WX-10 OWNER'S MANUAL

Operating & interpreting your new "Stormscope" WX-10 system for easy thunderstorm mapping.

3M

((Ryan)))))

Stormscope®

Weather Mapping System

Introduction:

With your new "Stormscope" system, you're flying the finest thunderstorm avoidance system available today.

Congratulations! You're now flying the finest thunderstorm avoidance system available today — the 3M ((Ryan))))) "Stormscope" Weather Mapping System. You'll soon trust your WX-10 as one of the most valuable instruments in your panel. You'll quickly respect it as a reliable aid in avoiding dangerous turbulence and other hazards of thunderstorms.

Be sure to use this manual.

This Owner's Manual will help you make the most of your "Stormscope" system. Read it completely and carefully to understand fully how this important instrument works and how to easily utilize its full capacity.

The product:

Your "Stormscope" WX-10 system consists of these components:

A Processor. Totally solid-state unit is compactly designed for easy remote installation in the aircraft.

B Display. Single panel-mounted 3ATI cathode-ray-tube unit contains all operational controls; screen is internally edge-lit for night viewing.

Antenna. Aerodynamically designed unit mounts externally on the aircraft; single, combined loop-sense without moving parts.

Basic benefits of the 3M ((Ryan))))) "Stormscope" Weather Mapping System:

- **You can choose from a series of models, offering a sensible range of capacity and affordability.**
- **Every model of the "Stormscope" system works as well on the ground as it does in the air. This means you can get up-to-the-minute thunderstorm information before takeoff — even before starting the engines! You can map the weather first, then map your flight!**
- **Every model can be installed in any single- or multi-engine aircraft; fixed- or rotor-wing; piston, turbo-prop or jet.**
- **Every model has inherently high reliability, because it's a solid-state, low-power, passive system with no moving parts.**
- **Every model is surprisingly lightweight and compact.**
- **Sold through a worldwide network of dealers, each model carries a full one-year warranty.**

WARNING: This "Stormscope" system is not intended for thunderstorm penetration. There is simply no weather mapping instrument available that can safely be used to penetrate thunderstorms. In this manual examples a given of aircraft passing close to thunderstorms. It is very important to note it is not always safe to pass this close to a thunderstorm. Pilot in command is responsible for all decisions regarding flight around thunderstorms.

The display:

Check these convenient control/screen features:

1 Power/mode switch. Turn "on" to operate. Turn to "forward" to concentrate instrument's memory capacity on forward 180°.

2 Test button. Push to check whether instrument is operating properly, either as a pre-flight procedure or during in-flight use. (See page 10 for demonstration.)

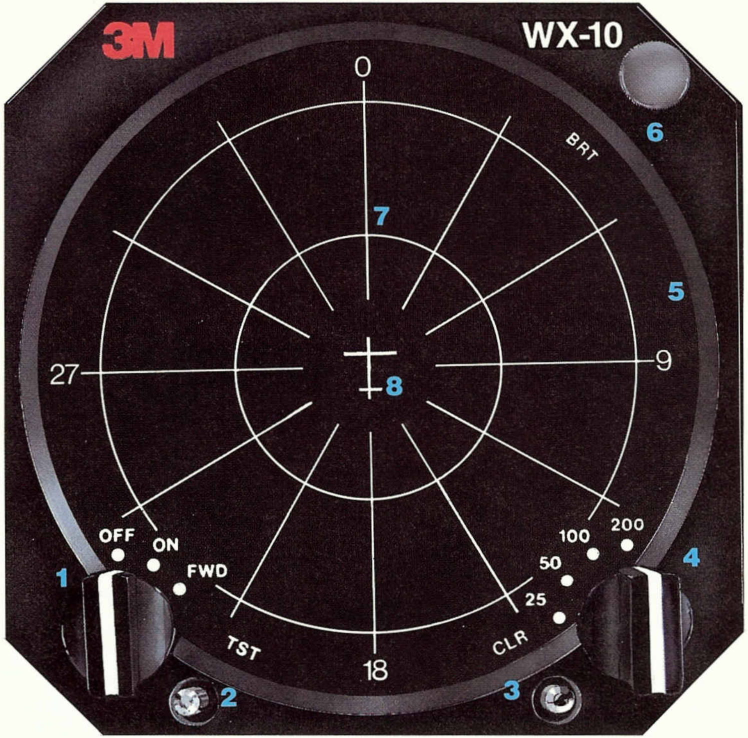
3 Clear button. Push to clear dots from screen so fresh, new thunderstorm data can be displayed.

4 Range-selection switch. Turn to desired range (25, 50, 100 or 200 nm); selected range corresponds to outer circle on screen (inner circle indicates half that range).

5 Internal-edge lighting. View display screen comfortably at night, with brightness controlled by panel-light dimmer switch.

6 Brightness control. Turn to dial in desired brightness of dots on screen (clockwise to brighten, counter-clockwise to dim).

7 Mapping lines. Outer circle indicates range selected by "range-selection switch"; inner circle indicates half selected range. Segments of 30° indicate arc width, at outer circle, equivalent to about half the nautical miles of outer-circle range. Example: With "range-selection switch" set at 200 nm, outer circle indicates 200 nm from aircraft, inner circle 100 nm, and width of 30° segment at outer circle is about 100 nm.



8 Mapping direction indicator. Aircraft diagram indicates position of thunderstorm **in relation to aircraft's heading** (not necessarily in terms of degrees off compass north or aircraft course).

Contents:

Look at virtually thousands of electrical discharges inside a distant thunderstorm.

There's a good reason to look at electrical discharges. After all, electrical discharges are directly related to convective wind shear. In fact, a thunderstorm by definition must have electrical discharges.

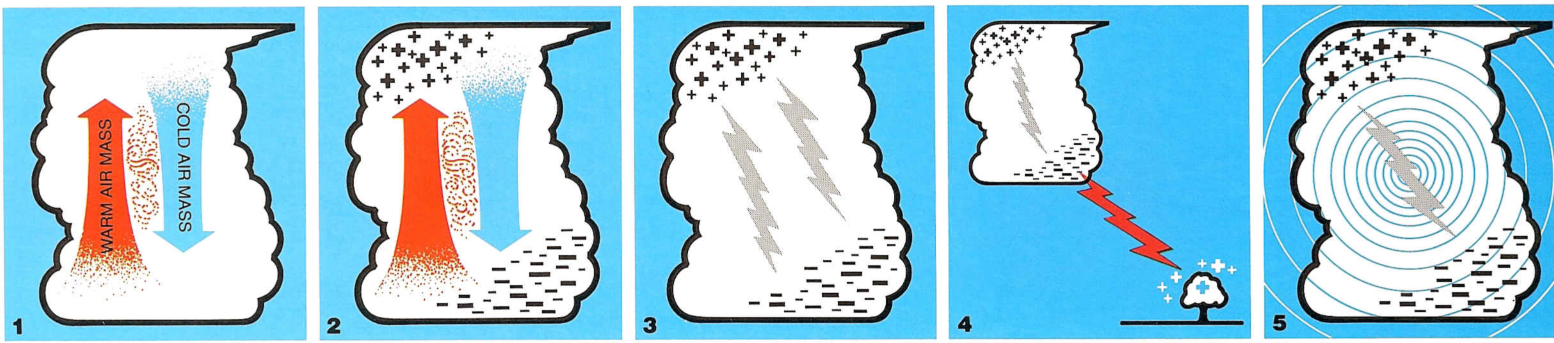
Find the discharges and you've found the wind shear...that special kind of turbulence that can mean gust loads strong enough to threaten structural failure. Defined updrafts and downdrafts, opposing each other, produce a separation of positive and negative charges. As these separated charges accumulate, electrical discharges occur. And for every discharge that can be seen by the eye, there may be a hundred more that can't be seen. All electrical discharges send out electromagnetic radio frequency energy — radiating in all directions at the same time at the speed of light. Each type of discharge has a unique "fingerprint," so to speak.

