

ADDITIONAL INSTRUMENT FLIGHT MANEUVERS

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The additional instrument flight maneuvers in this section will be accomplished during your flight training. These maneuvers are Appendix B "Flight Training Syllabus" in ***Instrument Pilot Flight Maneuvers and Practical Test Prep***. Note that they do not have associated PTS tasks.

INSTRUMENT TAKEOFF (ITO)

A. General Information

1. The objective of this maneuver is to provide you with the proficiency and confidence necessary for use of flight instruments under conditions of low visibility, rain, low ceilings, or night takeoffs toward and over water or deserted areas.
2. The instrument takeoff (ITO) is normally a composite visual and instrument takeoff, which allows for an easy and quick transition to instrument references anytime when outside visual references become unreliable or you become disoriented.
 - a. Attempting to make a sudden, rapid transition from visual to instrument references can result in serious disorientation and control problems.
3. 14 CFR Section 91.175, Takeoff and Landing under IFR, does not specify any takeoff minimums for 14 CFR Part 91 operations, such as flight instruction, personal flying, etc.
 - a. Published takeoff minimums or standard takeoff minimums apply to commercial operations.
 - 1) Published minimums are found in the IFR Takeoff Minimums and Departure Procedures section of the NOS *Terminal Procedures Publication*.
 - 2) A standard takeoff minimum of 1 SM visibility is specified in FAR 91.175(f)(1) for an airplane having two engines or less.
 - b. Some pilots and instructors use the minimums for an instrument approach to the departure airport as their takeoff minimums.
 - 1) The logic in this is that, if there is a problem or an emergency, you should be able to land at your departure airport.
 - c. As PIC of a 14 CFR Part 91 operation, you are not legally bound by any IFR takeoff minimums.
 - 1) We suggest that you discuss this topic, along with the options listed in items a. and b. above, with your instructor.

B. How to Perform an Instrument Takeoff

1. ITO techniques vary with different types of airplanes, but the method described below is applicable to single-engine airplanes.
2. Before performing an ITO, you must perform a complete and careful instrument cockpit check and a before-takeoff check.
 - a. These checks should include all flight and navigation instruments and encompass selecting appropriate navigation aids to be used for departure and setting the navigation instruments and switches as required.
 - b. You must thoroughly understand the ATC clearance and departure procedures before takeoff.
 - 1) Having the appropriate IAP chart available in the event that an instrument approach is necessary immediately after takeoff is a good operating practice.
 - 2) Review of the approach for an emergency return should include frequencies, final approach course, DH or MDA, and minimum safe altitudes.
 - c. Ensure that all trim tabs are set properly.
3. When cleared into position for takeoff, align the airplane with the runway centerline, and ensure that the nosewheel is straight before stopping the airplane.
 - a. Hold the brakes firmly to avoid creeping while you prepare for takeoff.
 - b. Recheck the heading and attitude indicators for possible precession error.
 - 1) You may find it easier to detect slight changes in heading during the takeoff by setting the HI on the 5° mark nearest the published runway heading.
 - c. Operate the pitot heat and any other anti-icing equipment as required and in accordance with the airplane's *POH*.
4. When cleared for takeoff, advance the throttle to a power setting that will provide partial rudder control. Release the brakes, advancing the power smoothly to takeoff setting.
 - a. The brakes must be released simultaneously to minimize initial directional control problems.
 - 1) Directional control immediately following brake release should be accomplished predominately with the aid of outside visual references.
 - a) Your instructor may require you to wear a view-limiting device, which means you will need to hold the heading constant on the HI by use of the rudder.
 - b. Avoid the use of brakes, except as a last resort, as it usually results in overcontrolling and extending the takeoff roll.
 - 1) Once you release the brakes, correct any deviation in heading immediately.
5. As the airplane accelerates, the cross-check should transition from outside references to the heading indicator, airspeed indicator, and attitude indicator.
 - a. The rate of transition is directly proportional to the rate at which the outside references deteriorate.

