The Instrument Know-All.

AXIOM AVIATION • FlyAxiom.com • Kelly Cross

Legal

Logging instrument time:

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

B. 61.51 g(3i-ii)(4) - location and type of each approach, safety pilot if required, flight simulator may be used by a person to log instrument time provided an authorized instructor is present during the simulated flight.

To act as pilot in command of a civil aircraft under IFR (or weather less than the minimum required for VFR flight):

• The pilot must have a current medical certificate and current instrument rating.

Recency experience requirements to act PIC under IFR: 61.57c - within 6 months:

• Conduct 6 instrument approaches, intercept and track navigational courses, and perform holding procedures.

• Have an additional six months after PIC currency expires (6 months) to complete these requirements before an Instrument Proficiency Check (IPC) is required (61.57d)

• Safety pilot must be rated in the same category and class of aircraft, with a current medical and private pilot cert.

• Passenger currency is the same 90 rule: you may be instrument current, but not to carry passengers if you haven't in the last 90 days performed 3 takeoffs and landings (full stop if taildragger) in the same aircraft category, class, and type if it's required.

• Night currency: 3 takeoffs and landings to a full stop, 1 hour after sunset to 1 hour before sunrise in same category, class, and type if it's required.

• When must we file an alternate:

-Always, except when within 1 hour before ETA to 1 hour after ETA, the weather is forecasted to be better then 2000' and 3 miles visibility

-If your airport of intended landing has only a GPS approach or no approach at all, you must file an alternate

Instrument Preflight

VFR Day Equip. Regs (91.205b)
Anti-Collision Lights
Tachometer
Oil Pressure Gauge
Manifold Pressure Gauge
Airspeed Indicator
Temp Gauge (liquid cooled)
Oil Temp (air cooled)
Fuel Quantity Indicator
Landing Gear Position
Altimeter
Magnetic Compass
ELT
Safety Belts

Required Documents
Airworthiness Certificate
Registration
Radio License (International Flights Only)
Operating Limitations(POH)
Weight and Balance

VFR Night Equip. Regs (91.205c)
All day VFR Equipment
Fuses
Landing Light (for Hire)
Anti-Collision Lights
Position Indicator Lights
Source of Electricity

Aircraft Airworthiness
Annual Inspection
VOR Check Every 30 Days
100 Hour Inspection (Hire Only)
AD's Compliance
Transponder (24 months)
ELT (12 Months, 1⁄2 shelf life of battery, 1 cumulative hour of use)
Static System (24 months)

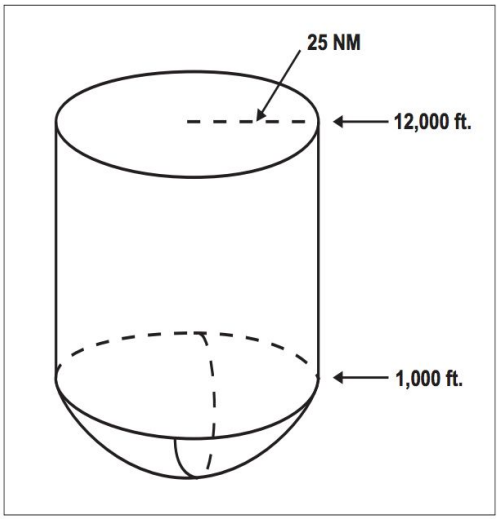
I FR Equip. Regs (91.205b)
Generator/Alternator
Radio (2 Way Comm, and Nav)
Altimeter
Ball (Slip/Skid Indicator)
Clock with Second Hand
Attitude Indicator
Rate of Turn Indicator
Directional Gyro
DME if above FL240 or using VOR's

VOR Equipment Checks for IFR Flight
• VOT: +/- 4 °. Published in A/FD, tune 108.0MHZ, 180 TO/360 FROM
• Ground checkpoint: +/- 4 °, specific point on airport listed in A/FD
• Airborne checkpoint: +/- 6 °, located over easily identifiable terrain or features on the ground, listed in A/FD
• VOR/VOR: +/- 4 °, dual check in the air
• VOR radial on airway centerline over identifiable ground point: +/- 6°
• Radiated test signal by A & P only

