NON percision Approach

As a private pilot you use a trafic pattern to Enter Airport + land now you us a instrument Approach

NDB - 3 mors code NON Directional Beacon

VOR - 3 UHF OMINI Range

LOL - 2 Localizer

GPS - RAIM Accuracy idicator measurment Global positoning system

LDA - 2 Localizer Directional Aid

SDF - 2 simplified Directional Facility

RNAV - System will tell you when locked on Area Navigation

USE Radio signal to Navigate. These facilities are all different - (no vertical guidance)
USE Them to land at Airport

Landings

Strait IN - Approach is within 30° of Runway

Circle to Land - land anyway you can - lose sight of Runway imediatly go missed
fly Runway heading.
Distance from Airport varys on ground speed (ours is 1.3 NM)

Feeder Roots not part of Approach But very important

Align with Approach course

Procedure turn 1) outbound leg + return
2) Hold

Final Approach Fix (FAF) * moltese cross 1) Timing
2) not in radar contact must anounce at Approach Fix

Start Decent

250 ft per min

is Faster But still

important to identify step downs

Missed Approach point

Get to Altitude before MAP so it will be easier to identify the 12 items you need to see before decent below DH - MDA

the Approach lights
Reils
Rwy markings + lights
Treshold
markings
lights
VASI
Touchdown zone + markings + lights

I. ILS

A. Precision Approach *Gives us three things*

1. Accurate course
2. Glide Slope
3. Distance guidance

B. Three categories, I, II, III *Three flavors*

1. Most are CAT I *That is what we will be flying*
   To be current
   a. Instrumented rated
   b. Current
   c. Aircraft properly equipped

2. CAT II & CAT III require special certification and have lower minimums *centerline taxi lights - progressive lights*

C. Localizer *Accurct course*

1. Represents a single mag course to the runway
2. Regardless of what is set on OBS, CDI senses off course position

D. Glide Slope

1. Useable out to about 10 NM
2. Usually 3 degrees wide *Loc 10° wide*
3. Full scale deflection is .7 degree up or down *Less then 1° ↑↓*

E. Marker beacons provide range information

Usually 2 beacons OM & MM *Provides range info*
Don't mistake MAP or IAF
Common student error

1. OM usually 4-7 NM
2. MM 3500' from runway, 200' AGL

F. Inoperative components

1. Lowest landing minima are authorized only when all components and usual aids are operations
2. FAR 91.175 shows equipment substitutions
3. When any basic ILS ground component (except MM or localizer) or required visual aid is inop – the standard straight-in landing minimums directly on the approach

chart (for NOS users see table in the Terminal Procedures Pub).

G. Flying the ILS when flying

1. While tracking the localizer your CDI senses horizontal movement of the aircraft from the course.

2. Simultaneously, a precise descent path to the runway is provided through glide slope information.

3. Prior to intercepting G/S 1900 RPM 90 Knots
   a. Stabilize A/S Touchdown speed @ 65
   b. Stabilize Alt Bleed A/S between MAP & Touchdown
   c. Establish Mag heading

4. At G/S interception
   A. Reduce power to correct A/S
   B. Lower gear and flaps
   C. Establish descent (ground speed)

5. To descend below DH 91.175

6. Staying ahead Don't get behind A/C
common mistake Not identifying station
   1. Call approach
   2. Preset for tower
   3. Localizer tuned and identified, OBS set
   4. NAV 2 set for missed approach

7. Descent begins @ GS intercept

TECHNIQUES

1. Assuming your intercept heading is good hold the heading until the CDI comes alive.

2. As soon as the needle come alive, begin turning towards the final course.

3. When the CDI stops moving stop turning.

4. This is your reference heading. (for wind)

5. Turn 5 degrees toward the needle. When needle centers pick up reference heading.

INCLUDE LIGHTING SYSTEM IN SYSTEM

Including = DME

1) ALS
   2) THRESHOLD
   3) THRESHOLD MARKINGS OR LIGHTS
   4) REIL
   5) VASI
   6) TDZE, MARKINGS OR LIGHTS
   7) RUNWAY, RUNWAY MARKINGS OR LIGHTS

Need to see these before continuing below DH - MDA
FAR 91.175 what equipment we can substitue

6. begin descent at glide slope interception.

7. With a 3 degree glide slope the rate is approximately 500 feet per minute at 90 knots.

8. Headwind will require a decreased descent rate.

9. Make glide path corrections with small pitch changes.

10. If you are very high or low, you need to make power changes with the pitch changes to keep from affecting A/S.

11. Good rule of thumb is 100 RPM for a half scale deflection.

12. Call out 500' and 100' prior to DH.

13. If you gain a visual and then lose it go missed approach immediately.

LESSON: PITOT-STATIC SYSTEM AND INSTRUMENTS

OBJECTIVE: To develop the student's knowledge of the pitot-static system and instruments.

PRE-READ: IFH pg.25-34; Aircraft Systems For Pilots pg. 382-392

SCHEDULE:

Preflight Discussion	2:00
Instructor Demonstration	N/A
Student Practice	N/A
Postflight Critique	N/A

EQUIPMENT: Whiteboard for preflight discussion

INSTRUCTOR'S ACTIONS:

-PREFLIGHT

-Discuss lesson objective

-Ask student questions on reading assignment and during discussion

-Discuss pitot-static system and instruments

-INFLIGHT

-Nothing required

-POSTFLIGHT

-Nothing required

STUDENT'S ACTIONS:

-PREFLIGHT

-Discuss lesson objective

-Resolve questions on reading assignment

-Answer instructor's questions

-INFLIGHT

-Nothing required

-POSTFLIGHT

-Nothing required

ELEMENTS:

-Pitot-static system operation

-In order for the pitot-static instruments to function properly, they must be connected into a system that senses dynamic air pressure (impact air) and ambient air pressure.

-Dynamic air pressure: Pressure caused by moving air. This air is taken into the aircraft via the *pitot tube*. This is mounted parallel to the longitudinal axis of the aircraft usually in line with the relative wind, in an area relatively undisturbed by the airframe. Areas such as the leading edge of the nose, wing, or vertical stabilizer are the usual mounting positions.

-**Ambient air pressure:** Pressure of non-moving air just outside the aircraft. This pressure is taken from the *static port*. This is basically a vent located on the outer surface of the aircraft where it does not receive impact air and a vacuum is not created. Planes may also have two flush-mounted vents on either side of the aircraft to prevent errors induced by changes in aircraft attitude.

-Pitot System

-The various types of airspeed indicators or Machmeters are connected into the pitot system.

-The plumbing that connects the pitot tube to the airspeed indicator is run as directly as possible, and there is usually a T-fitting or some form of sump at a low point in the line that will collect any moisture that should get into the line.

-If ice formed inside the pitot head or in the pitot line, the airspeed indication would no longer be accurate because the pressure inside the system would be trapped (drain hole clogged also). As the aircraft descends, the static pressure would increase showing a decreasing airspeed.

-To prevent the pitot tube from freezing, pitot heat is used to prevent this. It should not, however, be used unless sufficient airflow is over the pitot-tube to prevent burning out the tube.

-Static System

-Some aircraft have a combination pitot-static head, in which the pitot pressure is taken from the open end of the tube, and the static pressure comes from holes or slots around the head, back from the open end.

-Other have flush static ports located on the side of the fuselage.

-The static line from the static port(s) is connected to the back of the airspeed indicator, altimeter, and the vertical speed indicator.

-Since a blockage or loss of static pressure will result in an erroneous indication on all of the pitot-static instruments, it is vital that this system never become plugged.

-Many aircraft have an alternate static source located under the dash, in front of the pilot.

-With others, however, breaking the VSI is another, and the last resort, to acquiring alternate static pressure. If this is done, all instruments will have a slight error since the pressure in the cabin is slightly lower than outside. Therefore the altimeter and the airspeed indicator will read slightly higher.

-Altimeter - has its own test signoff

-Operation

-The pressure altimeter works on the principle of differential pressure.

-The difference between the pressure inside metal aneroid wafers in the instrument and the static pressure of the outside air make the wafers expand or contract, and through mechanical gearing, convert the movement to an indication on the front of the altimeter.

-**Calibrated Airspeed (CAS):** Indicated airspeed corrected for position (installation) and instrument errors. Calibrated airspeed is equal to true airspeed in standard atmosphere at sea level.

-**Equivalent Airspeed (EAS):** Calibrated airspeed of an aircraft, corrected for adiabatic compressible flow for the particular altitude. Equivalent airspeed is equal to calibrated airspeed in standard atmosphere at sea level.

-**True Airspeed (TAS):** The airspeed of an aircraft relative to undisturbed air. It is equivalent (calibrated for our purposes) airspeed corrected for temperature and non-standard pressure. True airspeed increases with altitude when indicated airspeed remains the same.

-**Mach Number:** The ratio of true airspeed to the speed of sound for a given density altitude.

-Airspeed Indicator Errors

-**Airspeed Errors:** The airspeed indicator is designed to provide speed information under specific limited conditions. Whenever the conditions alter, errors are introduced.

-**Position Errors:** Because the positioning of the static port and pitot tube cannot be perfect for every airspeed and attitude, error is induced. For the static port, it may not always sense the atmospheric pressure. The pitot tube may not always be directly parallel to the relative wind at certain airspeeds/attitudes.

-**Density Error:** This error is introduced by changes in altitude and temperature for which the instrument does not automatically compensate.

-**Compressibility Error:** This is caused by the packing of air into the pitot tube at high airspeed, resulting in higher than normal readings. Below approximately 200 kt. and at low altitudes the error is negligible.

-Vertical Speed Indicator

-Operation

-This instrument is contained within a sealed case, connected to the static pressure line through a calibrated leak.

-Changing pressures expand or contract a diaphragm, connected to the indicating needle through gears and levers.

-The instrument automatically compensates for changes in temperature.

-The instrument operates off differential pressure which is established between the instantaneous static pressure in the diaphragm and the trapped static pressure within the case.

-When the pressures are equalized in level flight, the needle reads zero.

-When a change in static pressure changes in a climb or descent, the needle immediately show a change of vertical direction.

-However, until the differential pressure stabilizes at a definite ratio, reliable rate indications cannot be read.

-For each pressure level, the aneroid assumes a definite size and causes the hands to indicate height above whatever pressure level is set into the altimeter setting window (Kollsman window).

-The altimeter setting dial provides a means of adjusting the altimeter for nonstandard pressure. This allows you to set in the sea level pressure for the air mass you are flying in, and therefore fly in reference to sea level pressure for that air mass.

-The Kollsman window should be set to the nearest altimeter setting within 100 miles of your location. This is obtained by ATC or FSS. Above 18,000 ft. the window is set to 29.92 since this will still always guarantee terrain clearance and all aircraft are operating on a standard setting since they are traveling at such high speeds.

-Types of Altitude Measurement

-Indicated Altitude: The altitude read directly from the altimeter with the proper altimeter setting in the Kollsman window.

-True Altitude: The actual altitude the aircraft is above sea level.(MSL)

-Absolute Altitude: The height of the aircraft above the ground.(AGL)

-Pressure Altitude: The height of an aircraft above the standard datum plane of 29.92" Hg. This will be read in the altimeter with the Kollsman window set to 29.92.

-Density Altitude: The altitude in standard air that corresponds to the existing air density. It is found by taking pressure altitude and correcting for non-standard ~~pressure~~ and temperature. This may be done by using a chart or your E6-B flight computer.

-Altimeter Errors

-Mechanical

-Elastic

-Temperature

-installation errors

-No more than 75 ft. between known elevation and indicated altitude.

-Airspeed Indicator

-Operation ~~has its own [illegible]~~

-Constructed to measure the difference between ram pressure from the pitot head and atmospheric pressure from the static source..

-The instrument is contained within a sealed case in which is mounted a diaphragm, while the inside of the case is vented to the static source.

-A the aircraft accelerates or decelerates, expansion or contraction of one side of the diaphragm moves the indicator needle by means of gears and levers.

-Types of Airspeeds

-Indicated Airspeed (IAS): The airspeed value read on the face of a standard airspeed indicator.

- Because of the restriction in air flow through the calibrated leak, a 6 to 9 second lag is required to equalize or stabilize the pressures.

-Limitations

- Because of the calibrated leak, the instrument has limitations.
- Sudden or abrupt changes in aircraft attitude cause erroneous readings as the air fluctuates over the static ports.
- Both rough control technique and turbulent air result in unreliable needle indications.
- When used properly, the instrument provides reliable information to establish and maintain level flight and rate climbs or descents.

-Adjustment

- The VSI needle should read "0" when on the ground or in level flight.
- Most VSIs can be adjusted by turning a small screw on the lower left corner of the instrument.
- If adjusting is not possible, you must allow for the error when interpreting the indications in flight.

<u>COMPLETION STANDARDS</u>: The student should exhibit adequate knowledge of the pitot-static system and instruments and their operating characteristics.

