Inoperative Equipment

A certificate holder's manual must contain enroute flight, navigation and communication procedures, including procedures for the dispatch, release or continuance of a flight if a required piece of equipment becomes inoperative.

When any required instrument or equipment in an aircraft is inoperative, the airplane cannot be flown unless that aircraft's **Minimum Equipment List (MEL)** allows such a flight.

The pilot-in-command of an aircraft operating IFR in controlled airspace shall report to ATC immediately any malfunction of navigational, approach or communications equipment that occurs in flight. The report must include:

- Aircraft identification;
- Equipment affected;
- Degree to which the capability of the aircraft to operate IFR in the ATC system is impaired; and
- Nature and extent of assistance desired from ATC.

Pitot-Static Instruments

Modern jet transports usually have three pitot-static systems. There are separate systems for the captain's and co-pilot's instruments plus an auxiliary system that provides a backup for either of the two primary systems. The instruments that require static pressure input are **airspeed, Mach, altitude** and **vertical speed indicators.** In addition, the airspeed and Mach indicators need a source of pitot pressure. Besides the flight instruments, static pressure input is required for the Mach warning, autopilot, flight director, flight recorder and cabin differential pressure. Pitot input is required for all those systems except for cabin differential pressure. The usual source for these non-flight instruments is the auxiliary pitot-static system. *See* Figure 2-1.

Altimeters compare the sea level pressure setting in their window with the outside air pressure sensed through the static system. The difference is displayed as the altitude above sea level. Part of the preflight check is to verify the accuracy of the altimeters. An altimeter should be considered questionable if the indicated altitude varies by more the 75 feet from a known field elevation.

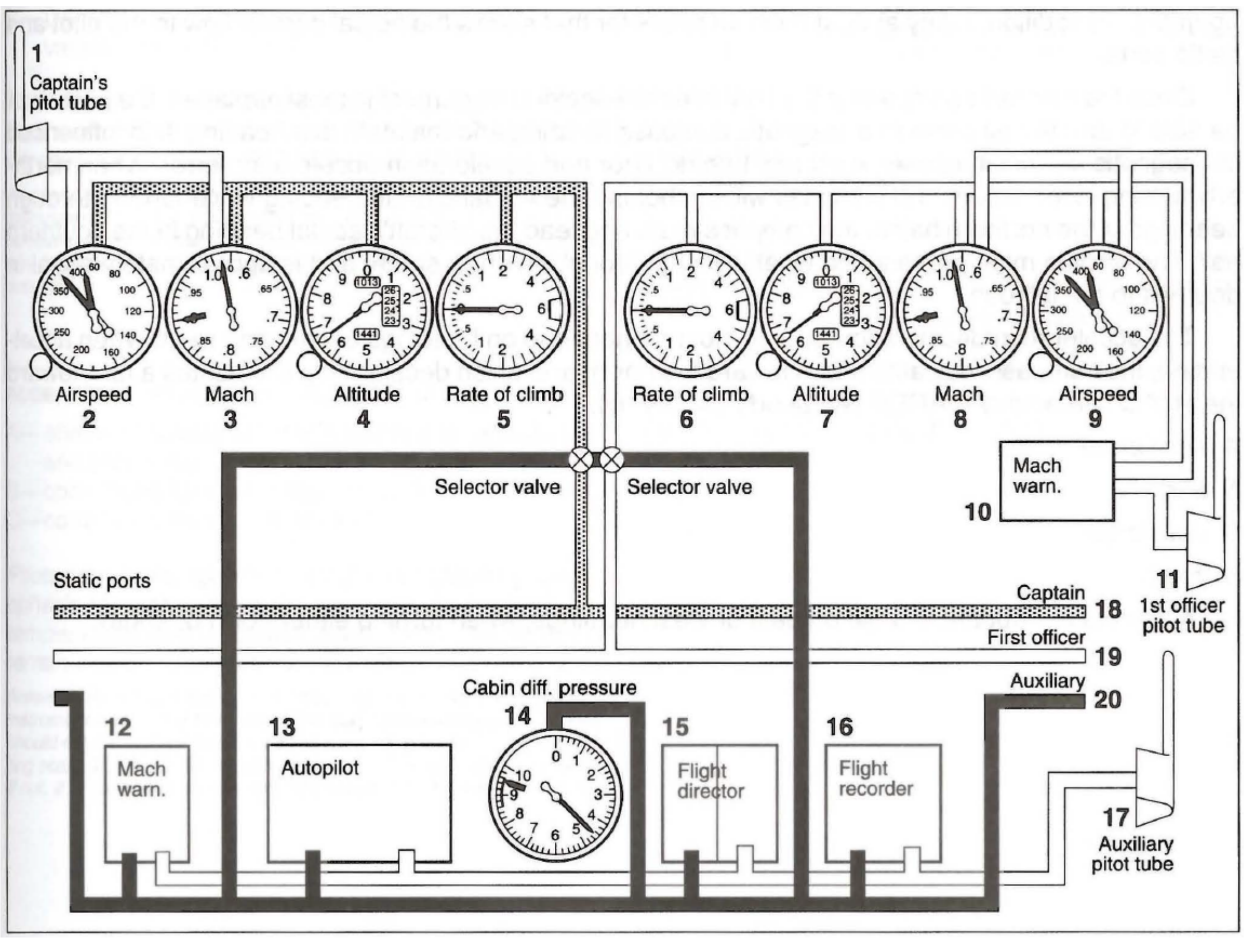
The altimeter setting used by pilots is always the station pressure of the reporting station corrected to sea level. **Station pressure** is the actual pressure at field elevation.

