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INSTRUMENT RATING
Everything You Need To Know

Instrument Time

§ 61.51g (1) - A person may log instrument time only for that flight time when the person operates the aircraft solely by reference to instruments under actual or simulated instrument flight conditions.

§ 61.51g (2) - An authorized instructor may log instrument time when conducting instrument flight instruction in actual instrument conditions.

Logging Instrument Time

§ 61.51 g(3i-ii)(4)

- Location and type of each approach
- Safety pilot name (if required)
- Flight simulator used
  - If used for certificate or rating, add Instructor name and number
  - If instrument rated and used for currency, no instructor needed

Instrument Rating Required

- When acting as PIC under IFR weather conditions *§ 61.3*
- Flight in Class A airspace *§ 91.135*
- Flight in Special VFR between sunset and sunrise *§ 91.157*
- When carrying passengers for compensation or hire on cross-country flights in excess of 50 NM or at night *§ 61.133*

To act as PIC under IFR

- Current medical certificate
- Current Instrument Rating

Aeronautical Experience Required for Instrument Rating

§ 61.65

- **50** hours of X-Country PIC time
  - At least **10** hours in airplanes
- **40** hours actual or simulated instrument time
  - At least **15** hours with a CFII
  - **20** of which may be accomplished in an approved FTD or ATD with instructor
- Use of full flight simulators or Flight Training devices (FTDs)
  - Must be with a CFII
  - **Max 30** hours under Part 141
  - **Max 20** hours under Part 61
- Use of FAA-approved Aviation Training Device
  - Must be with a CFII
  - **Max 10** hours if Basic ATD
  - **Max 20** hours if Advanced ATD
- One **250 NM** X-Country flight
  - Along airways or directed by ATC routing
  - An instrument approach at each airport
  - **3** different kinds of approaches using navigation systems
- **3** hours of instrument flight training in the last **2** calendar months

Recency Requirements

Instrument Currency

§ 61.57(c)

6 Months

- Conducted 6 Instrument Approaches
- Intercepted and tracked courses using navigation systems
- Performed holding procedures

***Note:** The FAA doesn't specify how many holds. Just more than one.*

These can be completed in an approved FFS, ATD, or FTD provided the device is of the same category of aircraft and the pilot performs them in simulated instrument conditions. A flight instructor is not required.

Additional 6 Months

- Additional time to accomplish the 3 tasks with...
  - A safety pilot in simulated instrument conditions
  - A CFI or examiner

Safety Pilot

- Must have at least a Private Pilot Certificate *(does not have to be current)*
- Must be rated in the same category and class aircraft
- Must have a current medical
- Aircraft must have dual controls
- Must have adequate visibility of front and each side of the aircraft

IPC Required

Instrument Proficiency Check

- Administered by a CFII, examiner, or FAA approved official
- Some IPC tasks can be conducted in an Advanced Aviation Training Device (AATD)

Helpful Tip

Use the acronym "**6 HITS**" to remember the IFR recency requirements

6 - 6 Instrument Approaches

H - Holding procedures
I - Intercepted a course
T - Tracked a course
S - Using navigational systems

Flight Review

- Within the last 24 calendar months
  - Min 1 hr flight instruction
  - Min 1 hr ground instruction
  - Conducted by authorized instructor
- May be substituted by...
  - A proficiency check
  - A practical test for a new rating or certificate
  - Completion of one or more phases of FAA sponsored pilot proficiency award program (WINGS)
  - Flight Instructor Renewal *§ 61.197 (substitutes ground portion only)*

Passenger Carrying

- 3 takeoffs and landings in the preceding 90 days in the same aircraft category, class, and type *(Full stop with a tail dragger)*

Passenger Carrying At Night

- 3 takeoffs and landings in the preceding 90 days in the same aircraft category, class, and type
- Full Stop
- 1 hour after sunset to 1 hour before sunrise

Required Personal Documents

- Pilot Certificate
- Medical Certificate
- Authorized photo ID
- Radio Operator Permit
  (for flight outside the US)

Required Aircraft Documents

§ 21.5, 91.103, 91.1, 91.203

"**ARROW**"

A - Airworthiness certificate
R - Registration
R - Radio station license *(for international flights)*
O - Operating limitations & Information *(in AFM)*
W - Weight and Balance data *(aircraft specific)*

Preflight Self Assessment

§ 91.17, AIM 8-1-1

"**IM SAFE**"

I - Illness
M - Medication
S - Stress
A - Alcohol
F - Fatigue
E - Emotion/ Eating

Preflight General

"**PAVE**"

P - Pilot
A - Aircraft
V - EnVironment
E - External Factors

Decision Making & Risk Management

"**DECIDE**"

D - *Detect* a change has occurred
E - *Estimate* the need to counter the change
C - *Choose* what is the desired outcome
I - *Identify* the solutions
D - *Do* the necessary actions
E - *Evaluate* the effects of the actions

Required Aircraft Maintenance Inspections

"**AV1ATES**"

A - Annual Inspection *§ 91.409*
- Every 12 Calendar Months

V - VOR Check *§ 91.171*
- Every 30 days

1 - 100 Hour Inspection *§ 91.409*
- Required if flying for hire

A - Altimeter *§ 91.411*
- Every 24 Calendar Months

T - Transponder *§ 91.413*
- Every 24 Calendar Months

E - ELT *§ 91.207*
- Every 12 Calendar Months
- Battery must be replaced after more than 1 hour of cumulative use

- or -

If 50% of the usable battery life is expired

S - Static System *§ 91.411*
- Every 24 Calendar Months

Minimum Required Equipment for VFR Flight

§ 91.205

"**A TOMATO FLAMES**"

A - Altimeter
T - Tachometer for each engine
O - Oil Temp indicator for each engine
M - Manifold pressure gauge for each altitude engine
A - Airspeed Indicator
T - Temp gauge for each liquid cooled engine
O - Oil pressure gauge for each engine
F - Fuel quantity gauge for each fuel tank
L - Landing gear position lights
A - Anticollision lights *(aircraft certified after 03/11/96)*
M - Magnetic direction indicator (compass)
E - ELT
S - Safety belts/shoulder harnesses

Minimum Required Equipment for VFR Night Flight

All day VFR + "**FLAPS**"

F - Fuses *(spare set)*
L - Landing light *(if for hire)*
A - Anticollision light
P - Position lights *(navigation lights)*
S - Source of power *(such as battery)*

Minimum Required Equipment for INSTRUMENT Flight

All day VFR (+ FLAPS if at night) "**GRABCARD**"

G - Generator/alternator
R - Radios *(two way and nav.)*
A - Altimeter *(pressure sensitive)*
B - Ball *(slip-skid indicator)*
C - Clock *(Installed & shows hrs. min. and sec with a sweep-second pointer or digital presentation)*
A - Attitude Indicator
R - Rate of turn indicator
D - Directional gyro *(Heading indicator)*

Preflight Info Required for IFR

§ 91.103

"**NW KRAFT**"

N - NOTAMs
W - Weather reports and forecasts
K - Known traffic delays
R - Runway length of intended use
A - Alternatives available
F - Fuel Requirements
T - Takeoff and landing performance data

Types of 30 Day VOR Checks

§ 91.171
(with acceptable tolerances)

VOT - ±4°
Repair Station - ±4°
VOR Ground Checkpoint - ±4°
VOR Airborne Checkpoint - ±6°
Dual VOR Cross-Check - 4° variation
Above a Prominent Ground Landmark
On a selected radial at least 20 NM from a VOR flying at a "reasonably low altitude" ±6°

Operating with inoperative equipment

§ 91.213

- Is the equipment required by:
  - An Airworthiness Directive (AD)
  - Regulations for type of flight operation
  - VFR Day certification requirements
  - An operational equipment list

Yes
Flying is NOT PERMITTED without a special flight permit

No
Flying is PERMITTED, so long as:
- equipment is removed

- or -

- deactivated and placarded "inoperative"
- pilot/mechanic determine safe to fly

If the aircraft has a Minimum Equipment List (MEL), refer to the MEL guidance.

