGL/246' MSL. Numerous trees 388' from departure end of runway, 324' left of centerline, 67' AGL/273' MSL. Light on pole 1107' from departure end of runway, 734' left of centerline, 37' AGL/253' MSL.

BELFAST, ME

BELFAST MUNI

TAKE-OFF MINIMUMS: **Rwy 33,** 300-1¾ or std. with a min. climb of 219' per NM to 600.

DEPARTURE PROCEDURE: **Rwy 15,** climb heading 136° to 900 before turning south.

NOTE: **Rwy 33,** light pole 1955' from departure end of runway, 510' left of centerline, 100' AGL/297' MSL. Multiple trees beginning 1.4 NM from departure end of runway, 1682' left of centerline, up to 80' AGL/429' MSL.

BENNINGTON, VT

WILLIAM H. MORSE STATE

TAKE-OFF MINIMUMS: **Rwy 13,** 2200-3, restricted to CAT A and B only, CAT C NA. **Rwy 31,** 500-2 or std. with a min. climb of 240' per NM to 1400.

DEPARTURE PROCEDURE: **Rwy 13,** climbing left turn direct to CAM VORTAC, continue climb in hold to 3500 before proceeding on course. **Rwy 31,** climbing right turn direct CAM VORTAC continue climb in hold to 3500 before proceeding on course.

Take-off Minimums/Departure Procedures (BHB)

BAR HARBOR, ME

HANCOCK COUNTY-BAR HARBOR

DEPARTURE PROCEDURE: **Rwy 17**, climbing right turn via heading 220° to 2100 before proceeding on course. **Rwy 22**, climb via heading 224° to 1100 before proceeding east or southeast bound. **Rwy 35**, climb via heading 349° to 600 before proceeding on course.

NOTE: **Rwy 4**, road 324' from departure end of runway, 524' left of centerline, 15' AGL/79' MSL. Multiple trees beginning 119' from departure end of runway, 231' right of centerline, up to 60' AGL/193' MSL. **Rwy 17**, bush 116' from departure end of runway, 164' left of centerline, 10' AGL/47' MSL. Tree 245' from departure end of runway, 346' right of centerline, 44' AGL/82' MSL. **Rwy 22**, multiple poles and trees beginning 562' from departure end of runway, 329' left of centerline, up to 60' AGL/135' MSL. Terrain, multiple poles and trees beginning 450' left of departure end of runway, up to 60' AGL/142' MSL. **Rwy 35**, terrain and multiple trees beginning 35' from departure end of runway, 340' left of centerline, up to 60' AGL/217' MSL. Glideslope antenna and multiple trees beginning 657' from departure end of runway, 565' right of centerline up to 60' AGL/146' MSL.

Departure Procedure (BHB)

ILS or LOC RWY 22

BAR HARBOR / HANCOCK COUNTY-BAR HARBOR (BHB)

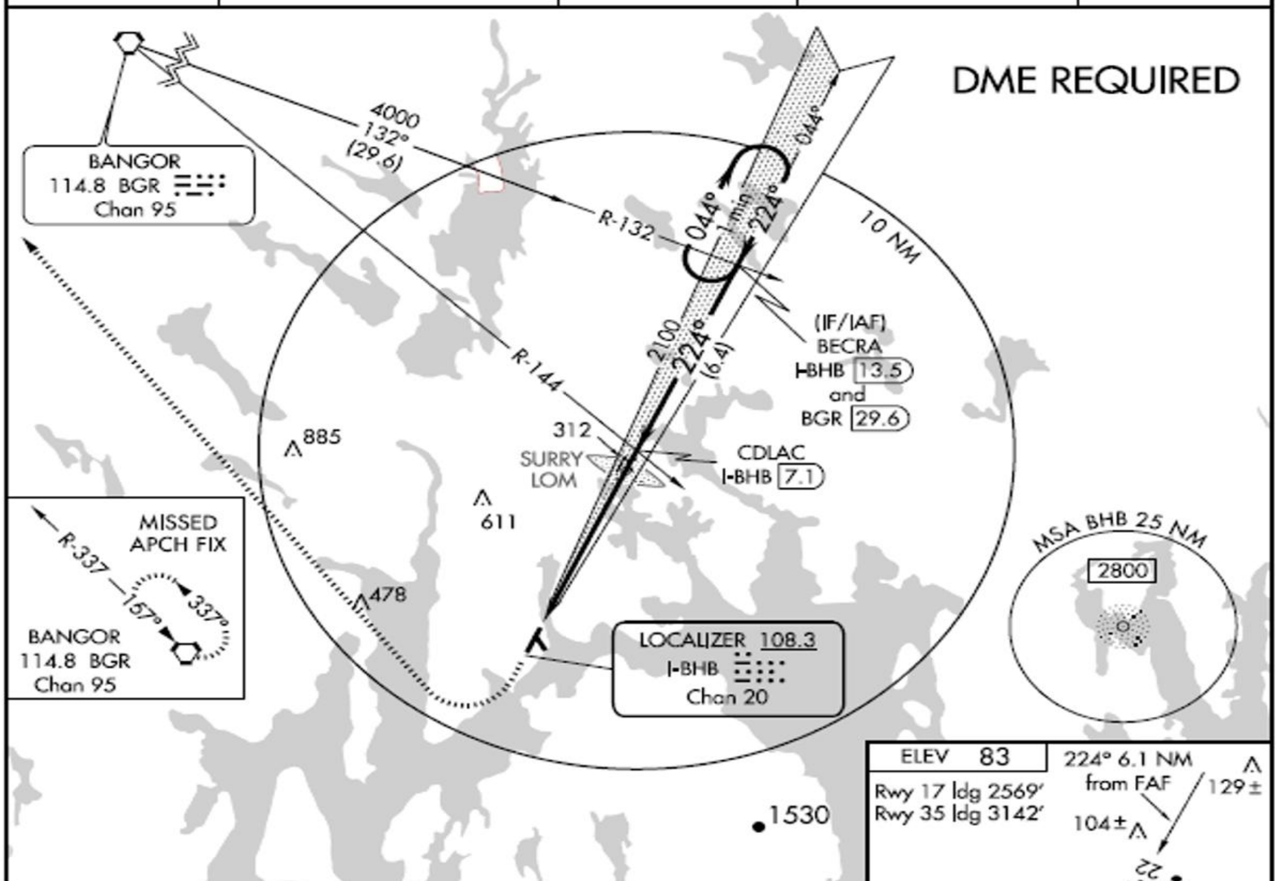
LOC/DME I-BHB	APP CRS	Rwy ldg	TDZE	Apt Elev
108.3 Chan 20	224°	5200	83	83

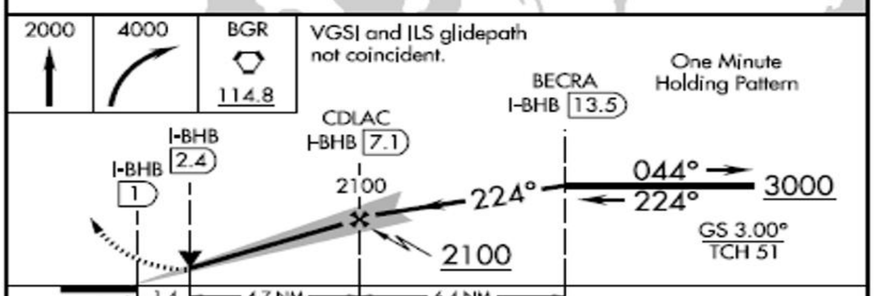
Inoperative table does not apply to S-LOC-22 Cat C. If local altimeter setting not received, use Bangor altimeter setting and increase all DAs/MDAs 100′. VDP NA when using Bangor altimeter setting.

MALSF

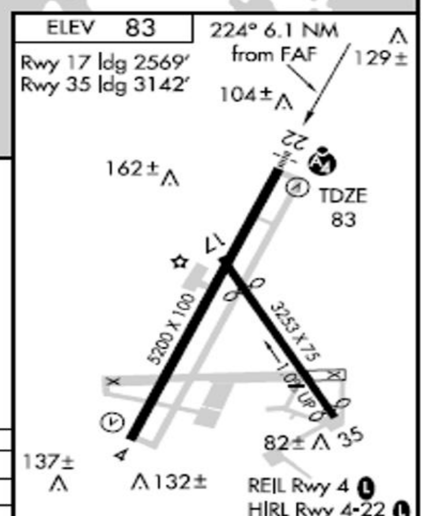
MISSED APPROACH: Climb to 2000 then climbing right turn to 4000 direct BGR VORTAC and hold.

AWOS-3	BANGOR APP CON	CLNC DEL	UNICOM	
118.025	124.5 251.125	119.9	123.0 (CTAF)	122.7





CATEGORY	A	B	C	D
S-ILS 22	283-¾ 200 (200-¾)			
S-LOC 22	580-¾ 497 (500-¾)		580-1¼ 497 (500-1¼)	580-1½ 497 (500-1½)
CIRCLING	600-1 517 (600-1)	620-1 537 (600-1)	620-1½ 537 (600-1½)	640-2 557 (600-2)



FAF to MAP 6.1 NM					
Knots	60	90	120	150	180
Min:Sec	6:06	4:04	3:03	2:26	2:02

NE-1, 10 APR 2008 to 08 MAY 2008

ILS or LOC RWY 22 (KBHB)

Chapter 6

Radar Traffic and Safety Advisories

ATC provides radar traffic advisories on a workload permitting basis. Since radar does not "see" every traffic conflict, collision avoidance is ultimately the responsibility of the pilot. This is true regardless of the type of airspace being flown, the type of operation being conducted, whether IFR or VFR and regardless of radar coverage. The only time the pilot is relieved of this responsibility is when he or she is actually in the clouds. Even then the pilot must maintain situational awareness and be alert to possible conflicts. The bottom line is that it remains the pilot's responsibility, whether operating under IFR or VFR, to see and avoid traffic when flying in VFR conditions. Despite this, radar traffic advisories do reduce the risk of mid-air collisions and should therefore be used and understood.

Position Reports

When radar is not available, ATC depends on position reports from pilots to ensure separation between aircraft. At each compulsory reporting point, or at any point requested by ATC, provide the controller the following:

- Identification.
- Position.
- Time.
- Altitude (state actual altitude when VFR-on-top).
- ETA and name of next reporting point.
- The name of the succeeding reporting point.
- Pertinent remarks.