Therein lies the concept of the "Stormscope" Weather Mapping System: Find the discharges (by receiving the electromagnetic energy radiations)...check the "fingerprint"...determine azimuth and range... then you can *accurately map* thunderstorm activity to *avoid* dangerous wind shears.

Determine the precise heading that will give the *smoothest, safest flight,* while optimizing flight time and fuel efficiency.

That's the name of the game. The consummate concept. Get to your destination as directly and as safely as possible. Go around the areas of wind shears. Use this newest, most reliable technology to fly around thunderstorms...and save time, save fuel, avoid discomfort at the same time.

Read on through this Owner's Manual to learn more about how to make the underlying concepts of the "Stormscope" Weather Mapping System work effectively for you.



1 The convective flow of air currents associated with thunderstorm development leads to wind shears in the space between the opposing air currents. The closer together these air currents are, the greater the shear activity. The currents oppose each other producing friction. **2** The friction between these convective currents causes electrical charges to separate. As positive and negative electrical charges are separated, they accumulate and congregate in masses of similar charges. **3** Electrical discharges occur as the accumulated masses of segregated positive and negative charges "try to get back together." **4** A few of the discharges are visible, as lightning. For every discharge that can be seen, however, there may be a hundred more that can't be seen. **5** All discharges, whether visible or not, radiate electromagnetic radio frequency energy in all directions at the same time at the speed of light. The electrical discharge signals have unique characteristics and vary rates of occurrence which, along with the strength of the signals, can be monitored

Look at ***computer-processed display*** of the information from the radio signals received from distant electrical discharges.

Our patented technology is ingeniously simple. Thanks to the marvel of tiny computer chips, plus the fact there's no need for a transmitter, the "Stormscope" Weather Mapping System is compact, lightweight, and highly reliable.

Here's a brief overview of the technology behind this product: Your WX-10 picks up electromagnetic radio frequency signals from electrical discharges, 360° around the aircraft out to more than 200 nm. This means your WX-10 can help you "see" electrical discharges in over 150,000 square miles of air space!

Since the electromagnetic signal from each type of discharge has a unique "fingerprint," the system can sort out those related to convective shear. The signals are run through a computer-processor to organize and map them, by range and by azimuth.

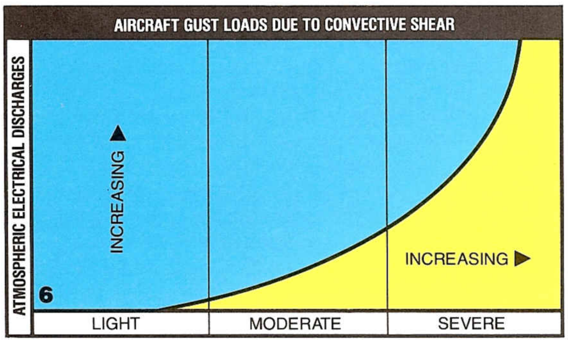
To determine range, the computer looks at each signal's intensity in a relatively narrow frequency bracket; it also analyzes vertical polarizations and the correlation between electrical and magnetic fields of each signal. Azimuth measurement is accomplished in much the same way as an ADF determines direction from an NDB.

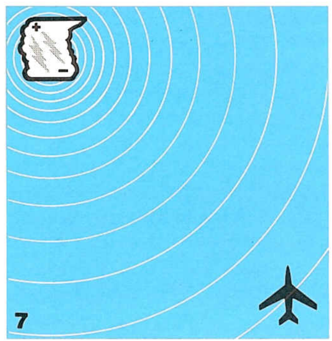
Finally, the computer-processed information is memorized and stored in the order the signals were received; the information is presented in an easy-to-read mapping format on the cathode-ray-tube screen.

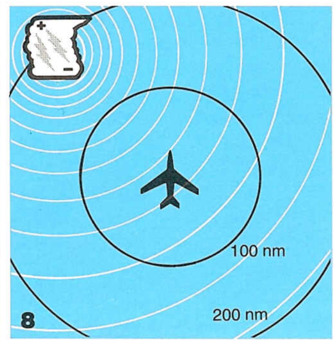
Sounds simple. But actually there are some mighty complicated things going on.

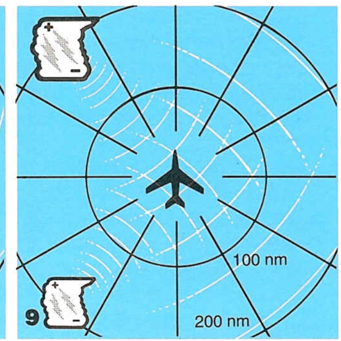
For one thing, it's all happening over and over again. The computer memorizes the data; with active thunderstorms, information on the screen may be completely updated and replaced every 25 seconds.

Obsolete information, more than a few minutes old, is automatically dropped. And the screen image uniquely indicates conditions of especially severe thunderstorm activity.









learn about the location and intensity of the convective shears which preceded the discharges. **6** It's critically important to monitor this atmospheric electrical activity accurately and thoroughly. For it's been well established that as electrical discharge activity increases, the potential risk of aircraft gust loads due to convective shear increases at an *increasing rate*. **7** The radiated electromagnetic signals from electrical discharges are powerful enough to be received and detected at great distances. Your WX-10 has the capability to receive such signals from discharges up to more than 200 nm away. **8** Since the signals radiate out in all directions at the same time, your aircraft is in a position to receive signals from electrical discharges anywhere in a full 360° out to more than 200 nm from the aircraft. **9** To effectively map the location of the convective shears, the radiated signals being received at your aircraft must be analyzed for azimuth, (in relation to the *aircraft's heading*), *rate of occurrence* (an indication of intensity of the thunderstorm), and range.

Dynamic, animated clusters of brightly-lit green location dots chart out map-like images of thunderstorm activity.

There's something fascinating about watching your display screen in action, especially when the instrument is receiving signals from active thunderstorms. As one pilot-author recently described it: "Like angry hornets from a stick-poked nest, the tiny green dots swarmed and flickered on the screen. Each time I pushed the Clear button, this awesome display would totally recreate itself within 10 seconds."

