Instrument Know-A-Lot Handout (v1.0)

Adapted from the Instrument "Know All" Handout November 2017

Maintaining Currency and Exercising Privileges of the Instrument Rating

Logging Instrument Time—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… instructor may log instrument time when conducting instrument flight instruction in *actual* instrument flight conditions.
(3) For the purposes of logging instrument time **to meet the recent instrument experience requirements of Sec. 61.57(c)** of this part, the following information must be recorded in the person's logbook--

(i) **The location and type** of each instrument approach accomplished; and (ii) The **name of the safety pilot**, if required.

(4) A person can use time in a flight simulator, flight training device, or aviation training device for acquiring instrument aeronautical experience for a pilot certificate, rating, or instrument recency experience, provided an authorized instructor is present to observe that time and signs the person's logbook or training record to verify the time and the content of the training session.

61.3(e) Instrument rating. No person may act as pilot in command of a civil aircraft **under IFR or in weather conditions less than the minimums prescribed for VFR** flight unless that person holds:
(1) The appropriate aircraft category, class, type (if required), and instrument rating on that person's pilot certificate for any airplane, helicopter, or powered-lift being flown;

61.3 also requires photo id and medical certificate (applies to VFR or IFR)

91.173 ATC Clearance and flight plan required. No person may operate an aircraft in **controlled airspace under IFR** unless that person has—(a) Filed an IFR flight plan; and (b) received an appropriate ATC clearance

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61.57(c) Instrument experience. Except as provided in paragraph (e) of this section, a person may act as pilot in command *under IFR or weather conditions less than the minimums prescribed for VFR* only if:

(1) Use of an airplane… Within the 6 calendar months preceding the month of the flight, that person performed and logged…in an airplane…in actual weather conditions, or under simulated conditions using a view-limiting device…

(i) **Six instrument approaches**.
(ii) **Holding** procedures and tasks.
(iii) **Intercepting and tracking courses** through the use of navigational electronic systems.

Takeoff/landing currency (same as VFR) is still required.
Requirements are slightly different if all experience is in simulators.

61.57(d) Instrument proficiency check. Except as provided in paragraph (e) of this section*, a person who has failed to meet the instrument experience requirements of paragraph (c) for more than six calendar months* may reestablish instrument currency only by completing an instrument proficiency check…

Alternates—91.169

1-2-3 Rule. Alternate is required unless:
Forecast weather within **±1 hour** of ETA
Indicates ceiling of **2000'**
And visibility of **3 miles**

Standard Alternate Minimums
600 ft and **2 miles** *at ETA* for a **precision** approach
800 ft and **2 miles** *at ETA* for a **non-precision** approach
visual descent from MEA, approach, and land in VFR conditions
(for airports without a published instrument approach)

Equipment Requirements—91.205

VFR DAY 91.205(b)
Temp gauge (ea. liquid cooled)
Oil temp gauge (air cooled)
Manifold pressure gauge
Air speed indicator
Tachometer
Oil pressure gauge

Fuel gauges
Landing gear position lights
Altimeter
Magnetic compass
ELT
Seat belts

VFR NIGHT 91.205(c)
Fuses (one full set OR 3 of each kind)
Landing light (electric)
Anti-collision lights
Position lights
Source of electrical power

INSTRUMENT 91.205(d) VFR DAY +
Generator/Alternator
Radio (2-way com and nav equipment suitable to route being flown)
Altimeter (sensitive, adjust. for pressure)
Ball (slip-skid indicator)
Clock (showing hours/minutes/seconds)
Attitude indicator
Rate of turn indicator
Directional gyro
DME (above 24,000 ft)

*IFR night = VFR day+night+ grabcardd

REQUIRED DOCUMENTS
Airworthiness Certificate
Registration
Radio license (international)
Operating limitations
Weight and balance

AIRCRAFT AIRWORTHINESS
Annual inspection
VOR checks every 30 days
100 hour inspections if for hire
ADs (one-time and recurring)
Transponder (24 months)
ELT (12 months, ½ battery shelf life, 1 cumulative hour use)
Static system (pitot/static and altimeter, every 24 months)