- b. It is very important to have the instrument cross-check in progress before you completely lose outside visual references during the takeoff roll or subsequent departure.
 - 1) Takeoffs at night or into poor visibilities are especially conducive to spatial disorientation.
 - 6. At V_R , apply back elevator pressure for the correct pitch attitude for takeoff on the attitude indicator.
 - a. Continue with a rapid cross-check of heading indicator and attitude indicator as the airplane leaves the ground.
 - 1) Do not attempt to make the airplane fly by adding additional back elevator pressure; instead, maintain the takeoff attitude and let the airplane fly off the ground.
 - 2) In your airplane, takeoff attitude is _____.
 - b. Maintain directional control with the heading indicator, and the desired pitch attitude and level wings on the attitude indicator.
 - 1) Begin to include all other flight instruments in the cross-check.
 - 7. When the altimeter and VSI indicate a positive rate of climb, retract the landing gear (if retractable) and flaps.
 - a. A positive rate of climb is indicated on the altimeter by a steady clockwise rotation of the needle (increasing altitude) at a rate that you can interpret with experience and on the VSI by a stable rate of climb appropriate to the airplane.
 - b. Because of control pressure changes during gear and flap operation, overcontrolling is likely unless you note pitch indications on the attitude indicator accurately and quickly.
 - c. Trim off control pressures necessary to hold the stable climb attitude.
 - 8. Check the altimeter, VSI, and airspeed indicator for a smooth acceleration to the climb airspeed (altimeter and airspeed increasing, VSI stable).
 - a. At the desired climb airspeed, set the power as specified in the airplane's *POH*.
 - 9. Throughout the ITO, cross-check and interpretation must be rapid and accurate, and control pressure must be positive and smooth.
 - a. During the takeoff and initial climb, gear and flap retraction, and power reduction, the changing control reactions demand rapid scanning, adjustment of control pressures, and accurate trim changes.
- C. Common Errors during an Instrument Takeoff
- 1. Failure to perform an adequate instrument cockpit check before takeoff.**
 - a. Attempting to take off with flight instruments not set properly, controls locked, or numerous other oversights is mainly due to haste or carelessness.
 - 2. Improper alignment on the runway.**
 - a. This error may result from applying brakes improperly, allowing the airplane to creep after initial alignment, or attempting alignment with the nosewheel (or tailwheel) cocked.
 - b. In any case, the result is a built-in directional control problem as the takeoff starts.

3. Improper application of power.

- a. Abrupt application of power complicates directional control.
- b. Add power with a smooth, uninterrupted motion.

4. Improper use of brakes.

- a. Incorrect seat or rudder pedal adjustment, with your feet in an uncomfortable position, frequently causes inadvertent application of brakes and excessive heading changes.
- b. Once you release the brakes, keep your feet away from them.

5. Excessive use of the rudder.

- a. This error may be caused by late recognition of heading changes, tension on the controls, misinterpretation of the heading indicator (and correcting in the wrong direction), failure to appreciate the changing effectiveness of rudder control as the airplane accelerates, and other factors.
- b. If heading changes are observed and corrected immediately with small movement of the rudder pedals, swerving tendencies can be reduced.

6. Failure to maintain attitude after becoming airborne.

- a. If you react to "seat-of-the-pants" sensations when the airplane lifts off, your pitch control is guesswork.
- b. You may either allow excessive pitch up or apply excessive forward elevator pressure, depending on your reaction to trim changes.

7. Inadequate cross-check.

- a. Fixation is likely during trim changes, attitude changes, gear and flap retractions, and power changes.
 - 1) Once you check an instrument or apply a control pressure, continue the cross-check and note the effect of your control during the next cross-check sequence.

8. Inadequate interpretation of instruments.

- a. Failure to understand instrument indications immediately indicates that additional study of an ITO is necessary.