If ATC advises "radar contact," further position reports are no longer required. Resume normal position reporting only if the controller states "radar contact lost" or "radar service terminated."
The following reports must be made at all times however.

- Vacating an assigned altitude for a newly-assigned one.
- Any altitude change when operating on a VFR-on-top clearance.
- Unable to climb or descend at least 500 feet per minute.
- A missed approach.
- Change in true airspeed of five percent or ten knots, whichever is greater, from that filed in the flight plan.
- Time and altitude reaching a holding fix or clearance limit.
- Leaving an assigned holding fix.
- Any loss of navigation or communication capability.
- Any hazardous weather encountered during flight.
- Any information relating to the safety of flight.

When not in radar contact, make these additional reports:

- Leaving the final approach fix inbound on an instrument approach.
- A corrected ETA if it becomes apparent a previous ETA is in error by more than three minutes.

Holds

In today's system, being assigned a holding pattern while en route is rare. Most spacing is accomplished through the use of speed reductions and vectors. But occasionally holds do occur, particularly in the terminal area, so the pilot must be able to comply.

What is a holding pattern? It is essentially a parking lot used for separation en route or for approach sequencing. What are its dimensions? While no longer described in physical terms, protected airspace is based on all pilots conforming to certain criteria. The maximum allowable indicated airspeed is 200 knots for all aircraft 6000 feet and below. Some holds may indicate a restriction of 175 knots.

The outbound leg is adjusted so that the inbound leg is one minute long, at or below fourteen thousand feet MSL. All turns are made at standard rate or thirty degrees of bank, whichever is less, or twenty-five degrees of bank if a flight director is used. If these criteria are adhered to, the protected airspace will not be exceeded.

There are four basic parts to a holding clearance:

1. the fix at which to hold,
2. the course on which to hold,
3. a direction that identifies the course and
4. a time to expect further clearance.

If the turns are non-standard (to the left), it is so specified. If nothing is said, it is to be understood that all turns are to the right. This is not to say that left turns can't be made during the entry, however, once established in the hold all turns are to the right.

After receiving the clearance, always visualize the pattern. This is accomplished by picking out the holding course from the clearance, visualizing the aircraft going inbound to the fix on the course, and when reaching the fix, making the appropriate turn.

The secret to success is to pick out the proper course and realize that whenever the aircraft is established on the holding course, it must be flying *inbound* to the fix. The most common error in visualizing the hold is to confuse the purpose of the direction given in the clearance. The direction does not refer to the assigned holding airspace: it only identifies the holding course.

Next comes the entry; the recommended entries based on the seventy-degree line are just that: recommended. The pilot can enter the hold any way he or she likes. It is conceded that if the most logical entry is made, it will be the one recommended. The point is that the pilot shouldn't become distressed about whether or not they are making the correct entry. The objective is to get into the hold without becoming disoriented or exceeding protected airspace.

At fixes where holding is frequently accomplished, these holds will be published on the charts. These depictions are not only to reduce communications but are also compulsory whenever holding is necessary and no other instructions have been received. An example of this would be reaching a clearance limit and, due to frequency congestion, not having received further clearance. In this situation the published hold is negotiated.

The figure below shows a typical holding pattern. The holding fix can be a VOR, VORTAC, NDB, a locator outer marker, intersection, waypoint, DME fix or any other point in space that can be identified with navigational equipment. At ninety degrees opposite the fix is the abeam point. The abeam point is the place where timing for the outbound leg is started (when it can be identified).

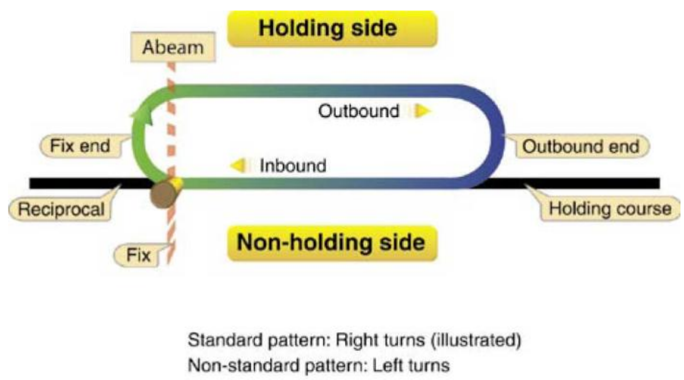
The abeam point can be identified when the holding fix is a VOR, VORTAC or NDB. If a VOR or VORTAC, this point is recognized by the "off" indication on the To/From indicator when the OBS is set to the inbound course. If it were an NDB, the ADF receiver is used to identify the abeam point.

When the abeam point cannot be identified, the outbound timing is started when the wings are level on the outbound heading. This situation would exist if the fix were a marker beacon or an intersection that was identified by radials that are not at ninety degrees.

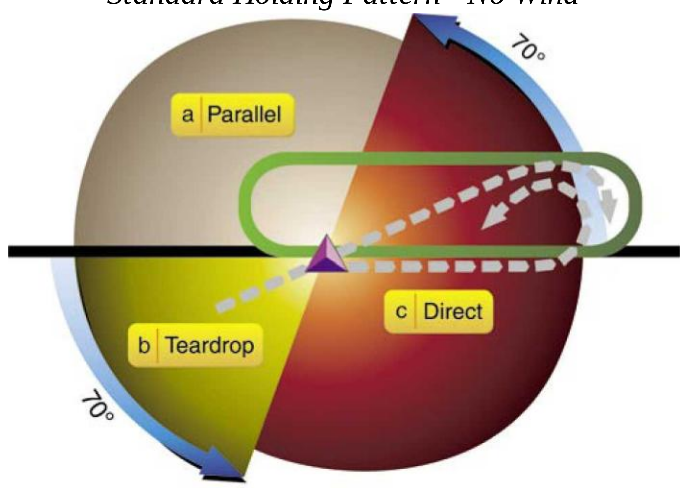
When the fix is an intersection that is located a substantial distance from the facilities used to provide the radials, the pilot should be aware of the decreased amount of needle sensitivity: a little deflection could represent a lot of distance. Proper interception and bracketing procedures must be used. When flying intersection holds, the preferred station should be used. The charts indicate the preferred facilities with arrows.

If one VOR receiver becomes inoperative while flying an intersection hold, the pilot shouldn't hesitate to request two-minute legs. This will provide more time to switch the receiver back and forth.

The outbound leg in a no-wind condition should be one minute long. Once established in the hold, this leg is strictly dead reckoning: the pilot flies a heading for a certain length of time. The inbound leg is always flown on the assigned holding course. When the fix is a VOR, theoretically the aircraft will never be more than one minute from the station where the needle is very sensitive and moves quickly. If the aircraft is equipped with a flight director, placing it in the approach mode will mitigate this problem. In any event, proper bracketing procedures are essential so that each consecutive pattern starts from exactly the same place.



Standard Holding Pattern - No Wind

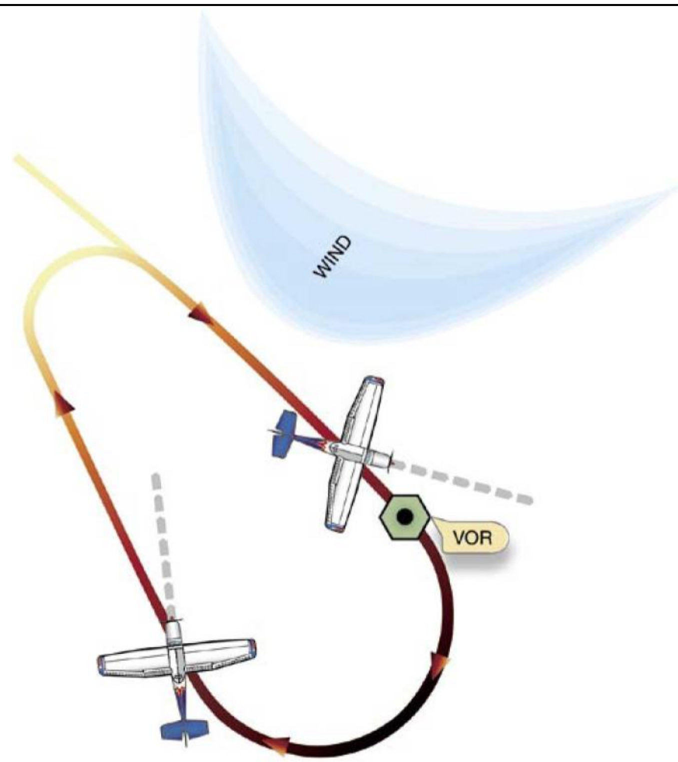


Holding Pattern Entry Procedures

Correcting for Wind in the Holding Pattern

If there is a headwind in the holding pattern, the outbound leg will be less than one minute long. If there is a tailwind in the hold, the outbound leg will be more than one minute. Notice the difference in the shape of the ground tracks. The figure below shows the shape of a holding pattern in a crosswind. Note that it is egg-shaped rather than like a race track, this is because all turns are made at standard rate, therefore the upwind and downwind turns have different radii. Recall that crosswind corrections are made by adjusting the heading on the outbound leg, not by changing the rate of turn.

It is very important that when coming out of the turn at the outbound end, the aircraft gets established on the holding course, tracks it inbound and crosses directly over the fix. Each subsequent pattern and correction must be started from exactly the same spot, or the corrections will be ineffective.



Drift Correction in Holding Pattern

Chapter 7

STARs

A standard terminal arrival (STAR) is a coded arrival procedure established to simplify clearance delivery procedures. Use of a STAR requires that you have either the graphic depiction (see IRA Supplement Figure 35) or the textual description (see IRA Supplement Figure 35A) available.

Each STAR consists of one or more transitions from en route fixes to an arrival fix. The arrival route leads from the arrival fix to an initial approach fix or to a point from which you may receive radar vectors to an approach course. To file a STAR in your flight plan, list the identifier for the appropriate transition and arrival.

ATC may issue a STAR anytime it is deemed appropriate, unless the pilot requests otherwise. Pilots should indicate "No STARs" in the remarks section of the IFR flight plan if they do not have STAR charts available in the cockpit.

Transition and Approach Procedures

At some point during every IFR flight, the aircraft must leave the en route phase and enter the approach phase. The list below shows the basic methods that ATC uses to accomplish this transition. The technical name for these transitions is terminal routing.