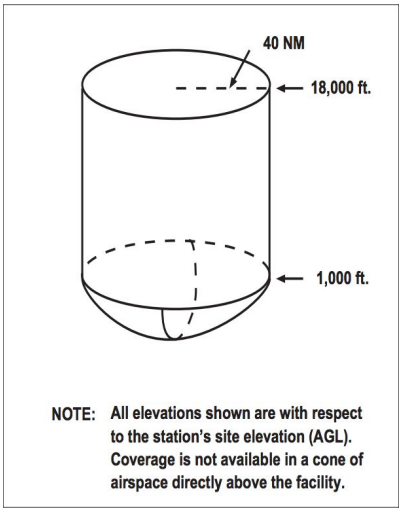
Compass Errors **V**ariation (True vs. Magnetic) A-Accelerate **D**eviation (magnetic interference) N-North N-North **M**agnetic dip (pulls towards earth) D-Decelerate **O**scillation (turbulence, combination) S-South **N**ortherly Turning Errors (UNOS) **A**cceleration Errors (ANDS)	**Acceleration Errors** **A**ccelerate **N**orth **D**ecelerate **S**outh	**North Turning Errors** **U**nder Shoot **North** **O**vershoot **S**outh
Lost Procedures **C**limb **C**all **C**onfess **C**omply **C**onserve	**Go Around Missed Approach** **C**ram **C**limb **C**lean **C**ool **C**all	**Holding** **T**urn **T**ime **T**wist **T**hrottle **T**alk
Must Know for Flight 91.103 • Notams • Weather • Known Traffic Delays • Runway Length • Alternates if Needed • Fuel Requirement • Takeoff/Landing Distances	**3 Errors of Scan** **F**ixation **O**mission **E**mphasis **Fundamental of Instrument Flying** • Instrument Cross Check • Instrument Interpretation • Aircraft Control	**Transponder Codes** • 1200 VFR • 7500 Hijack • 7600 Lost Comm • 7700 Emergency

AIM 1-1-8 VOR Service Volumes - VHF Frequencies between 108.0-117.95 MHz

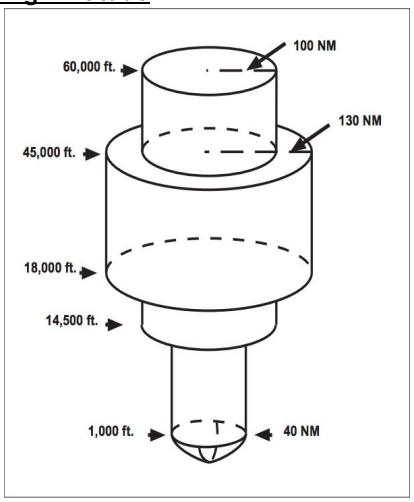
Terminal



Low Altitude



High Altitude



* Terminal VOR's can be used mainly for approaches.

Mode C Transponder Requirements 91.215

• Class A, B and C
• Within 30NM of Class B
• Above the ceiling within the lateral boundaries of class B or class C up to 10,000' MSL
• ALL airspace at and above 10,000' MSL, excluding that airspace below 2,500' AGL

*Not All Requirements Listed

Decide Model	**I'm Safe Checklist**	**Night Definitions**
Detect **E**stimate **C**hoose **I**dentify **D**o **E**valuate	**I**llness **M**edication **S**tress **A**lcohol **F**atigue **E**motion/Eating	-Sunset (91.209): Beacons go on (plane and airport) -Evening civil twilight (1.1): Generally 30 minutes after sunset (30 minutes before sunrise), this is used for logging night flight -1 hour after sunset to 1 hour before sunrise (61.57b): If not night current, must be on the ground 59 minutes after sunset. This time however is where we can gain our night passenger currency by: 3 takeoffs and landings to a full stop, acting as sole manipulator of the controls, and aircraft was same category, class, and type if type was required

Instrument Departure:

• DP's Departure Procedures: Either in front of NOS plates or right behind specific approach plates. Provides take off min's and transition from airport to en route. MUST have a textual description as a minimum in order to accept a Departure Procedure. If you don't want a DP, write "NO DP" in remarks section on flight plan.
• ODP Obstacle Departure Procedure
• SID Standard Instrument Departure
• Standard Climb for DP is 200 Feet per Nautical Mile & 35 ft above departure end of runway. Start turn after 400'AGL.