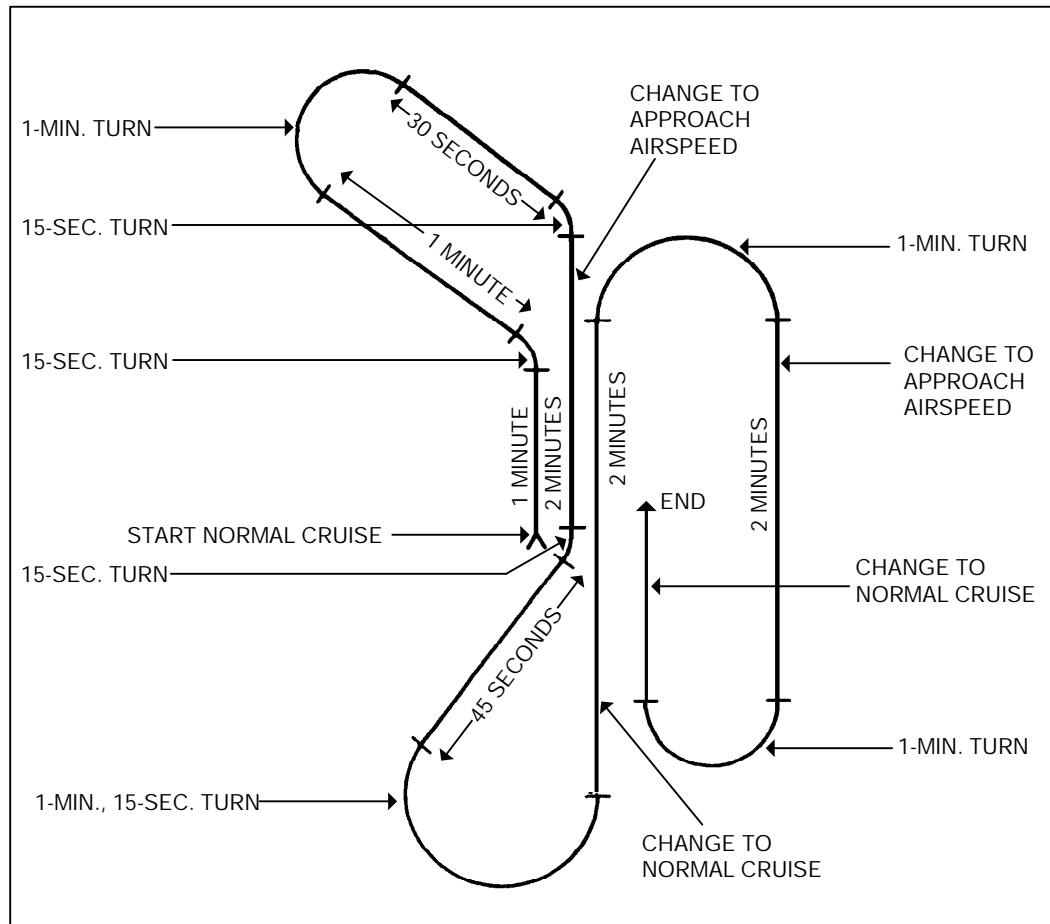
PATTERN A**A. General Information**

1. The objective of the Pattern A maneuver is to further develop your ability in maintaining straight-and-level flight and performing timed turns at definite time intervals.
 - a. The combination of these procedures will be used later in your flight training.
2. Flying Pattern A is an invaluable experience in planning, precision timing, maintaining orientation, holding, performing procedure turns, and making approaches.
3. Initial practice should be on cardinal headings for simplification.
 - a. As your proficiency increases, you should be able to accomplish Pattern A on any heading.
4. Your instructor may make various changes in Pattern A, or you may fly the pattern over a navigational facility, or waypoint, correcting for drift on each leg.
5. This maneuver should be performed first with all available instruments, then on partial panel.

B. How to Perform Pattern A

1. Timing should begin when the second hand is on a cardinal point, preferably 12 o'clock.
2. The timing for Pattern A is consecutive in that the time for each leg is started when control pressure is applied to recover from the preceding turn.
 - a. This applies even though the airplane is still turning and is not on the desired heading.
 - b. EXAMPLE: Refer to the illustration of Pattern A below. This first leg is straight and level and begins when the second hand is in the 12-o'clock position. When the second hand reaches 12 o'clock, a standard-rate left turn begins. When the second hand is in the 3-o'clock position, the rollout to straight-and-level flight begins and so does the timing of the next straight-and-level leg. Thus, the next turn would begin when the second hand is in the 3-o'clock position.

NOTE: Use of a digital clock will require some additional work since the timing is consecutive.



3. All turns are made at standard rate, i.e., 3° per second.
 - a. Thus, the turn coordinator should be calibrated for a standard-rate turn.
4. Before attempting to fly this pattern, you must be familiar with it and know the power settings for the different airspeeds used.

5. The following applies to flying Pattern A on partial panel (with attitude indicator and heading indicator inoperative):
 - a. You must have an understanding of the proper use of the magnetic compass and an awareness of its errors.
 - b. When the airplane is in straight flight and a few seconds have been allowed for the magnetic compass to stop oscillating, the compass heading is noted. If the airplane is not on the correct compass heading, a correction must be made.
 - 1) On a heading of north or south, the correction must be a timed turn.
 - a) For small heading changes, use a half-standard-rate turn.
 - 2) On a heading in the vicinity of east or west, a shallow bank and turn directly to the heading is possible since there is no turning error on a heading of east or west.
 - c. When the pattern requires a change of airspeed, make any heading corrections prior to the change of airspeed.
 - d. The turn coordinator is your primary bank instrument, and the magnetic compass is a supporting bank instrument that is used only to determine the accuracy of the heading.
 - e. The altimeter is the primary pitch instrument, and the VSI is a supporting pitch instrument.
 - f. A rapid and efficient cross-check is required during airspeed changes so that corrections may be applied immediately.

C. Common Errors While Performing Pattern A

1. Incorrectly calibrated turn coordinator.

- a. The turn coordinator should be calibrated before attempting to fly Pattern A.
- b. The turn coordinator should be calibrated for both left and right turns.

2. Poor bank control during turns.

- a. With all the instruments available, this error is due to poor cross-check and interpretation of the instruments.
- b. During partial-panel operations, the turn coordinator is the primary bank instrument.
 - 1) For a review of the proper procedures for timed turns, see *Instrument Pilot Flight Maneuvers and Practical Test Prep*, Task IV.E., Timed Turns, beginning on page 175.

3. Improper timing.

- a. Timing begins preferably when the second hand is in the 12-o'clock position, and the timing is cumulative.

