CHAPTER ONE – FUNDAMENTALS OF IFR

Are You IFR Legal?

Requirements of PIC to have IFR rating (61.3 e)

1. To operate as pilot in command of a civil aircraft, an instrument rating is required in the following circumstances:
    a. On an IFR flight plan
    b. In weather conditions less than the VFR minimums for the airspace; or
    c. In Class A airspace, regardless of weather conditions (91.135)
2. The instrument rating must be specific to the category and class of aircraft flown.
   Example: A private pilot with an airplane single engine land rating, and a rotorcraft rating, who only holds an instrument helicopter rating, cannot act as PIC in instrument conditions in an airplane single engine land.
3. A certificated commercial pilot who carries passengers for hire at night or in excess of 50 NM is required to have at least an instrument rating in the same category and class of aircraft.

Recent Flight Experience (61.57)

1. In order to act as PIC under IFR, a pilot has to log actual or simulated instrument time within the preceding 6 calendar months in either the same category of aircraft to be used or in an approved flight simulation training device and must have performed the following procedures:
    a. 6 instrument approaches
    b. Holding procedures; and
    c. Intercepting and tracking courses through the use of navigation systems
2. An instrument pilot who does not mean these requirements in the prescribed time or 6 calendar months thereafter must pass an instrument proficiency check, conducted by an FAA inspector, Designated Pilot Examiner, or an appropriately rated flight instructor.

3. Only the time flown in actual or simulated instrument conditions when the pilot controlled the aircraft solely by reference to flight instruments can be logged as instrument time.
4. When flying with a safety pilot in simulated instrument conditions, the pilot must log the location and type of each instrument approach, and name of the safety pilot.

Required Equipment for IFR (91.205 d)

1. In addition to the equipment required for VFR flight day and night, the following equipment is required for IFR flight:
    a. Generator/Alternator
    b. Radios appropriate for flight
    c. Sensitive Altimeter
    d. Inclinometer (ball)
    e. Second and minute hand clock with sweep or digital representation
    f. Attitude Indicator
    g. Rate of turn indicator
    h. Directional Gyro

Pitot-Static System (91.411)

1. Each static pressure system and altimeter instrument must be tested and inspected by the end of the 24th calendar month following the current inspection.
   Example: If the static pressure system and altimeter were inspected on March 28 of this year, they must be reinspected by March 31, 2 years from now.

VOR Inspections (91.171)

1. Operational checks of VORs must be made every 30 days if they are to be used for IFR navigation.
2. The maximum allowable tolerance on an operation check is:
    a. ±4° variation on a dual VOR check
    b. ±4° variation on a ground based VOT check
    c. ±6° variation using an airborne checkpoint
3. The date, place, bearing error, and pilot signature should be placed in the aircraft log or other record.

Flight Instruments

Pitot-Static System

1. The altimeter and vertical speed indicator (VSI) rely on air pressure for the static system, while the airspeed indicator relies on air pressure from both the pitot and static systems.
    a. When the pitot tube and drain hole are blocked, the airspeed indicator acts as an altimeter.
        i. The altimeter and VSI function as normal
        ii. The airspeed indicator is unaffected initially.
        iii. A climb to a higher altitude at the same true airspeed will cause the indicated airspeed to increase.
        iv. A descent to a lower altitude at the same true airspeed will cause the indicated airspeed to decrease.
    b. When the front of the pitot tube only is blocked, the airspeed indicator reads zero, and the altimeter and VSI are unaffected.
2. The calibrated airspeed (CAS) can be determined from the true airspeed, pressure altitude, and outside air temperature using a flight computer.
3. The altimeter determines altitude based on the difference between sea level pressure and outside air pressure. A difference of 1 inch of Mercury equates to roughly 1,000 feet of altitude.
   Example: If an altimeter setting of 29.55” reads 2,000 feet, a setting of 30.55,” 1 inch higher, will read approximately 3,000 feet.
4. The altimeter should be set to the reported sea level pressure of a nearby station.
    a. Above FL180, it should be set to standard pressure of 29.92”Hg regardless of actual conditions.
    b. Descending back below FL180, it should be reset to a nearby reported reading.

Gyroscopic Instruments

1. The turn coordinator indicates the rate of roll and rate of turn.

    a. The angle of bank is only indirectly indicated. The miniature airplane will show a turn whether a wings level, yaw only turn is made (such as during taxi) or a banked turn is made in flight. The speed of the turn, determined by the horizontal component of lift, dictates the rate of turn thus the movement of the miniature aircraft.

Glass Cockpits

1. Attitude and heading information is supplied by the Attitude and Heading Reference System (AHRS).
2. Airspeed, altitude, and vertical speed are generated by the Air Data Computer (ADC).

Pressure and Density Altitude

Types of Altitude

1. Actual Altitude is height above ground (Think A for Actual and A for AGL).
2. True Altitude is height above Mean Sea Level.
3. Indicated Altitude is true altitude as indicated on the altimeter.
    a. The altimeter displays indicated altitude by having a nearby sea level pressure set into its Kollsman window, and comparing outside air pressure to the set pressure. The greater the difference, the higher the indicated altitude.
    b. The altimeter is subject to temperature errors. The altimeter has a "built in" assumption on the lapse rate of pressure as we get higher. This assumption is based on standard temperature (15°C at sea level and a lapse rate of about 2°C per 1,000 feet gained). In warmer temperatures, the column of air we're flying through expands, and so changes in altitude result in a less than anticipated change in pressure. In other words, the altimeter is less sensitive to altitude changes.
    Example: In higher than standard temperatures, an aircraft's true altitude of 5,000 feet will only read as something lower like 4,700 on the altimeter. In order to maintain an indicated altitude of 5,000, we'd need to climb, thus giving us a higher true altitude.
4. Pressure Altitude is True Altitude corrected for nonstandard pressure. Standard pressure is 29.92”Hg.
    a. Pressure Altitude is the altitude the altimeter would indicate under standard pressure conditions, in other words where sea level pressure is 29.92. When actual sea level pressure is higher than standard, the indicated altitude will be higher than pressure altitude and vice versa.
    b. Setting the altimeter to 29.92 will show you pressure altitude.
    Example: If an altimeter is properly set to 30.12”Hg, and indicates 1,200 feet, setting it to 29.92 will indicate approximately 1,000 feet, and this is the pressure altitude.

5. Density Altitude is Pressure Altitude corrected for nonstandard temperature.
    a. Density Altitude is the altitude the altimeter would indicate under standard conditions, 29.92”Hg and 15°C at sea level, with a lapse rate of about 2°C per 1,000 feet of altitude gained.
    b. When standard atmospheric conditions exist, true altitude, indicated altitude, pressure altitude, and density altitude will all be equal.
    c. When temperatures are hotter than standard, density altitude will be higher than pressure altitude, and vice versa.

Types of Airspeed

1. True Airspeed is the actual speed the aircraft moves through the air.
2. Indicated Airspeed is the speed shown on the airspeed indicator.
    a. Indicated airspeed is determined by pressure differentials in the pitot and static system. In less dense air, the aircraft will need to fly faster through the air (i.e., faster true airspeed), in order to ram sufficient air molecules into the pitot to maintain the same indicated airspeed. As pressure decreases, or temperature increases, true airspeed increases for a constant indicated airspeed.
3. Calibrated Airspeed is Indicated Airspeed corrected for installation and instrument errors.

Attitude Instrument Flying

Pitch Instruments

1. Attitude Indicator
2. Altimeter
3. Airspeed Indicator
4. Vertical Speed Indicator (VSI)

Bank Instruments

1. Attitude Indicator
2. Heading Indicator
3. Turn Coordinator
4. Magnetic Compass

Power Instruments

1. Manifold Pressure Gauge and/or Tachometer
2. Airspeed Indicator

Flight Condition	**PITCH INSTRUMENTS**	**BANK INSTRUMENTS**	**POWER INSTRUMENTS**
Straight and level	**Altimeter (primary)** Attitude Indicator (supporting) VSI (supporting)	**Heading Indicator (primary)** Attitude Indicator (supporting) Turn Coordinator (supporting)	**Airspeed (primary)** Tachometer and/or MP (supporting)
Airspeed changes in straight and level flight	**Altimeter (primary)** Attitude Indicator (supporting) VSI (supporting)	**Heading Indicator (primary)** Attitude Indicator (supporting) Turn Coordinator (supporting)	**Tachometer and/or MP (primary)** Airspeed (supporting)

Flight Condition	**PITCH INSTRUMENTS**	**BANK INSTRUMENTS**	**POWER INSTRUMENTS**
Establishing a level standard rate turn	**Altimeter (primary)** Attitude Indicator (supporting) VSI (supporting)	**Attitude Indicator (primary)** Turn Coordinator (supporting)	**Airspeed (primary)** Tachometer and/or MP (supporting)
Stabilized standard rate turn	**Altimeter (primary)** Attitude Indicator (supporting) VSI (supporting)	**Turn Coordinator (primary)** Attitude Indicator (supporting)	**Airspeed (primary)** Tachometer and/or MP (supporting)
Change of airspeed in level turn	**Altimeter (primary)** Attitude Indicator (supporting) VSI (supporting)	**Turn Coordinator (primary)** Attitude Indicator (supporting)	**Tachometer and/or MP (primary)** Airspeed (supporting)
Straight and level to constant airspeed climb	**Attitude Indicator (primary)** Airspeed (supporting) VSI (supporting)	**Heading Indicator (primary)** Attitude Indicator (supporting) Turn Coordinator (supporting)	**Tachometer and/or MP (primary)** Airspeed (supporting)
Straight constant airspeed climb	**Airspeed (primary)** Attitude Indicator (supporting) VSI (supporting)	**Heading Indicator (primary)** Attitude Indicator (supporting) Turn Coordinator (supporting)	**Tachometer and/or MP (primary)** Airspeed (supporting)
Straight constant rate climb	**VSI (primary)** Attitude Indicator (supporting)	**Heading Indicator (primary)** Attitude Indicator (supporting) Turn Coordinator (supporting)	**Airspeed (primary)** Tachometer and/or MP (supporting)

Slips and Skids

1. A turn is coordinated when the horizontal component of lift (the force that produces the turn) is balanced by the centrifugal force (the force that moves opposite the turn. The “ball” on the inclinometer will be centered.
2. A skid is when the horizontal component of lift is less than the centrifugal force. The nose will tend to point towards the inside of the turn, and the ball will be on the outside of the turn.
3. A slip is when the horizontal component of lift is greater than the centrifugal force. The nose will tend to point towards the outside of the turn, and the ball will be on the inside of the turn.

Magnetic Dip

Acceleration/Deceleration Error

1. In the Northern Hemisphere, when an aircraft is on an east or west heading and accelerates or decelerates, the compass will show a turn. The memory aid is **ANDS** - Accelerate North Decelerate South:
    a. The compass will show a turn toward the north when accelerating on an east or west heading.
    b. The compass will show a turn toward the south when decelerating on an east or west heading.

Compass Turning Error

1. In the Northern Hemisphere, the compass will show an error when turning from a north or south heading. The memory aid is **UNOS** – Undershoot North Overshoot South.
    a. When turning from the north, the compass will show a turn in the opposite direction initially, and lag the turn, catching up with it at the end of the first 90 degrees, and then begin to lead the turn for the remaining 90 degrees. It will indicate a south heading too early, you should overshoot the compass south heading if you want to roll out on a south heading.
    b. When turning from the south, the compass will show a greater degree turn in the same direction, and lead the turn, catching up with it at the end of the first 90 degrees, and then begin to lag the turn for the remaining 90 degrees. It will indicate a north heading too late, you should undershoot the compass north heading if you want to roll out on a north heading.
    c. The compass does not exhibit turning errors and reads correctly when turning through an east or west heading.
    d. The compass does not exhibit turning errors unless a bank accompanies the turn. Therefore, during taxi, the compass should read the correct direction of a turn.
    e.

Standard Rate Turns

1. The turn coordinator has hash marks on either side indicating a standard rate of turn, equal to a full 360 degree circle in 2 minutes, or 180 degrees in 1 minute.
2. The angle of bank required for a standard rate turn depends on the airspeed. The faster the speed, the greater the angle of bank required.

Instrument Failures

Systems Groupings of Instruments

a. The heading indicator and attitude indicator run off the vacuum system.
b. The turn coordinator runs off the electrical system.
c. The airspeed indicator runs off the pitot static system, while the altimeter and VSI run solely off the static system.
d. When an instrument failure has occurred, identify which instruments conflict with each other, determine the system that has failed, cover up or isolate the failed instruments, and fly the aircraft partial panel on the working instruments.

CHAPTER 2 – VOR and NDB

VOR Explained/Navigating with VOR

<u>VOR Position Determination</u>

1. The course selection on a VOR receiver is done using the Omni Bearing Selector (OBS) a dial that is twisted to set a desired course away from or towards a VOR station.
2. A needle, the Course Deviation Indicator (CDI) moves left and right of center to show how far off in degrees the aircraft is from the selected course.
    a. A full scale deflection, from center all the way to one side of the instrument, indicates 10 or more degrees of deviation.
    b. A half scale deflection indicates 5 degrees of deviation.
3. The TO/FROM flag indicates that if the aircraft were to fly the course selected on the OBS, it would either be flying closer to or further from the station.
   Example: A course of 360° has been set on the OBS. The TO/FROM flag indicates FROM, meaning the aircraft would be getting further from the station if it flew a 360° course, putting it somewhere north of the station. The CDI needle is deflected to the right, showing that the line extending along the 360° course would be to the aircraft's right if it were flying a 360° course. This puts the aircraft northwest of the station.
4. Station passage is indicated when the TO/FROM flag shows a complete reversal.
5. When VORs are undergoing maintenance and could be considered unreliable, navigation indications may be received, but no coded identification will be broadcast.

The FAA makes use of the figure below on some questions involving the HSI. Note that the shadings on the localizer and backcourse feathers are on the wrong side. The approach course for runway 27, on the right side of the image, is the localizer front course, as evidenced by the two marker beacon symbols. The shading should be on the right side (top of the image). The approach course for runway 9, on the left side of the image, is the backcourse. The shading should be on the left side (top of the image). This will help answer questions related to this figure:

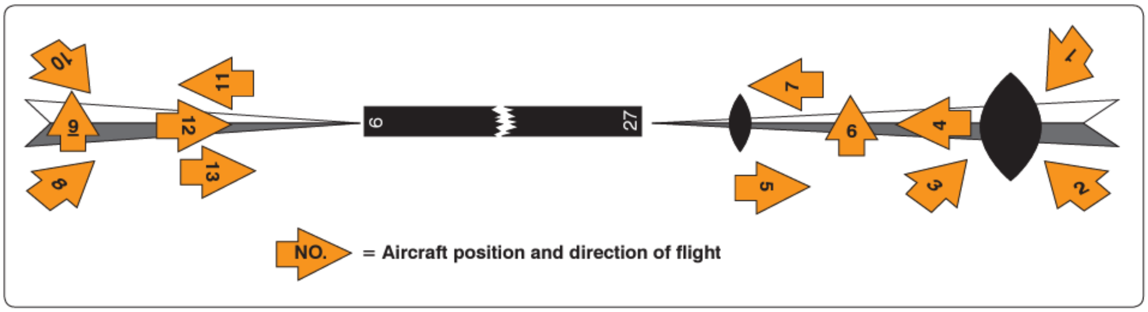


FIGURE 96.—Aircraft Position and Direction of Flight.

