Chapter 11

Emergency Operations

Introduction

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

Unforecast Adverse Weather

Inadvertent Thunderstorm Encounter

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

As with any emergency, the first order of business during an inadvertent thunderstorm encounter must be to fly the aircraft. The pilot workload is heavy; therefore, increased concentration is necessary to maintain an instrument scan. If a pilot inadvertently enters a thunderstorm, it is better to maintain a course straight through the thunderstorm rather than turning around. A straight course minimizes the amount of time in the thunderstorm and turning maneuvers only increase structural stress on the aircraft.

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

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

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

Inadvertent Icing Encounter

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

The effects of ice on aircraft are cumulative—thrust is reduced, drag increases, lift lessens, and weight increases. The results are an increase in stall speed and a deterioration of aircraft performance. In extreme cases, two to three inches of ice can form on the leading edge of the airfoil in less than 5 minutes. It takes only 1/2 inch of ice to reduce the lifting power of some aircraft by 50 percent and increases the frictional drag by an equal percentage.

A pilot can expect icing when flying in visible precipitation, such as rain or cloud droplets, and the temperature is between +02 and -10° Celsius. When icing is detected, a pilot should do one of two things, particularly if the aircraft is not equipped with deicing equipment: leave the area of precipitation or go to an altitude where the temperature is above freezing. This "warmer" altitude may not always be a lower altitude. Proper preflight action includes obtaining information on the freezing level and the above-freezing levels in precipitation areas.

If neither option is available, consider an immediate landing at the nearest suitable airport. Even if the aircraft is equipped with anti-icing/deicing equipment, it is not designed to allow aircraft to operate indefinitely in icing conditions. Anti-icing/deicing equipment gives a pilot more time to get out of the icing conditions. Report icing to ATC and request new routing or altitude. Be sure to report the type of aircraft, and use the following terms when reporting icing to ATC:

1. Trace. Ice becomes perceptible. Rate of accumulation is slightly greater than sublimation. Deicing/anti-icing equipment is not utilized unless encountered for an extended period of time (over 1 hour).
2. Light. The rate of accumulation may create a problem if flight is prolonged in this environment (over 1 hour). Occasional use of deicing/anti-icing equipment removes/prevents accumulation. It does not present a problem if deicing/anti-icing equipment is used.
3. Moderate. The rate of accumulation is such that even short encounters become potentially hazardous and use of deicing/anti-icing equipment or flight diversion is necessary.
4. Severe. The rate of accumulation is such that deicing/anti-icing equipment fails to reduce or control the hazard. Immediate flight diversion is necessary.

Early ice detection is critical and is particularly difficult during night flight. Use a flashlight to check for ice accumulation on the wings. At the first indication of ice accumulation, take action to get out of the icing conditions. Refer to the POH/AFM for the proper use of anti-icing/deicing equipment.

Figure 11-1. *St. Elmo's Fire is harmless but may affect both communication and navigation radios, especially the lower frequencies such as those used on the ADF.*

Precipitation Static

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

Precipitation static is caused when an aircraft encounters airborne particles during flight (e.g., rain or snow), and develops a negative charge. It can also result from atmospheric electric fields in thunderstorm clouds. When a significant negative voltage level is reached, the aircraft discharges it, which can create electrical disturbances. This electrical discharge builds with time as the aircraft flies in precipitation. It is usually encountered in rain, but snow can cause the same effect. As the static buildup increases, the effectiveness of both communication and navigation systems decreases to the point of potential unusability.

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

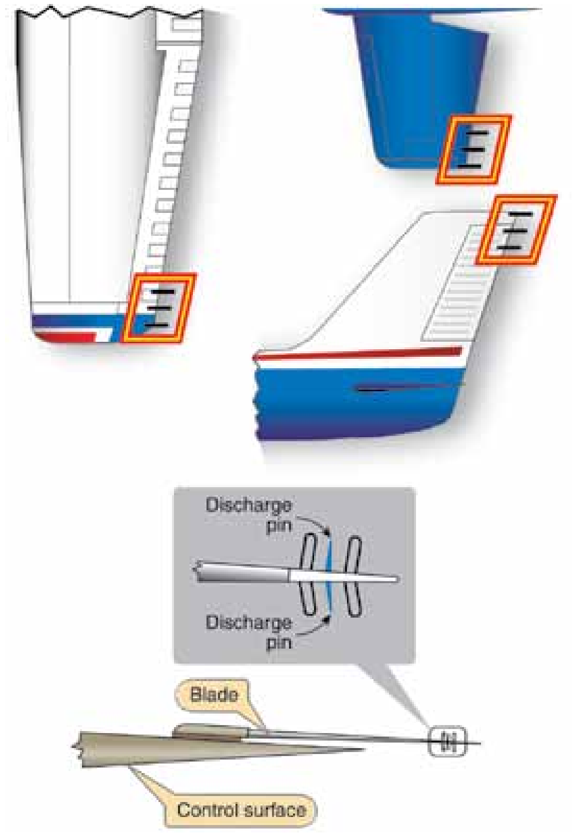

Figure 11-2. *One example of a static wick installed on aircraft control surface to bleed off static charges built up during flight. This will prevent static buildup and St. Elmo's fire by allowing the static electricity to dissipate harmlessly.*

Aircraft System Malfunctions

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

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

Electronic Flight Display Malfunction

When a pilot becomes familiar and comfortable with the new electronic displays, he or she also tends to become more reliant on the system. The system then becomes a primary source of navigation and data acquisition instead of the supplementary source of data as initially intended.