True altitude is the actual height of the aircraft above sea level. This is the same as indicated altitude when standard temperatures exist. When the temperature is warmer than standard, true altitude is higher than indicated altitude. When the temperature is colder than standard day conditions, just the opposite is true. Corrected altitude (approximately true altitude) can be calculated but it is neither practical nor useful to do so in most situations. When setting an altimeter, a pilot should just use the appropriate altimeter setting and disregard the effects of nonstandard atmospheric pressures and temperatures.

Pressure altitude is the altitude indicated when the altimeter is set to standard sea level pressure of 29.92" Hg. Density altitude is used in aircraft performance computations. It is pressure altitude corrected for nonstandard temperatures. If the temperature is warmer than standard, density altitude will be higher than pressure altitude.

The local altimeter setting is used when flying below FL 180 and the altimeter is 31.00" Hg or less. Special procedures apply when the local pressure is more than 31.00" Hg because most altimeters cannot be set higher than that. In the United States, all altimeters are set to 29.92" Hg when climbing through FL 180. Caution: outside the United States the transition altitude is often something other than FL 180.

A common reason for altimeter errors is incorrect setting of the altimeter. If the setting in the altimeter is higher than the actual sea level pressure, the altimeter will read higher than the actual altitude. If the setting is too low, the altimeter will read lower than it really is. As a rough rule of thumb, the magnitude of the error is about 1,000 feet for each 1" Hg that the altimeter is off. For example, if the altimeter is set to 29.92" Hg, but the real sea level pressure is 30.57" Hg, the altimeter will read about 650 feet lower than the actual airplane's altitude (30.57 - 29.92 = .65" Hg = 650 feet). In this example, the airplane would be 650 feet higher than the indicated altitude.



The airspeed indicators compare pitot pressure with static pressure and display the difference as **indicated airspeed.** This indicated airspeed equals the aircraft's actual speed through the air (True Airspeed) only under standard day conditions at sea level. Under almost all flight conditions, true airspeed will be higher than indicated airspeed because of the lower ambient pressures at altitude.

The Machmeter displays aircraft speed as a percentage of the speed of sound. For example, an aircraft cruising at a Mach number of .82 is flying at 82% of the speed of sound. The Machmeter works in a manner similar to the airspeed indicator in that it compares pitot and static pressure, but these inputs are corrected by an altimeter mechanism.

If a pitot tube becomes blocked, the airspeed and Mach indicators will read inaccurately. If pressure is trapped in the pitot line, the airspeed will read inaccurately high as the aircraft climbs, low as it descends, and will be unresponsive to changes in airspeed. The airspeed indicator acts as an altimeter because only the static pressure changes. This situation occurs in icing conditions if both the ram air inlet and the drain hole of the pitot tube become completely blocked by ice.

If the pitot tube is blocked but the static port and the pitot drain hole remain open, the indicated airspeed will drop to zero. The (drain) pitot tube drain hole allows the pressure in the pitot line to drop to atmospheric and therefore there is no differential between the static and pitot pressures.