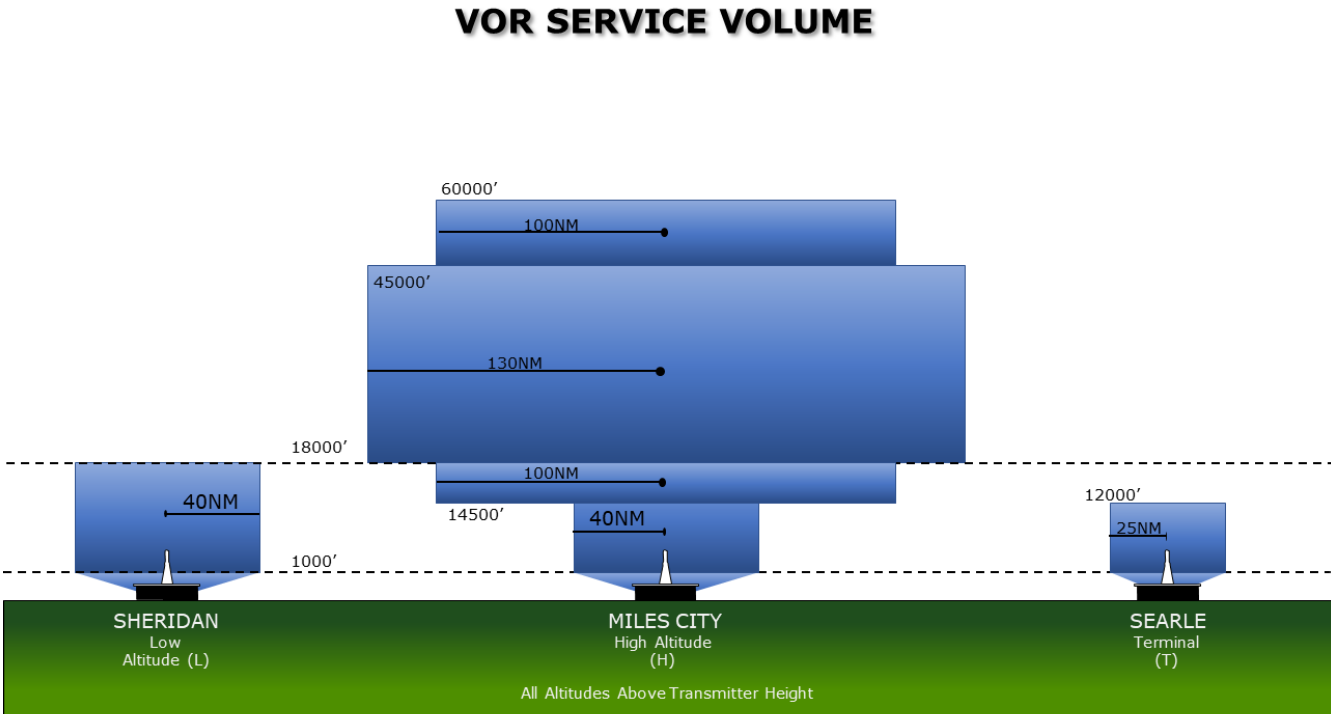
<u>HSI</u>

1. The compass card on the HSI rotates so that the heading is shown under the index at the top of the instrument.
2. The TO/FROM indicator is an arrow that either points the same direction as the course select pointer (TO) or the opposite direction (FROM).
3. The course select knob moves the pointer around the compass card to a desired course, the same way an OBS does on a VOR.
4. The course deviation indicator moves left and right of center to show deviation from selected course.
5. A glideslope indicator is often incorporated with the instrument.

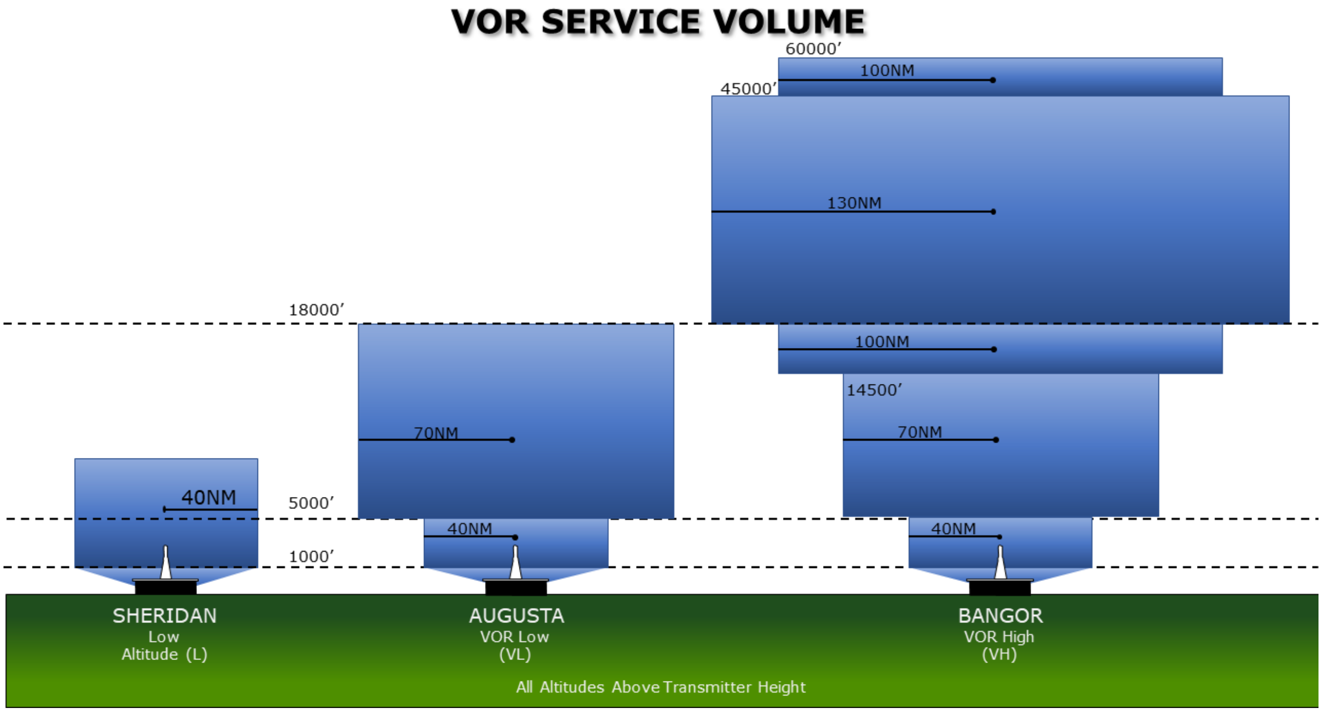
VOR Service Volume

VOR Service Volume

1. Traditional VOR service volumes are classified Terminal, Low, and High:



2. An additional two classifications have been added for the Minimum Operational Network, Very Low and Very High:



Distance Measuring Equipment (DME)

Slant Range Error

1. The DME indicates slant range distance, the straight line distance between the aircraft up at altitude and the DME transmitter on the ground. This is different, and longer, than simple ground distance between the aircraft and the station.
2. Slant range error is greatest at high altitudes very close to the VOR.
   Example: At 6,000 feet AGL, directly above a station, the DME will read 1.0 NM.
3. DME distance is given in tenths of a mile. A difference between slant range displayed on the unit and ground distance will only be apparent when the aircraft is within one mile of the station for every 1,000 feet AGL in altitude.

DME Speed

1. Some DME units will display speed, which is the rate the aircraft is getting closer or moving away from the station. On a DME arc, when the objective is to stay the same distance from the station, the speed will read zero.

GPS in lieu of DME

1. An IFR-approved GPS can be used in place of a traditional DME, but be aware that GPS distance is ground distance, not slant range distance shown by a DME.

Horizontal Situation Indicator (HSI)

Localizer Feather Errors

The FAA makes use of the figure below on some questions involving the HSI. Note that the shadings on the localizer and backcourse feathers are on the wrong side. The approach course for runway 27, on the right side of the image, is the localizer front course, as evidenced by the two marker beacon symbols. The shading should be on the right side (top of the image). The approach course for runway 9, on the left side of the image, is the backcourse. The shading should be on the left side (top of the image). This will help answer questions related to this figure:

Appendix 2

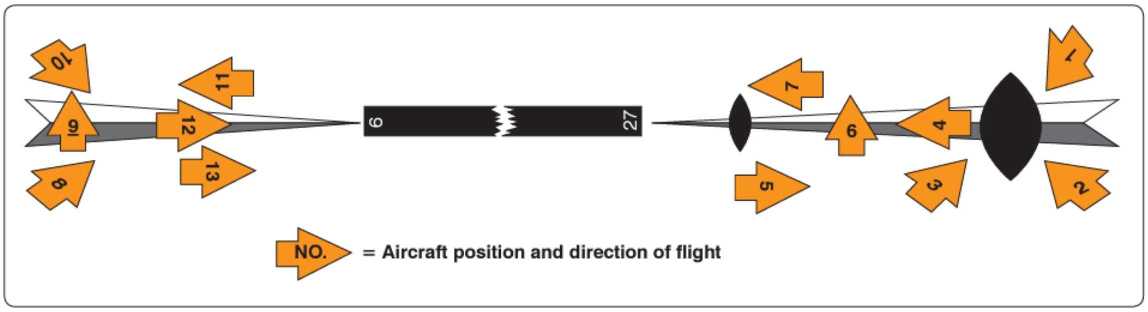


FIGURE 96.—Aircraft Position and Direction of Flight.

HSI

1. The compass card on the HSI rotates so that the heading is shown under the index at the top of the instrument.
2. The TO/FROM indicator is an arrow that either points the same direction as the course select pointer (TO) or the opposite direction (FROM).
3. The course select knob moves the pointer around the compass card to a desired course, the same way an OBS does on a VOR.
4. The course deviation indicator moves left and right of center to show deviation from selected course.
5. A glideslope indicator is often incorporated with the instrument.

CHAPTER 3 – Introducing Instrument Approaches

The Instrument Landing System (ILS)

Localizer and Glideslope

1. The localizer is a lateral course guidance displaying deviation from the runway centerline. When the needle is right of center, the aircraft is to the left of the centerline, and vice versa.
2. The glideslope is a vertical course displaying deviation from the appropriate descent angle to the touchdown zone. When the needle is above center, the aircraft is below the proper glideslope and vice versa.
    a. The glideslope is based on an angle, not a descent rate. The proper descent rate varies with airspeed and wind. A tailwind will require the aircraft to descend faster to remain on the glideslope.

Missed Approach

1. The aircraft continues along the glideslope and localizer until visual runway cues are gained, or else executes a missed approach when arriving at the decision height, along the glideslope.

Miscellaneous

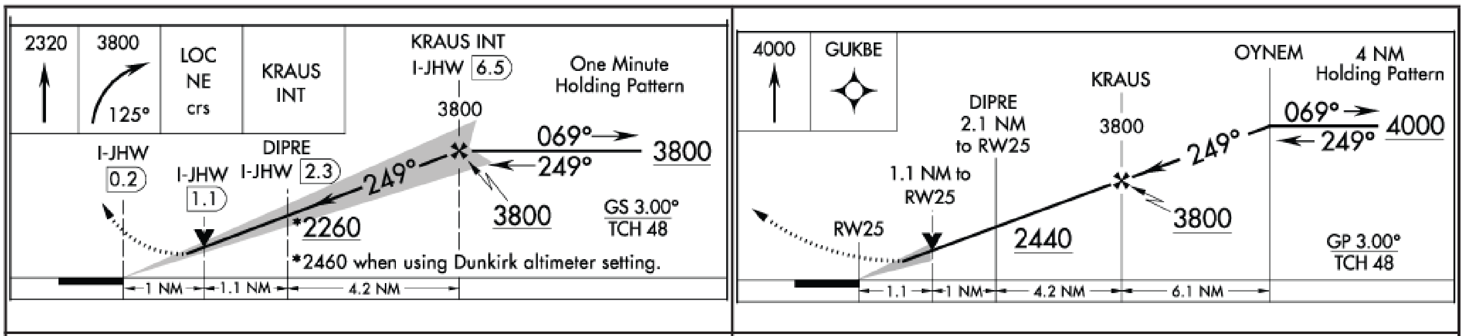
1. The precision final approach fix is indicated on an approach plate by the lightning bolt symbol.
2. A Precision Runway Monitor approach is when parallel runways are in use simultaneously. Two aircraft approach from opposing bases on different tower frequencies. The aircraft may be required to monitor both tower frequencies.
    a. Parallel ILS approaches provide aircraft a minimum of 1 ½ miles radar separation between successive aircraft on the adjacent localizer course.

Basics of Approach Plates/The Approach Brief

Aeronautical Chart Users' Guide

Precision Approaches

On precision approaches, the glideslope (GS) intercept altitude is illustrated by a zigzag line and an altitude. This is the minimum altitude for GS interception after completion of the procedure turn. Precision approach profiles also depict the GS angle of descent, threshold crossing height (TCH) and GS altitude at the outer marker (OM) or designated fix.

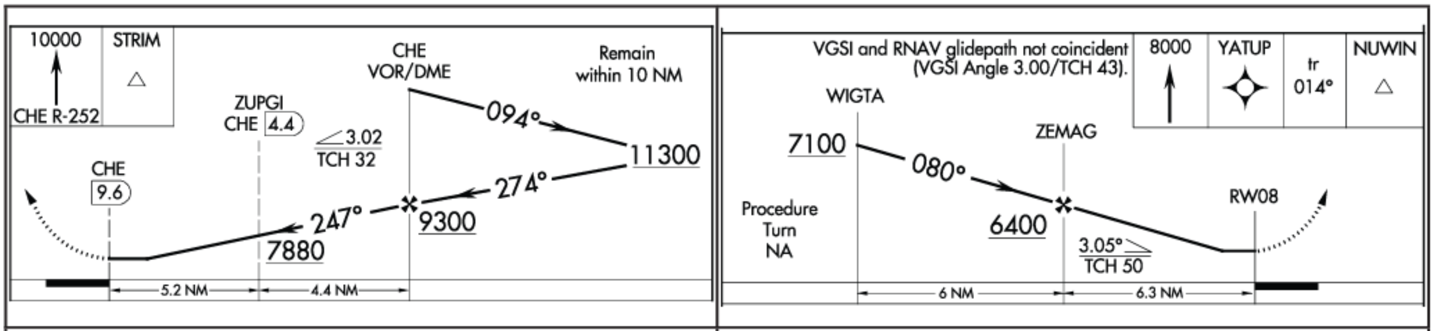


Traditional (NAVAID) Approach

RNAV Approach

Non-Precision Approaches

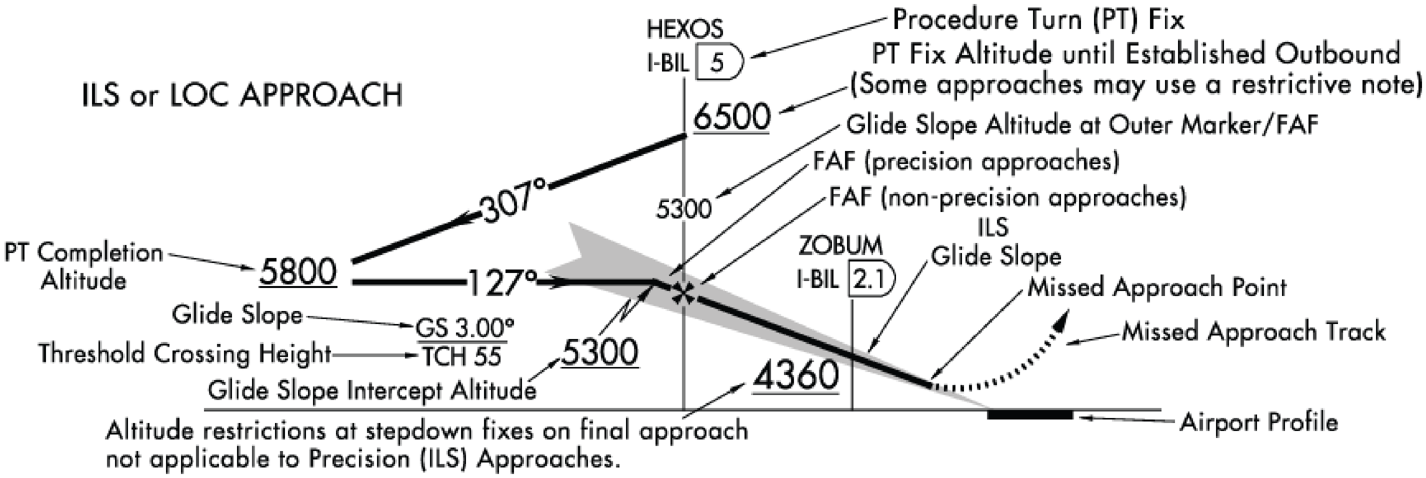
On non-precision approaches, the final segment begins at the Final Approach Fix (FAF), which is identified with the Maltese cross symbol ✖. When no FAF is depicted, the final approach point is the point at which the aircraft is established inbound on the final approach course. Stepdown fixes may also be provided between the FAF and the airport for authorizing a lower minimum descent altitude (MDA) and are depicted with the fix or facility name and a dashed line. Altitude restrictions at stepdown fixes on the final approach on procedures with both precision and non-precision minima are not applicable to precision (ILS, LPV, or LNAV/VNAV) use of the approach. On non-precision only approach procedures, the approach track descends to the MDA or VDP point, thence horizontally to the missed approach point.