Complete reliance on the moving map for navigation becomes a problem during a failure of one, more, or all of the flight display screens. Under these conditions, the systems revert to a composite mode (called reversionary), which eliminates the moving map display and combines the PFD with the engine indicating system. *[Figure 11-3]* If a pilot has relied on the display for navigation information and situational awareness, he or she lacks any concept of critical data such as the aircraft's position, the nearest airport, or proximity to other aircraft.

The electronic flight display is a supplementary source of navigation data and does not replace en route charts. To maintain situational awareness, a pilot must follow the flight on the en route chart while monitoring the PFD. It is important for the pilot to know the location of the closest airport as well as surrounding traffic relative to the location of his or her aircraft. This information becomes critical should the electronic flight display fail.

For the pilot who utilizes the electronic database as a substitute for the Airport Facilities Directory, screen failure or loss of electrical power can mean the pilot is no longer able to access airport information. Once the pilot loses the ability to call up airport information, aeronautical decision-making is compromised.

Alternator/Generator Failure

Depending upon the aircraft being flown, an alternator failure is indicated in different ways. Some aircraft use an ammeter

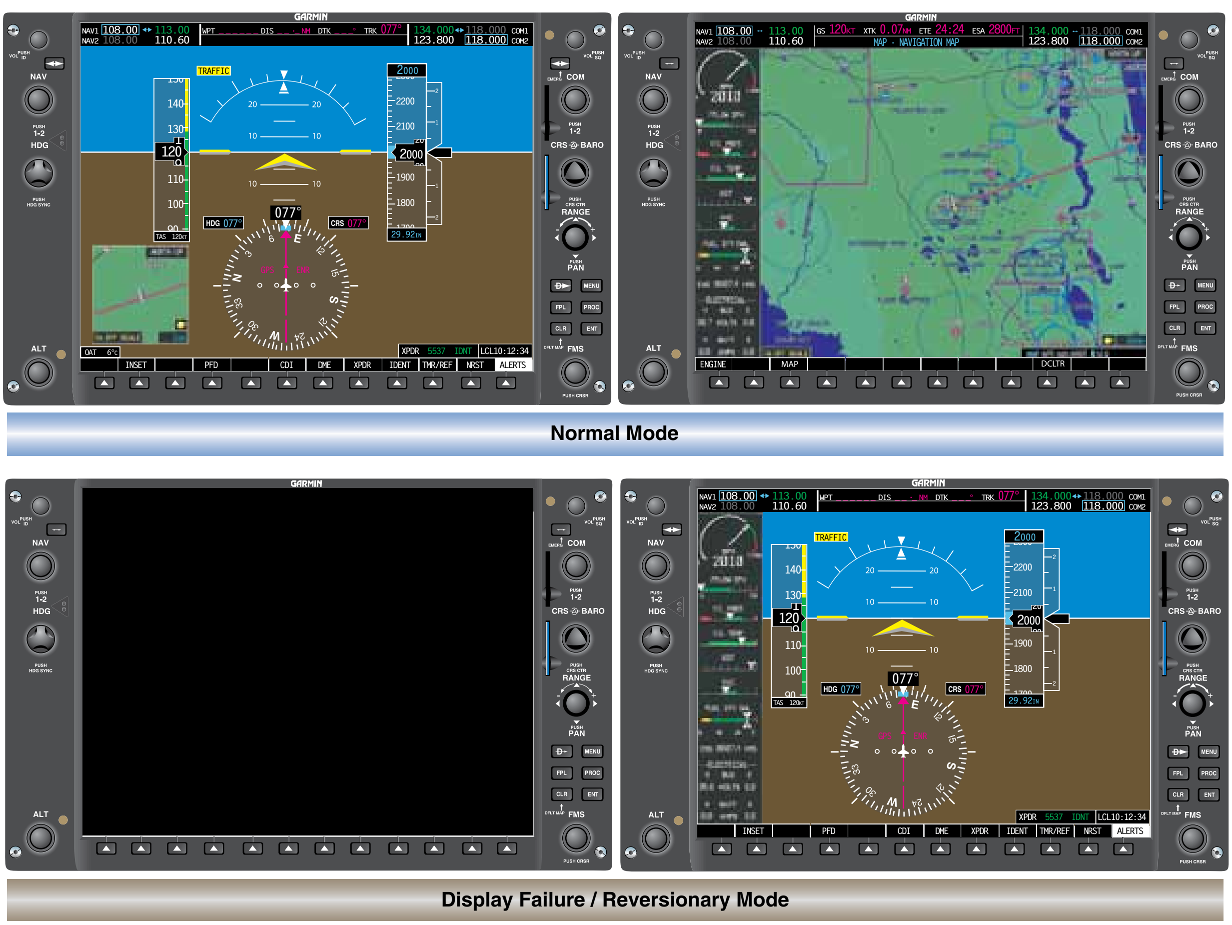

Figure 11-3. *G1000 PFD display in normal mode and in the reversionary mode activated upon system failure.*