Compass Errors, Lost procedures, 5Ts, etc

Compass Errors
Variation
Oscillation
Northerly turning (UNOS/OSUN)
Deviation
Acceleration (ANDS)
Magnetic dip

Acceleration Errors
Accelerate
North
Decelerate
South

Northerly Turning Errors
Undershoot
North
Overshoot
South

Lost Procedures
Climb
Call/communicate
Confess
Comply
Conserve

Go around / missed approach
Cram
Climb
Clean
Cool
Call

Five Ts (holding, etc)
Turn
Time
Twist
Throttle
Talk
Track (optional #6)

91.103 Airport Info
NOTAMs
Weather
Known traffic delays
Runway lengths
Alternates
Fuel requirements
Takeoff and landing distances

Instrument scan errors
Fixation
Omission
Emphasis

Fundamental Skills of Inst Flying
Instrument Cross-check
Instrument interpretation
Aircraft control

Transponder codes
1200 Emergency
7500 Hijack
7600 Lost com
7700 Emergency
7777 Military intercept

INOP Equipment—91.213(d)

Assuming the airplane does not have a minimum equipment list, we can fly with inoperative equipment.

- Inoperative equipment can't be required by type certificate, equipment list, 91.205 or other rules, or an AD.
- Removed, placarded, and maintenance recorded; OR deactivated/placarded (i/a/w Part 43 if maintenance is required).
- Determine that inoperative equipment does not pose a hazard to the aircraft

VOR Equipment Checks for IFR—91.171

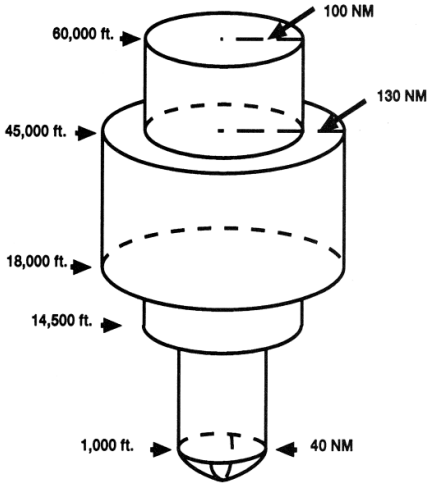
Each person making the VOR operational check…shall enter the date, place, bearing error, and sign the aircraft log or other record.

VOT:	±4° Published in A/FD. Tune 108.0, Center needle, OBS should read **180 TO** or **360 FROM** (indicates aircraft north of station)
Ground Checkpoint:	±4°, specific point on airport listed in A/FD
Airborne Checkpoint:	±6°, listed in A/FD
Independent NAV radios:	±4°, check against each other (tune to same station and center needles)
Airborne check on VOR radial:	±6°, on radial corresponding to airway centerline over an identifiable ground point
Test signal:	test performed by A&P with appropriate equipment

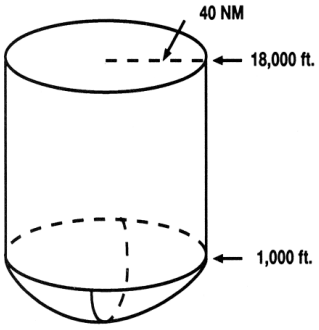
NOTE: All are ±4°, except airborne checks against ground points

VOR Service Volumes

High Altitude (40/100/130 nm radius)



Low Altitude (40 nm radius)



NOTE: All elevations shown are with respect to the station's site elevation (AGL). Coverage is not available in a cone of airspace directly above the facility.

Mode C Transponder Requirements

- Inside Class A, B, and C airspace.
- Above Class B and C airspace.
- Within 30 nm of the primary airport within Class B airspace (surface to 10,000 feet MSL)
- All airspace above 10,000 feet MSL, excluding the airspace at and below 2,500 feet AGL.
- The AIM states in Section 4-1-19(a)(3) that for airborne operations in Class G airspace, the transponder should be operating unless otherwise requested by ATC.