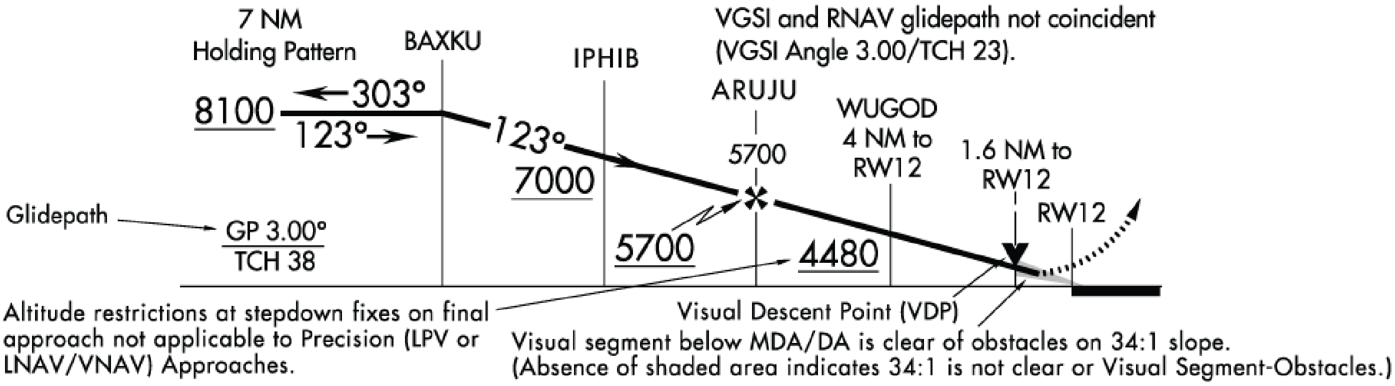
Traditional (NAVAID) Approach

RNAV Approach

ILS or LOC APPROACH

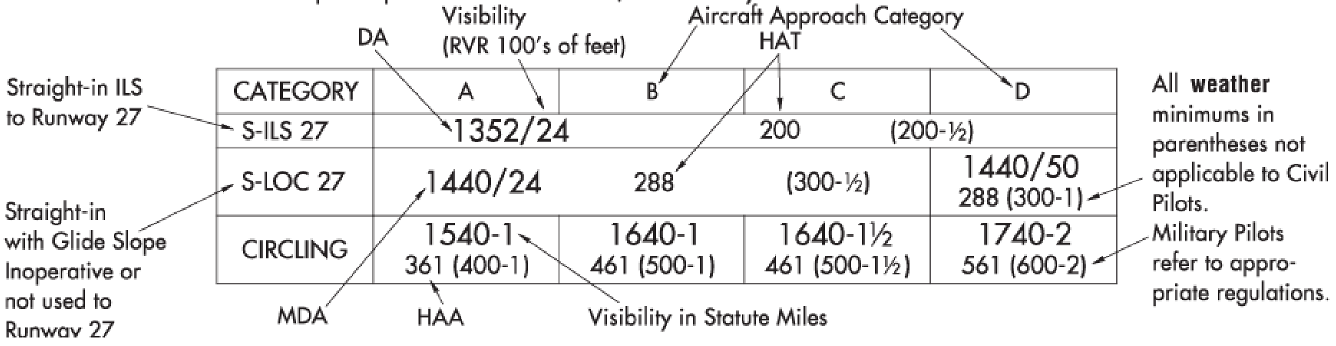


RNAV and GLS PROCEDURES WITH VERTICAL GUIDANCE



LANDING MINIMA FORMAT

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



CATEGORY	A	B	C	D
S-ILS 27	1352/24		200	(200-½)
S-LOC 27	1440/24	288	(300-½)	1440/50 288 (300-1)
CIRCLING	1540-1 361 (400-1)	1640-1 461 (500-1)	1640-1½ 461 (500-1½)	1740-2 561 (600-2)

All **weather** minimums in parentheses not applicable to Civil Pilots. Military Pilots refer to appropriate regulations.

Approach Minimums

Approach Categories

1. Category A: <91 KIAS
2. Category B: 91-120 KIAS
3. Category C: 121-140 KIAS
4. Category D: 141-165 KIAS
5. Category E: >165 KIAS
    a. An aircraft category is based on approach speed, or 1.3 times the stall speed in a landing configuration at gross weight. An aircraft whose approach speed is in one category but is descending fast enough to be in a higher category should adhere to the higher category's minimums.

Changing Minimums

a. If a component of an instrument approach procedure, such as the glideslope on an ILS, is inoperative, the pilot should use the highest minimum required by any single component that is usable, such as the localizer only.

Visibility Minimums

1. Runway Visual Range (RVR) is the horizontal distance a pilot should see when looking down the runway from a moving aircraft. It is sometimes used in place of flight visibility in statute miles.
   Example: If RVR is inoperative and the approach requires RVR24 (2,400 feet), a visibility of one half mile can be substituted.

Airport Environment

Land and Hold Short Operations (LAHSO)

1. At airports with intersecting runways and an operational control tower, LAHSO allows ATC to use both runways simultaneously. Airports with LAHSO will depict the hold short position on taxiway diagrams.
    a. Pilots are not required to accept LAHSO and can reject a request to land and hold short under any circumstances.
    b. Student pilots on solo flights are not permitted to participate in LAHSO.

Runway Lighting

1. Runway end identifier lights (REIL) are two white strobe lights positioned at the threshold with one on either side of the runway. They allow for the rapid identification of the approach end of the runway during reduced visibility or at night. They may be used on more than one runway.

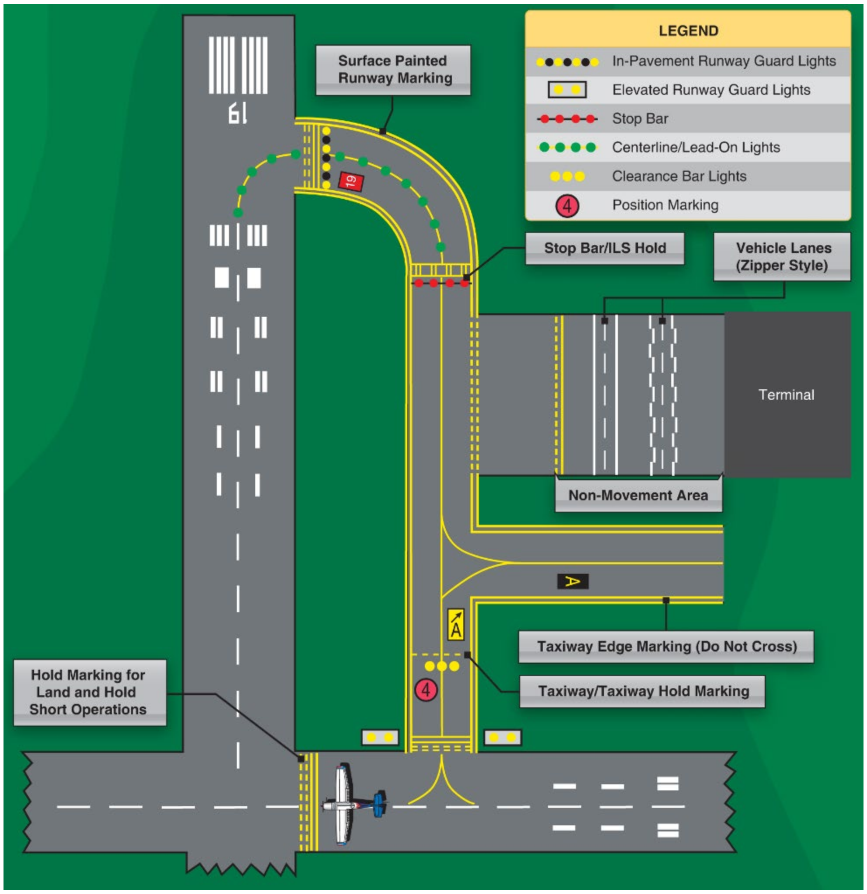
Wake Turbulence

1. Landing and departing aircraft will produce wingtip vortices while generating lift which can drift into the path of your aircraft.
    a. Landings should be planned to stay above, and land beyond preceding aircraft.
    b. Takeoffs should be planned to rotate prior to preceding aircraft.
    c. Crosswinds will decrease the lateral movement of an aircraft’s upwind vortex, while increasing the lateral movement of its downwind vortex

       Example: An aircraft departing on a westerly heading, with a wind from the north (right crosswind) will have the upwind vortex, off its right wind, remain over the runway, while the downwind vortex will be carried south.

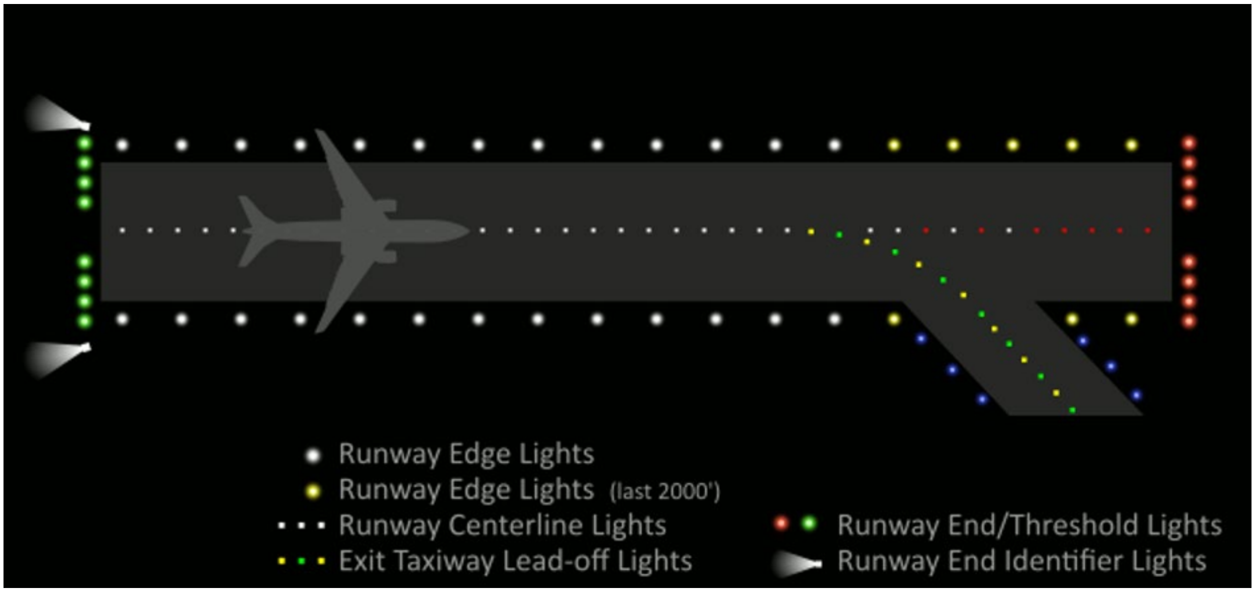
Airport Signs & Markings

Type of Sign	Action or Purpose	Type of Sign	Action or Purpose
4-22	**Taxiway/Runway Hold Position:** Hold short of runway on taxiway		**Runway Safety Area/Obstacle Free Zone Boundary:** Exit boundary of runway protected areas
26-8	**Runway/Runway Hold Position:** Hold short of intersecting runway		**ILS Critical Area Boundary:** Exit boundary of ILS critical area
8-APCH	**Runway Approach Hold Position:** Hold short of aircraft on approach	J→	**Taxiway Direction:** Defines direction & designation of intersecting taxiway(s)
ILS	**ILS Critical Area Hold Position:** Hold short of ILS approach critical area	↙L	**Runway Exit:** Defines direction & designation of exit taxiway from runway
⊖	**No Entry:** Identifies paved areas where aircraft entry is prohibited	22↑	**Outbound Destination:** Defines directions to takeoff runways
B	**Taxiway Location:** Identifies taxiway on which aircraft is located	↖MIL	**Inbound Destination:** Defines directions for arriving aircraft
22	**Runway Location:** Identifies runway on which aircraft is located		**Taxiway Ending Marker:** Indicates taxiway does not continue
4	**Runway Distance Remaining:** Provides remaining runway length in 1,000 feet increments	↙A G L →	**Direction Sign Array:** Identifies location in conjunction with multiple intersecting taxiways