The WX-10 has the capacity to show as many as 256 brightly-lit dots at one time. These 256 dots can appear anywhere in a grid of more than 12,500 locations over the entire cathode-ray-tube screen; dots can even appear outside the outer-circle mapping line. (When the range-selection switch is set at 200 nm, the edge of the screen where outermost dots can appear is calibrated at 220 nm from aircraft position.)

With the "power/mode switch" turned to "forward," the 256-dot mapping capability is concentrated on the upper half of the screen — the 180° forward of your aircraft's position — for much greater definition of thunderstorm activity.

Each electrical discharge associated with convective shear sends out an electromagnetic radio frequency signal. Each signal is received by the antenna of your WX-10 and computer-analyzed by the processor. The processor then instructs the display unit to place a bright green dot on the screen in the position that most accurately maps the azimuth and range of the particular electrical discharge which originally triggered this series of instrument responses.

Even though the electrical discharges, and the electromagnetic signals, are transitory, the computer stores the information in its memory — so each dot can be shown continuously on the screen. A cluster of dots, then, maps an area of thunderstorm activity as signaled from dozens, perhaps hundreds of separate electrical discharges.

The size and shape of the cluster will indicate how concentrated or dispersed the electrical discharges, and associated convective shears, are at the thunderstorm location. The rapidity with which individual green dots occur will indicate the rate of occurence of the electrical discharges and thunderstorm severity. Individual dots outside clusters can offer clues to developing thunderstorm formations and may help describe the severity of thunderstorm activity.

Thunderstorm activity is continually changing...so your "Stormscope" system keeps updating.

Updating means keeping the map of thunderstorm activity always up-to-the-minute and up-to-the-second. Much of the updating takes place automatically; or you can easily initiate an update of the WX-10 yourself.

Automatic updating works like this: When an electromagnetic signal is received from the 257th electrical discharge (exceeding the instrument's capacity to memorize and present 256 dots), the oldest dot in memory is automatically erased and replaced. This process goes on continuously. At all times, the green dots on the screen represent a recent history of electrical discharges.

With a typical midwestern-type thunderstorm, the screen may completely update itself within a 25- to 45-second time frame (representing, obviously, a very brief history). In extreme thunderstorm conditions, all the dots may "swarm and flicker" through a scintillating update in a mere 10 to 15 seconds.

On the other hand, when thunderstorm activity is minimal, the rate of discharge occurrence can be relatively slow and non-spectacular. But, in any event, whenever a dot has been on the screen about 5 minutes without being automatically updated, that particular dot is automatically cleared from the screen and memory. (On some occasions, dots may stay on screen for longer than 5 minutes.)

In addition, it is possible to manually clear the entire screen at any time by pushing the "clear" button. Then the entire series of instrument responses will begin to unfold again, recreating a fresh, new map of thunderstorm activity.

Clusters of dots map areas of significant thunderstorm activity. This cluster indicates a thunderstorm at the 1:30 position (about 45° off the aircraft's heading) — a thunderstorm that is about 25-30 nm in diameter, with the closest edge about 25 nm from the aircraft at this moment.

Individual isolated dots may offer clues about developing thunderstorm systems or severity of nearby thunderstorms.

Dots can appear anywhere in a grid of about 12,500 locations over the face of the screen.

Up to 256 dots can appear on the screen at the same time.

Some terms and concepts worth reviewing before reading on.

The following pages are devoted to explicit examples and explanations of how to read and interpret your WX-10 screen. You'll find it helpful to review the following terminology, conceptual ideas, and illustration/explanation approaches before studying the simulated flight sequences on pages 10-15.

Radial spread. This phrase is used to describe a common phenomenon: A stream of dots, trickling inward toward the center of the screen, tapering toward the center in a pie-shaped pattern. Radial spread appears to originate from or trickle out of, a larger cluster of dots representating an area of thunderstorm activity (or from a thunderstorm that's not visible on the screen because it's beyond the range-setting in use at the time). Dots in radial spread do not necessarily indicate the location of atmospheric electrical discharges; clusters of dots indicate the location of atmospheric electrical discharges. As thunderstorm severity increases, causing the number of dots in a cluster to increase, radial spread also increases.

Rate of occurrence. The "Stormscope" system is receiving electromagnetic radio frequency signals over and over, repeatedly storing the signals in computer memory, and repeatedly displaying dots on the screen. The rapidity with which the dots occur is directly related to the rapidity of electrical discharges. This is referred to as rate of occurrence. **Rate of occurrence is the best indicator of thunderstorm severity.**

Airspace/weather diagram. Screen examples on the following pages are accompanied by scaled diagrams of a large area of airspace, through which simulated flights are diagrammatically proceeding. These diagrams are used to show the locations of thunderstorm activity in relation to the ever-changing, ever-progressing positions of the aircraft. Each unit in the grid represents an area 100 nm square. The circles indicate the range being mapped on the screen below. For clarity, thunderstorm areas are indicated in sizes somewhat larger (in square miles of area, for instance) than would normally be the case under actual conditions; and the aircraft, obviously, is indicated considerably oversize in relation to the scale of the grid.