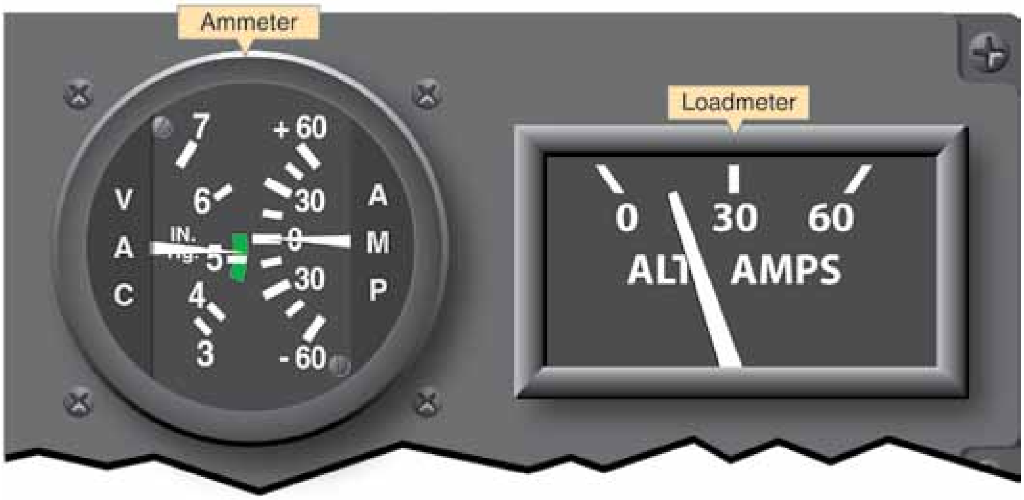

Figure 11-4. *Ammeter (left) and Loadmeter (right).*

that indicates the state of charge or discharge of the battery. *[Figure 11-4]* A positive indication on the ammeter indicates a charge condition; a negative indication reveals a discharge condition. Other aircraft use a load meter to indicate the load being carried by the alternator. *[Figure 11-4]*

Sometimes an indicator light is also installed in the aircraft to alert the pilot to an alternator failure. On some aircraft such as the Cessna 172, the light is located on the lower left side making it difficult to see its illumination if charts are open Ensure that these safety indicators are visible during flight.

When a loss of the electrical charging system is experienced, the pilot has approximately 40 minutes of battery life remaining before the system fails entirely. The time mentioned is an approximation and should not be relied upon as specific to all aircraft. In addition, the battery charge that exists in a battery may not be full, altering the time available before electrical exhaustion occurs. At no time should a pilot consider continuing a flight once the electrical charging system has failed. Land at the nearest suitable airport.

Techniques for Electrical Usage

Master Battery Switch

One technique for conserving the main battery charge is to fly the aircraft to the airport of intended landing while operating with minimal power. If a two-position battery master/alternator rocker switch *[Figure 11-5]* is installed, it can be utilized to isolate the main battery from the electrical system and conserve power.

Operating on the Main Battery

While en route to the airport of intended landing, reduce the electrical load as much as practical. Turn off all unnecessary electrical items such as duplicate radios, non-essential lighting, etc. If unable to turn off radios, lights, etc. manually, consider pulling circuit breakers to isolate those pieces of equipment from the electrical system. Maximum time of useful voltage may be between 30 and 40 minutes and is influenced by many factors, which degrade the useful time.

Loss of Alternator/Generator for Electronic Flight Instrumentation

With the increase in electrical components being installed in modern technically advanced aircraft, the power supply and the charging system need increased attention and understanding. Traditional round dial aircraft do not rely as heavily on electrical power for the primary six-pack instrumentation. Modern electronic flight displays utilize the electrical system to power the AHRS, ADC, engine indicating system (EIS), etc. A loss of an alternator or generator was considered an abnormality in traditionally equipped aircraft;

Figure 11-5. *Double Rocker Switch Seen on Many Aircraft.*

however, a failure of this magnitude is considered an emergency in technically advanced aircraft.

Due to the increased demand for electrical power, it is necessary for manufacturers to install a standby battery in conjunction with the primary battery. The standby battery is held in reserve and kept charged in case of a failure of the charging system and a subsequent exhaustion of the main battery. The standby battery is brought online when the main battery voltage is depleted to a specific value, approximately 19 volts. Generally, the standby battery switch must be in the ARM position for this to occur but pilots should refer to the aircraft flight manual for specifics on an aircraft's electrical system. The standby battery powers the essential bus and allows the primary flight display (PFD) to be utilized.