Climb/Descent Gradient Alternate Climb/Descent
• Formula: Ground Speed X Foot per Nautical Mile ÷ 60 = Feet per Minute Needed
• Ground Speed Calculated Using POH and Winds
• Climb/Descent Gradient also found in the **Digital Terminal Procedures Supplemental** (Downloadable to Foreflight)

IFR Flight Plan & Enroute Procedures

Opening/Closing Flight Plan
• C.R.A.F.T. **C**learance Limit, **R**oute of Flight, **A**ltitude, **F**requency for Departure, **T**ransponder Code
• File a flight plan 30 minutes prior to departure.
• Flight Plan deleted in 2 hours in not activated.
• We always have to close/cancel our flight plan!
• If we are at a controlled field with a tower operator currently working, they will close our flight plan for us.
• If we land at an uncontrolled field, we must either cancel with ATC in the air before we land, or once we are on the ground! Don't forget to close the flight plan!
• If landing at uncontrolled airport under Special VFR, be sure to check and close special VFR with ATC.
• If we are operating in VFR conditions which we will encounter for the remainder of our flight, and we are outside of positive control airspace, then we can cancel here as well.

Clearance Void Time
• Used by ATC when at an uncontrolled field. Somehow we need to get a release/clearance to depart, and if there is no tower, then we must:
    -find a frequency that will work on the ground to talk to ATC
    -call from a cell phone and get a clearance void time
• Purpose: to advise an aircraft that the departure clearance is automatically canceled if takeoff is not made prior to a specified time.
• The pilot must obtain a new clearance or cancel his/her IFR flight plan if not off by the specified time.

Instrument Altitudes - Magnetic Course
• 0-179° = odd thousands
• 180-359 ° = even thousands

IFR Altitudes

• **MEA:** Minimum En-route Altitude is the lowest published altitude between radio fixes that guarantees adequate navigational signal reception and obstruction clearance of 1,000’ in non mountainous and 2,000’ in mountainous terrain.
• **MOCA:** Minimum Obstruction Clearance Altitude. Ensures reliable navigation only within 22 NM of facility and obstacle clearance
• **MAA:** Maximum Authorized Altitude. Max usable altitude or flight level for an airspace structure or route segment for which adequate reception of navigation aid signals are assured.
• **MRA:** Minimum Reception Altitude. Lowest altitude at which an intersection can be determined.
• **MCA:** Minimum Crossing Altitude. The lowest altitude at certain fixes at which an aircraft must cross when proceeding in the direction of a higher minimum en route IFR altitude, must continue with 200ft per nautical mile after crossing to new mea.
• **OROCA (NOS):** Off Route Obstacle Clearance Altitude. Provides obstacle clearance of 1,000 and 2,000, but may not provide signal coverage from ground based nav aids, ATC radar, or communications.
• **MSA:** Minimum Safe/Sector Altitudes. Found on approach plates and provides 1000’ terrain clearance within 25NM of the airport, used for emergency purposes.

Standard Lost Communications Procedures - 91.185

VFR (91.185b): If the failure occurs in VFR conditions, or if VFR conditions are encountered after the failure, each pilot shall continue the flight under VFR and land as soon as practicable.

IFR (91.185c(1&2)):

Altitude:	**Route:**
Fly the highest of these in this order **M**inimum IFR Altitude **Expected** Altitude **A**ssigned Altitude	Fly in order of: **A**ssigned **V**ectored **E**xpected **F**iled

• If lost comms in IMC, fly to the IAF, hold and land at ETA.

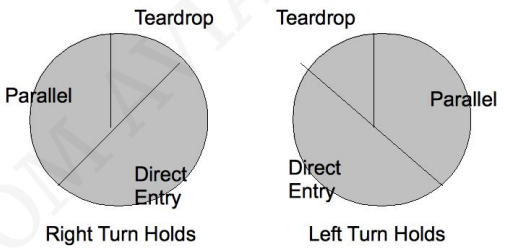
OXYGEN REQUIREMENTS 91.211

• Cabin pressure altitudes of 12,500’ up to and including 14,000’ MSL, required minimum flight crew provided and use O2 for that portion of the flight greater than 30 minutes
• Cabin pressure altitudes above 14,000’ minimum flight crew provided and use O2 entire flight
• Cabin pressure altitudes above 15,000’ provided to everyone (don’t have to use)

Reporting ATC

Compulsory Reports	**Not in Radar Contact**	**Position Reports Include:**
Missed Approach **A**ltitude Changes VFR on top **T**rue Airspeed change +/- 10 knots or 5% **H**olding: time and altitude when entering or leaving the holding fix **C**annot maintain a 500fpm climb/descent **A**ltitude and time when at holding fix or **L**eaving an assigned altitude **L**ost comm. nav, equipment **S**afety of flight, including un-forecasted weather **C**learance Limit	• Compulsory reporting points • Inbound at Final Approach Fix (FAF) or Outer Marker (OM) • ETA error of 3 minutes or more	**I**D **P**osition **T**ime & Type of flight plan **A**ltitude **N**ame of next fix **E**TA at that fix **S**upplemental Information