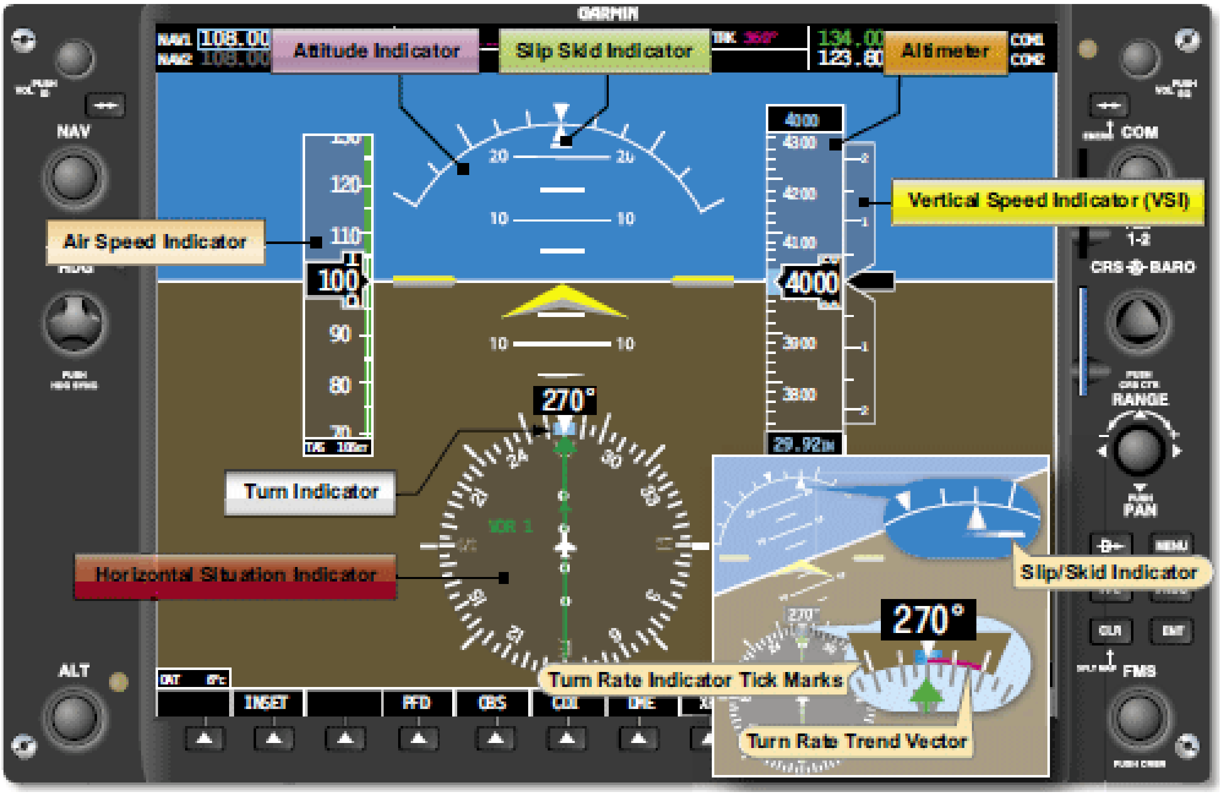
Pitot tubes and static ports are electrically heated to prevent ice formations that could interfere with proper operation of the systems. They are required to have "power on" indicator lights to show proper operation. In addition, many aircraft have an ammeter that shows the actual current flow to the pitot and static ports.

Since the magnetic compass is the only direction-seeking instrument in most airplanes, the pilot must be able to turn the airplane to a magnetic compass heading and maintain this heading. It is influenced by magnetic dip which causes northerly turning error and acceleration/deceleration error. When northerly turning error occurs, the compass will lag behind the actual aircraft heading while turning through headings in the northern half of the compass rose, and lead the aircraft's actual heading in the southern half. The error is most pronounced when turning through north or south, and is approximately equal in degrees to the latitude.

The acceleration/deceleration error is most pronounced on headings of east and west. When accelerating, the compass indicates a turn toward the north, and when decelerating it indicates a turn toward the south. The acronym **ANDS** is a good memory aid:
A accelerate
N north
D decelerate
S south
No errors are apparent while on east or west headings, when turning either north or south.

Electronic Flight Instruments

Electronic flight instrument systems integrate many individual instruments into a single presentation called a primary flight display (PFD). Flight instrument presentations on a PFD differ from conventional instrumentation not only in format, but sometimes in location as well. For example, the attitude indicator on the PFD is often larger than conventional round-dial presentations of an artificial horizon. Airspeed and altitude indications are presented on vertical tape displays that appear on the left and right sides of the primary flight display. The vertical speed indicator is depicted using conventional analog presentation. Turn coordination is shown using a segmented triangle near the top of the attitude indicator. The rate-of-turn indicator appears as a curved line display at the top of the heading/navigation instrument in the lower half of the PFD.


GARMIN
Attitude Indicator
Slip Skid Indicator
Altimeter
Vertical Speed Indicator (VSI)
Air Speed Indicator
Turn Indicator
Horizontal Situation Indicator
Slip/Skid Indicator
Turn Rate Indicator Tick Marks
Turn Rate Trend Vector


CMD
REF
141

Safety of Flight Equipment

Airborne weather radar is used to detect and avoid areas of heavy precipitation such as thunderstorms. With few exceptions, all air carrier aircraft must be equipped with an approved airborne weather radar unit. The radar must be in satisfactory operating condition prior to dispatch on an IFR or night VFR flight if thunderstorms (or other hazardous weather) that could be detected by the radar are forecast along the intended route of flight. An aircraft may be dispatched with an inoperative radar unit if one of two conditions is met:

- The flight will be able to remain in day VFR flight conditions, or
- Hazardous weather is not forecast.

An air carrier's operations manual must contain procedures for the flight crew to follow if the weather radar fails in flight.

A ground proximity warning system (GPWS) must be installed on all large turbine powered airplanes. The GPWS gives aural and visual warnings when an aircraft too close to the terrain is in an improper configuration for landing, or when it deviates below glide slope on an ILS approach.