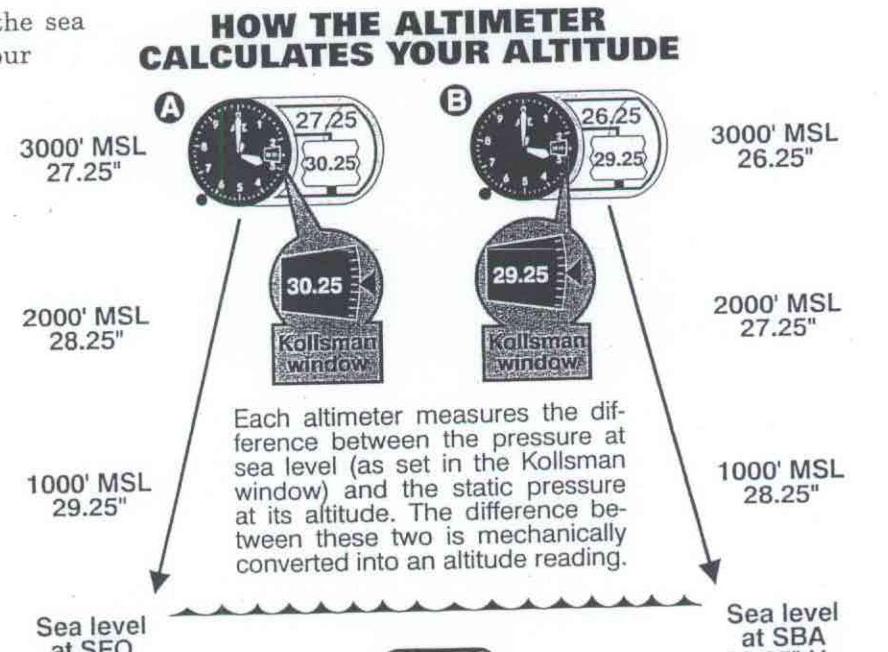


Fig. 23

The point is that we should always set the sea level pressure in the Kollsman window so our altimeter can read true altitude. "OK," you wonder, "how do we get the sea level pressure to set in the Kollsman window in the first place?" This sea level pressure is called the *altimeter setting*. It's easily obtained from several sources including: air traffic control towers, flight service stations and automatic weather observation stations. A bit later in this chapter I'll tell you about one more way you can get the right altimeter setting, even when nobody's home at the tower.

What happens if you don't continue to update the altimeter setting during every 100 miles or so of flight? There's a good chance your altimeter will not be providing the correct information—you're not going to be at the altitude you think you're at. This can be a problem.

Think of the problem as being similar to driving across the country while listening to your car radio. If you're listening to a lecture about Jung and yang on that philosophical radio station KYMI, after a short distance you'll need to re-tune to another station carrying the same program. You'll be out of range of the first station. If you fly more than 100 miles from the source of your last altimeter setting, you're technically out of range from this source. An error in the altimeter's reading is possible unless you reset the Kollsman window to a closer source.

Figure 24 depicts this process. Notice that at 1,000 feet MSL above SFO the pressure is 29.25" Hg (position A). This is the same as the sea level pressure at SBA (position B). Do you see how the 29.25" pressure level gradually sloped from 1,000 feet MSL down to the surface, between SFO and SBA? It can be said that pressure levels drop when flying towards an area of lower pressure.

At 3,000 feet above SFO the static pressure is 27.25" Hg (position C). Approaching SBA, the 27.25" pressure level slopes downward to 2,000 feet above the surface (position D). With the SFO sea level pressure of 30.25" Hg set in the Kollsman window, the altimeter indicates 3,000 feet as long as you stay at the level where the outside pressure is 27.25" Hg as shown by position C. Can you see what's happening? The level where the pressure is 27.25" Hg actually slopes downward closer to the surface yet the altimeter is still reading 3,000 feet position D. If we don't continue to update the altimeter setting, the *indicated altitude* (what's shown on the altimeter's face) becomes different from our true altitude (our actual height above sea level).

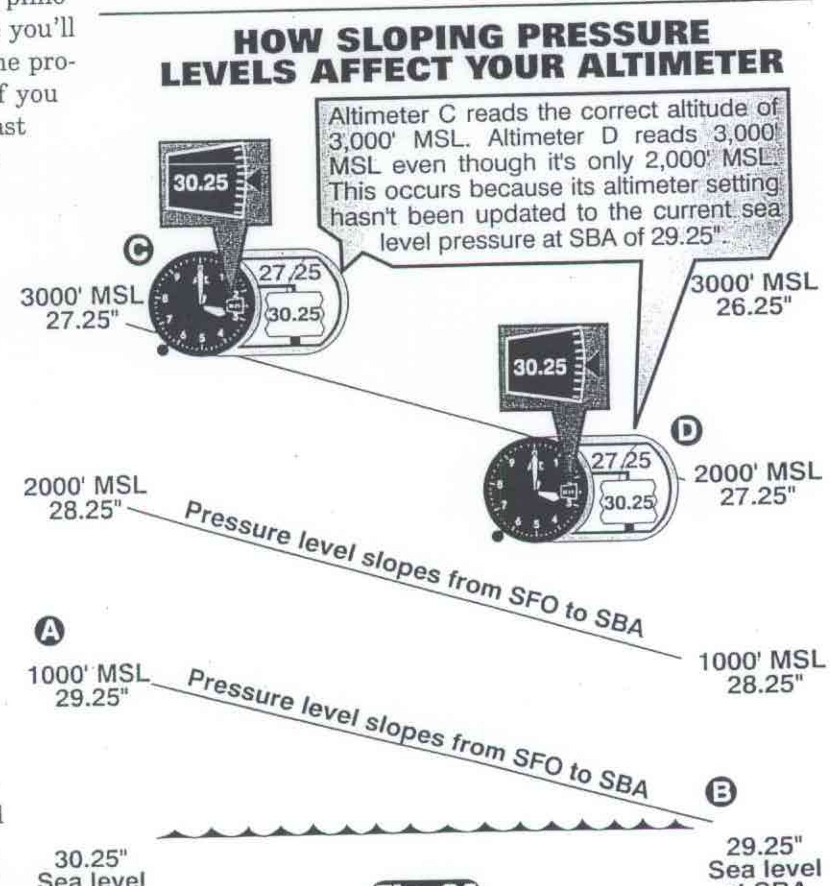


Fig. 24

Temperature Variations and the Altimeter

Just when you think you've got all the exceptions down pat, another gem in need of consideration pops up. You just can't seem to win. It's like going to the one hour photo shop, only to find they have 30 minute parking. Don't fret. The altimeter's *temperature errors* are easy to understand.

Normal changes in temperature produce relatively small and negligible errors in altimeter readings. If, however, you're taking the family's Boeing 747 out for a little cross country flight, you could travel to exotic places having extreme temperatures (in particular, extreme cold). Under these conditions, it's possible to have altimeter errors of 500 feet or more. Practically speaking, most pilots never correct their altimeters for temperature variations. Nevertheless, it's important to know when these errors can affect you and how to correct for them.

Most of the time, pilots fly with plenty of terrain clearance and are not affected by small, temperature-induced altimeter errors. On the other hand, if you're planning a night flight over mountains and don't plan on crossing them by at least 2,000 feet or more, you should check and see if temperature errors will significantly affect your altimeter's reading. (You should also have a CAT scan to check for reduced blood flow to the judgment section of your cortex if you're crossing mountains at less than 2,000 feet above ground level at night.)

HOW TEMPERATURE AFFECTS THE ALTIMETER

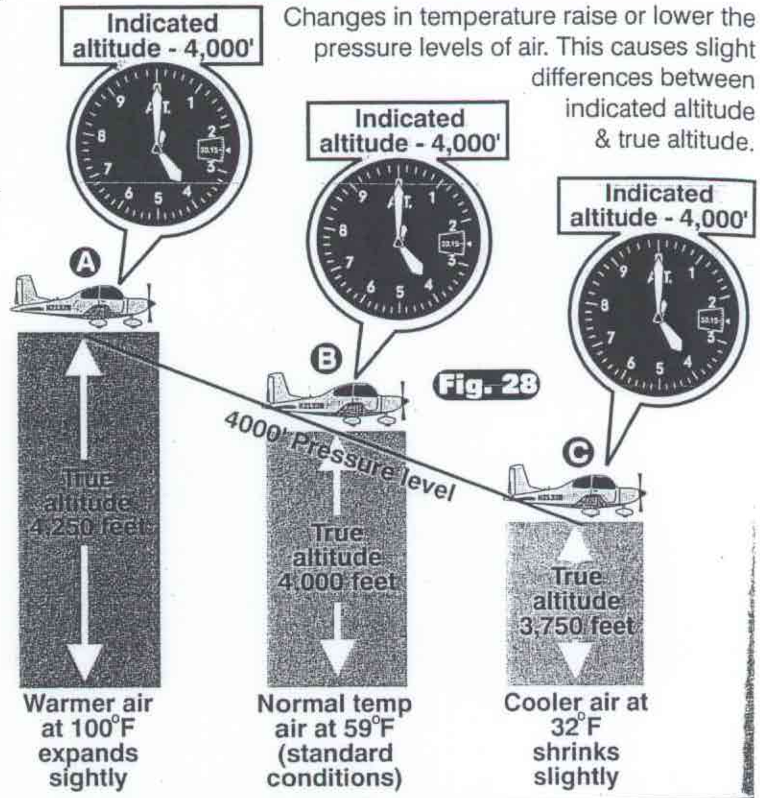


Figure 28 depicts the effect of temperature on columns of air. When air is at standard or normal temperature (59° F/15° C at sea level), the altimeter experiences no temperature error. Airplane B, sitting on top of a column of normal temperature air, has an indicated altitude (4,000 feet) which is equal to its true altitude (4,000 feet).

When temperatures are warmer, however, air expands. Airplane A rests atop an expanded layer of air. The air beneath Airplane A weighs the same as the air beneath Airplane B. The difference is that the warmer, expanded column of air is taller. This is similar to two guys both weighing 370 pounds, with one standing 6 feet tall and the other standing 4 feet tall. They both produce the same indication on a scale but their weight is distributed differently in the vertical direction. In a similar manner, a mass of air having temperatures that are different from standard distributed its weight differently in the vertical direction.

Because the pressure levels are taller or expanded in warmer air, Airplane A's indicated altitude is 4,000 feet and its true altitude is 4,250 feet. Colder air produces shorter or more closely spaced pressure levels. Airplane C's indicated altitude is 4,000 feet and its true altitude 3,750 feet.

Think about it in the following way. Without correc ing the altimeter for temperature variations, if the te perature is going down, then the airplane is going dow if the temperature is going up, then the airplane is go up.

On a flight from a warmer area to a colder area, w out correcting for temperature, the indicated altitud greater than the true altitude. In other words, the alti ter will indicate 4,000 feet but the true altitude wil 3,750 feet. *The temperature went down, so the airp went down.* It went down 250 feet and you still th you're at 4,000 feet above sea level.

On a flight from a colder area to a warmer area, out correcting for temperature, the indicated altitu lower than the true altitude. Imagine the airpla Figure 28 flying from right to left. In the warme the indicated altitude is 4,000 feet but the true alti 4,250 feet. Therefore, *if the temperature is going airplane is going up*. It went up 250 feet and yo think you're at 4,000 feet above sea level.

YOU KNOW YOU'VE BEEN FLYING TOO MUCH WHEN...

1. You use the emergency brake to drop the flaps.
2. You yell "clear" before starting your car.
3. You get out of your car and look for tiedown ropes.
4. You brake on left turns and speed up on right turns.
5. You tell the police officer that you're allowed to go 250 below 10,000 feet MSL.
6. You drive into a fog bank and immediately go on instruments.
7. You are entering the highway and hit *rotate speed* for the Cessna 150. You pull back on the wheel and don't become airborne. In a panic, you abort the takeoff and hit the brakes. (This drives the guy behind you crazy.)

MEASURING THE

THE AIRSPEED INDICATOR

AMY LABODA

About 10 years ago, in the scorching Texas sunshine, I made my first flight in an ultralight from a 20-foot-wide mowed strip in the middle of a half-grown field of alfalfa. The aircraft looked like a cross between an overgrown child's toy and the *Wright Flyer* — and it had one seat. My first flight would be solo.

Sitting in that single seat, I noticed a distinct lack of cockpit instrumentation. The two gauges before me, a tachometer and a cylinder head/exhaust gas temperature, wouldn't provide any information on the topic my instructor was discussing — airspeed.

After committing the pertinent airspeeds — stall, climb, cruise, never-exceed, and approach — to memory, I finally asked, "How do you measure airspeed in this thing, anyway?" My instructor pointed to a wind vane-like object on the wing.

Looking closer at the tube that hung in the breeze, I guessed it was calibrated to measure the speed of the air hitting the vane. Remarkably simple, but it worked. "Oh, yes," my instructor added, "if you don't feel the wind on your face, you are probably going too slow."

That primitive airspeed indicator (ASI) has haunted my curious nature ever since that flight. I wondered if it was similar to the first airspeed indicator on a powered airplane. A trip to the U.S. Air Force Museum at Dayton, Ohio, and a conversation with Sam Fishbein of the National Air & Space Museum's Paul Garber Restoration Facility at Silver Spring, Md., confirmed my educated guess.