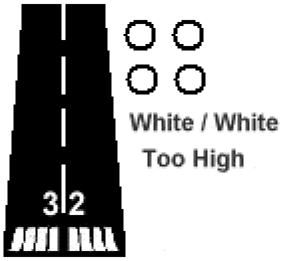


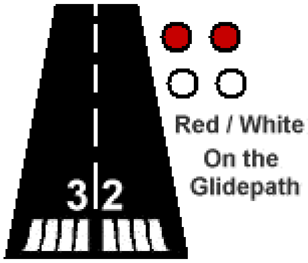
Runway Markings

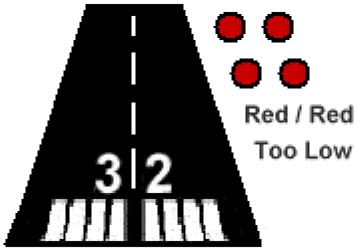
Airport Lighting



VASI/PAPI Lights

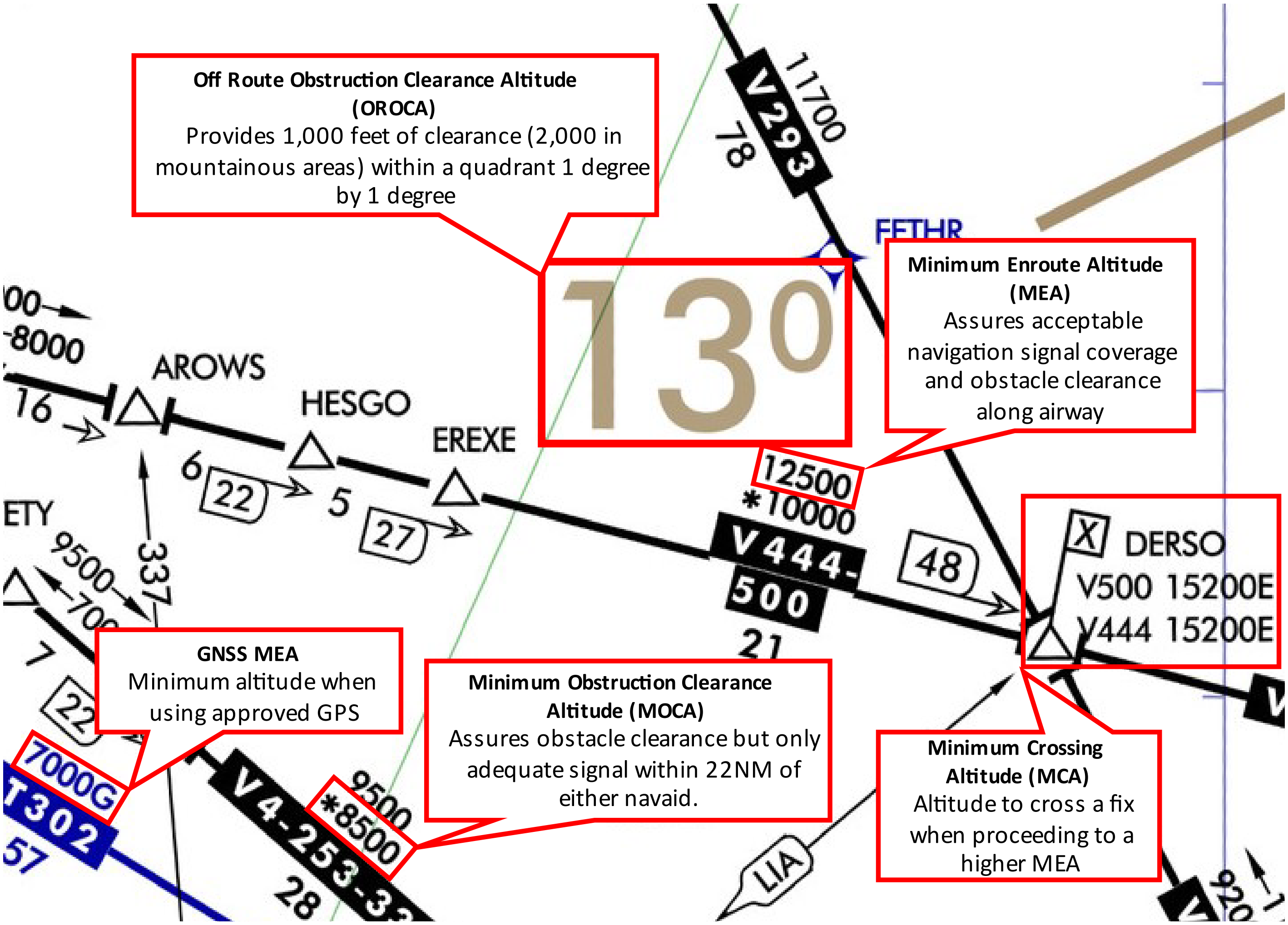






CHAPTER 4 – En Route Navigation

The IFR Enroute Low Chart/Minimum IFR Altitudes



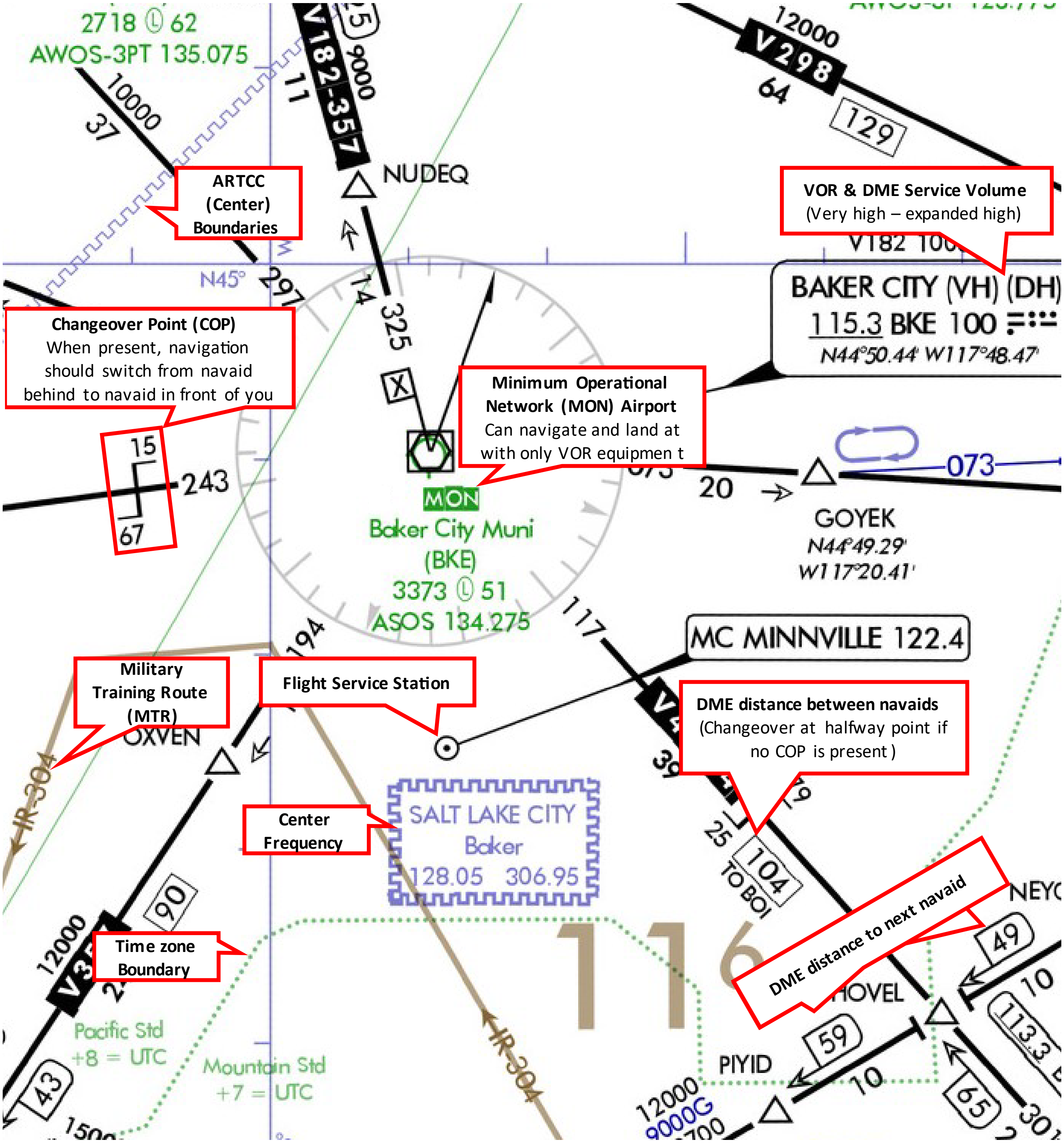
Off Route Obstruction Clearance Altitude (OROCA)
Provides 1,000 feet of clearance (2,000 in mountainous areas) within a quadrant 1 degree by 1 degree

Minimum Enroute Altitude (MEA)
Assures acceptable navigation signal coverage and obstacle clearance along airway

GNSS MEA
Minimum altitude when using approved GPS

Minimum Obstruction Clearance Altitude (MOCA)
Assures obstacle clearance but only adequate signal within 22NM of either navaid.

Minimum Crossing Altitude (MCA)
Altitude to cross a fix when proceeding to a higher MEA



ARTCC (Center) Boundaries

VOR & DME Service Volume
(Very high – expanded high)

Changeover Point (COP)
When present, navigation should switch from navaid behind to navaid in front of you

Minimum Operational Network (MON) Airport
Can navigate and land at with only VOR equipmen t

Military Training Route (MTR)

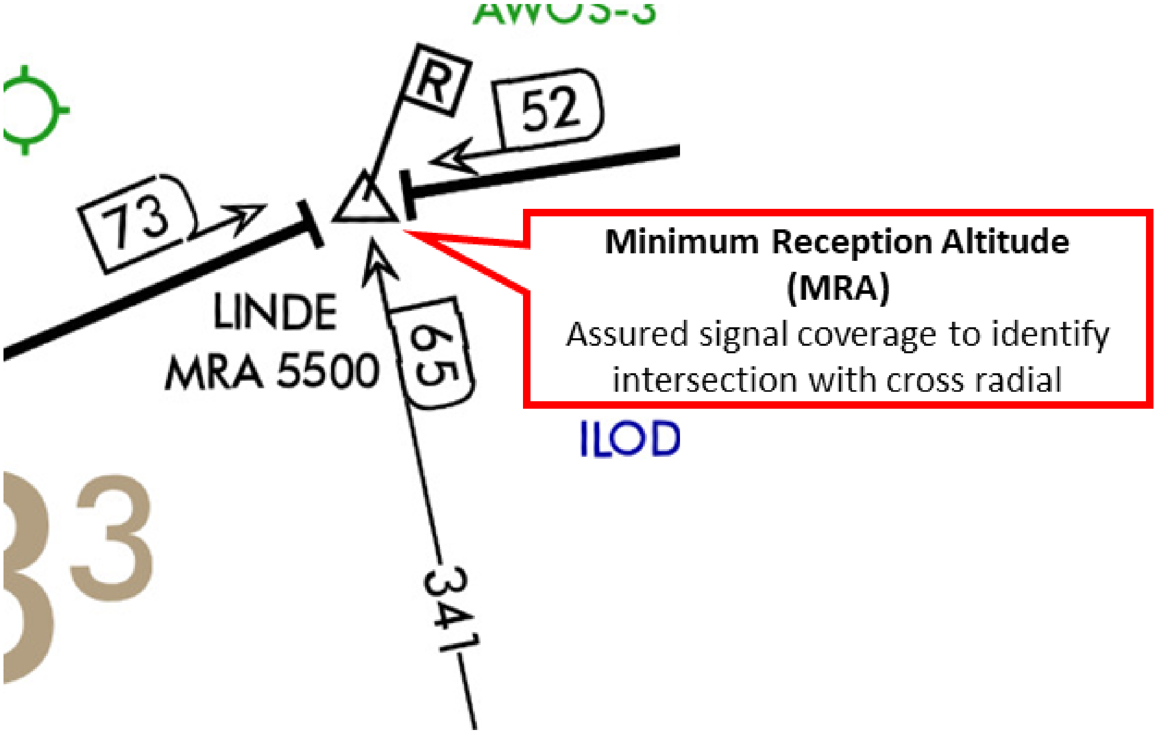
Flight Service Station

DME distance between navaids
(Changeover at halfway point if no COP is present)

Center Frequency

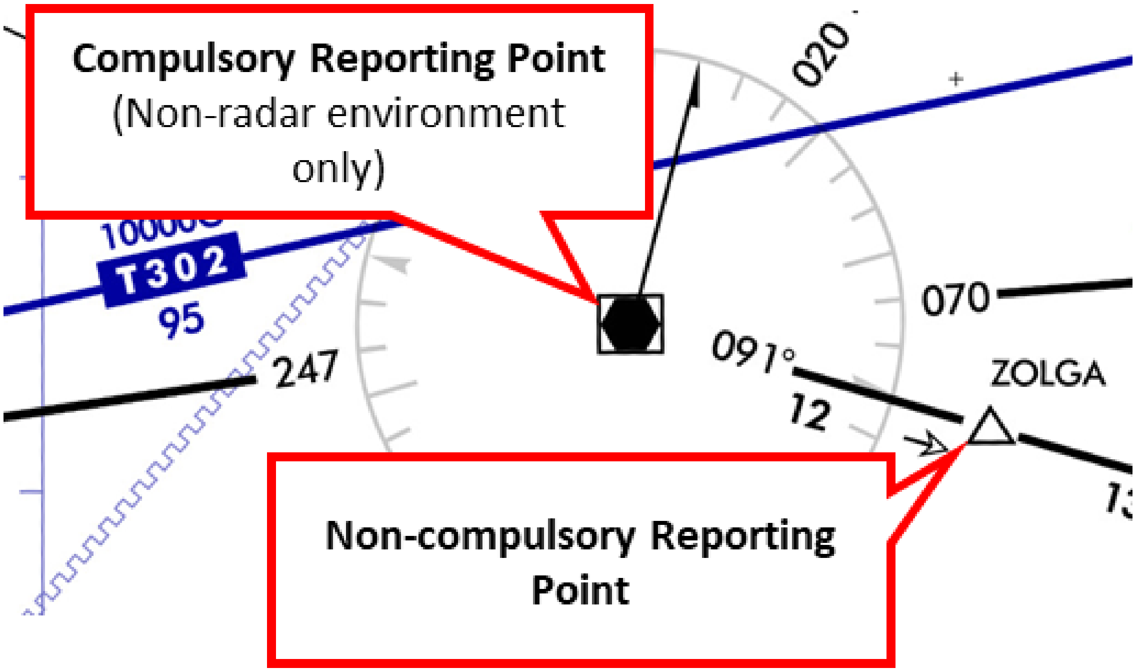
DME distance to next navaid

Time zone Boundary



Minimum Reception Altitude (MRA)

Assured signal coverage to identify intersection with cross radial

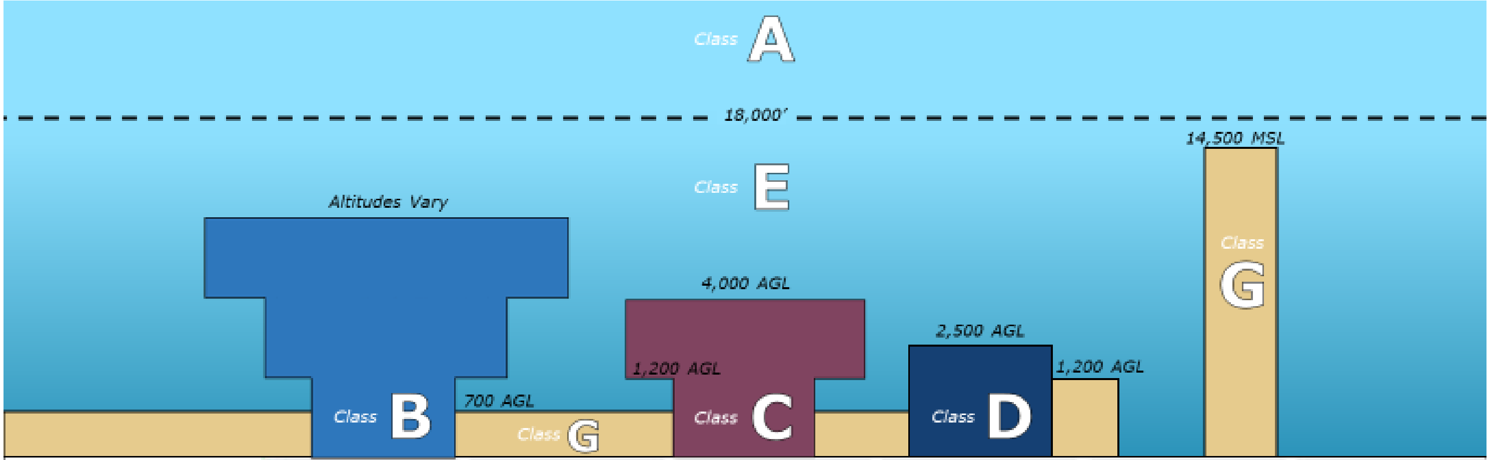


Compulsory Reporting Point

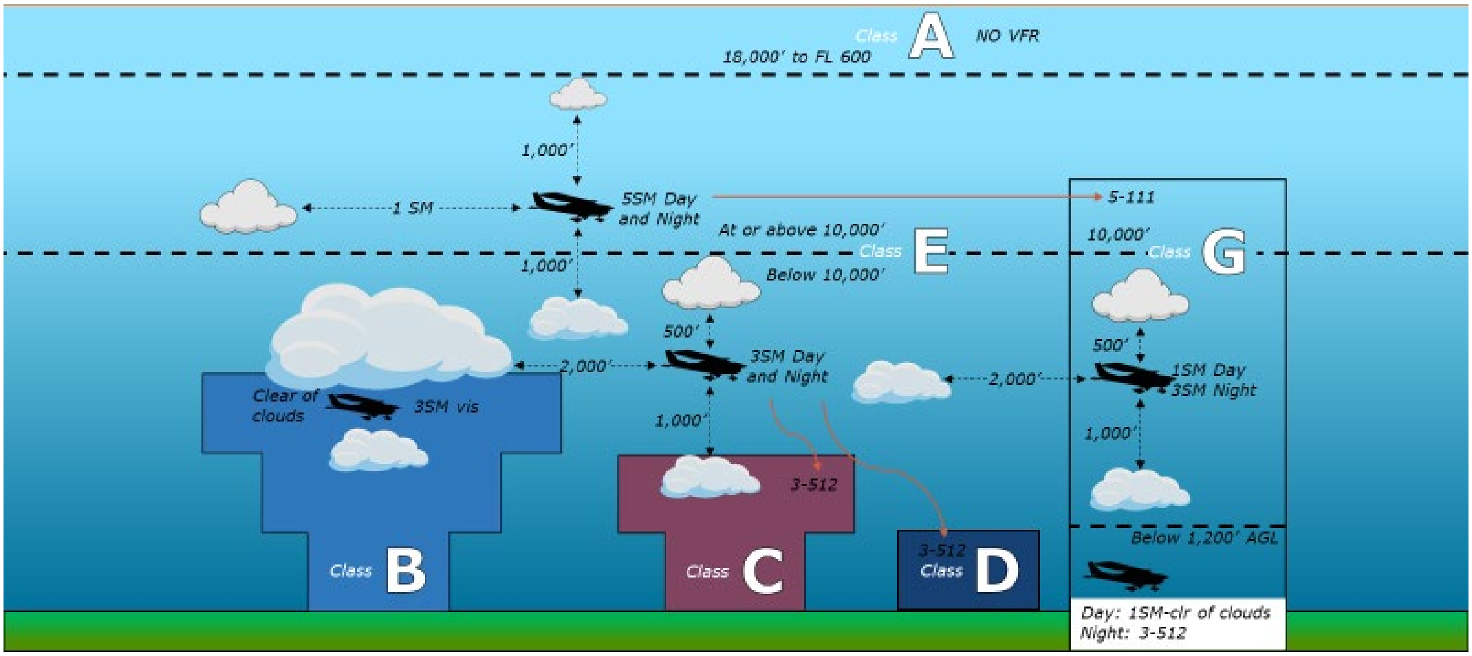
(Non-radar environment only)