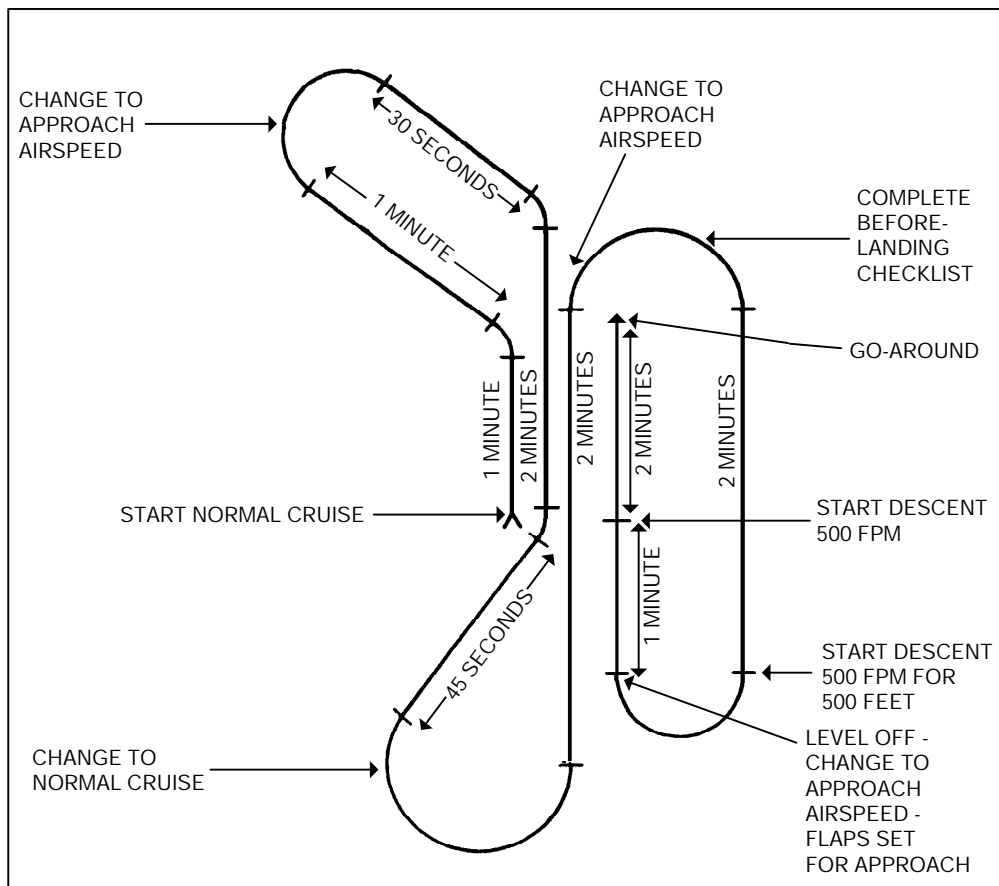
PATTERN B

A. General Information

1. The objective of Pattern B is to provide you with additional practice in the procedures to be used later in your flight training and to combine most of the maneuvers previously learned.
2. Pattern B is essentially the same maneuver as Pattern A with the following exceptions:
 - a. All available instruments are used.
 - b. Airspeed is changed during turns.
 - c. The before-landing checklist will be completed.
 - d. Descents at 500 feet per minute (fpm) are made during the maneuver.
 - e. The airspeed is maintained following the final turn, and a descent of 500 fpm is established followed by a go-around after descending 1,000 ft.

B. How to Perform Pattern B

1. Pattern B can be started on any heading, but initial practice should begin on cardinal headings.
2. The timing is consecutive, as it is for Pattern A.
 - a. In Pattern B, roll out on the desired heading, regardless of time.
3. When changing airspeed in turns, simultaneously change bank, power, and pitch as necessary.
 - a. For a review of changing airspeed in a turn, see *Instrument Pilot Flight Maneuvers and Practical Test Prep*, Task IV.B., Change of Airspeed, beginning on page 146.
4. Pattern B is shown below.



C. Common Errors While Performing Pattern B

1. Failure to control rate of turn.

- a. All turns are standard-rate turns, and failure to use the standard rate may be a fixation, an omission, or an emphasis error.

2. Failure to maintain heading and altitude.

- a. This error may indicate problems with your cross-check or instrument interpretation.
- b. Ensure that the airplane remains properly trimmed throughout the maneuver.

3. Poor bank and pitch control during airspeed changes during a turn.

- a. As the airspeed decreases, the bank angle must decrease to maintain a standard-rate turn.
- b. Pitch will need to be increased as the airspeed decreases.
 - 1) Trim the airplane to relieve control pressures.

VERTICAL S, S-1, AND S-2

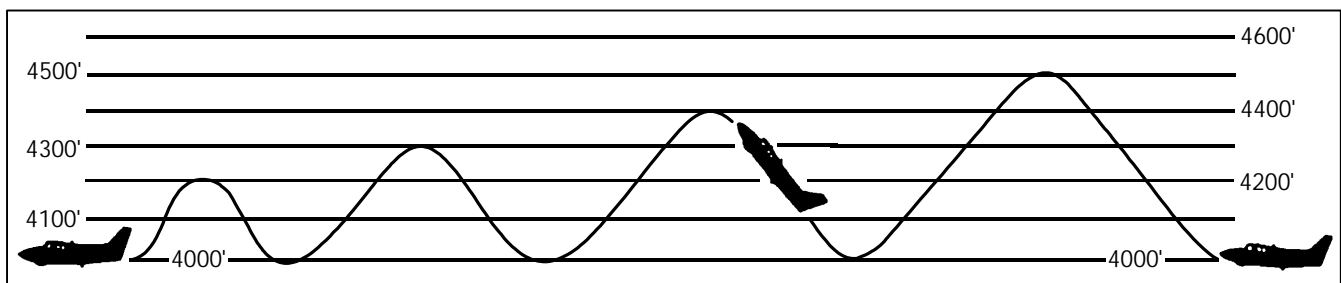
A. General Information

- 1. The objective of the vertical S, S-1, and S-2 maneuvers is to develop coordination in power, pitch attitude, and bank attitude control.
 - a. These maneuvers will also help increase speed in cross-checking instruments.

