S-TEC

# ADF-650D
# Automatic Direction Finder System
# Pilot's Operating Handbook



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| List of Effective Pages | * Asterisk indicates pages changed, added, or deleted by revision. |
|---|---|

| Record of Revisions | Retain this record in front of handbook. Upon receipt of a revision, insert changes and complete table below. | |
|---|---|---|
| **Revision Number** | **Revision Date** | **Insertion Date/Initials** |
| 1st Edition | Dec 11, 00 | |
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# Table of Contents

# Table of Contents
# (Cont'd)

# List of Figures

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# SECTION 1
# OVERVIEW

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## 1.0 Overview

This document provides operating instructions for the **ADF-650D** Automatic Direction Finder System.

**NOTICE**

This handbook must be used in conjunction with the Federal Aviation Administration **(FAA)** approved Aircraft Flight Manual **(AFM)** or Aircraft Flight Manual Supplement **(AFMS)**. Refer to the applicable **AFM** or **AFMS** for aircraft specific information, aircraft emergency procedures, and return of aircraft to service.

## 1.1 System Description

The **ADF-650D** is a microprocessor-based system that operates over a frequency range of 200 through 1799 kHz in 1 kHz increments. Three operating modes are utilized in the **ADF-650D**: **BFO**, **ADF** and **ANT**.

The **BFO** (Beat Frequency Oscillator) and **ADF** (Automatic Direction Finding) Modes are navigation modes that result in pointing operation when an in-range station is selected. The **BFO** Mode is used to aurally identify stations that employ keyed **CW** (Carrier Wave) rather than amplitude modulation techniques. Keyed **CW** stations are found in Europe and other areas outside of the United States. The **ADF** Mode is used with conventional nondirectional beacons and **AM** broadcast stations.

The **ANT** (Antenna) Mode cannot be used for navigation; this mode enhances audio reception clarity and is normally used for station identification or voice/music listening on **AM** broadcast stations.

## 1.2 Equipment Description

The **ADF-650D** Automatic Direction Finder System consists of three main components; the **RCR-650D** Receiver, the **IND-650A** Indicator and the **ANT-650A** Antenna.

### 1.2.1 Receiver

The **RCR-650D** Receiver processes the **ANT-650A** Antenna signal to derive the relative bearing between the centerline of the aircraft and the selected station. The receiver also provides an output to the aircraft audio system for verifying the station identifier and for **AM** voice/music reception. An additional feature of the **RCR-650D** is a digital synchronous filter that improves operation in the presence of noise and also enhances operation with keyed carrier stations by preserving bearing information during the long periods of signal absence.


***Fig. 1-1. RCR-650D Receiver***

### 1.2.2 Indicator

The **IND-650A** Indicator features a manually rotatable compass card and a high visibility pointer. The output from the **RCR-650D** Receiver causes the Indicator pointer to rotate to the relative bearing between the aircraft centerline and the selected station. The manual heading selector knob allows for positioning of the present heading beneath the lubber line, which results in the indicator pointer displaying the magnetic bearing to the selected station.


***Fig. 1-2. IND-650A Indicator***

### 1.2.3 Antenna

The **ANT-650A** Antenna combines sense and loop antennas in a single integrated package to eliminate the traditional long-wire sense antenna. The **ANT-650A** offers clean aerodynamic styling that reduces drag and minimizes the adverse effects that icing can have on conventional installations.


***Fig. 1-3. ANT-650A Antenna***

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# SECTION 2
# CONTROLS AND DISPLAYS

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## 2.0 Controls and Displays

### 2.1 RCR-650D Receiver

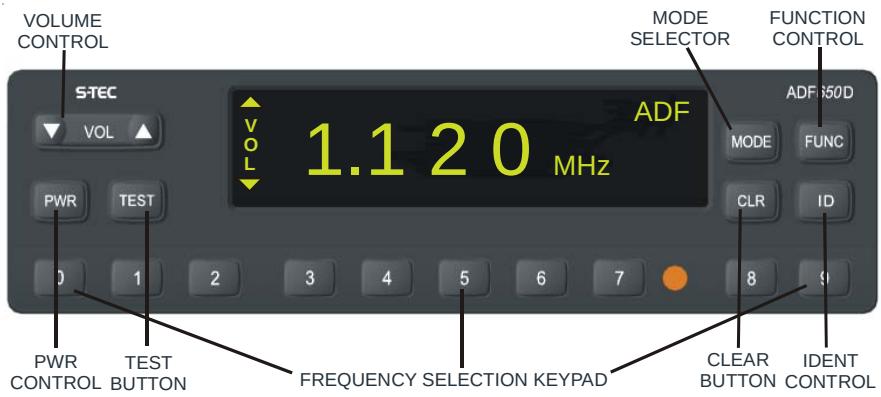


*Fig. 2-1. RCR-650D Receiver Controls*

#### 2.1.1 Power (PWR) Control

This control performs two main functions; to turn the receiver on and off. Depress the **PWR** button to turn on the **RCR-650D**. The receiver will immediately initiate a self test. During the self test, the receiver will display the "Self Test In Progress" message and Software Version with a moving (left to right) S-TEC logo. After a successful self test, the prior frequency settings will be displayed.

**NOTE: When turning the RCR-650D Receiver on, momentarily depress the PWR Button and release it. If the PWR Button is pressed for longer than 3 seconds the receiver will immediately shut off.**


*Fig. 2-2. Self Test*

**NOTE: The PWR Push Button remembers its current electronic state. For example, if the RCR-650D Receiver is on and power is removed (via the avionics master or radio circuit breaker), when power is reapplied the receiver will automatically come on. If the receiver is off and power is applied to the system, the receiver will stay off until the PWR Button is depressed.**

To turn off the **RCR-650D** Receiver during normal operations, depress the **PWR** Button. The "Powering down; release to restore" message will be displayed while the button **ID** depressed. If the Power Button is held for more than 3 seconds, the receiver will shut down. However, if the Power Button is released within 3 seconds, normal operations will resume.


***Fig. 2-3. Power Down***

### 2.1.2 Frequency Selection Keypad

Frequency numbers are entered into the **RCR-650D** Receiver using the 0 through 9 frequency selection keypad located on the bottom of the unit. The receiver is capable of tuning to any frequency between the range of 200 to 1799 kHz. When the first digit is entered, the unit clears the previous frequency display and displays dashes instead. If the first digit is a 1, the receiver expects that a frequency in the megahertz range is being tuned and places the first digit in the megahertz position.


***Fig. 2-4. Frequency, 1st Digit is 1***

If the first digit is 2 through 9, the receiver expects a frequency in the kilohertz range is being tuned, blanks the megahertz digit, and places the first digit in the 100 kilohertz position.

As subsequent digits are entered, the number appears in the location appropriate for the entry sequence. If a number is entered in error, pressing the clear button will erase the previously entered digit.

**NOTE: If the first two digits are 1 and 9 or 1 and 8 respectively, the receiver indicates flashing dashes (1799 kHz is the highest frequency number allowed).**

### 2.1.3 Clear

The clear function offers several options for the operator.

**1.** If the entire frequency is entered and the clear button is pushed, all the numbers will become dashes. An additional push on the clear button will restore and display the prior frequency entry.

**2.** If an entry is in progress and a number is entered in error, pressing the clear button will erase the last number entry.

**3.** Pressing the clear button while in the contrast function reverses the display image and also places the display in manual mode.

