$7.00 U.S.

Pilot's Guide for the Stormscope®

Series II Weather Mapping Systems

Model WX-950

BFGoodrich Aerospace

Avionics Systems

BFGoodrich FlightSystems, Inc.

Stormscope® System Advantages

Welcome

BFGoodrich Avionics Systems, the world's most experienced company in airborne thunderstorm avoidance instruments, is pleased to welcome you to the family of tens of thousands of pilots who are enjoying the benefits of safer flight with a *Stormscope*® weather mapping system.

The Original

Don't be fooled by *Stormscope*® system look-alikes. There is only one *Stormscope*® system, and only one company that makes the *Stormscope*® line of weather mapping systems. The *Stormscope*® system, the original, most accurate weather mapping system is now manufactured by BFGoodrich Avionics Systems.

Fly with Greater Confidence

You now own the leading instrument in the world for airborne detection and mapping of thunderstorms. Unlike any other product, your new *Stormscope*® system will enable you to make better informed thunderstorm avoidance decisions so you can fly more safely and with greater confidence than ever before.

Convenient Features

The advanced, patented technology in your new *Stormscope*® system was developed over many years and is so unique, so revolutionary, it surpasses all others. Here are some of its features:

-Precisely maps electrical discharges

-Operates in 25, 50, 100, and 200 nmi ranges

-Displays airspace in 120° forward view and 360° surrounding view

-Uses a high resolution 3-inch ATI CRT display/processor

Easy to Use

The *Stormscope*® system is extremely user friendly as a result of extensive ergonomic analyses by pilots from all segments of aviation and incorporation of this information by Human Factors engineers into the *Stormscope*® system design.

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Pilot's Guide
for the
Stormscope®
Series II Weather Mapping Systems
Model WX-950

Designed and manufactured in the United States of America by

BFGoodrich Aerospace
Avionics Systems

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Safety Summary

The following warnings and cautions appear in this guide and are repeated here for emphasis:

WARNING

The illustrations in this guide are only examples. Never use your *Stormscope®* system to attempt to penetrate a thunderstorm. The FAA Advisory Circular, Subject: Thunderstorms, and the Airman's Information Manual (AIM) recommend that you "avoid by at least 20 miles any thunderstorm identified as severe or giving an intense radar echo."

CAUTION

There are several atmospheric phenomena other than nearby thunderstorms which can cause isolated discharge points in the strike display mode. *Clusters* of two or more discharge points in the strike display mode however *do* indicate thunderstorm activity when they reappear after clearing the screen. Avoid the clusters and you'll avoid the thunderstorms. In the cell display mode, even a single discharge point may represent thunderstorm activity and should be avoided.

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System Description

General Description

The *Stormscope*® Series II Weather Mapping System, model WX-950 detects electrical discharges associated with thunderstorms within a 200 nmi radius of the aircraft and displays the location of the associated thunderstorms.

The *Stormscope*® system is a passive system that listens for electromagnetic signals with a receiving antenna. There's no transmitter and no harmful transmissions. The system operates as well on the ground as in the air, thereby giving the pilot important planning information even before takeoff.

Figure 1-1 shows the two major components of the *Stormscope*® system. Figure 1-2 shows how the components are connected to each other and to other aircraft systems.

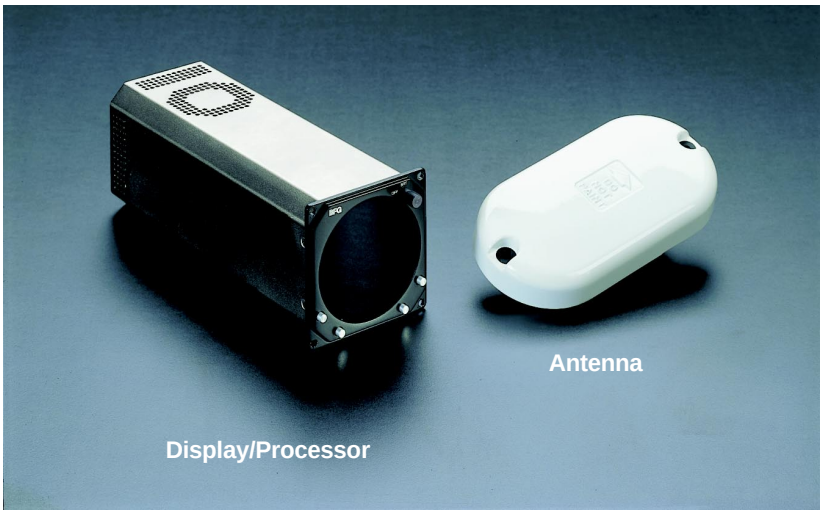

Figure 1-1. WX-950 System Components

Display/Processor

The display/processor mounts into any standard 3-inch ATI cutout in the aircraft instrument panel. The display/processor houses two main functional components: a high resolution, raster scan CRT display with a dedicated graphics controller, and two powerful processors on which the *Stormscope*® software runs. The processors are reprogrammable to allow for future enhancements to the lightning detection software.

Antenna

This combined crossed-loop and sense antenna is sealed in an aerodynamic flat-pack and mounted on the outside of the aircraft. The *Stormscope*® system can correlate the electric and magnetic signatures of lightning strikes

better than other systems due to its patented sense channel technology. The antenna has also been improved for the model WX-950 *Stormscope®* system to help filter out pulsed noise from sources other than atmospheric electrical discharges.

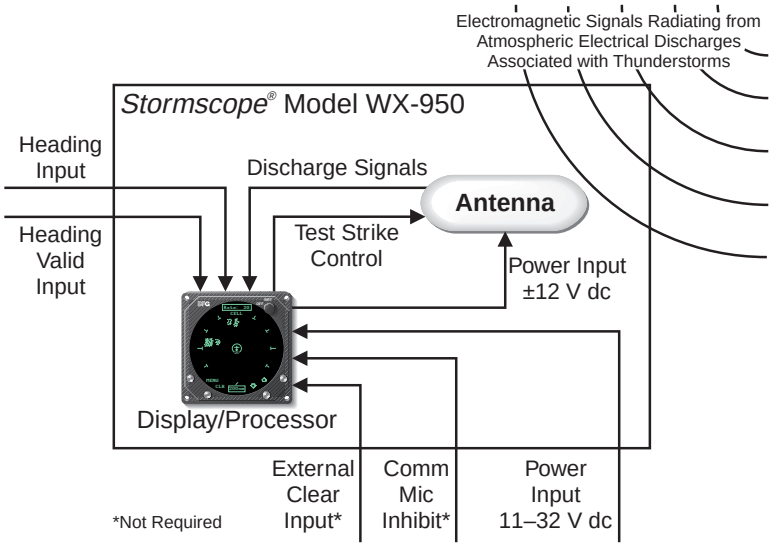

Figure 1-2. WX-950 Functional Diagram

Functional Description

The antenna detects the electric and magnetic fields generated by intra-cloud, inter-cloud, or cloud-to-ground electrical discharges that occur within a 200 nmi radius of the aircraft and sends the resulting "discharge signals" to the display/processor. The processor digitizes, analyzes, and converts the discharge signals into range and bearing data then stores the data in memory. The *Stormscope®* system displays discharges as storm cells or strikes depending on the display mode selected. (See figure 1-3.)

Cell Display Mode

In the cell display mode, the *Stormscope®* system plots a "+" symbol (discharge point) on the display when it detects associated discharges within the selected range and view. The processor will plot another "+" close to the first for each additional discharge determined to be associated with the group. The processor will not plot a "+" for any discharge not associated with a group unless it's detected within a 25 nmi radius of the aircraft. The effect of this clustering algorithm is to display the location of storm cells instead of individual discharges. The cell display mode is most useful during periods of heavy electrical discharge activity. Using the cell display mode during these periods frees the pilot from sifting through a screen full of discharge points to determine exactly where the storm cells are located.

360° View, CELL Display Mode **120° View, STRIKE Display Mode**

Figure 1-3. WX-950 Weather Views

Strike Display Mode

In the strike display mode, the *Stormscope®* system immediately plots an "x" symbol (discharge point) on the display for each individual discharge it detects within the selected range and view. The strike display mode plots discharge points on the display in relation to where the discharges are actually detected instead of plotting them close to an associated group of discharge points as is done in the cell display mode. The strike display mode is most useful during periods of light electrical activity because it may plot discharges associated with a building thunderstorm sooner than the cell display mode would.