Types of Transitions

- Airway transition
- Published transition
- No PT transition
- DME arc
- Radar vectors
- Authorized hold

A specific example of each method will be covered in more detail. However, in order to understand this discussion of procedures, the pilot must have a thorough knowledge of certain terms.

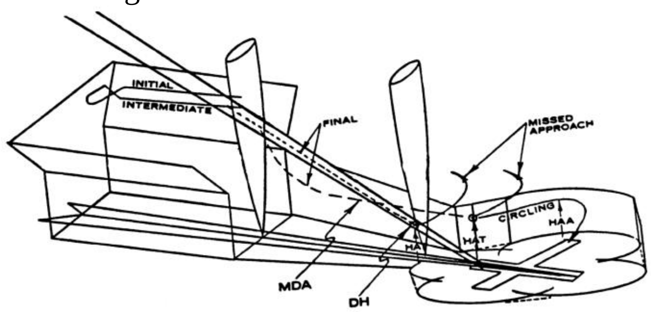
First of all, to what is the connection being made? The figure below schematically shows the approach corridor with its primary and secondary obstacle clearance areas for each segment of the approach. It shows the relative width of protected air space for each segment, the circle-to-land obstacle clearance area and the missed approach re-entry path.

The initial segment of the approach, and therefore the approach itself, starts at the initial approach fix or IAF. The altitude at which the aircraft crosses the IAF is defined as the initial approach altitude. This should not be confused with the altitude prescribed for the initial segment, which is called the Initial Segment Altitude. The former is usually higher, and a misunderstanding on the part of the pilot could have disastrous results.

The aircraft starts inbound in the approach corridor normally at the beginning of the intermediate segment. This part of the corridor usually extends for a distance of ten nautical miles from the approach facility, (the exact distance is noted in the profile view of the approach charts). It is very important for the pilot to realize that the altitude prescribed for the intermediate segment is safe only when operating on that segment within the confines of the corridor.

The approach gate is located one mile outside the final approach fix, or five miles from the runway, whichever is the greater distance. This point is important to the pilot because most approach procedures are designed to get the airplane inbound in the corridor at least one mile outside this gate. Even with radar vectors, the controller can not turn the airplane inside this point without the pilot's permission.

The phrase, *Cleared for the approach*, is authorization by ATC for the pilot to take over and negotiate the designated instrument approach procedure. This must not be done before receiving clearance for the approach.
A cruise clearance authorizes the pilot to climb to and descend from the altitude specified in the clearance. It is also an approval for the pilot to proceed to and make an approach at the destination airport. It is not authorization to descend below the appropriate IFR altitude at any time.
The difference between the terms *straight-in approach* and *straight-in landing* must be understood. There are seven ways to enter the approach corridor: course reversal (procedure turn, tear drop, or holding pattern), visual approach, contact approach, NoPT transition, radar vectors, DME arc and from a hold at the final approach fix. All but the course reversal method are considered straight-in approaches. When cleared for a straight-in approach, a course reversal may not be made unless the pilot requests one, and ATC approves.
A straight-in landing on the other hand, is when the approach procedure specifies a runway and the pilot is in a position to transition and land on that runway from the approach. No circle-to-land maneuver is needed. Normally a straight-in landing will have lower minimums than a circle-to-land maneuver.



Approach Corridor

Segments of the Approach

There are four segments to a typical instrument approach procedure:

1. Initial
2. Intermediate
3. Final
4. Missed

The initial segment of an approach is that segment that positions the aircraft inbound on the approach corridor and onto the intermediate segment, if the procedure has one. Initial segments can consist of a DME arc, radial, bearing, heading, radar vectors, or combination thereof. Procedure turns are initial segments. The initial segment altitude will provide at least one thousand feet of obstacle clearance if it is conducted within the prescribed limits. If the initial segment is a course reversal, it must be conducted within the prescribed distance on the designated side of the approach course. Initial segments are shown on the plan view of approach charts.
The intermediate segment blends the initial segment with the final segment. It is the segment in which aircraft configuration, speed and position adjustments are made for entry into the final segment. It is usually the segment on which the aircraft starts inbound in the approach corridor. It must be aligned within thirty degrees of the final approach and is usually ten miles long. The intermediate segment altitude will provide at least five hundred feet of obstacle clearance within the intermediate limits of the corridor. Not all approaches have intermediate segments.
The final segment is where alignment and descent for landing are accomplished. In the case of an ILS approach, this descent is made on the glide path to an altitude called a decision altitude, or DA. If, when at the DA on the glide path, the proper landing criteria are not met, a missed approach must be executed. On

an ILS, the final segment begins at the point where the glide path is intercepted and ends at the DA. On a fully operating ILS, the DA is usually two hundred feet above the touch down zone.

On a non-precision approach, the final segment begins at the final approach fix or at the end of the initial segment if the facility is on the airport. It ends at the missed approach point (MAP) which is normally the runway threshold, or the airport boundary. Occasionally, in mountainous terrain the MAP may occur at a point short of the airport with the remaining distance flown visually. This is done to provide a safe escape route from mountainous terrain if visual conditions do not exist at the MAP.

The lowest altitude authorized on the final segment of a non-precision instrument approach is called the minimum descent altitude (MDA). The MDA will provide at least two hundred fifty feet of obstacle clearance within the final limits of the corridor for a straight-in landing and at least three hundred feet of clearance within the corridor and obstacle clearance area for a circle-to-land maneuver. In mountainous terrain, because of the induced altimeter errors and pilot control difficulties with winds of twenty knots or more, obstacle clearance is raised by as much as five hundred feet.

The missed approach segment begins at the missed approach point and ends at re-entry into the initial segment or en route structure, providing obstacle clearance on a climb gradient of two hundred feet per nautical mile. The missed approach point on an ILS is at the DA. On a non-precision approach, the MAP may be at the beginning of the runway, field boundary or short of the airport as described above.

Approach Minimums

The lowest altitude you may use on an approach depends upon the type of approach, airplane approach category and the landing runway. A speed of 1.3 Vso determines the airplane's approach category (Vso is the stall speed in landing configuration at maximum gross landing weight).

You may use the straight-in minimums when landing on the runway specified in the procedure (i.e. S-ILS 27). This altitude is the DA for a precision approach or the MDA for a non-precision approach.

Landing on any other runway requires the use of the circling MDA. Some approaches show a side-step MDA which applies to a parallel runway. In the absence of side-step minimums, use the circling MDA when landing on a parallel runway.

The visibility minimum for landing, in statute miles or hundreds of feet, is expressed as runway visual range (RVR). A dash separates visibility in statute miles from the DA or MDA. A slash separates RVR values from the DA or MDA.

When operating under 14 CFR part 91, you may always fly an approach to minimums, regardless of reported or actual weather conditions. You may not land unless you determine the flight visibility is at or above the minimum shown on the IAP. Visibility is the only legal weather criterion for landing.

Immediately following the visibility value on the IAP is the AGL altitude of the DA or MDA. For straight-in minimums this value is measured in height above the landing threshold called height above touchdown (HAT). For circling MDAs this becomes height above the airport elevation (HAA).

Landing Criteria

Flight visibility at or above the minimum prescribed by the approach procedure is the only standard as to whether or not a pilot can legally land at an airport. However, there are different kinds of visibilities. Prevailing visibility is the greatest horizontal visibility equaled or exceeded throughout at least half the horizon circle. This visibility does not necessarily need to be continuous. Runway visibility value, or RVV, is determined by a transmissometer and represents a continuous indication of the visibility for a particular runway stated in terms of miles and fractions thereof.

Runway visual range, or RVR, is an instrumentally derived value that represents the horizontal distance a pilot in a moving aircraft should see looking down the runway from the approach end. The value 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. The transmissometer measurement is made from near the touchdown point of the instrument runway and is reported in hundreds of feet. This can be a disadvantage because the readout in the tower is based on this measurement and doesn't necessarily reflect the visibility on the remaining part of the runway.

Precision vs. Non-precision

As there is a very basic difference in premise between a precision and a non-precision approach, a difference in the techniques used to negotiate each one is therefore required. The most obvious differences are the obstacle clearances provided by the final segment and the location and means of identifying the missed approach point. In regard to the location of and the identification of the missed approach point, no person may operate an aircraft below the MDA or continue the approach below the DA unless the runway threshold or approved lighting aids or other markings identifiable with the runway are clearly visible to the pilot and the aircraft is in a position from which a normal descent to landing can be made.

Notice how with a precision approach the regulations state that the pilot will not continue the approach below the DA. This means that the missed approach point is located where the decision height altitude coincides with the glide path. At this point, a decision as to whether or not landing criteria have been met must be made by the pilot. If they have not, a missed approach is executed. This missed approach point usually occurs at or near the middle marker.

The implication is also made, and is true, that adequate obstacle clearance on the final segment, from the final approach fix to the missed approach point, is guaranteed only if the aircraft is on or above the glide path. Thus to be safe, the pilot must maintain the glide path angle, or at least never go below it. A non-precision approach is as good and safe a let down to its non-precision minimums as the ILS it to its precision minimums.

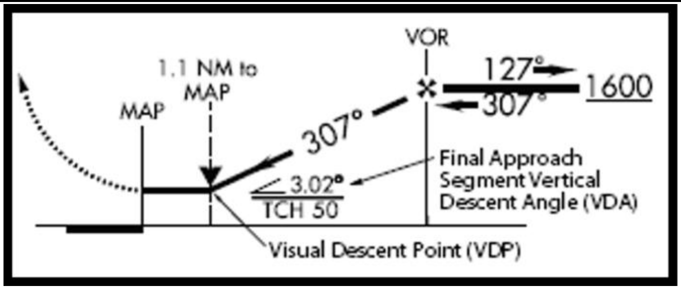
The only legal weather criterion for landing, as said, is visibility. That does not in any way mean that pilots can descend as low as they want on the final segment. The lowest safe altitude that a pilot can descend to is the minimum descent altitude, MDA. Most of the accidents that happen on non-precision approaches happen because the pilot went below the published MDA. The published MDA provides at least two hundred fifty feet of obstacle clearance, in the case of straight-in landing, anywhere in the final portion of the approach corridor, and at least three hundred feet in the case of a circle-to-land maneuver within the obstacle clearance area.

Two criteria must be met before a descent below the MDA is authorized. The pilot must have the runway environment in sight and the aircraft must be in a position from which a normal descent to landing can be accomplished. If these criteria are not met by the time the missed approach point is reached, a missed approach must be executed. The position from which the runway can be seen and a normal descent can be accomplished will be referred to as the Visual Contact and Descent Slot.