Aeromedical and ADM

DECIDE Model	**IM SAFE**	**PAVE (identify hazards)**	**TEAM (risk mgmt.)**
Detect	**I**llness	**P**ilot	**T**ransfer
Estimate	**M**edication	**A**ircraft	**E**liminate
Choose	**S**tress	en**V**ironment	**A**ccept
Identify	**A**lcohol	**E**xternal Pressures	**M**itigate
Do	**F**atigue		
Evaluate	**E**motions/Eating		

Physiological Factors

Hypoxia—Hypoxic (altitude), Hypemic (transport, e.g. CO poisoning), Stagnant (transport, G's), Histoxic (alcohol/drug impairment)
Symptoms include cyanosis, headache, impaired judgment/reaction/vision, euphoria, dizziness, tingling, numbness
Hyperventilation—Abnormal loss of CO_2. Symptoms: visual impairment, unconscious, dizziness, tingling, hot/cold, muscle spasms
Middle Ear and Sinus Problems—pressure trapped in ear/sinus cavities

Illusions Leading to Spatial Disorientation—IFH Chap. 3

The Leans—Abrupt return to level flight produces sensation of turning.
Coriolis Illusion—Movement of head in a different plane from stabilized turn –> illusion of accelerating on different axis.
Graveyard Spiral—Constant rate turn –> illusion of not turning –> recovery produces turning sensation –> go back into turn and pull back to stop perceived level descent –> spiral tightens, descent continues
Somatogravic Illusion—Rapid acceleration –> sensation of nose-up attitude
Inversion Illusion—Abruptly going from climb to straight and level –> illusion of tumbling backward
Elevator Illusion—Upward/downward acceleration –> illusion of being in climb/descent

Optical/Visual Illusions

False Horizon	Featureless Terrain Illusion	Fog
Autokinesis	Water Refraction	
Runway Width Illusion	Haze	
Runway and Terrain Slopes Illusion	Ground Lighting	

ATC Reporting (AIM 5-3-x)

ALWAYS Report to ATC:
Leaving assigned holding fix or point
Altitude change (VFR on top)
Rate of climb/descent < 500 fpm
Vacating assigned altitude for newly assigned altitude
Airspeed change 5% or 10kt (avg TAS)
Time and altitude upon reaching holding fix or clearance limit
Information related to safety of flight (incl. unforecast weather)
Missed approach
Equipment failure (VOR, ADF, GPS, ILS, etc)

Position Reports
Aircraft ID
Position
Time
Altitude
Type of flight plan (to FSS)
Next fix (name and ETA)
Succeeding fix (name only)
Remarks

Additional Reports when not in RADAR contact:
Inbound at FAF or OM
Compulsory reporting points
ETA changes of 3 minutes or more

IFR Clearances

CRAFT for initial clearance
Clearance limit
Route of flight
Altitude (initial/expected)
Frequency (departure)
Transponder code

Cruise Clearance
- Fly any altitude from the minimum IFR altitude up to and including altitude specified in clearance.
- Level-off/Climb/descend at pilot's discretion
- Is approval to fly the approach at destination airport
- Once *verbally reporting* leaving an altitude, may not return to that altitude without additional clearance.

VFR-ON-TOP
- Requested by pilot
- SEE AND AVOID traffic
- Fly appropriate VFR altitude
- Comply with VFR visibility and distance from clouds
- Comply with IFR rules

IFR Procedures

IFR Cruising Altitudes
NEodd (0-179° MC: odd thousands) SWeven (180-359° MC: even thousands)

IFR Altitudes
MEA: **minimum en-route altitude**. Adequate nav signal along route + obstruction clearance (1000'/2000' in non-mountainous and mountainous terrain, respectively)
MOCA: **minimum obstruction clearance altitude**. Nav signal within 22nm + obstruction clearance
MAA: **maximum authorized alt**. Max altitude to assure only one navaid is received on frequency
MRA: **minimum reception altitude**. Lowest altitude to receive nav signals to identify fix
MCA: **minimum crossing altitude**. Lowest altitude at which you may cross a fix
OROCA: **off route obstacle clearance altitude**. 1000'/2000' obstacle clearance only.
MSA: **minimum safe/sector altitude**. On approach plates. 1000' obstacle clearance within 22 nm. Emergency use only.