B. **Vertical S**

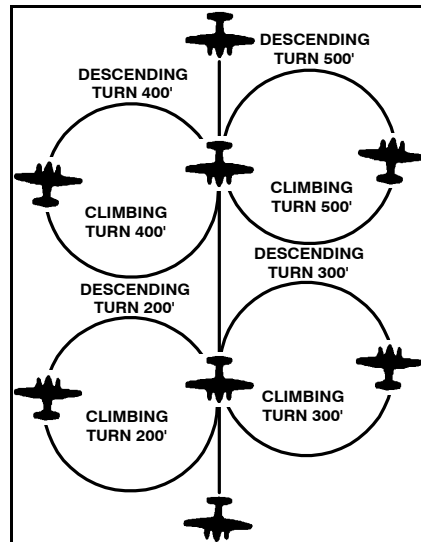
- 1. The vertical S consists of a series of climbs and descents.
 - a. Throughout the vertical S maneuver, constant airspeed and heading are maintained.
 - b. All climbs and descents are made at a constant rate, as shown on the VSI.
 - 1) For a review of rate climbs and descents, see *Instrument Pilot Flight Maneuvers and Practical Test Prep*, Task IV.D., Rate Climbs and Descents, beginning on page 166.
 - c. The reversing of vertical direction is made at specified altitudes.
- 2. Before starting the vertical S, establish a climb or descent airspeed at an entry altitude that is easy to remember (i.e., 2,000 ft., 3,000 ft., etc.).
 - a. Maintain this airspeed throughout the maneuver.
 - b. In your airplane, entry airspeed is _____ and power is _____.
 - c. Trim the airplane.

3. Once the airplane is stabilized at the appropriate entry airspeed, adjust both pitch attitude and power to enter a 500 fpm rate of climb.
 - a. Pitch attitude is adjusted on the attitude indicator to that required for a 500 fpm rate of climb.
 - b. As the power is increased in the entry, the airspeed indicator becomes the primary instrument for pitch.
 - c. As the vertical speed approaches 500 fpm, the VSI becomes the primary instrument for pitch, and the airspeed indicator becomes the primary instrument for power (i.e., to maintain a constant airspeed).
 - d. Since the airplane was trimmed for the airspeed used during the maneuver, no change in the trim should be necessary.
 - e. Remember to correct for left-turning tendencies as power is increased.
4. Continue the climb for 500 ft., and then start a descent to the entry altitude.
 - a. You should lead the altitude by 20 to 30 ft.
 - b. Power must be smoothly adjusted to the approximate setting to maintain the airspeed.
 - c. As the reversal of the vertical direction is started, the airspeed indicator becomes the primary instrument for pitch and remains so until the vertical speed approaches the desired rate of 500 fpm.
 - d. When approaching the entry altitude, lead the altitude by 40 to 60 ft. to reverse the vertical direction to a climb.
5. The next portion of the maneuver is a 400-ft. climb and then a 400-ft. descent, using a vertical speed of 400 fpm.
 - a. The 400-ft. climb/descent is followed by a 300-ft. climb/descent using a vertical speed of 300 fpm.
 - b. Finally, a 200-ft. climb/descent portion uses a vertical speed of 200 fpm.
 - c. Each portion is performed as discussed in items 3. and 4. above.



C. Vertical S-1

1. The vertical S-1 is a combination of the vertical S and standard-rate turns of 360°.
2. Enter the vertical S-1 in the same way that you enter the vertical S.
 - a. However, when you start the climb, you also start a standard-rate turn.
3. Continue the turn until you return to the entry altitude.
 - a. Thus, a 360° turn should be completed when the airplane returns to the entry altitude.
 - b. Reverse the direction of turn with each return to entry altitude.
4. The vertical S-1 is illustrated below.



D. Vertical S-2

1. The vertical S-2 is identical to the vertical S-1, except that the direction of turn is reversed with each reversal of vertical direction.

E. Common Errors While Performing the Vertical S, S-1, and S-2

1. **Failure to use the airspeed indicator properly for pitch control when changing the vertical direction.**
 - a. Since a constant airspeed is to be maintained during the maneuver, the airspeed indicator is the primary instrument for pitch.
 - b. As the vertical speed approaches the desired rate, the VSI becomes the primary pitch instrument (i.e., constant-rate climb/descent), and the airspeed indicator becomes the primary power instrument, i.e., to maintain the correct airspeed.
 - 1) You should know the power settings required for each climb and descent.
2. **Failure to avoid overcontrol of pitch attitude when climbing and descending.**
 - a. This error is usually indicated by excessive movement of the VSI.
 - b. It may be an indication of improper instrument interpretation.
3. **Failure to use the proper altitude lead when reversing the vertical direction.**
 - a. During the reversal of vertical direction, lead the altitude by 40 to 60 ft. in descents and by 20 to 30 ft. in climbs.
4. **Failure to correct sufficiently for left-turning tendencies when power is changed.**
 - a. Remember to scan all of your instruments and ensure that the ball of the TC remains centered at all times.