**NOTE: It is not necessary to push clear to enter a new frequency number. Simply enter the new numbers and they will replace the old frequency.**


***Fig. 2-5. Clear Mode***

### 2.1.4 Volume Control

The audio volume is controlled by pressing the ▲ and ▼ buttons on the volume control. The volume control is also used to adjust the settings and levels for all function selector and setup modes.

### 2.1.5 Function Selector

The function selector enables the user to select between contrast and volume display functions (on power-up, the **RCR-650D** will be in the volume display function). The first time the function selector is pressed, the receiver enters the contrast function. Subsequent presses of the function selector button toggles the unit between contrast and volume. Additionally, pressing the clear button while in the contrast function places the receiver in manual mode. In manual mode, subsequent pushes of the function selector will cycle the receiver through four functions: volume, contrast, display and keypad.

### 2.1.5.1 Volume

The volume control function is available on power-up and is accessed immediately by pressing the ▲ and ▼ buttons on the volume control. When the volume function is activated, the kHz and mode annunciations are temporarily replaced by the text **"VOLUME"** with a horizontal fill bar. The filled portion of the bar indicates the current volume setting. After approximately 5 seconds of inactivity on the volume control, the volume text and bar indicator are removed and the appropriate **kHz** and mode display are annunciated.

**NOTE: The RCR-650D Receiver also annunciates a Volume (VOL) Icon on the left side of the display panel. The icon remains on the annunciator unless in the Display, Contrast or Keypad function.**


*Fig. 2-6. Volume Function*

### 2.1.5.2 Contrast

The contrast function is entered by pressing the function selector. The contrast function is then activated and the **kHz** and mode annunciations are temporarily replaced by the text **"CONTRAST"** with a horizontal fill bar on the right side of the annunciator panel. The filled portion of the bar indicates the current contrast setting. The contrast is adjusted by pressing the appropriate ▲ and ▼ indicators on the volume control. After approximately 5 seconds of inactivity on the volume control, the contrast text and bar indicator are removed and the appropriate **kHz** and mode display are annunciated.

**NOTE: The RCR-650D Receiver also annunciates a Contrast (CON) Icon on the left side of the display panel. The icon remains on the display only while in the contrast function.**


*Fig. 2-7. Contrast Function*

**NOTE: Pressing the CLR button while in the contrast function reverses the display image and puts the receiver in manual mode. In manual mode, the user has access to display and keypad functions as well as contrast and volume functions.**

### 2.1.5.3 Display

The display function is entered by pressing the function selector to contrast and then pressing the **CLR** button. Next, press the function selector until the display function is selected. The display function is then activated and the **kHz** and mode annunciations are temporarily replaced by the text **"DISPLAY"** with a horizontal fill bar on the right side of the annunciator panel. The filled portion of the bar indicates the current display setting. The display is adjusted by pressing the appropriate ▲ and ▼ indicators on the volume control. After approximately 5 seconds of inactivity on the volume control, the display text and bar indicator are removed and the appropriate **kHz** and mode are annunciated.

**NOTE: The RCR-650D Receiver also annunciates a Display (DIS) Icon on the left side of the display panel. The icon remains on the annunciator only while in the display function.**


*Fig. 2-8. Display Function*

### 2.1.5.4 Keypad Light Brightness

The keypad light brightness setting is used to adjust the brightness of all legends on the display face. The keypad function is entered by pressing the function selector to contrast and then pressing the **CLR** button. Next, press the function selector until the keypad function is selected. The keypad function is then displayed with the text **"KEYPAD"** and a horizontal fill bar on the right side of the annunciator panel. The filled portion of the bar indicates the current keypad brightness setting. The brightness is adjusted by pressing the appropriate ▲ and ▼ indicators on the volume control.

**NOTE: The RCR-650D Receiver also annunciates a Keypad (KEY) Icon on the left side of the display panel. The icon remains on the display while in the keypad function.**


***Fig. 2-9. Keypad Function***

### 2.1.6 Mode Selector

The **RCR-650D** mode selector is used to select one of three system operating states: **BFO**, **ADF**, or **ANT**. The Beat Frequency Oscillator **(BFO)** and Automatic Direction Finding **(ADF)** positions are both pointing (Navigating) modes. These modes drive the **IND-650A** Indicator which will point toward the selected station when a valid signal is received. The Antenna **(ANT)** mode cannot be used for navigation and is normally used for station identification or when listening to voice and music broadcasts.

Pressing the mode selector button will step the receiver through the three modes. The current mode will be displayed in the upper right corner of the display. On system power-up, the **RCR-650**D will be in the **ADF** mode.


***Fig. 2-10. Mode Selector***

### 2.1.7 Ident (ID)

The receiver utilizes an Ident Filter for audio output. The Ident Filter, a narrow passband filter centered at 1020 **Hz**, aids in receiving weak signals. Pressing the **ID** button toggles the Ident Filter on and off. When the Ident Filter is active, the text **"IDENT"** is displayed in the bottom right corner of the display.


***Fig. 2-11. Ident (ID)***

### 2.1.8 Test Mode

Press the Test Button to start the test mode. The text **"TEST"** will be indicated in the bottom right corner of the display for approximately 15 seconds. During this time, the **ADF-650A** Indicator pointer will rotate 90º counterclockwise for bottom mounted antennas and clockwise for top mounted antennas. Press the Test button again to cancel the test while in this mode. The pointer will immediately return to its starting point.


***Fig. 2-12. Test***

## 2.2 IND-650A Indicator

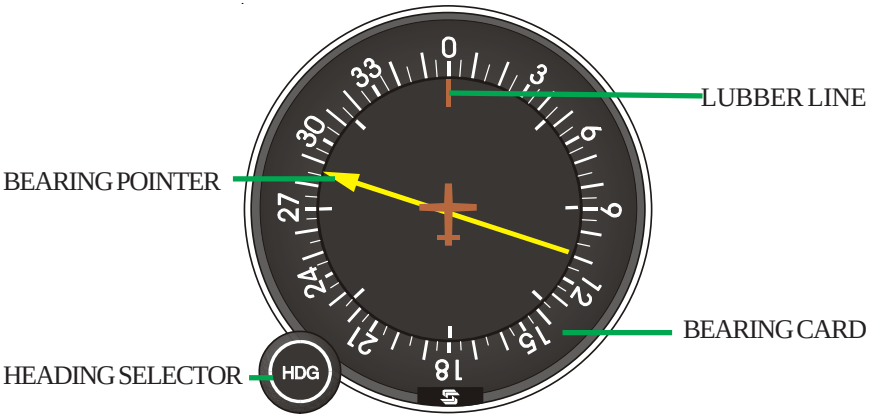


***Fig. 2-13. IND-650A Indicator***

### 2.2.1 Heading Selector

The heading **(HDG)** selector is used to rotate the instrument bearing card. The ability to rotate the bearing card eliminates the mental arithmetic normally required to determine the magnetic bearing to the station. Using the **HDG** knob, the current aircraft magnetic heading can be positioned above the lubber line. The pointer will then indicate the magnetic bearing to the station.

### 2.2.2 Bearing Card

The bearing card provides a 360º reference scale, graduated in 5º increments, that can be rotated so the pointer indicates the magnetic bearing to the station.

### 2.2.3 Lubber Line

The lubber line is a stationary reference point for setting headings.

### 2.2.4 Bearing Pointer

The bearing pointer indicates relative bearing between the centerline of the aircraft and the selected station. If the **HDG** selector is used to position the present aircraft heading above the lubber line, the bearing pointer will indicate the magnetic bearing to the station.