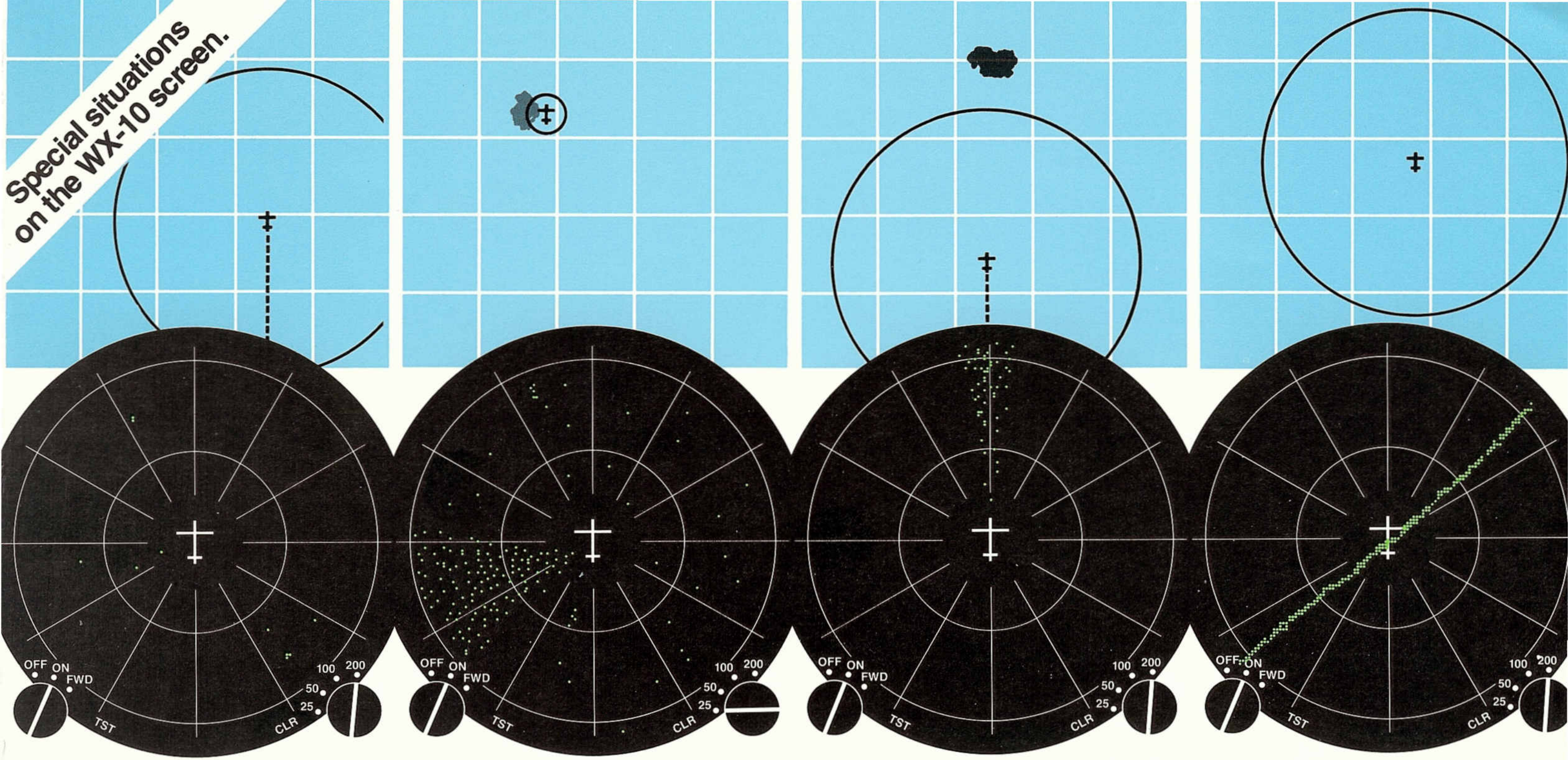
Weak, moderate, severe thunderstorms. Such adjectives are subjective, at best. But in the airspace/weather diagrams on the following pages, three levels of thunderstorm intensity are indicated — by light gray (weak), medium gray (moderate), and black (severe) — in order to somewhat approximate the way various intensities found in actual conditions will affect the screen image.

Storm movement. While thunderstorm systems generally are moving (and changing), the usual movement is relatively slow (5 to 45 knots) when compared to the speed of the aircraft. Therefore, no attempt has been made to accurately indicate storm movement in the airspace/weather diagram.

Range switching. For better definition of thunderstorms as you use your "Stormscope" system for mapping safe headings around thunderstorms, change to the next closer range setting whenever thunderstorms appear within the inner range circle. (Be aware that dots within the inner circle may be radial spread not thunderstorms.) When range is changed, your WX-10 retains in memory the electrical discharge locations (and the related dot positions of the screen image) from the previous range — until all available memory is utilized by new signals being received from within the newly selected range. Say, for instance, you have been operating on the 200-nm range with 125 dots appearing on the screen; then, if you changed to 100-nm range, the memory could accumulate up to 131 additional signals and related new dot locations — without dislodging the 125 dots on the 200-nm range. You can change back to the 200-nm range and see the same dot pattern still retained in memory.

Aircraft heading. When referring to the screen-image examples and airspace/weather diagrams of the following pages, remember that you're viewing thunderstorm locations in relation to the aircraft's heading (not necessarily in terms of degrees off compass north or aircraft course). As an aid to clear understanding, thunderstorm locations are described in captions by positions around the clock.

Special situations on the WX-10 screen.

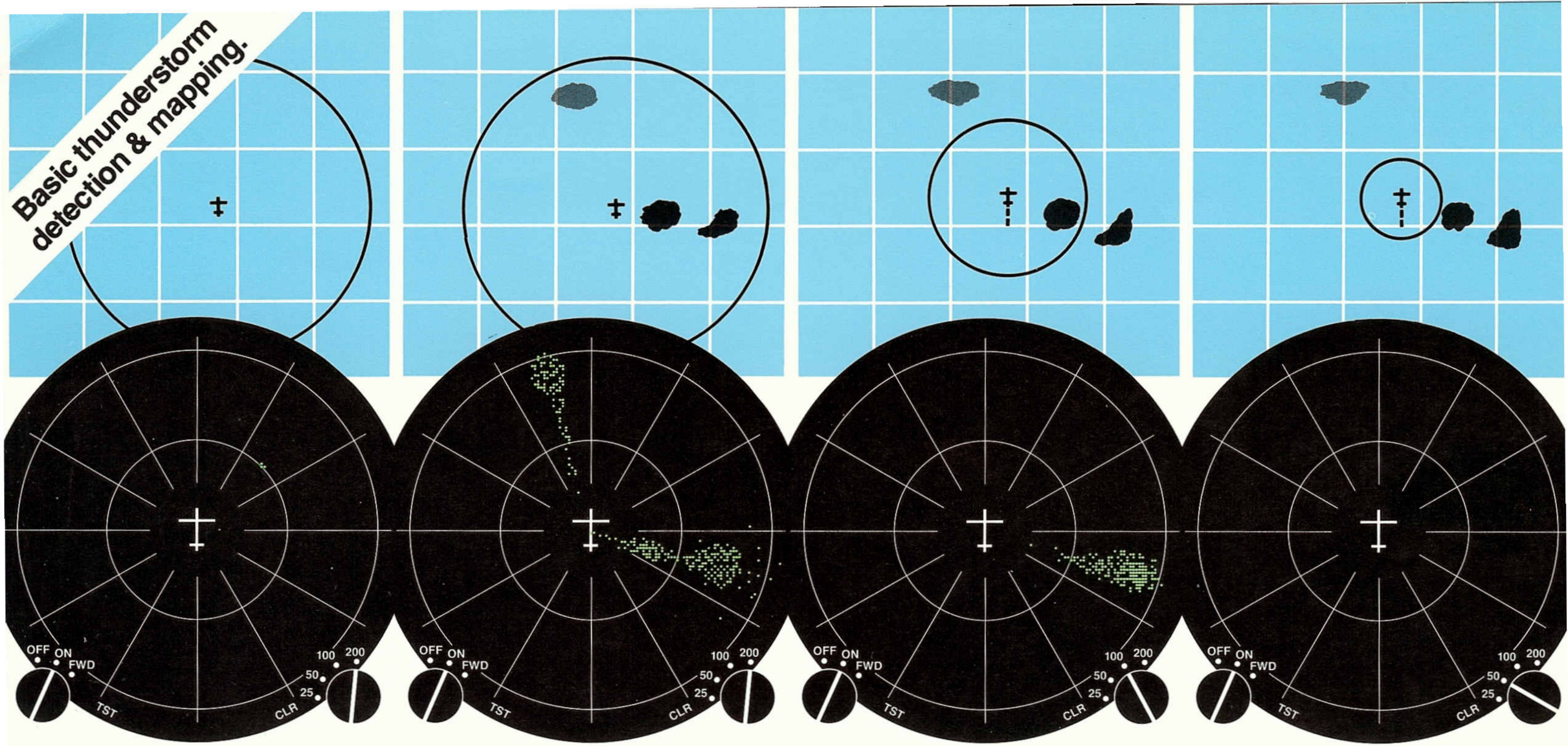


A-1 Example of randomly scattered dots. Several possible causes — turning on or off electrical switches, atmospheric instability associated with cumulus clouds, developing or dissipating thunderstorm, etc. If screen has randomly scattered dots, push clear button. Monitor screen, watching for developing clusters of dots that indicate actual atmospheric electrical discharges.