The essential bus usually powers the following components:

1. AHRS (Attitude and Heading Reference System)
2. ADC (Air Data Computer)
3. PFD (Primary Flight Display)
4. Navigation Radio #1
5. Communication Radio #1
6. Standby Indicator Light

Techniques for Electrical Usage

Standby Battery

One technique for conserving the main battery charge is to fly the aircraft to the airport of intended landing while using the standby battery. A two-position battery master/alternator rocker switch is installed on most aircraft with electronic flight displays, which can be utilized to isolate the main battery from the electrical system. By switching the MASTER side off, the battery is taken offline and the standby battery comes online to power the essential bus. However, the standby battery switch must be in the ARM position for this to occur. *[Figure 11-6]* Utilization of the standby battery first reserves the main battery for use when approaching to land. With this technique, electrical power may be available for the use of flaps, gear, lights, etc. Do not rely on any power to be available after the standby battery has exhausted itself. Once the charging system has failed, flight with a powered electrical system is not guaranteed.

Operating on the Main Battery

While en route to the airport of intended landing, reduce the electrical load as much as practical. Turn off all unnecessary electrical items such as duplicate radios, non-essential lighting, etc. If unable to turn off radios, lights, etc., manually, consider pulling circuit breakers to isolate those pieces of equipment from the electrical system. Keep in mind that once the standby battery has exhausted its charge, the flight deck may become very dark depending on what time of day the failure occurs. The priority during this emergency situation is landing the aircraft as soon as possible without jeopardizing safety.

A standby attitude indicator, altimeter, airspeed indicator (ASI) and magnetic compass are installed in each aircraft for use when the PFD instrumentation is unavailable. *[Figure 11-7]* These would be the only instruments left available to the pilot. Navigation would be limited to pilotage and dead reckoning unless a hand-held transceiver with a GPS/navigation function is onboard.

Once an alternator failure has been detected, the pilot must reduce the electrical load on the battery and land as soon as practical. Depending upon the electrical load and condition of the battery, there may be sufficient power available for 45 minutes of flight—or for only a matter of minutes. Pilots should also know which systems on the aircraft are electric and those that continue to operate without electrical power. Pilots can attempt to troubleshoot alternator failure by following the established alternator failure procedure published in the POH/AFM. If the alternator cannot be reset, advise ATC of the situation and inform them of the impending electrical failure.

Analog Instrument Failure

A warning indicator or an inconsistency between indications on the attitude indicator and the supporting performance

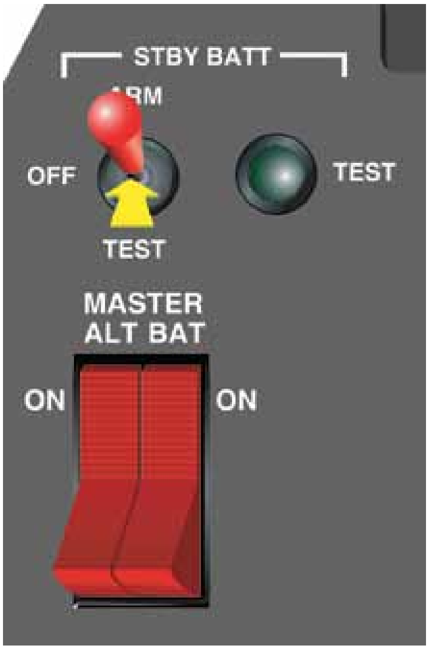

Figure 11-6. *Note the double rocker switch and the standby battery switch in this aircraft. The standby battery must be armed to work correctly; arming should be done prior to departure.*

Figure 11-7. *Emergency Instrumentation Available to the Pilot on Electronic Flight Instrumented Aircraft.*

instruments usually identifies system or instrument failure. Aircraft control must be maintained while identifying the failed component(s). Expedite the cross-check and include all flight instruments. The problem may be individual instrument failure or a system failure affecting multiple instruments.

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

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

Pneumatic System Failure

One possible cause of instrument failure is a loss of the suction or pressure source. This pressure or suction is supplied by a vacuum pump mechanically driven off the engine. Occasionally these pumps fail, leaving the pilot with inoperative attitude and heading indicators.

Figure 11-8 illustrates inoperative vacuum driven attitude and heading indicators which can fail progressively. As the gyroscopes slow down they may wander, which, if connected to the autopilot and/or flight director, can cause incorrect movement or erroneous indications. In *Figure 11-8,* the aircraft is actually level and at 2,000 feet MSL. It is not in a turn to the left which the pilot may misinterpret if he or she fails to see the off or failed flags. If that occurs, the pilot may transform a normally benign situation into a hazardous situation. Again, good decision-making by the pilot only occurs after a careful analysis of systems.

Many small aircraft are not equipped with a warning system for vacuum failure; therefore, the pilot should monitor the system's vacuum/pressure gauge. This can be a hazardous situation with the potential to lead the unsuspecting pilot into a dangerous unusual attitude which would require a partial panel recovery. It is important that pilots practice instrument flight without reference to the attitude and heading indicators in preparation for such a failure.