Features

- Four operator-selectable weather ranges:
  - 25 nmi
  - 50 nmi
  - 100 nmi
  - 200 nmi
- Two operator-selectable weather views (figure 1-3):
  - 360° view of surrounding airspace
  - 120° forward view
- Three types of self test:
  - Power-up self test
  - Continuous self test
  - Operator initiated self test

- Heading stabilization – automatically repositions discharge points on the display relative to the latest aircraft heading when connected to a compatible heading system
- Local and remote clear – allows operator to clear displayed discharge points using a button on the front of the *Stormscope®* display or from a remotely-mounted "clear screen" button (not supplied)
- Discharge rate indicator – displays estimated average discharge rate per minute for current range and view
- Mic inhibit – inhibits thunderstorm processing when the communications transmitter is keyed to prevent the processing of corrupted data (some aircraft need to use this feature, others don't)
- Integrity monitor – animated indicator on the display confirms that the *Stormscope®* system is working. This feature is most useful during periods of no electrical activity.
- Power/brightness control – allows operator to adjust the CRT brightness and to turn the *Stormscope®* system on and off
- Four buttons – these function keys perform various functions depending on what mode the *Stormscope®* system is in and what screen is being displayed. This variability allows for flexibility and future expansion.
- Cell and strike display modes – allows you to view all individual discharges (strikes) or groups of discharges (cells)

Chapter 2
Storm Mapping Principles

Anatomy of a Thunderstorm

The *Stormscope*® model WX-950 is intended to help pilots avoid the dangers associated with thunderstorms (convective wind shear, lightning, icing, tornadoes, etc.). The *Stormscope*® system locates thunderstorms by detecting the electrical discharges that thunderstorms always generate. Figure 2-1 shows how thunderstorms create electrical discharges and radiate electromagnetic signals.

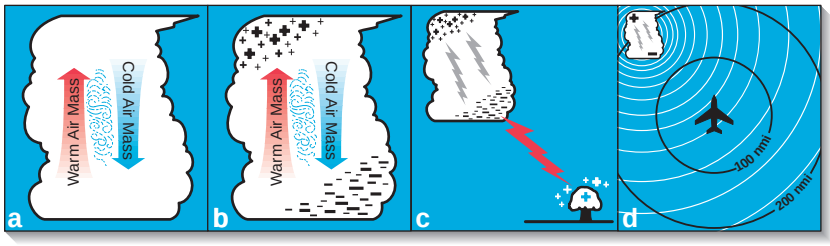

Figure 2-1. Electrical Discharges in Thunderstorms

a. The convective flow of air currents (warm air going up and cold air going down) leads to friction between the opposing air currents and wind shear in the space between the opposing air currents. The closer together the opposing air currents are, the greater the shearing force of the air currents.

b. The friction between the opposing air currents causes electrical charges in the area to separate. As positive (+) and negative (–) electrical charges are separated, they accumulate in masses of similar charges (positive charges near the top of the cloud and negative charges near the bottom).

c. Electrical discharges occur as the accumulated masses of separated positive and negative charges attempt to rejoin. These discharges continue to occur repetitively as long as the convective wind shear persists. A few of the discharges are visible as lightning, but most electrical discharges occur within a cloud or between clouds and are hidden by those clouds. Only a small percentage of discharges occurs between the clouds and the ground. Cloud to ground lightning occurs when the negatively charged lower part of a cloud induces a positive charge on an object on the ground. The immense charge separation finally breaks down the insulating air and a discharge occurs dumping negative charge from the cloud onto the object and the surrounding ground.

d. All electrical discharges radiate electromagnetic signals in all directions at the speed of light. The electromagnetic signals have unique characteristics and varying rates of recurrence and signal strength.

Figure 2-2 shows that the rate of electrical discharges detected in an area is directly related to the amount of convective wind shear turbulence present. In fact, as convective wind shear increases, the rate of electrical discharges increases at an increasing rate. This relationship means that if you find the electrical discharges, you've found the wind shear.

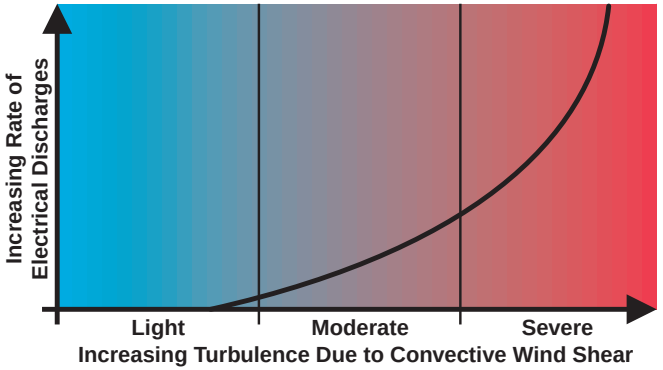

Figure 2-2. Discharge Rate a Function of Wind Shear

Stages of a Thunderstorm

All thunderstorms begin as cumulus clouds, build to an intense mature stage, and finally dissipate. Each of these stages in the life of a thunderstorm present a different set of dangers to aircraft. Your *Stormscope®* system maps all stages in the life of a thunderstorm so that you won't be caught unaware by a thunderstorm that can build, mature, and dissipate in as little as 20 minutes.

Cumulus Stage

The cumulus or beginning stage of a thunderstorm is usually precipitation free. In this stage, the risks to an aircraft and its occupants include strong vertical winds, severe turbulence, icing, and convective wind shear.

Mature Stage

In the mature and most intense stage of a thunderstorm, the water droplets within the cloud collide and combine to form rain and hail and, at cooler temperatures, sleet and snow. This stage poses many hazards to aircraft including heavy precipitation, high winds, convective wind shear, severe turbulence, downbursts, hail, icing, tornadoes, and lightning.

Dissipating Stage

In the dissipating stage, the updraft weakens and at the same time, the convective wind shear and other hazardous conditions begin to subside. There may be high rainfall rates in this stage, but the severe dangers are diminishing.

Storm Mapping Technology

The *Stormscope®* System and Weather Radar

The storm mapping technology used in the *Stormscope®* system is fundamentally different than the technology used in weather radar. Weather radar operates by transmitting UHF radio waves in the direction of interest and then receiving echoes from water droplets, whereas the *Stormscope®* system operates by receiving signals already present in the atmosphere due to electrical discharges. The *Stormscope®* system analyses the unique characteristics of these signals, their signal strength, and their varying rates of recurrence to determine the location and intensity of the thunderstorms that generated the discharges. The *Stormscope®* system can receive radiated electromagnetic signals from electrical discharges up to 200 nmi away.

One disadvantage of weather radar is that the cumulus stage of a thunderstorm (usually precipitation free) is unlikely to appear on weather radar; however, it generally does contain electrical discharges which *will* appear on your *Stormscope®* display as a light but increasing cluster of discharge points.

Another disadvantage of weather radar is that due to attenuation, it may not see the "storm behind the storm" or may understate its intensity. Your *Stormscope®* system is not subject to attenuation. With the *Stormscope®* system, electrical discharges are mapped throughout the storm area. The size of the cluster of discharge points on your *Stormscope®* system indicates the size of the storm area. The speed with which the discharge points appear indicate the intensity of the storm regardless of the size of the cluster. The more intense the storm, the faster the discharge points reappear.

Automatic Updating

The *Stormscope®* system receives and processes electrical discharge information continuously and updates the screen as needed, which may be many times every second. Even though the electromagnetic signals from electrical discharges are of very short duration, the *Stormscope®* system stores the resulting discharge points in memory and displays each point for a maximum of 3 minutes before it is erased from the screen and from memory.

In the 360° view, the *Stormscope®* system can store and display 512 discharge points within the selected range. In the 120° view, the *Stormscope®* system can store and display 256 discharge points within the selected range. When the number of electrical discharges exceeds the maximum displayable capacity in a given view within a 3-minute interval, the oldest discharge point in memory and on the screen in that view is erased and replaced with the newest discharge point. This process continues to replace old discharge points with new ones to make sure that discharge points on the screen represent the most recent electrical discharges. In a typical thunderstorm, all the points on the screen may be replaced with new points every 1 to 2 minutes. In a severe thunderstorm, the display may be completely updated every 30 to 60 seconds.

Chapter 3
Operation

Controls and Indicators

Figure 3-1 calls out all the major controls and indicators on the *Stormscope®* model WX-950. Table 3-1 is the legend for figure 3-1.

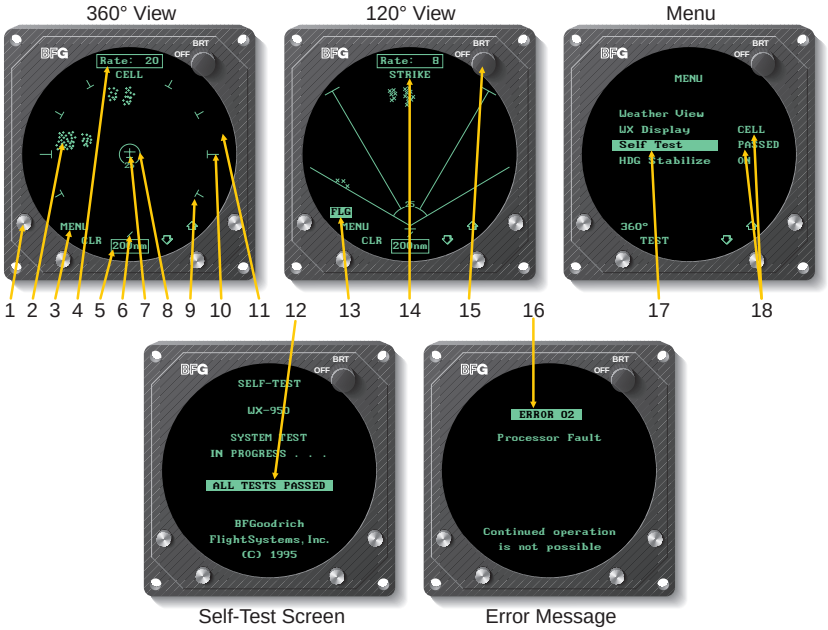

Figure 3-1. Controls and Indicators

Table 3-1. Controls and Indicators

Item	Name	Description
1	Buttons (4 places)	The four gray buttons protruding from the bottom half of the bezel are momentary contact switches. The *Stormscope®* system assigns them different functions depending on which screen and options are currently active. The system automatically debounces the buttons so that only the first stroke of an accidental multiple key stroke is acknowledged.
2	Discharge Points	The position of these + symbols in cell display mode, and x symbols in strike display mode indicates the azimuth and range of detected electrical discharge activity. Discharge points sometimes overlap to form clusters. A large cluster indicates that the thunderstorm covers a

