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Pilot's Guide RDR 1400C

Color Weather and Search & Rescue Radar

TELEPHONICS
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TABLE OF CONTENTS

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INTRODUCTION

In the early days of aviation, pilots were more concerned with just staying airborne than worrying about weather. Airplanes were for fun. Pilots flew only short hops, on clear days, and could often see their destination. There was little need for navigation equipment. If your compass was working and your gas held out, you could probably make it home safely. Later, as flying came of age, thunderstorms and their associated turbulence were more of a problem. When the weather was good aircraft utilization was high. But when storms were prevalent, you might take the long way home.

Today, weather radar is as much at home in the cockpit as the compass. Corporate aircraft operators, and private pilots, as well as the airlines have adopted weather radar with full confidence in its usefulness and reliability. Most commercial airborne weather radars available today also provide the pilot with one or more ancillary modes of operation and system options that make the radar more functional and increase its versatility.

AlliedSignal General Aviation Avionics Division would like to welcome you to the growing family of Bendix/King Colorvision Weather Radar System owners and operators.

The RDR 1400C Colorvision Weather Radar System is the newest advancement of the 1400 series of radars. The 1400 series radars are the most popular advanced capability, multi-mode radars available from any manufacturer.

The RDR 1400C provides five primary modes of operation: three air-to-surface search and detection modes, and two conventional weather avoidance modes. This lightweight digital X-band radar system provides a peak power of 10kW, and is primarily designed for fixed or rotary-wing aircraft engaged in patrol, search and rescue missions, and for transporting personnel and equipment to remote sites (off-shore oil rigs, etc.).

The system contains a color indicator display, and will also interface with optional NAV systems (such as VLF/Omega or RNAV) to display NAV information on the indicator screen.

The RDR 1400C also has the capability to receive and decode both standard 2-pulse beacon transponders and the DO-172 6-pulse transponders. This system also provides two short ranges of 0.5nm and 1.0nm.

In addition, an optional checklist may be installed that connects to the radar indicator and does not require any other supportive optional equipment. An automatic page recall feature can be used to present checklists keyed to certain equipment failure, even if another mode is selected.

This manual is designed to help you understand the RDR 1400C and its operational procedures. Please read it carefully before operating the unit. If you have any questions, contact AlliedSignal General Aviation Avionics or your nearest Bendix/King Distributor for assistance.

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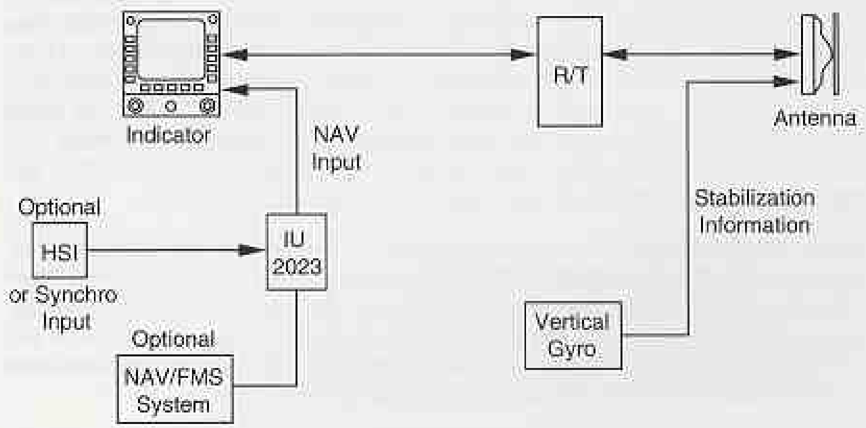
SYSTEM CONFIGURATION



Typical System Block Diagram

ANTENNA AND RECEIVER-TRANSMITTER

The RT-1401B Receiver-Transmitter generates 10 KW pulses of X-band energy. Reflected signals of weather, search and beacon modes received by the antenna are amplified and sent to the radar display indicator.

The flat-panel antenna, 10, 12 or 18 inches in diameter scans 60 or 120 degrees. Swept by a motor driven gear train, the vertical component is positioned by the tilt control on the indicator. A stabilization system presents an upright radar display while the aircraft is turning, climbing or descending.

RT14011B Receiver-Transmitter

DA 1203A Drive Assembly with AA4512A 12" Flat Plate Antenna

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RADAR DISPLAY INDICATOR

IN 2025B Indicator

The IN-2025B Colorvision indicator uses vivid displays of green, yellow and red to create moving maps of weather and surface features.

Rainfall per hour	Ground Return	Color
0-1 mm	No significant return	Dark
1-4 mm	Light	Green
1-12 mm	Medium	Yellow
12 mm or more	Heavy	Red

The choice of two weather modes, three search modes and antenna scan of 60 or 120 degrees is selected by the pilot. A target alert feature is active in the weather alert mode, and a movable track cursor helps the pilot plan his flight around severe weather. A beacon mode enables the display of beacon locations and a code feature identifies them. Beacon Format allows for the display of either standard or DO-172 type beacons. All this information can be displayed in any of eight separate ranges.