TCAS I (Traffic Alert and Collision Avoidance System) provides proximity warning only, to assist the pilot in the visual acquisition of intruder aircraft. No recommended avoidance maneuvers are provided nor authorized as a result of a TCAS I warning. TCAS II provides traffic advisories (TAs) and resolution advisories (RAs). Resolution advisories provide recommended maneuvers in a vertical direction to avoid conflicting traffic. TCAS does not alter or diminish the pilot's basic authority and responsibility to ensure safe flight. After the conflict, return to the ATC clearance in effect. If a deviation occurs, contact ATC as soon as practical.

Cockpit voice recorders are required on large turbine engine powered airplanes and large four engine reciprocating powered airplanes. The recorder must operate from before the start of the before starting checklist to the completion of the secure cockpit checklist. Although the recorder runs for the entire flight, only the most recent 30 minutes of information need be retained on the recorder tape.

An approved flight recorder must be installed on all airplanes certified for operations above 25,000 feet and on all turbine powered airplanes. What the flight recorder must record varies from airplane to airplane, but at a minimum it must record:

- Time
- Altitude
- Airspeed
- Vertical acceleration
- Heading
- Time of each radio transmission to or from ATC.

An air carrier must keep the flight recorder data until an aircraft has been operated at least 25 hours after the data was removed. However, 1 hour of the oldest recorded data may be erased to test the flight recorder.

The cockpit voice and flight recorder data can be used to identify malfunctions and irregularities with the aircraft and in carrying out investigations under NTSB Part 830. It cannot be used by the

FAA for enforcement purposes. If an incident occurs which would require the immediate notification of the NTSB, the data must be kept by the operator for at least 60 days.

Communications

Each flag and domestic operator must have a two-way radio system that, under normal conditions, allows reliable and rapid communications between its aircraft and the appropriate dispatch office. For operations within the 48 contiguous states, this system must be independent of any operated by the U.S. government.

Navigation Equipment

When an aircraft is flown IFR or VFR Over-the-Top it must have a dual installation of the navigation radios required to fly that route. This means that an aircraft flying Victor airways or jet routes must have two operable VOR systems. Only one ILS system and one marker beacon system is required under Part 121.

When an aircraft is navigating over routes using low frequency, ADF or Radio Range, it only needs one receiver for those NAVAIDs, if it is also equipped with two VOR receivers. If that is the case, the VOR stations must be located such that the aircraft could complete the flight to a suitable airport and make an instrument approach if the low frequency system fails. The airplane must also be fueled to allow for such a failure.

Whenever a different VOR station is tuned, the pilot must listen to the Morse code identification. This will ensure that the correct frequency has been tuned and that a usable signal is available. Occasionally, when a VOR station is undergoing routine maintenance, it will broadcast a signal that is not reliable enough to use for navigation. This condition is indicated in one of two ways. Either the coded ident will be turned off or the ident will be changed to the letters T - E - S - T. Other than the identifier, the station may appear to be broadcasting a normal signal.

To be flown IFR, an aircraft must have had its VORs checked within the past 30 days. The pilots may check the accuracy of the VORs in one of several ways.

The VORs may be checked using a VOT facility on an airport. The VOT broadcasts the 360° radial and so the CDI needle should center either on a setting of 360° with a FROM indication or on 180° with a TO indication. A deviation of ±4 ° is acceptable for a VOT check.

If a VOT is not available, a VOR checkpoint may be used instead. The aircraft must be moved to the checkpoint and the designated radial set in the CDI course. The acceptable variation for a ground check is ±4°. For an airborne check the allowable variation is ±6°.

If no VOT or VOR check point is available, the VORs may be checked against each other. This is called a "dual VOR check." Tune the VORs to the same station and check the difference in indicated bearing. If they are within 4° of each other, the check is satisfactory. This check can be performed on the ground or in the air.

The person making a VOR check must make an entry in the aircraft log or other record. A proper entry includes the date, place and bearing error. The checker must sign the entry. Besides the VOR check, the altimeter system and the transponder must have been checked within the last 24 calendar months (14 CFR §91.411 and §91.413).

Whenever VOR receivers are required on board an aircraft operating within the United States, it must also have at least one DME receiver on board as well. *Note:* 14 CFR §91.205 requires a DME only if the aircraft is operated above FL240. 14 CFR §121.349 makes the DME required equipment for all air carrier aircraft operating in the U.S. If the DME fails in flight, the pilot must inform ATC as soon as possible.

DME indicates the actual distance from the station to the receiving aircraft in nautical miles. That is different from the horizontal distance because the aircraft is always higher than the DME ground station and altitude is included in the slant range. As a practical matter, the difference between the horizontal distance and the "slant range" is insignificant at distances of more than 10 miles from the station. There is a considerable error close to the station when the aircraft is at high altitudes. In such a situation, almost all of the slant range distance is vertical. When an aircraft passes over a DME station, the distance indicated at station passage is the altitude of the aircraft above the station in nautical miles. For example, if an airplane flew over a VORTAC site 12,000 feet above the station, the DME would indicate 2.0 NM.