Table 3-1. Controls and Indicators (Continued)

Item	Name	Description
2	Discharge Points (Continued)	large area. A dense cluster indicates an intense thunderstorm. The size of the discharge points increases as the selected range decreases in order to enhance the storm clustering effect on the shorter ranges. The *Stormscope®* system can display 256 discharge points in the 120° view, and 512 discharge points in the 360° view. The latest discharge points (none older than 3 minutes) are stored in memory and displayed even if you switch ranges or views and then switch back to the original range or view.
3	Button Labels (4 places)	These labels indicate the function of the adjacent buttons. The labels change from screen to screen.
4	Discharge Rate Indicator	This indicator displays an estimate of the average number of electrical discharges detected per minute in the selected range and view. The indicator is updated every 5 seconds. The range of the indicator is 0–999.
5	Range Indicator	This indicator displays the numerical value of the current range displayed on the screen. This value corresponds to the distance from the aircraft to the outer range ring. The possiblities are 25, 50, 100, and 200 nmi.
6	Integrity Monitor	This bar rotates to indicate that the *Stormscope®* system is working. This indicator is most us eful during periods of no lightning activity.
7	Aircraft Symbol	This symbol indicates the location and heading of your aircraft relative to the thunderstorm a ctivity.
8	25 nmi Range Ring	This solid ring is displayed on every range of both weather views to keep you informed of any thunderstorm activity within a 25 nmi radius of your aircraft.
9	Outer Range Ring	The outer range ring indentifies the outer boundary of the current range. In the 360° view, the outer range ring is made up of 8 arcs spaced 30° apart along a circle centered on the aircraft symbol. In the 120° view, the outer range ring is made up of 2 arcs each spaced 30° on either side of the aircraft heading along a circle centered on the aircraft symbol. If the range is set to 25 nmi in either view, the outer range ring is a solid ring instead of arcs. The numerical value of the radius of the outer range ring is displayed in the range indicator at the bottom of the screen.

Table 3-1. Controls and Indicators (Continued)

Item	Name	Description
10	Azimuth Marker	The azimuth markers help to quantify the angular location of electrical discharges relative to the aircraft. In the 360° view, 8 short radial markers are spaced 30° apart around the outside of the outer range ring. In the 120° view, 4 azimuth markers radiate out from the aircraft symbol at 30° and 60° on either side of the aircraft heading.
11	CRT Display	The display is a 2.6-inch diameter, green phosphor CRT. The entire display screen serves as a multipurpose indicator. It displays electrical discharge activity and various menu items and status messages.
12	Self-Test Result Indicator	This indicator displays the current self test status.
13	Heading Flag Indicator	The heading flag indicator consists of the letters "FLG" in reverse video just above the menu button label on both weather views. This indicator will appear if the *Stormscope®* system detects a heading invalid flag from the aircraft navigational system while heading stabilization is enabled on the *Stormscope®* system. Upon receiving a heading flag, the *Stormscope®* system will also clear the display and begin operating in a "fixed card" manner without heading stabilization.
14	WX Display Mode Indicator	This indicator reports the current wx (weather) display mode (CELL or STRIKE). Weather is defined as electrical activity. The indicator is present on both the 360° and the 120° views.
15	Power/Brightness Control (OFF/BRT)	Rotating this knob clockwise turns on the *Stormscope®* system and increases the brightness of the display. Rotating this knob counter-clockwise decreases the brightness of the display and turns off the *Stormscope®* system when the knob reaches its fully counterclockwise position.
16	Error Message Indicator	This indicator appears when the *Stormscope®* system detects a fault. The error message includes an error number, a short description of the fault, and whether continued operation is possible. In most cases, the operator must press any button to acknowledge and clear the error message and to resume operation. If a recoverable fault goes away while the error message is being displayed, the error message will disappear after it has been displayed for at least 10 seconds.

Table 3-1. Controls and Indicators (Continued)

Item	Name	Description
17	Highlighted Menu Item	A highlighted menu item identifies the currently selected menu item.
18	Menu Item Status Indicator	These indicators display the status of the test or function named in the menu item.

Operating Instructions

This section lists procedures for configuring and operating the *Stormscope®* system. The procedures are organized into tasks. There is no predefined order for performing the tasks (other than turning on the *Stormscope®* system first). You should perform all the tasks at least once after your *Stormscope®* system is first installed; that way you will be familiar with how to use the features before you actually *need* to use them.

Turn On the *Stormscope®* System

a. Rotate the OFF/BRT knob clockwise about 180 degrees.

The switch will click and the *Stormscope®* system will begin the power-up self test and will display the SELF-TEST screen with the message SYSTEM TEST IN PROGRESS… (See figure 3-2.) The power-up self test takes about 25 seconds to ensure that all major *Stormscope®* system functions are operating properly. Functions tested include antenna reception, memory, and microprocessor functions.

If the *Stormscope®* system detects no faults, the SELF-TEST screen will display the message ALL TESTS PASSED. (See figure 3-3.) After a few seconds, the display will switch to the 360° weather view screen set at the 200 nmi range. (See figure 3-4.) The WX Display mode setting and the HDG Stabilize setting will be in the same states as they were in when the *Stormscope®* system was last used.

If the *Stormscope®* system detects a fault, an error message is displayed. Refer to the section on error messages later in this chapter for more information on error messages.

Note

The *Stormscope®* system may complete its power-up self test before the CRT display comes on. In this case, it is possible that the first screen you see will be the 360° weather view screen or an error message resulting from the self-test.

Adjust the Screen Brightness

a. Rotate the OFF/BRT knob clockwise to increase the brightness of the display or counterclockwise to decrease the brightness of the display.

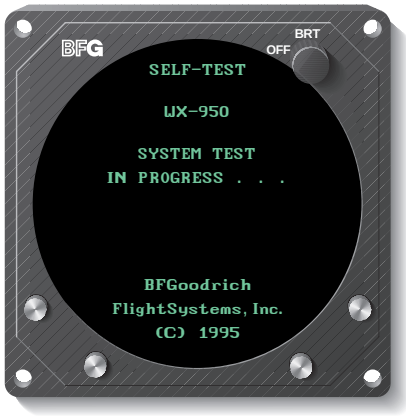

Figure 3-2. Self Test In Progress

Figure 3-3. Self Test OK

Figure 3-4. 360° Weather View at 200 nmi Range

Switch to the MENU Screen

a. From either of the two weather views (360° or 120°) press the MENU button. (See figure 3-1.)

The display will switch to the MENU screen. The first menu item, Weather View, will be highlighted. (See figure 3-5.)

Figure 3-5. MENU Screen with Weather View Highlighted

Scroll Through the Menu Items

a. Switch to the MENU screen (figure 3-5).

b. Press the down arrow button to move the highlighting bar down the menu.

When the highlighting bar reaches the last menu item, pressing the down arrow button again will move the highlighting bar up to the first item in the list.

c. Press the up arrow button to move the highlighting bar up the menu.

When the highlighting bar reaches the first menu item, pressing the up arrow button again will move the highlighting bar down to the last item in the list.

Switch to a Weather View

There are two ways to get to a weather view from the MENU screen. These are described below as method A and method B.

Method A

a. On the MENU screen, scroll through the menu items until the menu item Weather View is highlighted. (See figure 3-5.)

b. Press the 360° button to switch to the 360° weather view screen or press the 120° button to go to the 120° weather view screen.

The position of the 360° and 120° button labels depends on the last weather view screen displayed. If the 360° weather view screen was displayed last, the upper left button will be labeled 120° and the lower left button will be labeled 360°. If the 120° weather view screen was displayed last, the upper left button will be labeled 360° and the lower left button will be labeled 120°.

Method B

a. With the MENU screen displayed and the Weather View menu item *not* highlighted, press the upper left button (labeled 360° or 120°) to switch to the weather view screen that was displayed last.

   The display will switch to the weather view screen that was last displayed as indicated by the button label.

Switch Between Weather Views

The sequence of physical buttons to push to switch between the two weather views is the same whether you start from the 360° view or the 120° view; only the button labels are different. (See figure 3-6.) In short, to switch from one weather view to the other, press the upper left button twice.

a. Press the MENU button (the upper left button).

   The display will switch to the MENU screen.

b. Press the upper left button (now labeled 120° or 360°) again.

   The display will switch to the other weather view. Note that when switching between weather views, the range remains constant.