Holding



Non Published
Direction of hold
Fix
Radial
Altitude
Turns L or R
EFC Time

Published
Direction
Fix
EFC Time

Holding Airspeeds
• Up to 6000' = 200KIAS
• 6001'-14,000' = 230KIAS
• 14,001'- above = 265KIAS

Arrival/Approach

Standard Terminal Arrival Route
STAR- simplifies clearances, provides guidance from en-route to approach to destination.
• Must have at least a textual or graphic depiction in order to perform.
• If you don't want a STAR, write "NO STAR" in remarks section of flight plan.

How to determine approach category.
• Look at the Digital Terminal Procedures Supplemental and reference it with your approach speed in the POH.
• or VSO (dirty stall speed) X 1.3 to get approach speed.

MANEUVERING TABLE

Approach Category	A	B	C	D	E
Speed (Knots)	0-90	91-120	121-140	141-165	Abv 165

Segments of an Instrument Approach
• INITIAL: aligns aircraft with approach course, begins at IAF
• INTERMEDIATE: Designed primarily to position your aircraft for the final descent to the airport.
• FINAL: navigate from this point to DH or MDA. Gear down before landing checklist w/in 2 miles of this point (or ½ dot ILS)
• MISSED: Begins at MAP (missed approach point) by: DH, time, Middle Marker, DME, Runway (GPS)

Determining the Approach Category
• Approach categories are determined off of the aircraft's approach speed. If none is published, than 1.3 Vso
• If you are ever between two categories, or on the border between them, always use the higher category
• Timed missed approaches however are based off of ground speed, not approach speed which is indicated

Precision Approach
• Includes both course guidance with a localizer, and altitude guidance with a glide slope, as well as DME.
• DA=Decision Altitude (proceed to land or go missed). This is the missed approach point in an ILS approach.

Types of Precision Approaches
• ILS - Instrument approach with vertical guidance
• LPV - An LPV approach still provides vertical guidance and is a precision approach, but in contrast uses WAAS GPS satellite information to provide the aircraft with the vertical descent information.
• LNAV/VNAV - In aviation, vertical navigation is an autoflight function which directs the vertical movement of an aircraft (i.e. gains or losses in its altitude). If used in the cruise,VNAV causes an aircraft to climb or descend according to a vertical elements of a pre-programmed FMS (flight management system) flight plan.

Parallel ILS Approach
• Conducted if centerline are at least 2500’ apart, aircraft separated by 1.5 miles diagonally

Non Precision Approach
• Will provide course guidance, but no glide slope or altitude guidance.
• MDA = Minimum Descent altitude. This is the altitude which we can only descend from if requirements of 91.175 are met. This is not the missed approach point like DH is on a precision approach, but the altitude at which the missed approach will be located.

Types of Non Precision Approaches
• Localizer - Its antennas are arranged and manufactured in such a way to transmit a narrow signal on the runway approach path.
• Localizer Back Course - Back-course (BC) localizer approaches subject a pilot to reverse needle indications on the OBS.
• LDA - A localizer type directional aid (LDA) is a type of localizer-based instrument approach to an airport. It is used in places where, due to terrain and other factors, the localizer antenna array is not aligned with the runway it serves.
• SDF - Simplified directional facility (SDF) is a localizer-based instrument non-precision approach to an airport, which provides final approach course similar to instrument landing system (ILS) and localizer type directional aid (LDA) approaches, although not as precise.
• VOR - Uses a VOR radial as the approach course Step down fixes using DME.
• GPS - Put the GPS in GPS Mode, not VLOC, Receiver Autonomous Integrity Monitoring (RAIM) must be maintained throughout the approach. Can only file to an airport where the only approach is a GPS approach if you have filed for an alternate airport that has something other than GPS.