## 2.3 Installation Setup Mode

The function selector also includes a unique function called the installation setup mode. This special mode enables the installer to make initial display and volume settings by extending the setup options of the function selector to seven additional adjustment functions. These setup functions include **LCD** back light setup, contrast, keypad light brightness, threshold setup, display lighting, background display and volume control. The **LCD** back light setting is essentially the display function. The display, contrast, keypad and volume functions work exactly as the normal function selector functions and are explained in the previous paragraphs.

With power off, the setup mode is entered by pushing in and holding the function selector button while pressing the **PWR** button to turn on the receiver. Release the function selector after the receiver turns on. The function selector will now allow access to all seven functions.

### 2.3.1 Threshold Setup

In auto mode (background display mode set to auto), the threshold setup function is used to adjust the ambient light level at which the back light will change on the display face (from light to dark or dark to light). By adjusting the ambient light level, the receiver can also be setup to match an additional **ADF** (for example a Garmin **GTX**) in the aircraft. This will enable both units to change background lighting (at almost the same time) during peak light level changes (dusk and dawn). The threshold setup is selected by first entering the installation setup mode. Next, press the function selector until the appropriate function is selected. The threshold setup function is then displayed with the text **"THRESHOLD"** and a horizontal fill bar on the right side of the annunciator panel. The filled portion of the bar indicates the current threshold setting. The threshold is adjusted by pressing the appropriate ▲ and ▼ indicators on the volume control.

**NOTE: The RCR-650D Receiver annunciates a Display (DIS) Icon on the left side of the display panel. The icon remains on the display while in the threshold function.**


***Fig. 2-14. Threshold Function***

### 2.3.2 Display Lighting Setting

The display lighting setting enables the user to select from three different modes to adjust the brightness of the display. In **MAN** (manual) mode, the brightness is adjusted by pressing the function selector to display and pressing the appropriate ▲ and ▼ indicators on the volume control. In **OPTO** (optical sensor) mode, the brightness is adjusted automatically (using a built in photo cell) to ambient lighting. In **BUS** mode, the brightness is controlled by the aircraft lighting bus adjustment.

The display lighting setting is selected by first entering the installation setup mode. Next, press the function selector until the appropriate function is selected. The display setting is then displayed with the text **"OPTO**, **BUS** and **MAN"** and a horizontal fill bar on the right side of the annunciator panel. The filled portion of the bar indicates the current display lighting setting. The three modes of the display setting are adjusted by pressing the appropriate ▲ and ▼ indicators on the volume control.

**NOTE: There are only three settings on the horizontal fill bar. If the horizontal bar indicator is to the far left ▬, the BUS mode is selected. If the horizontal bar indicator is to the far right ▬, the MAN mode is selected. If the indicator is in the middle ▬, the OPTO mode is selected.**

**NOTE: The RCR-650D Receiver also annunciates a Display (DIS) Icon on the left side of the display panel. The icon remains on the display while in the lighting mode.**


***Fig. 2-15. Display Lighting Setting***

### 2.3.3 Background Display Mode

The background display mode enables the user to select from three different background display modes. In ▬ mode, the background is black and the text is green. In ▭ mode, the background is green and the text is black. In AUTO mode, the background and text are controlled by the photocell and the threshold setting. The background display mode is selected by first entering the installation setup mode. Next, press the function selector until the appropriate function is selected. The background mode is then displayed with the text **"AUTO**, ▭ and ▬" and a horizontal fill bar on the right side of the annunciator panel. The filled portion of the bar indicates the current background display mode setting. The three modes of the display setting are adjusted by pressing the appropriate ▲ and ▼ indicators on the volume control.

**NOTE: There are only three settings on the horizontal fill bar. If the horizontal bar indicator is to the far left, the ▭ mode is selected. If the horizontal bar indicator is to the far right, the ▬ mode is selected. If the indicator is in the middle (▬▭), the AUTO mode is selected.**

**NOTE: The RCR-650D Receiver also annunciates a Display (DIS) Icon on the left side of the display panel. The icon remains on the annunciator while in the background display mode.**


***Fig. 2-16. Background Display Mode***

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# SECTION 3
# ADF-650D OPERATION

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## 3.0 ADF-650D Operation

### 3.1 General

The **ADF-650D** System is a reliable navigation aid providing automatic pointing to low and medium frequency nondirectional beacons and standard broadcast stations. Navigation using **ADF** has an advantage over **VHF** equipment because the **"line of sight"** requirement does not exist. Even stations located over the horizon can be used for accurate **ADF** navigation. In addition to navigation, the **ADF-650D** may be used for reception of transcribed weather broadcasts and conventional **AM** broadcast programs for information and entertainment. Transcribed weather broadcasts can be heard over radio beacons having voice transmission capability. Stations providing this service are identified on most navigation charts.

### 3.2 System Operational Checkout


***Fig. 3-1. System Power On***

To activate the **ADF-650D** System, press the **PWR** button on the **RCR-650D** Receiver. After the self test is complete, input the desired station frequency using the 0 - 9 numeric keypad and select the **ANT** mode. Positively identify the selected station or beacon by listening for the Morse code or station voice identification. Adjust the volume control as required to provide a comfortable listening level.

If the **ADF-650D** System is used for navigation, select the **ADF** or **BFO** mode immediately after the station has been positively identified. The **BFO** mode is not used in the United States, but some countries do operate stations that make the **BFO** mode necessary. Basically, the stations that require its use **(BFO)** transmit a signal that does not contain any audio. Selection of the **BFO** mode tells the receiver that it must add an audio component to the received signal so that you can hear the station identification code. That is the main difference between the **BFO** and **ADF** modes.

To ensure that the system is operating properly, push the **TEST** button after the station has been identified and the **ADF** or **BFO** mode is selected. If the system is operating properly and a reliable signal is present, the **IND-650A** Indicator Pointer will rotate 90º and stop. When the **TEST** button is pushed again, the pointer should return to its original position. Successful completion of the **TEST** function indicates that the **ADF-650D** System is ready for use as a navigation aid.

### 3.3 Preflight Checklist and Self Test

**1.** Turn the system on by depressing the **PWR** button.

**2.** After a successful self test, press the mode control until **ANT** is displayed and input a predetermined frequency to select a station in the immediate area. Adjust the volume control, as necessary, to provide a comfortable listening level.

**3.** Press the **ID** button and observe that the station identification code becomes louder (if the station is voice-identified, it is not necessary to press the **ID** button).

**4.** Press the **ID** button again to cancel the **IDENT** function and press the mode control until **ADF** is displayed.

**5.** Observe the I**ND-650A** Indicator and note that the bearing pointer indicates the relative bearing to the station.

**6.** Push the **TEST** button while observing the indicator bearing pointer. The bearing pointer will rotate 90º and stop.

**7.** Push the **TEST** button again (to turn off test function). The bearing pointer returns to the original relative bearing position.

**8.** Switch to **BFO** mode, if appropriate, and verify a tone is present. Select the appropriate operating mode when all checks have been completed.

### 3.4 Basic ADF Indications

The **IND-650A** Indicator bearing pointer always points to the station and the indicator lubber line always represents the nose of the aircraft. The indicator includes a fixed aircraft symbol on its face to help visualize the direction in which the station lies relative to the aircraft nose.