Pitot/Static System Failure

A pitot or static system failure can also cause erratic and unreliable instrument indications. When a static system

Figure 11-8. *Vacuum Failure.*

problem occurs, it affects the ASI, altimeter, and the VSI. In most aircraft, provisions have been made for the pilot to select an alternate static source. Check the POH/AFM for the location and operation of the alternate static source. In the absence of an alternate static source, in an unpressurized aircraft, the pilot could break the glass on the VSI. The VSI is not required for instrument flight, and breaking the glass provides the altimeter and the ASI a source of static pressure. This procedure could cause additional instrument errors.

Communication/Navigation System Malfunction

Avionics equipment has become very reliable, and the likelihood of a complete communications failure is remote. However, each IFR flight should be planned and executed in anticipation of a two-way radio failure. At any given point during a flight, the pilot must know exactly what route to fly, what altitude to fly, and when to continue beyond a clearance limit. Title 14 of the Code of Federal Regulations (14 CFR) part 91 describes the procedures to be followed in case of a two-way radio communications failure. If operating in VFR conditions at the time of the failure, the pilot should continue the flight under VFR and land as soon as practicable. If the failure occurs in IFR conditions, or if VFR conditions cannot be maintained, the pilot must continue the flight:

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

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

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

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

1. When the clearance limit is a fix from which an approach begins, commence descent or descent and approach as close as possible to the expect-further-clearance time if one has been received. If an expect-further-clearance time has not been received, commence descent or descent and approach as close as possible to the estimated time of arrival as calculated from the filed or amended (with ATC) estimated time en route.

2. If the clearance limit is not a fix from which an approach begins, leave the clearance limit at the expect-further-clearance time if one has been received. If no expect-further-clearance time has been received, leave the clearance limit upon arrival over it, and proceed to a fix from which an approach begins and commence descent or descent and approach as close as possible to the estimated time of arrival as calculated from the filed or amended (with ATC) estimated time en route. *[Figure 11-8]*

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

GPS Nearest Airport Function

Procedures for accessing the nearest airport information vary by the type of display installed in an aircraft. Pilots can obtain information relative to the nearest airport by using the PFD, MFD, or the nearest function on the GPS receiver. The following examples are based on a popular system. Pilots should become familiar with the operational characteristics of the equipment to be used.

Nearest Airports Using the PFD

With the advancements in electronic databases, diverting to alternate airports has become easier. Simply by pressing a soft key on the PFD, pilots can access information for up to 25 of the nearest airports that meet the criteria set in the systems configuration page. *[Figure 11-9]* Pilots are able to specify what airports are acceptable for their aircraft requirements based on landing surface and length of runway.

When the text box opens, the flashing cursor is located over the nearest airport that meets the criteria set in the auxiliary setup page as shown in *Figure 11-10*. Scrolling through the 25 airports is accomplished by turning the outer FMS knob, which is located on the lower right corner of the display screen. Turning the FMS knob clockwise moves the blinking cursor to the next closest airport. By continuing to turn the knob, the pilot is able to scroll through all 25 nearest airports. Each airport box contains the information illustrated in *Figure 11-11,* which the pilot can utilize to determine which airport best suits their individual needs.

Additional Information for a Specific Airport

In addition to the information that is presented on the first screen, the pilot can view additional information as shown in *Figure 11-12* by highlighting the airport identifier and then pressing the enter key.

Figure 11-9. *The default soft key menu that is displayed on the PFD contains a "NRST" (Nearest Airport) soft key. Pressing this soft key opens a text box which displays the nearest 25 airports.*

Figure 11-10. *An enlargement of the box shown in the lower right of Figure 11-9. Note that KGNV would be flashing.*