In aviation, speed is everything. It is the reason people go places in airplanes instead of using other forms of transportation. Speed is also essential to the safety of every flight. Airplanes won't fly if they are not moving at the appropriate speed. From the beginning, Orville and Wilbur knew they needed to quantify the breeze they felt kissing their cheeks to ensure it was enough to keep them safely airborne. The 1903 *Wright Flyer* was equipped with an anemometer and a stopwatch to measure airspeed — and it worked.

Aeronautical publications credit both a Frenchman, Eteve, and an Englishman or American (hard to tell which) named Ellsworth, with developing airspeed indicators relying on weights and even electricity as early as 1911. While wind-vane airspeed indicators persisted on light airplanes, documents from as early as 1917 show that manufacturers had a preference for panel-mounted dials rigged to a pitot tube.

For those who had a basic interest in speed, a piece of string mounted in the airstream served their needs. This string still serves a useful purpose today as a glider's yaw indicator. Typically taped to the centerline of the canopy, it tells glider pilots if they are engaged in coordinated flight. The panel-mounted airspeed indicator connected to a pitot tube, however, grew to become manufacturers' standard answer to the requirements of FAR Part 91.205, *Instrument and Equipment Requirements.*

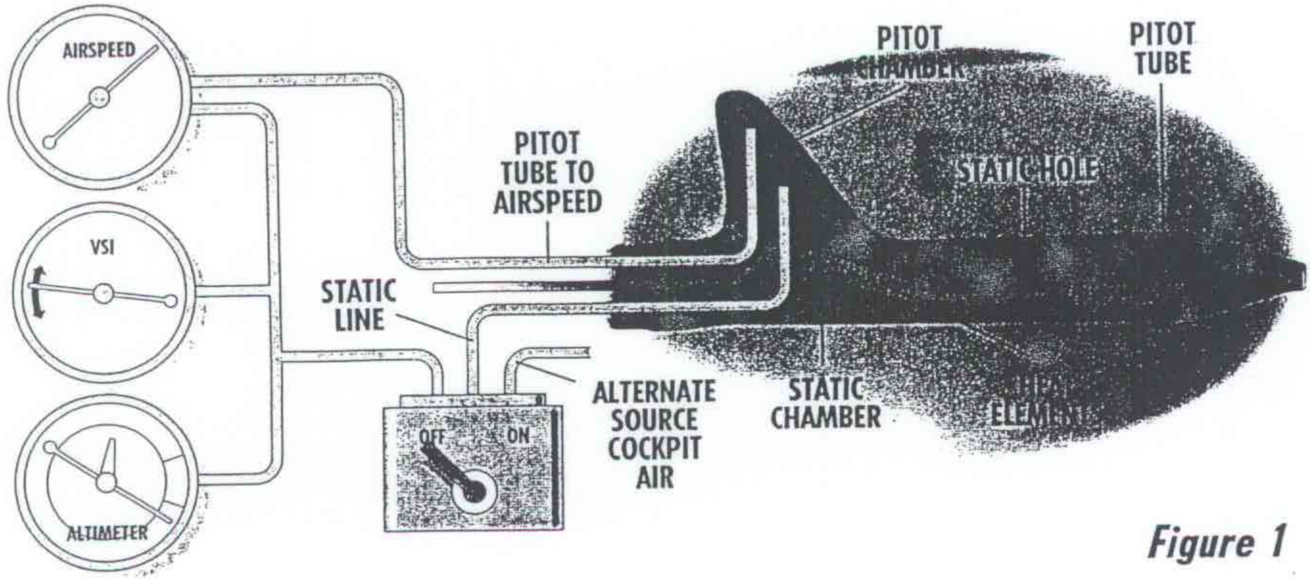
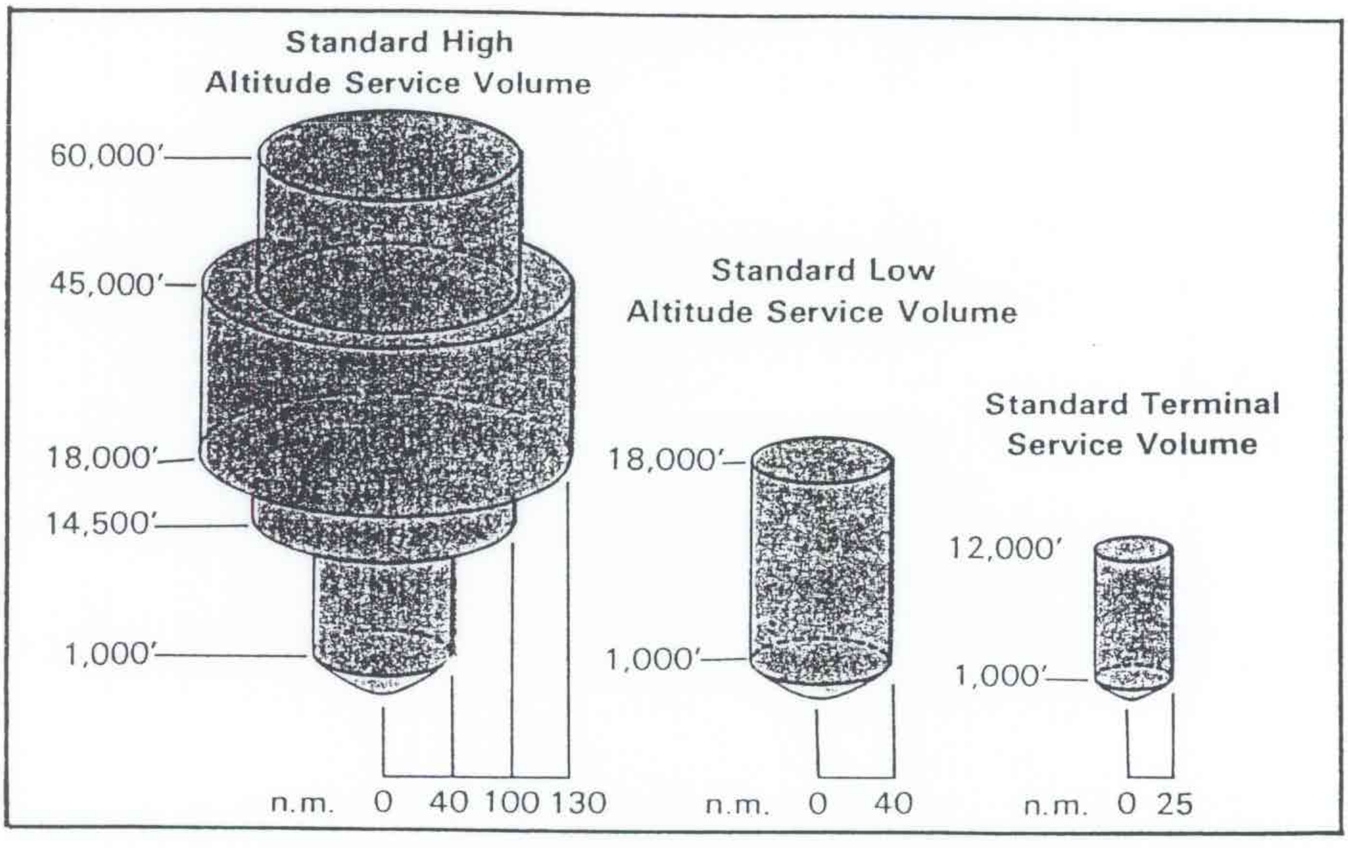


Figure 1


Standard High
Altitude Service Volume
60,000'
45,000'
18,000'
14,500'
1,000'
n.m. 0 40 100 130
Standard Low
Altitude Service Volume
18,000'
1,000'
n.m. 0 40
Standard Terminal
Service Volume
12,000'
1,000'
n.m. 0 25

SSV CLASS DESIGNATOR	ALTITUDE AND RANGE BOUNDARIES
T (Terminal)	From 1000 feet above ground level (AGL) up to and including 12,000 feet AGL at radial distances out to 25 NM.
L (Low Altitude)	From 1000 feet AGL up to and including 18,000 feet AGL at radial distances out to 40 NM.
H (High Altitude)	From 1000 feet AGL up to and including 14,500 feet AGL at radial distances out to 40 NM. From 14,500 up to and including FL 600 at radial distances out to 100 NM. From 18,000 feet AGL up to and including 45,000 feet AGL at radial distances out to 130 NM.

MAXIMUM ERROR	TYPE OF CHECK
Ground: ± 4°	1. VOT or Approved Radio Repair Station Test Signal
	2. Designated VOR System Checkpoint on Airport Surface
Flight: ±6°	3. Designated Airborne VOR Checkpoint
	4. Made-up Check
Ground and Flight 4° Differential	5. Dual VORs, Both Tuned to the Same VOR

PARTIAL PANEL FLYING

OBJECTIVE: *To determine the applicant:*

1. Exhibits adequate knowledge of the elements relating to recognizing f attitude indicator and/or heading indicator is inaccurate or inoperative, and advises ATC or the examiner.
2. Advises ATC or examiner anytime the aircraft is unable to comply with a clearance.
3. Completes instrument approach if applicable.

ELEMENTS: Magnetic compass turns, timed turns, partial panel instrument approaches, vacuum system, directional gyro, attitude indicator.

SCHEDULE:

Preflight discussion	:15
Demonstration	:10
Student practice	:30
Postflight brief	:10

MATERIALS: Dry erase board.

INSTRUCTOR'S ACTIONS: *Preflight discussion*—Discuss the elements of partial panel flying.
Demonstration—Demonstrate partial panel flying, and a partial panel approach.
Postflight brief—Critique and answer questions.

STUDENT'S ACTIONS: Pre-read assignment on partial panel flying;
Demonstrate partial panel flying;
Postflight discussion.

COMPLETION STANDARDS: The student should demonstrate the proper procedures and elements of partial panel flying, including an approach, using the standards outlined in the lesson objective.

See previous

VOR ORIENTATION TRACKING AND INTERCEPTION

OBJECTIVE: *To determine the applicant:*

1. Exhibits knowledge by explaining VOR navigation, equipment, procedures, and limitations.
2. Selects and identifies the desired facility.
3. Locates position relative to the station.
4. Intercepts and tracks a given radial.
5. Locates position using cross radials.
6. Recognizes or describes the indication of station passage.
7. Recognizes signal loss and takes appropriate action.
8. Maintains the appropriate altitude, + or - 200 ft. (Private) and 100 ft. (commercial).

ELEMENTS: Operational principles, procedures for tracking, intercepting, and homing on radials to and from the station.

SCHEDULE:

Preflight discussion	:15
Demonstration	:10
Student practice	:30
Postflight brief	:10

MATERIALS: Dry erase board and model airplane.

INSTRUCTOR'S ACTIONS: *Preflight discussion*—Discuss tracking, homing, and intercepting radials. Also provide the background behind and how they operate.
Demonstration—Demonstrate homing, tracking and intercepting.
Postflight brief—Critique and answer questions.

STUDENT'S ACTIONS: Pre-read assignment on VORs;
Demonstrate usage of VORs;
Postflight discussion.

COMPLETION STANDARDS: The student should safely demonstrate the objectives outlined for this lesson. Altitude should be kept within 200ft. for Private Test Standards, and 100ft. for Commercial Standards.

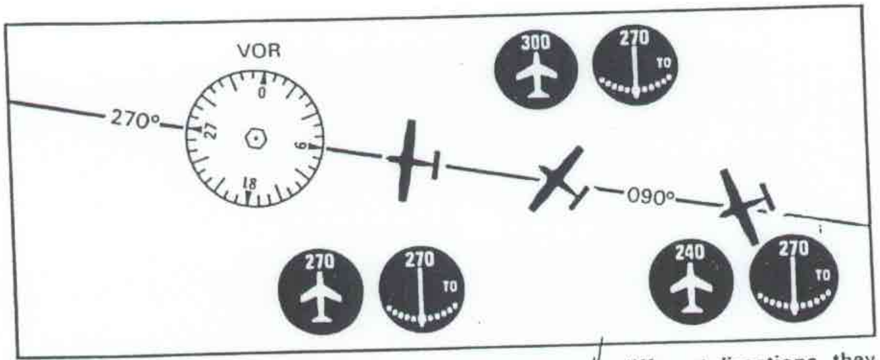


Figure 7-8. Even though the aircraft are heading in three different directions, they are all located on the 090° radial (inbound course of 270°) and have the same VOR indications. However, only the airplane nearest the station will remain on the 090° radial, provided wind is not a factor. The headings of the other two airplanes will carry them away from the course selected.

