Instrument Procedures Training Manual

A Study Guide for Pilots and Flight Instructors

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Introduction. This Instrument training manual will provide an overview of the training, basic lesson plans and a brief synopsis of terms and procedures for instrument flying This also has articles summarizing aspects of instrument flying. *It is highly recommended to review "Training Tips for Aircraft Control" toward the end of this manual before, during and toward end of training.* Hopefully, this will be a helpful guide to the Instrument Student and Instructor.

Recommended references:

available for free download in PDF from the FAA or purchase by most pilot shops and Amazon:

- FAA 8083-15B Instrument Flying Handbook (for flight lessons, could be better written)
- FAA 8083-16 Instrument Procedures Handbook ***(for ground lessons)***
- FAR/AIM. (ASA IPAD app highly recommended over PDF or Paperback)
- Airman Certification Standards, Instrument Airplane
- Terminal Procedures Publications
- Low Altitude En Route Charts
- Chart Supplement (Airport/Facility Directory)
- FAA Chart Users Guide 12th Edition (great guide for learning IFR charts)

Instrument Training Phases and Goals

- Basic Instrument attitude flying skills
- Navigation and tracking: VOR radial intercept, holding patterns, procedure turns.
- Instrument approaches
- Partial Panel maneuvers, approaches, unusual attitudes
- Cross country planning and execution
- Final Flight check prep.

Table of Contents

Instrument Rating Practical check list

Eligibility 14 CFR 61.65

___ Hold min current Private Pilot certificate, or currently applying

___Read, write, speak understand English

___Ground training/home course in aeronautical knowledge per 61.65 (b)

___Logbook/training record endorsement prepared to take knowledge test

___ Pass knowledge test

___Log training in areas of operation 61.65 (c) in aircraft, training device

___Logbook entry prepared to take practical test

___ Pass practical test

Documents:

___ Pass Knowledge test, bring copy to practical

___ Private or higher pilot certificate

___ third class medical (or basic med)

Aeronautical Knowledge 61.65(b) receive and LOG Ground training

___ (1) FAR that apply to IFR

___ (2) AIM information that applies to IFR

___ (3) Air traffic control system and procedures for IFR

___ (4) IFR navigation and approaches

___ (5) IFR en route and approach procedure charts

___ (6) Use of aviation weather reports, forecasts, trends

___ (7) Safe/efficient operation under IFR/IMC

___ (8) Recognition of critical weather and wind shear avoidance

___ (9) ADM and judgment

___ (10) Crew resource management

Flight Proficiency receive and log ground/flight training 61.65 (c)

___Preflight preparation

___preflight procedures

___Air traffic control clearances and procedures

___Flight by reference to instruments

___Navigations Systems

___Instrument approach procedures

___ Emergency operations

___Post flight procedures

Flight Experience 61.65 (d)

___50 hours X-country as PIC, 10 hrs. must be in an airplane

___40 hours in actual or sim IMC in areas of paragraph (c),

___15 (of the total 40) hours with CFII including

 ___3 hours w/ CFII in prep for practical in preceding two calendar months

 ___Instrument flight training on X-country w/ CFII and IFR flight plan, 250 nm, approach at each airport, 3 different approaches.

Logbook Endorsements AC 61-65:

Aeronautical Knowledge Test

I certify that ____________ has received the required training in accordance with section 61.65(b). I have determined he/she is prepared for the _________________(knowledge test). *Date/CFI signature/CFI number/exp date.*

Flight proficiency/Practical test

I certify that ____________has received the required training in accordance with sections 61.65 (c) and (d). I have determined he/she is prepared for the _______________practical test. *Date/CFI signature/CFI number/exp date.*

Prerequisites for practical test: 14 CFR § 61.39(a)(6)(i) and (ii).

I certify that ____________ has received and logged training time within 2 calendar months preceding the month of application in preparation for the practical test and they are prepared for the required practical test for the issuance of ____________certificate. .They have demonstrated satisfactory knowledge of the subject areas in which they were deficient on the ____ airman knowledge test.

Instrument Proficiency Check

14 CFR 61.57(c) a person may act as pilot in command under IFR or weather conditions less than the minimums prescribed for VFR only if within the 6 calendar months preceding the month of flight, that person performed and logged at least the following tasks… in actual weather or simulated

- Six instrument approaches
- Holding procedures and tasks
- Intercepting and tracking courses through use of navigational electronic systems

14 CFR 61.57 (d) …. If failed to meet provisions of paragraph (c) for more than six calendar months may establish currency only by completing an instrument proficiency check…. Consisting of areas of operation and tasks required in the instrument rating practical test standards.

IPC must be in aircraft appropriate for category, given by an examiner, authorized instructor, military, or company check pilot.