Circling Approach
• If approach course is not aligned within 30° of the runway, only circling minimums will be published
• Will also be published on standard straight in approaches in the case that a circling approach is needed
• Circling minimums provides 300’ AGL obstacle clearance in the circling area. These are MINIMUMS, so if weather allows a higher altitude to be flown that more closely approximates TPA, fly it, it will create a more realistic approach and landing!
• Circling approach protected area is based off your approach category
• If you lose sight of the runway at any time, immediately begin a climbing turn toward the airport to intercept the missed approach procedure

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
All Altitudes	1.3	1.5	1.7	2.3	4.5

PAR/ASR
• PAR: Precision approach radar – controller provides both azimuth and elevation navigational guidance
• ASR: Airport Surveillance Radar – provides azimuth guidance only

Contact vs. Visual
• Contact – cannot be initiated by ATC, but can be request by the pilot to expedite arrival instead of the published procedure if the following is met:
- The airport has a standard or special instrument approach procedure
- Reported ground visibility is at least 1 mile
- You can remain clear of clouds with 1 mile flight visibility

• Visual – can be initiated by ATC or

- ATC must ensure that you have the airport or the preceding aircraft in sight once you announce aircraft in sight, you are responsible for aircraft separation.
- Is authorized when ceiling is reported or expected to be at least 1,000' AGL and 3 miles visibility, and you remain clear of clouds at all times

DME ARC and DME ARC Approach

• Turn 10° Twist 10°
• Give your turn into the DME Arc a .5nm Lead (dependent on aircraft speed). Turn early.
• 1nm +/- tolerance
• When approach course comes in, turn into it and track it to the approach lead sometimes displayed on plate.

GPS Knowledge

• Sensitivity of the GPS = 5 (some set to 2) miles en-route, 1 mile terminal, and .3 miles in approach mode.
• 24 satellites, minimum of 5 needed for RAIM
• 4 satellites needed for 3D positioning
• GPS database updated every 28 days

To descend out of the DA OR MDA 91.175

• 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. (Part 121 and 135 unless that descent rate will allow touchdown to occur within the touchdown zone of the runway of intended landing)
• The flight visibility is not less than the visibility prescribed in the standard instrument approach being used.
• At least one of the following 12 visual references for the intended runway is distinctly visible and identifiable to the pilot:

- The threshold
- The threshold markings
- The threshold lights
- The runway end identifier lights
- Visual approach slope indicator
- The touchdown zone
- The touchdown zone markings
- The touchdown zone lights
- The runway
- The runway markings
- Runway lights

When is a procedure turn not required? AIM 5-4-9

• When there is a "NoPT" remark at the IAP
• Otherwise directed by ATC
• Radar vectored to final
• Timed approaches from a holding fix
• Holding or Teardrop depicted in lieu of PT

How can we identify the missed approach point?

• Time from the final approach fix
• DME
• Cross radial

• DH
• Circling when you lose right of the runway

How is the Visual Descent Point Calculated and what is it?
• 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 be commenced, provided the runway environment is clearly visible to the pilot.
• Essentially, it is the decision making point whether we can make a normal safe approach and landing, or if the field is still not in sight, we execute a missed approach because we could not use normal maneuvers to a safe landing.
• Calculation: HAT (MDA-TDZE) / 300 Example: 900 / 300 = 3NM. At a DME of 3NM, this is our VDP.

What is the 3-1 rule, and how is it calculated?
• The 3-1 rule is a tool used for descent planning when you are at altitude
• It is calculated by multiplying how many feet you want to lose (minus the zeros), and multiplying that by 3
Example: Cruise flight at 10,000 and a TPA of 1200. Need to lose 8800 feet (drop the zeros):
88 x 3 = approximately 26 miles. 26 miles from your destination begin a descent at a rate that you calculate (see below)

How do you calculate 3° glideslope?
• Airspeed / 2 = FPM (add a zero to the calculated number)
Example: 140 KIAS / 2= 700 FPM(add a zero)

Alternate Minimums FAR 91.169
• If required to file an alternate the following must be met:
- Precision Approach : 600’ ceilings & 2 statute miles of visibility at the ETA
- Non Precision Approach: 800’ ceilings & 2 statute miles of vis. at the ETA
- Visual Approach: descent from the MEA and Land in VFR. * Ceilings must be higher than the MEA.
- Can’t file an airport as alternate is destination airport and alternate only have GPS approach.

Fuel Requirements FAR 91.167
• Enough fuel to get to destination and fly for 45 minutes after.
• Enough fuel to fly to destination, then alternate and then 45 minutes after is alternate required.

If a negative T is found on an approach plate, be aware that the takeoff minimums for that airport are non standard. Standard Takeoff Minimums are 200’ per NM.