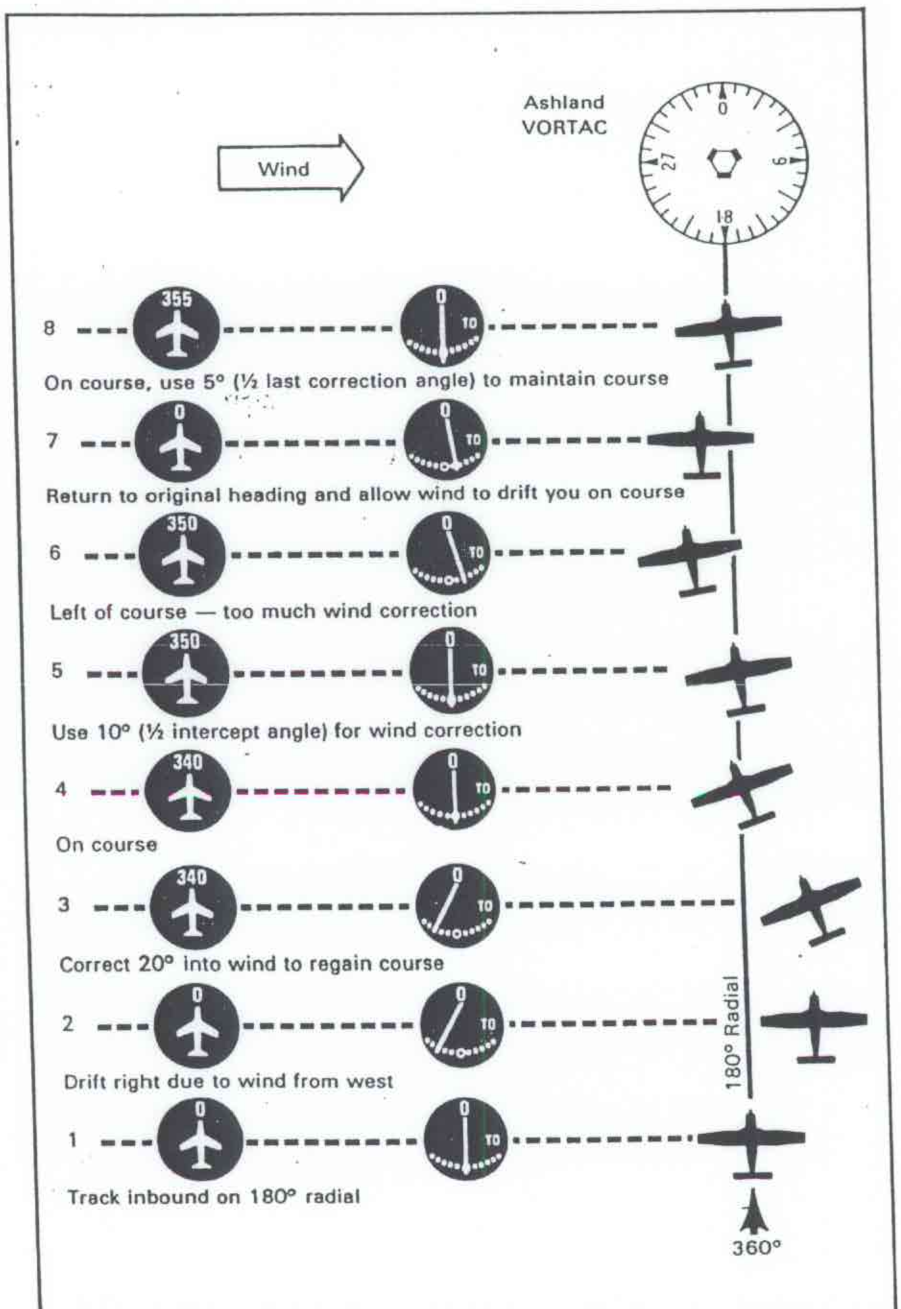


Figure 7-10. While tracking inbound to the Ashland VORTAC on the 180° radial, assume you begin to drift right of course due to a crosswind. This example shows the bracketing procedure required to regain the course and determine a heading that will compensate for wind.

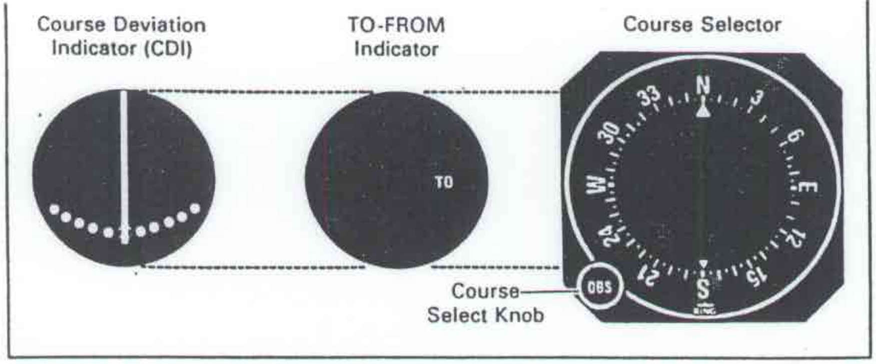


Figure 7-4. The CDI needle shows you whether you are on or off course. When it is centered, you are on course. If it swings to either side, you are off course. The TO FROM indicator tells you whether your selected course will take you to or from the station. The course selector, also called the omnibearing selector (OBS), allows you to choose a particular radial by setting it under the course index.

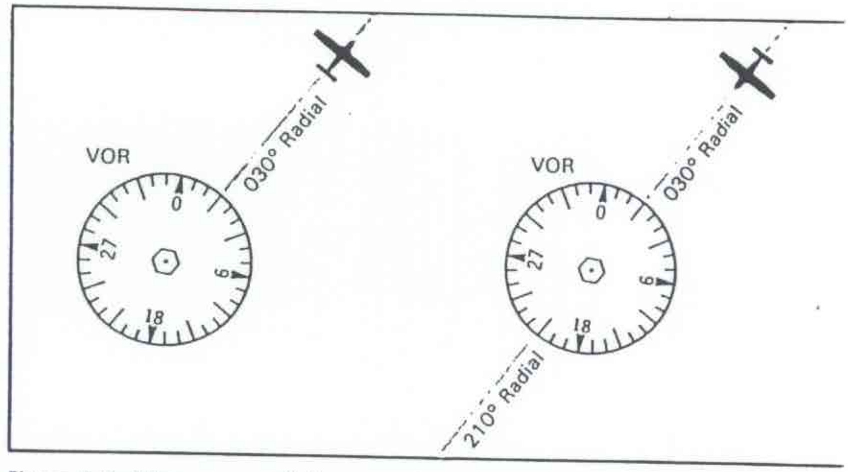


Figure 7-5. When you are flying away from a VOR station on the 030° radial (in no-wind condition), your heading indicator will read 030°. On the other hand, if y
fly inbound to the station on the 030° radial, your heading will be 210°.

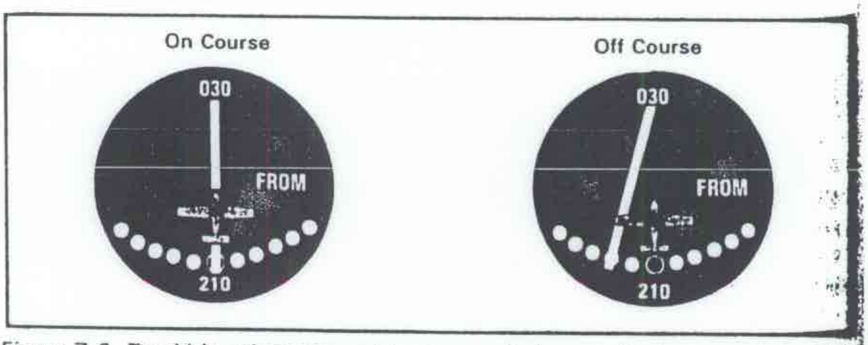


Figure 7-6. To aid in orientation, picture your airplane at the bottom of the VOR indicator. If the CDI overlaps the airplane, as it does on the left, you are on the selected course. If your airplane and the CDI are not aligned, you are off course, as shown on the right side of the illustration.

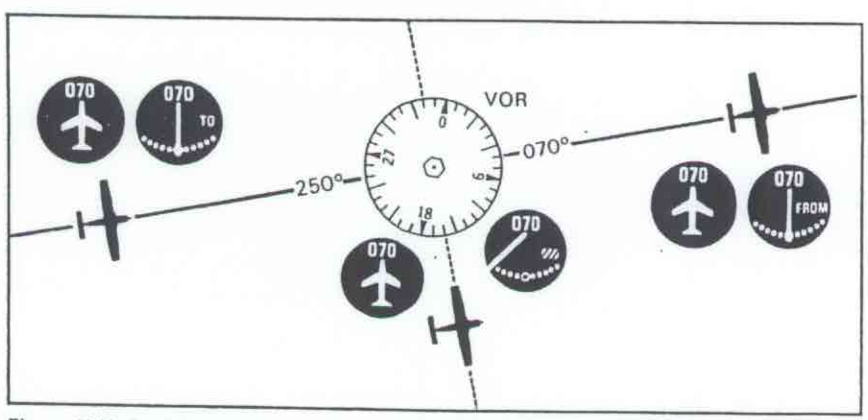


Figure 7-7. Besides signaling your position over the station, the OFF or NAV indication appears briefly when you are abeam, or 90° to either side of, your desired course. The FROM indication appears as you continue past the abeam position, even if you don't pass directly over the station.

LESSON: VOR FACILITIES AND ACCURACY CHECKS

OBJECTIVE: To teach the student the basics of VOR system operation and VOR accuracy checks.

PRE-READ: IFH pg. 111-119; FAR 91.171

EQUIPMENT: Whiteboard

SCHEDULE:

Preflight Discussion	:45
Instructor Demonstration	:05
Student Practice	:05
Postflight Critique	:05

INSTRUCTOR'S ACTIONS:

-PREFLIGHT

-Discuss lesson objective

-Ask questions over reading assignment

-INFLIGHT

-Demonstrate elements of lesson

-POSTFLIGHT

-Critique student performance

-Assign reading assignment for next lesson

STUDENT'S ACTIONS:

-PREFLIGHT

-Discuss lesson objective

-Answer instructor's questions

-Ask any questions over reading assignment

-INFLIGHT

-Review previous maneuvers

-Practice elements relating to lesson

-POSTFLIGHT

-Resolve any questions

ELEMENTS:

-VOR

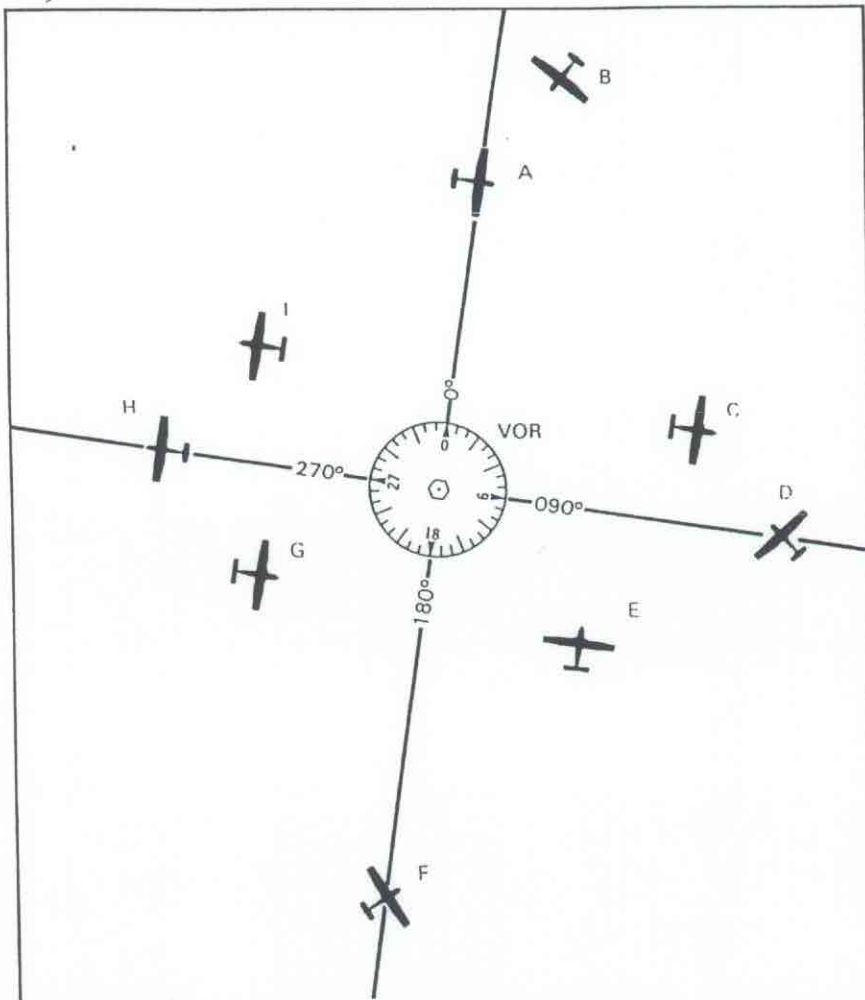
-The very high frequency omnirange (VOR), is the primary navigation facility for civil aviation in the National Airspace System.

-Wave Transmission

-A pulse of energy traveling through a medium by means of vibrations from particle to particle.