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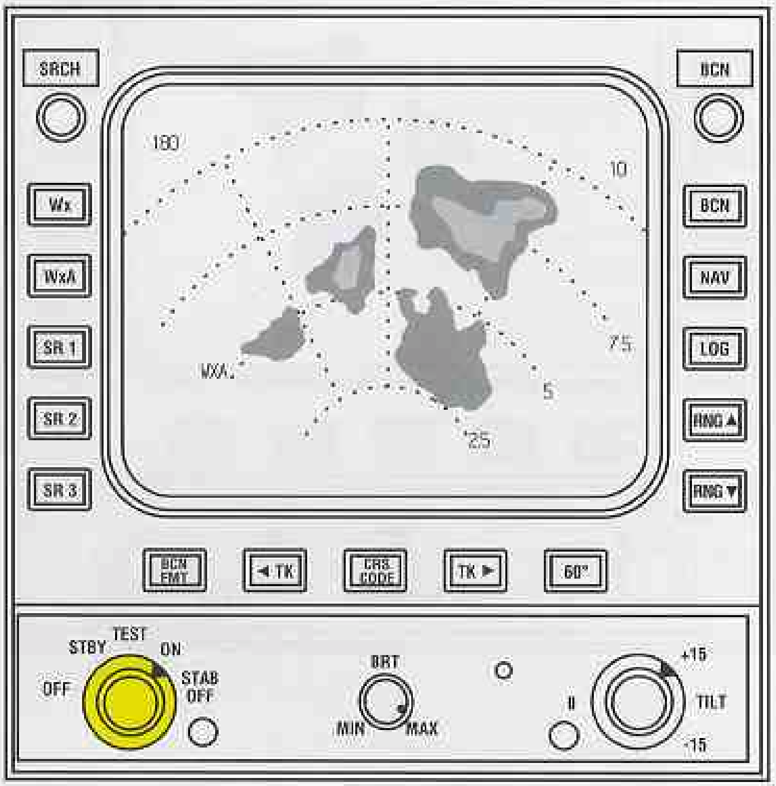
OPERATIONAL CONTROLS

FUNCTION SELECTOR

OFF	Removes system power.
STBY	System is operationally ready; no display.
TEST	Displays a test pattern without transmitting, identified by TEST and RT FAULT. (see Pg. 13)
ON	System transmits in normal operation.
STAB OFF	System transmits without antenna stabilization; STAB OFF displayed.



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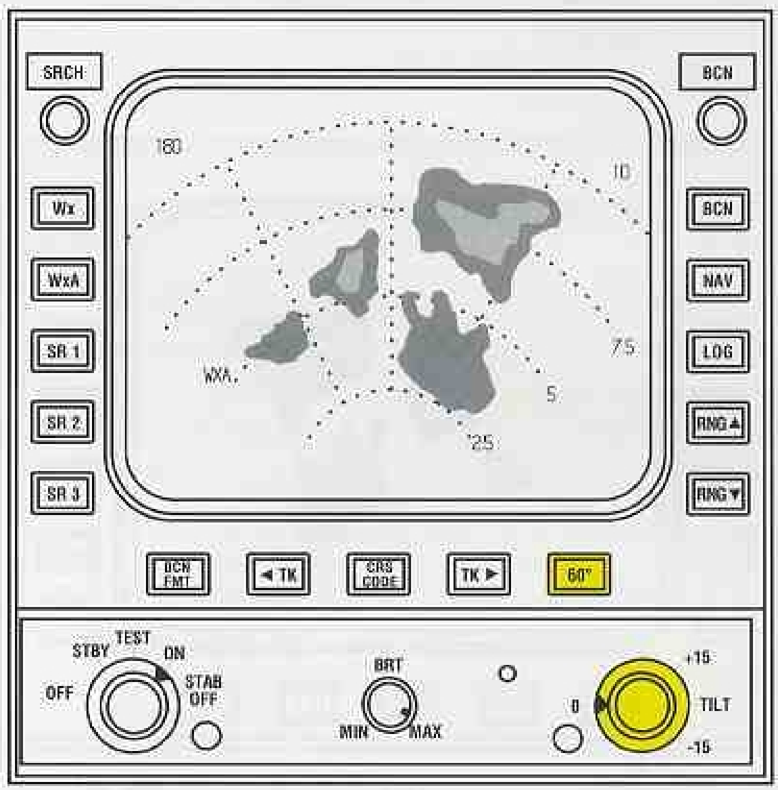
ANTENNA CONTROLS

60°	Narrows antenna scan from120° to 60°.
TILT	Adjusts antenna tilt angle.