A-2 Dot cluster at 8:30, centered about 12 nm from aircraft. Electrical discharges close to aircraft, within 3 to 5 nm, may cause splattering of dots. Clustered dots are primary concern. If splattering appears, aircraft is probably too close to thunderstorm and should immediately change heading. When splattering first appears, push clear button; screen will clear, then dots will cluster to map location of thunderstorm.

A-3 Dots appearing off nose of aircraft. Two possible explanations: Thunderstorm just beyond 220-nm range, producing radial spread. Or dots may represent distant electrical discharges arriving by atmospheric skip — from thunderstorm well beyond the instruments range. Neither is cause for immediate concern. Continue monitoring.

A-4 Line of dots across screen while taxiing. Caused by "noisy" underground cable beneath taxiway. Can go across entire screen or only part way. Once aircraft has crossed cable, push clear button. Normal operation will resume.

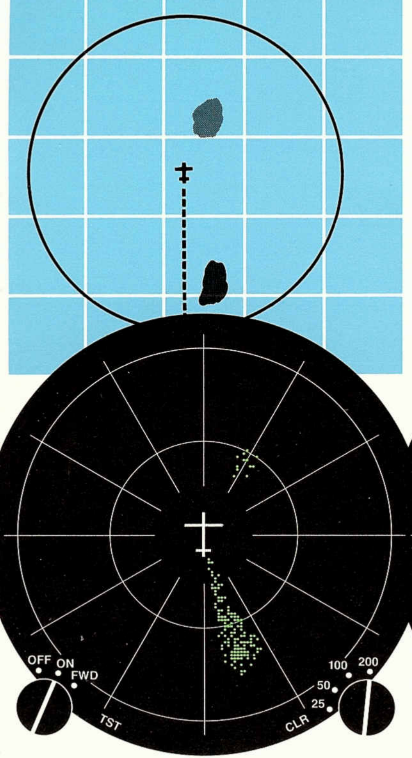


B-1 To test, turn power/mode switch to "on" and set range on "100" or "200" nm. No test pattern visible on 50-nm or 25-nm ranges. Allow about 30 seconds for warm-up, then push test button. If functioning correctly, small cluster of dots appears at about 1:30 and 100 nm. Holding test button in generates several dots per second at correct position. Press clear button after completing test.

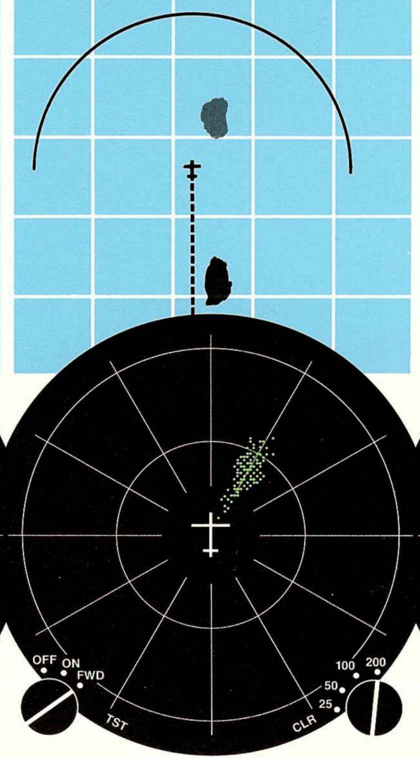
B-2 Before take-off, screen maps thunderstorm activity within 220 nm of aircraft. Three thunderstorms illustrated: one at 11:30, centered 180 nm; two at 3:30, one centered 160 nm, other 65 nm. Each produces some radial spread. Thunderstorms at 3:30 have more dots than one at 11:30, indicating greater rate of occurrence, or more severe thunderstorm.

B-3 After changing range-selection switch to 100 nm, outer circle represents 100-nm, inner circle 50 nm. After a couple minutes, thunderstorm is mapped at 3:30, centered at about 65 nm from aircraft. Thunderstorms beyond 110 nm not now visible. (Rate of occurrence is less on shorter ranges.) Can change back to 200-nm range and still view B-2 image if memory capacity permits.

B-4 Range changed to 50-nm. No dots accumulate because no thunderstorms within 55 nm of aircraft. Thus no need to try 25-nm range. Closer ranges useful only if clustered dots appear within inner circle of current range setting. Radial spread transversing inner circle will not necessarily be visible with closer range settings.

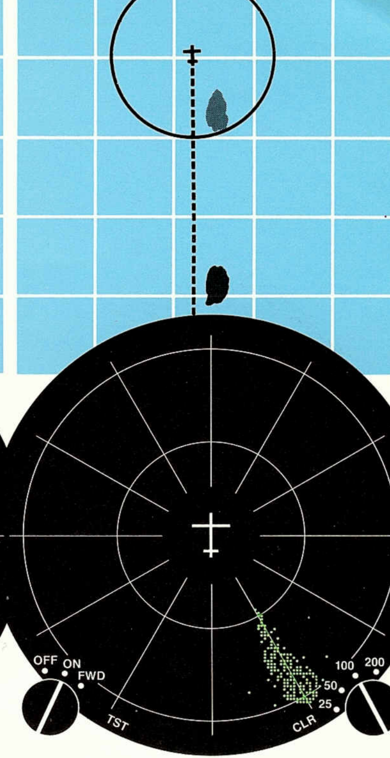


C-1 Weak thunderstorm at 1:00, about 80 nm from aircraft. Severe thunderstorm at 5:30, about 130 nm. Fewer dots at location of weak thunderstorm indicates lesser rate of occurrence; also little radial spread. Opposite true of severe thunderstorm.