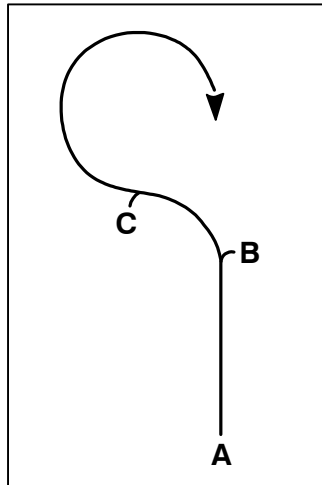
BASIC INSTRUMENT FLIGHT PATTERNS

A. General Information

1. After you have attained a reasonable degree of proficiency in basic instrument maneuvers, you can apply your skills to the various combinations of individual maneuvers.
2. The following practice patterns, and Patterns A and B discussed previously, are directly applicable to operational instrument flying.

B. **80/260 Procedure Turn**

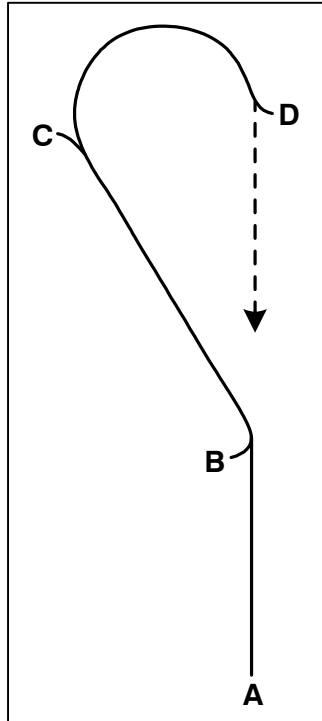
1. The entire pattern is flown in level flight, i.e., at a constant altitude.



2. Use the following steps to perform the 80/260 procedure turn:
 - a. Start timing at A for 2 min. from A to B.
 - 1) Reduce airspeed to approach airspeed during this time.
 - b. At B, enter a left standard-rate turn for a heading change of 80°.
 - c. At the completion of the 80° turn at C, immediately turn right for a heading change of 260°, rolling out on the reciprocal of the entry heading.

C. Teardrop Holding Pattern Entry

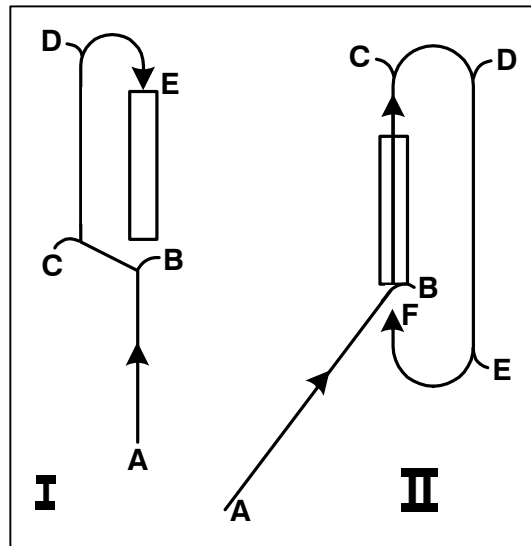
1. The entire maneuver is flown in level flight.



2. Use the following steps to perform the teardrop holding pattern entry:
 - a. Start timing at A for 2 min. from A to B.
 - 1) Reduce airspeed to holding airspeed during this interval.
 - b. At B, enter a left standard-rate turn for a 30° change of heading.
 - 1) Time 1 min. from B to C.
 - c. At C, enter a right standard-rate turn for a 210° change of heading, rolling out on the reciprocal of the original entry heading.

D. Patterns Applicable to Circling Approaches

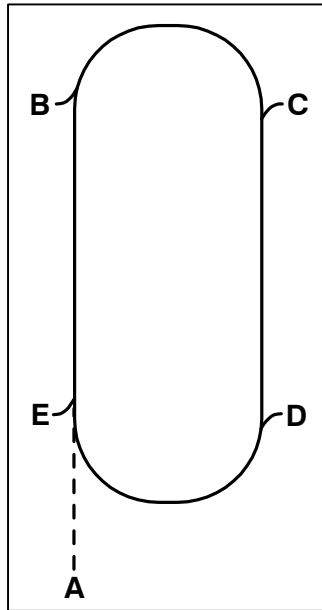
1. The runways shown in the figure below are imaginary.