A multi-function display (MFD) presents information drawn from a variety of aircraft information systems. The moving map function uses the MFD to provide a pictorial view of the present position of the aircraft, the route programmed into the flight management system, the surrounding airspace, and geographical features. The MFD and moving map can help you maintain the "big picture" and awareness of potential landing sites.

Horizontal Situation Indicator (HSI)

The **Horizontal Situation Indicator (HSI)** is a combination of two instruments: the heading indicator and the VOR. *See* Figure 2-3.

The aircraft heading displayed on the rotating azimuth card under the upper lubber line in Figure 2-2 is 330°. The course-indicating arrowhead that is shown is set to 300°. The tail of the course-indicating arrow indicates the reciprocal, or 120°.

The course deviation bar operates with a VOR/LOC navigation receiver to indicate either left or right deviations from the course that is selected with the course-indicating arrow. It moves left or right to indicate deviation from the centerline in the same manner that the angular movement of a conventional VOR/LOC needle indicates deviation from course.

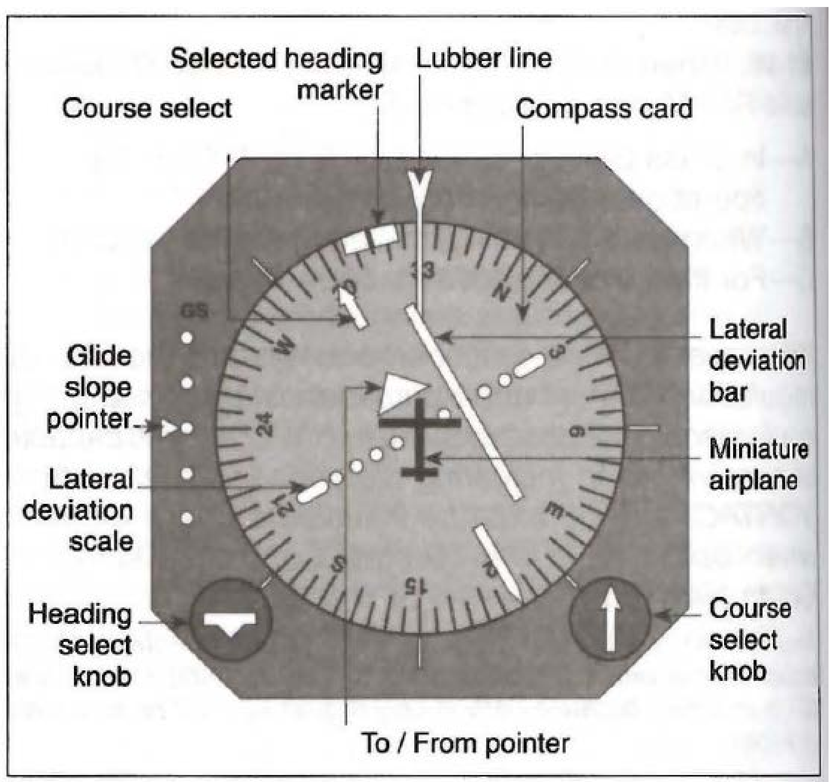
The desired course is selected by rotating the course-indicating arrow in relation to the azimuth card by means of the course set knob. This gives the pilot a pictorial presentation. The fixed aircraft symbol and the course deviation bar display the aircraft relative to the selected course as though the pilot was above the aircraft looking down.

The TO/FROM indicator is a triangular-shaped pointer. When this indicator points to the head of the course arrow, it indicates that the course selected, and if properly intercepted and flown, will take the aircraft TO the selected facility, and vice versa.

The glide slope deviation pointer indicates the relationship of the aircraft to the glide slope. When the pointer is below the center position, the aircraft is above the glide slope and an increased rate of descent is required.

To orient where the aircraft is in relation to the facility, first determine which radial is selected (look at the arrowhead). Next, determine whether the aircraft is flying to or away from the station (look at the TO/FROM indicator) to find which hemisphere the aircraft is in. Next, determine how far from the selected course the aircraft is (look at the deviation bar) to find which quadrant the aircraft is in. Last, consider the aircraft heading (under the lubber line) to determine the aircraft's position within the quadrant.

Aircraft displacement from course is approximately 200 feet per dot per nautical mile. For example, at 30 NM from the station, 1-dot deflection indicates approximately 1 NM displacement of the aircraft from the course centerline. Therefore, a 2.5-dot deflection at 60 NM would mean the aircraft is approximately 5 NM from the course centerline.



Global Navigation

When an air carrier operates on routes outside of the 48 contiguous states where the aircraft's position cannot be reliably fixed for more than one hour, special rules apply. The aircraft must either be equipped with a "specialized means of navigation" (INS or Doppler Radar), or one of the flight crewmembers must have a current flight navigator certificate. The FAA may also require either a navigator or the specialized navigation on routes which meet the one hour rule if they feel it's necessary. All routes that require either the navigator or specialized means of navigation must be listed in the air carrier's operations specifications.

Certain routes over the North Atlantic Ocean between North America and Europe require better than normal standards of navigation. Appendix C of 14 CFR Part 91 defines these routes and the required navigation standards. The Administrator (the FAA) has the authority to grant a deviation from the navigation standards of Appendix C if an operator requests one.