-Amplitude

-Distance of wave from highest or lowest point to midpoint. (BH, ID, FJ)



Airplane	A	B	C	D	E	F	G	H	I
Heading	090°	210°	090°	310°	0°	045°	090°	270°	270°
Course Selector	0°	180°	270°	270°	130°	180°	180°	270°	270°
CDI									
TO-FROM	FR	TO	TO	TO	FR	FR	FR	FR	FR

Figure 7-14. You can see that there are many possible combinations of aircraft position, heading, and VOR indications. For example, airplane A is directly north of the station on the zero degree radial with a magnetic heading of 090°. With zero degrees set in the VOR indicator, the CDI will be centered with a FROM indication. Study the other airplane positions, headings, and CDI indications so you are sure you understand VOR navigation.

-Cycle

-Interval between any two points measuring the completion of a single wave movement (A to E, B to F, C to G)

-Wavelength The linear distance of a cycle, measured in units appropriate to the size of the wave (A to E).

-Frequency

-The number of cycles completed in one unit of time. Expressed in cycles per second or Hertz (Hz).

-VOR Frequency Range

-108.0MHz to 117.95 MHZ. Operates in the line of sight very high frequency range (VHF).

-Basic Navigation Equipment

-Includes a identification keyer, modulator, transmitter and navigational signal source and a tuner, audio amplifier, navigational instrument.

-VOR Principle of Operation

-VOR operation is based upon the principle that the phase difference between two radio signals can be used to determine azimuth location. A reference signal sends out signal in all directions while a variable signal rotates around at 1,800 rpm. The receiver in the aircraft measures the difference in timing or phase of the two signals to determine location from the station. There are 360 different "radials" that emanate from the station.

-VOR Identification

-A voice transmission is also radiated by the VOR station on the same frequency to identify the station. Three letter code every 15 seconds and/or voice every 15 seconds.

-VOR Class Designation

-See chart legend and AFD.

-HIGH CLASS (H-VOR)

1,000'-14,500' = 40NM
14,500'-18,000' = 100NM
18,000'- 45,000' = 130NM
45,000'- 60,000' = 100NM

-LOW CLASS (L-VOR)

1,000'-18,000' = 40NM

-TERMINAL CLASS (T-VOR)

1,000'-12,000' = 25NM

-VOR RECEIVER

Contains a frequency selector, course selector, course deviation indicator (needle), TO/FROM indicator (ambiguity indicator), and off flags.

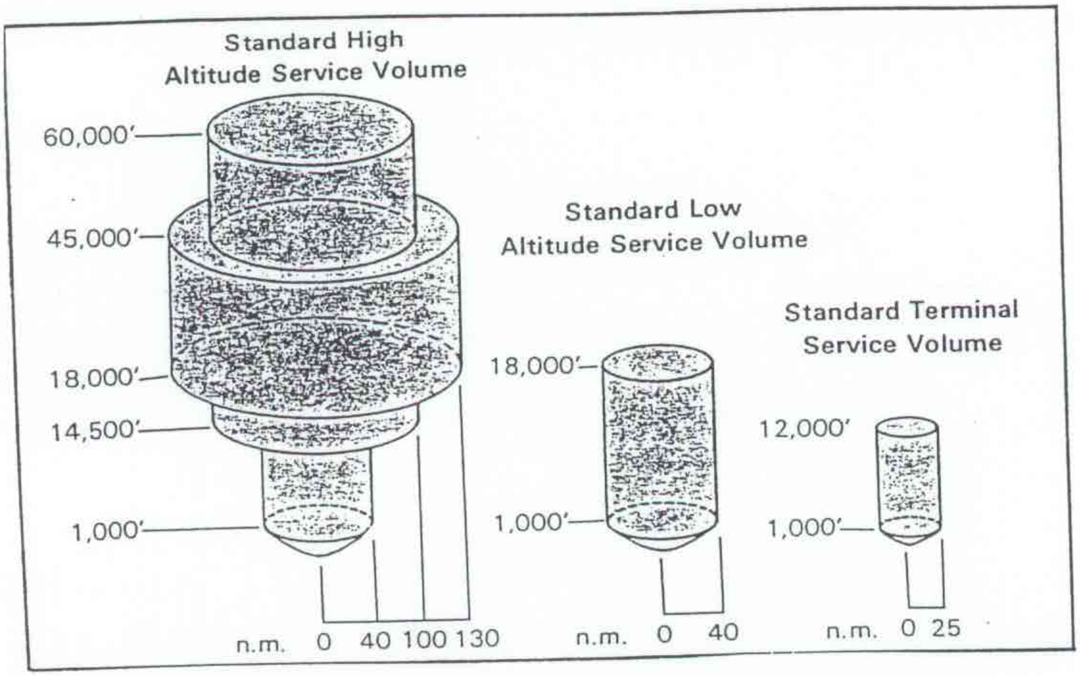
-VOR CHECKS

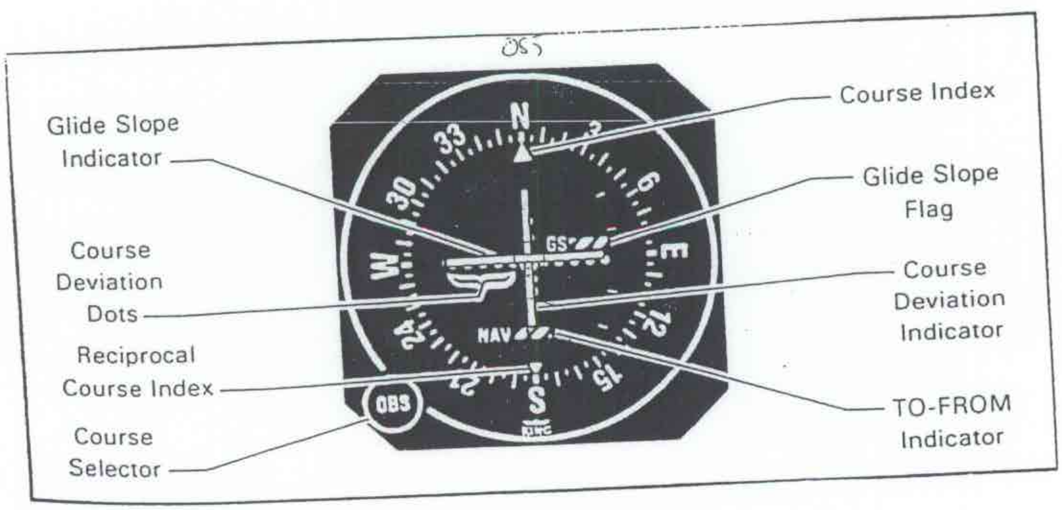
1. VOT CHECK-Max error ±4°. Select VOT frequency and center the CDI with a TO indication and should read 180°. Continuous tone or dots
2. DESIGNATED GROUND CHECKPOINT-Max error ±4°. Find in AFD, park aircraft in designated location on surface, center the CDI.

3. DESIGNATED AIRBORNE CHECKPOINT-Max error ±6°. Find in AFD, fly over location, center the CDI.
4. MADE-UP AIRBORNE CHECKPOINT-Max error ±6°. Find landmark on sectional, fly over and center CDI. Beyond 20 nm from VOR
5. DUAL VOR CHECK-Max differential 4°. Tune both VOR's and center CDI's.
6. RADIO SHOP CHECK-Must be signed by radio shop rep. (±4°)

Date, Place, Error, Signature

COMPLETION STANDARDS: The student should exhibit adequate knowledge of the elements related to VOR facilities and accuracy checks.


Standard High
Altitude Service Volume
60,000'
45,000'
18,000'
14,500'
1,000'
n.m. 0 40 100 130
Standard Low
Altitude Service Volume
18,000'
1,000'
n.m. 0 40
Standard Terminal
Service Volume
12,000'
1,000'
n.m. 0 25


OBS
Glide Slope
Indicator
Course
Deviation
Dots
Reciprocal
Course Index
Course
Selector
Course Index
Glide Slope
Flag
Course
Deviation
Indicator
TO-FROM
Indicator
GS
NAV
N
E
S
W
33
30
24
21
15
12
6
3
OBS

STEEP TURNS

OBJECTIVE: *To determine the applicant:*

1. Exhibits adequate knowledge of the factors relating to attitude instrument flying during steep turns.
2. Enters a turn using a bank of approximately 45° for an airplane and 30° for a helicopter.
3. Maintains the specified angle of bank for either 180° or 360° of turn, both left and right.
4. Maintains altitude within 100 feet, airspeed within 10 knots, 5° of specified bank angle, and rolls out within 10° of the specified heading.
5. Uses proper instrument cross-check and interpretation, and applies the appropriate pitch, bank, power, and trim corrections.

ELEMENTS: Proper procedure for steep turn entry and, establishing bank, instrument cross check, pitch, power, and trim.

SCHEDULE:

Preflight discussion	:10
Demonstration	:05
Student practice	:15
Postflight brief	:10

MATERIALS: Dry erase board.

INSTRUCTOR'S ACTIONS: *Preflight discussion*—Discuss the elements of steep turns and how to properly execute them.
Demonstration—Demonstrate steep turns to both the left and right.
Postflight brief—Critique and answer questions.

STUDENT'S ACTIONS: Pre-read assignment on steep turns;
Demonstrate steep turns;
Postflight discussion.

COMPLETION STANDARDS: The student should demonstrate the proper procedures and elements of steep turns using the standards outlined in the lesson objective.

STEEP TURNS

1. **Enter maneuver at Va (90-100knots in the Warriors).**

2. **Using the attitude indicator, establish a coordinated 45º bank turn.**

3. **Back pressure should be needed at 30º, use trim to help maintain altitude.**

4. **Roll out before your desired heading by 1/2 of the bank angle (22.5º).**

Hint: Start your 360º turn on a heading with a number on the D.G. for memory purposes.

LESSON: UNUSUAL ATTITUDE RECOVERY AND PARTIAL PANEL FLYING

OBJECTIVE: To familiarize the student with the conditions that produce unusual attitudes, characteristics or warning signs of unusual attitudes, and develop a habit in the student of taking prompt preventive or corrective action. The student will also learn how to control the aircraft without reference to the attitude indicator or heading indicator.

PRE-READ: IFH pg. 90-91

SCHEDULE:

Preflight Discussion	:30
Instructor Demonstration	:15
Student Practice	:45
Postflight Critique	:10

EQUIPMENT: Whiteboard

INSTRUCTOR'S ACTIONS:

-PREFLIGHT

-Discuss lesson objective
-Ask questions over reading assignment

-INFLIGHT

-Demonstrate elements of lesson

-POSTFLIGHT

-Critique student performance
-Assign reading assignment for next lesson

STUDENT'S ACTIONS:

-PREFLIGHT

-Discuss lesson objective
-Answer instructor's questions
-Ask any questions over reading assignment

-INFLIGHT

-Review previous maneuvers
-Practice elements relating to lesson

-POSTFLIGHT

-Resolve any questions

ELEMENTS:

UNUSUAL ATTITUDES

-Conditions and situations that may result in unusual flight attitudes

-When visual references are inadequate or lost, a pilot may unintentionally let the airplane enter a critical (unusual) attitude. Since such attitudes are forward pressure should be applied to stop the movement of the pointer on the altimeter. The point reversal is level attitude for that airspeed. Deflecting ailerons to level the wings before the angle of attack is reduced could result in a spin.

-**Level the wings**. Correct the bank (if any) by applying coordinated ailerons and rudder pressure to level the miniature airplane of the attitude indicator and center the ball of the turn coordinator.

-The corrective control applications should be made almost simultaneously but in the sequence above.

-After the initial control has been applied, continue with a fast cross-check for possible over controlling, since the necessary initial control pressure may be large. As the rate of movement of the altimeter and VSI needles decrease, the attitude is approaching level flight. When the needles stop and reverse direction you airplane is passing through level flight for that airspeed.

-When airspeed increases to normal speed, set cruise power.

-Control sequence for recovery from a nose-low attitude and the reasons for that sequence

-Nose-low unusual attitude is indicated by:

-Nose low and wings banked on the attitude indicator

-Increasing airspeed

-Decreasing altitude

-A turn on the turn coordinator

-Take action in the following sequence:

-**Reduce power to idle**. If the airspeed is increasing or is above the desired speed, reduce power to prevent excessive airspeed (e.g., approaching V_{NE} and loss of altitude.

-**Level the wings**. Correct the bank attitude with coordinated aileron and rudder pressure to straight flight by referring to the attitude indicator and turn coordinator. Increasing elevator back pressure before the wings are leveled will tend to increase the bank and make the situation worse. Excessive G-loads may be imposed, resulting in structural failure.

-**Raise the nose**. Smoothly apply back elevator pressure to raise the nose on the attitude indicator to level flight. With the higher-than-normal airspeed, it is vital to raise the nose very smoothly to avoid over stressing the airplane.

-The corrective control applications should be made almost simultaneously but in the previous sequence.

-After the initial control has been applied, continue with a fast cross-check for possible over controlling, since the necessary initial control pressure may be large. As the rate of movement of the altimeter and VSI needles decrease, the attitude is approaching level flight. When the needles stop

-Attempting to recover from an unusual flight attitude or fly partial panel by "feel" rather than by instrument indications

-The most hazardous illusions that lead to spatial disorientation are created by information received by our motion sensing system, located in each inner ear.

-The motion sensing system is not capable of detecting a constant velocity or small changes in velocity, nor can it distinguish between centrifugal force and gravity.