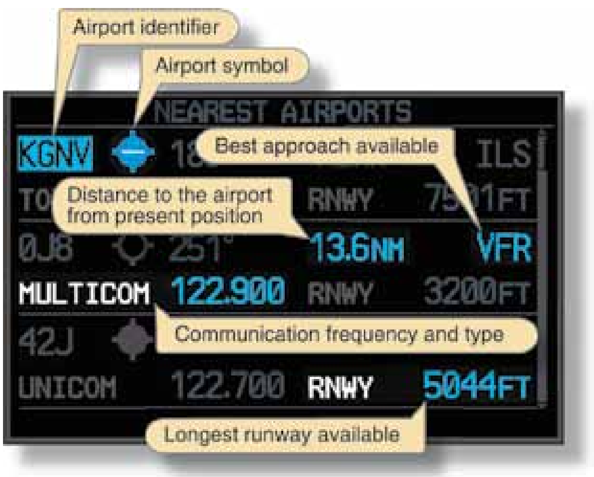

Figure 11-11. *Information shown on the nearest airport page.*

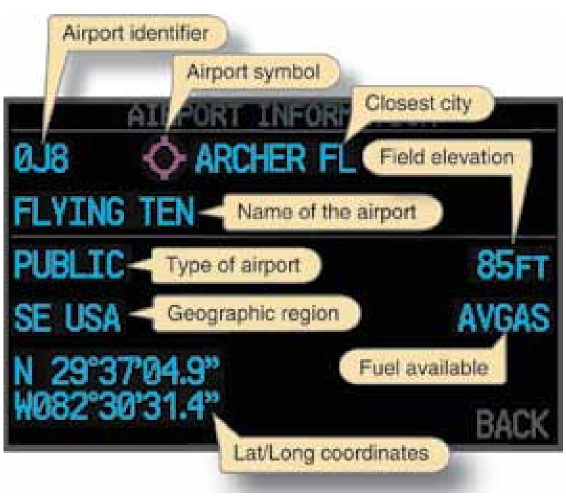

Figure 11-12. *Information shown on the additional information page that will aid the pilot in making a more informed decision about which airport to choose when diverting.*

From this menu or the previous default nearest airport screen, the pilot is able to activate the Direct-To function, which provides a direct GPS course to the airport. In addition, the pilot can auto-tune communication frequencies by highlighting the appropriate frequency and then pressing the enter key. The frequency is placed in the stand-by box of either COM1 or COM2, whichever frequency has the cyan box around it.

Nearest Airports Using the MFD

A second way to determine the nearest airport is by referencing the NRST Page Group located on the MFD. This method provides additional information to the pilot; however, it may require additional steps to view. *[Figure 11-13]*

Navigating the MFD Page Groups

Most display systems are designed for ease of navigation through the different screens on the MFD. Notice the various page groups in the lower right-hand corner of the MFD screen. Navigation through these four page groups is accomplished by turning the outer FMS knob clockwise. *[Figure 11-14]*

Within each page group are specific pages that provide additional information pertaining to that specific group. Once the desired page group and page is selected, the MFD remains in that configuration until the page is changed or the CLR button is depressed for more than 2 seconds. Holding the CLR button returns the display to the default moving map page.

Nearest Airport Page Group

The nearest airport page contains specific areas of interest for the airport selected. *[Figure 11-15]* The pilot is furnished information regarding runways, frequencies, and types of approaches available.

Nearest Airports Page Soft Keys

Figure 11-16 illustrates four specific soft keys that allow the pilot to access independent windows of the airport page. Selection of each of these windows can also be accomplished by utilizing the MENU hard key.

The soft keys and functions are as follows: Scroll through each section with the cursor, then press enter to accept the selection.

1. APT. Allows the user access to scroll through the 25 nearest airports. The white arrow indicates which airport is selected. The INFORMATION window is slaved to the white arrow. The INFORMATION window decodes the airport identifier. Scroll through the 25 airports by turning the outer FMS knob.

Figure 11-13. *The MFD is another means of viewing the nearest airports.*

2. RNWY. Moves the cursor into the Runways section and allows the user to scroll through the available runways at a specific airport that is selected in conjunction with the APT soft key. A green arrow indicates additional runways to view.

3. FREQ. Moves the cursor into the Frequencies section and allows the pilot to highlight and auto-tune the frequency into the selected standby box.

4. APR. Moves the cursor into the Approach section and allows the pilot to review approaches and load them into the flight plan. When the APR soft key is selected, an additional soft key appears. The LD APR (Load Approach) soft key must be pressed once the desired instrument approach procedure has been highlighted. Once the soft key is pressed, the screen changes to the PROC Page Group. From this page the pilot is able to choose the desired approach, the transition, and choose the option to activate the approach or just load it into the flight plan.

Situational Awareness

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

Figure 11-14. *Page Groups. As the FMS outer knob is rotated, the current page group is indicated by highlighting the specific group indicator. Notice that the MAP page group is highlighted.*

Figure 11-15. *The page group of nearest airports has been selected.*

lacks a vision of future events and is forced to make decisions quickly, often with limited options.

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

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

Pilots should be alert to a loss of SA anytime they are in a reactive mindset. To regain SA, reassess the situation and seek additional information from other sources, such as the navigation instruments or ATC.

Traffic Avoidance

Electronic flight displays have the capability of displaying transponder-equipped aircraft on the MFD as well as the inset map on the PFD. However, due to the limitations of the systems, not all traffic is displayed. Some TIS units display only eight intruding targets within the service volume. The normal service volume has altitude limitations of 3,500 feet below the aircraft to 3,500 feet above the aircraft. The lateral limitation is 7 NM. *[Figure 11-17]* Pilots unfamiliar with the limitations of the system may rely on the aural warnings to alert them to approaching traffic.