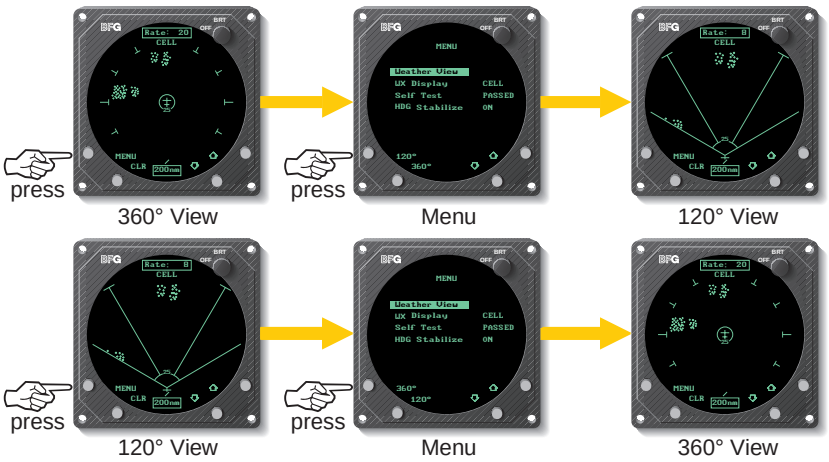

Figure 3-6. Switching Between Weather Views

Select the Range

a. Switch to one of the two weather views (360° or 120°).

b. Press the up arrow button repeatedly to step up through the operating ranges 25, 50, 100, and 200 nmi.

c. Press the down arrow button repeatedly to step down through the operating ranges 200, 100, 50, and 25 nmi.

With each press of the up or down arrow button, the screen changes to display the electrical discharge activity detected within the new range. The range indicator will also change to display the numerical value of the new range (25, 50, 100, or 200 nmi). This new range corresponds to the distance from the aircraft to the outer range ring on the screen.

Pressing the up arrow button when in the 200 nmi range will change the range to 25 nmi. Likewise, pressing the down arrow button when in the 25 nmi range will change the range to 200 nmi.

The *Stormscope®* system stores electrical discharge information for all ranges simultaneously to provide you with an instant, up-to-date display of electrical discharge activity when you select a new range.

As you move from one range to the next, the 25 nmi range is always indicated by a solid ring to advise you of your close proximity to thunderstorms. You may also notice that the discharge points are progressively larger on the shorter ranges and smaller on the longer ranges. This effect makes it easier to spot clusters of discharge points in any range.

Clear All Discharge Points

a. Switch to one of the two weather views (360° or 120°).

b. Press the CLR button.

All discharge points will be erased from the screen and from the *Stormscope®* system memory. The *Stormscope®* system will continue to plot any new discharge points on the cleared screen.

Clearing the discharge points periodically while you're monitoring thunderstorms is a good way to determine if the storm is building or dissipating. Discharge points in a building storm will reappear faster and in larger numbers after you press the CLR button. Discharge points in a dissipating storm will reappear slower and in smaller numbers after you press the CLR button.

If you have the standard heading stabilization feature connected and turned on (on the MENU screen), you do not have to press the CLR button after every heading change to ensure that the discharge points are positioned correctly with respect to the current heading.

Switch Between WX Display Modes

The WX Display menu item selection determines how the *Stormscope®* system will display electrical activity on both the 360° and 120° weather views. (WX stands for weather and is defined as electrical activity.)

a. Switch to the MENU screen.

b. Scroll through the menu items until the WX Display menu item is highlighted. (See figure 3-7.)

   The currently selected weather display mode is listed to the right of the highlighted menu item.

Figure 3-7. MENU Screen with WX Display Highlighted

c. Press the button labeled CELL or STRIKE to toggle between the cell and strike display modes. (Chapter 1 describes the display modes.)

   The currently selected weather display mode listed to the right of the highlighted menu item will toggle between CELL and STRIKE with each press of the button labeled CELL or STRIKE. The mode selected here will remain in effect until you change it, even if the unit is turned off and back on. To see the results of selecting a new weather display mode, switch to a weather view. The current weather display mode (CELL or STRIKE) is displayed under the discharge rate indicator box at the top of the screen. In the cell display mode, the discharge points are +'s. In the strike display mode, the discharge points are x's.

Run Operator-Initiated Self Test

a. Switch to the MENU screen.

b. Scroll through the menu items until the Self Test menu item is highlighted. (See figure 3-8.)

   The current self test status is listed to the right of the highlighted menu item.

Figure 3-8. MENU Screen with Self Test Highlighted

c. Press the TEST button to run the operator-initiated self test.

The *Stormscope®* system will switch to the SELF-TEST screen (figure 3-2) and will begin the self test. Functions tested include microprocessor functions and memory. The SELF TEST screen will display the message SYSTEM TEST IN PROGRESS… for the duration of the test (between 5 and 25 seconds).

If the *Stormscope®* system detects no faults, the SELF TEST screen will display the message ALL TESTS PASSED. (See figure 3-3.) After a few seconds, the display will switch back to the MENU screen and PASSED will be displayed to the right of the highlighted menu item.

If the *Stormscope®* system detects a fault, an error message is displayed. Refer to the section on error messages later in this chapter for more information on error messages. Once you've pressed any button to acknowledge the error message, the display will switch back to the MENU screen and FAULT will be displayed to the right of the highlighted menu item.

Toggle Heading Stabilization On and Off

The heading stabilization feature automatically adjusts the position of the discharge points on the display when your aircraft changes heading. Normally, if the *Stormscope®* system was installed to use the heading stabilization feature, you should never have to turn heading stabilization off; however, a situation may occur in which the heading input appears to be invalid but no heading flag is displayed. In this case, you should turn heading stabilization off until the heading input is corrected. If you are flying with heading stabilization turned off, or do not have a compatible heading system, you can press the CLR button after each heading change to display new discharge points in the proper location relative to the heading of the aircraft symbol on the display.

a. Switch to the MENU screen.

b. Scroll through the menu items until the HDG Stabilize menu item is highlighted. (See figure 3-9.)

The current state of the heading stabilization feature is listed to the right of the highlighted menu item. An "N/A" displayed here means that heading stabilization is not available due to your particular installation configuration. (See figure 3-10.)

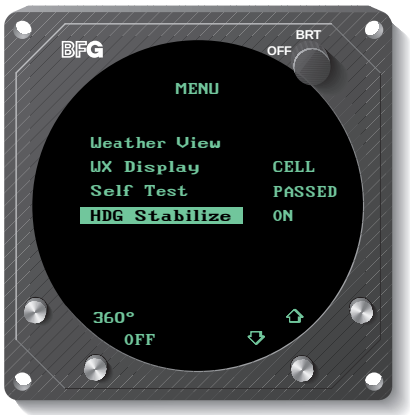

Figure 3-9. MENU Screen with HDG Stabilize Highlighted

Figure 3-10. MENU Screen with HDG Stabilize N/A

c. Press the button labeled ON or OFF to toggle the heading stabilization feature on and off.

The current state of the heading stabilization feature listed to the right of the highlighted menu item will toggle between ON and OFF with each press of the button labeled ON or OFF. (If N/A is displayed, the button will have no label and pressing it will have no effect.) The state selected here will remain in effect until you change it, even if the unit is turned off and back on.

Turn Off the *Stormscope®* System

a. Rotate the OFF/BRT knob counterclockwise until it turns off.

The *Stormscope®* display will turn off, the processor will stop processing, power will be turned off to the antenna, and all discharge points will be erased from memory.

Continuous Self Test

In addition to the power-up self test and the operator-initiated self test, the *Stormscope®* system also performs a continuous self test. Items tested include antenna reception, microprocessor functions, memory, heading inputs, and microprocessor temperature. The *Stormscope®* system performs this continuous self test several times each minute.

Error Messages

The *Stormscope®* system detects most common faults and displays error messages indicating the nature of the faults and which functions may be inoperative. These error messages enable your authorized *Stormscope®* dealer or BFG Avionics Systems factory service personnel to quickly diagnose and correct the fault. Figure 3-11 shows an error message. Table 3-2 lists all the possible error messages, the probable causes, and the recommended actions.

Figure 3-11. Error Message for a Recoverable Weather Fault

Table 3-2. Error Messages

Error Message	Fault Source	Type*	Recommended Action
Error 01 Processor Fault	Main processor	F	Turn off the unit and see your dealer for service.
Errors 02 and 03 Processor Fault	Video controller	F	Turn off the unit and see your dealer for service.
Error 04 Processor Fault	Video memory	F	Turn off the unit and see your dealer for service.
Errors 05 thru 08 Processor Fault	Main processor memory	F	Turn off the unit and see your dealer for service.
Errors 09 thru 13 Processor Fault	DSP memory	F	Turn off the unit and see your dealer for service.
Errors 14 and 15 Processor Fault	DSP	F	Turn off the unit and see your dealer for service.

*F=Fatal, NF=Non-Fatal, R=Recoverable, NR=Non-Recoverable
(Description follows table.)