The Airman Certification Standards requires the MINIMUM tasks for IPC:

___ Holding procedures

___Unusual flight attitudes

___ Intercepting and tracking navigational systems and DME arcs

___ Two non-precision approaches (one with loss of primary flight indicators)

___ One precision approach

___ Missed approach

___Circling approach

___Landing from a straight in or circling approach

___one engine in-op level flight and turns (Multi engine airplane)

___ One engine in-op instrument approach (multi engine airplane)

___Post flight procedures

Endorsement: I certify that ___________ (*name, certificate, number*) has satisfactorily completed the instrument proficiency check of section 61.57(d) in a _____________(*make and model*) aircraft on ______ *(date*). *Name, number, CFI, Exp date.*

Attitude Instrument Flying

Objective: Develop understanding of principles of attitude instrument flying

Elements:

- Instrument cross check (scan) techniques
- Instrument interpretation (what info are we getting from them)
- Aircraft Control
- Basic Flight Maneuvers

Schedule: 1:30 min **Equipment:** whiteboard, airplane,

Introduction: There are two general methods of instrument use to control the aircraft in IMC:

- **Primary and Supporting Method (FAA emphasized)**
- **Control and Performance Method.**

The method preferred by the FAA de-emphasizes the Attitude indicator and emphasizes use of instruments that tell the pilot what the aircraft WAS doing or already did, not what it is going to do. Consequently, the pilot will spend time chasing and correcting what the plane did. It is my opinion that the pilot is never really in control of the aircraft, except after many hours of experience.

Many Professional pilots, Military pilots and operators of performance aircraft prefer the second method which emphasizes use of the attitude indicator*, using specific and known power settings, aircraft attitudes, and aircraft configuration to command the aircraft.* The other instruments are briefly consulted to verify aircraft compliance. The aircraft will give the same performance (airspeed, climb, turn rate etc.) for a given power, attitude, and configuration ("PAC"). If the pilot develops a "PAC" for each phase of flight, then the aircraft will respond as anticipated. For example, in a typical GA aircraft, during a straight and level Vy climb on runway heading can be "commanded" with full power, 7 degrees pitch up, wings level in clean configuration. 90% of visual scan is on the attitude indicator (7 degrees pitch up, wings level) and only glancing at Airspeed indicator once to confirm performance, then occasionally checking DG and Altimeter. Consequently, this reduces the instrument scan, reduces time on the secondary instruments, and keeps your attention on the Attitude indicator with replication of VFR flight control.

The FAA method of Primary and supporting is also presented. Specifically, the instrument of reference for primary and secondary for each phase of flight is frequently a subject on the Instrument Knowledge Tests for the FAA certificates.

Control and Performance Method: (*preferred method*)

Attitude + Power = Performance

Control instruments - **attitude indicator** and Manifold/RPM

Performance Instruments- **DG, Altimeter** + remaining six pack instruments secondary.

Navigation Instruments –VOR, ILS, GPS

For any given aircraft, a set of Power, Attitude, and Configuration can be developed. Many General Aviation aircraft have similar settings to start with. After a couple of test flights, a "PAC" for each phase of flight can be determined. A table can then be made with the settings and used as reference until second nature. Be sure to reference the "Tips and Tricks" at the very end of this syllabus. Generally, *Power is used to initiate a descent and level off* (small altitude deviations in level flight can be adjusted with pitch and trim), bank to maintain lateral navigation. Typical settings that might be used in a retractable gear aircraft are provided as an example listed below:

Phase	MP	RPM	Pitch	Gear	Flaps	KIAS	VSI
Initial Climb	Full	Max	$+10^0$	UP	UP	Vx	
Cruise Climb	Full	2500	$+7^0$	UP	UP	Vy	
Cruise	23"	2300	Level	UP	UP		
Descent	18"	2300	-2^0	Up	UP		500fpm
Approach	18"	2300	$+2^0$	Up	10^0	100	
Precision descent	18"	2300	$+2^0$	Down	10^0	100	500fpm
Non-Precision Descent	15"	2300	$+2^0$	Down	10^0	100	800fpm
Level off MDA	22"	2300	$+2^0$	Down	10^0	100	0
Missed Approach	**Full**	**Max**	**$+7^0$**	**UP**	**UP**	**Vy**	

Climb: full power, 10 degrees for Vx until gear up. Then 6-7 degrees pitch up typically produces a Vy climb. Air speed is checked just briefly to verify performance. Emphasis is on attitude indicator. Check Altimeter for level off, Directional Gyro to hold course.

Turns and Climbing turns: 10% of IAS + 5 approximates a standard rate turn. If traveling at 100 kts, a standard rate turn = 15^0 on the attitude indicator. A climbing turn is accomplished with

7 degrees pitch up and 15 degrees of bank in a typical GA aircraft. The turn coordinator and Airspeed indicator are only referenced very briefly to verify performance.

Level off to Cruise: Pitch to level on AI and trim off pressure as aircraft accelerates. Reduce power to cruise once reach desired cruise speed. Check DG and Altimeter as needed.