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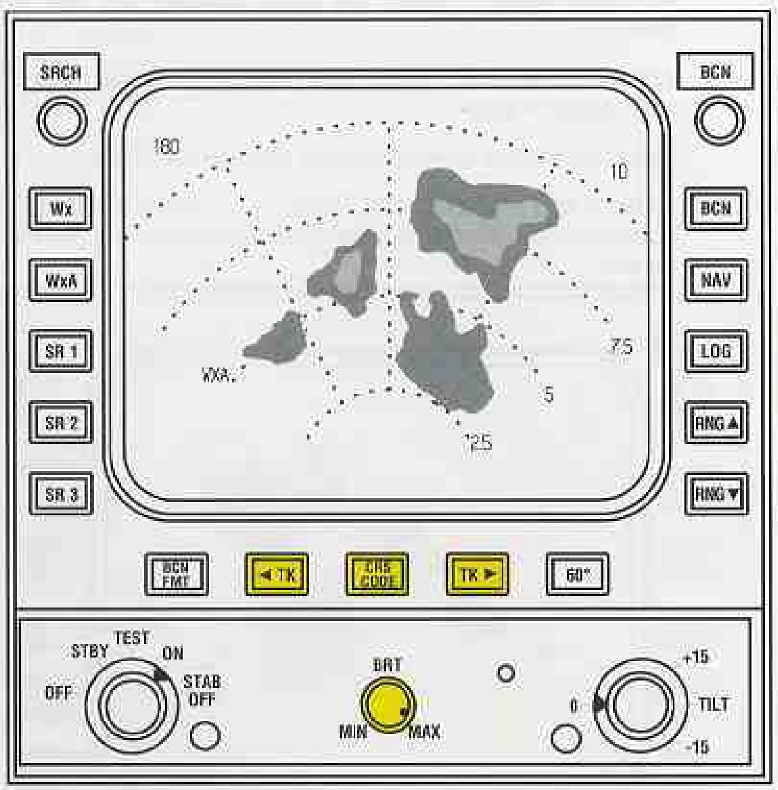
DISPLAY CONTROLS

< TRK TRK >	Displays and moves the yellow track cursor right or left. Track cursor disappears after 20 seconds.
BRT	Adjusts display intensity.
CRS CODE	Selects beacon codes in BCN mode. Selects OBS-TRK when out of BCN mode, and when out of NAV mode.



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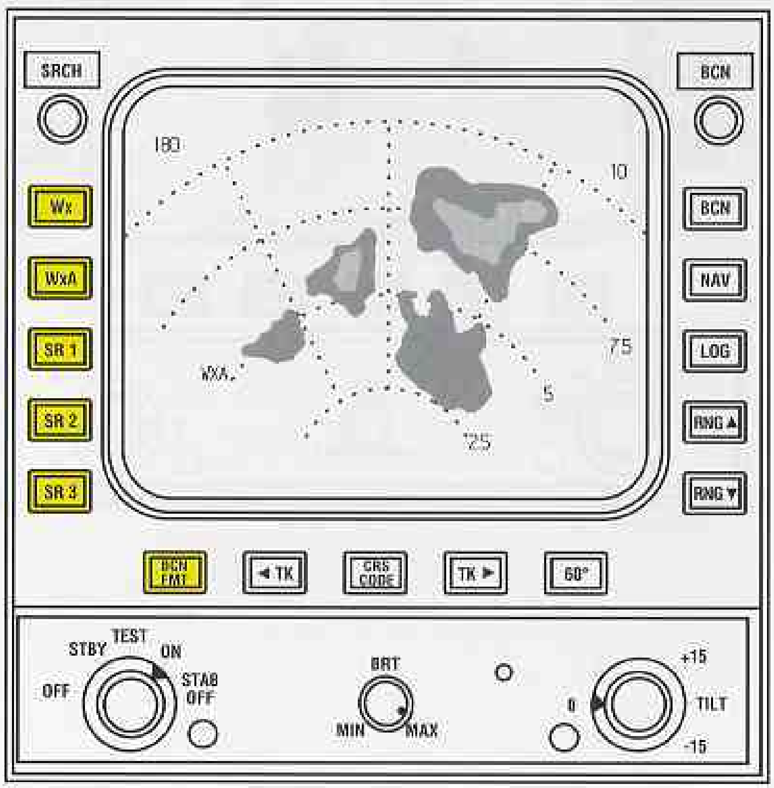
PRIMARY MODE SELECTORS

(PUSH ON/PUSH OFF)

Wx	Selects weather mode, the primary mode of operation (automatically selected at turn-on). Weather displayed and Wx appear on screen. When pressed again, the weather mode is removed. If no other mode button is active, the Wx mode remains.
WxA	Selects weather alert mode causing red returns to flash. WxA appears and Target Alert is enabled.
SR1	Activates search 1 mode; sea clutter rejection (20 mile range or less).
SR2	Activates search 2 mode; short range precision mapping (20 mile range or less).
SR3	Activates search 3 mode; normal surface mapping.
BCN FMT	Selects beacon format of DO-172 (6-pulse) or standard (2-pulse) format. Message displayed in upper right hand corner of screen.