Table 3-2. Error Messages (Continued)

Error Message	Fault Source	Type*	Recommended Action
Error 16 Antenna Fault	Antenna is not able to receive or forward the necessary thunderstorm data or it could be a faulty connection	NF/R	Press any button to continue without weather mapping functions. See your dealer for service.
Error 17 Processor Fault	No test strikes**	NF/R	Press any button to continue without weather mapping functions. See your dealer for service if this error occurs frequently.
Error 18 Processor Fault	Invalid test strike	NF/R	Press any button to continue without weather mapping functions. See your dealer for service if this error occurs frequently.
Error 19 Processor Fault	Main Processor data overload	NF/R	Press any button to continue without weather mapping functions. See your dealer for service if this error occurs frequently.
Error 20 Configuration Changed	Antenna jumper configuration changed since last time power was applied to the system	NF/R	Press the “TOP” or “BOTTOM” button to respond to the prompt “Select Antenna Location.” If jumper does not agree with user selection, “Configuration Fault” is displayed and continued operation is not possible.
Error 21 Processor Fault	Main processor	F	Turn off the unit and see your dealer for service.
Error 22 Invalid Synchro Signals	Invalid XYZ input (gyro may still be spinning up)	NF/R	Press any button to continue without heading stabilization. See your dealer for service.

*F=Fatal, NF=Non-Fatal, R=Recoverable, NR=Non-Recoverable (Description follows table.)

**Flying within 5 nmi of a certain Government antenna near Annapolis Maryland can also cause this error message to appear. The recommended action in this case is to do nothing.

Table 3-2. Error Messages (Continued)

Error Message	Fault Source	Type*	Recommended Action
Error 23 Invalid Synchro Ref	No 400 Hz reference	NF/R	Press any button to continue without heading stabilization. See your dealer for service.
Error 24 Mic Key Stuck	Mic key (inhibit line) stuck. The microphone key has been depressed for more than 1 minute	NF/R	Check your microphone key to correct the problem. If not correctable, press any button to continue without weather mapping functions and see your dealer for service.
Error 25 SW Ver Error	Main processor	F	Turn off the unit and see your dealer for service.
Errors 26 thru 34 Processor Fault	Main processor	F	Turn off the unit and see your dealer for service.
Errors 35 and 36 Processor Fault	DSP or main processor	NF/R	Press any button to continue without weather mapping functions. See your dealer for service.
Error 38 Invalid Configuration	Invalid heading configuration. Stepper & XYZ selected.	NF/NR	Press any button to continue without heading stabilization. See your dealer for service.
Error 39 High Temperature	Processor high temperature	NF/R	Press any button to continue. Perform the self test from the MENU screen to see if the fault condition is still present. See your dealer for service.
Error 40 Processor Fault	Main processor	NF/R	Press any button to continue. See your dealer for service if this error occurs frequently.
Error 41 Processor Fault	DSP or main processor	F	Turn off the unit and see your dealer for service.
Error 42 Processor Fault	Main processor	F	Turn off the unit and see your dealer for service.

*F=Fatal, NF=Non-Fatal, R=Recoverable, NR=Non-Recoverable
(Description follows table.)

Non-Fatal Faults

If a non-fatal fault occurs, all functions not directly affected by the fault will continue to operate and the message “Press any key to continue” will appear. Pressing any button returns you to the screen that was displayed before the error message appeared. (You should still see your authorized *Stormscope®* dealer as soon as possible to correct the fault.)

Recoverable Faults

A recoverable fault is one that allows the affected functions to automatically resume proper operation after the fault goes away. The associated error message will disappear within 10 seconds after the fault goes away. The following are two examples of recoverable faults.

Weather-Mapping-Inhibited Faults

After you clear a weather fault error message (figure 3-11), the message "Weather Mapping Fault Present; Please Stand By" will appear continuously on the lower half of both weather views as long as the fault condition exists. (See figure 3-12.) Any existing or new discharge points will continue to be displayed along with the message, but due to the fault condition, the points may not be valid.

Figure 3-12. Weather Mapping Inhibited Screen

Heading-Related Faults

After you clear a heading fault error message (figure 3-13), "FLG" will appear continuously in reverse video above the MENU button label on both weather views as long as the fault condition exists. (See figure 3-14.)

Non-Recoverable Faults

A non-recoverable fault will allow you to press a button and continue operation, but without the function that is affected by the fault. The affected function will not resume proper operation until the system is turned off and repaired. In the case of error 38, invalid configuration, you can press a button to clear the associated error message, but heading stabilization will not be available until the heading configuration jumpers are corrected.

Figure 3-13. Error Message for a Heading-Related Fault

Figure 3-14. Weather View with a Heading Flag

Fatal Faults

If a fatal fault occurs, all functions will cease to operate and the message "Continued operation is not possible" will appear. (See figure 3-15.) In this case, turn off the *Stormscope®* system and see your authorized *Stormscope®* dealer for service.

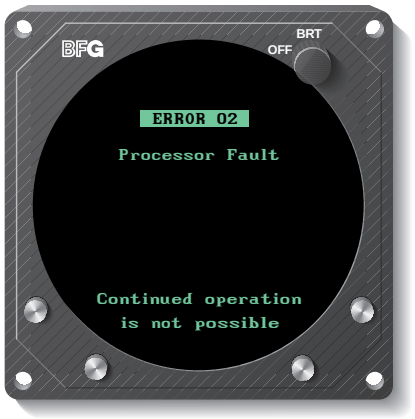

Figure 3-15. Error Message for a Fatal Fault

Chapter 4
Weather Display Interpretation

WARNING

The illustrations in this guide are only examples. Never use your *Stormscope®* system to attempt to penetrate a thunderstorm. The FAA Advisory Circular, Subject: Thunderstorms, and the Airman's Information Manual (AIM) recommend that you "avoid by at least 20 miles any thunderstorm identified as severe or giving an intense radar echo."

CAUTION

There are several atmospheric phenomena other than nearby thunderstorms which can cause isolated discharge points in the strike display mode. *Clusters* of two or more discharge points in the strike display mode however *do* indicate thunderstorm activity when they reappear after clearing the screen. Avoid the clusters and you'll avoid the thunderstorms. In the cell display mode, even a single discharge point may represent thunderstorm activity and should be avoided.

Introduction

The examples in this chapter are designed to help you relate the patterns of +'s or x's on your *Stormscope®* screen to the size and location of thunderstorms that may be near your aircraft.

A blue and white grid in the examples represents the airspace around your aircraft. (See figure 4-1.) Each square in the grid represents a 100 by 100 nmi area. A circle represents the area being monitored by your *Stormscope®* system. Areas of gray or black indicate thunderstorms. The darker the area, the greater the rate of electrical discharge activity.

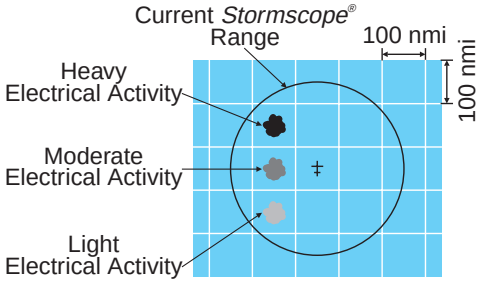

Figure 4-1. Airspace Diagram

The *Stormscope®* system detects electrical discharges and displays them as storm cells or as independent strikes. The examples in this chapter include *Stormscope®* screens in both the cell display mode and the strike display mode.

Radial Spread

When the *Stormscope®* system is in the strike display mode, it is common for a triangular-shaped stream of discharge points to appear between the aircraft symbol in the center of the *Stormscope®* screen and a cluster of discharge points within the range of the *Stormscope®* system. A similar stream of discharge points may appear radiating away from the aircraft symbol in the direction of possible thunderstorm activity beyond the range of the *Stormscope®* system. These phenomena are examples of radial spread. Discharge points in radial spread do not necessarily indicate the exact location of atmospheric electrical discharges. To counteract radial spread, BFGoodrich Avionics Systems applied its extensive research in lightning detection to develop enhanced lightning positioning algorithms. These algorithms (used only in the cell display mode) greatly reduce radial spread and improve the depiction of thunderstorms on the display. The strike display mode does not use the enhanced lightning positioning algorithms; instead, it uses technology similar to that found in older *Stormscope®* systems and in competitor lightning detection systems.

Typical Patterns

Three Clusters within the 200 nmi Range Ring

Figure 4-2 shows the *Stormscope®* screen in the 360° weather view at the 200 nmi range. Using this knowledge, the outer range ring, and the azimuth markers, the three clusters of discharge points on the left-hand *Stormscope®* screen (cell display mode) can be interpreted as representing three thunderstorm cells at the following azimuth and range:

Cluster	Azimuth (clock position)	Range
1	11:00	180 nmi
2	4:00	75 nmi
3	4:00	180 nmi

Analysis of the right-hand *Stormscope®* screen (strike display mode) yields a similar, but less certain interpretation due to radial spread.

The *Stormscope®* screen can also tell us about the relative amount of electrical discharge activity in thunderstorm cells. Clusters 2 and 3 have more discharge points than cluster 1 indicating greater electrical discharge activity. All three clusters however must be avoided because you can't necessarily determine the severity of thunderstorms based strictly on the number of discharge points. For example, in the western United States, a severe thunderstorm may only have a few electrical discharges.