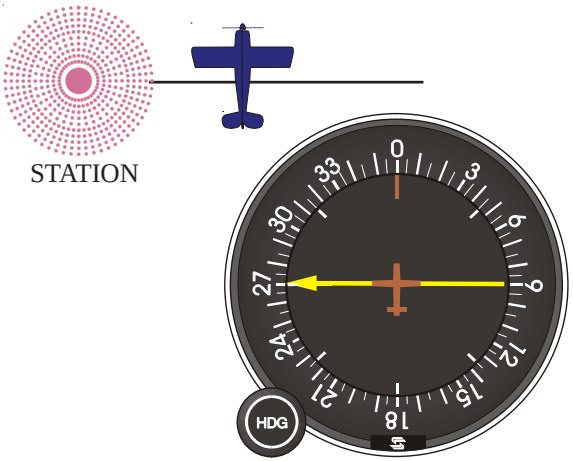


***Fig. 3-2. ADF Indications***

## 3.5 ADF-650D Navigation Techniques

### 3.5.1 Tracking

Tracking is simply flying a selected course toward or away from the station. This technique presents no real problems provided there is no wind. When wind is introduced, the situation changes somewhat and tracking then requires more finesse.

When wind is present, tracking becomes a process of continually making progressively smaller corrections to the desired heading until a stabilized on track condition exists.

### 3.5.2 Homing

Homing is flying toward the station, without correcting for the effects of wind, by adjusting heading to maintain a relative bearing of 0 degrees. In other words, homing is turning to put the bearing pointer on the lubber line and then changing heading as required to keep the bearing pointer on the lubber line. The end result of homing is an unprofessional and inefficient curved path to the station. Attempts to home away from a station will result in the display of completely meaningless information on the **IND-650A** Indicator. Because of this, homing is a marginal **VFR** navigation technique at best and is totally unreliable for **IFR** navigation.

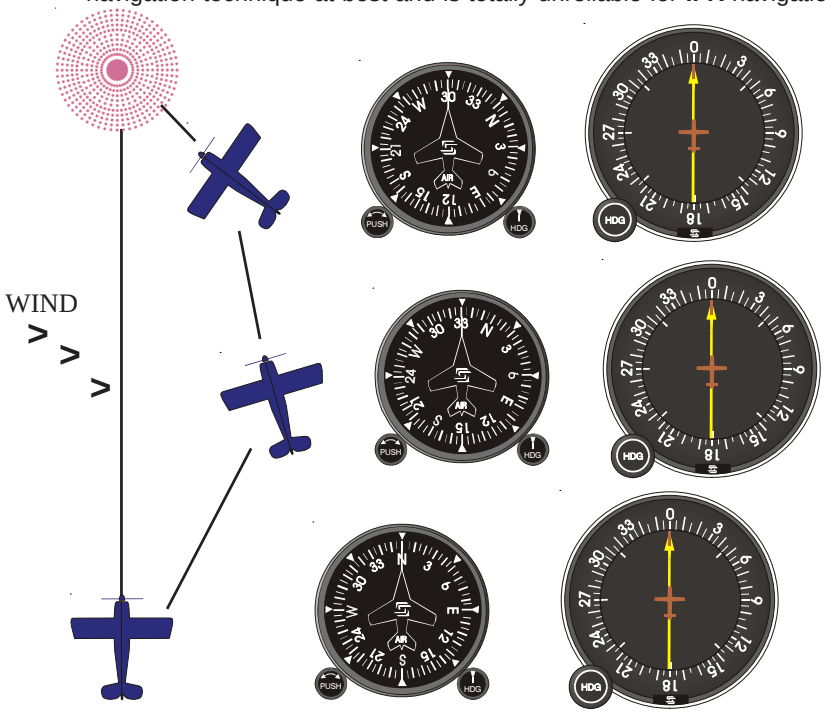


***Fig. 3-3. Homing***

### 3.5.3 Defining Relative and Magnetic Bearing

Relative bearing is the relationship between the nose of the aircraft and the direction to the station. The relative bearing to the station, read directly from the **IND-650A**, indicates the angular difference between the aircraft heading **(nose)** and a line projected from the aircraft to the station. Magnetic bearing is the aircraft magnetic heading added to the indicated relative bearing. The magnetic bearing, when calculated and flown will lead directly to the station.

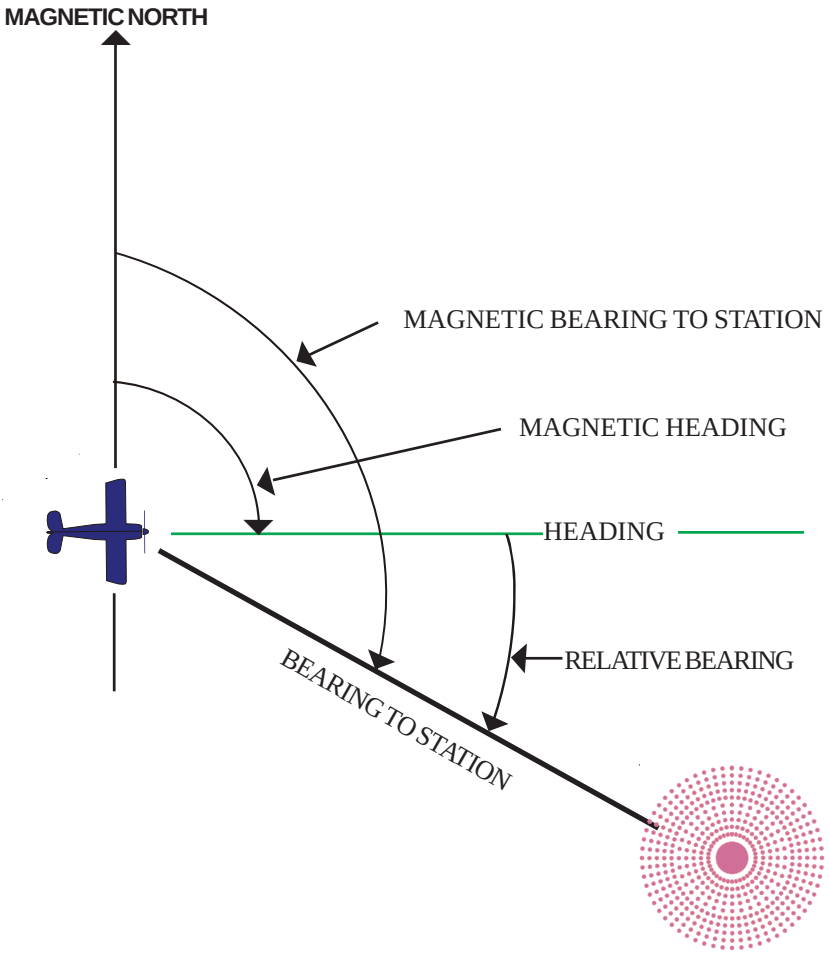


***Fig. 3-4. Relative and Magentic Bearing***

### 3.5.4 Determining the Magnetic Bearing to the Station

One method of determining the magnetic bearing to the station is to observe the current magnetic heading on the Directional Gyro or magnetic compass and add this to the relative bearing indicated on the **IND-650A** Indicator when the bearing card is set to zero.

For example, Lets assume the aircraft magnetic heading is 300º and the indicated relative bearing is 340º. Adding these two numbers together yields 280º (whenever the sum is greater than 360º, subtract 360 from the calculated bearing; that is, 640 - 360 = 280). Tracking a 280º magnetic bearing in this example will lead directly to the station.