2. Use the following steps to perform Pattern I:
 - a. At A, start timing for 2 min. from A to B.
 - 1) Reduce airspeed to approach airspeed during this interval.
 - b. At B, make a standard-rate turn to the left for 45°.
 - c. At the completion of the turn, time for 45 sec. to C.
 - d. At C, make a standard-rate turn to the right for 45°, back to the original heading.
 - 1) Fly 1 min. to D, extending the landing gear (if retractable) and flaps (as recommended).
 - e. At D, make a standard-rate turn to the right for 180°, rolling out at E on the reciprocal of the entry heading.
 - f. At E, enter a 500-fpm rate of descent.
 - 1) At the end of a 500-ft. descent, enter a straight constant airspeed climb, retracting the landing gear (if retractable) and flaps.
3. Use the following steps to perform Pattern II:
 - a. At A, start timing for 2 min. from A to B.
 - 1) Reduce airspeed to approach airspeed during this interval.
 - b. At B, make a standard-rate turn to the left for 45°.
 - 1) At the completion of the turn, time for 1 min. to C.
 - c. At C, make a standard-rate turn to the right for 180° to D.
 - d. At D, start timing for 1 min. 30 sec. to E.
 - 1) Extend the landing gear (if retractable) and flaps (as recommended) during the interval between D and E.
 - e. At E, make a standard-rate turn to the right for 180°, and roll out at F.
 - f. At F, enter a 500-fpm rate of descent.
 - 1) At the end of a 500-ft. descent, enter a constant airspeed climb, retracting the landing gear (if retractable) and flaps.

E. Holding Pattern

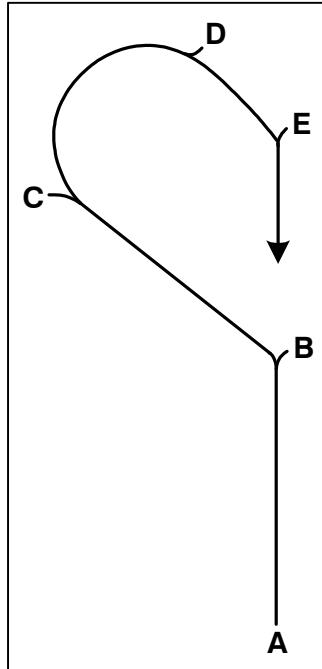
1. The entire pattern is flown in level flight.



2. Use the following steps to perform the holding pattern:
 - a. Time 3 min. straight-and-level flight from A to B.
 - 1) During this interval, reduce airspeed to holding airspeed.
 - 2) In your airplane, holding airspeed is _____.
 - b. At B, make a standard-rate turn to the right for 180°.
 - 1) Roll out at C on the reciprocal of your entry heading.
 - c. Time 1 min. straight-and-level flight from C to D.
 - d. At D, make a standard-rate turn to the right for 180°, rolling out on the original heading at E.
 - e. At E, time for 1 min. to B.
3. This pattern should also be performed using left turns.

F. Standard Procedure Turn

1. The entire pattern is flown in level flight.



2. Use the following steps to perform the standard procedure turn:
 - a. At A, start timing for 2 min. from A to B.
 - b. At B, make a standard-rate turn to the left for 45°.
 - 1) After rolling out, time for 1 min. to C.
 - c. At C, make a standard-rate turn to the right for 180°, and roll out at D.
 - d. At D, time for 45 sec. from D to E.
 - e. At E, make a standard-rate turn to the right for 45° to the reciprocal of the entry heading.
3. This pattern should also be performed with a right turn at B.

G. Common Errors in Basic Instrument Flight Patterns

1. **Failure to understand the principles of basic attitude instrument flying.**
 - a. Errors in these flight patterns relate to a fundamental weakness in basic attitude instrument flying.
2. **Failure to plan ahead.**
 - a. In performing these patterns, and later in operational instrument flight, you must plan ahead for what will happen next.
 - b. These patterns will help you to develop your ability to divide your attention and to plan ahead.

VOR TIME/DISTANCE CHECKS

A. General Information

1. The objective of performing VOR time/distance checks is to provide you with the knowledge to estimate the time and distance to a VOR station when you can receive only one VOR station and have no other navigation system available.
 - a. Knowledge of these procedures can also assist you in maintaining situational awareness, such as when you are being radar vectored for a VOR approach.
2. Time/distance computations are estimates since many factors limit the accuracy. Some of these factors include
 - a. Wind drift
 - b. Change in groundspeed due to heading changes
 - c. The assumption that a 1-degree angle is 1 NM wide at 60 NM from the station (an approximation)

B. Wingtip Bearing Change Method

1. The formula solution is applied to the elapsed time for a predetermined change in degrees (radials) from the airplane to a VOR station located at 90° from the airplane heading.
2. Determine the time/distance to a VOR station by the following steps:
 - a. Tune and identify the VOR station.
 - b. Determine the radial on which you are located.
 - c. Turn inbound to the VOR station and recenter the CDI if necessary.
 - d. Turn the airplane 80° right (or left) of the inbound course, and rotate the OBS to the nearest 10° increment opposite the direction of the turn.
 - e. Maintain heading. When the CDI centers, note the time.
 - f. Maintain the same heading and rotate the OBS 10° in the same direction as in step d. above.
 - g. Note the elapsed time when the CDI centers.
 - h. Time/distance from the station is determined from the following formulas:

$$1) \quad \textit{Time to station} = \frac{60 \times \textit{Minutes flown}}{\textit{Degrees change}} = \frac{\textit{Seconds flown}}{\textit{Degrees change}}$$

$$2) \quad \textit{Distance to station} = \frac{\textit{TAS} \times \textit{Minutes flown}}{\textit{Degrees change}}$$

NOTE: Seconds must be changed to decimal parts of a minute. For example, 2 min. 6 sec. would be 2.1 minutes.