IFR Minimum Fuel Requirements

§ 91.167

Fuel from **departure** to **destination**

+

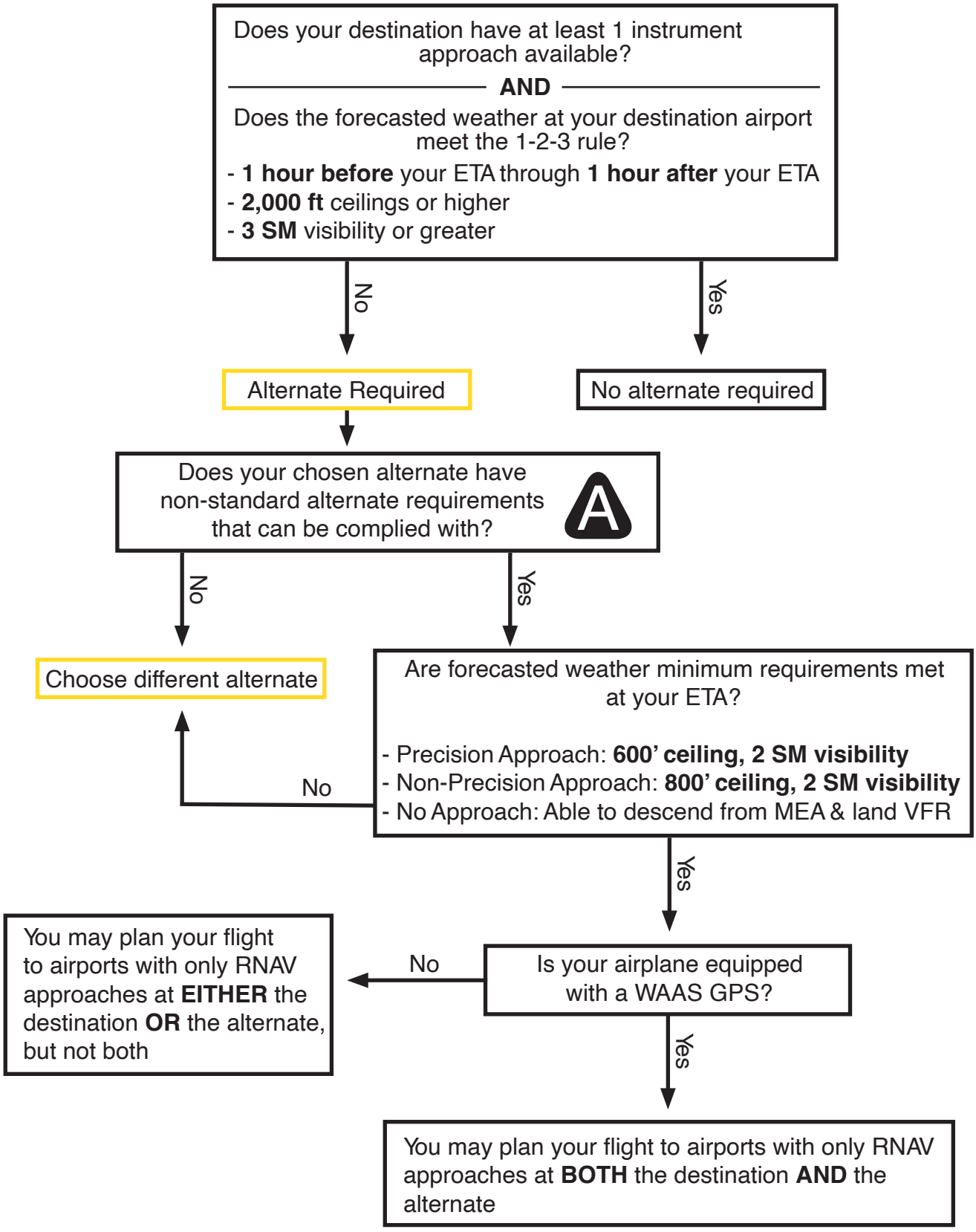
Fuel from **Destination** to most distant **Alternate**
(If alternate is required)

+

45 Minutes calculated at normal cruise speed/alt.

Do you need an Alternate?

§ 91.169



IFR Takeoff Minimums

§ 91.175

No T/O minimums mandated for Part 91.

For Part 121, 125, 129, 135:

- Published T/O minimums for the runway
- 1-2 engines: 1SM visibility
- More than 2 engines: ½ SM visibility

Non-Standard:

Published Takeoff Minimums & DPs

Non-Standard alternate minimums

NA Alternate minimums not authorized

Because of unmonitored facility or absence of weather reporting

Standard Terminal Arrival (STAR)

- Transition between the enroute and a point from which an approach to landing can be made.
- **Transition** - Fix that connects enroute flight plan to the beginning of the STAR.
- Some STARs require **RNAV 1** navigation ability
- You may state "**NO STARs**" in the remarks section of a flight plan to avoid STAR clearances.

IFR Departure Clearance

AIM Chapter 5 Section 2

"**CRAFT**"

C - Clearance Limit
R - Route
A - Altitude
F - Frequency (for departure)
T - Transponder "squawk" code

- **Clearance Void Time** - Time in which your clearance becomes void, after which you may not takeoff. Notify ATC within 30 minutes after void time has lapsed if you haven't departed.
- **Hold for release** - You cannot depart until released by ATC for departure.
- **Release Time** - Earliest time the aircraft may depart under IFR.
- **Expected Departure Clearance Time (EDCT)**- Runway release time assigned to aircraft for traffic management. May depart no earlier than 5 minutes before/ after EDCT time.
- **Abbreviated Departure Clearance** - Filed plan is approved with little or no revision. Cleared "As Filed" plus transponder code.

Departure Procedures (DPs)

AIM 5-2-9

Ensures obstacle clearance,
as long as:

- The airplane crosses the **departure end** of the runway by **at least 35 ft** above the departure end of runway elevation
- The airplane reaches **400 ft** above the departure end of the runway elevation **before making the initial turn**
- The airplane climbs at least **200 ft per NM**, **or as published**