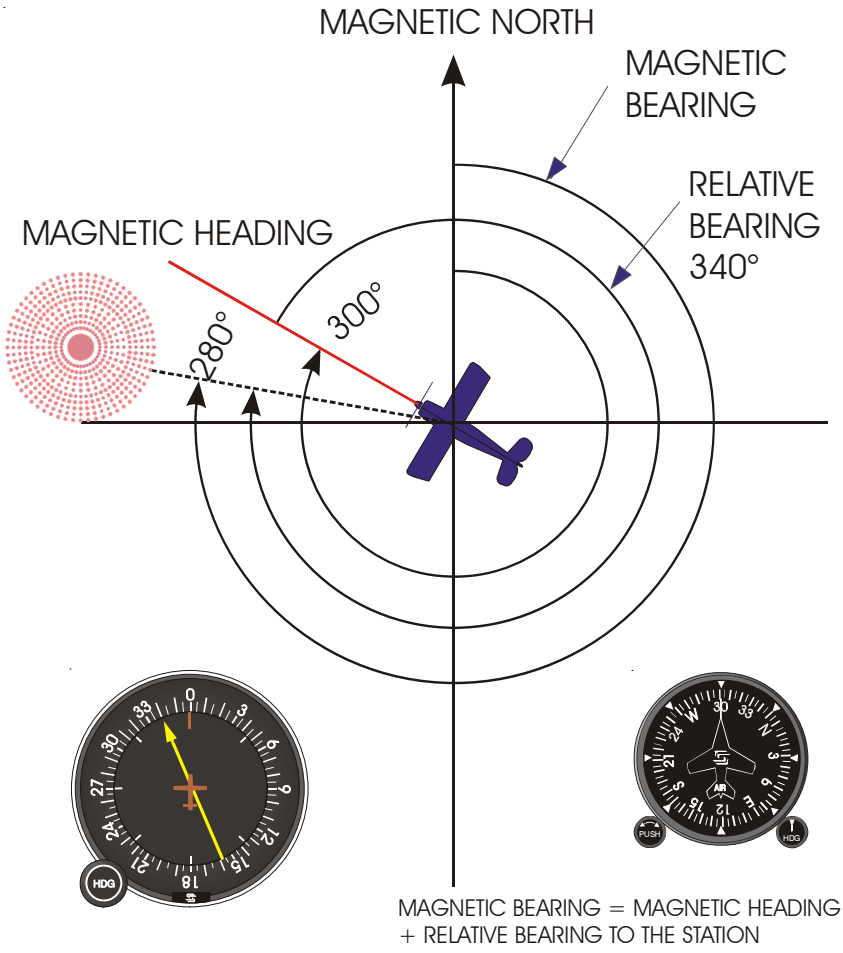


***Fig. 3-5. Determining Magnetic Bearing Using DG***

An alternate method of quickly determining the magnetic bearing to the station is accomplished using the **IND-650A HDG** knob. The **IND-650A** Indicator compass card can be rotated (using the **HDG** knob) to position the current magnetic heading above the lubber line. With the compass card in this position, the magnetic bearing to the station will be indicated by the bearing pointer.

When the **HDG** knob is used to rotate the compass card for magnetic bearing calculations, the magnetic heading must be kept up-to-date and centered above the **IND-650A** each time a reading is accomplished.

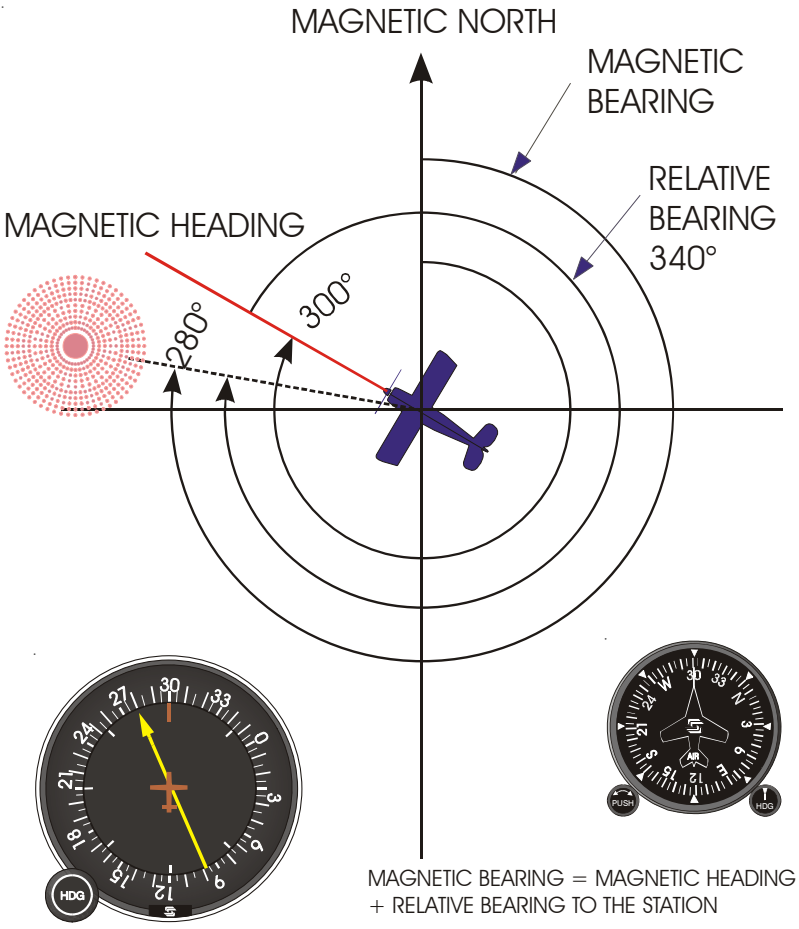


***Fig. 3-6. Determining Magnetic Bearing Using HDG Knob***

### 3.5.5 Interception of an Inbound or Outbound Bearing

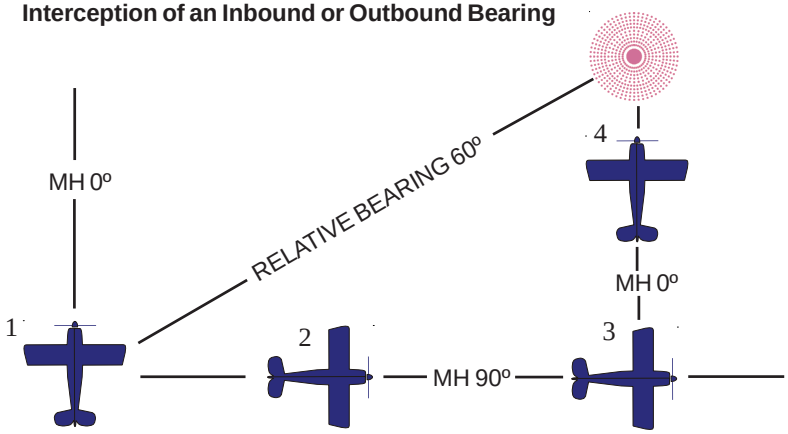


***Fig. 3-7. Intercepting a Course Line***

To intercept a course line with an assigned or desired magnetic bearing to the station, first turn the aircraft to the same magnetic heading as the bearing of the course line to be intercepted as shown in view 1 of the above figure. Next, observe the relative bearing to the station on the **IND-650A** (60º in the above example) and double this indication to determine the angle of interception. Since it is not advantageous to intercept a bearing at more than 90º, the intercept angle should be limited to not more than 90º or less than 20º (an intercept angle in this range ensures an expeditious capture of the desired course). In the above example, the intercept angle is 90º since twice the relative bearing is 120º. Turn the aircraft to a magnetic heading of 90º as shown in view 2 above and hold this heading until the bearing pointer moves from the lubber line the number of degrees equal to the intercept angle. In the above figure, course interception will be indicated when the bearing pointer is 270º or 90º left of the lubber line as shown in view 3 above.