When the final segment is not aligned with a runway, only circling minimums apply and the procedure name will not indicate a runway number. This however does not prevent you from landing straight-in if you sight the runway in enough time to line up.

As in the figure below, a Visual Descent Point (VDP), indicated by the symbol "**v**", shows the earliest position to begin descent to the runway. The VDP establishes a descent angle of about three degrees.

RNAV approaches indicate a descent angle for use if your RNAV equipment has vertical guidance capability. Setting the angle shown in the profile view will permit the airplane to arrive at the MDA at the distance shown from the runway threshold.



Visual Descent Point

The Missed Approach

The missed approach segment begins at the missed approach point (MAP) and ends at the missed approach fix. In the event it becomes necessary to abandon the approach before reaching the MAP, obstacle clearance will only be assured by proceeding to the MAP at or above the MDA or DA before executing a turning maneuver.

A holding pattern depicted at the missed approach fix indicates how to "park" your airplane while you decide what to do next. You may try the approach again, try a different approach to the airport, hold and wait for the weather to improve or proceed to an alternate airport. Keep in mind that you must divert to the alternate while you still have enough fuel to get there.

Ask yourself the following questions to determine where the missed approach segment begins.

Is this a precision approach?

- If the answer is *yes*, the MAP is the decision altitude.
- If the answer is *no*, go to the next question.

Is DME required to fly the procedure?

- If it is, the MAP will be a DME fix shown in the profile view.
- If DME is not required, the distance to the MAP will appear below the airport sketch.

If no distance to the MAP appears below the airport sketch, refer to the profile view. The MAP occurs upon crossing the navaid or waypoint used to identify the MAP. In this case, station passage indicates the MAP.

If visual reference is lost while circling to land from an instrument approach, the missed approach specified for the procedure must be followed. Since the circle-to-land maneuver can be accomplished in any direction, different patterns will be required to execute the missed approach depending on where the airplane is when visual reference is lost. In any case, the initial turn when executing a missed approach while circling-to-land should always be made towards the airport.

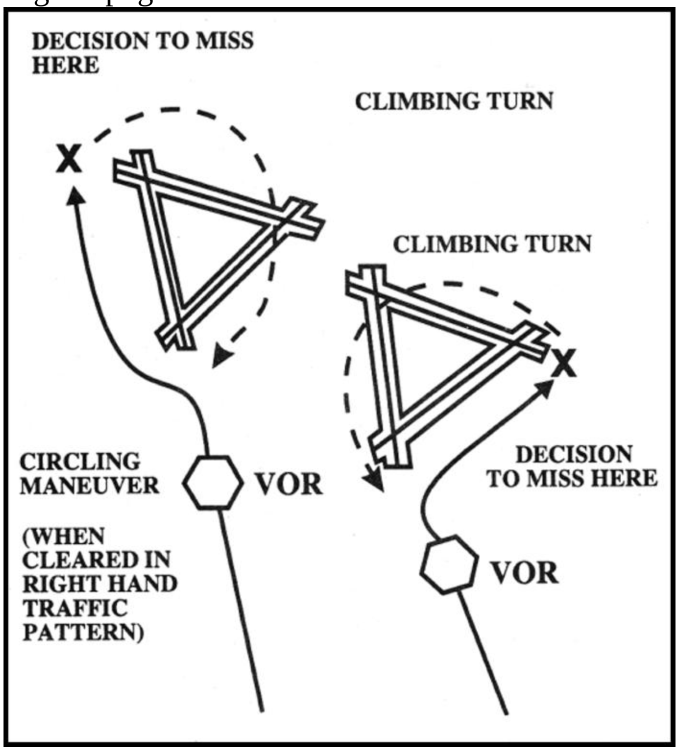
The figure below shows two examples of patterns that will keep the aircraft within the obstacle clearance area while maneuvering to reenter the published procedure. Note that the initial climbing turn is toward the airport or landing runway. Let's elaborate on those missed approach procedures in general.

The missed approach segment is initiated at the decision altitude in precision approaches and at a specified point, usually the end of the runway, on non-precision approaches. The obstacle clearance plane for the missed approach segment is based on the assumption that the pilot initiates the missed approach at the point specified on the chart. There is no consideration given to obstacle clearance if the turn is made early. Therefore, if the pilot decides early to execute a missed approach, he or she should fly the procedures specified on the chart to the missed approach point, at or above the MDA or DA, before executing any turning maneuver.

Many times ATC will issue alternate missed approach procedures, especially in a radar environment. These instructions supersede the published procedure and are designed to expedite traffic.

A missed approach with stated intentions is a compulsory report. The organized pilot will be aware of what his or her options are. A common misconception is that if a missed approach is executed, the pilot must go to the alternate designated on the flight plan. With the system today, the controller may not even know what the alternate is. The pilot's request will depend on the circumstances, most importantly the available fuel.

14 CFR defines standard alternate minimums. If the alternate airport has a precision approach installed and the aircraft is equipped to use it, then the forecast at the ETA for that airport must predict at least a six hundred foot ceiling and two miles visibility in order to be designated as an alternate. If the airport being considered has only non-precision facilities, then the forecast must call for at least eight hundred feet and two miles. If the alternate minimums for an airport are non-standard, NOS charts depict an inverted triangle with an "A" to notify the pilot that non-standard minimums apply. Jeppesen prints this information on the airport diagram page.



Missed Approach during Circling-to-land

Advance Information for the Approach

The ATIS or controller will advise you of the approach in use at your destination. This is provided for planning purposes only. Changing weather and traffic conditions will affect the handling of your flight. If you are not able to fly the approach in use or want a different approach, advise ATC immediately.

Where ATIS is in use, the approach controller will expect you to already have the appropriate information prior to your initial call. As discussed earlier, this is not always possible. If you are able to pick up the information ahead of time, let the controller know you have the current information on your initial call. If you do not have the information when instructed to contact approach, simply state, "Negative ATIS," on your initial call; do not delay calling approach when instructed to do so since the controller is waiting for your call.

Radar Arrivals

Approach control can provide radar vectors to the approach course of a non-radar approach such as an ILS, VOR or NDB approach. Radar vectors eliminate the need for a procedure turn and expedite the flow of traffic into the airport. If an IFR flight is given a vector for an ILS final approach, the pilot should expect to assume navigation responsibility on the intermediate segment of that approach.

The controller should advise you if you will be vectored through the final approach course for sequencing or spacing. If you are nearing the course and have not been cleared for the approach or have not been instructed to turn inbound, maintain the last assigned heading and query ATC. Never turn inbound on the approach course unless cleared to do so.

When you are not on the approach course, ATC will issue an altitude to maintain until established on a segment of the approach. Radar vectors take you off the published routes so you must maintain the last assigned altitude until you are on a segment of the approach. Once established, descend to the appropriate minimum altitude for your position. Remember, the MSAs on the approach chart are emergency-use altitudes and *not* appropriate for normal operations.

Plan for the possibility of a circling maneuver unless the weather is down to minimums or you are operating at night. Under those conditions you will be safer landing straight-in, even if you have to divert to an alternate in order to do so. While circling, set up a safe approach speed and maintain aircraft control by reference to the flight instruments. Only use outside references while circling for position and heading information. Do not descend below the MDA until in a position that assures a normal descent to landing. Use minimums for the next higher category if airspeed so dictates. If in doubt, execute a missed approach.

Contact and Visual Approaches

Two IFR approaches that don't follow a published procedure are the contact and visual approaches. The contact approach is an approach to an airport that has a published procedure and an approved weather observer where an aircraft on an IFR flight plan, operating clear of clouds with at least one mile visibility and having received ATC authorization, may deviate from the prescribed procedure and proceed to the destination airport by visual reference to the surface.

The contact approach can be requested before or at any time during an instrument approach. The request must be initiated by the pilot and authorized by ATC; it cannot be initiated by ATC. In the event that the required weather conditions cannot be maintained or visual contact with the ground is lost, the alternate instructions contained in the Contact Approach clearance will be executed.

ATC provides separation from other IFR and special VFR aircraft but the pilot is responsible for obstruction clearance. The contact approach is sometimes a useful tool at controlled airports where special VFR is prohibited.

The visual approach is basically a procedure that is used at major airports in VMC (Visual Meteorological Conditions), or conditions that allow you to maintain required cloud clearances and visibilities. To be vectored for a visual approach, the ceiling is required to be 500 feet above the minimum vectoring altitude, MVA.

A visual approach allows traffic to be expedited and reduces controller workload by eliminating the need for each arriving aircraft to negotiate the published procedure. As with DPs and STARs, ATC may issue a clearance for a visual approach without prior pilot request. Visual approaches may be issued for either controlled or uncontrolled airports.

Reported weather must allow an aircraft flying at the MVA to be in VFR weather. If weather reporting service is not available at the airport, the controller may ask you if you can accept a visual approach.

ATC will not clear you for a visual approach until you report the airport, or the traffic you are to follow, in sight. You accept separation and wake turbulence avoidance responsibility when you accept a visual approach clearance.

IFR FLIGHT PLAN		
	CONTACT	VISUAL
WEATHER	GROUND AND FLIGHT VISIBILITY 1 MILE CLEAR OF CLOUDS	VISIBILITY OF AT LEAST 3 MILES CEILING AT LEAST 500 FEET ABOVE MVA AIRCRAFT MUST MAINTAIN VMC AT ALL TIMES
AIRPORT	APPROVED WEATHER OBSERVATION PUBLISHED IAP	
PILOT ACTION	CAN ONLY BE REQUESTED BY THE PILOT: NOT INITIATED BY ATC	INITIATED BY ATC OR REQUESTED BY THE PILOT IF TO AN UNCONTROLLED AIRPORT PILOT MUST CANCEL IFR FLIGHT PLAN

Requirements for Visual and Contact Approaches

Canceling the IFR Flight Plan

Your IFR flight plan is automatically canceled by the control tower upon landing at your destination. When landing at an airport not being served by an operating control tower, the pilot must close the flight plan. This can be done by radio directly with ATC if weather conditions permit you to continue under VFR. If you cannot maintain VFR cloud separation or do not have the required visibility for VFR you must wait until after landing and then contact the nearest FSS or ATC facility by radio or telephone as soon as possible. You may cancel your IFR flight plan anytime you are flying in VFR conditions (except in Class A airspace).