Descents: Descend with power reduction, typically 5" manifold or 300 RPM = 500 fpm, attitude indicator may settle at or just below horizon. Verify descent rate using VSI. The air speed will be maintained as trim should not have to change. (Trim sets air speed in normal flight regimes, power determines climb, descent, or level off).

Level off from a Descent: Return power to same setting as before descent about 100 ft prior to target altitude. For example, if power reduced from 23" manifold to 18" for descent, return power to 23" and level off will not require pitch change nor re-trim. For fixed pitched prop, use RPM as power indicator.

Approach phase: 5 to 8 miles before Initial approach fix, reduce power to approach. Typically, 17-18" manifold, or if in a fixed pitch aircraft about 2100 RPM (c-172). Re-trim. Attitude indicator may show level to +2 degrees. This will typically get you into flap and gear speed and slow aircraft for the approach.

Precision Final Approach Fix: "Gear down to come down." Typically, gear +/- approach flaps will initiate a descent that is close to the 3 percent gradient on a precision approach (about 500-600 fpm). Power can be left alone. In a fixed gear aircraft, reducing the power approximately 5" of manifold pressure (3-400 RPM) will give a 500-fpm descent rate. The required descent rate should be 5 times the ground speed for precision approaches (100 kts=500 fpm descent). Adjust power (or pitch) in small increments using VSI to check descent rate to stay on glide slope (if above glide path, increase descent rate by 200-300 ft/min till recaptured, then maintain descent rate on VSI that holds glide slope/path.

Non-Precision Final Approach Fix: Typical descent rate should be 50% more than precision to "dive and drive" each step-down fix (if descent gradient more than 3^0 a greater descent rate will be required). Typical descent rate should be about 800 fpm at 100-110 kts. In complex aircraft, drop the gear and decrease manifold about 2-3", adjust per VSI for the desired rate. In fixed gear aircraft, decrease Manifold 8" for 800 fpm descent. IAS should stay the same.

MDA Level Off: In retractable gear, add about 7-8" manifold to level off 100 ft prior to MDA. In fixed gear, return power setting to the same as prior to the descent (also about 8" manifold).

Missed Approach: Typically, aircraft will be significantly above stall speed. To avoid descent below MDA or DA, it is recommended to Pitch up to Vy ATTITUDE (typically 7 degrees), then "cram" mixture, prop, carb heat, and throttle. Then clean up – gear up, flaps up, cowl flaps open- **"Climb, Cram, Clean."**

Notice the Attitude indicator pitch reference is near level (+2 to -2, depending on aircraft) from approach phase up to the missed approach. The VSI is used to aid in small power/pitch changes to adjust descent rate. Gear deployment typically yields about 500-600 fpm descent.

Flight Instruments

Objective To teach the student about VFR/IFR instruments, their function, and the requirements.

Elements

VFR and IFR required instruments
Vacuum-driven gyroscopic instruments
Electric-driven gyroscopic instruments
Pitot-static system
Compass errors

Schedule Discussion 1:30 ***Equipment*** Aircraft

Instructor Actions

IFR (CFR 91.205) required equipment

VFR day + VFR night plus
Two-way radio and nav for route to be flown
Gyroscopic rate of turn indicator (or third attitude indicator)
Slip –skid indicator
Altimeter (adj for barometric pressure)
Clock with hours, minutes, seconds
Generator/alternator
Attitude indicator
Directional gyro (or equivalent)

Inoperative instruments and equipment 14 FAR 91.213

<u>Aircraft Equipment Is required by:</u>
MEL for aircraft (usually for commercial or on demand turbine aircraft)
FAR required equipment for type of flight (91.205)
Type certificate (required equipment list in POH)/KOEL
Airworthiness Directive (check maintenance logs)
<u>IF in-op equipment required by above, aircraft may only be flown if:</u>
Deficiency repaired by certified technician/aircraft mechanic
Or Ferry Permit obtained via Mechanic and FSDO for trip to repair shop
<u>If in-op equipment NOT required by above, aircraft may be flown if:</u>
Equipment Removed from aircraft and or placarded,
Maintenance recorded
Determined by pilot or certified mechanic not a hazard

Discuss Vacuum-Driven Gyroscopic Instruments: Rigidity and precession

Attitude Indicator: Review markings and how to interpret.