Finally, upon course interception, turn inbound and track to the station. The amount of turn lead required for a smooth transition to the desired course will depend upon aircraft speed and distance to the station. The key to estimating the correct amount of lead is based upon the turn rate of the **ADF** bearing pointer (the bearing pointer turn rate is directly related to the course closure rate).

Interception of an outbound magnetic bearing is accomplished using the same procedures except that the 180º position is used for reference rather than the lubber line.

> **NOTE: When turning to the inbound or outbound heading upon interception of the desired course, always complete the turn and rollout on the course heading using the directional gyro (remember to add some crab if wind is a factor). After establishing a straight and level attitude, check the ADF relative bearing and make corrections as necessary to remain on the desired course.**

**NOTE: Do not rely upon the ADF-650D System while turning. This usually leads to overshoot of the desired heading due to two characteristics of the ADF operation. First, ADF relative bearing indication is affected by bank angle and is accurate only in straight and level flight. Second, electronic filtering used in ADF's to improve performance in the presence of atmospheric noise causes a lag in relative bearing indication during a turn. For this reason, a few seconds may be needed for the needle to catch up after a turn.**

### 3.5.6 Determining Your Position

To determine your position, first select and positively identify a station in the vicinity. After the station has been identified, observe your magnetic heading and rotate the **IND-650A** bearing card using the **HDG** knob until your magnetic heading is positioned above the lubber line. With the current magnetic heading positioned above the lubber line, the **IND-650A** bearing pointer will indicate your magnetic bearing to the station.

In the example below, the magnetic bearing to the station is 270º, and the local magnetic variation is 005º east. Since the magnetic variation is easterly, add it to the 270º magnetic bearing to obtain a true bearing of 275º to the station. The true bearing from the station is the reciprocal of 275º or 95º.

**NOTE: Remember that the magnetic north pole and the true north pole are not the same and some variation must always be taken into account when using your ADF-650D System for a position fix. Variation in the United States ranges from 20º east in Oregon to 22º west in Maine and the effects on navigation can be substantial.**

**NOTE: If variation is easterly, add it to the indicated magnetic bearing to arrive at the true bearing. If variation is westerly, subtract it from the indicated magnetic bearing to arrive at the true bearing. Don't become confused by the old "east is least and west is best" adage. It only works when converting from true course or heading to magnetic course or heading.**

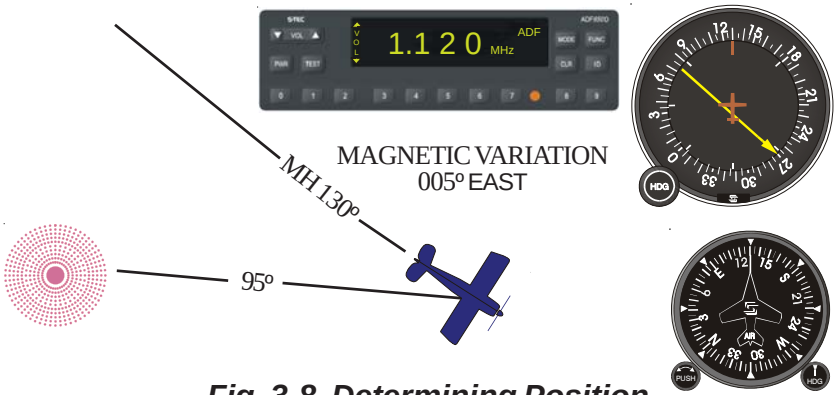


***Fig. 3-8. Determining Position***

Next, select another station in the area and obtain your magnetic bearing to that station. As shown in the example below, the magnetic bearing to the second station is 210º as indicated by the **IND-650A** bearing pointer. Add 005º magnetic variation to the reciprocal of 210º or 30º and draw the 35º line from the second station out until it intersects with the 95º line from the first station. The point at which these two lines intersect is the approximate position of the aircraft.

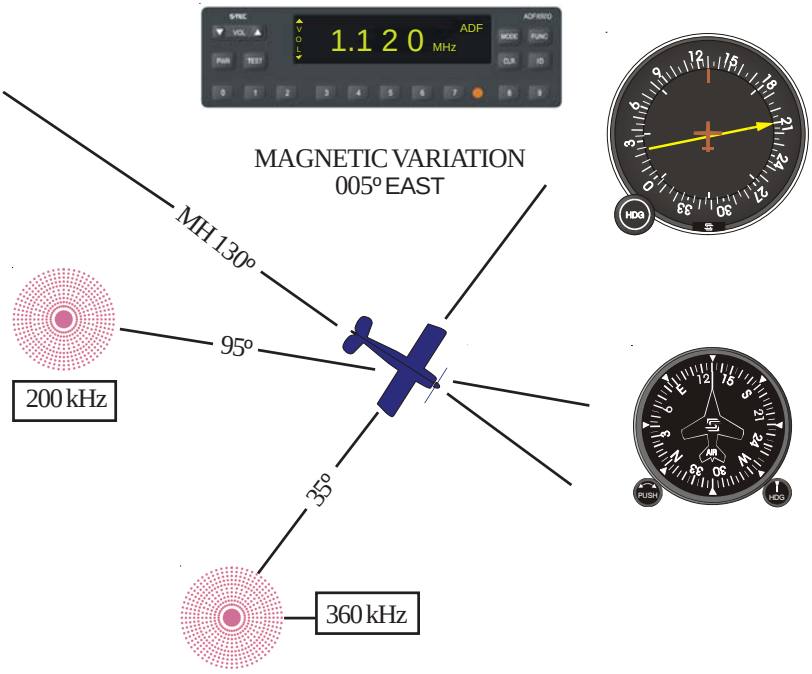


***Fig. 3-9. Determining a Second Position***

### 3.5.7 NDB Approach

An **NDB** (Nondirectional beacons) Approach (also commonly referred to as an **ADF** approach) requires a high level of skill in the use of basic flight and navigation instruments. **NDB** approaches require lots of practice with a periodic brush-up on the side to maintain proficiency once the procedure has been mastered.

Keep in mind that the **NDB** may be located in a vast number of locations relative to the approach end of the runway (on the field, as much as 5 or more miles away, on or opposite to the approach end of the runway, etc.). Figure 3-10 examines a typical **NDB** approach and procedures involved.