Lost Comm in IFR Conditions 91.185(c)
Fly HIGHEST **altitude** of:
Minimum IFR altitude
Expected altitude as advised by ATC
Assigned in an ATC clearance

Fly **route**, in order:
Assigned in ATC clearance
Vectors—direct to the fix, route, airway specified in vector clearance
Expected route, as advised by ATC previously
Filed in flight plan

Descent/approach:
If clearance limit is:
Fix from which approach begins: Begin descent/approach as close as possible to **EFC time** or **ETA as filed or amended.**
Not a fix where approach begins: Leave clearance fix **upon arrival** (**or EFC time** if received). Proceed to a fix from which an approach begins and commence descent/approach **as close as possible to your ETA**.

91.185(b) VFR conditions. If the failure occurs in VFR conditions...continue the flight under VFR and land as soon as practicable.

Holding

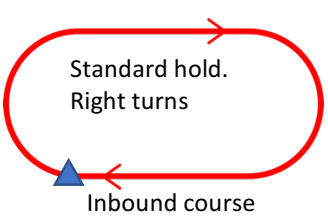
Non-Published Hold
Direction of hold in relation to fix
Fix
Radial (or airway)
Altitude
Direction of turns (right is standard)
EFC time

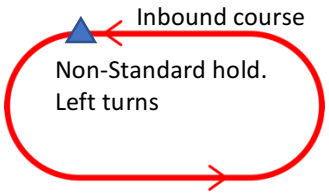
Published Hold
Direction
Fix
EFC time

Note: If holding at a **VOR**, inbound course is reciprocal of holding radial.
If holding at **intersection**, inbound course *might* be same as radial, or could be reciprocal depending on hold direction.
Always twist to INBOUND course.

Maximum holding airspeeds

SFC–6000	200 KIAS
6001–14,000	230 KIAS
14,001–up	265 KIAS



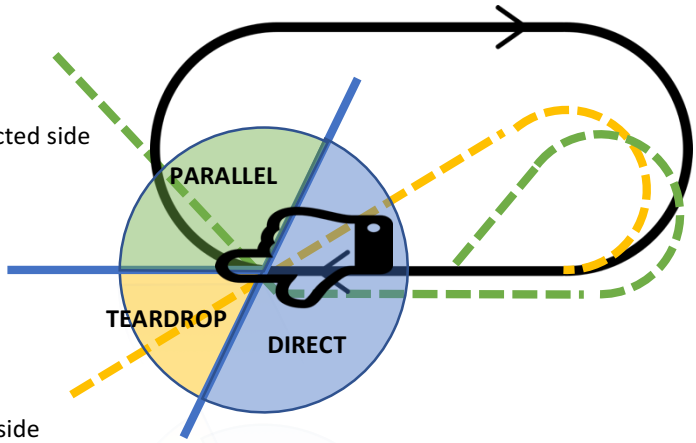


Entries

TEARDROP:
- Cross holding fix
- Turn to HDG of OB course -30°, toward protected side
- Fly 1 minute, then turn to intercept IB course

DIRECT:
- Cross fix
- Make turn to OB heading; join OB course
- Start time when abeam fix or wings level

PARALLEL:
- Cross fix
- Turn to outbound course parallel to IB (will be on unprotected side, or flying the "wrong way" on IB course)
- After 1 minute, turn >225° toward protected side
- Intercept inbound course