When the *Stormscope®* range is changed to 100 nmi (figure 4-3), only cluster 2 remains visible. Clusters 1 and 3 are beyond the 100 nmi range and therefore no longer appear on the screen. (Clusters 1 and 3 would again be visible if the range were returned to 200 nmi.) Cluster 2 is now more defined and the discharge points are larger. The interpretation of cluster 2 remains the same: a moderately active thunderstorm at azimuth 4:00,

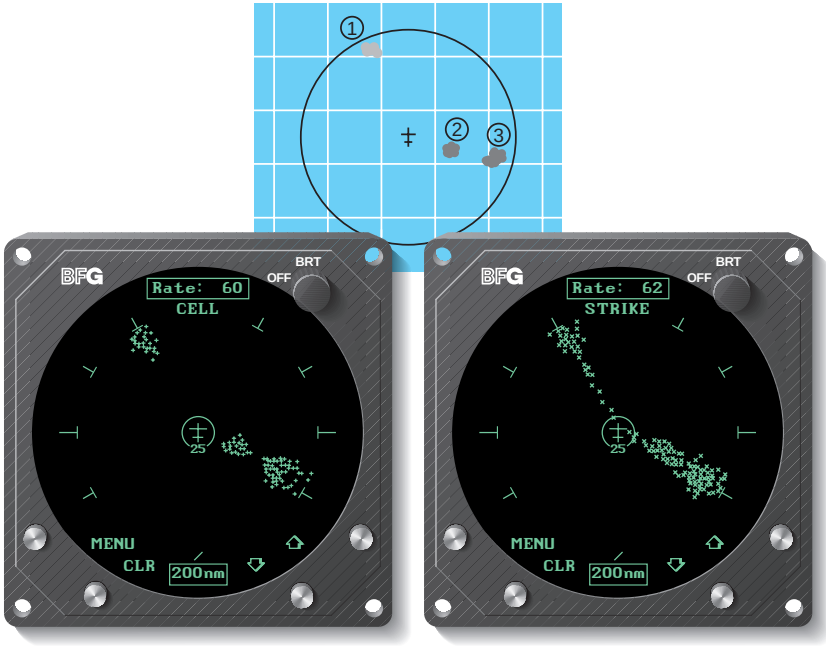

Figure 4-2. Three Clusters Within 200 nmi

Figure 4-3. Range Changed to 100 nmi

range 75 nmi. You'll notice on the right-hand *Stormscope®* screen (strike display mode) that there is less radial spread than there was in the 200 nmi range. It is true in general that radial spread is reduced on the shorter ranges.

Two Clusters within the 200 nmi Range Ring

Figure 4-4 shows the *Stormscope®* screen in the 360° weather view at the 200 nmi range. Using this knowledge, the outer range ring, and the azimuth markers, the two clusters of discharge points on the *Stormscope®* screen can be interpreted as representing one thunderstorm cell at 5:30, about 150 nmi from the aircraft, and another thunderstorm cell at 1:00, about 100 nmi from the aircraft. The cluster at 1:00 has less radial spread (in the strike display mode) and fewer discharge points than the cluster at 5:30 indicating a lower rate of electrical activity. Both clusters must be avoided.

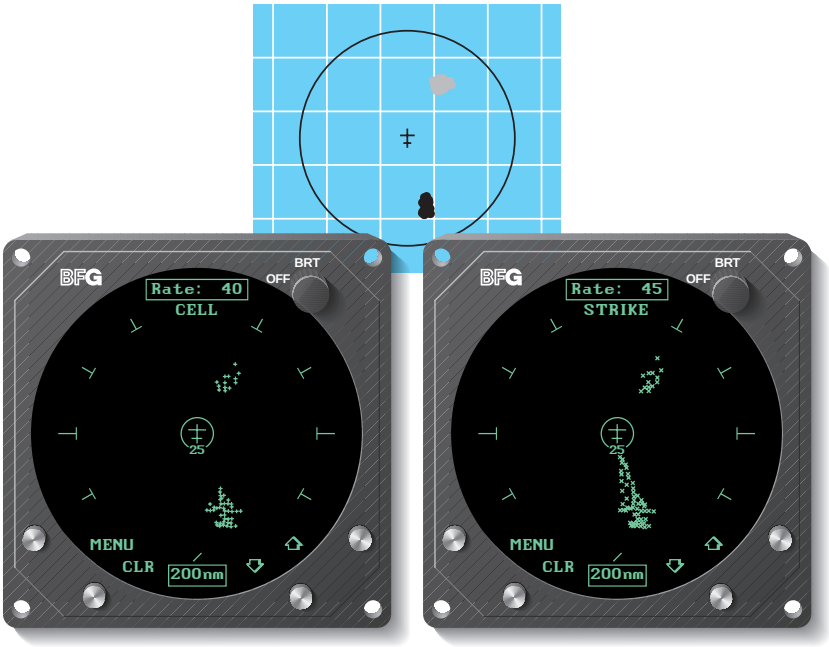

Figure 4-4. Two Clusters Within 200 nmi

Mapping Headings Past Thunderstorms

Figures 4-5 through 4-8 and the following paragraphs depict the progression of an aircraft past several thunderstorms.

Range Set at 200 nmi

Figure 4-5 shows the *Stormscope®* screen in the 360° weather view at the 200 nmi range. Two thunderstorms appear almost as one cluster of discharge points off the nose of the aircraft, centered 180 nmi away. A second cluster at 9:30 indicates a storm system which contains three thunderstorms.

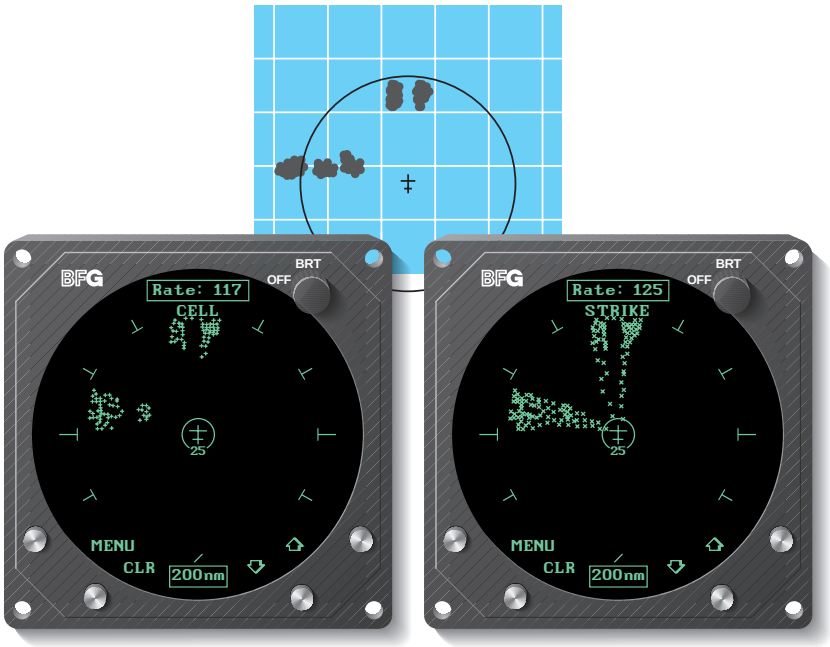

Figure 4-5. Range Set at 200 nmi

Aircraft Progresses 100 nmi

Figure 4-6 shows that the aircraft has maintained its heading and progressed 100 nmi. The two thunderstorms off the nose of the aircraft appear to have expanded horizontally on the screen. This effect is normal anytime you get closer to a storm. The line of thunderstorms previously at 9:30 now appears at 8:30.

Range Changes to 100 nmi

Figure 4-7 shows the *Stormscope®* screen a short time later in the 120° weather view at the 100 nmi range. The thunderstorms at 8:30 are not visible in this view but the thunderstorms off the nose of the aircraft appear in greater detail as two separate thunderstorms. The thunderstorms at 11:30 and 12:15 are centered 90 nmi from the aircraft. Information is now sufficient to map a route around the thunderstorms. The *Stormscope®* system plots discharge points within the selected range even if the points obscure the CELL or STRIKE display mode indicator as they do in figure 4-7.

Aircraft Turns to Avoid Thunderstorms

Figure 4-8 shows the *Stormscope®* screen a short time later after the aircraft has turned to the right to avoid the thunderstorms. When connected to a compatible heading system, the *Stormscope®* system automatically rotates the existing discharge points to their correct position relative to the new heading.