Non-compulsory Reporting Point

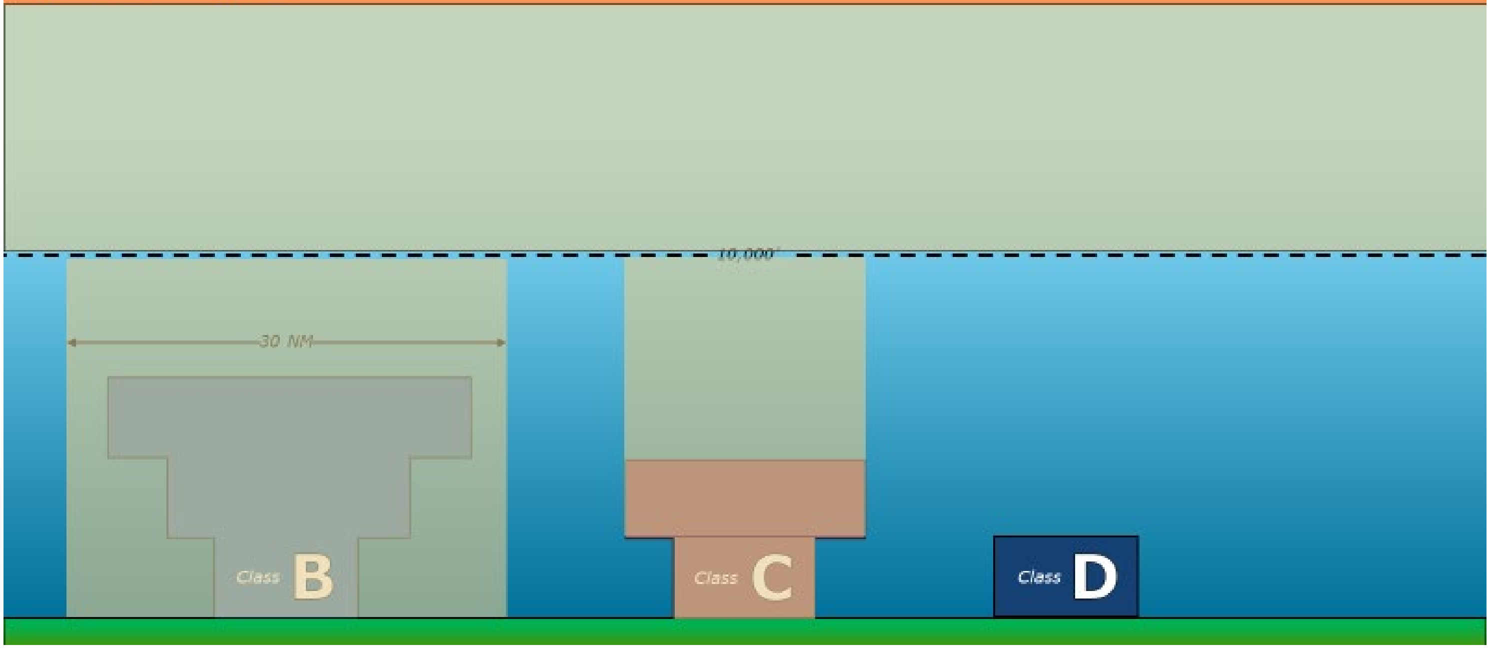
Review of Airspace



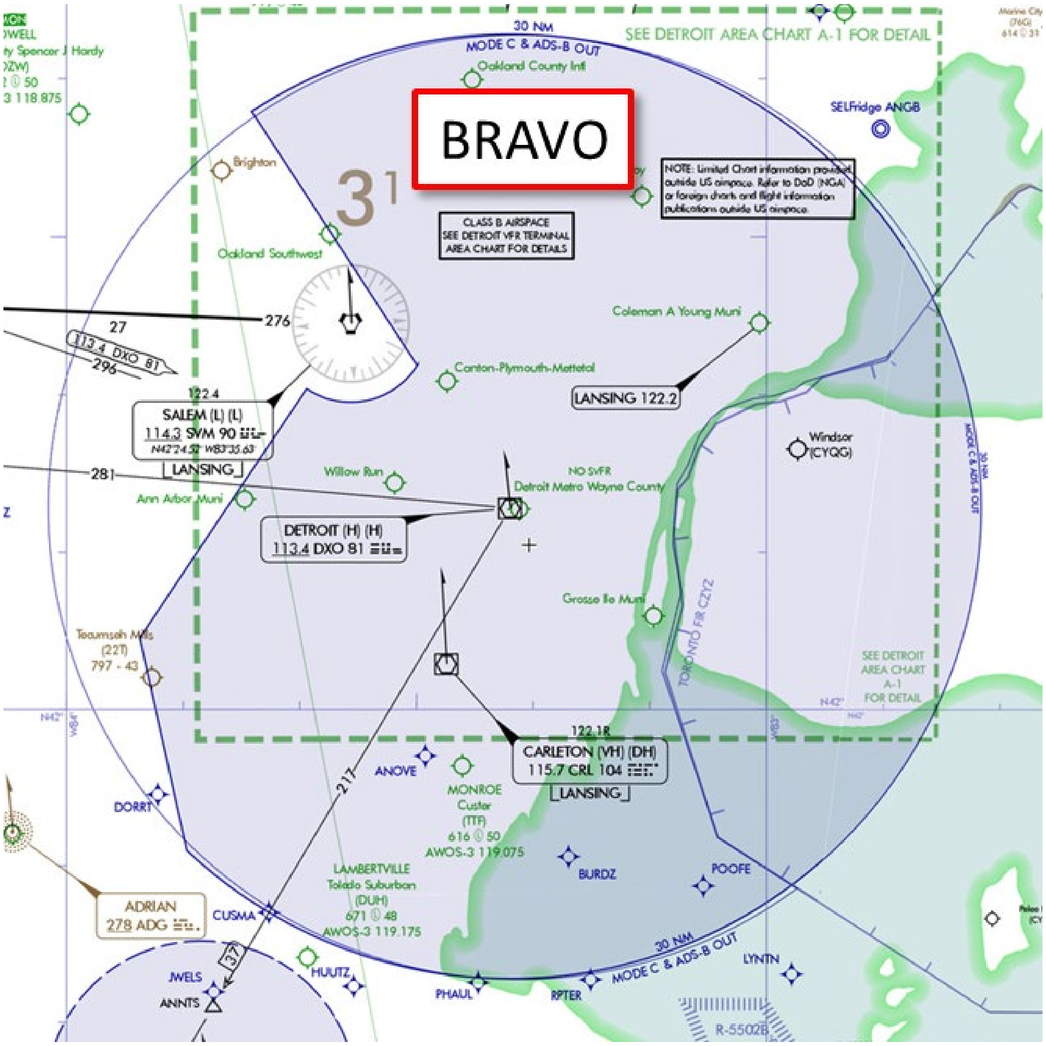
	Class A	Class B	Class C	Class D	Class E	Class G
Entry Requirements	IFR Flight Plan	ATC Clearance	Two-Way Radio Contact	Two-Way Radio Contact	IFR Radio/VFR None	None
VFR Visibility Minimums	IFR Only	3SM	3SM	3SM	3SM/5SM above 10,000′	1SM/3SM at night 5SM>10k
VFR Cloud Clearance	IFR Only	Clear of Clouds	500′ below 1000′ above 2000′ horizontal	500′ below 1000′ above 2000′ horizontal	5-1-2 <10k 1-1-1>10k	Clear of clouds 5-1-2 @ night 5-1-2 >1200′

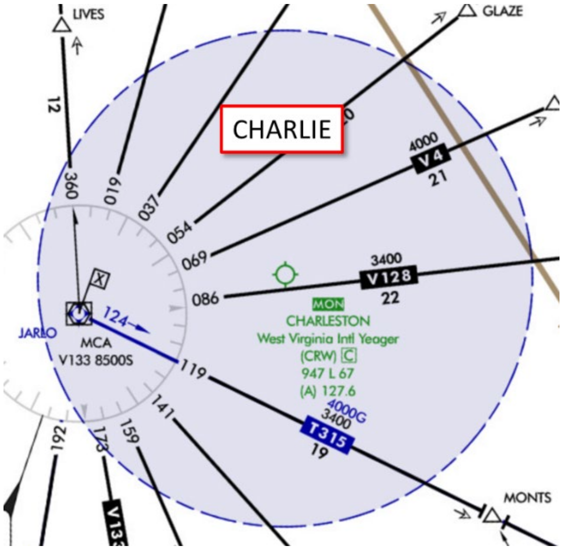


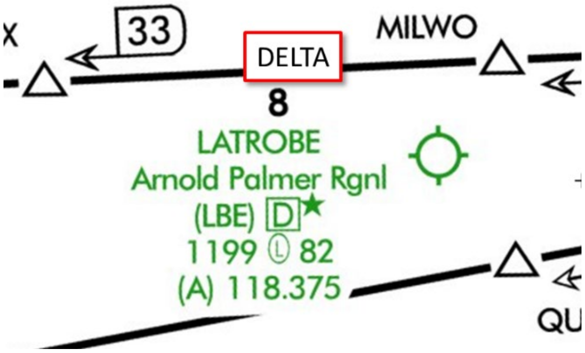
Aircraft must be equipped with a Mode C Transponder and ADS-B Out in certain airspace

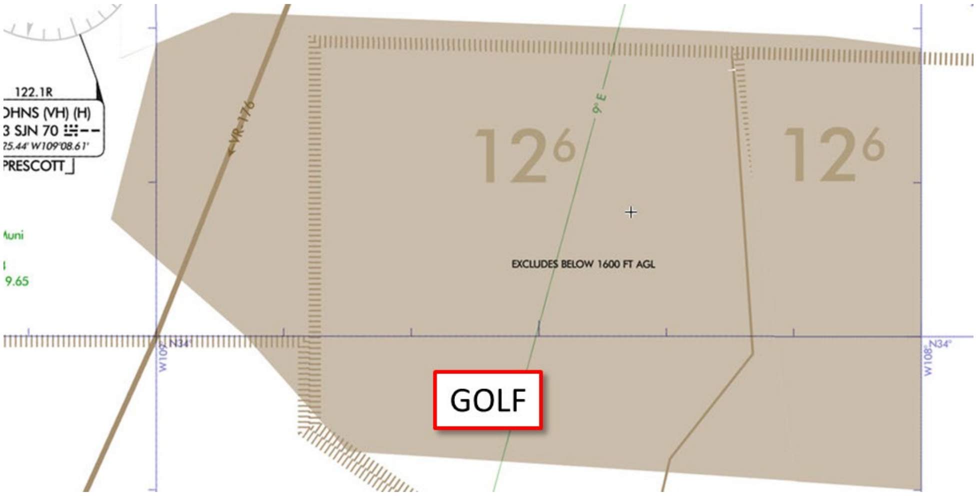


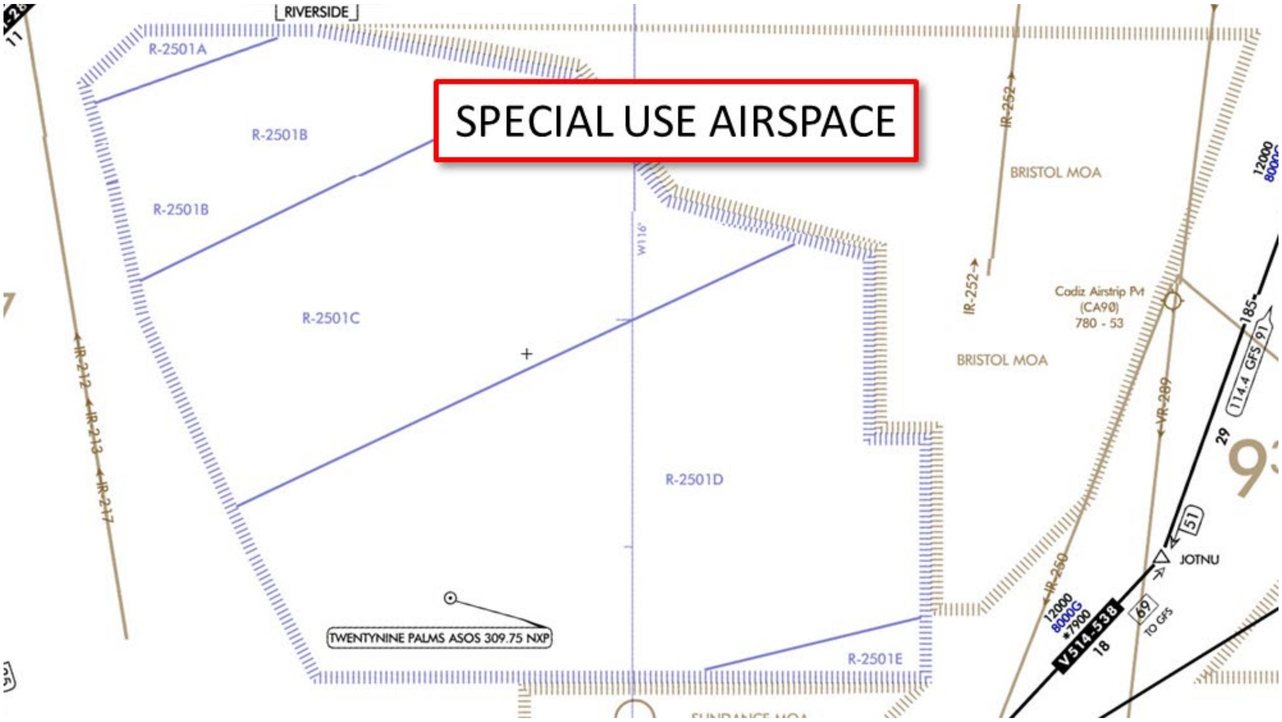
Airspace on IFR Charts








GOLF
12⁶
12⁶
EXCLUDES BELOW 1600 FT AGL
VR-176
9° E
122.1R
PRESCOTT
9.65
N34°
W109°
W108°

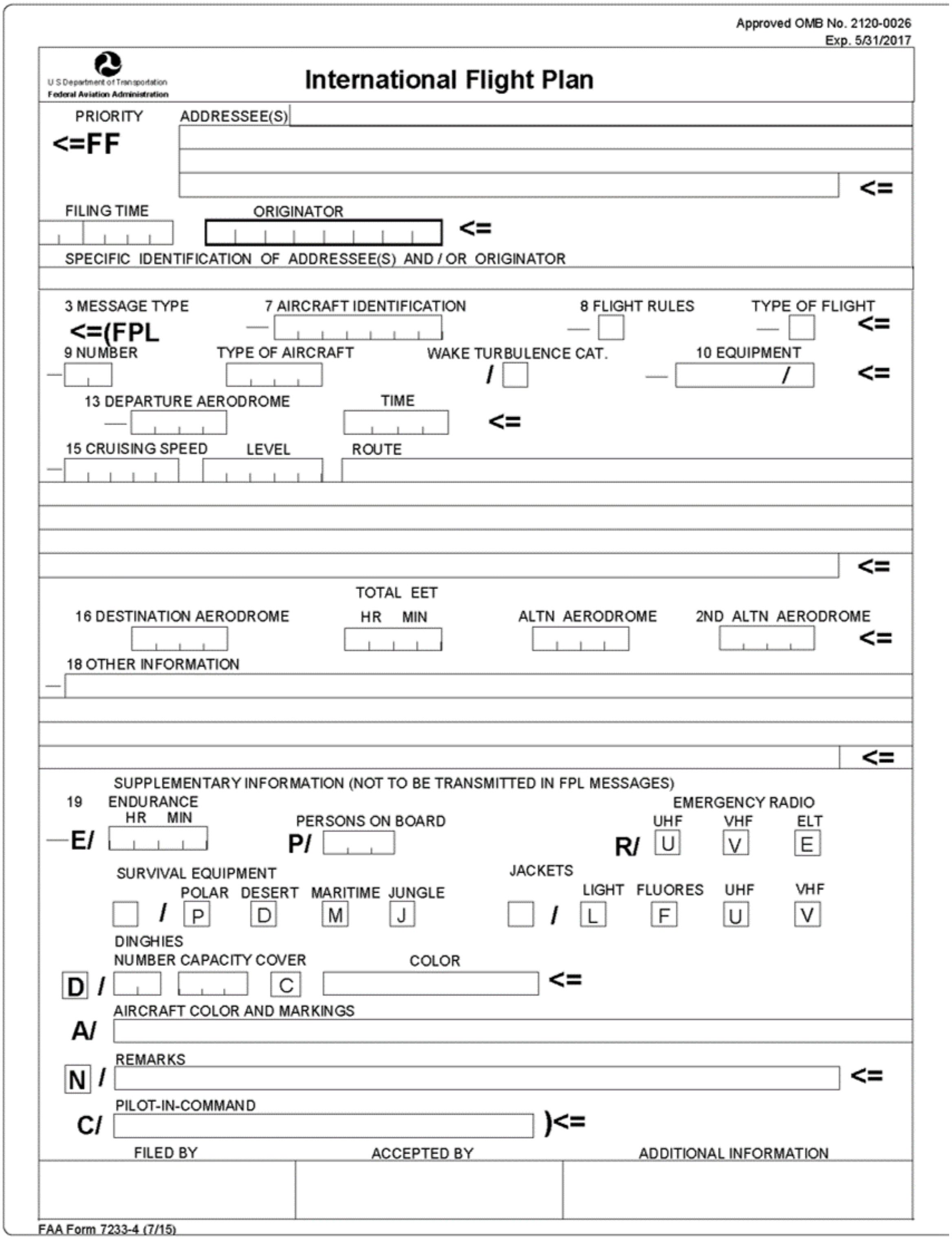

SPECIAL USE AIRSPACE
RIVERSIDE
R-2501A
R-2501B
R-2501B
R-2501C
R-2501D
R-2501E
W116°
TWENTYNINE PALMS ASOS 309.75 NXP
IR-212
IR-213
IR-217
IR-252
IR-252
BRISTOL MOA
BRISTOL MOA
Cadiz Airstrip Pvt
(CA90)
780 - 53
VR-289
IR-250
JOTNU
V514-538
114.4 GFS 91
185
29
51
69
TO GFS
12000
8000G
*7900
18

CHAPTER 5 – Departing IFR

Filing a Flight Plan

ICAO Flight Plan Form

1. IFR operations in controlled airspace (A through E) require an IFR flight plan on file.
    a. Aircraft wake turbulence category is specified in Item 9.
        i. L is for light aircraft with MTOW 15,500 lb. or less
        ii. M is for medium with weight between 15,500 and 300,000 lb.
        iii. H is for heavy with weight 300,000 lb. or greater.
    b. Separate equipment codes are required for each type of on board equipment, as specified in AIM 5-1-9, such as:
        i. S for standard VHF radio, VOR receiver, and ILS receiver.
        ii. G for IFR approved GPS.
    c. Item 19, "Endurance" should have the aircraft's usable fuel on board, in time remaining.
    d. IFR flight plans can only be cancelled if you are in VFR conditions outside of Class A airspace.
        i. Control towers close IFR flight plans for you, at non towered fields you will need to do so by contacting Flight Service on the ground, ATC while still airborne, or as dictated by local procedures.