In addition to an outside visual scan of traffic, a pilot should incorporate any Traffic Information electronically displayed such as TIS. This innovation in traffic alerting reinforces and adds synergy to the ability to see and avoid. However, it is an aid and not a replacement for the responsibilities of the pilot. Systems such as TIS provide a visual representation of nearby traffic and displays a symbol on the moving map display with relative information about altitude, vertical trends, and direction of flight. *[Figure 11-18]*

It is important to remember that most systems display only a specific maximum number of targets allowed. Therefore, it

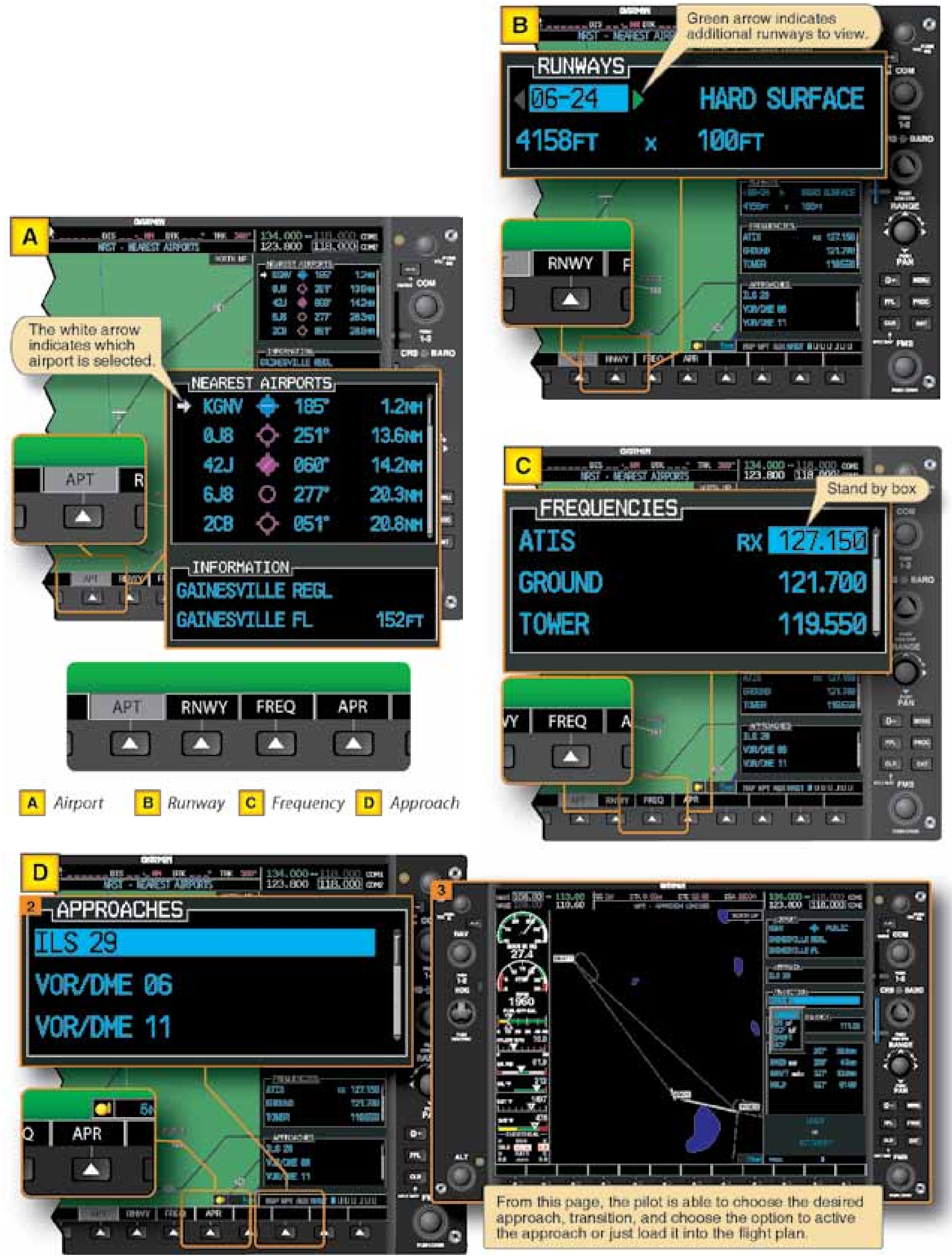

Figure 11-16. *The four soft keys at the bottom of the MFD are airport (A), runway (B), frequency (C), and approach (D).*