If filing and using an airport for an alternate, check if the approach you want to use has a negative A or not. If it does, check the “Instrument Approach Procedures Charts” for the alternate minimums at that airport.

If approach plate has a negative C on it, note the airport has non standard circling minimums. This non standard information applies for distances only. To find the non standard circling minimums, locate the Digital Terminal Procedures Supplemental. Referencing aircraft approach speed against the approach circling MDA (in MSL) will give you your new circling minimums.

Supplemental Information

Weather & Forecasts
• Sigmet - Good for 4 hours. Shows information like icing, turbulence, sand & dust storm, visibility less than 3 miles, volcanic ash.
• Convective Sigmet - Significant Meteorological Warning. Good for 2 hours. Covers a wide area. Shows info:
- Hailstones bigger than ¾" & 50kts surface winds
- Tornados
- Embedded Thunderstorms that cover 3,000 square miles.
• Airmet - Weather warning for small area. Good for 6 hours. Three types of Airmets:
- Sierra: IFR conditions
- Tango: turbulence, surface winds +30kts, wind shear
- Zule: icing
•Pireps: Pilot reports.

Weather Reporting Systems
• A01 - Precipitation
• A02 - Type of precipitation
• A03 - Type and depth of precipitation
• HIWAS - Hazardous Inflight Weather Advisory Service. Transmits over certain VOR's

Icing
• Clear - Heavy, most dangerous. Hard to remove. Can build on surface of wing. Disrupts airflow over wing.
• Rime - Milky color. Forms on leading edges. Brittle. Hit angle of attack sooner.
• Mixed - Combination of Rime & Clear
• Icing can occur, structurally, on the instruments (pitot tube) and in the engine intake. Icing first noticeable on surfaces with the shortest radius of curvature (example - external thermometer)
• De-ice Methods: Deice boots & Heated Strips
• Anti- Ice Methods: TKS Fluid (Weeping Wing)

Tailplane Icing
• Slow down, not too fast and nose up.
• Symptoms of tailplane icing include:
- Buffering flight controls
- Flight controls easier to push forward and pull back
- Difficulty setting trim
- Pilot onset of pilot induced oscillations

Altimeter Errors (Temperature and Pressure Change) • High to low, look out below • Low to high, you're in the sky	**Frequency Ranges** • 118.0 - 137.0 Comms • 109.0 - 117.95 VOR • 108.1 - 11.95 LOC

Gyroscopic Instruments • Heading Indicator → Vacuum Driven • Attitude Indicator → Vacuum Driven • Turn Coordinator → Electrical	• This is done for redundancy. If one instrument fails, generally a combination of the others will still infer the same information. Example: If you lose your vacuum, you will be losing your heading indicator and attitude indicator. You will still have your compass to know where you are heading, and will have the turn coordinator to know if you are actually in a turn. You can use the VSI to know if you are in a climb or descent.

Airspace	Flight visibility	Distance from clouds
Class A (Comms, ATC Clearance)	Not Applicable	Not Applicable.
Class B (Comms, ATC Clearance)	3 statute miles	Clear of Clouds.
Class C (Comms, Two-way comm before entry)	3 statute miles	500 feet below. 1,000 feet above. 2,000 feet horizontal.
Class D (Comms, Two-way comm before entry)	3 statute miles	500 feet below. 1,000 feet above. 2,000 feet horizontal.
Class E: (No Comm, no clearance for VFR) Less than 10,000 feet MSL.	3 statute miles	500 feet below. 1,000 feet above. 2,000 feet horizontal.
At or above 10,000 feet MSL.	5 statute miles	1,000 feet below. 1,000 feet above. 1 statute mile horizontal.
Class G: (No Comm, no clearance for VFR) 1,200 feet or less above the surface (regardless of MSL altitude).		
Day, except as provided in Sec. 91.155(b).	1 statute mile	Clear of clouds.
Night, except as provided in Sec. 91.155(b).	3 statute miles	500 feet below. 1,000 feet above. 2,000 feet horizontal.
More than 1,200 feet above the surface but less than 10,000 feet MSL		
Day ----------	1 statute mile	500 feet below. 1,000 feet above. 2,000 feet horizontal.
Night ----------	3 statute miles	500 feet below. 1,000 feet above. 2,000 feet horizontal.
More than 1,200 feet above the surface and at or above 10,000 feet MSL.	5 statute miles	1,000 feet below. 1,000 feet above. 1 statute mile horizontal.