- Rigidity in space.
- Supporting instrument only for FAA scan
- Primary instrument in Command and Performance.
- <5 degrees bank in turns
- stable in pitch during taxi

Directional Gyro (Heading Indicator) precession,

- Rigidity in Space
- Primary bank indicator (FAA method), straight, climbs and descents
- Spin up and stable 3 to 5 minutes
- Indicate known headings (taxi ways, runway, magnetic compass)

Turn Coordinator (Electric Gyro) **Instruments:**

- Primary instrument for STD rate turn (FAA method)
- Turn Coordinator (with Inclinometer): standard rate turn, slips/skids
- Detects yaw and roll direction and rate (3^{0}/sec), not bank angle.
- During taxi: plane tilts into turn, ball slides to outside of turn (skid)

Pitot-Static System: (check q 24 months, check logs)

Airspeed Indicator:

- Construction, how works, indications (V-Speeds)
- Stagnation pressure - static pressure = Dynamic pressure (airspeed)
- IAS, CAS, TAS (corrected for compressibility-temp, PA)
- pitot tube at high pitch attitude
- In straight and level flight, primary power instrument. (FAA method)
- In climbs and descents, primary pitch instrument. (FAA Method)

Altimeter:

- aneroid wafers at 29.92, expands with increasing altitude
- PA, True Altitude (MSL), Absolute Altitude (AGL)
- Density Altitude (PA corrected for Temp)
- errors "High to Low or Hot to Cold, Look Out Below!"
- Non-standard temps not adjustable,
- Kollsman for non-standard pressure, 1"=1000ft
- straight and level flight, primary pitch instrument. (FAA Method)
- Altimeter should be within 75' of field elevation.

Vertical Speed Indicator:

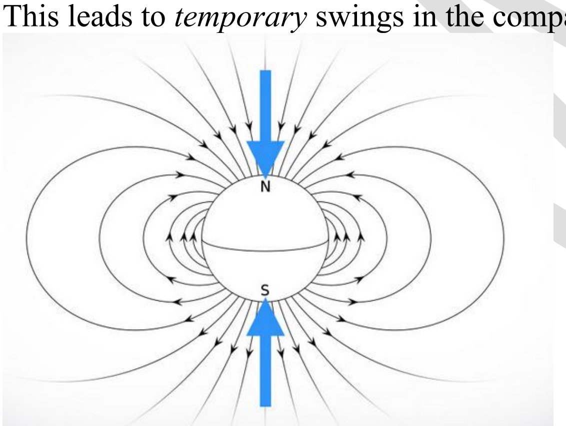
- Altimeter with calibrated leak, trend, and rate information
- 6-9 second lag, preflight reads zero
- Constant rate climbs and descents, primary pitch instrument. (FAA Method)

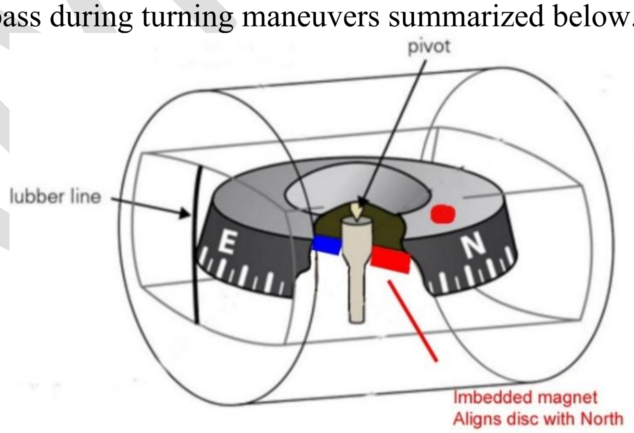
Explain Pitot-Static System Blockages:

- Complete blockage (Pitot tube and drain, static ports):
    - Airspeed, Altimeter will "Freeze"
    - VSI will indicate zero
- Pitot tube and drain hole blockage (static port open):
    - Pressure trapped in "Diaphragm."
    - Expands, contracts with altitude change
    - Airspeed acts like altimeter
- Pitot tube blocked, drain hole clear (static port open):
    - Drain hole acts like static port
    - Pressure in diaphragm is same as static
    - air speed will decrease to zero
- Static port only blocked (very rare):
    - Lower altitude than when the blockage occurred, Airspeed reads too high
    - Problematic on approach to land
    - Higher altitude than where blockage occurred, Airspeed reads too low
- Alternate Static Source:
    - Cabin pressure lower than outside
    - Altimeter and IAS read high
    - Problematic on approach to land

Magnetic compass errors: variation (magnetic versus true north), deviation, magnetic dip errors

Magnetic Dip Errors: The earth's magnetic field is not parallel to the surface. During banking maneuvers, the down turning magnetic field can pull the compass needle away from magnetic north. This leads to *temporary* swings in the compass during turning maneuvers summarized below.