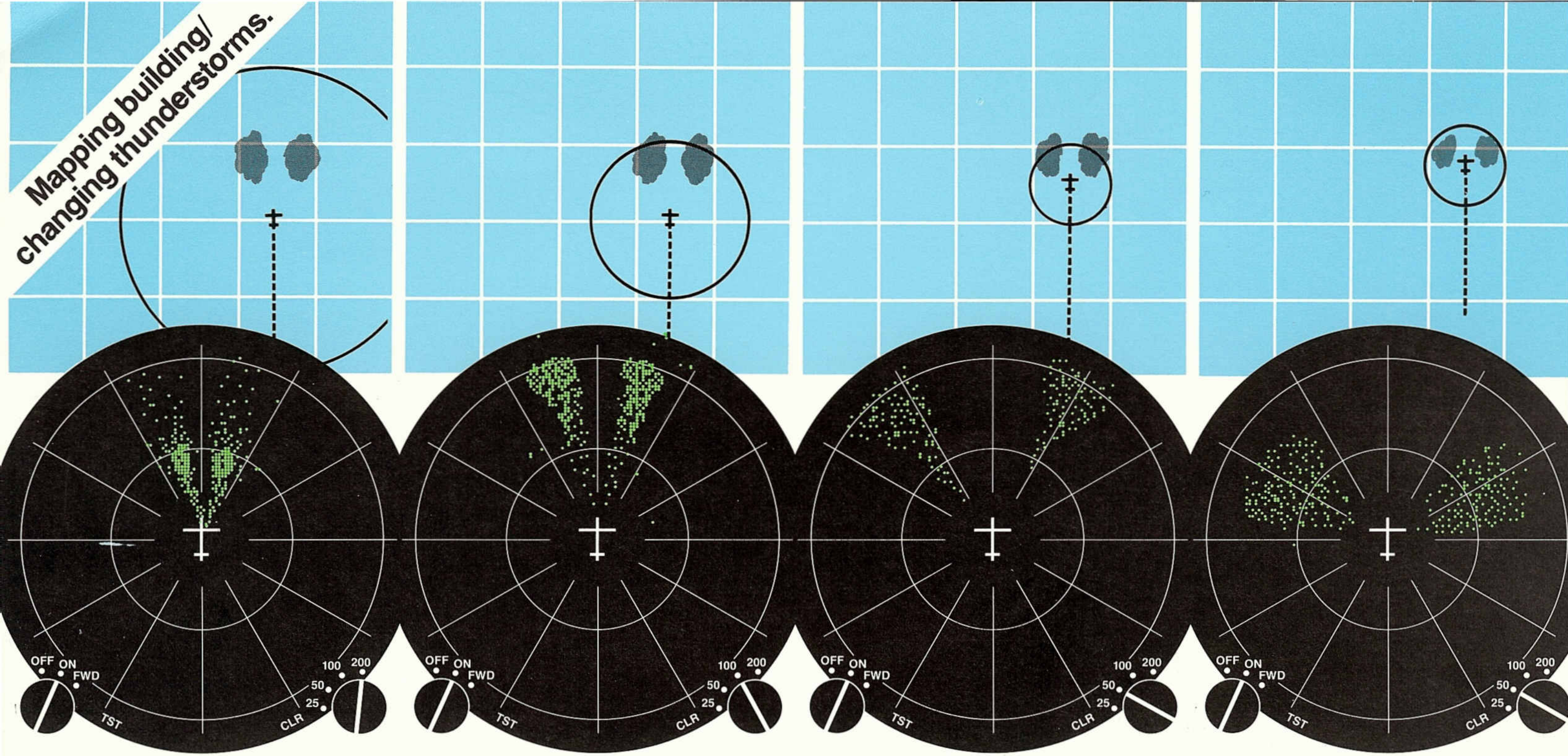


C-2 Power/mode switch turned to "forward." No change in range. After about 3 to 5 minutes, all dots disappear from 5:30 thunderstorm because it's not in forward 180°. Weak thunderstorm at 1:00, now about 80 nm from aircraft, mapped in greater detail because all 256 dots are available for forward 180° now that severe storm to rear is not being shown.

C-3 Range-selection switch changed to 100-nm. The power/mode switch turned back to "on," restoring 360° view. Only thunderstorm visible is at 2:30, centered about 70 nm from aircraft. Severe thunderstorm outside 100-nm range, thus not visible. Thunderstorm at 2:30 has become moderate intensity, indicated by greater rate of occurrence and increased radial spread.



C-4 Aircraft has flown past thunderstorm, now at 5:30, about 90 nm away. Your WX-10 can be changed to longer range at any time to get overview of any new developing thunderstorm activity.



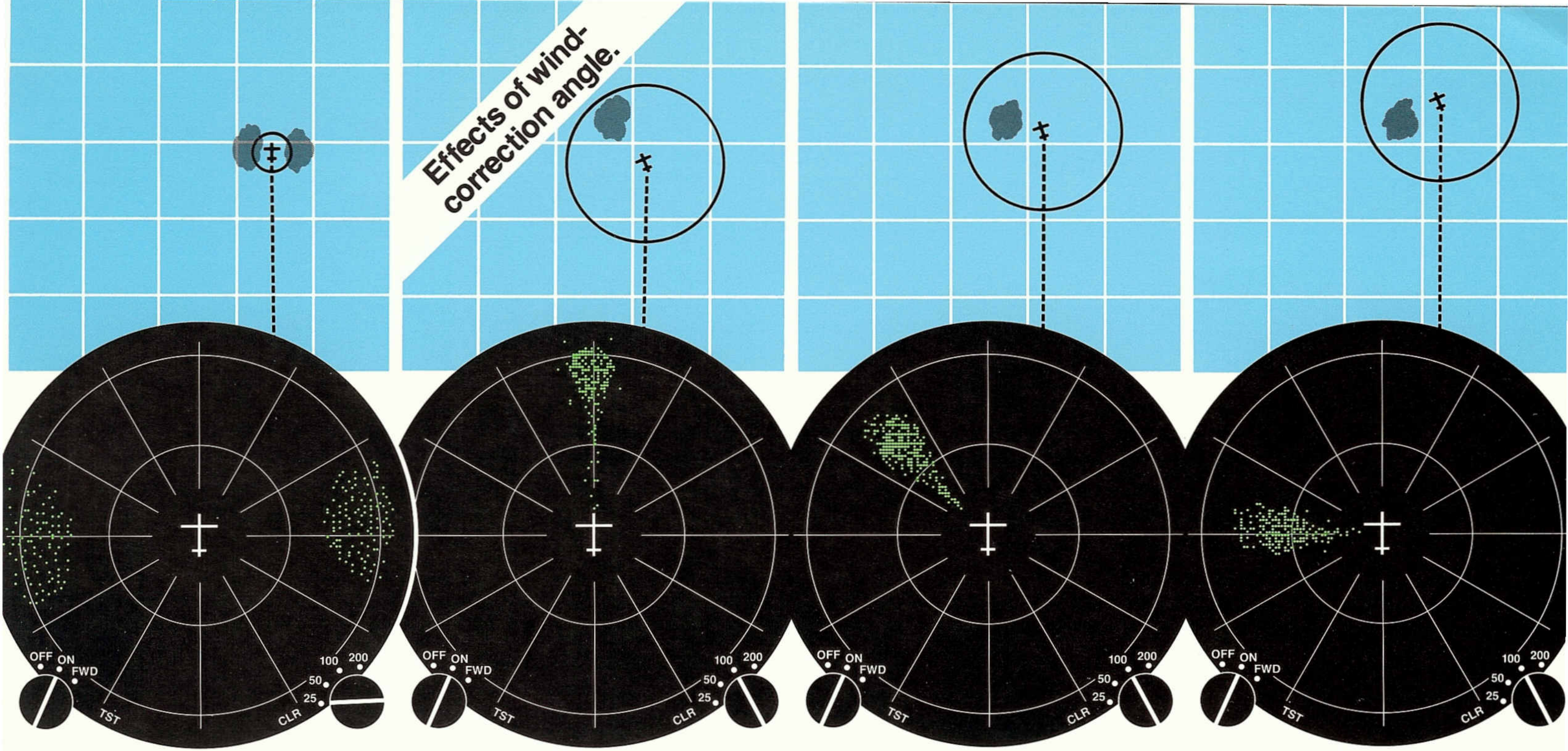
D-1 Two moderate thunderstorms, at 11:30 and 12:30. Each approximately 25 to 30 nm wide. Each centered about 90 nm from aircraft. Significant radial spread from both indicate both are moderate intensity.