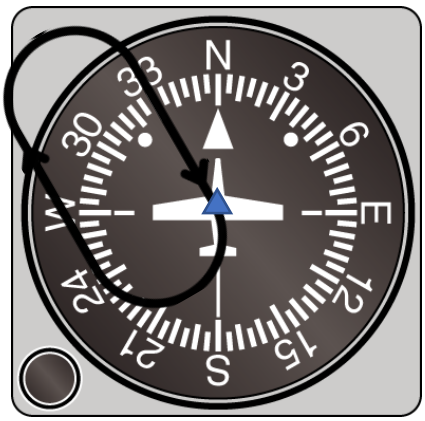


Visualizing holds on the DG

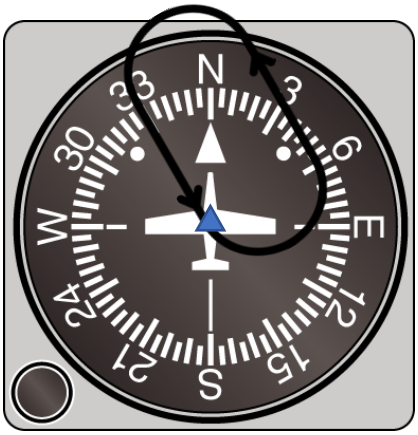
Mentally overlay the holding pattern on the DG, with the inbound leg on the specified radial, and inbound course pointing toward center of DG. If your entry course is generally in direction of the inbound course, entry is direct. Otherwise use teardrop or parallel.

Standard Hold at a VOR on 060 Radial
TEARDROP Entry

Standard Hold at a VOR on 330 Radial
PARALLEL Entry



Non-Standard Hold on 330 Radial
TEARDROP Entry



Instrument Approaches

Segments of an approach

Initial:	Begins at IAF; aligns aircraft with approach course
Intermediate:	To position aircraft for final descent.
Final:	Navigate from this point to DH or MDA
Missed:	Begins at MAP. Initiated at DH, time (for timed approach), MM, DME distance, or Runway (GPS waypoint)

Approach categories

Based on approach speed or 1.3 Vso.

Precision Approach

MAP is the point where DA/DH (decision altitude/height) is reached on glide slope.

Instrument Landing System (ILS)

Localizer:	108.1–111.94 MHz
	Transmits signal 18 nm from antenna up to altitude of 4500 ft above antenna site
	Full scale deflection is normally 2.5° (4 times more sensitive than a VOR)
	Signal width is 3-6°
Glideslope:	Located 750'–1250' down runway
	Displaced 400'–600' from centerline
	Signal width is 1.4°
Outer Marker:	4–7 miles from airport
	Glide slope intercept
	Identified by first two letters of airport identifier
Middle Marker:	About 3500' from threshold on centerline.
	Generally indicates aircraft at DH
Approach lights	

Parallel ILS Approaches

Centerlines at least 2500 ft apart; aircraft separated by 1.5 miles diagonally

Simultaneous approaches are permitted:	With centerlines 4,300–9,000' apart;
	Equipped with final monitor controllers;
	Requiring radar monitoring to ensure aircraft separation

Non-Precision Approach

Lateral guidance only. MDA (minimum descent altitude) is provided.

Localizer Approach

Course guidance, 3-letter identifier
Course width normally 5° (2.5° per side)
Transmits on 108.1–111.95 MHz

Localizer Back Course

If flying with an HSI, set the OBS to localizer front course, it will sense correctly.
Reverse sensing will occur if not using an HSI.

LDA (Localizer type directional aid)

Accuracy comparable to localizer
Course width 3–6°
Identified by three letters, preceded with an "I"

SDF (simplified directional facility)
Less accurate than localizer: either 6° or 12° course width.
Identified by three letters, NOT preceded with an "I"

VOR Approach
Full scale defection is 10° (each side)
No vertical guidance; step-down fixes are used

GPS/RNAV Approach
Non-WAAS GPS: RAIM prediction must be done prior to flight, and RAIM must be maintained throughout the approach.
WAAS GPS: RAIM check is not required, can fly LPV approaches.
Need proper annunciators for stage of flight. Sensitivity is: **En-route: 5 nm**
Terminal: 1 nm
Approach: 0.3 nm
A non-GPS approach must exist at alternate (if an alternate is required), and plane must have NDB/DME if required for approach.
*However, this restriction does not apply to GPS with WAAS (TSO-C145/146)—**AIM 1-2-3, AIM 1-1-19***
You may plan for GPS approach at your destination or alternate (but not both) if flying with a TSO-C129 GPS.
With a WAAS GPS (TSO-C145/146), you may plan to fly a GPS/RNAV approach at the destination *and* alternate, as long as you plan to LNAV or circling minimums, and determine the alternate using Part 91 *non-precision* std alternate minimums.