Approved OMB No. 2120-0026
Exp. 5/31/2017

U S Department of Transportation
Federal Aviation Administration

International Flight Plan

PRIORITY
<=FF

ADDRESSEE(S)
<=

FILING TIME
ORIGINATOR
<=

SPECIFIC IDENTIFICATION OF ADDRESSEE(S) AND / OR ORIGINATOR

3 MESSAGE TYPE
<=(FPL

7 AIRCRAFT IDENTIFICATION
—

8 FLIGHT RULES
—

TYPE OF FLIGHT
—
<=

9 NUMBER
—

TYPE OF AIRCRAFT

WAKE TURBULENCE CAT.
/

10 EQUIPMENT
— /
<=

13 DEPARTURE AERODROME
—

TIME
<=

15 CRUISING SPEED
—

LEVEL

ROUTE

<=

16 DESTINATION AERODROME

TOTAL EET
HR MIN

ALTN AERODROME

2ND ALTN AERODROME
<=

18 OTHER INFORMATION
—

<=

SUPPLEMENTARY INFORMATION (NOT TO BE TRANSMITTED IN FPL MESSAGES)

19 ENDURANCE
HR MIN
—E/

PERSONS ON BOARD
P/

EMERGENCY RADIO
UHF VHF ELT
R/ U V E

SURVIVAL EQUIPMENT
POLAR DESERT MARITIME JUNGLE
☐ **/** P D M J

JACKETS
LIGHT FLUORES UHF VHF
☐ **/** L F U V

DINGHIES
NUMBER CAPACITY COVER COLOR
D / C **<=**

AIRCRAFT COLOR AND MARKINGS
A/

REMARKS
N / **<=**

PILOT-IN-COMMAND
C/ **)<=**

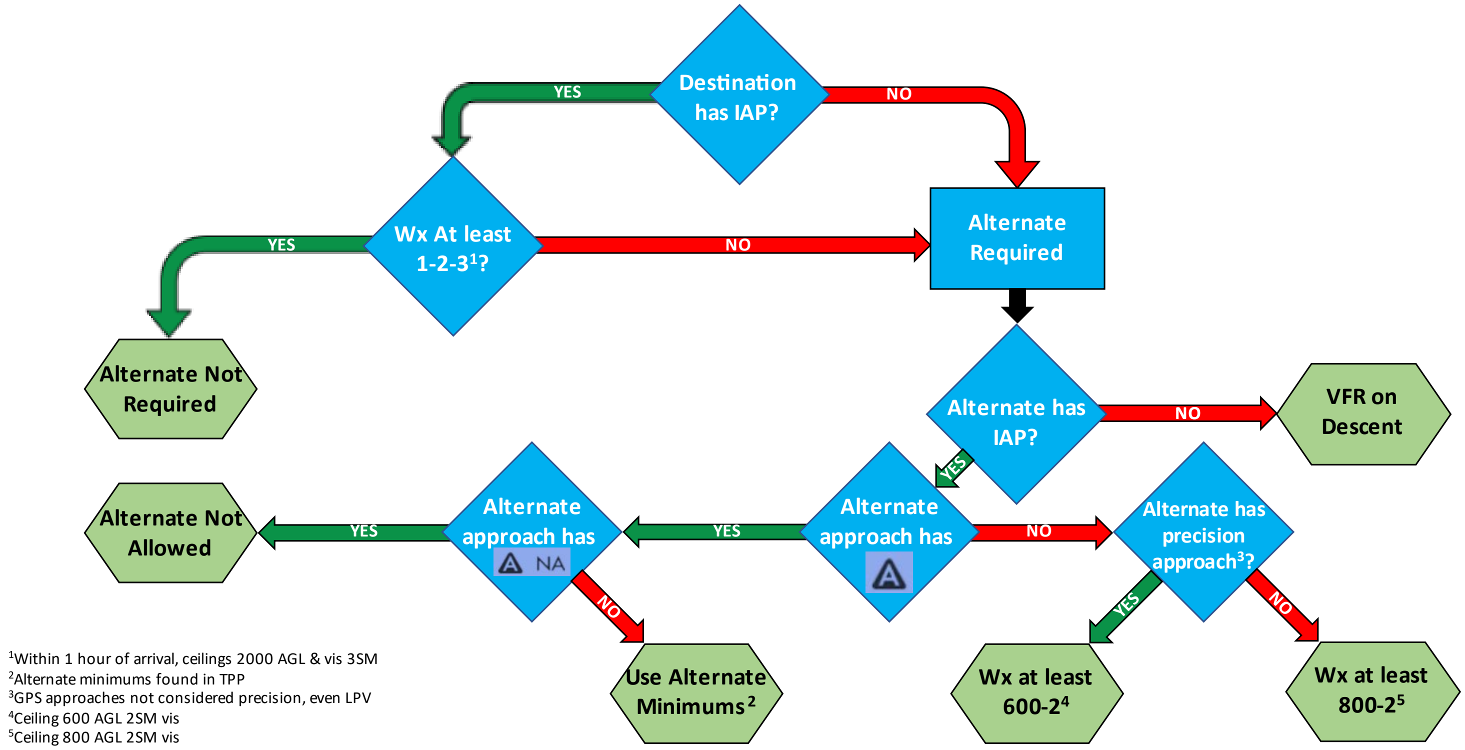
FILED BY	ACCEPTED BY	ADDITIONAL INFORMATION

FAA Form 7233-4 (7/15)

Filing a Flight Plan

IFR Alternate Requirements

Part 91 IFR Alternate Planning



[1] Within 1 hour of arrival, ceilings 2000 AGL & vis 3SM
[2] Alternate minimums found in TPP
[3] GPS approaches not considered precision, even LPV
[4] Ceiling 600 AGL 2SM vis
[5] Ceiling 800 AGL 2SM vis

1. An alternate is required if in the forecast period starting from 1 hour before, to 1 hour after the time of intended landing, the weather is poorer than:
    a. 2000' AGL ceiling or
    b. 3 statute miles of visibility
2. If the desired alternate has a precision approach that is usable on your flight, the forecast weather must be at least:
    a. 600 AGL ceilings and
    b. 2 statute miles of visibility
3. If the desired alternate has only non precision approaches available, the forecast weather must be at least:
    a. 800 AGL ceilings and
    b. 2 statute miles of visibility

4. When making a landing at the alternate, the landing minimums published for the procedure selected apply, not the planned minimums stated above.

IFR Clearance

Clearance Elements

Clearance Limit
Radio Frequency
Altitude
Frequency
Transponder code

Abbreviated Clearances

1. An abbreviated IFR clearance is given by ATC to save time and free up the radio frequency when the route filed has not been amended or has been changed very little.
    a. The clearance limit will still be stated.
    b. Any departure procedure, and transition will be stated.
    c. The remainder of the route may be given "as filed."
    d. The frequency may be omitted if there is only one for the airport or departure procedure flown.
    e. The transponder code will still be stated.

Departing

1. When taking off IFR from a towered airport, the tower will instruct the aircraft when to switch over to the departure frequency.

Cruise Clearance

1. A cruise clearance assigns the aircraft a block of altitude between the given altitude and the minimum IFR altitude for the area.
    a. A level off can be made at any intermediate altitude within this block, and descents can be made at pilot discretion.
    b. If a descent is made AND the pilot advises ATC, a subsequent climb above that altitude cannot be made without a new clearance from ATC.

Departing Non-towered

Clearance Void Times

1. When departing IFR from an airport that does not have an operational control tower, a clearance void time is often given with the departure clearance.
    a. If you have not begun the takeoff roll by this time the clearance is no longer valid.
    b. You must inform ATC that you have not departed as soon as possible but no later than 30 minutes after the void time or when instructed.
    c. Unless ATC has heard from you, they will assume you have departed and keep the airspace open. You will be overdue at your destination at the time of your planned arrival.

Ground Communications Outlet (GCO) & Remote Outlets

1. A GCO is an indirect means of communicating with ATC at a non towered airport by contacting them through a telephone line attached at the outlet.
    a. The frequency for a GCO can be found in the airport chart supplement, airport diagram, or IFR charts.
2. A remote outlet is a direct radio link with ATC from the ground at a non towered airport.
    a. The frequency for a remote outlet can be found in the airport chart supplement, airport diagram, or IFR charts.
3. Neither of these communication outlets connects to Flight Service, this can be done by contacting them directly on an appropriate frequency, though they cannot issue an IFR clearance, only relay a clearance from ATC to you.

Standard Instrument Departures

Climb Gradient

1. Required climbs on instrument departures are given in gradients – the required altitude gain for a 1 nautical mile distance travelled over the ground.
2. To convert an aircraft's climb gradient, in feet per nautical mile, to its climb rate, in feet per minute, the ground speed must be divided by 60, and the result multiplied by the climb gradient.

   Example: If an aircraft climbs at 80 Knots Indicated Airspeed, with a 10 knot direct headwind on takeoff, the climb rate in feet per minute required to maintain a 400 foot per nautical mile climb gradient is:

   Groundspeed = 80KIAS-10=70
   *Climb rate = (70÷60)*400=466 feet per minute*

Acceptance of SIDs

1. A pilot may request in the flight plan not to be assigned a departure procedure by putting "No SIDs or STARs" or "No DP" in the remarks.
2. If an instrument departure is accepted, the pilot must possess at least a textual depiction of the procedure.
   a. All weather minimums and climb gradients must be followed if the procedure is accepted.
   b. If no climb gradient is specified, the standard climb gradient is 200 feet per nautical mile.
   c. If no weather minimums are specified, the standard visibility minimum is 1 mile for aircraft with one or two engines, and one half mile for aircraft with more than 2 engines.

CHAPTER 6 – Air Traffic Control

Approach Clearances

PTAC

1. When issuing approach clearances, controllers will follow the acronym "PTAC" – Position, Turn, Altitude, Clearance
   Example: While enroute to the destination, the controller issues this clearance: "N12345 you are 5 miles from RIKME (position), turn left heading 070 (turn), maintain 2,000 until established on localizer (altitude), cleared ILS runway 4 (clearance).
   a. When receiving such a clearance, the pilot should maintain the last assigned altitude until reaching a published portion of the approach, and then follow altitude restrictions on the approach.
   b. Only the parts of the clearance containing the altitude assignments and vectors and the clearance itself should be read back.
   c. The controller will issue a vector to intercept final approach course with a heading that is no more than a 30 degree angle to the inbound course.
   d. If ATC issues you a vector without clearing you for the approach, you should continue as assigned and query the controller for new instructions. Do not turn to intercept the approach if you have not been cleared.

LAHSO

1. Land and Hold Short Operations (LAHSO) give the pilot the option to accept or reject landing and holding short, regardless of any meteorological conditions.

Clearance Enroute

Filing IFR and Departing VFR

1. When weather conditions allow for a flight to depart VFR, the pilot can request an IFR clearance if a flight plan has been filed and VFR conditions are maintained.
2. The "CRAFT" acronym will be used when issuing IFR clearances to enroute aircraft. Only the portions containing altitude assignments and vectors or any part requiring instructions need to be read back.

Pop-Up IFR Clearance

1. If no IFR flight plan is on file, a pilot may request a pop-up IFR clearance. A nearby approach or departure control frequency or center sector can be found on an IFR chart or in the chart supplement page for a nearby airport, and the request can be made with them.

Nontowered Arrival

Changing to Advisory Frequency

1. When ATC clears you for an instrument approach into a nontowered airport, they will eventually tell you "frequency change approved," allowing you to switch over to the airport's CTAF frequency, but you are still on an IFR flight plan until it is cancelled, and cannot deviate from the assigned approach, even if visual conditions prevail.

Closing the IFR flight plan

1. Unlike at towered airports, the flight plan is not cancelled for you when landing at a nontowered field. You must close the flight plan by contacting flight service or ATC by radio or phone as soon as possible.
2. If you are still in the air and in visual conditions, you may cancel with the last assigned ATC controller, even if you have been approved for a frequency change already.
3. A Ground Communications Outlet can be used to cancel IFR, the frequency for which can be found in the chart supplement of instrument approach chart.
    a. If no GCO or remote outlet exists, a phone number for clearance delivery, found in the chart supplement, can be used to cancel.

Lost Comms

Lost Communications Protocol

1. If a loss of communication occurs in IFR conditions, continue the flight according to the acronym AVEnue of FAME:
    a. **A**: Fly the **assigned** route as per last ATC clearance received.
    b. **V**: If being **vectored**, fly the direct route from point of radio failure to the fix, route, or airway specified in the vector clearance.
    c. **E**: Fly the route that ATC has said to **expect** in a further clearance.
    d. **F**: Fly the route **filed** on the **flight plan**.
    e. **A**: Fly your last assigned **altitude**.
    f. **M**: Be aware of **minimum** altitude (MEA) for IFR operations.
    g. **E**: Fly the altitude ATC has told you to **expect** in a further clearance.

Holding Procedure – Expect Further Clearance

1. When issued a hold, ATC will also assign you a time to expect further clearance (EFC). In the event of a lost comms, you should remain in the hold until the EFC time, and then continue according to the protocol above.

CHAPTER 7 – The Instrument Approach

MDA vs DA

Decision Approach

1. Precision instrument approaches, and approaches with vertical guidance, allow aircraft to descend on an approach using both horizontal and vertical guidance. They are able to arrive at a lower altitude above the ground, at a specific point, a decision altitude, along the glidepath.
2. It is ok, and in fact part of a precision approach, to descend below the decision altitude briefly. Since the decision to go missed is made AT the decision altitude, the execution of the missed approach will take the aircraft briefly below the DA.

Minimum Descent Altitude

1. A non precision approach like a Localizer only or VOR approach uses an MDA. Since there is no vertical guidance, an aircraft descends down to an MDA, and levels off at or above it at any point along the final approach semgnet.
2. The MDA cannot be crossed – it is a minimum altitude – until a visual approach to landing can be made.

Missed Approach Point

Precision Approach

1. On a precision approach, the missed approach point is the point along the glideslope where you reach the decision altitude. It is a fixed point in three-dimensional space. A missed approach can only be initiated at that point.

Non Precision Approach

1. A missed approach point will be indicated on the approach plate for a non precision point on the profile view where the bolded line ends. It can end at a runway, a cross radial, or a DME distance. It can also be determined using a time elapsed from the final approach fix. A missed approach can only be initiated at that point.