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Northerly Turning Error ("Leads turning toward North, Lags turning toward South"

UNOS- Under steer turning north, Oversteer turning south)

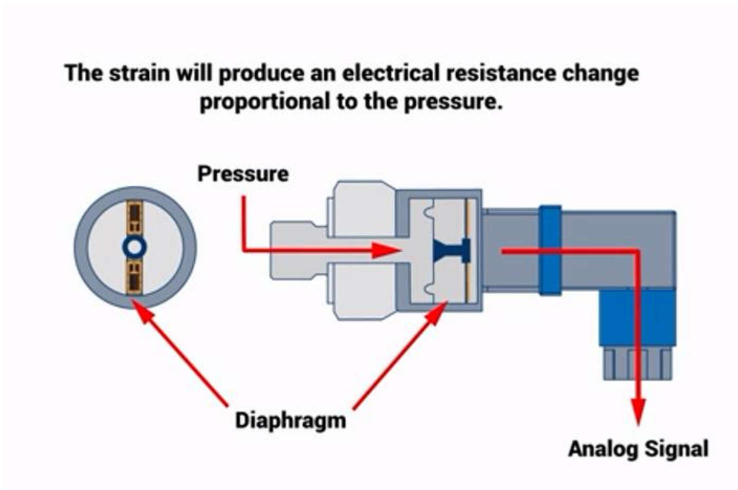
Acceleration Errors (east or west heading, in a dive to accelerate, climb to decelerate)

ANDS: Accelerate turns to the North, Decelerate turns to the South

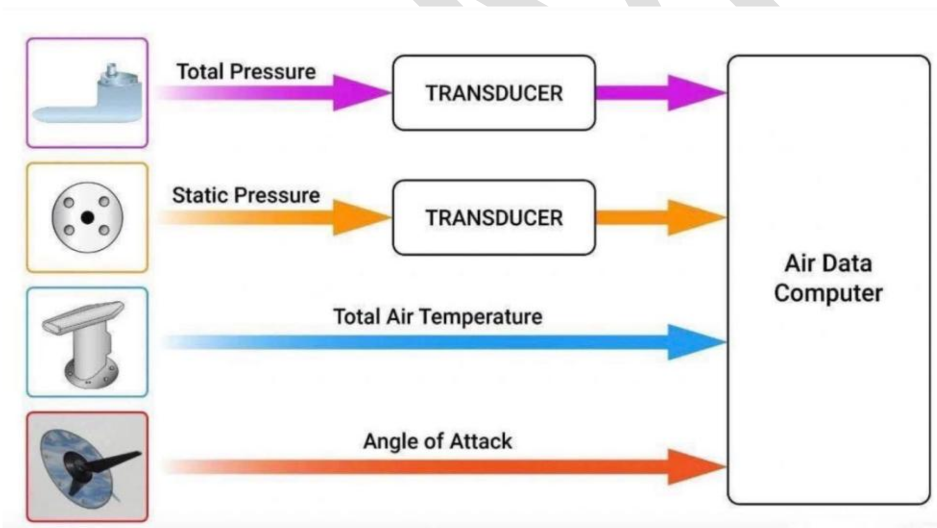
<u>**Operation Check**</u>: Fluid filled, moves freely, compass correction card present.

Glass panel primary flight displays

Pitot Static Instruments: Use the same concepts as the above mechanical instruments, however the pressures are measured with pressure transducers. The pressure transducer has a diaphragm that flexes against the pressure and its motion is converted to an electrical signal proportionate to the pressure. The pressure information is processed by an air data computer (ADC).



IAS is calculated in the same manner (Stagnation – static = dynamic) and sent to the electronic display. The ADC will also use outside air temperature and report Altitude, Vertical Speed, and calculate TAS. Ground speed is obtained from the GPS. Then winds aloft, cross track, wind correction and other parameters can be calculated in the Primary Flight Display.

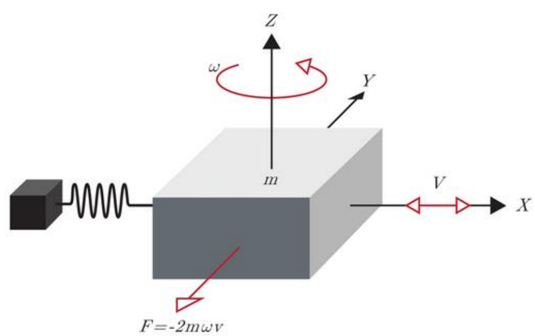


Note: In the pitot tube, Total pressure = Stagnation Pressure. Total pressure -Static pressure = Dynamic pressure. IAS is not an airspeed but rather a numeric representation of Dynamic pressure (the same pressure in the lift formula)

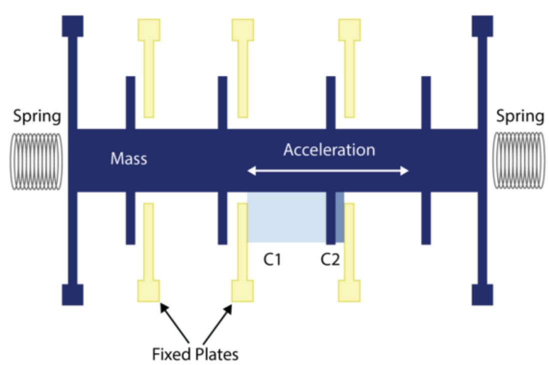
Attitude and Heading Reference systems (AHRS): Uses many of the same principles to determine aircraft attitude and heading as the mechanical instruments.

Attitude information: Uses a combination of a micro electro-mechanical device (MEM) and accelerometers to determine aircraft attitude.