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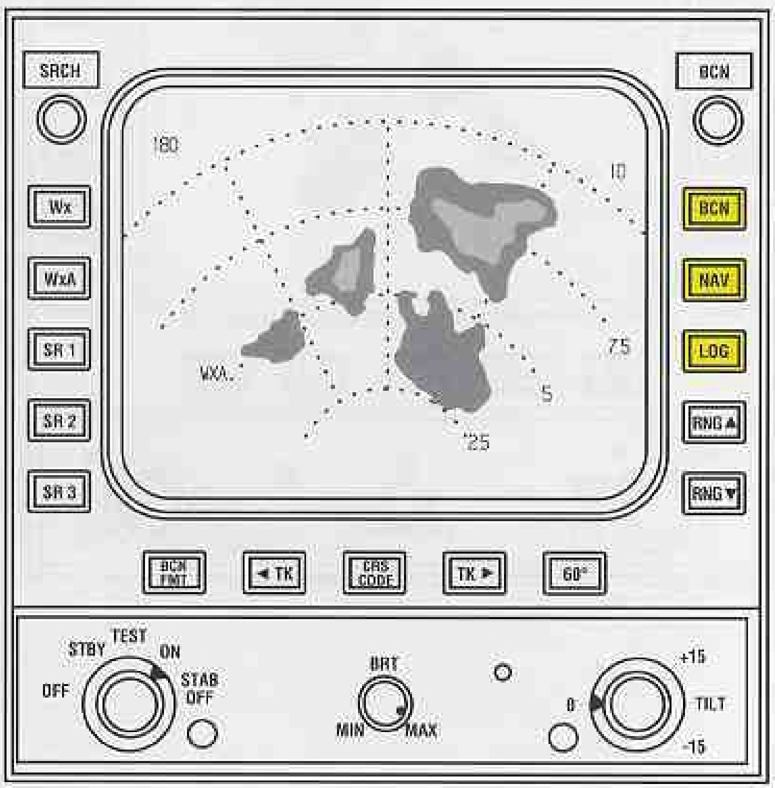
SECONDARY MODE SELECTORS

BCN	Selects Beacon mode. All beacons within range and BCN appear.
NAV	Selects navigation display. Used only with optional equipment.
LOG	Selects flight log display from optional NAV equipment.



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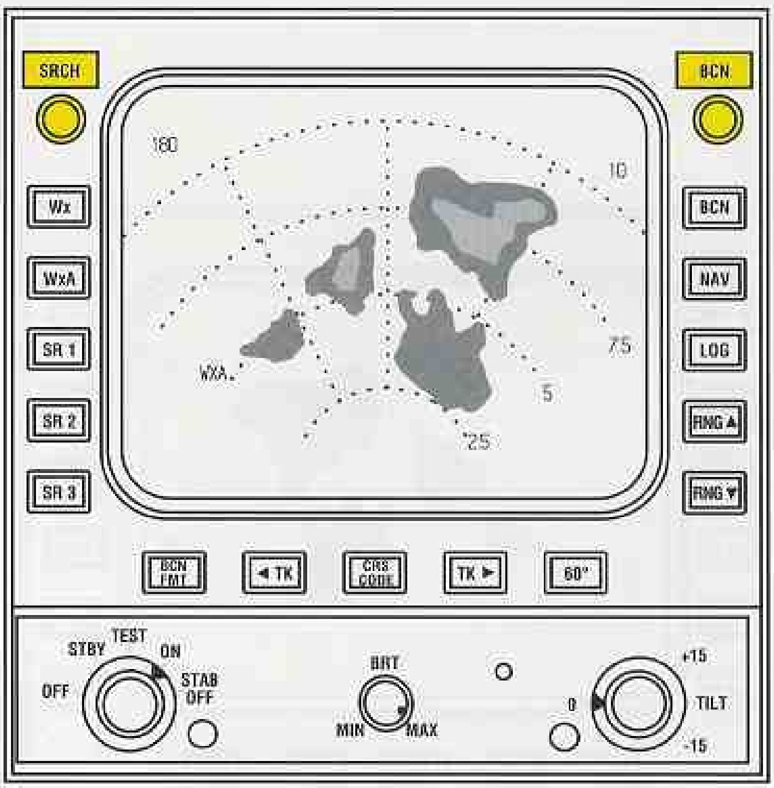
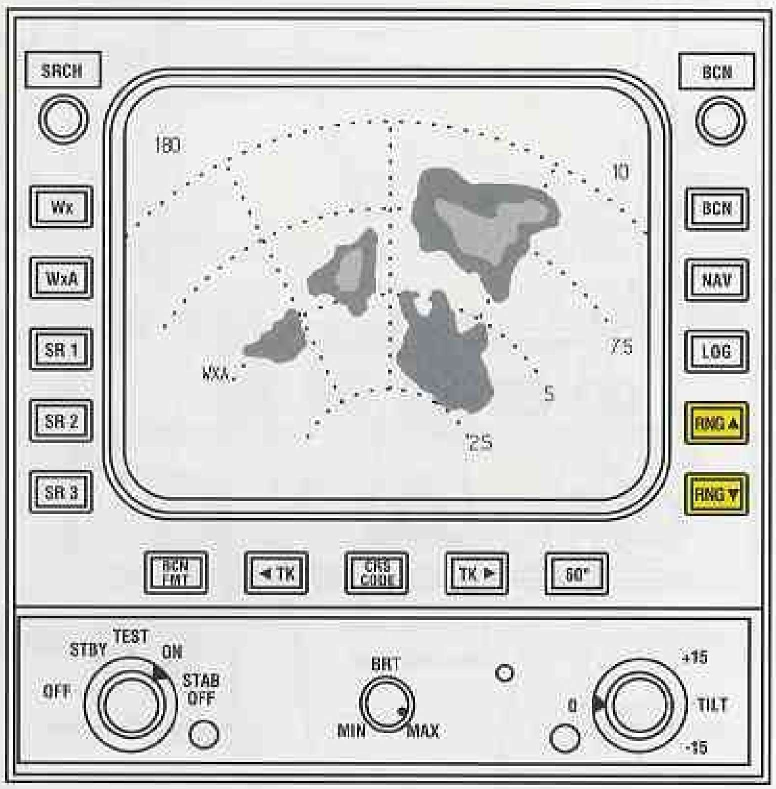
GAIN CONTROLS