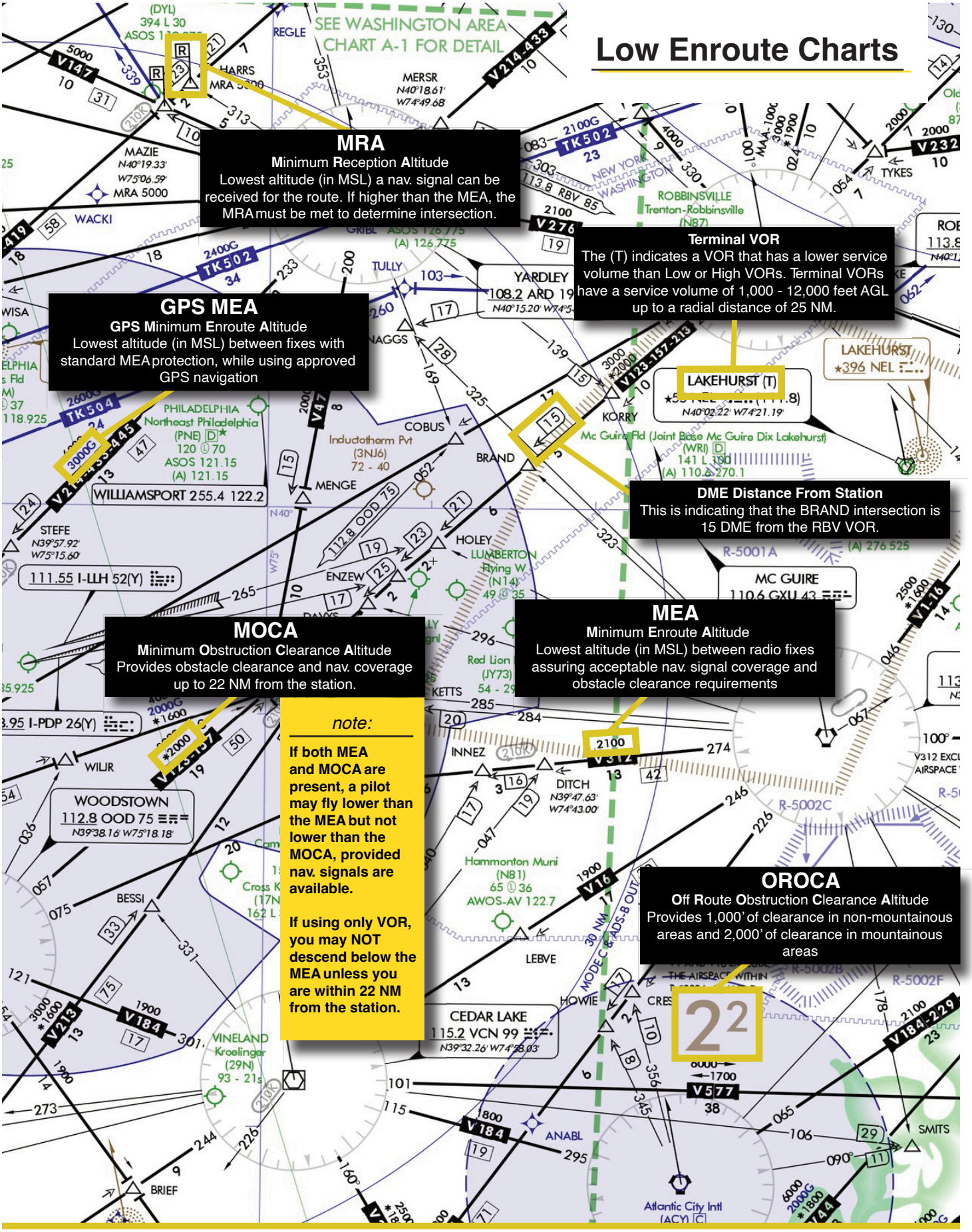
2 Types of DPs

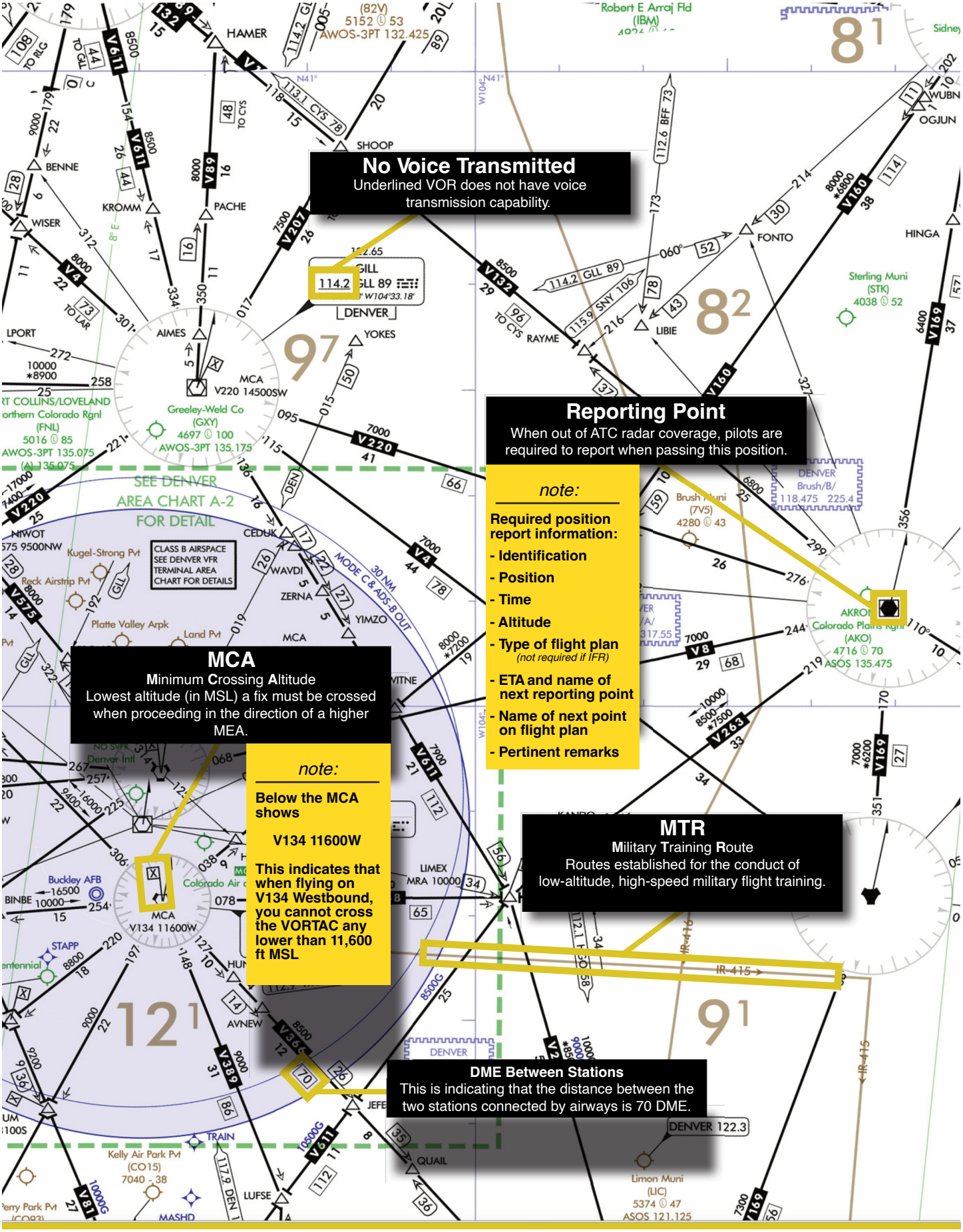
1) **Obstacle Departure Procedure (ODP)**
   - Provides only obstacle clearance
   - Printed either textually or graphically
2) **Standard Instrument Departure (SID)**
   - Provides obstacle clearance and reduces pilot and controller workload with published route
   - Always printed graphically
   - Some may also have published lost comms procedures

Suggested to file a DP when departing at night, marginal VMC or IMC

Feet Per Minute (FPM) = Feet Per Nautical Mile (FPNM) x Groundspeed / 60

Low Enroute Charts





Types of Speeds

- **Indicated Airspeed (IAS)** - Speed indicated on the airspeed indicator
- **Calibrated Airspeed (CAS)** - Indicated airspeed corrected for instrument and position errors
- **Equivalent Airspeed (EAS)** - Calibrated airspeed corrected for compressibility error
- **True Airspeed (TAS)** - Actual speed through the air. Equivalent Airspeed corrected for non-standard temperature and pressure
- **Mach number** - The ratio of True Airspeed relative to the local speed of sound
- **Groundspeed** - Actual speed across the ground. True Airspeed corrected for wind conditions.

Types of Altitudes

- **Indicated Altitude** - Uncorrected altitude indicated on the altimeter when barometric pressure is set to current pressure setting
- **Pressure Altitude** - Altitude corrected for non-standard pressure
- **Density Altitude** - Pressure altitude corrected for non-standard temperature
- **True Altitude** - Altitude above Mean Sea Level (MSL)
- **Absolute Altitude** - Altitude above ground level (AGL)

Mandatory IFR Reporting

- Any un-forecasted weather conditions *§ 91.183*
- When vacating any previously assigned altitude or flight level *AIM 5-3-3*
- The time, altitude or flight level upon reaching a holding fix *AIM 5-3-3*
- When leaving any assigned holding fix *AIM 5-3-3*
- Compulsory Reporting Points *§ 91.183*
- When unable to climb/descend at a rate of at least 500 feet per minute *AIM 5-3-3*
- When executing a missed approach *AIM 5-3-3*
- A change in average true airspeed (at cruise) when it varies by 5% or 10 knots from the speed filed in the flight plan *AIM 5-3-3*
- Loss of navigation *AIM 5-3-3*
- Any information relating to safety of flight *§ 91.183*

Airspeed Indicator Markings

White Arc -
Flap operating range.
Starts at V_{SO} and ends at V_{FE}

Green Arc -
Normal operating range.
Starts at V_{S1} & ends at V_{NO}

Yellow Arc -
Caution range.
Fly only in smooth air with caution.
Relative to V_A

Red Line -
Warning range. V_{NE}.
Structural damage possible.

Speed Review

V-Speeds

- **Va** - Design maneuvering speed
- **Vs** - Stall speed, clean configuration
- **Vso** - Stall speed, landing configuration
- **Vs1** - Stall speed, Specific configuration
- **Vfe** - Max flap extended speed
- **Vno** - Max structural cruise speed
- **Vne** - Never exceed speed
- **Vx** - Best angle of climb
- **Vy** - Best rate of climb

Max Airspeeds in the United States *§ 91.117*

- **Mach 1.0** - (speed of sound) above 10,000 ft MSL
- **250 kts** - Below 10,000 ft MSL
- **200 kts** - Under Class B airspace, or inside a VFR corridor through Class B
- **200 kts** - At or below 2,500 ft within 4 NM of Class C or D airport

IFR Flight Planning

§ 91.173

How to file a flight plan:

- Flight Service Station
  - By phone: 1-800-WX-BRIEF
  - Over the radio through an RCO or GCO
- Online
  - www.1800wxbrief.com
  - www.fltplan.com
- Electronic Flight Bag
  - Apps like Foreflight etc...
- With ATC
  - Over the radio or phone
  - "Pop-up Clearance" lets a pilot transition from VFR to IFR with or without a previously filed flight plan.
  - Subject to ATC workload and not guaranteed
  - Must be at or above the minimum IFR altitude

Flight Plan Requirements: *§ 91.173*

- May not operate under IFR in controlled airspace unless...
  - Filed on a flight plan
  - Received appropriate ATC clearance
- It is **LEGAL** to fly in uncontrolled airspace without a flight plan or clearance, but you **MUST** file a flight plan to enter controlled airspace
- Recommended to file at least 30 minutes prior to estimated departure *AIM 5-1-6*
- Non-scheduled flights above flight level 230 should be filed at least 4 hours before estimated departure time. *AIM 5-1-6*