-The motion sensing system, functioning normally in flight, can produce false sensations.

-During unusual flight attitudes, you must believe and interpret the flight instruments because spatial disorientation is normal in unusual flight attitudes.

-Inappropriate control applications during recovery or partial panel

-Accurately interpret the initial instrument indications before recovery is started.

-Follow the recovery steps in sequence.

-Control movements may be larger, but they must be smooth, positive, prompt, and coordinated.

-Failure to recognize from instrument indications when the airplane is passing through a level flight attitude

-With an operative attitude indicator, level flight exists when the miniature airplane is level with the horizon.

-Without an attitude indicator, a level flight is indicated by the reversal and stabilization of the airspeed indicator and altimeter needles.

COMPLETION STANDARDS: The student should be able recover from unusual flight attitudes to level flight quickly and effectively with minimal control inputs and use proper cross-check and interpretation for both unusual attitudes and partial panel flying. The student should be able to maintain altitude +/-100 ft., heading within 10°, and airspeed within 10 kt. during partial panel flying.

LESSON: HOLDING PATTERNS AND PROCEDURES

OBJECTIVE: To develop the students skill and knowledge of the elements and procedures relating to holding patterns and procedures

PRE-READ: IFH pg. 206-209; Jeppesen Instrument/Commercial Manual pg. 5-16 to 5-22

SCHEDULE:

Preflight Discussion	:45
Instructor Demonstration	:15
Student Practice	:45
Postflight Critique	:15

EQUIPMENT: Whiteboard

INSTRUCTOR'S ACTIONS:

-PREFLIGHT
- -Discuss lesson objective
- -Ask questions over reading assignment

-INFLIGHT
- -Demonstrate elements of lesson

-POSTFLIGHT
- -Critique student performance
- -Assign reading assignment for next lesson

STUDENT'S ACTIONS:

-PREFLIGHT
- -Discuss lesson objective
- -Answer instructor's questions
- -Ask any questions over reading assignment

-INFLIGHT
- -Review previous maneuvers
- -Practice elements relating to lesson

-POSTFLIGHT
- -Resolve any questions

ELEMENTS:

-Usage
- -Holding patterns are used to delay aircraft for various reasons.
- -ARTCCs may assign holding patters to regulate the flow of traffic and maintain separation.
- -Approach control facilities often use a holding "stack" to sequence aircraft for the active instrument approach.

-**Holding Pattern Entries**

-There are three standard holding pattern entries. Direct, Teardrop, and Parallel.

-The type of entry you use depends on your heading as you approach the holding fix.

-**Direct Entry**

-This is the least complicated of all entries.

-It is also the one most often used, because it can be applied throughout 180° of azimuth in relation to the holding fix.

-When you use the direct entry, you simply fly across the fix, turn right to the outbound heading, and fly the pattern.

-**Teardrop Entry**

-After crossing the holding fix, turn right to a heading which is approximately 30° away form the holding course, but on the holding side of the pattern.

-Once you are established on this heading, begin timing for approximately one minute, turn right to intercept the holding course at a 30° intercept angle inbound, and return to the fix.

-Parallel Entry

-After crossing the holding fix, turn the airplane to a heading that parallels the outbound course and begin timing for one minute.

-Then, initiate ~~a left side~~ or proceed to the holding fix. turn towards the holding side (turn opposite holding direction of turns)

-**Visualizing Entry Procedures**

-There are many ways to visualize entry procedures, but there is a simple way to visualize the procedures.

-For standard holding patterns:

-If the holding course is behind the aircraft when you arrive at the fix, make a direct entry.

-When the holding course is ahead and to the right of the aircraft, use a teardrop entry.

-If the holding course is ahead and to the left of the aircraft as it crosses the fix, use a parallel entry.

-For nonstandard holding patterns:

-If the holding course is behind the aircraft when you arrive at the fix, make a direct entry.

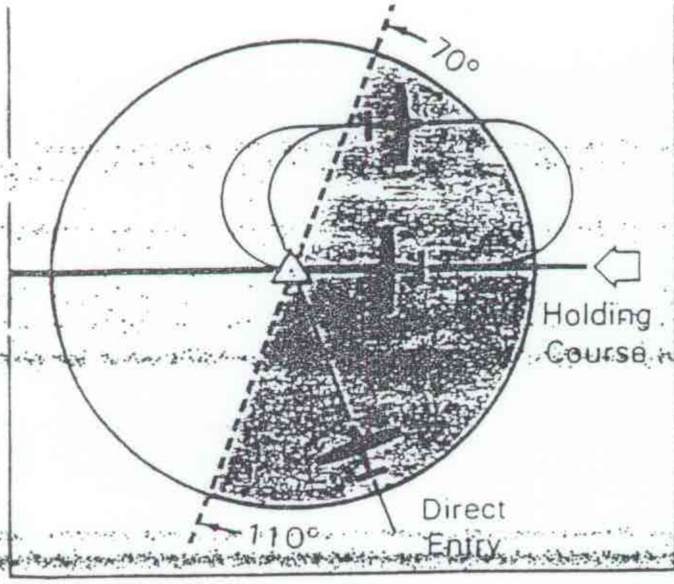
-When the holding course is ahead and to the left of the aircraft, use a teardrop entry.

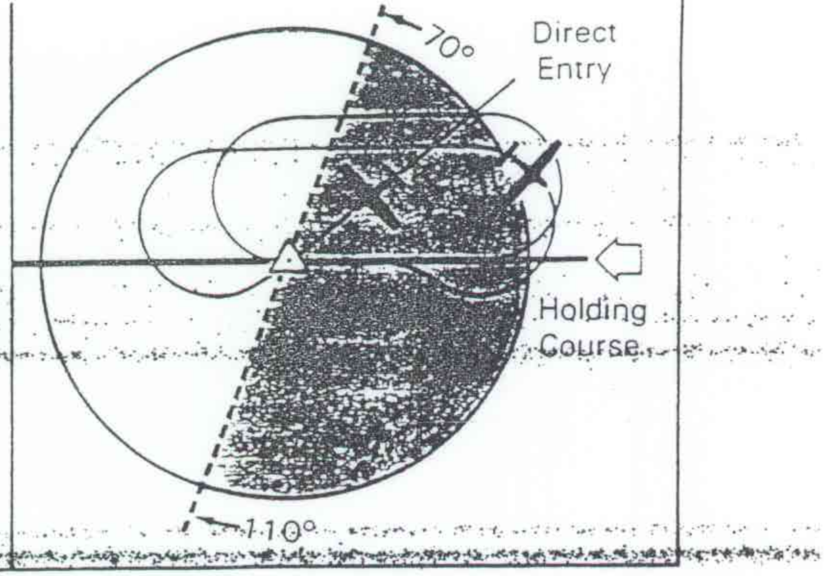
-If the holding course is ahead and to the right of the aircraft as it crosses the fix, use a parallel entry.

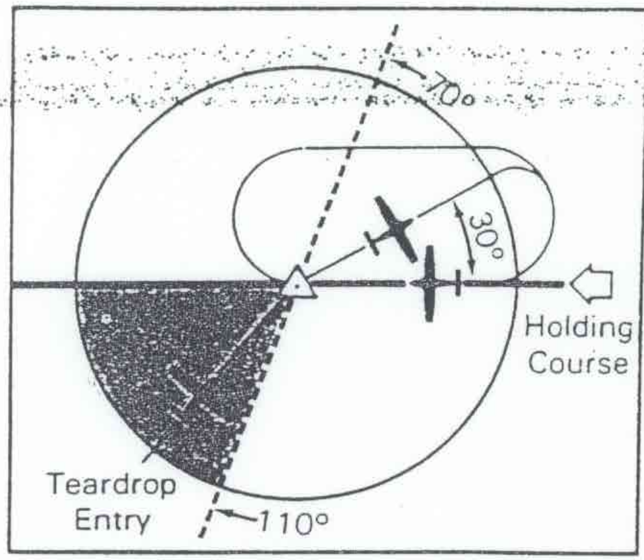
-**ATC Holding Instructions**

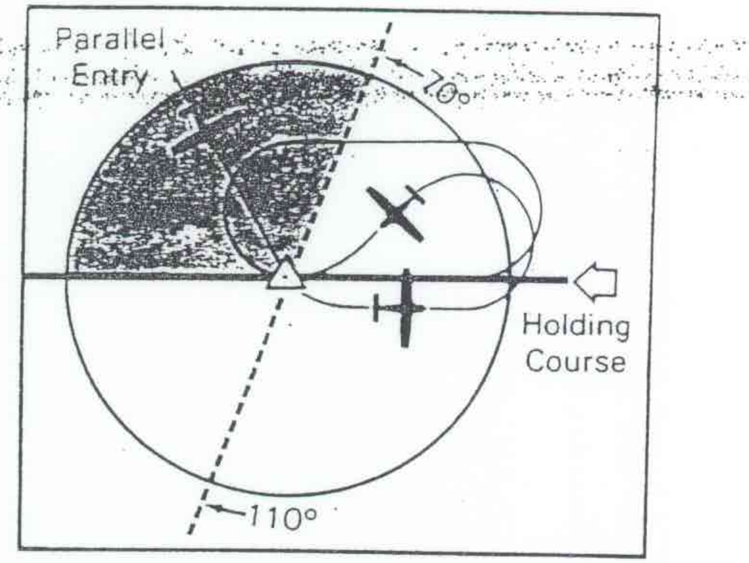
-You should be issued holding instructions by ATC at least five minutes before you reach the holding fix.

-The holding instruction is issued two different ways, depending on whether the pattern is published or not.









ELEMENTS OF HOLDING CLEARANCES

Holding Pattern Published	Sample Clearance
1. The direction to hold from the holding fix	". . . *Hold northwest*
2. Holding fix	*of Drako Intersection as published.*
3. Expect further clearance time	*Expect further clearance at 2102."*

Holding Pattern Not Charted	Sample Clearance
1. The direction to hold from the holding fix	". . . *Hold west*
2. Holding fix	*of Green Intersection*
3. The specified radial, course, magnetic bearing, airway number, or route	*on V-8,*
4. The outbound leg length in minutes or nautical miles when DME is used	*five-mile legs,*
5. Nonstandard pattern, if used	*left turns.*
6. Expect further clearance time	*Expect further clearance at 1528."*

I. WHY HOLD

A. SMOOTH FLOW OF TRAFFIC
B. REACH CLEARANCE LIMIT
C. WAITING FOR WX TO CLEAR
D. AFTER MISSED APPROACH
E. PROCEDURE TURN FOR ILS