Chapter 8

Overview

Like beauty, an emergency is in the eye of the beholder. Your idea of what constitutes an emergency is going to change as your level of proficiency improves and you gain experience. But whatever your level of experience, if you think you have an emergency, you probably do. Don't feel embarrassed. Confess your problem and ask for help. Declaring an emergency is what controllers need to hear from you before they can give you priority treatment.

There isn't any way to list and plan for every possible emergency. Your training is designed to give you basic procedures in the types of trouble that most often occur and this, combined with good judgment, should give you the insight to cope with any situation that you might encounter. There are also rules, regulations and recommended good operating procedures that you must know so that, should certain situations occur, you will know what ATC expects you to do.

Many minor emergencies have turned into major emergencies because the pilot became distracted from the primary job of flying the airplane. Early detection will keep minor emergencies from becoming major ones. An instrument scan that includes the ammeter, engine instruments and the vacuum gauge as well as the flight instruments will provide the necessary early detection that will allow a proactive response such as landing at an airport short of your destination before systems begin to fail.

Discuss with your student normal errors in instruments and systems that result in incorrect indications. The installation error in the pitot-static system for example will result in the airspeed pointer showing a speed less than the minimum limit of the white arc when practicing power-off stalls with full flaps. This is normal and should not raise concern.

Navigation Equipment Malfunction

A failure of any of your navigation instruments may impair your ability to navigate and may affect the kinds of instrument approaches you will be able to conduct. The failure of one of the VORs in a dual VOR installation may be inconvenient, but it probably will not impair the remainder of your flight. The failure of an ADF radio will probably not affect the en route portion of your flight, but will obviously prevent you from making an NDB approach. A failed glide slope or marker beacon receiver will affect your approach procedures, but will not prevent an instrument approach.

The VOR CDI and GS indicators have "Off" flags which will warn you that a usable signal is not being received. Obviously, these instruments cannot be used for an approach if the off-flag is showing. While the ADF and the marker beacons do not have an off-flag, they can be tested for proper indications. When using NAV receivers, always tune and identify the station to make sure that it is transmitting the proper identifier.

Remember that the loss of navigational capability is a compulsory report; you must notify ATC immediately should a failure occur.

Instrument and Instrument Systems Malfunction

The major hazard of completely trusting your instruments--as you must for instrument flying--is that they can fail. Yet the redundancy of the information that the instruments provide, not to mention the redundancy of the systems that power the instruments, will provide backup information that will allow you to detect a failed instrument.

Vacuum Failure In most general aviation airplanes, the vacuum pump drives the attitude indicator and the heading indicator; should this pump fail, these are the instruments you would lose. When the pump fails the instruments begin to spin down and their indications become unusable. Because it takes a while for the gyros to spin down, it will not immediately be obvious that the instruments have failed.

These instruments do not normally have an "Off" flag and, unless you notice that the vacuum gauge is reading out of the green, your instrument indications will be quite confusing. However, there are always at least two other instruments which provide pitch and bank information, even when the vacuum instruments have failed. In this case your instrument crosscheck and interpretation skills are most valuable.
Assuming you are in IMC when the vacuum pump fails, the preferred order of action is:

- Radar vectors to VMC nearby.
- If ceilings are high enough, clearance for an en route descent to VFR conditions.
- Radar vectors to the nearest airport where a "no-gyro" ASR approach is available.
- If your proficiency is high enough, an instrument approach to the nearest available airport. However, if you do not have to fly a partial-panel approach do not do so.

Pitot-static System Problems Blockage of the pitot tube or static vent will cause erroneous indications on the pressure instruments. If ice blocks the pitot tube, the ram pressure will vent through the drain hole causing the airspeed indicator to drop to zero. In severe icing conditions, the pitot opening and drain hole may become blocked. The trapped ram pressure will cause the airspeed indication to act like an altimeter and remain the same during level flight even if large power changes are made. A climb will result in an increasing airspeed indication, a descent in a decreasing indication. Activating pitot heat should solve the problem.
Blockage of the static vent will render the altimeter and vertical speed indicator inoperative. Unless corrected, the airspeed indication will decrease during a climb and increase during a descent. If the aircraft is so equipped, activate the alternate static source. If not equipped with an alternate static source, break the glass on the VSI. Remember however, that now the airspeed and altimeter will read high and, if not damaged, the VSI indications will be reversed.

Radio Communications Failure

If anytime during a flight in IMC you are unable to contact a controller:

- Go back to the last assigned frequency--if no contact,
- Go to the FSS frequency--if no contact,
- Go to 121.5 MHz--if no contact,
- Listen on the appropriate NAV frequency (your NAV radios may work even when your COM radios don't)--if no contact, continue to broadcast your intentions in the blind on 121.5 (you may still be able to transmit even though you cannot receive).

Before you get to this point, make sure that the audio panel is set up correctly. Also, make sure you do not have a stuck microphone. A stuck mic will mute the receive function of the transmitters. If you are using the speaker, plug in a headset. It operates on a different circuit than the speaker and may solve the problem. If you are using a headset, try the speaker function. Once you have definitely established that you have a total communications failure, adjust your transponder to code 7600.
If VFR conditions are encountered en route, remain VFR, land as soon as practical, and notify ATC once on the ground. While in IFR conditions you must proceed on to your destination based on these priorities.
Route - Follow in this order:

- the last assigned route.
- if being radar vectored, go direct to the fix or airway to which you were being vectored.
- the route ATC advised you to expect at a later point.
- the route you filed in your flight plan.

Altitude - Maintain the highest of:

- the last assigned altitude.
- the airway MEA.
- expected higher altitude.

When to leave a hold - If two-way radio communication failure occurs while holding at a fix which is not the approach fix, depart the hold at the EFC time.

When to begin the approach - Unless you have received specific holding instructions that included an EFC, proceed all the way to your destination. When the clearance limit is a fix from which an approach begins, begin your descent and/or approach as close as possible to the estimated time of arrival as calculated from the filed or amended estimated time en route. If you arrive prior to your ETA, hold at the facility or fix which is the most convenient IAF for the approach you have chosen to use.

While you can choose any approach you want, your preflight weather briefing provided you with the forecast winds at your ETA. Unless they were forecast to be light, you will probably want to pick an approach that is appropriate for the forecast winds. You also probably want to choose an ILS, if one is available. You will want the lowest minimums available to reduce any chance of having to make a missed approach and proceed on to an alternate.

If the IAF over which you will hold is also the FAF, hold on the approach course on the procedure turn side, or as published if different. You must remain in the hold, at the altitude you arrived at the fix, until your ETA. Make it a habit to always record your time off the departure runway, so that you will be able to compute your ETA, which is based on your flight plan ETE. When you reach your ETA, you may descend, if necessary, in the holding pattern to arrive at the glide slope intercept altitude and then make a straight-in approach from the hold.

If you arrive at your destination after your ETA, you may immediately begin the approach. If you must lose altitude, this can be done in a holding pattern as described above or during a full instrument approach procedure.

Airplane Systems Malfunction

The best defense against mechanical malfunctions is a good maintenance program, preflight inspection, and engine run-up. However, even the best of these inspections will not guarantee trouble-free operation of all aircraft systems. While in flight, the most helpful thing you can do is to make sure that your scan includes the engine and electrical instruments. Many failures give some advanced warning. A few minutes warning can make the difference in the outcome of a problem. If you notice that the engine oil temperature is increasing, you can keep on top of the situation and make contingency plans. You may decide, based on the instrument indications, to make a precautionary landing rather than continuing to your destination.

Electrical System Failure - Electrical failures are not always initially total or complete, many electrical failures occur over time. The most common cause of electrical failure is the loss of an alternator. Even with a complete alternator failure, the battery will continue to supply power to the airplane's electrical systems for a period of time. It is obvious, however, that it is to your advantage to detect a failed alternator as soon as possible. This will allow you to reduce the electrical load and save power.

There are several ways to detect a failed alternator. Many aircraft have a low voltage light that illuminates whenever the system voltage drops below a certain level. In the absence of a warning light, the ammeter will show that the battery is discharging, a sign that the alternator has failed or is not supporting the electrical load on the system.

If the low voltage light does come on, follow the manufacture's emergency checklist for this condition. The low voltage light does not always mean that the alternator has failed. Sometimes the alternator is knocked off-line and can be brought back on-line simply by recycling the alternator.

A total and complete electrical failure has some serious consequences. Not only will you be without communication and navigation ability, even if you managed to come near your destination, you would not have the means to conduct an instrument approach. In addition, your turn coordinator will be inoperative, interior and exterior lights will be off, you may be without flaps and the gear will have to be manually operated. Your only hope in the event of a total and complete electrical failure is to have gotten a good preflight weather briefing and to know where to find VFR weather. There are no regulations to cover the procedures for a complete electrical failure.

Because of the possible serious consequences of such an event, it is important that all the gauges be included in your scan to detect a problem as early as possible so that you can take positive action while you still have some options available.

Engine Failure (single engine)

Assuming a restart is impossible, you should:

- trim for the best glide speed (remember that you will be partial-panel).
- notify ATC and request the nearest weather information.
- turn into the last known wind, if able.
- limit the electrical load.
- upon breaking out of the clouds, pick a place to land and perform the emergency landing procedures outlined in your manufacturer's emergency checklist.

Summary

During your training, the emergency conditions that are discussed and practiced, to the extent possible, are often "worst case." In reality, if emergencies occur, they are often not the worst case. For example, engine failures are not always complete failures, some power may be available, enough to still fly at reduced power. Communication failures are rarely total failures. However, if you learn these lessons well, you will be as prepared as possible to handle the emergencies which may arise.

Chapter 9

Overview

GPS is fast becoming the principal means of navigation for many pilots. More accurate navigation is a good thing, but dependency on GPS can lead to weakness in other forms of navigation (e.g., pilotage and dead reckoning). Flight instructors should be able to teach proper use of GPS systems, their limitations, database update requirements and regulatory requirements.

Situational Awareness and Safety

Lack of situational awareness is one of the most commonly cited causes for incidents involving all certificate and experience levels. Examples of situational awareness incidents include: a student pilot is unable to find the destination airport, and gets disoriented to point where a violation of restricted or Class B airspace occurs; a private pilot runs out of fuel and is required to make a forced landing short of the airport; a commercial pilot flies into terrain after thinking he was cleared to descend on an approach even though a lower altitude was not approved.