Non Precision Approaches

Stabilized Approach

1. Non precision approaches don’t use vertical guidance, so the pilot must determine a rate of descent in order to maintain a stable approach. The aircraft should be in an approved configuration for landing with the correct speed before descending below the altitude at the final approach fix or at least before reaching 1,000 feet AGL.
2. A stable approach using a three degree glidepath requires a constant feet per minute descent. A chart in the testing supplement can be used to determine this by taking the aircraft’s ground speed.

Procedure Turns

When a Procedure Turn Should not be Done

1. Even when a procedure turn or hold in lieu of procedure turn is depicted on an approach plate, it should not be executed in these circumstances:
    a. **S**: Cleared for a **straight** in approach
    b. **H**: **Holding** instead of executing the procedure turn
    c. **A**: Executing a DME or GPS **arc**
    d. **R**: Being **radar** vectored to the final approach course
    e. **P**: "**NoPT**" is depicted on the chart
    f. **T**: **Timed** approach
    g. **T**: **Teardrop** course reversal

Maximum Speed

1. The holding speeds applicable to the altitude flown should be maintained while executing a procedure turn.

CHAPTER 8 – Weather

Heating Effects

Heat Exchanges

1. Every physical process of weather is accompanied by, or is the result of, heat exchanges.
2. Unequal heating in different geographic areas causes pressure differences, which read as different barometric or altimeter settings.
3. The development of thermals depends upon solar heating.

Jet Stream

1. The troposphere is the lowest layer of the atmosphere, and is where almost all flight and weather occur.
    a. The troposphere is defined b a decrease in temperature with an increase in altitude.
    b. The top of the troposphere is the topopause, which is associated wit an abrupt change in the temperature lapse rate.
2. Where the troposphere meets the next highest layer, the stratosphere, there is often a large pressure gradient, causing high winds. These are the jet stream winds.
    a. The fast moving air of the jet stream causes long streaks of cirrus clouds.
    b. Clear air turbulence is commonly found on the trough on the colder (polar) side of a jet stream.
3. During winter months in the middle latitudes, the jet stream shifts toward the south and its speed increases.

Temperature Inversion

1. Because temperature typically decreases with an increase in altitude, when the reverse is true, and temperature increases with altitude gains, a temperature inversion is said to occur.

Sea Breezes

1. Land heats up faster than water, which causes air to rise over land when heated. This creates a low pressure area over land, which brings in cooler, denser air from over water. The wind moving inland from coastal waters is called a seabreeze.

Wind

Pressure Gradient Force

1. Areas of different pressure induce winds to flow from high to low pressure.
    a. The closer the pressure areas are, or the greater the difference in pressure, the stronger the wind force.

Coriolis Force

1. Because the Earth rotates counterclockwise (as viewed from the North Pole), winds are curved to the right in the Northern Hemisphere.

Surface Friction

1. Winds are slowed close to the surface due to interference from terrain and obstructions. This weakens the Coriolis Force, which curves winds to the right, so a southwesterly wind up at altitude will be weakened and will back to a southerly wind close to the surface.

Wind Shear

1. A temperature inversion trap air below a layer, preventing mixing of different air masses. This leads to winds of different speeds and directions on different sides of the layer. Descending or climbing through the layer can lead to wind shear.
    a. Wind shear can most likely be expected during a temperature inversion with winds at the surface at least 25 knots, however:
    b. Wind shear can occur at all altitudes and from all directions.

Clouds

Cloud Formation

- a. Moisture is added to air by evaporation and sublimation of surface water.
- b. The amount of water vapor which air can hold depends on the air temperature. As the air temperature cools, it approaches its dew point, the point at which air is saturated, and condensation occurs.
    - i. According to the standard temperature lapse, approximate cloud bases can be calculated by taking the difference between the surface temperature and dew point, in Fahrenheit, and dividing it by 4.4. That result is multiplied by 1,000 to estimate the height above ground of the cloud bases.
- c. Clouds are divided into four families according to their height ranges.

Stability of Air Mass

1. The lapse rate of the temperature of the air determines its stability. This determines how rapidly air cools as it rises. A large lapse rate indicates instability, while a small lapse rate shows stability. A temperature inversion, where the lapse rate is negative, is an extreme form of stability.
    - a. Stable air is characterized by stratiform clouds, poor visibility, and smooth air.
    - b. Unstable air is characterized by cumuliform clouds, good visibility, and turbulence.

CHAPTER 9 – Weather cont’d

Air Masses and Fronts

Fronts

1. The boundary between two different airmasses is referred to as a front.
2. One weather phenomenon which will always occur when flying across a front is a change in temperature.
3. Stable airmasses will produce steady precipitation in advance of a front, with poor visibility and stratiform clouds.
4. Unstable airmasses will produce showery precipitation in advance of a front, with cumuliform clouds.

Hazards

Thunderstorms

1. Three things are necessary for the formation of thunderstorms:
    1. High humidity
    2. lifting force, and
    3. unstable conditions
2. Cumulonimbus clouds develop into thunderstorms, and carry the greatest turbulence (nimbus means rain cloud).
3. Thunderstorms generally producing the most intense hazard to aircraft are squall line thunderstorms.
4. The phases of a thunderstorm are
    1. Developing (cumulus) stage, characterized by updrafts.
    2. Mature stage, with both up and down drafts and beginning of precipitation.
    3. Dissipating stage, characterized by downdrafts.

Structural Icing

1. Icing spoils the smooth flow of air over the wings, thereby decreasing lifting capability.
2. Structural ice is most likely to have the highest accumulation rate during freezing rain.
3. If you encounter icing with the autopilot engaged, you should be aware that it may be best to periodically disengage it and hand-fly the aircraft.

Fog

1. Advection fog occurs when an airmass moves inland from the coast in winter.

CHAPTER 10 – Sources of Flight Information

Weather Observations and Forecasts

Aviation Routine Weather Report (or METAR)

1. a METAR is an hourly weather report localized around certain airports.
2. Let's look at a METAR example:

   SPECI KCGE 051732Z 12010KT 6 SM -RA BKN 060 12/10 A3010

   a. **SPECI** is the type of report. It can be METAR or SPECI. METAR are routine, SPECI are issued when the weather has changed significantly since the last METAR.

   b. **KCGE** 4 letter airport ICAO identifier.

   c. **051732Z** The time the report was issued. Z means it's given in UTC time. The group is read as ddhhmm: 051732Z is the fifth day of the month at 17:32 zulu.

   d. **12010KT** Wind direction. The first 3 digits indicate the direction the wind is blowing from, the last 2 digits indicate the strength of the wind. (Here 120 degrees at 10 knots)

   e. **6 SM** is the visibility in statute miles. The maximum reported visibility is always smaller or equal to 10, so 10 SM means 10 miles or greater.

   f. **-RA** is the present weather group: -/+ for light/heavy intensity. Then the descriptor: RA= Rain, TS=Thunderstorms, SH=Showers are some of the most common ones.

   g. **BKN 060** Sky Condition, the first 3 letters are the type of cloud layer: SKC=Clear, FEW=few, SCT=Scattered, BKN= Broken OVC= Overcast CB=Cumulonimbus and TCU= Towering cumulus. The 3 digit group indicate the altitude of the layer in 100s of feet AGL.

h. **12/10** Temperature/Dewpoint in Celsius.

i. **A3010**: Altimeter setting in inches of mercury.

Terminal Area Forecast (TAF)

1. A TAF is similar to a METAR except that it is a forecast not a report. It covers 4NM around an airport, and is good for either 24 hours or 30 hours.
2. A TAF is broken down in several lines, each of which gives the weather for a particular interval of time. Let's breakdown a TAF example:

TAF KBWI 181732Z 1818/1924 28014G21KT P6SM FEW070 FEW110
FM181900 28015G24KT P6SM FEW070 SCT250
FM190000 29008KT P6SM SKC

a. **181732Z** is the time at which the forecast was issued. It follows the ddhhmm format.

b. **1818/1924** is the window that the TAF is valid for. It follows the ddhh/ddhh format. This one is valid from the 18th day of the month at 18:00z to the 20th day at 00:00 zulu (1924 is the 24th hour of the 19th, which is midnight on the following day).

c. Following the 1818/1924 are the forecasted meteorological conditions, written in a similar format as a METAR would be.

d. **P6SM** Visibility is more than 6 miles.

e. **FM181900** each new line that starts with FM indicates that the forecasted conditions change starting at the time indicated in the 6 digit group. For example here, on the 18th starting at 1900z, the wind changes from 28014G21KT to 28015G24KT. This forecast is valid until the next FM group.

Pilot Report (PIREP) is a weather report made by a pilot in flight.

1. A Pilot Report (PIREP) is a weather report made by a pilot in flight.
2. It's broken down in several elements:

    a. a 3 letter station identifier of the nearest weather facility.
    b. Report type UA=Routine, UUA= Urgent.
    c. /OV Location in relation to a VOR, /TM Time the report was made (UTC).
    d. /FL Altitude, /TP Aircraft Type.
    e. /SK Sy cover, /WX Weather.
    f. /TA Temperature in Celsius,/TB Turbulence.
    g. /IC Icing, /RM Remarks.

3. Let’s look at an example:
    a. AGC UA /OV AGC/TM 2025/FL040/TP EC45/IC LGT-MOD RIME: Over the Allegheny VOR (AGC) at 20:25z at 4,000 ft an EC 45 encountered light to moderate rime ice.

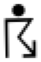
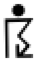
<u>Winds and Temperatures Aloft (FBs)</u>

1. A winds and temperature aloft forecast gives the reported wind conditions and temperature at different altitudes in 3000 ft increments.
2. The forecast uses a 4 digit wind group followed by a + or - sign and a 2 digit temperature group.
3. Above 24,000 ft, the - sign is dropped and all temperatures are assumed negative.
4. The first 2 digits of the wind groups is the wind direction in 10s of degrees. The last 2 digits is the strength in knots. For example, 2212 means the wind is coming from 220 degrees at 12 knots.
5. If the wind is stronger than 100 knots, then 50 is added to the wind direction: 7208 means the wind is coming from 220 degrees at 108 knots.
6. The last 2 digit temperature group is the temperature in celsius.

Weather Charts and NOTAMs

Weather Charts

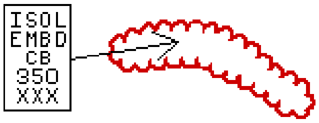
1. Aviation Surface Forecast Legend:

	-RA	Light rain
	RA	Moderate rain
	+RA	Heavy rain
	TSRA	Light to moderate thunderstorm with rain
	TSGR	Light to moderate thunderstorm with hail
	+TSRA	Thunderstorm with heavy rain
	VCFG	Vicinity fog
	BCFG	Patchy fog
	PRFG	Fog, sky discernable
	FG	Fog, sky undiscernable
	FZFG	Freezing fog

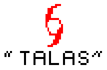
2. Some airplanes are equipped with Airborne Radar Systems. Those systems can give live information about the location of areas of precipitation. Be aware that airborne radars only detect precipitation, and not the presence of clouds so they cannot be used to avoid instrument weather conditions.

3. High level significant weather prognostic chart legend:

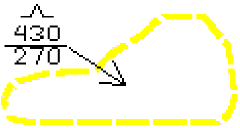
- thunderstorms and cumulonimbus clouds



- tropical cyclones



- moderate or severe turbulence

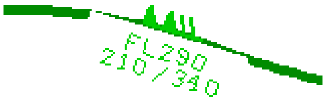


- tropopause heights

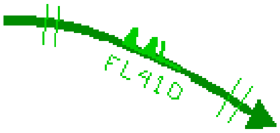
- jetstreams (80kt and above depicted)

- volcanic eruptions

- Jet Depth *



- Hash Marks (each pair indicates successive 20kt wind speed changes referenced to Jet Max)



- Release of Radioactive Materials

Chapter 11 - Global Positioning System (GPS)

RNAV Approaches and GPS Navigation

RNAV Approaches

1. Area Navigation (RNAV) is a method of navigation that permits aircraft operation on any desired flight path with the coverage of ground or space-based navigation aid.

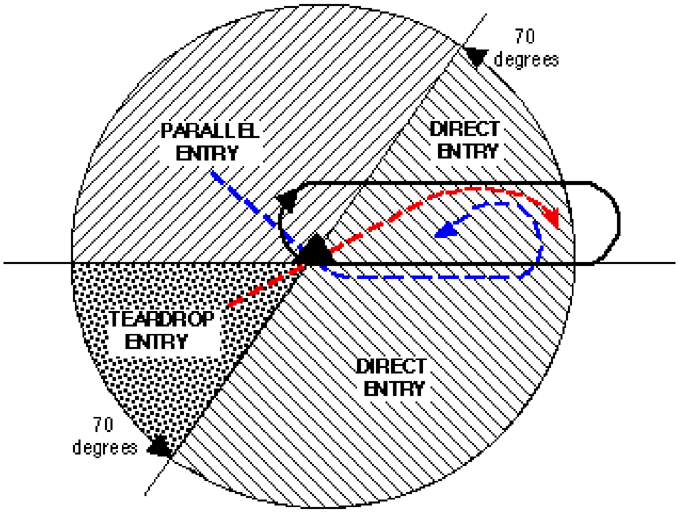
GPS Navigation

1. To be used as primary means of navigation, a GPS unit must be mounted on the airplane, handheld units can only be used for situational awareness.
2. The navigation database of a GPS must be current to be used for IFR navigation. Typically, the database is updated every 28 days.
3. Receiver Autonomous Integrity Condition (RAIM) ensures the integrity of the GPS signal. If RAIM is not available prior to beginning a GPS approach, the pilot must revert to another means of navigation.
4. GPS uses a feature called auto sensitivity to automatically adjust the scale of the CDI during an approach. If auto sensitivity is deactivated, the approach mode will disengage.
5. All newly installed GPS units will require a supplement to the aircraft's flight manual. You can always check that supplement to verify that the GPS unit is compatible with IFR operations.

Chapter 12 - Holding Patterns

Hold Entries

1. The type of entry used to enter a hold depends on the relative position of the aircraft to the holding radial and holding fix. To determine which entry to use the following procedure:
    a. Draw the holding radial,
    b. Draw the holding pattern on that radial. (Remember standard turns are right turns and non-standard turns are left turns, if the controller doesn't specify if the turns are standard or not, you can use standard turns.)
    c. Draw a line at a 70-degree angle from the radial into the track as shown on the figure below.
    d. Finally, draw the position of the airplane, and use the figure below to determine what kind of entry you should be using



2. When flying a holding pattern, you should abide by the following speed restrictions:
    a. Below 6,500 ft: 200kt
    b. Between 6,500 ft and 14,000 ft: 230kt
    c. Above 14,500 ft: 265 kt
3. When performing a VOR hold, you should always start the timing of the outbound leg when over or abeam the VOR, whichever occurs last.

Chapter 13 – Mastering Approaches

RNAV Approaches and GPS Navigation

Horizontal Situation Indicator (HSI)

1. The HSI is used by a pilot to determine the position of their aircraft with respect to a NAVAID such as a VOR or an ILS, or to fly a precise course using a NAVAID. An example of a reading from an HSI is shown below (Figure 109).

FIGURE 109.—CDI Direction from VORTAC.

2. The yellow Arrow on the HSI is called the Omni Bearing Selector (OBS), and is used to select a radial.

3. The HSI is the combination of a heading indicator and a VOR receiver. The top of the HSI shows the heading of the airplane.

4. The white arrow on the HSI is the TO/FROM flag. A white arrow pointing in the same direction of the OBS is a TO indication, if it's pointing the other way it's a FROM indication. On the example above we have a TO indication. If no white arrows are shown, then the

aircraft is on the radial that is 90 degrees from the selected radial under the OBS, or is in the process of overflying the station.

5. The yellow “needle” on the HSI is called the Course Deviation Indicator (CDI). It shows how far the aircraft is from the radial selected on the OBS. If the CDI is centered, the aircraft is on the chosen radial or its reciprocal. Each white dot on the CDI represents 2 degrees of deflection off of the selected radial. The HSI has 5 dots on each side of the airplane, so the maximum deflection that can be shown by the instrument is 10 degrees.