Figure 4-6. Aircraft Progresses 100 nmi

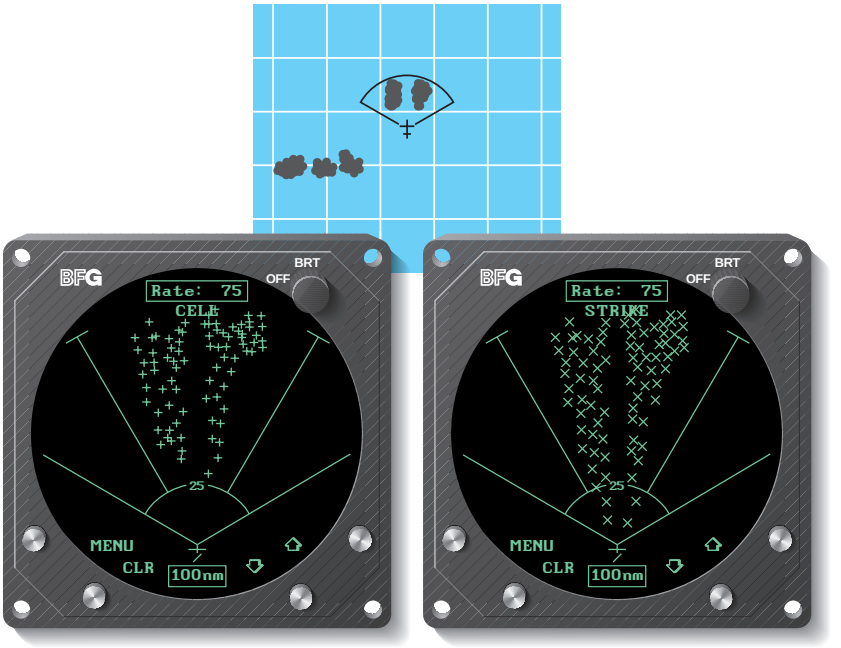

Figure 4-7. Range Changes to 100 nmi

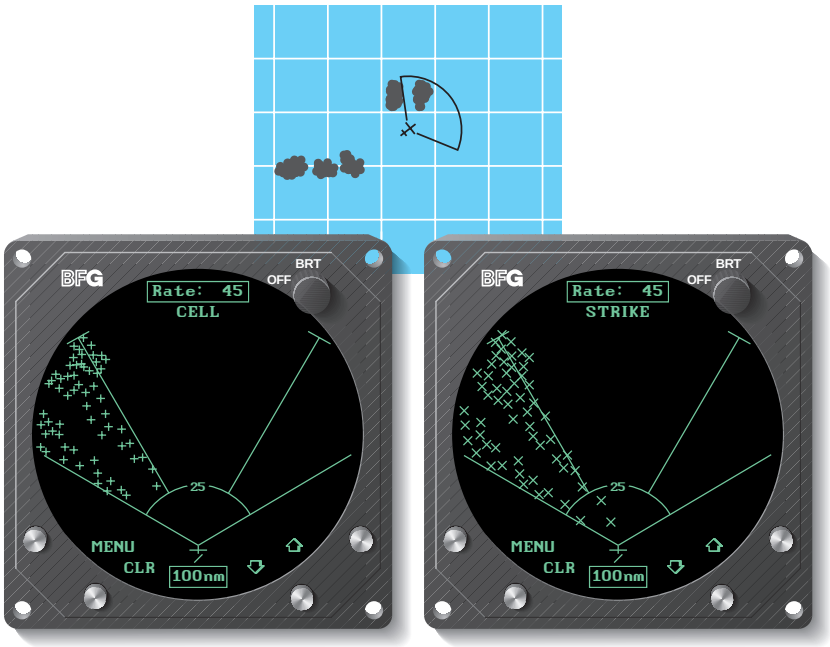

Figure 4-8. Aircraft Turns To Avoid Thunderstorms

Special Patterns

Randomly Scattered Discharge Points

Atmospheric instability associated with cumulus clouds, or developing or dissipating thunderstorms could cause randomly scattered discharge points on the *Stormscope®* screen as shown in figure 4-9. Random discharge points are more likely to appear in the *Stormscope®* system's strike display mode than in the cell display mode due to the cell display mode's clustering algorithm. If you observe random discharge points, continue to monitor the screen for developing clusters which indicate thunderstorm activity.

Cluster and Splattering Within 25 nmi

Figure 4-10 shows the *Stormscope®* screen in the 360° weather view at the 25 nmi range. One moderately active thunderstorm appears as a cluster of discharge points at 8:30 centered 14 nmi away with a splattering of discharge points throughout the 25 nmi range. Such splattering is due to electrical discharges within 3 to 5 nmi of the aircraft and indicates that the aircraft is too close to the thunderstorm.

Continue to head away from the main cluster. While the main cluster should be your primary concern, you should also avoid any grouping of discharge points within the 25 nmi range. Switch to the other range settings to ensure that there is no thunderstorm activity indicated along your intended path.

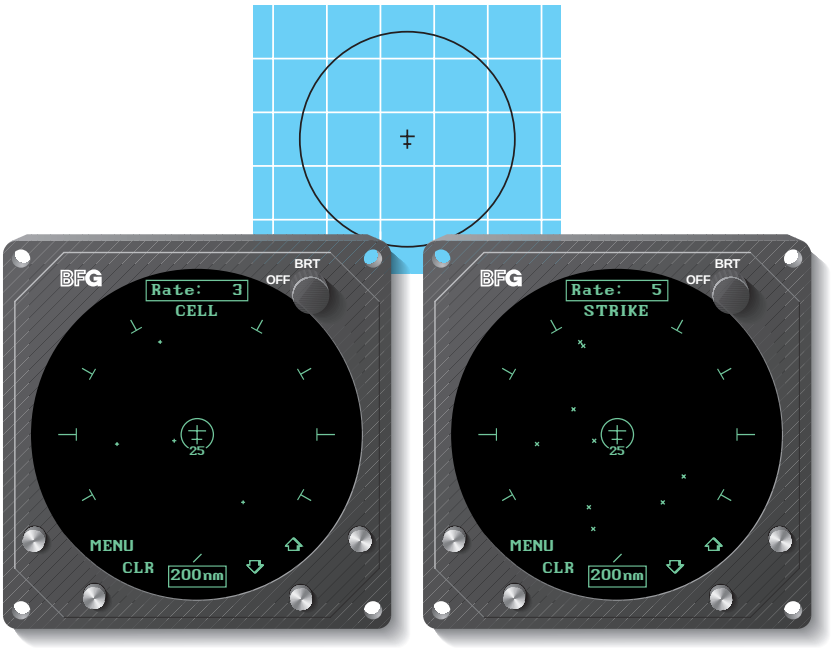

Figure 4-9. Randomly Scattered Discharge Points

Figure 4-10. Cluster and Splattering Within 25 nmi

You'll notice in figure 4-10 that the location of random, individual discharge points is about the same on both the cell and storm display modes. This is true because in the cell display mode, the *Stormscope®* system plots every electrical discharge detected within the 25 nmi range at the exact location detected unless the discharge is associated with a cluster of discharges, in which case the discharge point is clustered with the associated discharge points. You'll also notice that there are more points in the cluster of points at 8:30 in the cell display mode than there are in the strike display mode. This is due to the cell display mode's clustering algorithm "pulling in" individual discharge points associated with the cluster.

Discharge Points Off Aircraft's Nose

Figure 4-11 shows the *Stormscope®* screen in the 360° weather view at the 200 nmi range. The discharge points ahead of the aircraft could be caused by a strong thunderstorm just beyond the 200 nmi range. Another scenario might be that electrical discharge signals are arriving via atmospheric skip from a distant thunderstorm well beyond the *Stormscope®* range. In either case, no immediate action is required.

Figure 4-11. Discharge Points Off Aircraft's Nose

Line of Discharge Points While Taxiing

Passing over a cable beneath the taxiway can cause a line of discharge points across the screen as shown in figure 4-12. Similar concentrations of discharge points across the screen may appear while taxiing due to electrical signals from nearby equipment such as arc welders or subway rails. After passing the source of the interference, press the CLR button.

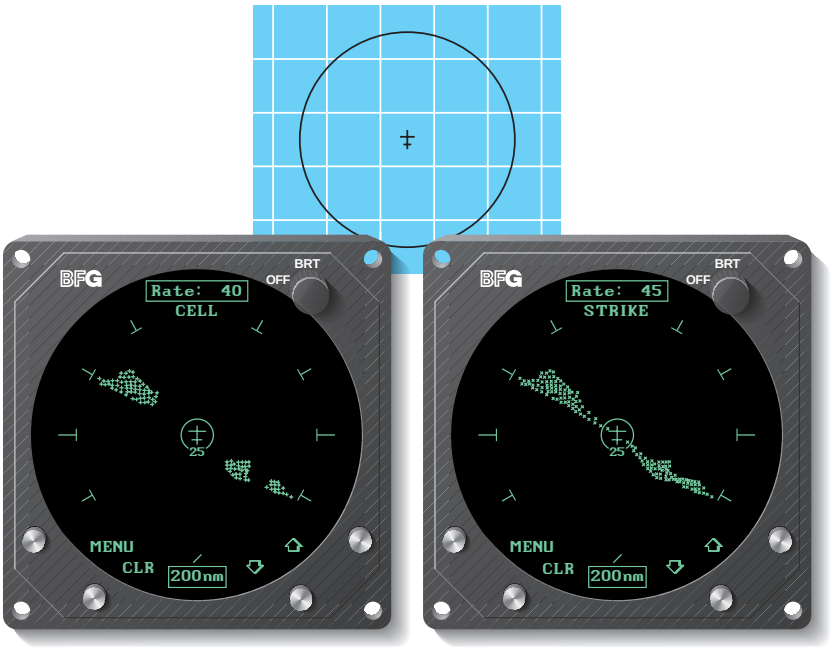

Figure 4-12. Line of Discharge Points While Taxiing

Developing Cluster Within the 25 nmi Range Ring

Figure 4-13 shows a developing thunderstorm 12 nmi from the aircraft. If you see a screen such as this with a developing cluster within the 25 nmi range ring, you should change course to avoid the storm and continue to monitor the *Stormscope®* screen.