For these and other examples, instructors must emphasize to their students methods and techniques that can be used to avoid becoming disoriented. Keeping track of weather, other aircraft, terrain and your fuel are just a few reasons why preflight preparation should include proficiency in all forms of navigation, including GPS. However it is important that your students be trained in more than just the "Direct To" function of the GPS.

Use of the moving map and the "Nearest Airport" function can be a big help to your student pilot if they get disorientated on their first solo cross-country. IFR pilots, knowing that ATC is primarily responsible for separation, will find the obstacle/terrain clearance information available with GPS exceptionally helpful in meeting their responsibilities.

Aviators throughout the world use the Global Positioning System to increase the safety and efficiency of flight. With its accurate, continuous and global capabilities, GPS offers seamless satellite navigation services that satisfy many of the requirements for aviation users. Space-based position and navigation enables three-dimensional position determination for all phases of flight from departure, en route and arrival to airport surface navigation.

The trend toward an Area Navigation concept means a greater role for GPS. Area Navigation allows aircraft to fly user-preferred routes from waypoint to waypoint; these waypoints do not depend on a surface infrastructure. Procedures have been expanded to use GPS and augmented services for all phases of flight. This has been especially true in areas that lack suitable ground-based navigation aids or surveillance equipment.

New and more efficient air routes made possible by GPS are continuing to expand; vast savings in time and money are being realized. In many cases, aircraft flying over data-sparse areas such as oceans have been able to safely reduce their separation between one another, allowing more aircraft to fly more favorable and efficient routes, saving time and fuel and increasing cargo revenue. Improved approaches to airports are now being implemented even at remote locations where traditional ground-based services are unavailable. In some regions of the world, satellite signals are augmented or improved for special aviation applications such as landing during poor visibility conditions. In those cases, even greater precision operations are possible.

The good news for the aviation community is that GPS is being constantly improved and modernized. A main component of the ongoing civilian modernization effort is the addition of two new signals. These signals complement the existing civilian service. The first of these new signals is for general use in non-safety critical applications. The second new signal will be internationally protected for aviation navigational purposes. This additional safety-of-life civilian signal will make GPS an even more robust navigation service for many aviation applications.

The second safety-of-life signal will enable significant benefits above and beyond the capabilities of the current GPS services. The availability of this signal offers increased instrument approach opportunity throughout the world by making the use of dual-frequency avionics possible. Dual frequency means that errors that occur in the signals due to disturbances in the ionosphere can be significantly reduced through the simultaneous use of two signals. This will improve the overall system robustness to include accuracy, availability, and integrity and will allow a precise approach capability with little or no ground infrastructure investment.

Reliance on GPS as the foundation for today and tomorrow's air traffic management system is a major part of many national plans. Those aviation authorities that are moving forward with GPS have observed and documented reductions in flight time, workload, and operating costs for both the airspace user and service provider. GPS also serves as an essential component for many other aviation systems, such as the Enhanced Ground Proximity Warning System (EGPWS) that has proven successful in reducing the risk of controlled flight into terrain.

Benefits of Satellite Navigation

- Continuous, reliable and accurate positioning information for all phases of flight on a global basis, freely available to all.
- Safe, flexible, and fuel-efficient routes for airspace service providers and airspace users.
- Potential decommissioning and reduction of expensive ground-based navigation facilities, systems, and services.
- Increased safety for surface movement operations made possible by improved situational awareness.
- Reduced aircraft delays due to increased capacity made possible through reduced separation minimums and more efficient air traffic management, particularly during inclement weather.
- Increased safety-of-life capabilities such as EGPWS.

Limitations and Regulatory Compliance

GPS is a U.S. satellite-based radio navigational, positioning, and time transfer system operated by the Department of Defense (DOD). The system provides highly accurate position and velocity information and precise time on a continuous global basis to an unlimited number of properly equipped users. The system is unaffected by weather and provides a worldwide common reference system based on the earth-fixed coordinate system. For its earth model, GPS uses the World Geodetic System of 1984 (WGS-84) datum.

GPS provides two levels of service: Standard Positioning Service (SPS) and Precise Positioning Service (PPS). SPS provides to all users a horizontal positioning accuracy of 100 meters or less, with a probability of 95 percent and 300 meters with a probability of 99.99 percent. PPS is more accurate than SPS; however, this is limited to authorized U.S. and allied military, federal government, and civil users who can satisfy specific U.S. requirements.

GPS operation is based on the concept of ranging and triangulation from a group of satellites in space which act as precise reference points. A GPS receiver measures distance from a satellite using the travel time of a radio signal. Each satellite transmits a specific code, called a course/acquisition (CA) code, which contains information on the satellite's position, the GPS system time, and the health and accuracy of the transmitted data. Knowing the speed at which the signal traveled (approximately 186,000 miles per second) and the exact broadcast time, the distance traveled by the signal can be computed from the arrival time.

The GPS receiver matches each satellite's CA code with an identical copy of the code contained in the receiver's data base. By shifting its copy of the satellite's code in a matching process, and by comparing this shift with its internal clock, the receiver can calculate how long it took the signal to travel from the satellite to the receiver. The distance derived from this method of computing distance is called a *pseudo-*

range because it is not a direct measurement of distance, but a measurement based on time. Pseudo-range is subject to several error sources such as ionospheric and tropospheric delays and multipath.

In addition to knowing the distance to a satellite, a receiver needs to know the satellite's exact position in space (known as its *ephemeris)*. Each satellite transmits information about its exact orbital location and the GPS receiver uses this information to precisely establish the position of the satellite.

Using the calculated pseudo-range and position information supplied by the satellite, the GPS receiver mathematically determines its position by triangulation. The GPS receiver needs at least four satellites to yield a three-dimensional position (latitude, longitude, and altitude) and time solution. The GPS receiver computes navigational values such as distance and bearing to a waypoint, ground speed, etc., by using the aircraft's known latitude/longitude and referencing these to a database built into the receiver.

The GPS constellation of 24 satellites is designed so that a minimum of five are always observable by a user anywhere on earth. The receiver uses data from a minimum of four satellites above the mask angle (the lowest angle above the horizon at which it can use a satellite).

The GPS receiver verifies the integrity (usability) of the signals received from the GPS constellation through receiver autonomous integrity monitoring (RAIM) to determine if a satellite is providing corrupted information. At least one satellite, in addition to those required for navigation, must be in view for the receiver to perform the RAIM function. Thus, RAIM needs a minimum of five satellites in view, or four satellites and a barometric altimeter (baro-aiding) to detect an integrity anomaly. For receivers capable of doing so, RAIM needs six satellites in view (or five satellites with baro-aiding) to isolate the corrupt satellite signal and remove it from the navigation solution. Baro-aiding is a method of augmenting the GPS integrity solution by using a non-satellite input source. GPS-derived altitude should not be relied upon to determine aircraft altitude since the vertical error can be quite large. To ensure that baro-aiding is available, the current altimeter setting must be entered into the receiver as described in the operating manual.

RAIM messages vary somewhat between receivers, however there are generally two types. One type indicates that there are not enough satellites available to provide RAIM and another type indicates that the RAIM integrity monitor has detected a potential error that exceeds the limit for the current phase of flight. Without RAIM capability, the pilot has no assurance of the accuracy of the GPS position.

The DOD declared initial operational capability (IOC) of the U.S. GPS on December 8, 1993. The FAA has granted approval for U.S. civil operators to use properly certified GPS equipment as a primary means of navigation in oceanic airspace and certain remote areas. Properly certified GPS equipment may be used as a supplemental means of IFR navigation for domestic en route, terminal operations, and certain instrument approach procedures (IAPs). This approval permits the use of GPS in a manner that is consistent with current navigation requirements as well as approved air carrier operations specifications.

Definitions and Abbreviations

Active Waypoint - The waypoint to/from which navigational guidance is being provided.

Along Track Distance (ATD) Fix - A distance in nautical miles to the active waypoint along the specified track. An ATD fix will not be used where a course change is made.

Course Set - Guidance set from information provided by the GPS equipment that assists the pilot in navigating to or from an active waypoint on a heading/bearing.

Data Agency - An agency, public or private, other than a publisher of government source documents that compiles official document information into charts or electronic formats for cockpit use.

Dead Reckoning (DR) - The navigation of an aircraft solely by means of computations based on airspeed, course, heading, wind direction and speed, ground speed, and elapsed time.

Direct To - A function used with GPS equipment to provide the necessary course from the present position directly to a selected waypoint.

Fly-By Waypoint - A waypoint that permits turn anticipation and does not require the aircraft to pass directly over it.

Fly-Over Waypoint - A waypoint that requires the aircraft to pass directly over it.

Instrument Approach Waypoints - Geographical positions, specified in latitude/longitude used in defining GPS instrument approach procedures, including the initial approach waypoint, the intermediate waypoint, the final approach waypoint, the missed approach waypoint, and the missed approach holding waypoint.

NAS - National Airspace System.

Receiver Autonomous Integrity Monitoring (RAIM) - A technique whereby a GPS receiver determines the integrity of the GPS navigation signals using only GPS signals or GPS signals augmented with altitude. At least one satellite in addition to those required for navigation must be in view for the receiver to perform RAIM function.

Sensor FAF - A final approach waypoint created and added to the database sequence of waypoints to support GPS navigation of an FAA-published, no-FAF, nonprecision instrument approach procedure.

TO-FROM Navigation - RNAV equipment in which the desired path over the ground is defined as a specific course emanating either to or from a particular waypoint. The equipment functions like a conventional VOR receiver where the CDI needle and the to/from indicator respond to the movement of the OBS. With this equipment, the aircraft may fly either to or from any single designated waypoint.

TO-TO Navigation - RNAV equipment in which a path is computed that connects two waypoints. With this equipment, two waypoints must always be available, and the aircraft is usually flying between the two waypoints and to the active waypoint. The CDI functions like it is tracking a localizer signal: movement of the OBS has no effect on the CDI needle or the to/from indicator.

Turn Anticipation - The capability of RNAV systems to determine the point along a course, prior to a turn waypoint, where a turn should be initiated to provide a smooth path to intercept the succeeding course within the protected airspace and to annunciate the information to the pilot.

User-selectable Navigation Database - A navigation database having user-defined contents accessible by the pilot and/or the navigation computer during aircraft operations in support of navigation needs. The database is stored electronically and is typically updated at regular intervals. It does not include data that can be entered manually by the pilot or operator.

Waypoint - A predetermined geographic position used for route definition and/or progress reporting purposes that is defined by latitude/longitude.