6. If the deflection of the CDI is to the right (left), it means that the aircraft is to the left (or right) of the selected radial. If you are flying in the same direction as the TO/FROM flag, (away from the station with a FROM indication, towards the station with a TO indication) you will always need to “chase the needle” to get back on course (right CDI deflection= turning the aircraft to the right will get you back on course, left CDI deflection=turning aircraft to the left). Except when flying a back course (See explanation below)

7. Let’s take a look at the HSI above (Figure 109):
    a. The radial selected is due south or 180 degrees.
    b. The TO/FROM flag shows a TO indication. This tells us that flying a heading of 180 degrees will get us closer to the VOR station. So, the aircraft must be somewhere north of the station.
    c. The CDI shows a right deflection. So, if we are flying towards the station, we would need to make a correction to the right of the selected 180° to center the CDI which means that the aircraft is somewhere north east of the station.
    d. The CDI is deflected by about 9 degrees. This means that if we selected the 189 degree radial, the CDI would center with a TO indication. Turning the aircraft to a 189 degree heading would then fly you direct to the station, (assuming there is no crosswind).
    e. Note that this does not mean we are on the 189 radial! Radials radiate out from the station. If we need to fly a 189° course to go directly to the station, the radial we are on is the reciprocal of this, 009.

8. The back course of an ILS approach is the course line along the extended centerline in the opposite direction of the front course.

9. When flying the back course, it is necessary to fly the aircraft in the opposite direction of the needle, except if the aircraft ILS equipment includes reverse sensing capability.

10. When flying a backcourse, using reverse sensing it is helpful to picture your position as being the needle, or the CDI, and needing to correct towards the center.

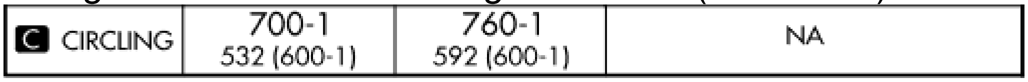
Circle to Land

Circling approaches

1. A circling approach can be found either at airports with no straight in approaches, or if the pilot does not want to make a straight in approach to a runway if available. The pilot executes the approach, and once the desired runway is in sight, breaks from the approach, and circles the airport to land on the desired runway.

2. Depending on the category of aircraft, the aircraft must remain within a certain radius of each runway threshold. This radius depends not only on the category of the aircraft, but also on the time the circling approach was developed:

    a. If the approach was developed prior to late 2012 it will have a standard circling approach maneuvering radius.
    b. If the approach was developed after late 2012 it will have an expanded circling approach maneuvering airspace radius.
    c. Circling approaches with an expanded circling approach maneuvering airspace radius will have a white C over a black background before the circling minimums (see below)



C CIRCLING	700-1 532 (600-1)	760-1 592 (600-1)	NA

    d. The table containing all the standard and expanded expanded circling approach maneuvering airspace radius can be found in the AIM 5-4-20

3. Circling approaches will generally have higher minimums than straight in approaches.

4. If the name of an approach consists of a NAVAID followed by a letter, such as VOR/DME-A or VOR/DME-B, then this approach only has circling minimums and no straight in minimums.

5. When executing a circling approach, the pilot must maintain visual contact with the airport environment at all times.

6. To execute a missed approach during a circling maneuver, the pilot must initiate a climbing turn toward the runway until established on the missed approach procedure.

Standard Terminal Arrivals Routes

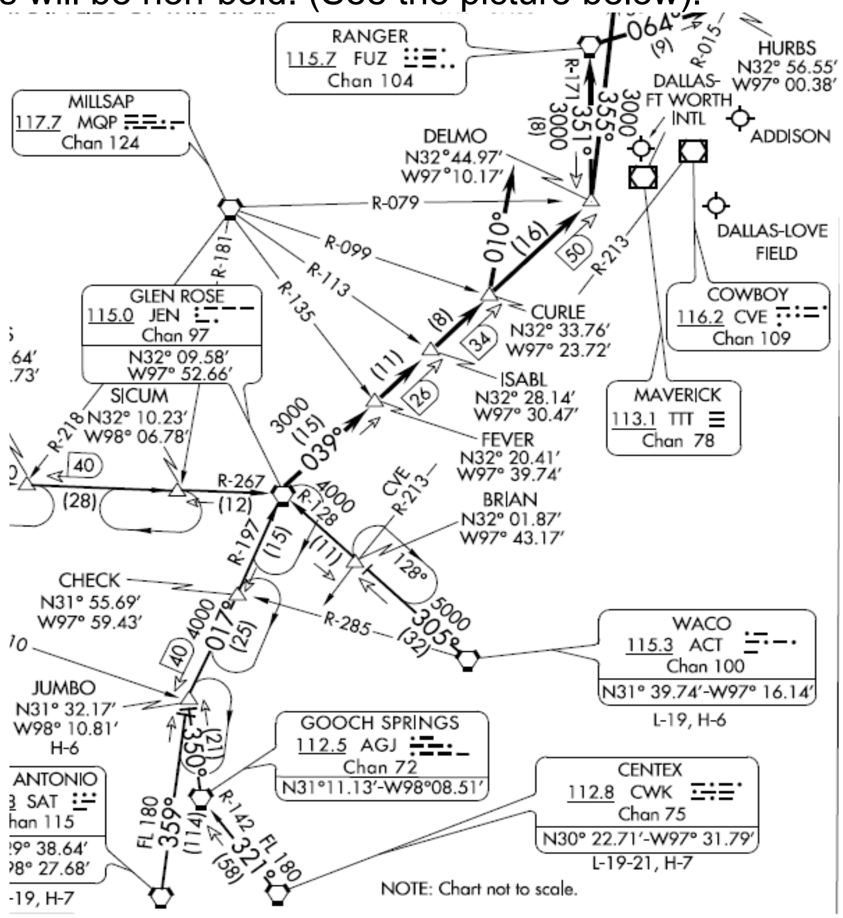
Standard Terminal Arrivals Routes (STARs)

1. A STAR is a published procedure that allows to transition from the enroute phase of flight to the approach.

2. It simplifies the clearance delivery process.

3. The controller will assign a STAR when deemed necessary. If the pilot does not wish to get a STAR, they should write “NO STAR” in the remarks section of the flight plan.

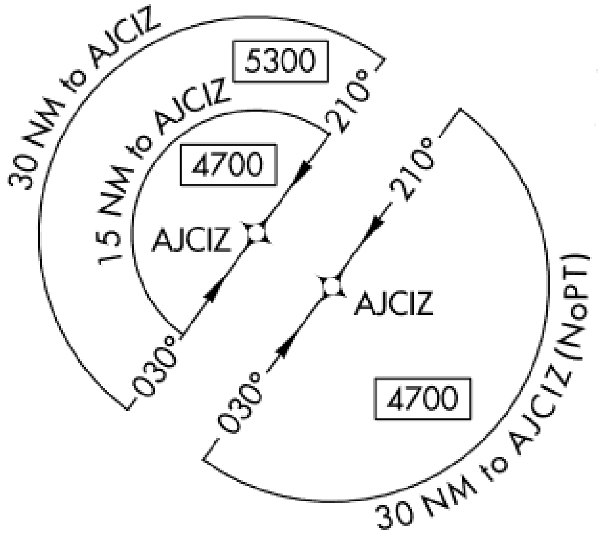
4. STARs typically have a few feeder routes that will feed the beginning of the arrival. The arrival will have bold lines whereas the feeder routes will be non-bold. (See the picture below).



Terminal Arrival Area (TAA)

TAA

1. TAAs are GPS approaches that follow a uniform design.
2. On the plan view of a TAA there will be a broken circle that divides the approach in different sectors. Each segment will have a fix associated with it, and altitude restrictions that depend on the heading toward the fix.
3. Let’s look at the TAA sector division below:
    a. This TAA is divided into 2 sectors.
    b. The first sector is defined by a magnetic course clockwise from 030° to 210° to the AJCIZ fix. The second sector is defined by the opposite courses.
    c. An airplane coming from the first sector will have to stay above 5,300ft between 30 and 15 NM from AJCIZ, and can go down to 4,700 ft 15 NM from AJCIZ
    d. An airplane coming from the second sector can descend to 4,700 ft.



Visual and Contact Approaches

Visual and contact approaches

1. A contact approach can be used by a pilot in lieu of a standard or special IAP, the requirements for a contact approach are:
    a. 1 SM visibility and clear of clouds.
    b. Has to be requested by the pilot – ATC can't offer the option without the pilot requesting it.
    c. It's not required by the pilot to see the airport to do a contact approach.

2. A visual approach can be requested by the pilot or assigned by ATC and must meet the following requirements:
    a. 3 SM visibility and ceilings above 1000 ft.
    b. Must have the airport or the preceding aircraft in sight.

3. On a visual approach, the radar service will be terminated when handed off to the tower.

Chapter 14 – The Human in the Cockpit

Lungs and Circulatory System

Lung and circulatory system

1. **Hyperventilation** results from over-breathing usually caused by emotional tension, anxiety or fear.

2. Hyperventilating can induce drowsiness, tingling of the fingers, nausea and a feeling of suffocation.

3. If you are hyperventilating you need to slow down your breathing rate. Some techniques to help with that include: breathing in a paper bag, talking out loud or singing.

4. **Hypoxia** is a deficiency of oxygen in the body. There are several kinds of hypoxia:
    a. Hypoxic hypoxia is a result of insufficient oxygen available in the body as a whole. This can happen at high altitudes where the air pressure is lower.
    b. Hypemic hypoxia occurs when the blood is not able to transport oxygen to the cells in the body. This can be caused by carbon monoxide poisoning.
    c. Stagnant Hypoxia happens when the blood in the body cannot move, for example when pulling high Gs during a maneuver.
    d. Histotoxic hypoxia is the inability of the cells to use oxygen. This can be caused by alcohol or drug use.

5. Some of the symptoms of hypoxia include:
    a. Headache, drowsiness and dizziness.
    b. Tunnel vision
    c. Cyanosis (A bluish discoloration of the skin)

6. If you are experiencing hypoxia, you should descend to a lower altitude as soon as possible.

7. CO2 poisoning can cause hypoxia. If you suspect that some exhaust fumes are getting into the cabin, you should open the vents and windows, and land as soon as practicable.

Vision

Scanning method

1. During daytime hours, the best method to scan for collision avoidance is to divide the sky into 10 degree vertical sectors, scan each sector for at least 1 second and move on to the next one.

2. During night time, the best method to scan for collision avoidance is to keep your eyes moving slowly but continuously and use your peripheral vision.

3. Before a night flight, a pilot should prepare his eyes by avoiding any bright lights for 30 minutes before the flight.

Spatial disorientation

1. Pilots are most susceptible to spatial disorientation when visual cues are taken away, such as flying in IMC.

2. To avoid or recover from spatial disorientation, pilots must rely on their instruments rather than their sensory organs.

Aeronautical Decision Making (ADM)

Aeronautical Decision Making

1. The advancement of automation and avionics in general aviation airplanes has led to some great tools to enhance situational awareness. However, pilots using those tools must pay extra attention to not become complacent and stay focused on their duties.

2. One of the common factors which affects most preventable accidents is human error (fuel exhaustion, VFR flight into IMC, flight into known icing, controlled flight into terrain etc.)

3. The FAA had identified several hazardous attitudes in pilots and devised some ‘antidotes’ that pilot can use to remedy them:
    a. Anti-authority: “Don’t tell me!”. Antidote: follow the rules. They are usually right.
    b. Impulsivity: “Do something quickly!”. Antidote: not so fast. Think first.
    c. Invulnerability: “It won’t happen to me!”. Antidote: It could happen to me.
    d. Macho: “I can do it!”. Antidote: taking chances is foolish.
    e. Resignation: “What’s the use?”. Antidote: I’m not helpless. I can make a difference.

Chapter 15 – Review of Regulations

Certification

Flight Review and Recency

1. Every pilot must complete a flight review every 24 calendar months.

2. To act as a pilot in command of an aircraft carrying passengers, the pilot must have made at least three takeoffs and landings in an aircraft of the same category, class and type within the last 90 days. If the flight is to occur at night then the 3 landings must be made in the time between 1 hour after sunset until 1 hour before sunrise and be to a full stop (no touch and goes).

Class and category:

1. With respect to certification of aircraft:
    a. Categories of aircraft include: normal, utility, acrobatic.
    b. Classes of aircraft include: airplane, rotorcraft, glider, lighter than air.

2. With respect to certification of airmen:
    a. Categories of aircraft include airplane, rotorcraft, glider, lighter than air.
    b. Classes of aircraft include:
        i. For airplanes single engine land, single engine sea, multi engine land, multi-engine sea.
        ii. For rotorcraft helicopters and gyroplanes.

Medical Certificate:

1. Medical certificates of different classes have different durations:
    a. A first class medical expires after 12 calendar months for pilots under 40 and after 6 calendar months for pilots over 40.
    b. a second class medical expires after 12 calendar months.
    c. a third class expires after 60 calendar months for pilots under 40 and after 24 calendar months for pilots over 40.

2. In order to qualify for BasicMed a pilot must have:
    a. Held an FAA medical certificate at any time after July 14, 2006:
        i. Which may be expired.
        ii. May have been a special issuance.
        iii. Cannot have been suspended, revoked, withdrawn or denied.
    b. Completed an online medical education course in the last 24 calendar months.
    c. Completed a physical examination by a state licensed physician in the last 48 calendar months.

Private pilot limitations and requirements

1. Private pilots may not pay less than the pro rata share of the operating expenses of a flight with passengers. provided the expenses involve only fuel, oil, airport expenditures, or rental fees.

2. Private pilots may not act as pilot in command of an aircraft that is carrying passengers or property for compensation or hire.
    a. There is an exception for charitable, nonprofit or community event flight described in 14 CFR 91.146

3. Any person that holds a pilot or a medical certificate shall present it for inspection upon the request of any representative of the FAA, NTSB or law enforcement (14 CFR 61.3).

4. Any person that acts as pilot in command must have in his possession:

a. A photo ID
b. A pilot certificate applicable to the type of operation being conducted.
c. A medical certificate applicable to the type of operation being conducted.

Position lights

1. Except in Alaska, no person may operate an aircraft from sunset to sunrise without position lights.

Operating Rules

Emergency Locator Transmitter (ELT):

1. An ELT is a battery powered device that broadcasts a distinct sound on the 121.5 and 243 MHz frequency.

2. They can trigger automatically after an impact or can be manually activated by the pilot.

Maintenance

1. Preventative maintenance tasks are smaller maintenance items that can be done by a pilot granted that they possess at least a private pilot certificate.

2. Preventative maintenance is defined in Appendix A to Part 43 of the FAR.

3. The owner or operator is responsible for ensuring that appropriate entries are made in maintenance records indicating the aircraft has been approved for return to service.

4. Any aircraft used for commercial purposes must undergo a 100 hour inspection. This 100 hours may be exceeded by no more than 10 hours while en route to reach a place where the inspection can be done. The excess time must be included when computing the next 100 hours of time in service.

Airworthiness

1. When an aircraft meets its design requirements and is in condition for sage operations, an Airworthiness certificate is issued by the FAA.

2. This airworthiness certificate has no expiration date and is valid as long as the aircraft is maintained in airworthy condition.

Aircraft Registration

1. On January 23, 2023 the FAA extended the duration of aircraft registration certificates from 3 to 7 years.

2. After buying an aircraft, the new owner must register the aircraft and cannot fly under the dealer's registration.

Airworthiness Directive (AD)

1. ADs are legally enforceable rules issued by the FAA to correct an unsafe condition in a product.

2. They are mandatory in nature and come in two different kinds:

    a. Urgent ADs that require immediate action by the owner/operator.
    b. Non-urgent that usually come with a date before which the action must be taken.

Authority

1. According to 14 CFR 91.3The final authority to the operations of the aircraft, and the person directly responsible for them, is the pilot-in-command.

2. If an in-flight emergency requires immediate action, the pilot-in-command may deviate from any rule of 14 CFR part 91 to the extent required to meet that emergency.

Dropping an object

1. 14 CFR 91.15 states that if reasonable precautions are taken to avoid danger to people or property it is allowed to drop objects from an aircraft

Parachute

1. Every occupant of an aircraft must wear a parachute if the aircraft is to be flown with:
    a. A bank of more than 60 degrees
    b. A nose-up or nose-down attitude of more than 30 degrees relative to the horizon.

2. No pilot may allow a parachute to be carried in an aircraft unless it is of an approved type and has been packed by a certificated and appropriately rated parachute rigger:
    a. Within the preceding 180 days if the parachute is made of nylon, rayon, or other similar synthetic fiber or materials that are substantially resistant to damage from mold, mildew, or other fungi and other rotting agents propagated in a moist environment,
    b. Within the preceding 60 days, if any part of the parachute is composed of silk, pongee, or other natural fiber.

Accident reports

1. If an aircraft is involved in an accident which results in substantial damage to the aircraft, the nearest NTSB field office should be notified immediately.