II. WHERE TO HOLD

A. VOR
B. INTXN
C. NDB
D. OUTER MARKER
E. DME (1 MIN LEGS OR DME LEGS)

III. HOW TO HOLD

A. STANDARD PATTERN

2 STANDARD RATE TURNS
1 MINUTE LEGS
SIZE OF PATTERN VARIES WITH A/S

↑ 14,001 265 KIAS

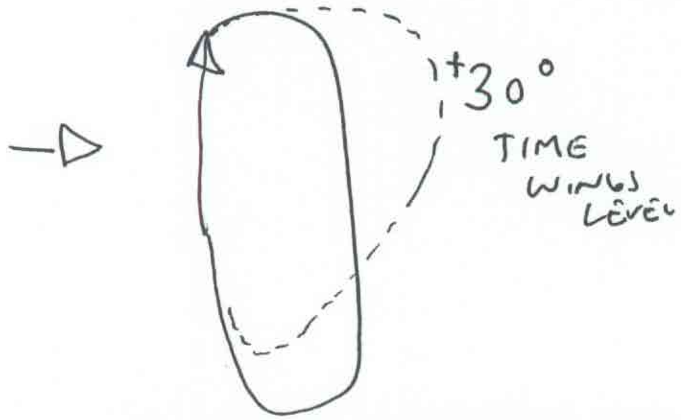
↑ 6001 230 KIAS

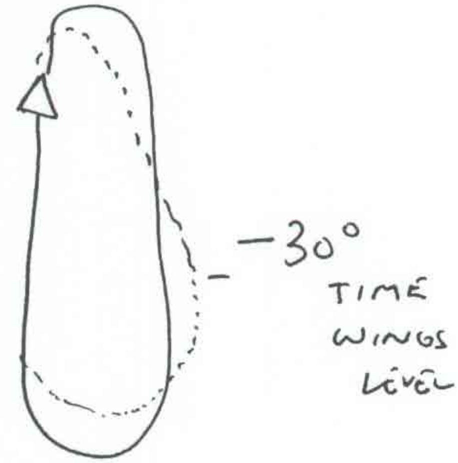
↑ SUFACE 200 KIAS

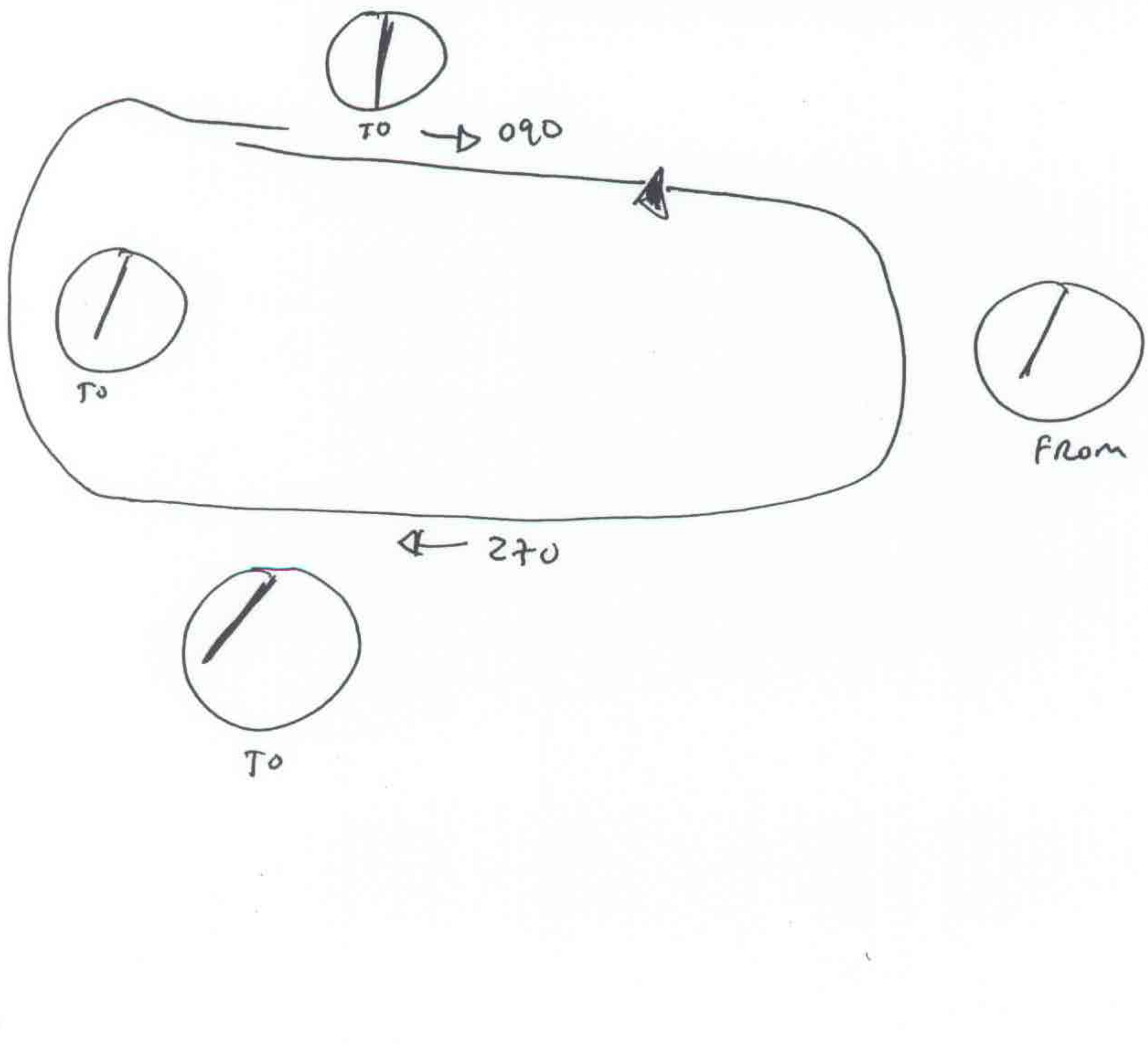
B. TIME

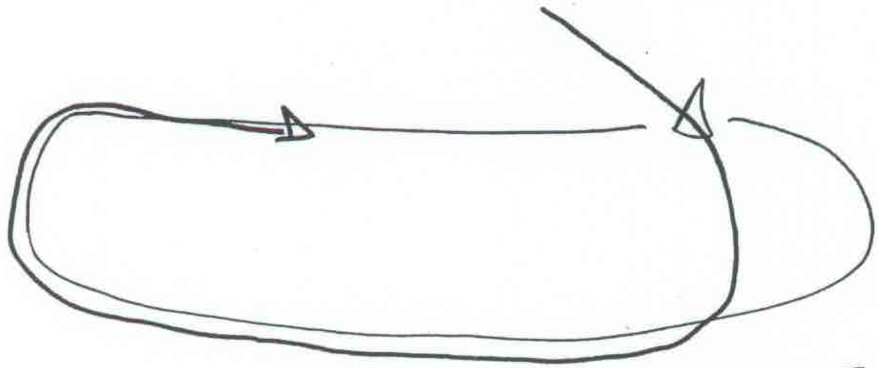
TURN
TWIST
THROTTLE
TALK

C. ADJUST FOR WIND

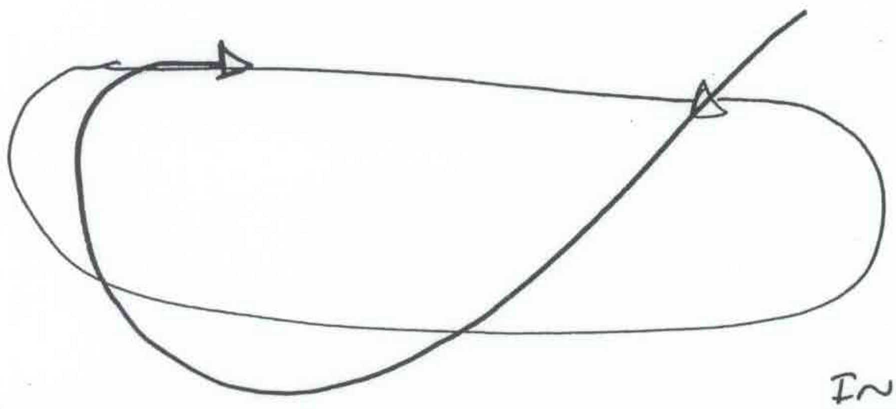








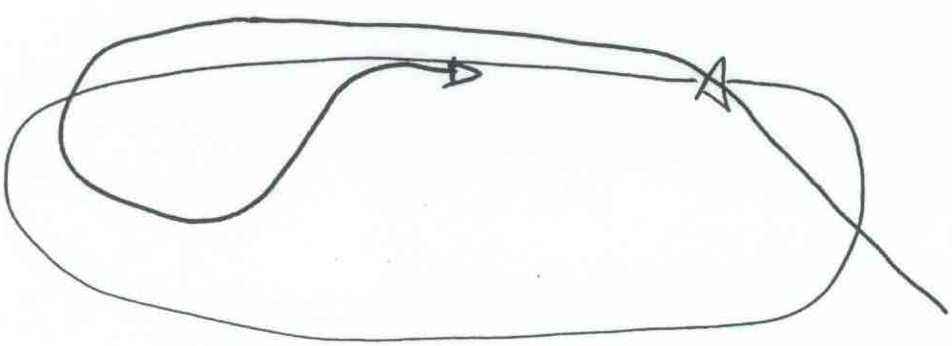
DIRECT



TEARDROP

IF HOLD RT, SUBTRACT 30
LT ADD 30

INITIAL TURN
HEADING 30° TO
THE HOLDING SIDE

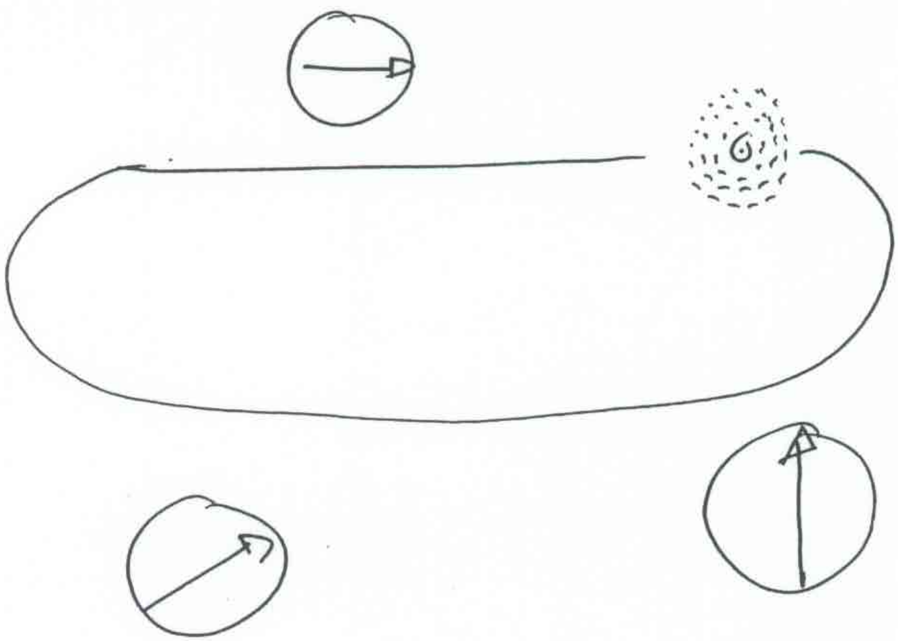


PARALLEL

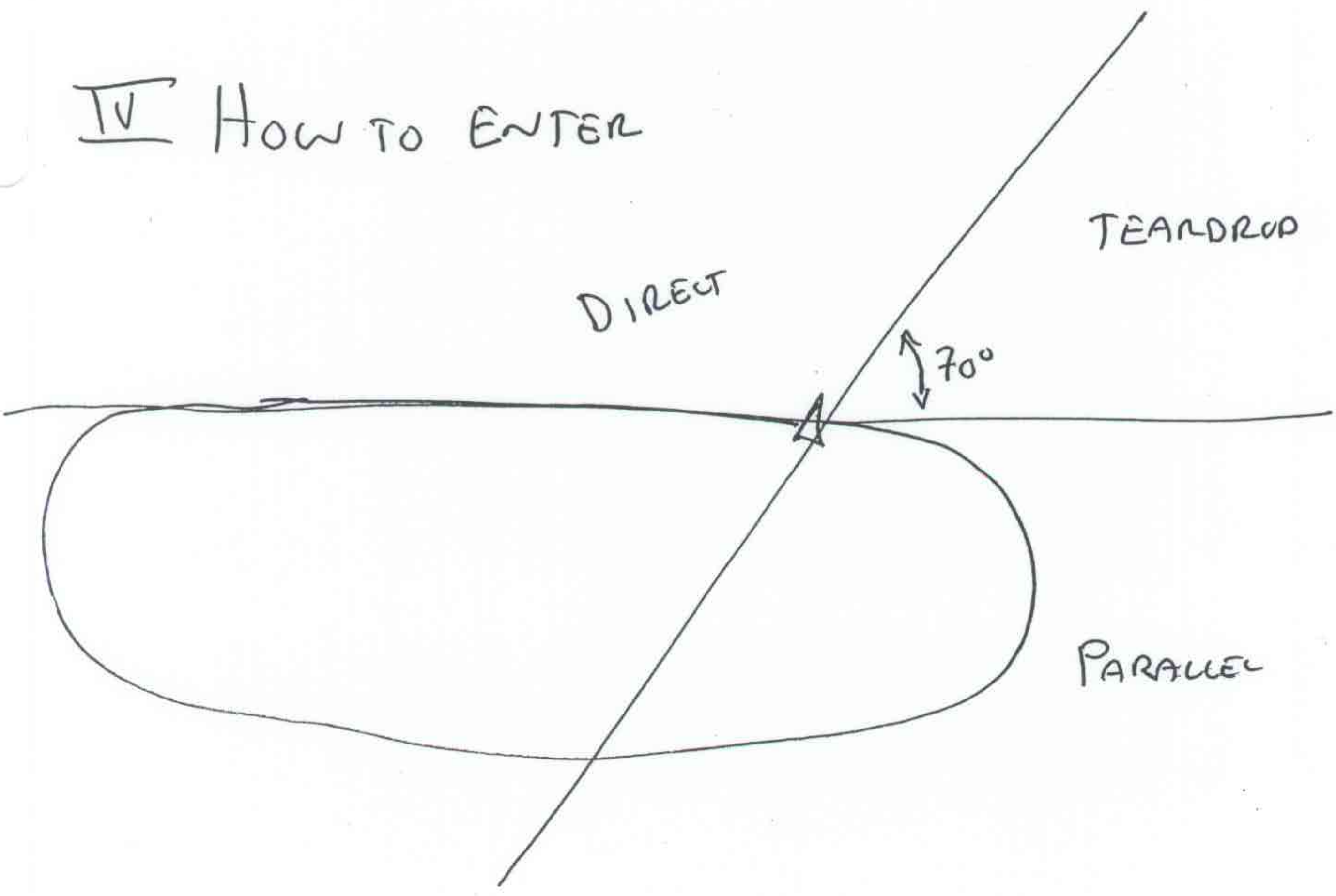
INTERCEPT COURSE
BEFORE VOR

USE A 30°/45°
INTERCEPT

NDB



IV How to Enter



DETERMINE WIND ON INBOUND COURSE AND TRIPLE WIND CORRECTION ON OUTBOUND LEG

ENTRY = WHICHEVER ENTRY GO TO HOLDING FIX!