C. Isosceles Triangle Method

1. Time/distance to a VOR station can also be determined by application of the isosceles triangle principle (i.e., if two angles of a triangle are equal, two sides are also equal), as follows:
 - a. With the airplane established inbound on a radial, rotate the OBS 10° to the left (or right).
 - b. Turn 10° to the right (or left) and note the time.
 - c. Maintain a constant heading until the CDI centers, and note the elapsed time.
 - d. Time to the station is the same time as the time taken to complete the 10° of bearing change.

D. Common Errors in VOR Time/Distance Checks

1. Incorrect tuning and identification procedures.

- a. Select the proper VOR station and tune the correct frequency into the appropriate VOR receiver. Frequencies are printed on IFR en route and terminal procedures charts.
- b. Before attempting to use the VOR, you must identify the station by its Morse code identifier. Some VORs use a voice identifier, which states the station's name followed by the letters V-O-R.

2. Incorrect rotation of the OBS.

- a. This error may initially be due to failing to visualize your position relative to the VOR station.
- b. Remember to visualize your position. Also remember that the course selected must be a radial that you are heading toward.

ADF TIME/DISTANCE CHECKS

A. General Information

1. The objective of performing ADF time/distance checks is to provide you with the knowledge to estimate the time and distance to an NDB station when you can receive only one NDB and have no other navigation system available.
 - a. Performing these checks is also an exercise in division of attention.
2. The accuracy of time/distance checks involves a number of variables, including existing wind conditions, accuracy of timing, and heading control.
 - a. Time checks, especially those involving a rapid rate of bearing change, demand precise techniques in basic instrument flying while you maintain heading and check the elapsed time.
3. The procedures are similar to the VOR procedures explained on the previous page and above.

B. Wingtip Bearing Change Method

1. To determine the time/distance to the NDB station, use the following steps:
 - a. Tune and identify the NDB station.
 - b. Determine the relative bearing from the NDB station, and turn the number of degrees necessary to place the ADF needle on 090° or 270° (fixed-card ADF).
 - 1) On a movable-card ADF, the ADF needle should be at a 90° angle to the airplane's heading; i.e., the NDB station should be abeam either the right or the left wingtip.
 - c. Note the time, and fly a constant heading (using the heading indicator) for a specific number of degrees of bearing change.
 - 1) The amount of bearing change flown varies with the observed rate of bearing change.
 - a) EXAMPLE: A 10° change at a considerable distance from the NDB station may take unnecessarily long; the time/distance check can be accomplished in this case by timing a 5° change.
 - d. Time/distance from the NDB station is determined by the following formulas:

$$1) \quad \textit{Time to station} = \frac{60 \times \textit{Minutes flown}}{\textit{Degrees of bearing change}} = \frac{\textit{Seconds flown}}{\textit{Degrees of bearing change}}$$

$$2) \quad \textit{Distance to station} = \frac{\textit{TAS} \times \textit{Minutes flown}}{\textit{Degrees of bearing change}}$$

NOTE: Seconds must be changed to decimal parts of a minute. For example, 2 min. 6 sec. would be 2.1 min.

C. Bow-to-Beam Bearing Method

1. Tune and identify the NDB station.
2. Turn the number of degrees necessary to place the ADF needle on 045° or 315° (fixed-card ADF) or 45° off the airplane heading (movable-card ADF).
3. Maintain heading until the ADF needle is on 090° or 270° (fixed-card ADF) or abeam the right or left wingtip (movable-card ADF), and note the elapsed time.
4. Time to the NDB station equals the elapsed time.
5. Use the distance-to-station formula to determine the distance to the NDB station.

D. Double-the-Angle-on-Bow Method

1. Tune and identify an NDB station that is between 10° and 45° off the nose position, and note the relative bearing.
2. Maintain a constant heading until the angle on the nose doubles, and note the elapsed time.
3. The time to the station equals the elapsed time.
4. Use the distance-to-station formula to determine the distance to the NDB station.

E. Common Errors in ADF Time/Distance Checks**1. Incorrect tuning and identifying procedures.**

- a. Select the proper NDB station, and tune the correct frequency on the appropriate navigation radio. Frequencies are printed on IFR en route charts and terminal procedure charts.
- b. Before attempting to navigate, you must identify the NDB station by its Morse code identifier.
 - 1) Since the ADF has no warning flag that a signal is unreliable, continuously monitor the NDB station's Morse code identifier to confirm signal reliability.

2. Failure to keep the heading indicator set with the magnetic compass.

- a. Check the heading indicator against the magnetic compass, and make corrections as necessary.
 - 1) This should be done after about 10 to 15 min. of straight flight and after any turn.

3. Failure to maintain selected headings.

- a. Any heading change is accompanied by an ADF needle change.
- b. This will cause errors in timing.