Route Planning:

- AIM recommends filing a preferred route if one is available *AIM 5-1-6*
- Preferred IFR routes are published in the Chart Supplement

Canceling a Flight Plan: *AIM 5-1-15*

- At a towered airport
  - Automatically canceled by ATC upon landing
- At an untowered airport
  - Pilot must cancel through ATC or FSS by radio or phone number
- In Flight
  - Pilot may cancel anytime if not in IMC or Class A airspace

Flight Plan Elements:

- Aircraft Identification
- Flight rules and type of flight
- Aircraft type
- Departure Airport
- Estimated departure time
- Cruising speed
- Cruising altitude
- Route of flight
- Destination Airport
- Estimated time enroute
- Alternate airport if required
- Fuel endurance
- Total number of souls on board
- Emergency equipment on board
- Remarks (Example: NO STAR)
- Any other relevant information

Required IFR Filed Altitudes: *§ 91.177*

- Filed in even or odd altitudes (Example: 10,000, 17,000, FL340)
- Even altitudes for West (Example: 8,000, 14,000, FL260)
- Odd altitudes for East (Example: 9,000, 15,000, FL270)
- May not be less than minimum altitudes for published segments
- Mountainous areas: 2,000 ft above the highest obstacle within 4 NM from the planned course
- Non-mountainous areas: 1,000 ft above the highest obstacle within 4 NM from the planned course

Know Your Flight Instruments

§ 91.173

Gyroscopic Instruments:

- Two principles of a gyroscope
  1 - Rigidity in space
  2 - Precession

- **Attitude Indicator**
  - Operates on rigidity in space
  - Shows bank and pitch information
  - Should show correct attitude within 5 minutes of engine start
  - Could be vacuum driven or electrical
  - May have slight acceleration and deceleration errors
    - Accelerate = Slight pitch up
    - Decelerate = Slight pitch down

- **Heading Indicator**
  - Operates on rigidity in space
  - Only reflects changes in heading. Must be calibrated with magnetic compass
  - May be “slaved” with a magnetic heading source, such as a flux gate, and automatically sync to present heading
  - Could be vacuum driven or electrical

- **Turn Coordinator**
  - Operates on precession
  - Shows rate of turn and rate of roll

Magnetic Compass Errors
“**DV MONA**”

D - Deviation
V - Variation
M - Magnetic Dip
O - Oscillation
N - North/South turn errors **“UNOS”**
  - **U**ndershoot **N**orth/**O**vershoot **S**outh
A - Acceleration errors **“ANDS”**
  - **A**ccelerate **N**orth/**D**ecelerate **S**outh

Pitot Static Instruments:

- **Altimeter**
  - Operates an aneroid barometer
    - Shows the height above a given pressure level, based on a standard pressure lapse rate of 1,000 ft per 1 inch of mercury
  - Aneroid wafers expand and contract with changes in atmospheric pressure received by the static port
  - Mechanical linkage between the wafers and the display translate the sensed pressure into an altitude indication
  - “Pressure Sensitive Altimeter” allows the pilot to adjust the current pressure with the current altimeter setting
  - Adjusted pressure is shown through the “Kollsman Window” in either millibars (mb) or inches of mercury (Hg)
  - Above transition level - the altimeter must be set to 29.92” Hg and altitudes are referred to as “flight levels”
  - Regularly reset the altimeter to a station within 100 NM of the aircrafts position.

Helpful Tip

“High to low - Watch out below!”

When flying from high pressure to low pressure areas, if altimeter setting is not updated, indicated altitude will show higher than actual altitude.

Hot to cold areas result in the same error.

Continued:

Pitot Static Instruments (continued):

- **Vertical Speed Indicator (VSI)**
  - Indicates rate-of-climb in "feet per minute" (fpm)
  - Has a "Calibrated Leak" with roughly a 5-9 second lag for correct indication
  - Operates by responding to static pressure change over time
  - As the diaphragm expands or contracts, a mechanical linkage moves the pointer needle up or down to display the current rate of climb
  - Newer VSIs, Instantaneous VSI (IVSI), have a vertical accelerometer which eliminates the lag

- **Airspeed Indicator**
  - Measures the difference between ram air pressure from the pitot tube and ambient pressure from the static port, resulting in "dynamic pressure" and corresponds to airspeed

Dynamic Pressure = Ram Air Pressure - Static Pressure

  - A diaphragm in the instrument receives ram air pressure from the pitot tube. The outside of the diaphragm is sealed and connected to the static port. A mechanical linkage converts the expansion and contraction of the diaphragm to airspeed shown on the instrument face

Pitot Static System Errors

	Airspeed Indicator	Altimeter	Vertical Speed Indicator
1. Pitot Tube blocked Static Port open	Reads 0 kts	Functions Normally	Functions Normally
2. Pitot Tube & Drain Hole blocked, Static Port open	Acts as an improperly calibrated altimeter	Functions Normally	Functions Normally
3. Static Port blocked Pitot Tube open	Reads low in a climb Reads high in a descent	Stuck in place	Reads 0 fpm
4. Using alternate cockpit Static Source	Reads high	Reads high	Momentarily shows a climb

Helpful Tip:
The most common reason for a Pitot Tube or Static Port blockage is icing, so the FAA recommends turning on Pitot Heat or any other anti-icing measure when ambient temperature is less than 40°F.

Electronic Flight Instruments:

- **Attitude Heading Reference Systems (AHRS)**
  - Operate on either solid state technologies or laser gyros and flux valves
  - Provide more accurate and reliable attitude and heading data than traditional gyros
  - Found in “Glass Panel” instrumentations

- **Flight Management Systems (FMS)**
  - Receives information from various sensors
  - Provides guidance to the autopilot and flight director
  - Continually monitors most appropriate navigation source for accurate aircraft position

- **Primary Flight Display (PFD)**
  - Displays information such as attitude, altitude, airspeed, VSI, rate of turn, slip-skid information and heading

- **Multi-Function Display (MFD)**
  - Displays information such as moving maps, weather, aircraft systems, and traffic
  - May also act as a reversionary panel if the PFD fails at any point

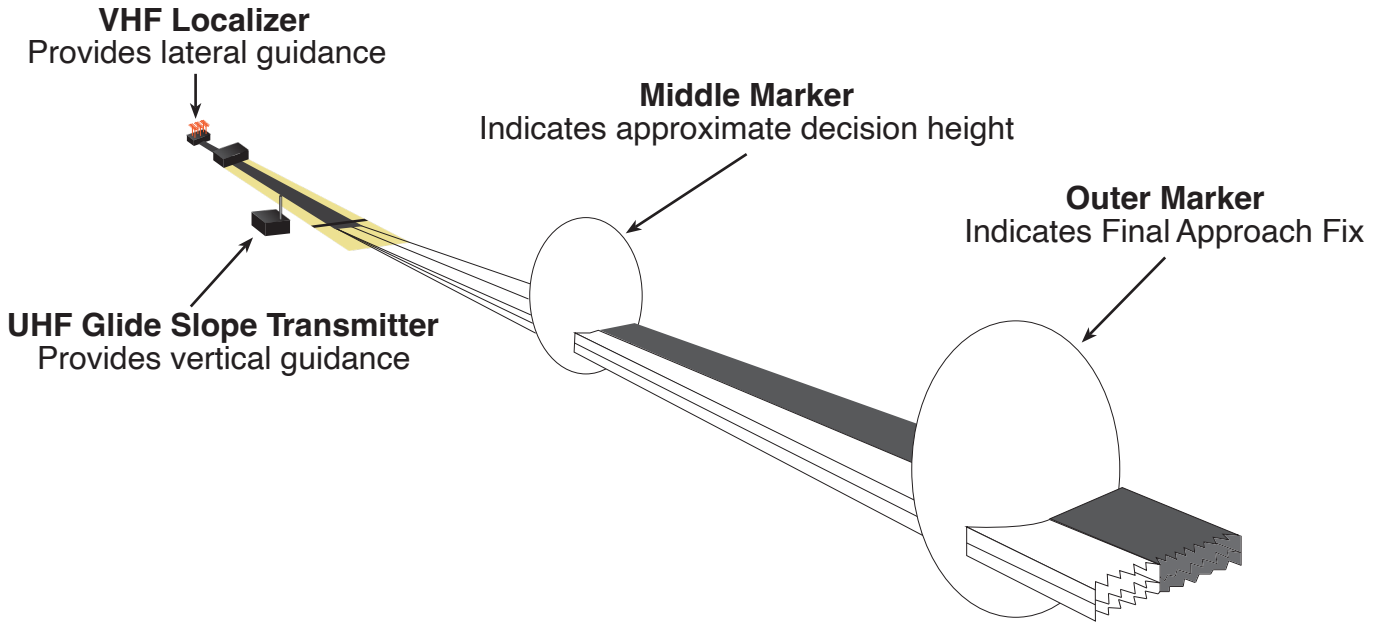
- **Air Data Computers (ADC)**
  - Still uses traditional Pitot Tube, Static Port, & Temperature Probes
  - Distills information through computer(s) and calculates airspeed, true airspeed, vertical speed, and altitude

- **Flight Director (FD)**
  - Computes appropriate flight path for the set guidance parameters
  - Assists with turns, heading, course, pitch, and vertical speed

Helpful Tip:

It’s important to remember that even though “Glass Panel” instrumentation may seem more sophisticated, it operates on all of the same principles and raw data as “Traditional” instruments.