Approach Systems

The primary instrument approach system in the United States is the **Instrument Landing System (ILS)**. The system can be divided operationally into three parts: guidance, range and visual information. If any of the elements is unusable, the approach minimums may be raised or the approach may not be authorized at all.

The guidance information consists of the localizer for horizontal guidance and the glide slope for vertical guidance. The localizer operates on one of 40 frequencies from 108.10 MHz to 111.95 MHz. The glide slope operates on one of 40 paired UHF frequencies. The Morse code identifier of the localizer is the letter "I" (• •) followed by three other letters unique to that facility. The portion of the localizer used for the ILS approach is called the front course. The portion of the localizer extending from the far end of the runway is called the back course. The back course may be used for missed approach procedures or for a back course approach if one is published.

Range information is usually provided by 75 MHz marker beacons or, occasionally, by DME. There are four types of marker beacons associated with ILS approaches-the outer marker, the middle marker, the inner marker and the back course marker. Flying over any marker beacon will result in both visual and aural indications. The outer marker is identified by a blue light and continuous dashes in Morse code at a rate of 2 per second. The middle marker is indicated by a flashing amber light and alternating dots and dashes at a rate of 2 per second. The inner marker flashes the white light and sounds continuous dots at 6 per second. The back course marker will also flash the white light and sound a series of 2-dot combinations. *See* Figure 2-4 on the next page.

Often, an ADF facility (called a compass locator) is associated with an ILS approach. Usually it is located at the outer marker, but occasionally it is co-located with the middle marker. An outer compass locator is identified with the first 2 letters of the localizer identification group. A middle compass locator is identified by the last 2 letters of the localizer.

If a middle marker is out of service, the middle compass locator or PAR radar can be substituted. The middle marker being inoperative does not affect minimums during a Category I ILS approach.

The visual information portion of the ILS consists of approach lights, touchdown and centerline lights and runway lights.

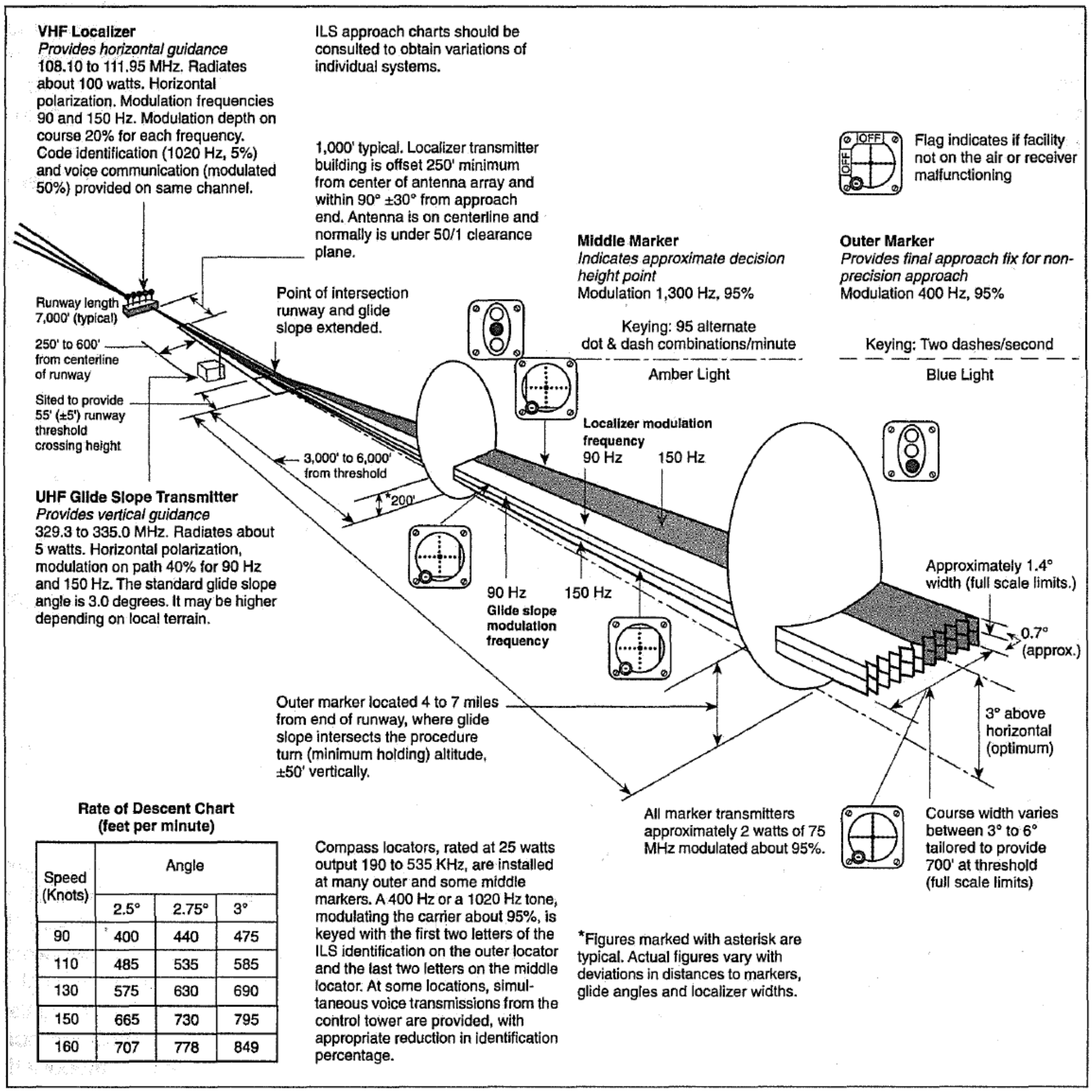
The localizer is very narrow. In fact a full scale deflection (CDI moving from the center to full scale left or right) is only about 700 feet at the runway threshold.