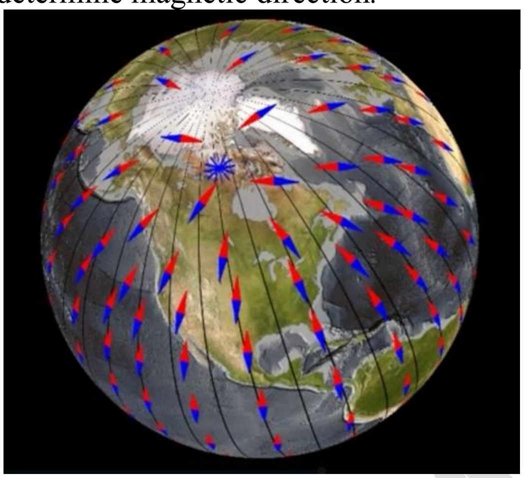
MEM Gyro chip. Both "rotating" gyros in mechanical attitude indicators and "oscillating" gyros in MEM chips (see below) work on the principle of momentum. A mass in motion will resist being displaced. In the mechanical gyro, the aircraft rotates around the gyro (rigidity in space). The MEM gyro detects displacement of the mass (similar to Coriolis causing winds to displace east and west with rotation of the earth). In the schematic below, a small mass is oscillated rapidly along the X axis by electrical impulses. This imparts a momentum that causes the mass to resist displacement. When the aircraft turns or rotates (as seen by "ω" and arrow), it causes the mass to displace laterally along the Y axis. This movement is detected by a change in electrical capacitance and calibrated to register the change in aircraft attitude.



Accelerometers: Microscopic weights (mass) on a spring. In the diagram below, if the device is moved abruptly to the right (acceleration force), the "mass" resist motion and compress the spring on the left. The rate and magnitude of deflection of the mass on the spring is measured electrically by changes in capacitance (C1 and C2 in the diagram). Three accelerometers are placed in three directions (X, Y, & Z axis) and determine accelerations and decelerations in each of three planes of space.



Magnetometer: There are several variations of this device. Older avionics used a "Flux Gate" magnetometer that is large and heavy (see description in the PHAK). The most common type used in modern avionics (and handheld electronics) uses the "Hall effect." An electrical current is passed through a conductive plate (Hall element- see below). Normally, the current (red circuit) would pass in a straight line through the middle of the plate. The earth's magnetic field runs in very specific paths from the north to the south. Depending on how the magnetic field passes through the plate it displaces the current to one side of the plate and creates "Polarization" or voltage difference. This voltage difference (green circuit) is measured and calibrated to determine magnetic direction.



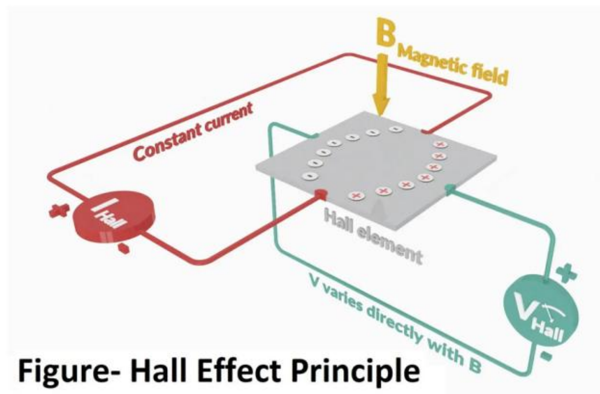


Figure- Hall Effect Principle

In the figure above, the Earth's magnetic field travels in lines from the magnetic North to South. These magnetic lines are "polarized" as seen by the red and blue arrows. As the lines of magnetic "flux" cross the "hall plate" the current is displaced in specific directions based on the "polarity" and direction of the magnetic field. *Micro magnetometers use hall effect to detect magnetic flux and direction.*

Evaluation

Lesson is complete when student has a thorough knowledge of required instruments and compass errors.

References FAA-H-8083-15A Instrument Flying Handbook Chapter 3, FAA-H-8083-35 PHAK

Departure Procedures

Attention motivation: Any airport that has a published instrument approach (blue and green airports on enroute charts) has been surveyed for obstacle departures with the OIS described below. This lesson emphasizes how these procedures can be determined and how they are observed as the initial component of *every IFR flight.*

Objective

To teach the student to determine how to depart an airport safely using obstacle notes, departure procedures and climb tables.