SRCH	Adjusts radar receiver gain when search mode is selected.
BCN	Adjusts beacon receiver gain when BCN mode is selected.



RANGE CONTROLS

RNG (up)	Range increase.
RNG (down)	Range decrease.



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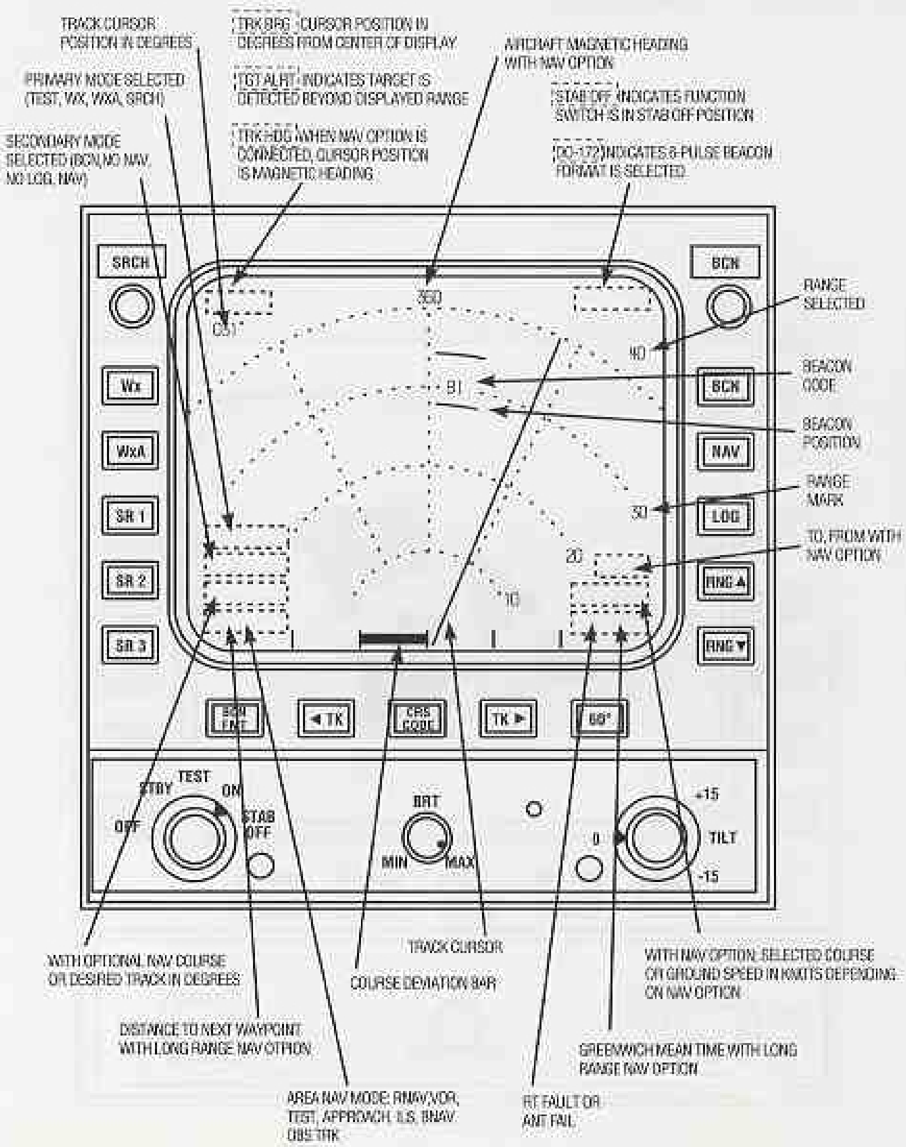
ALPHANUMERICS