Different aircraft will require different rates of descent to stay on glide slope. A good rule of thumb is that the vertical speed in feet per minute will be equal to about five times the ground speed in knots. For example, an aircraft with an approach speed of 140 knots will require a descent rate of about 700 feet per minute (140 x 5 = 700).

The lowest approach minimums that can be used for a normal (Category I) ILS approach are a DH of 200 feet and 1,800 feet RVR. A Category II ILS approach will have minimums as low as a DH of 100 feet and a visibility requirement of 1,200 feet RVR. The approach has to be approved for

Category II minimums. In addition to suitable localizer, glide slope and marker beacons, the approach must have certain additional equipment working on the landing runway. This equipment includes an approach light system, High Intensity Runway Lights (HIRL), Touchdown Zone Lights (TDZL), Runway Centerline Lights (CL) and Runway Visual Range (RVR). Radar, VASI and Runway End Identifier Lights (REIL) are not required components of a Category II approach system. To descend below the DH from a Category II approach the pilot must be able to see one of the following:

- The runway threshold;
- The threshold markings;
- The threshold lights;
- The touchdown zone or the touchdown zone markings;
- The touchdown zone lights; or
- The approach light system, except that a pilot may not descend below 100 feet above the touchdown zone unless the red terminating bars or the red side row bars are distinctly visible and identifiable.



Rate of Descent Chart (feet per minute)

Speed (Knots)	Angle		
	2.5°	2.75°	3°
90	400	440	475
110	485	535	585
130	575	630	690
150	665	730	795
160	707	778	849

The Simplified Directional Facility (SDF) and the Localizer-type Directional Air (LDA) are approach systems that give a localizer-type indication to the pilot, but with some significant differences. The LDA is essentially a localizer, but it is not aligned within 3° of the runway as a localizer must be. The localizer can be any width from 3° to 6° wide. If the LDA is within 30°, straight-in minimums will be published for it; if not, only circling minimums will be published. The SDF may or may not be aligned with the runway. The main difference between it and a localizer is that its width is fixed at either 6° or 12°.

GPS

The Global Positioning System (GPS) is a satellite-based radio navigational, positioning, and time transfer system. The GPS receiver verifies the integrity (usability) of the signals received from the GPS satellites through receiver autonomous integrity monitoring (RAIM) to determine if a satellite is providing corrupted information. Without RAIM capability, the pilot has no assurance of the accuracy of the GPS position. If RAIM is not available, another type of navigation and approach system must be used, another destination selected, or the trip delayed until RAIM is predicted to be available on arrival. 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 appropriate sovereign authority.

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. The database may not contain all of the transitions or departures from all runways and some GPS receivers do not contain DPs in the database. The GPS receiver must be set to terminal (±1 NM) course deviation indicator (CDI) sensitivity and the navigation routes contained in the database in order to fly published IFR charted departures and DPs. Terminal RAIM should be automatically provided by the receiver. Terminal RAIM for departure may not be available unless the waypoints are part of the active flight plan rather than proceeding direct to the first destination. Overriding an automatically selected sensitivity during an approach will cancel the approach mode annunciation. The RAIM and CDI sensitivity will not ramp down, and the pilot should not descend to MDA, but fly to the MAWP and execute a missed approach.

It is necessary that helicopter procedures be flown at 70 knots or less since helicopter departure procedures and missed approaches use a 20:1 obstacle clearance surface (OCS), which is double the fixed-wing OCS, and turning areas are based on this speed as well.

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 missed approach waypoint (MAWP). Activating the missed approach prior to the MAWP will cause CDI sensitivity to immediately change to terminal (±1 NM) 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. A GPS missed approach requires pilot action to sequence the receiver past the MAWP to the missed approach portion of the procedure. 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.

Any required alternate airport must have an approved instrument approach procedure other than GPS, which is anticipated to be operational and available at the estimated time of arrival and which the aircraft is equipped to fly. 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.