D-2 Closer range provides better definition of both thunderstorms. Aircraft has not moved significantly from D-1 to D-2. Dot clusters map opening of 40-45 nm between two thunderstorms. (At the outer circle, 30° represents about one-half of selected range.)

D-3 Range-selection switch turned to 50 nm. Aircraft traveled about 50 miles since D-2. Same thunderstorms display fewer dots while on closer range, but not necessarily indicating decreased intensity. Thunderstorms still about 40-45 nm apart. Width of both still 25-30 nm. Thunderstorms at 10:30 and 1:00 centered about 45 nm from aircraft.

D-4 Thunderstorms now at 9:30 and 2:30, still about 40-45 nm apart. Thunderstorm mapping indicates each thunderstorm is about 25 nm from aircraft.

Effects of wind-correction angle.

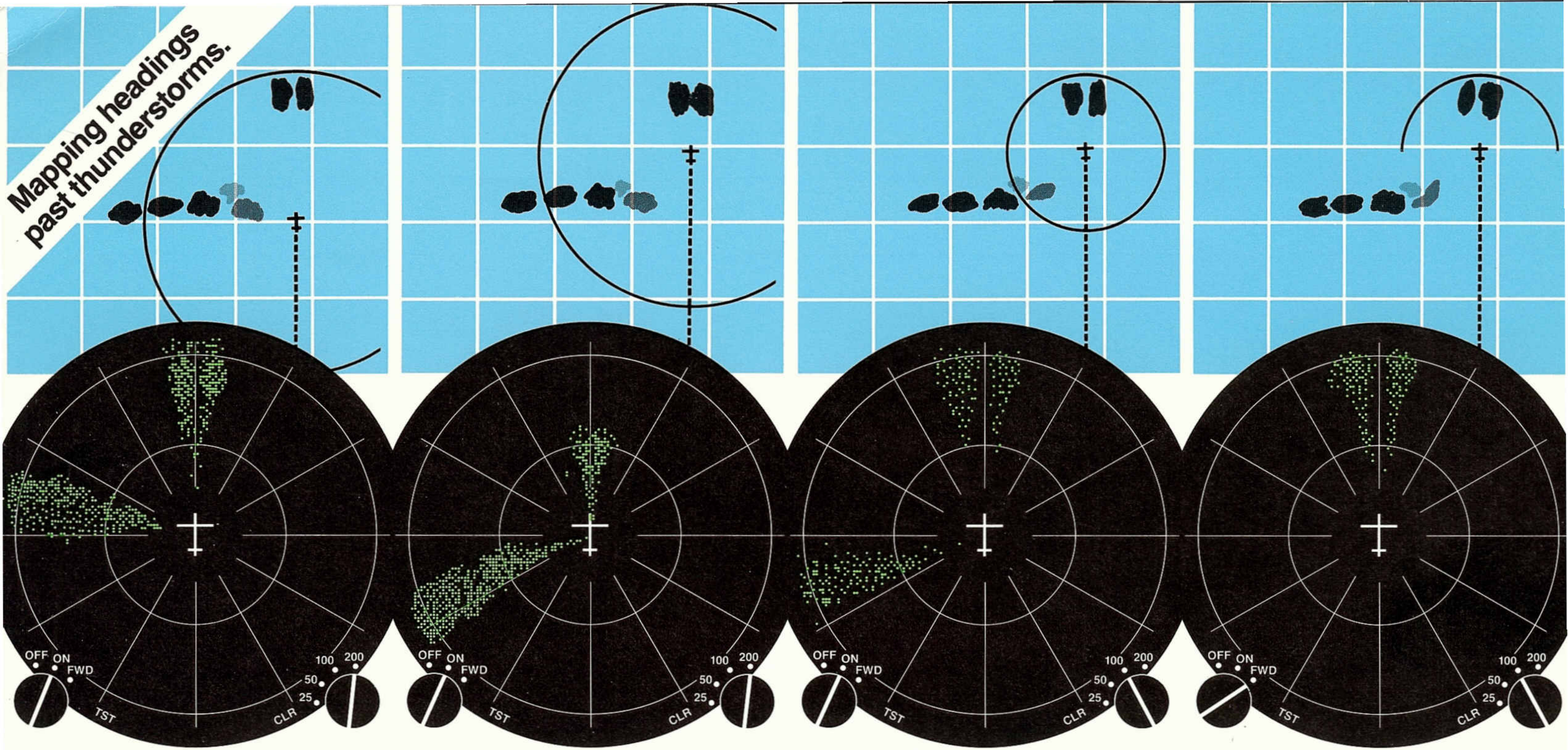


D-5 Range-selection switch changed to 25 nm. Thunderstorms mapped at 9:00 and 3:00. Each centered about 25 nm from aircraft. This does not guarantee safe passage in all situations. (Clustering on 25-nm range.) Radial spread virtually non-existent because of 25-nm range. Thunderstorms display fewer dots on shorter range, but have not decreased in intensity.

E-1 Moderate thunderstorm indicated at 12:00, about 90 nm from aircraft. Appears aircraft is flying directly toward thunderstorm. Airspace/weather diagram indicates contrary. Aircraft crabbed 15° left for wind correction. Thunderstorm, in fact, is directly off nose of aircraft, but flight course will maintain distance between aircraft and thunderstorm. **Important to be aware of wind-correction angle.**

E-2 Aircraft maintains heading while approaching thunderstorm. Cluster of dots now appear at 10:30, centered about 75 nm from aircraft. Thunderstorm continues to be mapped in relation to aircraft heading, not ground track.

E-3 Thunderstorm, centered about 50 nm from aircraft, appears at 9:00, due to wind-correction angle — even though aircraft has already passed thunderstorm.