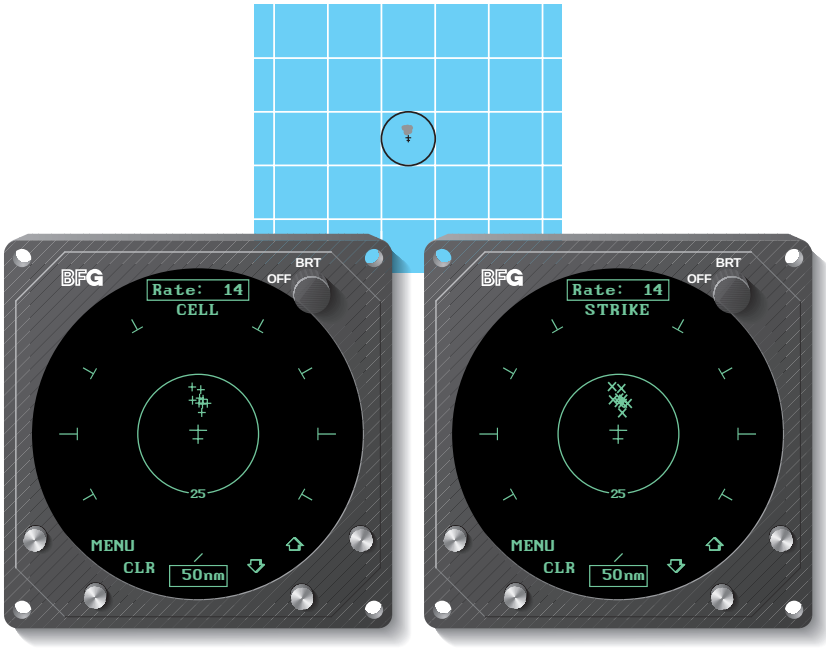

Figure 4-13. Developing Cluster Within 25 nmi Range Ring

Chapter 5
Specifications, Maintenance, & Service

Specifications

Table 5-1 lists the specifications for the *Stormscope®* system.

Table 5-1. WX-950 *Stormscope®* System Specifications

PART NUMBER:
805-10950-( )

FEATURES:
Selectable weather ranges: 25, 50, 100, or 200 nautical miles
Selectable weather views: 120 or 360 degrees
Selectable display modes: Cell or Strike
Integral CRT display screen
Built-in self tests
Automatic heading stabilization
Discharge rate indicator
Microphone inhibit line
Integrity indicator
Power/brightness control knob
Four software-defined buttons

DIMENSIONS:
Display/Processor (a standard 3ATI instrument):
3.37 inches (8.56 centimeters) high
3.37 inches (8.56 centimeters) wide
11.46 inches (29.11 centimeters) deep, including connector backshell
Antenna:
1.00 inch (2.54 centimeters) high
3.45 inches (8.76 centimeters) wide
6.85 inches (17.40 centimeters) long

WEIGHT:
Display/Processor:
2.9 pounds (1.3 kilograms)
Antenna:
0.84 pound (0.38 kilogram) without doubler plate

ELECTRICAL CHARACTERISTICS:
Input voltage: 11 to 32 volts dc
Current: 2.0 A ±0.5 A @ 12 volts dc
0.8 A ±0.25 A @ 28 volts dc

ENVIRONMENTAL CHARACTERISTICS:
Display/Processor:
Operating temperature range: -20 to +55 °C (-4 to +131 °F)
Cooling: internal fan
Operating altitude: 35,000 feet maximum
Antenna:
Operating temperature range: -55 to +70 °C (-67 to +158 °F)
Operating altitude: 55,000 feet maximum

SPECIFICATION COMPLIANCE:
Complies with FAA TSO C110a
Meets major international government requirements

Maintenance & Service

Your *Stormscope®* system should be checked for proper operation and performance at least once a year, preferably before the thunderstorm season. Your authorized *Stormscope®* dealer has the specialized test equipment and training required to check that your *Stormscope®* system's many functions are operating properly.

Your *Stormscope®* system can be checked either in your instrument panel or on the dealer's test bench. If the dealer finds a problem, the dealer will return the faulty component to BFG Avionics Systems. For a nominal charge, BFG will repair, test, and certify the component to its original operating performance standards, rewarrant it for an additional 90 days (assuming the original warranty has expired), and return it to your dealer.

To ensure continued compliance with the specifications, replacement parts for repair of the *Stormscope®* system should be obtained from BFG. Only persons with the proper maintenance ratings working in a BFG-approved *Stormscope®* repair facility should attempt to repair the *Stormscope®* system; otherwise, return the unit directly to BFG for repair.

Chapter 6
Warranty Information

Introduction

The *Stormscope*® system is warranted for 2 years from the date of installation (not to exceed 30 months from the date of shipment from BFGoodrich Avionics Systems) subject to the following limitations.

Warranty Statement

BFGoodrich Avionics Systems, (hereinafter called BFGAS), warrants each item of new equipment manufactured or sold by BFGAS to be free from defects in material and workmanship, under normal use as intended, for a period of 30 months from date of shipment by BFGAS to an authorized facility, or 24 months from date of installation by an authorized facility, whichever occurs first. No claim for breach of warranties will be allowed unless BFGAS is notified thereof, in writing, within thirty (30) days after the material or workmanship defect is found.

The obligation of BFGAS shall be limited to replacing or repairing at its factory the equipment found defective under terms of this warranty certificate; providing that such equipment is returned in an approved shipping container, transportation charges prepaid, to BFGAS, Grand Rapids, Michigan, or such other location as BFGAS may authorize. BFGAS reserves the right to have necessary repairs performed by an authorized agency.

This warranty shall not apply to any unit or part thereof which has not been installed or maintained in accordance with BFGAS instructions, or has been repaired or altered in any way so as to adversely affect its performance or reliability, or which has been subjected to misuse, negligence or accident.

This warranty is exclusive and is accepted by buyer in lieu of all other guaranties or warranties express or implied, including without limitation the implied warranties of merchantability and fitness for a particular purpose. Buyer agrees that in no event will BFGAS liability for all losses from any cause, whether based in contract, negligence, strict liability, other tort or otherwise, exceed buyer's net purchase price, nor will BFGAS be liable for any special, incidental, consequential, or exemplary damages.

BFGAS reserves the right to make changes in design or additions to or improvements in its equipment without the obligation to install such additions or improvement in equipment theretofore manufactured.

A Subsidiary of The BFGoodrich Company

Related Policies and Procedures

a. If the original registered owner of a *Stormscope®* system sells the aircraft in which the *Stormscope®* system is installed during the warranty period, the remaining warranty may be transferred. Written notification of the transaction must be submitted by the initial recipient of the warranty to:

ATTENTION: WARRANTY ADMINISTRATOR
BFGoodrich Avionics Systems
5353 52nd Street, S.E.
Grand Rapids, MI 49588-0873
U.S.A.

b. Equipment must be installed by a BFG Avionics Systems authorized dealer or installer. Installation of equipment by facilities not specifically authorized will void the equipment warranty.

c. Notice of a claimed product defect must be given to BFG Avionics Systems or a designated BFG Avionics Systems service agency within the specified warranty period.

d. A product which is defective in workmanship and/or material shall be returned to BFG Avionics Systems via any authorized dealer with transportation charges prepaid. After correction of such defects, the equipment will be returned to the dealer, transportation prepaid by BFG Avionics Systems via surface transportation. Any other means of transportation must be paid by the customer.

   The risk of loss or damage to all products in transit shall be assumed by the party initiating the transportation of such products. All items repaired or replaced hereunder shall be warranted for the unexpired portion of the original warranty.

e. BFG Avionics Systems is in no way obligated or responsible for supporting or participating in the costs of the installation warranty. The entire responsibility lies with the BFG Avionics Systems authorized dealer making the installation. BFG Avionics Systems is only responsible for the product warranties outlined in the warranty statement.

f. BFG Avionics Systems cannot authorize warranty credit for troubleshooting of other systems in the aircraft in order to reduce noise interference with the *Stormscope®* system.

Appendix A
Dealer Information & Annual Performance Check

Dealer Information

Name _____

Address _____

City, State, Zip _____

Telephone _____

Equipment Information

Model Number _____

Part Number _____

Serial Number _____

Date of purchase _____

Installation Date from FAA form 337 _____

Annual Performance Checks

Date	Dealer Name	Remarks

Note

To ensure that a repaired *Stormscope®* system meets FAA TSO, major government regulatory agencies approvals outside the U.S.A., and BFGoodrich Avionics Systems performance standards, your *Stormscope®* system must be reinstalled and tested by an authorized *Stormscope®* dealer.

BFGoodrich
Aerospace

Avionics Systems

009-10951-001 (Rev. 00, 2/9/96)

BFGoodrich FlightSystems, Inc.
5353 52nd Street, S.E.
P.O. Box 873
Grand Rapids, MI, 49588-0873 USA

Stormscope®
Series II *Weather Mapping Systems*