Chapter 10

Overview

Before conducting IFR operations utilizing GPS, the pilot must determine whether a GPS installation is approved for use under IFR by referring to the FAA-approved Airplane Flight Manual supplement. The equipment should be operated in accordance with the provisions of the applicable AFM including the specific start-up and self-test procedures for the GPS receiver. All pilots must be thoroughly familiar with the GPS equipment installed in the aircraft and its limitations.

Prior to any GPS IFR operation, the pilot should review the appropriate NOTAMs. NOTAMs will be issued to announce outages for specific GPS satellite vehicles by pseudo random noise (PRN) number and satellite vehicle number (SVN). GPS NOTAMs are issued under the identifier GPS. Pilots may obtain GPS NOTAM information by request to the FSS briefer or by requesting NOTAMs using the identifier GPS through the Direct User Access Terminal System (DUATS). Pilots should review the NOTAMs for the underlying approach procedure. When executing a Phase II approach, pilots should ensure the ground-based facilities upon which the approach is based are operational. If an approach is not authorized due to an inoperative navigation facility, the associated Phase II GPS approach is not authorized.

The pilot must select the appropriate airport(s), runway/approach procedure, and initial approach fix on the aircraft's GPS receiver to determine RAIM integrity for that approach. Air traffic controllers are not provided any information about the operational integrity of the system. This is especially important when the pilot has been cleared for the approach. Procedures should be established by the pilot in the event that GPS navigation outages are predicted or occur. In these situations, the pilot should rely on other approved equipment, delay departure, or cancel the flight.

Aircraft that are navigating by GPS are considered to be RNAV-equipped aircraft and the appropriate equipment suffix should be included in the ATC flight plan. Most users should file **/G**, indicating GPS and transponder with Mode C. Consult the latest edition of the Aeronautical Information Manual for appropriate suffix information. If the GPS avionics become inoperative, the pilot should advise ATC and amend the equipment suffix.

GPS Systems and Procedures

GPS domestic en route and terminal IFR operations can be conducted as soon as proper avionics systems are installed, provided all general requirements are met. The avionics necessary to receive all of the ground-based facilities appropriate for the route to the destination airport and any required alternate airport must be installed and operational. Ground-based facilities necessary for these routes must also be operational.

The GPS Approach Overlay Program is an authorization for pilots to use GPS avionics under IFR for flying designated nonprecision instrument approach procedures--except LOC, LDA and simplified directional facility (SDF) procedures. These procedures are now identified by the name of the procedure with *or GPS* appended (e.g., VOR/DME or GPS RWY 15). Other previous types of overlays have either been converted to this format or replaced with stand-alone procedures. Only approaches contained in the current onboard navigation database are authorized. The navigation database may contain information about non-overlay approach procedures that is intended to be used to enhance position orientation, generally by providing a map, while flying these approaches using conventional NAVAIDs. This approach information should not be confused with a GPS overlay approach (see the receiver operating manual, AFM, or AFM Supplement for details on how to identify these approaches in the navigation database).

Note that overlay approaches are predicated upon the design criteria of the ground-based NAVAID used as the basis of the approach. As such, they do not adhere to the design criteria for stand-alone GPS approaches.

GPS IFR approach operations can be conducted as soon as proper avionics systems are installed and the following conditions are adhered to:

- The authorization to use GPS to fly instrument approaches is limited to U.S. airspace.
- The use of GPS in any other airspace must be expressly authorized by the FAA Administrator.
- GPS instrument approach operations outside the U.S. must be authorized by the appropriate sovereign authority.

Subject to the restrictions below, operators in the U.S. NAS are authorized to use GPS equipment certified for IFR operations in place of ADF and/or DME equipment for en route and terminal operations. For some operations there is no requirement for the aircraft to be equipped with an ADF or DME receiver. The ground-based NDB or DME facility may be temporarily out of service during these operations.
Charting will not change to support these operations:

- Determining the aircraft position over a DME fix; GPS satisfies the 14 CFR section 91.205(e) requirement for DME at and above 24,000 feet mean sea level (FL 240).
- Flying a DME arc.
- Navigating to/from an NDB/compass locator.
- Determining the aircraft position over an NDB/compass locator.
- Determining the aircraft position over a fix defined by an NDB/compass locator bearing crossing a VOR/LOC course.
- Holding over an NDB/compass locator.

This approval does not alter the conditions and requirements for use of GPS to fly existing nonprecision instrument approach procedures as defined in the GPS approach overlay program.
Restrictions:

- GPS avionics approved for terminal IFR operations may be used in lieu of ADF and/or DME. Included in this approval are both stand-alone and multi-sensor systems actively employing GPS as a sensor. This equipment must be installed in accordance with appropriate airworthiness installation requirements and the provisions of the applicable FAA-approved AFM, AFM supplement, or pilot's guide. The required integrity for these operations must be provided by at least en route RAIM, or an equivalent method, i.e., Wide Area Augmentation System (WAAS).
- For air carriers and operators for compensation or hire, Principal Operations Inspector (POI) and operations specification approval is required for any use of GPS.
- Waypoints, fixes, intersections, and facility locations to be used for these operations must be retrieved from the GPS airborne database. The database must be current. If the required positions cannot be retrieved from the airborne database, the substitution of GPS for ADF and/or DME is not authorized.
- The aircraft GPS system must be operated within the guidelines contained in the AFM, AFM supplement, or pilot's guide.
- The CDI must be set to terminal sensitivity (normally 1 or 1 1/4 NM) when tracking a GPS course guidance in the terminal area. This is to ensure that small deviations from course are displayed to the pilot in order to keep the aircraft within the smaller terminal protected areas.
- Charted requirements for ADF and/or DME can be met using the GPS system, except for use as the principal instrument approach navigation source.
- Procedures must be established for use in the event that GPS integrity outages are predicted or occur (RAIM annunciation). In these situations, the flight must rely on other approved equipment; this may require the aircraft to be equipped with operational NDB and/or DME receivers.

- A non-GPS approach procedure must exist at the alternate airport when one is required. If the non-GPS approaches on which the pilot must rely require DME or ADF, the aircraft must be equipped with DME or ADF avionics as appropriate.

Guidance. The following provides general guidance which is not specific to any particular aircraft GPS system. For specific system guidance refer to the AFM, AFM supplement, pilot's guide, or contact the manufacturer of your system.

1. To determine the aircraft position over a DME fix:
    a. Verify aircraft GPS system integrity monitoring is functioning properly and indicates satisfactory integrity.
    b. If the fix is identified by a five-letter name which is contained in the GPS airborne database, you may select either the named fix as the active GPS waypoint (WP) or the facility establishing the DME fix as the active GPS WP. *NOTE: When using a facility as the active WP, the only acceptable facility is the DME facility which is charted as the one used to establish the DME fix. If this facility is not in your airborne database, you are not authorized to use a facility WP for this operation.*
    c. If the fix is identified by a five-letter name which is not contained in the GPS airborne database, or if the fix is not named, you must select the facility establishing the DME fix or another named DME fix as the active GPS WP. *NOTE: An alternative, until all DME sources are in the database, is using a named DME fix as the active waypoint to identify unnamed DME fixes on the same course and from the same DME source as the active waypoint.*

       CAUTION: Pilots should be extremely careful to ensure that correct distance measurements are used when utilizing this interim method. It is strongly recommended that pilots review distances for DME fixing during preflight preparation.

    d. If you select the named fix as your active GPS WP, you are over the fix when the GPS system indicates you are at the active WP.
    e. If you select the DME providing facility as the active GPS WP, you are over the fix when the GPS distance from the active WP equals the charted DME value and you are on the appropriate bearing or course.
2. To fly a DME arc:
    a. Verify aircraft GPS system integrity monitoring is functioning properly and indicates satisfactory integrity.
    b. You must select, from the airborne database, the facility providing the DME arc as the active GPS WP. *NOTE: The only acceptable facility is the DME facility on which the arc is based. If this facility is not in your airborne database, you are not authorized to perform this operation.*
    c. Maintain position on the arc by reference to the GPS distance in lieu of a DME readout.
3. To navigate to or from an NDB/compass locator: *NOTE: If the chart depicts the compass locator collocated with a fix of the same name, use of that fix as the active WP in place of the compass locator facility is authorized.*
    a. Verify aircraft GPS system integrity monitoring is functioning properly and indicates satisfactory integrity.
    b. Select terminal CDI sensitivity in accordance with the AFM, AFM supplement, or pilot's guide if in the terminal area.
    c. Select the NDB/compass locator facility from the airborne database as the active WP.
    d. Select and navigate on the appropriate course to or from the active WP.

4. To determine the aircraft position over an NDB/compass locator:
    a. Verify aircraft GPS system integrity monitoring is functioning properly and indicates satisfactory integrity.
    b. Select the NDB/compass locator facility from the airborne database as the active WP. *NOTE: When using an NDB/compass locator, that facility must be charted and be in the airborne database. If this facility is not in your airborne database, you are not authorized to use a facility WP for this operation.*
    c. You are over the NDB/compass locator when the GPS system indicates you are at the active WP.
5. To determine the position over a fix made up of an NDB/compass locator bearing crossing a VOR/LOC course:
    a. Verify aircraft GPS system integrity monitoring is functioning properly and indicates satisfactory integrity.
    b. A fix made up by a crossing NDB/compass locator bearing will be identified by a five-letter fix name. You may select either the named fix or the NDB/compass locator facility providing the crossing bearing to establish the fix as the active GPS WP. *NOTE: When using an NDB/compass locator, that facility must be charted and be in the airborne database. If this facility is not in your airborne database, you are not authorized to use a facility WP for this operation.*
    c. If you select the named fix as your active GPS WP, you are over the fix when the GPS system indicates you are at the WP as you fly the prescribed track from the non-GPS navigation source.
    d. If you select the NDB/compass locator facility as the active GPS WP, you are over the fix when the GPS bearing to the active WP is the same as the charted NDB/compass locator bearing for the fix as you fly the prescribed track from the non-GPS navigation source.
6. To hold over an NDB/compass locator:
    a. Verify aircraft GPS system integrity monitoring is functioning properly and indicates satisfactory integrity.
    b. Select terminal CDI sensitivity in accordance with the AFM, AFM supplement, or pilot's guide if in the terminal area.
    c. Select the NDB/compass locator facility from the airborne database as the active WP. *NOTE: When using a facility as the active WP, the only acceptable facility is the NDB/compass locator facility which is charted. If this facility is not in your airborne database, you are not authorized to use a facility WP for this operation.*
    d. Select nonsequencing (e.g. HOLD or OBS) mode and the appropriate course in accordance with the AFM, AFM supplement, or pilot's guide.
    e. Hold using the GPS system in accordance with the AFM, AFM supplement, or pilot's guide.