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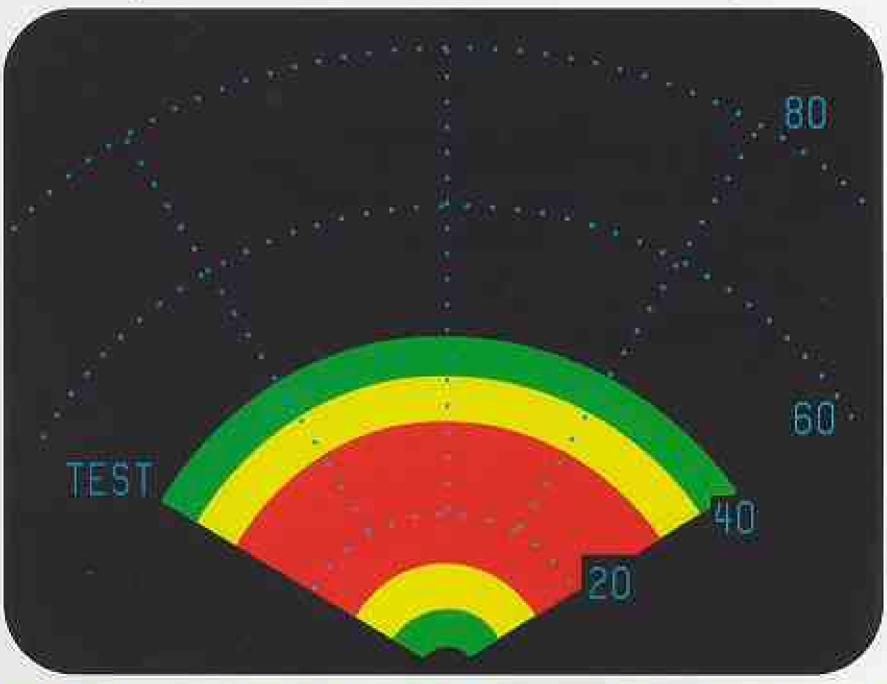
PREFLIGHT (PFT)

PREFLIGHT WARNINGS

Test the system to verify proper operation before each flight. Rotate the function selector from OFF to STBY. Allow system to warm up for about 100 seconds, then move the function selector to TEST. No display appears in the STBY position and the radar does not transmit in either STBY or TEST. The test pattern scans 120° and automatically selects the 80 mile range. Look for distinct color bands and range marks in the order shown. Adjust display brightness for a comfortable level. Checklist and flight log options may be used at this time if installed.

WARNING: Do not turn the radar on within 7 feet of ground personnel or containers holding flammable or explosive material. The radar should never be operated during refueling.

When ready to use the radar, rotate the function selector to ON position.



NOTE: The design of the Colorvision system is such that full operation is possible approximately two minutes after turn-on. Therefore, the pilot may choose to leave the function switch in OFF, rather than STBY, if no significant weather is in the immediate area of the aircraft. The life of the magnetron transmitting tube will be extended by leaving the system "OFF" when possible. This, in turn, will reduce the cost of maintenance.

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THEORY OF OPERATION

GENERAL

The primary use of this radar is to aid the pilot in avoiding thunderstorms and associated turbulence. Since each operator normally develops specific operational procedures for use of Weather Radar, the following information is presented for use at the operator's discretion.

Operational techniques with the RDR 1400 Series Weather Radars are not different than with earlier generation radars. The proficient operator manages his antenna tilt control to achieve best knowledge of storm height, size, and relative direction of movement.

RADAR PRINCIPLES

Radar is fundamentally a distance measuring system using the principle of radio echoing. The term RADAR is an acronym for Radio Detecting And Ranging. It is a method for locating targets by using radio waves. The transmitter generates microwave energy in the form of pulses. These pulses are then transferred to the antenna where they are focused into a beam by the antenna. The radar beam is much like the beam of a flashlight. The energy is focused and radiated by the antenna in such a way that it is most intense in the center of the beam with decreasing intensity near the edge. The same antenna is used for both transmitting and receiving. When a pulse intercepts a target, the energy is reflected as an echo, or return signal, back to the antenna. From the antenna, the returned signal is transferred to the receiver and processing circuits located in the receiver transmitter unit. The echoes or returned signals are displayed on an indicator.

Radio waves travel at the speed of 300 million meters per second and thus yield nearly instantaneous information when echoing back. Radar ranging is a two-way process that requires 12.36 micro-seconds for the radio wave to travel out and back for each nautical mile of target range. As shown in the distance illustration below, it takes 123.6 micro-seconds for a transmitted pulse of radar energy to travel out and back from an area of precipitation 10 nautical miles away.