Instrument Landing system (ILS)



Localizer: *AIM 1-1-9*

- 108.1 - 111.95 MHz with odd tenths only.
- 90 and 150 Hz signals are sent over VHF frequency and used by the receiver to interpret the plane's lateral position
- Extends 18 NM
- Calibrated to approximately 700 ft. wide at the threshold
- 4 times more sensitive than a VOR

Glide Slope: *AIM 1-1-9*

- 329.3 - 335 MHz (UHF)
- Automatically tuned with the localizer
- Vertical position interpreted by the intensity of 90 - 150 Hz signals carried over the UHF frequency
- 1.4 degrees in width (full deflection is 0.7 degrees either direction)
- Range of around 10 NM
- Typically 3 degree slope

Marker Beacons:

- Provide range information over points
- Transmit at 75 MHz
- Outer Marker: 4-7 miles out. Indicates position for glide slope intercept.
  - Shows as **BLUE**
- Middle Marker: Approximately 3,500 ft. from the runway.
  - Shows as **AMBER**
  - Indicates where Glide Slope meets Decision Height
  - Usually 200 ft above touchdown zone elevation
- Inner Marker: Indicates point where the Glide Slope meets the Decision Height on a CAT II ILS approach.
  - Shows as **WHITE**
- Back Course Marker: Indicates Final approach Fix on a selected Back Course approach.
  - Shows as **WHITE**

Area Navigation (RNAV)

Allows navigation on any desired path without the need to overfly ground-based facilities

Types:

- Global Navigation Satellite System (GNSS)
- VOR/DME RNAV
- DME/DME RNAV
- Inertial Reference Unit/System (IRU/IRS)

RNAV VNAV

- RNAV with Vertical Guidance

BARO-VNAV

- RNAV system that uses the barometric pressure to compute vertical guidance

Published RNAV routes:

- "Q Routes" (FL180 - FL450) and
- "T Routes" (1,200 ft AGL - 18,000 ft MSL)

These are designated as "RNAV 1" unless otherwise charted.

Magnetic Reference Bearing (MRB) - The published bearing between two waypoints on a charted RNAV route.

Global Positioning System (GPS)

A Global Navigation Satellite System (GNSS) operated by the United States

- Minimum of 24 satellites
  - At least 5 satellites are in view at any given location
- 3+ satellites are required for 2D positioning
- 4+ satellites are required for 3D positioning
- Inertial Reference Unit/System (IRU/ IRS)

RAIM

- "Receiver Autonomous Integrity Monitoring"
  - Requires a minimum of 5 satellites
    - or -
    4 satellites + an altimeter input
  - Frequently monitor RAIM prediction if available on your receiver

WAAS

- "Wide Area Augmentation System"
  - Ground stations (Wide-area Reference Stations and Wide-area Master Stations) measure GPS errors and produce correction signals. These corrections are broadcasted back to the satellite segment from which they are bounced back to aircraft GPS WAAS receivers to improve accuracy, integrity, and availability monitoring for GPS navigation.
  - Facilitates approaches beyond LNAV alone.
    - LPV
    - LNAV/ VNAV

Required Navigation Performance (RNP)

- A statement of navigation equipment and service performance
- RNAV with navigation monitoring and alerting
- All RNAV approaches are RNP approaches
  - Most are titled "**RNAV (GPS)**"

RNAV (GPS) RWY 33
RONALD REAGAN WASHINGTON NTL (DCA)

  - If the approach is titled "**RNAV (RNP)**"

RNAV (RNP) RWY 19
RONALD REAGAN WASHINGTON NTL (DCA)

  - These are "Authorization Required" approaches
  - These require special FAA approval for the crew, aircraft, and operation
  - Other countries all GPS approaches have RNP in the title, even though they don't require special authorization
- RNP approach minimums and equipment:
  - **GLS** DA minimums using **GBAS** (formerly **LAAS**)
  - **LP** MDA or **LPV** DA minimums require RNP achieved by **WAAS**
  - **LNAV/ VNAV** DA achieved by VNAV-approved WAAS, or BARO-VNAV systems
  - **LNAV** MDA achieved by a basic, un-augmented IFR-approved GPS

Primary & Supporting Instruments

Theory that divides all cockpit instruments into Bank Instruments, Pitch Instruments, and Power Instruments.

Pitch	Bank	Power
Attitude Indicator	Attitude Indicator	Airspeed Indicator
Altimeter	Heading Indicator	Tachometer
Airspeed Indicator	Magnetic Compass	Manifold Pressure
VSI	Turn Coordinator	Gauge

	Airspeed Indicator	Attitude Indicator	Altimeter	Turn Coordinator	Heading Indicator	Vertical Speed Indicator	Tachometer or MP
Straight and Level	**Primary Power**	Supporting Pitch and Bank	**Primary Pitch**	Supporting Bank	**Primary Bank**	Supporting Pitch	Supporting Power
Straight and Level (with speed change)	Supporting Power	Supporting Pitch and Bank	**Primary Pitch**	Supporting Bank	**Primary Bank**	Supporting Pitch	**Primary Power**
Starting a Climb or Descent	Supporting Pitch	**Primary Pitch** Supporting Bank	Supporting Pitch	Supporting Bank	**Primary Bank**	Supporting Pitch	**Primary Power**
Climbs and Descents (Constant Speed)	**Primary Pitch**	Supporting Pitch Supporting Bank	Supporting Pitch	Supporting Bank	**Primary Bank**	Supporting Pitch	**Primary Power**
Climbs and Descents (Constant Rate)	Supporting Pitch	Supporting Pitch Supporting Bank	Supporting Pitch	Supporting Bank	**Primary Bank**	**Primary Pitch**	**Primary Power**
Starting a Turn	**Primary Power**	**Primary Bank** Supporting Pitch	**Primary Pitch**	Supporting Bank	Supporting Bank	Supporting Pitch	Supporting Power
Turns	**Primary Power**	Supporting Pitch Supporting Bank	**Primary Pitch**	**Primary Bank**	Supporting Bank	Supporting Pitch	Supporting Power

Holding Procedures

AIM 5-3-8

ATC may assign a holding instruction for a number of reasons. Most commonly a hold is associated with traffic spacing, weather, or airport closures.

Clearance Items (Non-Published)

- **Direction** of hold from the fix (Example: N, S, E, NE etc...)
- Holding **Fix**
- **Radial**, course, airway, or route (on which to hold)
- **Leg length** in miles or minutes
- **Direction** of turns (right turns are standard)
- **EFC** "Expected Further Clearance Time"

Clearance Items (Published)

- Holding **Fix**
- **Direction** of turns (right turns are standard)
- **EFC** "Expected Further Clearance Time"

Holding Entries

AIM 5-3-8

- **Direct Entry**

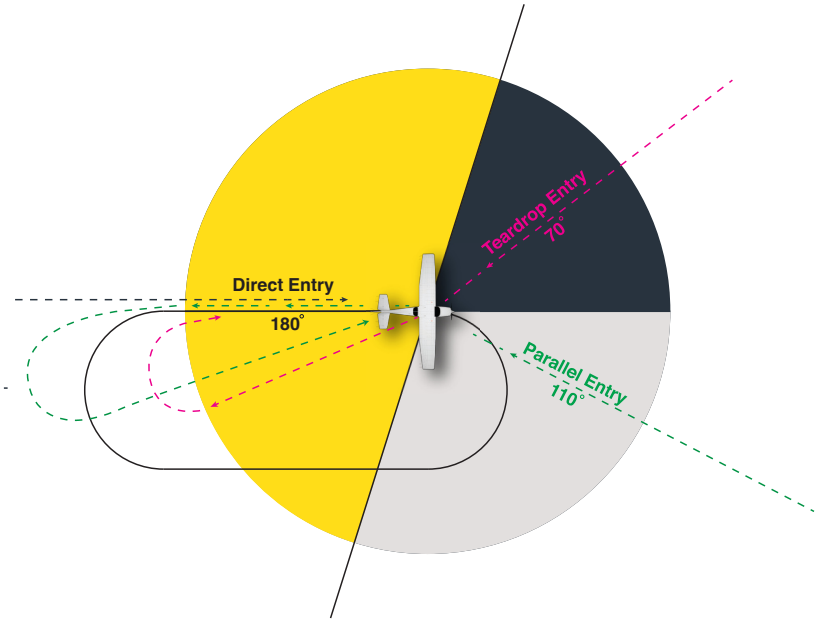
  Upon crossing the fix, turn to follow the holding pattern.