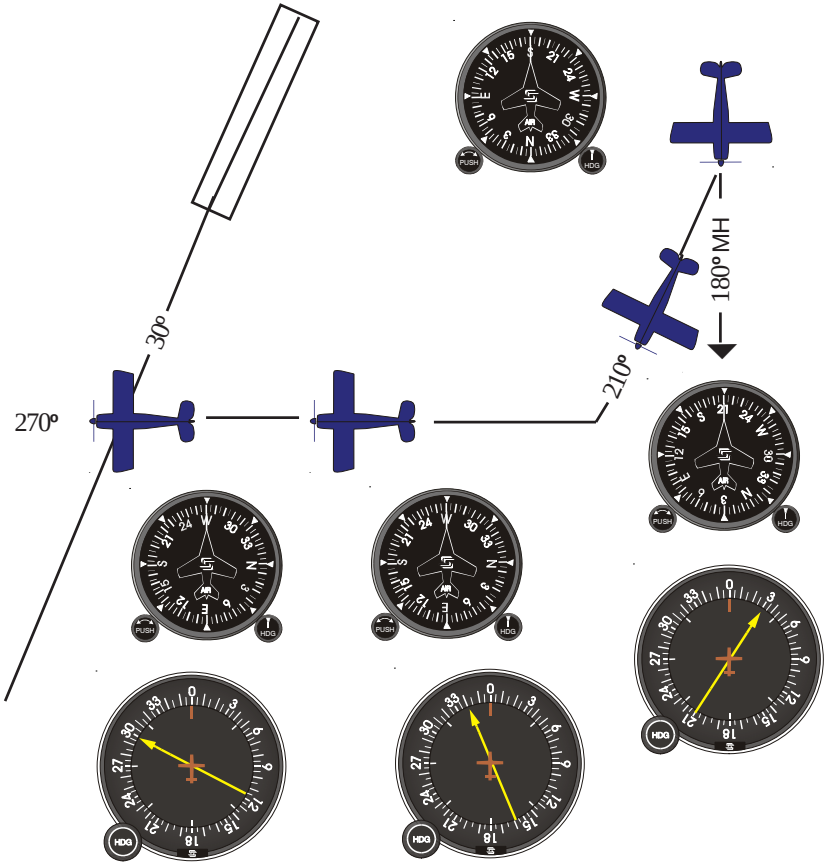


***Fig. 3-10. NDB Approach***

In the above example, the aircraft is flying a magnetic heading of 180º and an **NDB** approach to runway 3 is to be made using the compass locator at the outer marker. The first step in executing the approach is to turn the aircraft to a heading that is parallel to runway 3. In the above example, the parallel heading is 210º (reciprocal of 30º). Once established on the 210º heading, observe the indicated relative bearing to establish position relative to the compass locator. In this case, the indicated relative bearing is 30º. This relative bearing indicates that the desired track is off the right wing and that the compass locator lies ahead. A course intercept angle is now selected by doubling the relative bearing (remember to limit the course intercept angle to not more than 90º and not less than 20º). This heading will be held until approximately 5º before arriving at the desired course. At this time, a turn toward the station is made using the directional gyro to roll out on course. In the example, a 60º intercept angle is used. Steering a magnetic heading of 270º will yield the desired intercept angle. Course interception will be indicated when a relative bearing of 300º is shown on the indicator.

Once established on the inbound track to the locator, the course is held until station passage (noted by 180° bearing indicator reversal). Upon passage, continue tracking outbound; this heading should be held for 2 to 3 minutes, after which time a procedure turn is initiated. A procedure turn is accomplished as follows: (1) a 45° turn to the left is executed (to the right, if specified on the approach plate) and when complete, the new heading is held for 1 minute, (2) a 180° turn to the right is completed and the new heading is held for a 45° inbound course interception, (3) course change is initiated when a relative bearing of 40° is observed (5° is reserved for the turn). Once the inbound course to the station has been intercepted (30° in the example), track to the station and precisely hold the desired magnetic bearing. After station passage, track outbound from the station to the approach end of the runway. Once again, be careful to hold a precise magnetic bearing through the entire procedure and avoid "needle chasing".

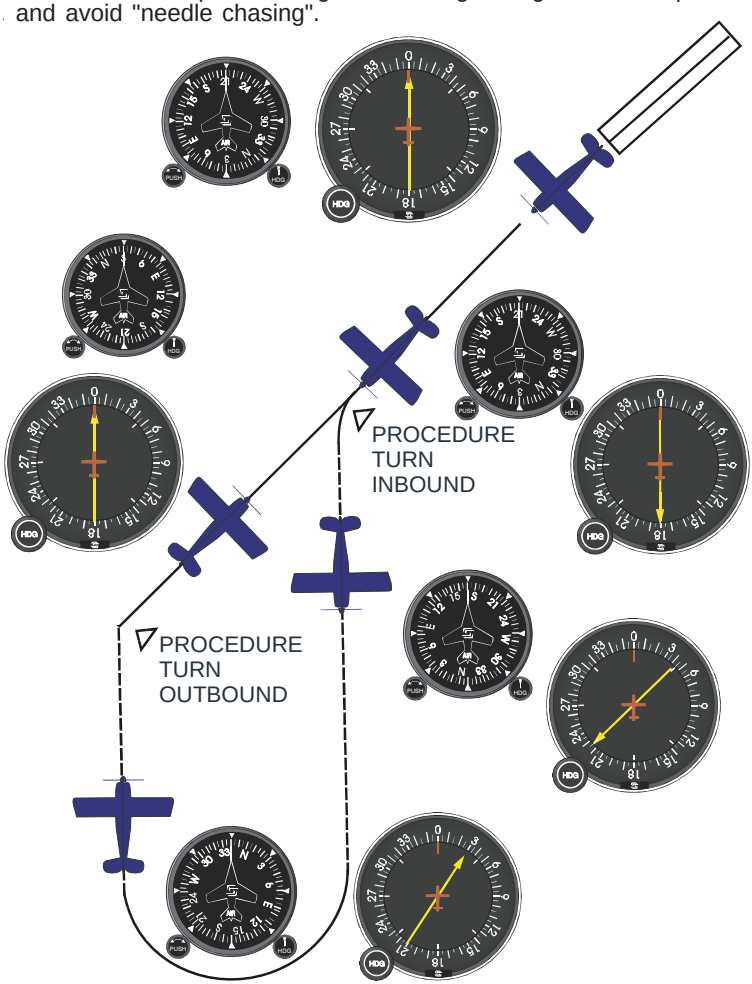


***Fig. 3-11. NDB Approach, Procedure Turn***

### 3.5.8 ADF Holding Pattern

An **ADF** holding pattern is flown using the following procedure:

**1.** Fly the inbound course directly over the station and make a 180º standard rate turn upon station passage (recall that station passage is indicated by a bearing pointer swing past the wing tip position).

**2.** As soon as you recognize station passage, make a standard rate turn to the outbound holding pattern heading.

**3.** If wind correction is required, put it in now. The wind correction angle flown inbound should be doubled on the outbound leg to compensate for drift during the two 180º standard rate turns. Timing the outbound leg begins as you roll out from the standard rate turn.

**4.** Fly the outbound leg for the specified time and then make another 180º standard rate turn onto the inbound leg.

**5.** Track the inbound course to the station and repeat the entire procedure, if continued holding is required.

If correct inbound and outbound drift correction angles were applied in the holding pattern, your **ADF** bearing pointer should read zero, plus or minus the appropriate drift correction angle, as you complete the turn to track inbound to the station.