Airport Lighting and Marking

A rotating beacon not only aids in locating an airport at night or in low visibility, it can also help to identify which airport is seen. Civilian airports have a beacon that alternately flashes green and white. A military airport has the same green and white beacon but the white beam is split to give a dual flash of white. A lighted heliport has a green, yellow and white beacon.

FAA Figure 129 shows the basic marking and lighting for a runway with a nonprecision approach. The threshold is marked with 4 stripes on either side of the centerline. 1,000 feet from the threshold, a broad “fixed distance” marker is painted on either side of the centerline (A). The runway lights are white for the entire length of the runway (as are the centerline lights if installed). The threshold is lit with red lights.

FAA Figure 130 shows the somewhat more elaborate ICAO markings for a nonprecision runway. In addition to the fixed distance marker, there are stripes painted on the runway every 500 feet to a distance of 3,000 feet from the threshold. This runway has either High Intensity Runway Lights {HIRL) or Medium Intensity Runway Lights (MIRL) installed. These lights are amber rather than white in the areas within 2,000 feet of the threshold. This gives the pilot a "caution zone" on landing rollout.

FAA Figure 131 shows the lighting and marking for a precision instrument runway. The runway striping has been modified to make it easier to tell exactly how much runway remains. The stripes are still at 500 foot intervals for the 3,000 feet from the threshold. The HIRL or MIRL turns amber for the 2,000 feet closest to the threshold. The centerline lighting has alternating red and white lights from 3,000 feet to 1,000 feet to go, and has all red lights in the 1,000 feet closest to the threshold.

In addition to the markings discussed above, some runways have distance remaining markers. These are simply signs showing the remaining runway in thousands of feet.

Taxi leadoff lights associated with runway centerline lights are green and yellow alternating lights, curving from the centerline of the runway to a point on the exit.

Some runways have Runway End Identifier Lights (REIL) installed at the threshold. These are synchronized flashing lights (usually strobes) placed laterally at either side of the runway threshold. Their purpose is to facilitate identification of a runway surrounded by numerous other lighting systems.

LAHSO is an acronym for "Land And Hold Short Operations." These operations include landing and holding short of an intersecting runway, an intersecting taxiway, or some other designated point on a runway other than an intersecting runway or taxiway. At controlled airports, ATC may clear a pilot to land and hold short. The pilot-in-command has the final authority to accept or decline any land and hold short clearance. The safety and operation of the aircraft remain the responsibility of the pilot. To conduct LAHSO, pilots should become familiar with all available information concerning LAHSO at their destination airport. Pilots should have, readily available, the published Available Landing Distance (ALO) and runway slope information for all LAHSO runway combinations at each airport of intended landing. Additionally, knowledge about landing performance data permits the pilot to readily determine that the ALO for the assigned runway is sufficient for safe LAHSO. If, for any reason, such as difficulty in discerning the location of a LAHSO intersection, wind conditions, aircraft condition, etc., the pilot elects to request to land on the full length of the runway, to land on another runway, or to decline LAH SO, a pilot is expected to promptly inform ATC, ideally even before the clearance is issued. A LAHSO clearance, once accepted, must be adhered to, just as any other ATC clearance, unless an amended clearance is obtained or an emergency occurs. However, a LAHSO clearance does not preclude a rejected landing. The airport markings, signage, and lighting associated with LAHSO consist of a three-part system of yellow hold-short markings, red and white signage and, in certain cases, in-pavement lighting.

Approach Lighting

An airplane approaching to land on a runway served by a **Visual Approach Slope Indicator (VASI)** must remain on or above the glide slope (except for normal bracketing) until a lower altitude is necessary for a safe landing.

A VASI gives the pilot a visual glide slope to follow when landing on certain runways. A VASI glide slope is normally about 3° (the same as an ILS) and the aim point is about 1,000 feet down the runway from the threshold. The angle and aim point of the VASI can be adjusted as necessary to accommodate the runway conditions. If a pilot of a high performance airplane is flying a VASI with a glide slope steeper than 3.5°, he/she should be aware that a longer than normal roll-out may result from the flare maneuver required by the steep angle.

Many runways used by air carrier aircraft have a three-bar VASI system to accommodate aircraft with a high cockpit such as Boeing 747 or DC-10. These aircraft need a glide slope that has an aim point further down the runway to ensure adequate clearance for the landing gear at the runway threshold. The pilot of such an airplane must use the two upwind lights (middle and far bars) for glide slope information.

The **Precision Approach Path Indicator (PAPI)** approach light system consists of a row of four lights perpendicular to the runway. Each light can be either red or white depending on the aircraft's position relative to the glide slope. The glide slope indications of a PAPI are as follows:

- High - 4 white lights
- Slightly high - 1 red, 3 white lights
- On glidepath - 2 red, 2 white lights
- Slightly low - 1 white, 3 red lights
- Low - 4 red lights

Pulsating visual approach slope indicators normally consist of a single light unit projecting a two-color visual approach path. The below glidepath indication is normally pulsating red and the above glidepath indication is normally pulsating white. The "on glide slope" indication for one type of system is a steady white light, while for another type it is an alternating red and white.