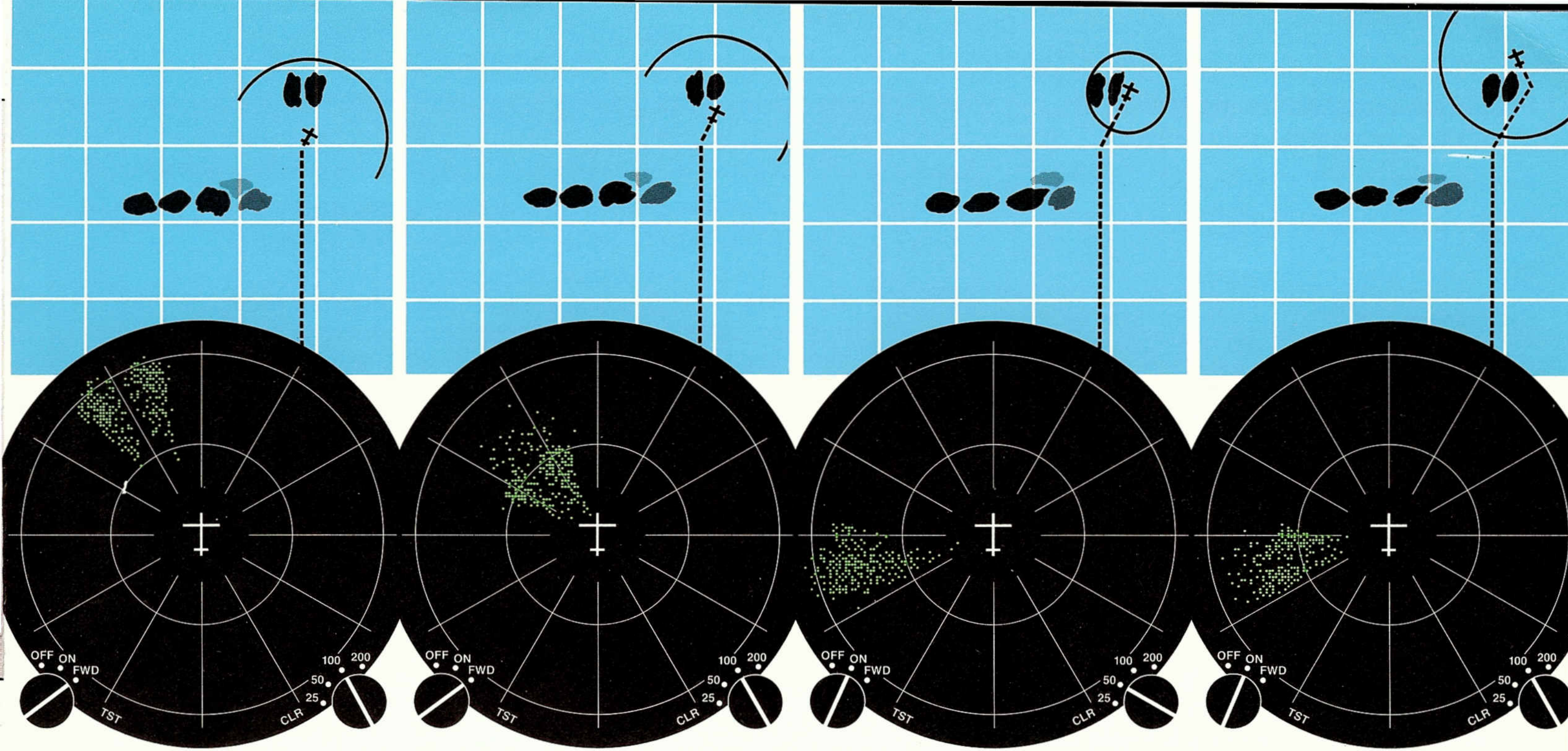


F-1 Two severe thunderstorms are off nose of aircraft, appearing almost as one cluster of dots, centered about 180 nm from aircraft. Cluster of dots at 9:30 indicates system which contains several severe thunderstorms. Avoid premature judgment when thunderstorms are mapped near outer circle on 200-nm range, because thunderstorm conditions can change rapidly.

F-2 Aircraft maintained original heading, progressed about 100 nm from F-1. Two thunderstorms off nose of aircraft now appear to be one; radial spread indicates intensity still severe. Line of severe thunderstorms previously at 9:30 in F-1 now at 8:30; radial spread still indicates severe intensity.

F-3 Range-selection switch turned to 100-nm range for greater detail of the thunderstorms. Thunderstorms off nose of aircraft now are shown to be two separate thunderstorms. Line of severe thunderstorms at 8:30 maintain severe intensity.

F-4 Power/mode switch turned to forward for greater detail. Thunderstorms appearing in F-3 at 8:30 now behind aircraft, suggesting use of forward mode. Severe thunderstorm at 11:30 now centered about 90 nm from aircraft. Thunderstorm at 12:15 also about 90 nm. (F-2, F-3, and F-4 occur over short distance.) Mapping information now sufficient to choose route around storms.



F-5 Aircraft turns to right to fly around thunderstorms. When turn completed, push clear button. Screen updates, mapping new positions of thunderstorms. When shorter ranges can be used, more accurate decisions can be made to navigate around thunderstorms.

F-6 Aircraft maintains heading around thunderstorms, about 50 nm away. The number of dots from the two thunderstorms to left of aircraft's track indicates continued severe intensity.

F-7 Range-selection switch turned to 50-nm range. Power/mode switch turned back to "on" for 360° view. Thunderstorms behind the aircraft will become visible. From angle of aircraft, two thunderstorms to left appear as one cluster of dots. Aircraft has passed by thunderstorms while maintaining at least 25 nm from each. No need to switch to 25-nm range as no dots would appear.

F-8 Aircraft turns to left to begin returning to original course. When turn complete, push clear button. Range-selection switch turned to 100-nm. All thunderstorm activity now behind aircraft course. No new thunderstorm activity appears ahead of aircraft. Switch to 200-nm range to get overview of possible new thunderstorm activity.

WX-10 specifications:

Practical dimensions, lightweight durability, convenient features.

Input voltage	10-30 v DC
Power requirement	20 w (max)
CRT screen size	2⅝ in dia
Operating range	Switch-selectable — 25, 50, 100, 100 nm Max range — 220 nm
Operating azimuth	Normal — 360° Forward mode — 180°

Weight

Computer-processor	4.3 lb (2.000 kg)
Display with tray	3.4 lb (1.500 kg)
Antenna	1.5 lb (0.675 kg)
Total	9.2 lb (4.175 kg)

Dimensions

Computer-processor	2.25 in x 7.63 in x 12.9 in
Display	3.19 in x 3.19 in x 9.22 in
Antenna	5.00 in x 9.50 in x 1.10 in

Parts and service warranty:

We stand behind the materials and workmanship of your "Stormscope" system.

The 3M ((Ryan))))) "Stormscope" Weather Mapping System is warranted against defects in materials and workmanship for one year from date of installation. 3M's obligation is limited to the repair or replacement, at 3M's option, of products which prove to be defective during the warranty period. No other warranty is expressed or implied. 3M is not liable for consequential damages.

NOTE:

Warranty protection is assured only when installed by an authorized 3M ((Ryan))))) "Stormscope" dealer.

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((Ryan))))) "Stormscope"
Weather Mapping Systems/3M
6530 Singletree Drive, Columbus, OH 43229
Call (614) 885-3310