Elements

- Take off Minima
- Close in obstacles
- OIS and departure procedures
- Climb tables
- Clearances from Non-towered Airports

Recommended Reading:

- FAA H 8083 16, Instrument Procedures Handbook, Chapter 1
- FAA H 8083 15B Instrument Flying Handbook 10-5 to 10-7, AIM 5-9-2
- Terminal Procedures Publication (TPP) aka Terminal Instrument Procedures (TERPS)
- Chart Supplement (aka Airport Facility Directory)

Instructor's Actions Discuss:

- Elements for departing an airport safely- see elements above.
- Review Airport Diagrams and lighting and signs as needed
- Runway Hot spots and reference in the Chart Supplement (A/FD)
- Obtaining Clearance (**see Radio Comm Lesson**)

NOTE to General Aviation pilots: Make sure weather is adequate to return to airport of origin in case of emergency (ill passenger, mechanical problems, door pop in winter) Recommend use *CIRCLING* minimums are present at airport of origin as a *PERSONAL* departure minimum in case you have to turn around and land

When a  Appears in the notes section an approach plate for the airport you are departing from, then the airport has IFR takeoff minimums and/or Departure procedures published

<u>**Departure Minimums:**</u>

Standard take-off minima=1 statute mile w/ 1 or 2 engines (½ mile for 3+ engines) (91.175).

Non-Standard take-off minima may be published for an airport if obstacles penetrate OIS that require more than a standard climb gradient (200 ft/nm) <u>*within 2.6 nm of DER*</u>. AIM 5-2-9(e)(4)(a)(2)

1) required for commercial operators as conditions when they can or cannot depart IFR.
2) Not required for Part 91 (although good guidance for all departures)
3) <u>*Not a departure procedure*</u>- does not guarantee obstacle and terrain clearance to the enroute structure.

Take off minimums that are published as part of an ODP or SID must be complied with by all aircraft to obtain obstacle clearance.

<u>**Take off obstacle notes:**</u> Low, Close in obstacles < 1nm from runway at or below 200' AGL from DER, listed in "Takeoff Minimums and (obstacle) departures" specifically for pilot's responsibility to avoid obstacles via
1) visual identification 2) early liftoff & climb or 3) alternate rwy. **(AIM 5-2-9.e.4)**

<u>**Obstacle Ident Surface (OIS)**</u> – Imaginary sheet/surface that slopes up away from airport At 152 feet per nm (1:40) starting at 35 ft above end of runway. If object penetrates *OIS ≥1nm from DER* then IFR departure procedure will be published and indicated by NACO has "T" in black triangle. Jeppesen "IFR Departure procedures" printed on front or rear of chart. No obstacles penetrate OIS, then no Departure Procedure required to be published- Default **Standard Departure** may be used.

Types of Departures:

1) <u>**Standard (normal) departure:**</u> Default departure *ONLY if NO OTHER* departure published at surveyed airport. To obtain Required Obstacle Clearance- "fly above the OIS"
   1) Fly 35 ft above DER
   2) Climb RWY heading Minimum 200 ft/nm to 400 ft before turning on course.
   3) This is required minimum performance for all departures unless otherwise published in "take off Minimums", in the ODP or SID.
   4) Provides clearance of 1000 ft up to 25 nm in flat lands, 2000 ft up to 46 nm in mountainous areas. **AIM 5-2-9 e.3.**
   5) Pilot is responsible for own terrain clearance if does not reach enroute structure and published safe altitudes within 25 nm flat lands, 46 nm in mountains.

2) <u>**ODP- Obstacle departure Procedure (review examples in TPP)**</u>
   - Located in "Take off Minimums" section of TERPS
   - Text or graphic- Some are named (appear similar to SID)

- Pilot discretion to fly unless ATC assigns other SID/RCP
- ***advise ATC when using!!!***
- Pilot responsible for own obstacle clearance if not on published enroute structure with in 25nm flat land or 46 nm mountains
  (see Instrument Procedures Handbook, 1-16, AIM 5-2-9(e)(4)(a)(2))

3) **SID- Standard Instrument Departures**
   - Must have at least text of SID to accept (otherwise "NO SID" in flight plan)
   - Must meet aircraft equipment and climb requirements.
   - ATC assigned during clearance
   - NOT MANDATORY, if accept, must comply.
   - SIDs may have non-standard lost comm procedures- verify on SID
   - RNAV SID- must be retrievable from the GPS NAV database
     - entry of individual way points not permitted as removes GPS navigation sensitivity and RNP
   - **Transition routes and nomenclature** – last three letters in SID changed to transition fix:

     Freehold Three Departure, file "FREH3.RBV"
     Freehold Three Departure with Elwood City Transition file "FREH3.EWC"

4) **RCP- Radar Controlled Departures "Radar Vector Departure" (Diverse Vector Area)**
   - ATC Assigns "Cleared to destination via Radar Vectors, then as filed"
   - Obstacle and terrain clearance must have all three
     - "radar contact" confirmed by ATC
     - Heading "160"
     - altitude assignment "maintain 4000" (AIM 5-2-8)

   - **Diverse Vector Area-** not published ATC uses for Altitude minima assignment when giving radar vectors

5) **Visual Climb Over Airport**- must be VMC to published "climb to" altitude. Published in TPP. Must notify ATC. Example is non turbine aircraft departing in mountainous terrain. (AIM 5-2-9e.7)

Rate of Climb table and calculations (Back of TERP); used to determine if aircraft capable of climbing at required rate for obstacle clearance on ODP, SIDs

1) Determine Climb speed (KIAS) and Rate of climb (Feet per minute) from takeoff to safe altitude with POH Performance charts
2) Calculate TAS in climb with E6B
3) Use winds aloft to determine Ground speed during climb
4) Use Rate of Climb table in back of TERPs to determine rate of climb per nautical mile

<u>Example:</u> 320 ft/nm climb required =480 fpm at 90 kts **ground speed**)

NOTE: climb performance significantly degraded with tail wind ALOFT.