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WEATHER RADAR PRINCIPLES

Airborne weather avoidance radar, as its name implies, is for avoiding severe weather - not for penetrating it. Whether to fly into an area of radar echoes depends on echo intensity, spacing between the echoes, and the capabilities of both pilot and aircraft. Remember that weather radar detects only precipitation drops; it does not detect minute cloud droplets. Therefore, the radar scope provides no assurance of avoiding instrument weather in clouds and fog. Your indicator may be clear between intense echoes; this clear area does not necessarily mean you can fly between the storms and maintain visual sighting of them.

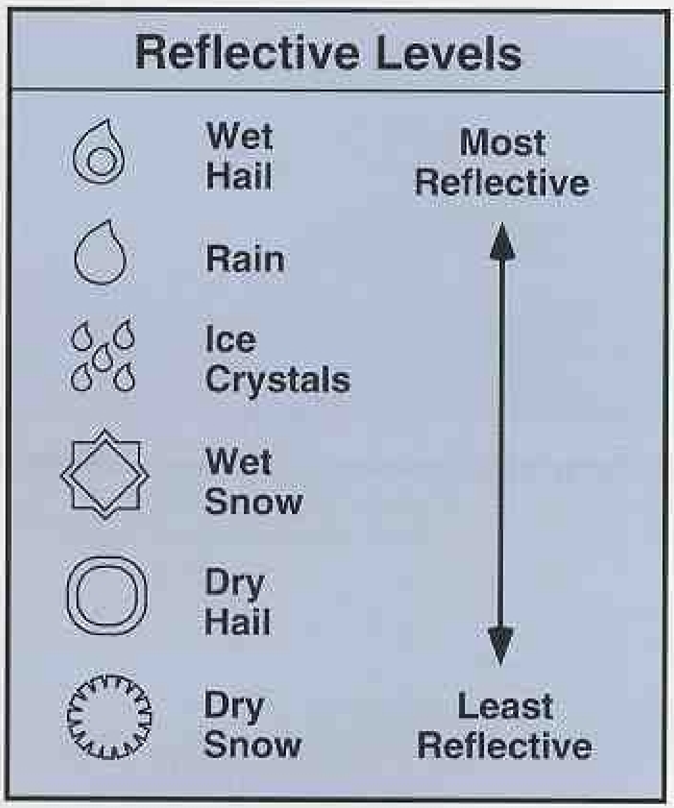
The geometry of the weather radar radiated beam precludes its use for reliable proximity warning or anti-collision protection. The beam is characterized as a cone shaped pencil beam. It is much like that of a flashlight or spotlight beam. It would be an event of chance, not of certainty, that such a beam would come upon another aircraft in flight.

Note: Weather radar is not practical as a pilot operable collision avoidance system. Weather analysis and avoidance are the primary functions of the radar system.

RADAR REFLECTIVITY

What target will reflect the radar's pulses and thus be displayed on the indicator? Only precipitation (or objects more dense than water such as earth or solid structures) will be detected by an X-band weather radar. Therefore, weather radar does not detect clouds, thunderstorms or turbulence directly. Instead, it detects precipitation which may be associated with dangerous thunderstorms and turbulence. The best radar reflectors are raindrops and wet hail. The larger the raindrop the better it reflects. Because large drops in a small concentrated area are characteristic of a severe thunderstorm, the radar displays the storm as a strong echo. Drop size is the most important factor in high radar reflectivity. Generally, ice, dry snow and dry hail have low reflective levels and often will not be displayed by the radar.

A cloud that contains only small raindrops, such as fog or drizzle, will not produce a measurable radar echo. But if the conditions should change and the cloud begins to produce rain, it will be displayed on radar.



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WEATHER DISPLAY CALIBRATION

The radar display has been calibrated to show four levels of target intensity: Black (level 0), Green (level one), Yellow (level two) and Red (level three) . The meaning of these levels is shown in the following chart as is their approximate relationship to the Video Integrated Processor (VIP) intensity levels used by the National Weather Service (NWS). These levels are valid only when (1) the Wx or WxA mode are selected; (2) the displayed returns are within the STC range of the radar (approximately 40 miles); (3) the returns are beam filling; and (4) there are no intervening radar returns.