- **Parallel Entry**

  Upon crossing the fix, turn to a heading parallel to the holding course outbound for 1 minute. Then turn into the hold pattern to intercept the inbound course.

- **Teardrop Entry**

  Upon crossing the fix, turn outbound to a heading 30 degrees into the pattern. Fly for 1 minute, then turn in the direction of the hold turns to intercept the inbound course.



Altitude (MSL)	Max Airspeed (kts)
6,000' or below	200 kts
6,001' - 14,000'	230 kts
14,001 and above	265 kts
May be restricted to 175 kts on approach	

Report when entering the hold

- **Callsign**
- **Position**
- **Altitude**
- **Time**

Helpful Tip

Remember the "**5 Ts**"

- **T** - Turn
- **T** - Time
- **T** - Twist
- **T** - Throttle
- **T** - Talk

There are speed limits, but you are always allowed to go slower. There is no reason to waste fuel when holding in place. Consider slowing down, conserving fuel, and lightening the workload.

Lost Communication Procedures

§ 91.185

The most important part of lost communication procedures is to remain as predictable as possible to ATC.

Altitude
Fly the highest of: "MEA"

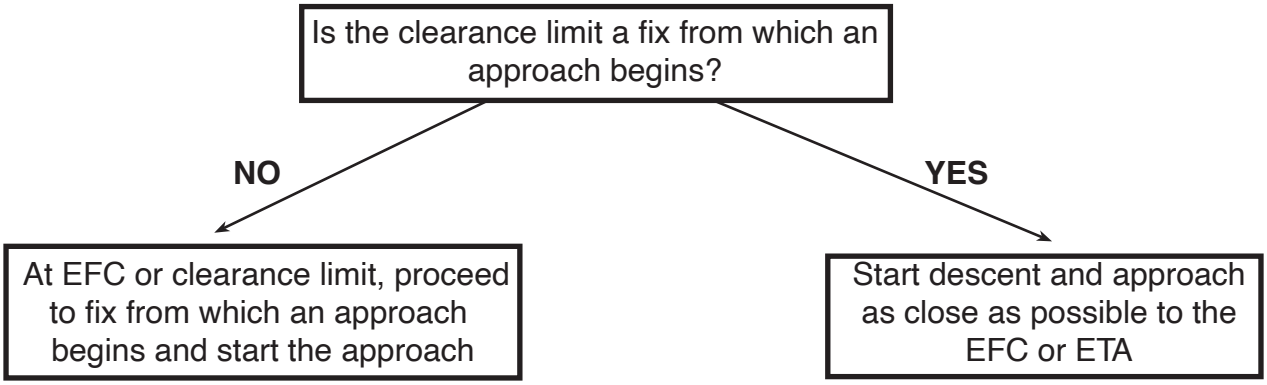
- **M -** Minimum altitude prescribed for IFR
- **E -** Expected
- **A -** Assigned (last assigned by ATC)

Route
Select course in this order: "AVEF"

- **A -** Assigned route
- **V -** Vectored (fly to published airway/fix on plan)
- **E -** Expected
- **F -** Filed route

Leaving the Clearance Limit

§ 91.185



Approach Procedures

Procedure Turns (PTs)

§ 91.175, AIM 5-4-9

A maneuver that enables:

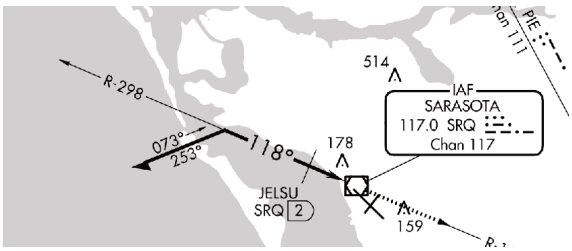
- A course reversal
- A descent from the IAF
- Inbound course interception

Max Speed - 200 kts.

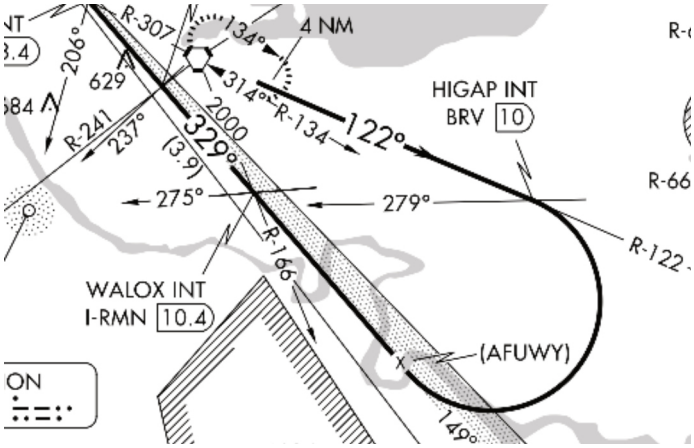
Remain within the charted distance

- Complies with published altitudes and obstacle clearances

The shape of the turn is mandatory if a teardrop or holding-in-lieu of a PT is published. Otherwise only the direction of the turn is required.



Teardrop Entry



- **If NO published IF** - Intermediate segment begins 10 miles prior to the final approach fix.
- **NAV facility located at the airport** - Final approach is started at the completion of the teardrop turn.

PT Not Authorized when

- Straight-in approach clearance
- Holding in lieu of procedure turn
- DME Arc
- Radar vectors to final
- "NO PT" published on the chart
- Timed approach from a hold fix
- Teardrop course reversal

Types of Approaches

Non-Precision

- **VOR**
- **NDB**
- **RNAV**
- **LOC -** Localizer
- **LDA -** Localizer-type Directional Aid
  Same as a LOC, but not lined up with runway
- **SDF -** Simplified Directional Facility
  Similar to LOC with 6 or 12 degree width
  May or may not be aligned with the runway
- **ASR -** Approach Surveillance Radar

Precision

- **ILS** - Instrument Landing System
- **PAR -** Precision Approach Radar
- **GLS -** GBAS Landing System
- **TLS -** Transponder Landing System

When to descend below MDA/DA

§ 91.175

1. The aircraft is **continuously in a position** from which a **descent to a landing on the intended runway** can be made at a **normal rate of descent using normal maneuvers**
2. The **flight visibility** is not less than the **visibility prescribed** in the standard instrument approach being used.
3. **At least one** of the following **visual references** for the intended runway is **distinctly visible** and identifiable to the pilot: *(Not including CAT II & III approaches)*
   - **i.** The approach light system, except that the pilot may **not descend below 100 feet** above the touchdown zone elevation **using the approach lights as a reference** unless the **red terminating bars** or the **red side row bars** are also distinctly visible and identifiable.
   - **ii.** The threshold
   - **iii.** The threshold markings
   - **iv.** The threshold lights
   - **v.** The runway end identifier lights
   - **vi.** The visual glideslope indicator
   - **vii.** The touchdown zone or touchdown zone markings
   - **viii.** The touchdown zone lights
   - **ix.** The runway or runway markings
   - **x.** The runway lights

Visual Descent Point (VDP)

AIM 5-4-5

- A defined point on the final approach course of a non-precision straight-in approach procedure from which normal descent from the MDA to the runway touchdown point may begin, provided adequate visual reference is established.
- Identified as a “V” symbol on the descent profile.
- If not equipped to identify the VDP, fly the approach as if no VDP was published
- Do not descend below the MDA prior to reaching the VDP

Visual Descent Angle (VDA)

AIM 5-4-5

- A computed glide path from the FAF to the runway’s TCH published for non-precision approaches
- FAA policy is to publish a VDA/TCH on all non-precision approaches except those published in conjunction with vertically guided minimums (Example: ILS or LOC RWY) or non FAF procedures without a stepdown fix (Example: on-airport VOR or NDB). A VDA does not guarantee obstacle protection below the MDA in the visual segment. The presence of a VDA does not change any non-precision approach requirements.
- VDAs are **advisory only.** Pilots must still comply with all published altitudes.