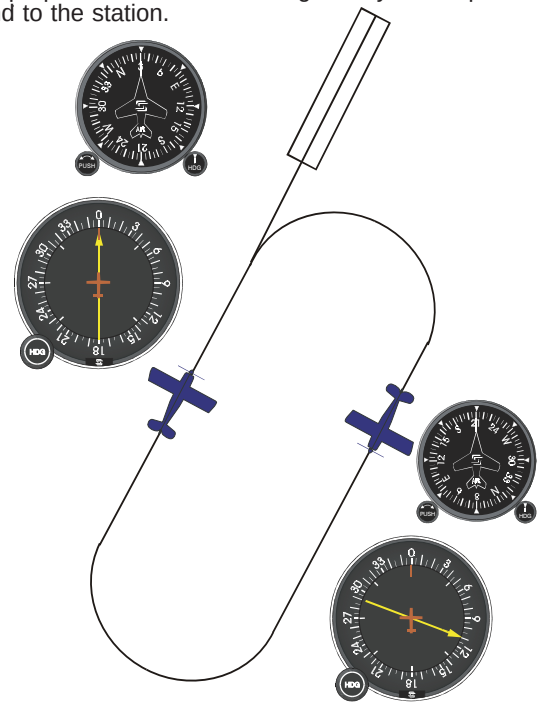

***Fig. 3-12. ADF Holding Pattern***

# SECTION 4
# ADDITIONAL INFORMATION

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## 4.0 Additional Information

### 4.1 Points to Remember

**CAUTION**

**The ADF-650D System has been designed to exhibit a very high degree of functional integrity. Nevertheless, the user must recognize that failures are possible and may not always be obvious in nature. It is your responsibility to detect a malfunction by means of cross checks with redundant or correlated information available in the cockpit.**

**1.** Use the **ANT** mode and press the **ID** button for clearer audio reception.

**2.** Always aurally identify the selected station before using it for navigation.

**3.** Functional testing of the **ADF-650D** system can be accomplished only in the **ADF** and **BFO** modes.

**4.** The **BFO** mode enables a tone generator to make identification of **CW** (Carrier Wave) signals possible.

**5.** Aircraft attitude influences relative bearing indications. Maximum accuracy is obtained in a straight and level attitude; the bearing indication is often incorrect when the aircraft is banked. Attempts to read relative bearing in a turn will result in some error due to (a) time lag of the bearing pointer and (b) bank error.

**CAUTION**

**Instrument approaches in Instrument Flight Rules (IFR) conditions may be conducted in accordance with approved procedures by appropriately rated pilots only. Practice approaches under Visual Flight Rules (VFR) conditions in controlled airspace should normally be authorized by Air Traffic Control.**

**6.** Compass locator transmitters are often situated at either the middle **(LMM)** or the outer **(LOM)** marker beacon sites. The operating frequencies are between 200 and 415 kHz with an effective range of at least 15 miles. At some locations, higher powered radio beacons are used as outer marker compass locators. These generally carry transcribed weather broadcast information. Compass locators transmit 2-letter **ID** groups. The outer locator transmits the first two letters of the localizer **ID** group and the middle locator, the last two letters of the group.

**CAUTION**

**Non-directional beacon signals are subject to interfering signals that could result in erroneous bearing information. Nearly all disturbances which affect ADF bearing will be apparent in the audio along with the station identification. Interfering voice, music or erroneous identification signals should be regarded as a warning that erroneous bearing information could be displayed.**

**CAUTION**

**Standard broadcast stations are not authorized for primary IFR navigation.**

## 4.2 ADF Limitations

**1.** In some parts of the world, commercial or government operated broadcast stations may be the only navigation aids available. Broadcast stations can often be used to supplement the low frequency navigation facilities, but they must be used with care. Several limitations of these stations should be understood before they are used for air navigation.

**a.** At broadcast frequencies, the ground waves may be overridden by unreliable skywaves, particularly at night.

**b.** More than one station may be transmitting on the same frequency in a given area. It is absolutely necessary to aurally identify the station being used. Check for time of operation, frequency, and call letters of the station to ensure that the correct station is being received. If it appears that signals from two stations are being received, don't attempt **ADF** aided navigation on that frequency.

**c.** For best results in **ADF** use of broadcast stations, try to choose stations of relatively high power and low frequency.

**2.** The propagation path of low frequency transmissions is affected by variations in terrain. This can result in inaccurate **ADF** bearings when a shoreline is located between the aircraft and the station or when the propagation path is **"bent"** by mountainous terrain.

**3. ADF** navigation is based upon the reception of ground waves from the transmitter. During the evening hours, skywaves reflected from the ionosphere may interfere with the ground waves where they are weak. This may result in inaccurate **ADF** bearings that fluctuate with the skyway path. In severe situations, the pointer may be wrong by 180º.

**4.** Severe atmospheric or precipitation static can disrupt **ADF** performance. These noise sources normally result in erratic bearing pointer movement and can ultimately make **ADF** navigation impossible.

**5.** Aircraft attitude influences relative bearing indications. Maximum accuracy is obtained in straight and level flight; the bearing indication is often incorrect when the aircraft is banked. Attempts to read relative bearing in a turn will result in some error due to (a) time lag of the bearing pointer and (b) bank error.

## 4.3 What To Do When the ADF-650D System Doesn't Appear to Be Working Properly

**1.** Check the selected frequency against the frequency listed on your chart to ensure that they are the same.

**2.** Be sure to aurally identify the selected station; the **ADF** could be pointing to another station on the same frequency.

**3.** Check station operating hours and current Notices to Airmen **(NOTAM's)** to ensure that the station is operational.

**4.** Verify that the system is being supplied operating power; check that the **PWR** button is depressed to on and that the **ADF** circuit breaker is set.

**5.** If you want the **ADF** to point, check that the **ADF** or **BFO** mode is selected.

**6.** If you want to listen to music, check that the **ANT** mode is selected.

**7.** If the system doesn't seem to be pointing properly in the **ADF** or **BFO** mode, push the **TEST** button. The bearing pointer should rotate 90º from its present position. Push the **TEST** button once again. As soon as the button is released, the bearing pointer should begin returning to the same position it occupied before the **TEST** button was pushed. If the bearing pointer returns to its original position, the system is very likely okay and is pointing properly. If the bearing pointer doesn't return to the original position, the selected station may be out of range, one of the **ADF** limitations has been exceeded, or the system is defective.

**8.** If the keypad functions appear to be locked, recycling power may clear the condition.

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# SECTION 5
# APPENDIXES

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# Appendix A:
# Specifications

**RCR-650D Receiver**

| | | | |
|---|---|---|---|
| Operating Input Voltage | +11 VDC | to | +15.1 VDC |
| Operating Temperature | -15 °C | to | +71 °C |
| Storage Temperature | -54 °C | to | +71 °C |
| Weight (Maximum) | 2.44 lb. | | |
| Length | 9.78 in. | | |
| Width | 6.25 in. | | |
| Height | 1.75 in. | | |

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# SECTION 6
# GLOSSARY

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## GLOSSARY

| Term | Meaning |
|---|---|
| ADF | Automatic Direction Finding |
| ANT | Antenna |
| AUTO | Automatic |
| BFO | Beat Frequency Oscillator |
| C | Centigrade |
| CLR | Clear |
| CON | Contrast |
| CONT'D | Continued |
| CW | Carrier Wave |
| DIS | Display |
| HDG | Heading |
| ID | Ident |
| IFR | Instrument Flight Rules |
| IN. | Inches |
| KEY | Keypad |
| kHz | Kilo Hertz |
| LB. | Pound |
| LCD | Liquid Crystal Display |
| MAN | Manual |
| MH | Magnetic Heading |
| NDB | Nondirectional beacons |
| NOTAM | Notice to Airmen |
| OPTO | Optical Sensor |
| POH | Pilot Operating Handbook |
| PWR | Power |
| VDC | Volts Direct Current |
| VOL | Volume |
| VFR | Visual Flight Rules |
| º | Degrees |

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Notice: You must contact S-TEC Customer Support at 800-872-7832 for a Return Material Authorization (RMA) number prior to the return of any component for any reason.

P/N: 87111
Date: 11 Dec 00
Printed in USA