Circling Approach
Protected area is based on approach category.
Circling minimums provide 300 ft obstacle clearance in protected area.
If you lose sight of the runway, initiate missed approach by climbing turn toward the runway/MAP.

PAR/ASR
Precision approach radar: lateral and vertical navigational guidance from controller.
Airport surveillance radar: lateral guidance only.

Contact vs Visual Approach
Contact: Initiated only by pilot; airport must have IAP; reported visibility 1 mile or more; maintain 1 mile and clear of clouds.
Visual: May be initiated by ATC; airport or preceding aircraft in sight (once the preceding aircraft is in sight, the pilot is responsible for separation); reported weather is at least 1000 ft and 3 miles; maintain clear of clouds; no MA procedure.

DME Arc
Track radial that will intercept the arc, then lead your 90-degree turn to intercept arc at specified DME distance.
General rule: **TURN 10, TWIST 10**. Last "TWIST" will be to the inbound course.

GPS Substitution and Alternates

For IFR en route and terminal operations, GPS may be substituted for:

DME: Determining position over DME fixes and flying DME arc
NDB: Navigating to/from, holding over, and determining position over NDB or compass locator
Fix: position over a fix defined by NDB/compass locator bearing crossing a VOR/LOC course

Notes: There are some restrictions regarding installation, RAIM availability (for non-WAAS GPS), database currency, etc.
A non-GPS approach must exist at alternate if an alternate is req'd, and aircraft must have NDB/DME if req'd by approach.
However, this restriction does not apply to GPS with WAAS (TSO-C145/146)—AIM 1-2-3, AIM 1-1-19
Charted requirement for ADF/DME can be met using GPS, except for use as the principal approach navigation source.

Requirements to descend below DA or MDA—91.175(c)

Operation below DA/DH or MDA. Except as provided in paragraph (l) of this section or § 91.176 of this chapter…no pilot may operate an aircraft…below the authorized MDA or continue an approach below the authorized DA/DH unless -

(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; and
(3) Except for a Category II or Category III approach where any necessary visual reference requirements are specified by the Administrator, at least one of the following visual references for the intended runway is distinctly visible and identifiable to the pilot:

- (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.

Procedure Turns

Not required when:

- There is a NoPT remark
- Directed as such by ATC
- Receiving radar vectors to final
- When conducting timed approaches from holding fix
- PT barb is missing from plan view
- Cleared for a "straight-in" approach (not the same as straight-in landing!)

When a holding pattern or teardrop is depicted in lieu of Procedure Turn, you must fly that type of course reversal.

Oxygen Requirements—91.211

Cabin pressure **above 15,000'**: each occupant must be **provided** supplemental oxygen.
Cabin pressure **above 14,000'** (14,001' and above): minimum flight crew must **use** oxygen during entire flight at those altitudes.
Cabin pressure **above 12,000'** (12,501'–14,000' MSL): minimum flight crew must use oxygen for portion of flight > 30 minutes.

Definitions of Night

Sunset (91.209): aircraft **lighting** required (position and anti-collision if equipped)
Civil twilight (1.1): about 30 minutes after sunset to 30 minutes before sunrise: for **logging night flight**
1 hr after sunset–1 hr before sunrise (61.57b): limit on **carrying passengers**; time frame for gaining currency to carry pax at night

Climb Gradient

Standard climb gradient is **200 ft/nm**, but departure procedures may specify a minimum climb gradient.
To convert to ft/min use the following equation, where ROC is "rate of climb" and GS is "ground speed":

$$ROC_{fpm} = ROC_{fpnm} \times \frac{GS_{kt}}{60} \qquad \text{or with units shown:} \qquad ROC\left[\frac{\text{ft}}{\text{min}}\right] = ROC\left[\frac{\text{ft}}{\text{nm}}\right] \times \frac{GS}{60}\left[\frac{\text{nm/hr}}{\text{min/hr}}\right]$$