Descent Planning

From Top of Descent

- Calculating when to start descending from cruise (TOD) can be made with a simple equation.

Distance = Altitude needed to lose / 1000 x 3

Example: You are flying at 25,000 ft. and you need to get to 10,000 ft.
25,000 minus 10,000 is 15,000.
15,000 / 1000 = 15
15 x 3 = 45
It will take you 45nm to reach 10,000 ft from FL250.

- Calculating rate of descent (ROD) required for a 3 degree flight path angle.

ROD = Groundspeed x 5

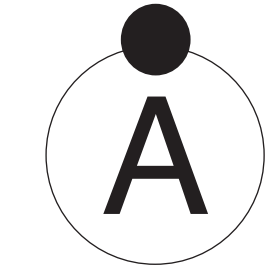
Example: You are flying at 200 knots groundspeed.
200 x 5 = 1000
You will need a 1000 fpm descent to maintain a 3 degree path.

Approach Lighting Systems (ALS)

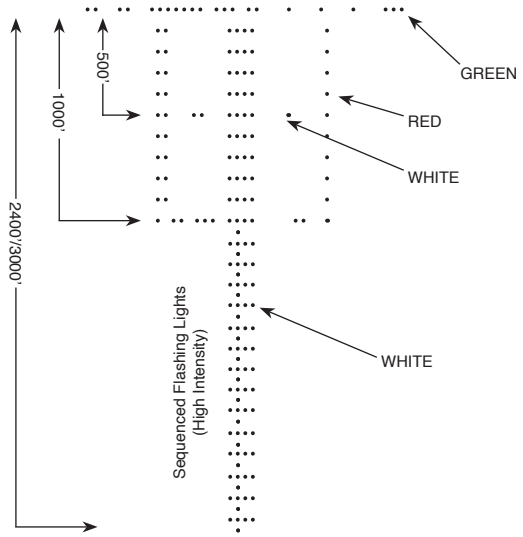
AIM 2-1-1

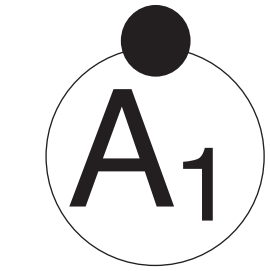
Approach lighting and visual glide slope systems are indicated on the airport sketch by an identifier.

A dot "●" portrayed with approach lighting letter identifier indicates a sequence of flashing lights (F) installed with the approach lighting system "Rabbit Trail" Ⓐ. Negative symbology 🅐₁ indicates Pilot Controlled Lighting (PCL).

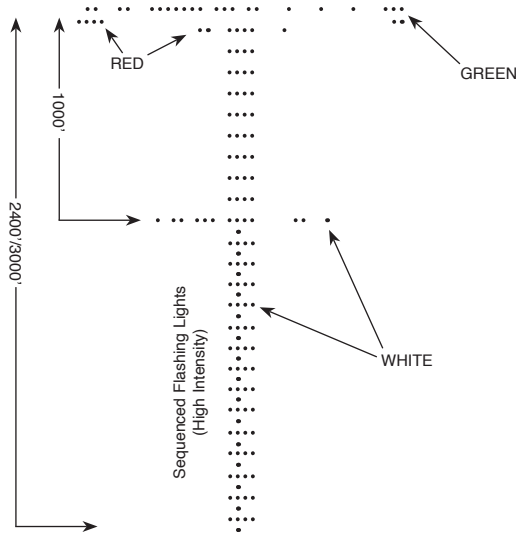


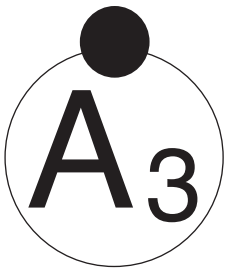
ALSF - 2





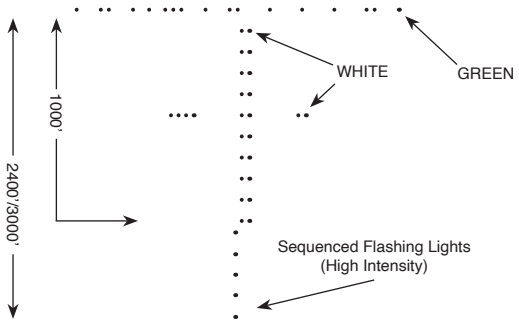
ALSF - 1

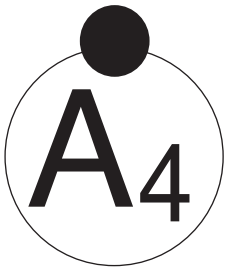




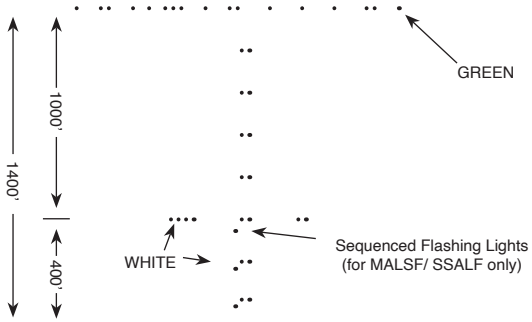
SSALR

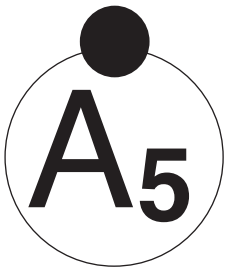
Simplified Short Approach Lighting System





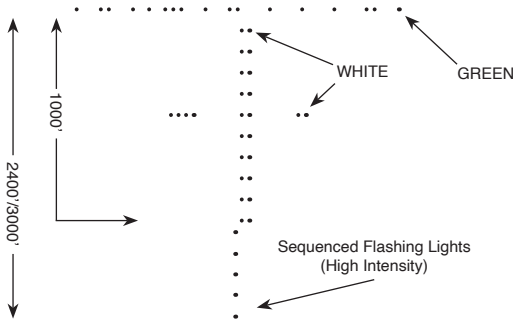
Medium Intensity (MALS and MALSF) or simplified short (SSALS and SSALF) Approach Lighting Systems





MALSR

Medium Intensity Approach Lighting System (with Runway Alignment Indicator Lights)



Same as SSALR

Additional ADS-B Out Requirements

- Class E airspace at or above 10,000 feet MSL, excluding airspace at and below 2,500 feet AGL
- Within 30 nautical miles of a Class B primary airport (the Mode C veil)
- Above the ceiling and within the lateral boundaries of Class B or Class C airspace up to 10,000 feet MSL
- Class E airspace over the Gulf of Mexico, at and above 3,000 feet MSL, within 12 nm of the U.S. coast

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Missing or Broken Transponder

- Prior to operating an aircraft **NOT** equipped with a transponder in Class B airspace, a request for a deviation must be submitted to the controlling ATC facility at least 1 hour before the proposed flight.
- If the transponder fails during the flight in Class B airspace, a request must be immediately made and a transponder requirement deviation may be issued to allow the flight to continue through the airspace.

Supplemental Oxygen Requirements

§ 91.211

25,001’ MSL - **Unlimited**

Required to satisfy all requirements below + an additional 10 minutes of oxygen for each person on board

25,000’ MSL

15,001’ MSL

Required to be used by flight crew
- and -
Must be provided to every occupant

15,000’ MSL

14,001’ MSL

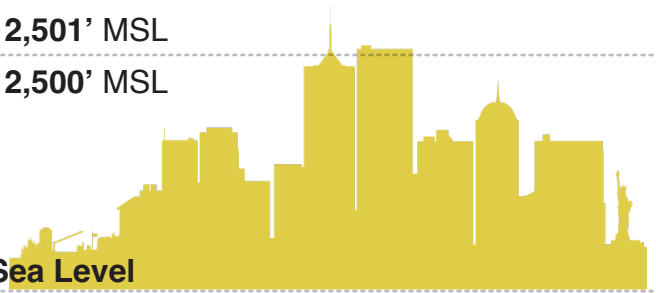
Required to be used by flight crew

14,000’ MSL

12,501’ MSL

Required by required crew if over 30 minutes at this altitude

12,500’ MSL



Sea Level

No supplemental oxygen required

Note: All MSL altitudes listed here are “Cabin Pressure Altitudes”

Electronic Devices

§ 91.21

No person may operate, nor may any operator or pilot in command of an aircraft allow the operation of, any portable electronic device on any civil aircraft:

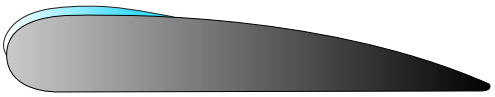
- Does not apply to -

1.) Portable voice recorders
2.) Hearing aids
3.) Heart Pacemakers
4.) Electric Shavers
5.) Any other portable electronic device that the operator of the aircraft has determined will not cause interference with the navigation or communication system of the aircraft of which it is to be used.