People get confused with PARALLEL

FIVE Ts ON ENTRY

TIMING IN HOLD - HEADWIND VS. TAILWIND

TIMING ON INBOUND WINGS LEVEL ESTABLISHED ON INBOUND COURSE

CORRECT ERROR ON OUTBOUND LEG

~~Sect~~

W/IN 30° OF INBOUND COURSE AND CDI NOT ACTIVE HOLD HEADING TO INTERCEPT AND THEN MAKE CRAB CORRECTION ON OUTBOUND

Air • Desert • Pacific

INSTRUMENT INSTRUCTOR ADD-ON – FAR PART 61

Cost: $699.00

Minimum Completion Time: Two days, with check ride completed on third day.

Prerequisites:
Hold an FAA Commercial Pilot certificate – Airplane Single Land.
Hold an FAA Instrument Rating – Airplane.
Hold an FAA Flight Instructor Certificate – Airplane Single Engine Land.
Flight Instructor Instrument Knowledge Test Passed.

Training Content:
5 Hours dual instruction in Archer aircraft.
5 Hours Ground School.
1.5 Hours Archer aircraft rental for check ride.

Supplemental Materials: (Not Included)
Instrument theory book/s
Instrument Approach Procedures and Charts.
Instrument Instructor Practical Test Standards.

Additional Costs:
Supplementary Materials.
Training beyond the package content:
- Aircraft - $62 per hour
- Instructor - $36 per hour.
- Dual Simulator - $66 per hour (solo Simulator free)

Examiner's Fee - $350

1889 McKinley Ave, La Verne, CA 91750
(909) 596-6059, FAX (909) 596-9852
info@airdesertpacific.com

SECTION B—GENERAL SYSTEMS

The following section provides the multi-engine applicant with a general overview of representative systems incorporated on modern twin-engine airplanes. This section is *not* designed to be used in lieu of the specific pilot's operating handbook, but, rather, to acquaint the pilot with the major systems and system variations found in general aviation airplanes. *For specific operational details and limitations, the appropriate pilot's operating handbook must be consulted.*

PROPELLER SYSTEMS

The propellers installed on most multi-engine aircraft may be classified as constant speed, controllable pitch, full feathering propellers. Depending on the propeller manufacturer, there are two types of controlling mechanisms. The first utilizes boosted engine oil pressure and nitrogen pressure within the propeller hub. The second system uses boosted engine oil pressure and mechanical springs for system operation.

CONSTANT SPEED PROPELLERS

When a fixed pitch propeller system is installed on an aircraft, the propeller r.p.m. changes according to the speed and angle of attack of the airplane. For example, if the airplane begins to accelerate, the propeller r.p.m. tends to increase. Conversely, if the airspeed decreases, as in a climb, the propeller r.p.m. decreases. The constant speed system eliminates propeller r.p.m. fluctuation by changing the *blade angle* automatically according to the conditions. If the airspeed increases, the blade angle increases; conversely, when the airplane decelerates, the blade angle decreases automatically. Maintenance of a constant r.p.m. by variation of the propeller blade angle also tends to maintain the desired propeller angle of attack and optimum propeller efficiency. The constant speed system requires a hydraulic propeller governor and pitch change mechanism

When the propeller control lever is adjusted to the desired r.p.m., the hydraulic governor is thereby adjusted to maintain that r.p.m. If the engine speed begins to increase above the r.p.m. for which the governor is adjusted, the governor actuates the pitch-change mechanism in the propeller hub and the blade angle increases. When the blade angle increases, the angle of attack is increased, resulting in higher drag loading. The increased load causes a lower propeller speed. As the engine r.p.m. decreases, the governor reverses the process in the pitch-change mechanism, which returns the blade angle to the original pitch and the engine to the desired speed. When the engine speed begins to decrease below the selected r.p.m., the process is the same, except the blade angle is decreased.

PROPELLER CONTROLS

The propeller control levers allow the pilot to select the desired r.p.m., which the constant speed system will then maintain. To select the desired setting, the controls are moved either forward or aft. If the controls are moved full forward, the blade angle is decreased and high r.p.m. results. When the controls are moved aft, the governor increases the blade angle and the r.p.m. decreases. If the propeller control levers are moved to the full aft position into the feather detents, the blade angle is increased to nearly align with the relative wind. This action stops the rotation of the propeller, as shown in figure 1-15.

The purpose of the full feathering propeller is to eliminate the parasite drag developed by a windmilling propeller. When the propeller is windmilling, the drag is increased greatly and airplane performance is decreased significantly. This consideration becomes critical during engine-out operations.

FEATHERING

Since the propellers on multi-engine airplanes are not only constant speed but also full feathering, two mechanisms are required to change the blade angle from low pitch to full feather. The basic pitch-change mechanism depends on boosted engine oil pressure from the propeller governors. However, if the pitch-change mechanism depended entirely on oil pressure to feather the propeller, the loss of oil pressure or governor failure would prevent the propeller from being feathered. Therefore, a secondary method of increasing blade angle is required for full feathering pitch-change mechanisms.

When the propeller is spinning, the normal aerodynamic twisting forces are acting on the propeller to move it towards low pitch (high r.p.m.). These forces can be altered by changing the blade's center of mass in lieu of opposing oil pressure from the propeller governor. To alter the center of mass, featherable propellers have counterweights attached to the base of each blade, as shown in figure 1-16. As the propeller rotates, the counterweight's center of mass moves toward the blade's plane of rotation, tending to increase the blade angle, as shown in figure 1-17. The centrifugal force produced by the counterweights is designed to be slightly *greater* than the aerodynamic twisting force, and hydraulic pressure is used to aid the aerodynamic force in decreasing the blade angle. In addition to the counterweights, the propeller system incorporates either compressed air or a mechanical spring to aid in moving the blades to the full feather

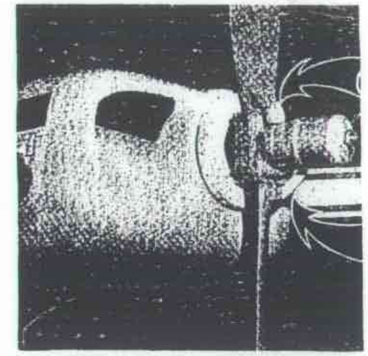


Fig. 1-16. Propeller Counterw

An important aspect of the
procedure is engine speed.
device in the propeller hut
feathering the propeller at lo
speeds, usually below 700 to
This insures that the propelle
feather during engine startin
down, when the engine oil
very low. The pilot's operat
book should be consulted f
operational details.

POWER APPLICATION OR RED

Correct propeller operation
related to proper engine care. I
is very important to maintain
ifold pressure and propeller r.p
their respective operating ra
specific limitations and guid
appropriate pilot's operating
should be consulted.

Proper propeller operation
during the phases of flight
power application or reductio
the propellers are constant s
basic operating procedures m
lowed. Specifically, for powe
tion, the propeller control leve
advanced first, followed by in
manifold pressure. For power
the manifold pressure must b
prior to reduction in propel
This procedure maintains th
balance between internal cyli
sure and the power requi

CONSTANT SPEED PROPELLER SYSTEM

following components, when installed on an aircraft form an essential part of the propeller and the propeller control system. Note that some of the components are frequently not supplied by the propeller manufacturer.

- Propeller
- Primary Governor
- Overspeed Governor and Primary Pump
- Synchrophaser
- Spinner and Bulkhead
- De-Ice System

A propeller system consists of far more than just blades mounted in a hub at the front of the typically configured aircraft. First of all, the propeller hub serves as a device to contain the blades (centrifugal force can range from 15,000 lbs. to as much as 50,000 lbs. for normal operation). Secondly, the hub assembly contains the propeller blade pitch change mechanism that adjusts b'^de angle on command from a governing device. Of amental importance in the design of this pitch change mechanism is the manner in which it defaults upon loss of control input (usually engine oil supply for the typical hydraulically actuated system). A twin-engine aircraft will default to feather and a single-engine aircraft will typically default to low pitch. There are exceptions as with most things. A single-engine aircraft system with a reciprocating engine may be so defined as to default to high pitch on loss of engine oil pressure if the installation is aerobatic. Therefore, when oil pressure is lost during an aerobatic maneuver, the propeller will coarsen pitch thus resulting in a reduced RPM thus preventing an engine overspeed. Another exception is the single-engine turboprop powered aircraft where the propeller will typically default to feather on loss of control input.

Propeller construction may consist of an aluminum "clam-shell" hub where the hub captures the blades, or a steel hub "spider" design where the blades are clamped to a hub . The blades may be made from an aluminum forging or from either Kevlar 49® or Carbon based fabrics or unidirectional tapes. The composite blades would additionally incorporate a leading edge erosion sheath to protect the blade from both abrasion (sand) and erosion (water) as well as offer an external conductive for a lightning strike.

The pitch control typically comes from a hydraulic fly-ball mor mounted on the engine. The governor senses whether the engine/propeller is running at the correct RPM and either supplies or maintains oil flow to the propeller, or drains oil to the engine sump. Of course, it is very important that the engine-mounted governor be properly matched to the propeller for proper cessary to ensure the propeller manufacturer has approved the go or for use with its propeller. In addition to controlling the propeller, this governor typically contains a pump that increases the oil pressure to a higher level than that which the engine supplies to a value sufficient to control the propeller.

On turbine-powered aircraft, it is normal to include an overspeed governor into the propeller control system that backs-up the primary propeller governor. Therefore, if the primary governor fails in such a manner as to command a reduced pitch (increased RPM), it can be overridden by the overspeed governor whose setting is just above normal maximum RPM, and therefore the overspeed governor can provide sufficient RPM control to so as to allow the aircraft to safely land. An overspeed governor is not used on reciprocating engines because the reciprocating engine can be sufficiently slowed (in such a failure mode condition) with a throttle reduction so as not to overspeed. The overspeed governor is often not supplied by the propeller manufacturer.

On twin-engine aircraft, whether they are reciprocating or turbine-powered, the propeller governor or synchronizer may be supplemented with an electronic synchrophaser. One purpose of the synchrophaser is to match the two propellers to the same RPM. However, the more difficult and relevant task of the synchrophaser is to match not only the RPM, but also the phase position between the two propellers. In other words, when a blade on one propeller passes the fuselage, a blade on the other pr ller is operating at the same speed and is at a specific and p fined relative position. In doing so, airframe vibration and cabin noise can be substantially reduced.

The propeller hub mechanism will nearly always be protected by and streamlined to the airframe nacelle by a spinner assembly.

If the aircraft is intended for operation in an icing environment, or, if it is just desired to protect the aircraft somewhat from unintentional encounter into icing conditions, the propeller blades would need to perform satisfactorily in icing conditions, just as the wing does. Therefore, propeller blade mounted de-ice boots (and sometimes spinner dome mounted boots as well) provide sufficient heating to the blades as to guard against excessive ice build-up. Most de-ice boots today are electrically powered thus there is a need to supply and properly sequence the delivery of this electrical power to the de-ice boots. This is accomplished through the use of a timer, an ammeter (for system function verification and diagnostics), a brush block and slip-ring assembly for transmitting the power to the rotating propeller, and on the propeller, additional wiring and terminal blocks to deliver the electrical current from the slip ring to the blade mounted de-ice boots.

Charting the Course

Pilotage + Dead Reckoning

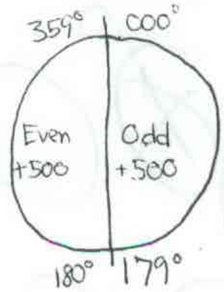
1. Draw course line from center of departure to center of destination (if direct)

2. Select checkpoints - choose prominent features that can be readily identified + recognized (large towns, lakes, roads, railroads, comb.) (5-20nm, either side of track)

3. Study Route + Terrain - check for obstructions, heights, + other airspace

4. Select appropriate altitude - based on terrain, obstructions, airspace, + wind

cruise altitudes



* above 3000' agl
* magnetic course

5. Measure total distance + distance between checkpoints.

6. Determine true course - use mid meridian to determine degrees measured from true north. TC°

7. Determine WCA - using a flight computer
- add if a right correction is needed, subtract if left.
* TC° + WCA = TH°

8. Determine Magnetic Heading - add if westerly, subtract if easterly
* TH° + Var = MH°

* $TC^\circ + WCA = TH^\circ + Var = MH^\circ + Dev = CH^\circ$

(10) Determine groundspeed - using flight computer (TAS, windsaloft

(11) Determine ETE for total flight and between checkpoints.

(12) Determine fuel consumption - using flight computer

(13) Overview - groundspeed
- total distance
- ETE, ETA
- total fuel needed

Applicable equations

$$\text{speed} = \frac{\text{distance}}{\text{time}} \qquad \text{time} = \frac{\text{distance}}{\text{speed}}$$

$$\text{fuel flow} = \frac{\text{gallons}}{\text{time}} \qquad \text{gallons} = \text{flow} \cdot \text{time}$$

Flight Plan
- specified info. relating to the intended flight of an aircraft filed with an FSS or ATC.

- primarily concerned with route, airspeed, ETE, total fuel
  - used for search + rescue periods
  - only kept 1 hour after ETD
  - close flight plan upon arrival