Planning Ahead

Good planning and intimate knowledge of your navigational systems are vital to safe and successful use of GPS in lieu of ADF and/or DME.

You should plan ahead before using GPS systems as a substitute for ADF and/or DME; you will have several alternatives in selecting waypoints and system configurations. In the flight planning process you should determine whether you will use the equipment in the automatic sequencing mode or in the nonsequencing mode and select the waypoints you will use.

When you are using your aircraft GPS system to supplement other navigation systems, you may need to bring your GPS control panel into your navigation scan to see the GPS information. Some GPS aircraft installations will present localizer information on the CDI whenever a localizer frequency is tuned, removing the GPS information from the CDI display.

When installing a GPS receiver in your aircraft, install it within or near the primary instrument cluster to facilitate using the GPS in lieu of ADF and/or DME. This will preclude breaking the primary instrument scan. This becomes increasingly important on approaches and missed approaches.

Many GPS receivers can drive an ADF-type bearing pointer. Such an installation will provide the pilot with an enhanced level of situational awareness by providing GPS navigation information while the CDI is set to VOR or ILS.

The GPS receiver may be installed so that when an ILS frequency is tuned, the navigation display defaults to the VOR/ILS mode, preempting the GPS mode. However, if the receiver installation requires a manual selection from GPS to ILS, it allows the ILS to be tuned and identified while navigating on the GPS. Additionally, this prevents the navigation display from automatically switching back to GPS when a VOR frequency is selected. If the navigation display automatically switches to GPS mode when a VOR is selected, the change may go unnoticed and could result in erroneous navigation and departing protected airspace.

GPS is a supplemental navigation system in part due to signal availability. There will be times when your system will not receive enough satellites with proper geometry to provide accurate positioning or sufficient integrity. Procedures should be established by the pilot in the event that GPS outages occur. In these situations, the pilot should rely on other approved equipment, delay departure, reroute or discontinue IFR operations.

Equipment and Database Requirements

Authorization to fly approaches under IFR using GPS avionics systems requires that a pilot use a GPS approved for IFR terminal procedures (check the FAA-approved Airplane Flight Manual supplement) and all approach procedures to be flown must be retrievable from the current airborne navigation database supplied by the equipment manufacturer or other FAA-approved source.

GPS Approaches

Pilots should "arm" or enable the GPS approach mode prior to the IAF and fly the full approach from an Initial Approach Waypoint (IAWP) or feeder fix unless specifically cleared otherwise. Randomly joining an approach at an intermediate fix does not ensure terrain clearance.

When an approach has been loaded in the flight plan, GPS receivers will give an arm annunciation at 30 NM straight-line distance from the airport reference point. Pilots should arm the approach mode at this time if it has not already been armed (some receivers arm automatically). Without arming, the receiver will not change from en route CDI and RAIM sensitivity of ±5 NM either side of centerline to ±1 NM terminal sensitivity.

Where the IAWP is inside this 30 mile point, a CDI sensitivity change will occur once the approach mode is armed and the aircraft is inside 30 NM. Where the IAWP is beyond 30 NM from the airport reference point, CDI sensitivity will not change until the aircraft is within 30 miles of this reference point even if the approach is armed earlier. Feeder route obstacle clearance is predicated on the receiver being in terminal (±1 NM) CDI sensitivity and RAIM within 30 NM of the airport reference point. Therefore the receiver should always be armed (if required) no later than the 30 NM annunciation.

The pilot must be aware of what bank angle/turn rate the particular receiver uses to compute turn anticipation and whether wind and airspeed are included in the receiver's calculations. This information should be in the receiver operating manual. Over or under-banking the turn onto the final approach course may significantly delay getting on course and may necessitate higher descent rates to achieve the next segment altitude.

When within two nautical miles of the FAWP with the approach mode armed, the approach mode will switch to active, which results in RAIM changing to approach sensitivity and a change in CDI sensitivity. At two nautical miles prior to the FAWP, the full scale CDI sensitivity will smoothly change from ±1 NM to ±0.3 NM at the FAWP. As sensitivity changes from ±1 NM to ±0.3 NM approaching the FAWP and the CDI is not centered, the corresponding increase in CDI displacement may give the impression that the aircraft is moving further away from the intended course even though it is on an acceptable intercept heading.

Referencing the digital track displacement information (cross-track error), if it is available in the approach mode, may help the pilot remain position-oriented in this situation. Being established on the final approach course prior to the beginning of the sensitivity change at two nautical miles will help prevent problems in interpreting the CDI display during scale change. Therefore, requesting or accepting vectors which will cause the aircraft to intercept the final approach course within two NM of the FAWP is not recommended.

When receiving vectors to final, most receiver operating manuals suggest placing the receiver in the nonsequencing mode on the FAWP and manually setting the course. This provides an extended final approach course in cases where the aircraft is vectored onto the final approach course outside of any existing segment which is aligned with the runway. Assigned altitudes must be maintained until established on a published segment of the approach. Required altitudes at waypoints outside the FAWP or stepdown fixes must be considered. Calculating the distance to the FAWP may be required in order to descend at the proper location.

Overriding an automatically selected sensitivity during an approach will cancel the approach mode annunciation. If the approach mode is not armed by two nautical miles prior to the FAWP, the approach mode will not become active and the equipment will flag accordingly. In these conditions the RAIM and CDI sensitivity will not scale down; the pilot should not descend to MDA but fly to the MAWP and execute a missed approach. The approach-active annunciator and/or the receiver should be checked to ensure the approach mode is active prior to the FAWP.

Do not attempt to fly an approach unless the procedure is contained in the current, onboard navigation database and identified as *GPS* on the approach chart. GPS approaches are normally designed to eliminate inefficient and time-consuming course reversals such as procedure turns and holding patterns. Waypoint sequencing is automatic and may have to be disabled by the pilot in the event that a course reversal becomes necessary.

The navigation database may contain information about non-overlay approach procedures that is intended to be used to enhance position orientation, generally by providing a map, while flying these approaches using conventional NAVAIDs. This approach information should not be confused with a GPS overlay approach (see the receiver operating manual, AFM, or AFM Supplement for details on how to identify these procedures in the navigation database). Flying point to point on the approach does not assure compliance with the published approach procedure. The proper RAIM sensitivity will not be available and the CDI sensitivity will not automatically change to ±0.3 NM. Manually setting CDI sensitivity does not automatically change the RAIM sensitivity on some receivers. Some existing nonprecision approach procedures cannot be coded for use with GPS and will not be available as overlays.

Pilots should pay particular attention to the exact operation of their GPS receivers for performing holding patterns. In the case of overlay approaches, operations such as procedure turns may require manual intervention by the pilot to stop the sequencing of waypoints by the receiver and to resume automatic GPS navigation sequencing once the maneuver is complete. The same waypoint may appear in the route of flight more than once consecutively (e.g., IAWP, FAWP, MAHWP on a procedure turn).

Care must be exercised to ensure that the receiver is sequenced to the appropriate waypoint for the segment of the procedure being flown, especially if one or more fly-overs are skipped (e.g., FAWP rather than IAWP if the procedure turn is not flown). The pilot may have to sequence past one or more fly-overs of the same waypoint in order to start GPS automatic sequencing at the proper place in the sequence. Incorrect inputs into the GPS receiver are especially critical during approaches. In some cases, an incorrect entry can cause the receiver to leave the approach mode.

A fix on an overlay approach identified by a DME fix will not be in the waypoint sequence on the GPS receiver unless there is a published name assigned to it. When a name is assigned, the along track distance (ATD) to the waypoint may be zero rather than the DME stated on the approach chart. The pilot should be alert for this on any overlay procedure where the original approach used DME.

If a visual descent point (VDP) is published, it will not be included in the sequence of waypoints. Pilots are expected to use normal piloting techniques for beginning the visual descent, such as ATD.
Unnamed step-down fixes in the final approach segment will not be coded in the waypoint sequence of the aircraft's navigation database and must be identified using ATD. Step-down fixes in the final approach segment of RNAV (GPS) approaches are being named, in addition to being identified by ATD. However, since most GPS avionics do not accommodate waypoints between the FAF and MAP (even when the waypoint is named) the waypoints for these step-down fixes may not appear in the sequence of waypoints in the navigation database. Pilots must continue to identify these step-down fixes using ATD.

Missed Approach

A GPS missed approach requires pilot action to sequence the receiver past the MAWP to the missed approach portion of the procedure. The pilot must be thoroughly familiar with the activation procedure for the particular GPS receiver installed in the aircraft and must initiate appropriate action after the MAWP. Activating the missed approach prior to the MAWP will cause CDI sensitivity to immediately change to terminal (±1NM) sensitivity and the receiver will continue to navigate to the MAWP. The receiver will not sequence past the MAWP. Turns should not begin prior to the MAWP. If the missed approach is not activated, the GPS receiver will display an extension of the inbound final approach course and the ATD will increase from the MAWP until it is manually sequenced after crossing the MAWP.
Missed approach routings in which the first track is via a course rather than direct to the next waypoint require additional action by the pilot to set the course. Being familiar with all of the inputs required is especially critical during this phase of flight.

Summary

Pilots should practice GPS approaches under visual meteorological conditions until thoroughly proficient with all aspects of their equipment prior to attempting flight by IFR in instrument meteorological conditions. Some of the areas which the pilot should practice are:

- Utilizing the RAIM prediction function.
- Inserting a DP into the flight plan, including setting terminal CDI sensitivity, if required, and the conditions under which terminal RAIM is available for departure.
- Programming the destination airport.
- Programming and flying the overlay approaches (especially procedure turns and arcs).
- Changing to another approach after selecting an approach.
- Programming and flying "direct" missed approaches.
- Programming and flying "routed" missed approaches.
- Entering, flying, and exiting holding patterns, particularly on overlay approaches with a second waypoint in the holding pattern.
- Programming and flying a route from a holding pattern.
- Programming and flying an approach with radar vectors to the intermediate segment.
- Know indications and actions required for RAIM failure both before and after the FAWP.
- Programming a radial and distance from a VOR (often used in departure instructions).

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