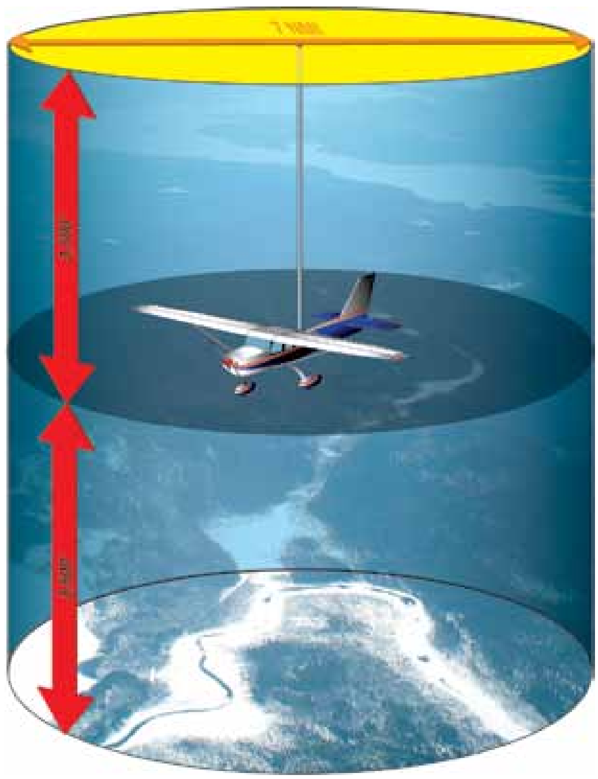

Figure 11-17. *The Area Surrounding the Aircraft for Coverage Using TIS.*

does not mean that the targets displayed are the only aircraft in the vicinity. The system displays only the closest aircraft. In addition, the system does not display aircraft that are not equipped with transponders. The display may not show any aircraft; however, a Piper Cub with no transponder could be flying in the area. TIS coverage can be sporadic and is not available in some areas of the United States. Traffic advisory software is to be utilized only for increased situational awareness and not the sole means of traffic avoidance. There is no substitute for a good visual scan of the surrounding sky.

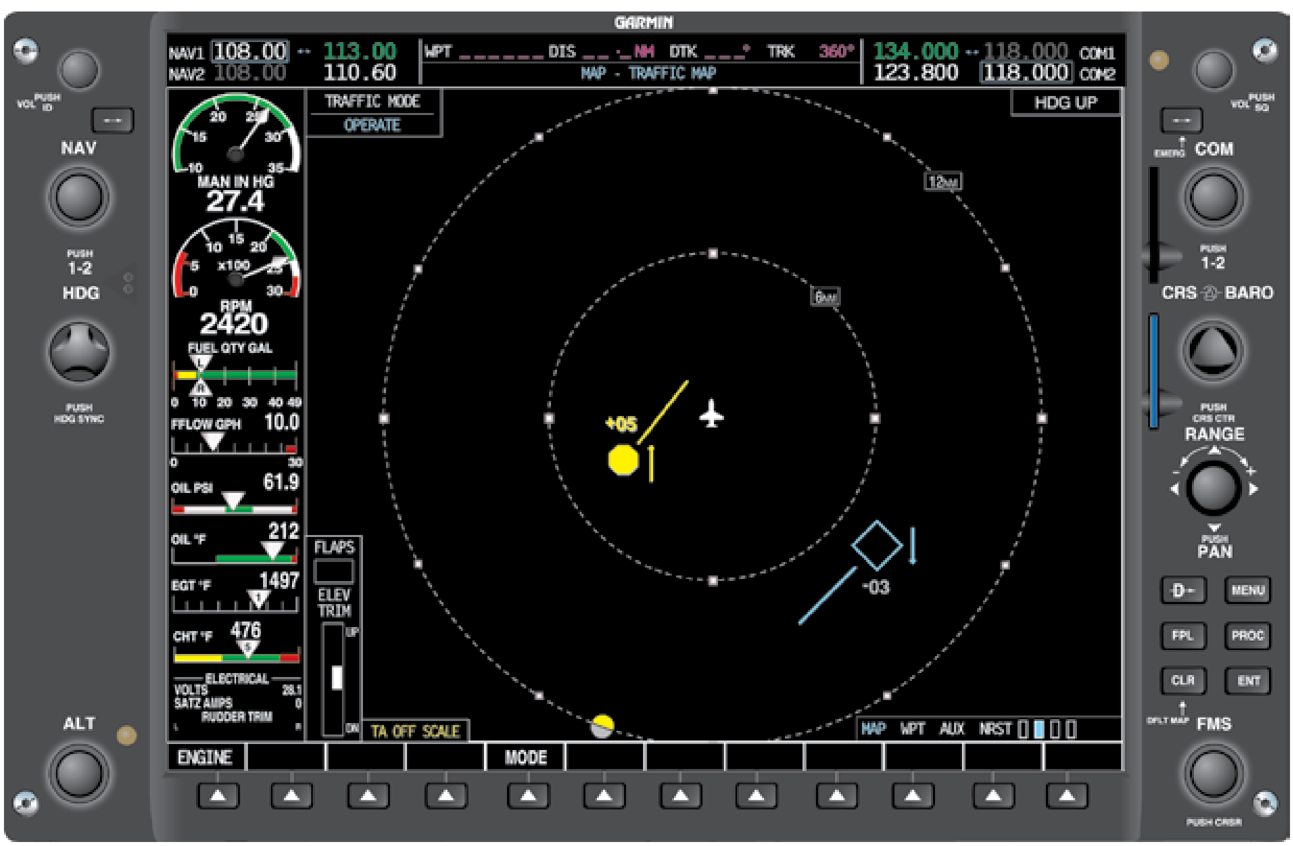

Figure 11-18. *A Typical Display on Aircraft MFD When Using TIS.*