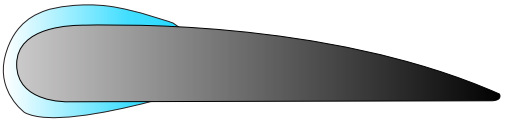
Types of Aircraft Icing

- **Rime Ice**
  - Rough, milky, opaque ice
  - Formed by the instantaneous or very rapid freezing of super cooled droplets as they strike the leading edges
  - Rough surface can decrease aerodynamic efficiency, but it is lighter than clear ice

- **Clear Ice**
  - Glossy, transparent ice formed by the relatively slow freezing of super cooled water
  - Denser, harder, and sometimes more transparent than the rime ice
  - Harder to remove than rime ice



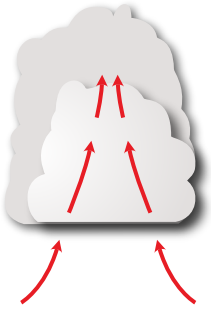
- **Mixed Ice**
  - Combination of clear and rime ice
  - Roughness and weight can have an effect on aerodynamics



Icing Intensities

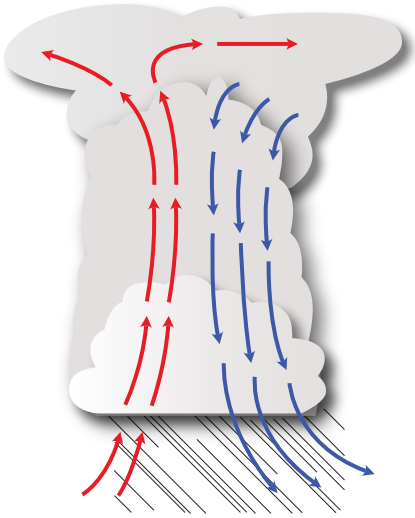
Trace	Light	Moderate	Severe
Icing perceptible. Not hazardous unless encountered for an extended period of time.	Icing clearly visible. Anti-icing/deicing equipment removes/ prevents accumulation.	Even short encounters can be hazardous. Anti-icing/deicing equipment must be used, or diversion.	Rate of accumulation is such that deicing/ anti-icing equipment fails to reduce the hazard. Diversion mandatory.

Phases of a Thunderstorm



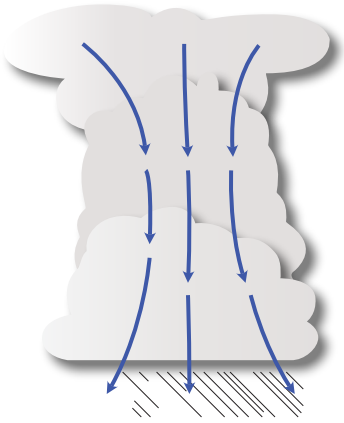
Cumulus

- Air that is warmer than its environment starts to rise.
- As the warm, moist air rises, it cools and condenses to form cumulus clouds.
- Creates strong updrafts.
- Once the cloud reaches the freezing level, supercooled water molecules exist.



Mature

- Characterized by the presence of both updrafts AND downdrafts.
- The downdrafts cause evaporative cooling.
- When the downdraft hits the ground, it has no where to go so it spreads out in all directions.
- Anvil shape forms when water molecules are pushed into the higher parts of the cloud.
- Hail can be formed and intense cloud-to-ground lightning is present.



Dissipating

- Downdrafts prominent in this phase.
- Anvil top begins to weaken.
- Towering cumulonimbus clouds turn into wispy, non-threatening clouds.

Types of Hydroplaning

Viscous

- Occurs when a film of moisture forms on the painted or rubber coated portions of the runway.
- Can occur at relatively low speeds.

Dynamic

- Occurs when ground speed is at least **8.73** times the square root of the main tires' pressure.

Reverted Rubber

- Occurs when tires are held off the runway by steam, generated from friction.

Terms and Definitions

AATD	Advanced Aviation Training Device
AAWU	Alaskan Aviation Weather Unit
AC	Advisory Circular
ACS	Airman Certification Standards
AD	Airworthiness Directive
ADC	Air Data Computer
ADM	Aeronautical Decision Making
ADS-B	Automatic Dependent Surveillance Broadcast
AFM	Airplane Flight Manual
AGL	Above Ground Level
AHRS	Attitude Heading Reference System
AI	Attitude Indicator
AIM	Aeronautical Information Manual
ALS	Approach Light System
ALSF	Approach Light System with Sequence Flashing Lights
APV	Approach with Vertical Guidance
ARTCC	Air Route Traffic Control Center (“Center”)
ASI	Airspeed Indicator
ASOS	Automated Surface Observation System
ASR	Approach Surveillance Radar
ATC	Air Traffic Control
ATD	Aviation Training Device
ATIS	Automatic Terminal Information System
AWC	Aviation Weather Center
AWOS	Automated Weather Observation System
BATD	Basic Aviation Training Device
DA	Decision Altitude
DH	Decision Height
DME	Distance Measuring Equipment
DP	Departure Procedure
EDCT	Expected Departure Clearance Time
EFB	Electronic Flight Bag
ELT	Emergency Locator Transmitter
ETA	Estimated Time of Arrival
FAA	Federal Aviation Administration
FAF	Final Approach Fix
FCC	Federal Communications Commission
FFS	Full Flight Simulator
FIS-B	Fight Information Services-Broadcast
FL	Flight Level
FPM	Feet Per Minute
FPNM	Feet Per Nautical Mile
FSS	Flight Service Station
FTD	Flight Training Device
GBAS	Ground Based Augmentation System
GP	Glide Path
HAT	Height Above Touchdown
HFO	Weather Forecast Office Honolulu
HI	Heading Indicator
IAF	Initial Approach Fix
ICAO	International Civil Aviation Organization
IF	Intermediate Fix
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IM	Inner Marker

IMC	Instrument Meteorological Conditions
IPC	Instrument Proficiency Check
KTAS	Knots True Airspeed
Kts	Knots. NM/hour
LAAS	Local Area Augmentation System
LDA	Localizer Type Direction Aid.
LIFR	Low IFR
LNAV	Lateral Navigation
LOC	Localizer
LOM	Locator Outer Marker
LP	Localizer Performance RNAV/RNP Approach
LPV	Localizer Precision with Vertical Guidance approach
MAA	Maximum Authorized Altitude
MALSR	Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights
MAP	Missed Approach Point
MCA	Minimum Crossing Altitude
MDA	Minimum Descent Altitude
MDH	Minimum Descent Height
MEA	Minimum Enroute Altitude
MEL	Minimum Equipment List
MFD	Multi Function Display
MLS	Microwave Landing System
MM	Middle Marker
MOCA	Minimum Obstruction Clearance Altitude
MON	VOR Minimum Operational Network program
MORA	Minimum Off Route Altitude (Jeppesen charts)

MRA	Minimum Reception Altitude
MSL	Mean Sea Level
MVFR	Marginal VFR
NDB	Non-Directional Beacon
NHC	National Hurricane Center
NMC	National Meteorological Center
NOTAM	Notice to Airmen
ODALS	Omni-Directional Approach Lighting System
ODP	Obstacle Departure Procedure
OM	Outer Marker
PAPI	Precision Approach Path Indicator
PAR	Precision Approach Radar
PFD	Primary Flight Display
PIC	Pilot-in-Command
PIREP	Pilot Report
RAIM	Receiver Autonomous Integrity Monitoring
REIL	Runway End Identifier Lights
RNAV	Area Navigation
RVR	Runway Visual Range
RVSM	Reduced Vertical Separation Minimum
SBAS	Satellite-based Augmentation System (e.g., WAAS)
SDF	Simplified Directional Facility
SID	Standard Instrument Departure
STAR	Standard Terminal Arrival
STC	Supplemental Type Certificate
SVFR	Special VFR
TDZE	Touchdown Zone Elevation
TDZL	Touchdown Zone Lights

TOC	Top Of Climb
TOD	Top Of Descent
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VIP	Video Integrator Processor
VMC	Visual Meteorological Conditions
VNAV	Vertical Navigation
VOR	VHF Omnidirectional Range
VORTAC	VHF Omnidirectional Range Tactical Air Navigation (VOR + TACAN)
VS	Vertical Speed
VSI	Vertical Speed Indicator
WAAS	Wide Area Augmentation System
WPC	Weather Prediction Center
WX	Weather

Beyond Learning

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