INSTRUMENT TAKEOFF OR APPROACH PROCEDURE CHARTS
RATE OF CLIMB/DESCENT TABLE
(ft per min)

A rate of climb/descent table is provided for use in planning and executing climbs or descents under known or approximate ground speed conditions. It will be especially useful for approaches when the localizer only is used for course guidance. A best speed, power, and altitude combination can be programmed which will result in a stable glide rate and altitude favorable for executing a landing if minimums exist upon breakout. Care should always be exercised so that minimum descent altitude and missed approach point are not exceeded.

ft/NM	%	GROUND SPEED (knots)											ANGLE
		60	90	120	150	180	210	240	270	300	330	360	
152	2.50	150	230	300	380	460	530	610	680	760	840	910	1.43
200	3.29	200	300	400	500	600	700	800	900	1000	1100	1200	1.89
210	3.46	210	320	420	530	630	740	840	950	1050	1160	1260	1.98
220	3.62	220	330	440	550	660	770	880	990	1100	1210	1320	2.07
230	3.79	230	350	460	580	690	810	920	1040	1150	1270	1380	2.17
240	3.95	240	360	480	600	720	840	960	1080	1200	1320	1440	2.26
250	4.11	250	380	500	630	750	880	1000	1130	1250	1380	1500	2.36
260	4.28	260	390	520	650	780	910	1040	1170	1300	1430	1560	2.45
270	4.44	270	410	540	680	810	950	1080	1220	1350	1490	1620	2.54
280	4.61	280	420	560	700	840	980	1120	1260	1400	1540	1680	2.64
290	4.77	290	440	580	730	870	1020	1160	1310	1450	1600	1740	2.73
300	4.94	300	450	600	750	900	1050	1200	1350	1500	1650	1800	2.83
310	5.10	310	470	620	780	930	1090	1240	1400	1550	1710	1860	2.92
320	5.27	320	480	640	800	960	1120	1280	1440	1600	1760	1920	3.01
330	5.43	330	500	660	830	990	1160	1320	1490	1650	1820	1980	3.11
340	5.60	340	510	680	850	1020	1190	1360	1530	1700	1870	2040	3.20
350	5.76	350	530	700	880	1050	1230	1400	1580	1750	1930	2100	3.30
360	5.92	360	540	720	900	1080	1260	1440	1620	1800	1980	2160	3.39
370	6.09	370	560	740	930	1110	1300	1480	1670	1850	2040	2220	3.48
380	6.25	380	570	760	950	1140	1330	1520	1710	1900	2090	2280	3.58

Planning Your Departure

1) Review **Take off Minimums and Departure Procedures** in TERPS for:
    a. **<u>Obstacle notes</u>** < 1 nm from departure end of runway and pre-flight plan to avoid
    b. commercial **<u>"Take off minimums"</u>** published for obstacles within 2.6 nm of DER. (not a DP)
    c. Review any **<u>unnamed ODPs or VCOA</u>** and consider use if applicable

2) Review TERPS for any **<u>NAMED ODPs or SIDs</u>** in TERPS and consider if appropriate
    a. If there is no published ODP or SID, use Standard Departure procedure.

3) Determine if your aircraft has:
    a. capability to meet **<u>required climb gradient</u>** with use of climb table, aircraft performance charts, and winds aloft
    b. **<u>Navigation performance</u>** to fly named ODPS or SIDS (pre-loaded in GPS database)

4) If using <u>un-named</u> ODP or VCOA, then inform ATC of use when obtain Clearance

5) If using <u>named</u> ODP or SID, file with IFR flight plan and obtain clearance to fly

6) If assigned a named ODP or SID, verify you can comply:
    a. Must have at least textual description of procedure
    b. Procedure pre-loaded in navigation database and CURRENT.
    c. Aircraft capable of required minimum climb ability as noted above.

7) IF using electronic flight bag (EFB) such as Garmin Pilot or Foreflight, make sure you know how to:
    a. locate Take off minima and Obstacle departure procedures portion of TERPS
    b. Named ODPs and SIDS
    c. TERPS supplement with climb tables, in-op equipment, and legends

8) Review Chart Supplement for Departure and Arrival Airport critical information such as runway lengths, frequencies, services, hours of operations, nav aids, weather reporting, etc.