Display Level	Rainfall Rate		Video Integrated Processor (VIP) Categorizations				Remarks
	mm/Hr.	In./Hr.	Story Category	VIP Level	Rainfall Rate mm/Hr.	Rainfall Rate In./Hr.	
3 (Red)	12	0.5	Strong	3	Greater than 12	Greater than 0.5	Severe turbulence, possible lightning
2 (Yellow)	4-12	0.17-0.5	Moderate	2	2.5-12	0.1-0.5	Light to moderate turbulence is possible with lightning
1 (Green)	1-4	0.04-0.17	Weak	1	0.25-2.5	.01-0.1	Light to moderate turbulence is possible with lightning
0 (Black)	Less than 1	Less than 0.04					

Radar Display and Thunderstorm Levels versus Rainfall Rates

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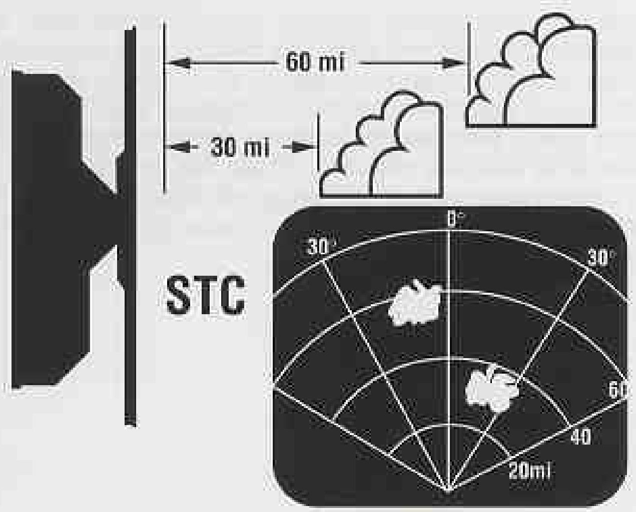
WEATHER ATTENUATION COMPENSATION

An extremely important phenomenon for the weather radar operator to understand is that of attenuation. When a radar pulse is transmitted into the atmosphere, it is progressively absorbed and scattered so that it loses its ability to return to the antenna. This attenuation or weakening of the radar pulse is caused by two primary sources, distance and precipitation. The RDR 1400C radars have several advanced features which significantly reduce the affects of attenuation but no airborne weather radar can eliminate them completely. It is therefore up to the operator to understand the radar's limitations in dealing with attenuation.

Attenuation because of distance is due to the fact that the radar energy leaving the antenna is inversely proportional to the square of the distance. For example, the reflected radar energy from a target 60 miles away will be one fourth (if the target is beam filling) of the reflected energy from an equivalent target 30 miles away. The displayed effect to the operator is that as the storm is approached it will appear to be gaining in intensity. To compensate for distance attenuation both Sensitivity Timing Control (STC) and Extended STC circuitry are employed. The RDR 1400C has an STC range of approximately 40 nautical miles and within this range the radar will electronically compensate for the effects of distance attenuation with the net effect that targets do not appear to grow larger as the distance decreases.

Outside the STC range the Extended STC circuitry increases the displayed intensity to more accurately represent storm intensity. The Extended STC will not, however, totally compensate for distance attenuation and, therefore, targets in this range can be expected to grow as the distance decreases until reaching the STC range.



STC electronically compensates for distance attenuation.

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Attenuation due to precipitation is far more intense and is less predictable than attenuation due to distance. As the radar pulses pass through moisture, some radar energy is reflected. But much of that energy is absorbed. If the rain is very heavy or extends for many miles, the beam may not reach completely through the area of precipitation. The weather radar has no way of knowing if the beam has been fully attenuated or has reached the far side of the precipitation area. If the beam has been fully attenuated, the radar will display a "radar shadow" which appears as an end to the precipitation when, in fact, the heavy rain may extend for many more miles. In the worst case, precipitation attenuation may cause the area of heaviest precipitation to be displayed as the thinnest area of heavy precipitation. Or it may cause one cell containing heavy precipitation to totally block or shadow a second heavy cell located behind the first cell and prevent it from being displayed on the radar. Never fly into radar shadows and never believe that the full extent of heavy rain is being seen on radar unless another cell or a ground target can be seen beyond the heavy cell. Proper use of the antenna tilt control can help detect radar shadows. Attenuation can also be a problem when flying in a large area of general rain. If the rain is moderate, the radar beam may only reach 20 or 30 miles before it is fully attenuated. The pilot may fly along for many miles seeing the same 20-30 miles of precipitation ahead on the radar when, actually, the rain may extend for a great distance. In order to aid in reducing the effects of precipitation attenuation, the RDR 1400C contains sophisticated weather attenuation compensation circuitry. The Attenuation Compensation feature is totally automatic and requires no pilot action to activate it. However, the Compensation logic cannot operate until echoes are within the Sensitivity Time Control range of approximately 40 miles. Whenever a level two (yellow) or three (red) echo is displayed within the STC range, the Compensation circuits cause the receiver gain to increase while the antenna scans the sector containing heavy rain. The Compensation circuitry allows the radar beam to effectively look deeper into and through heavy rain to search for possible storm cells beyond. While Attenuation Compensation does not eliminate precipitation attenuation, it does allow the radar to see through more rain at short ranges where every bit of weather information possible is needed. If there is suspicion that the radar is attenuating due to precipitation, exercise extreme caution and ask the ATC Controller what they are showing. Often the ground-based ATC radar will have a better overall picture of a large rain area and the pilot can compare the controller's information with his own radar picture to avoid the strongest cells in a general area of rain.

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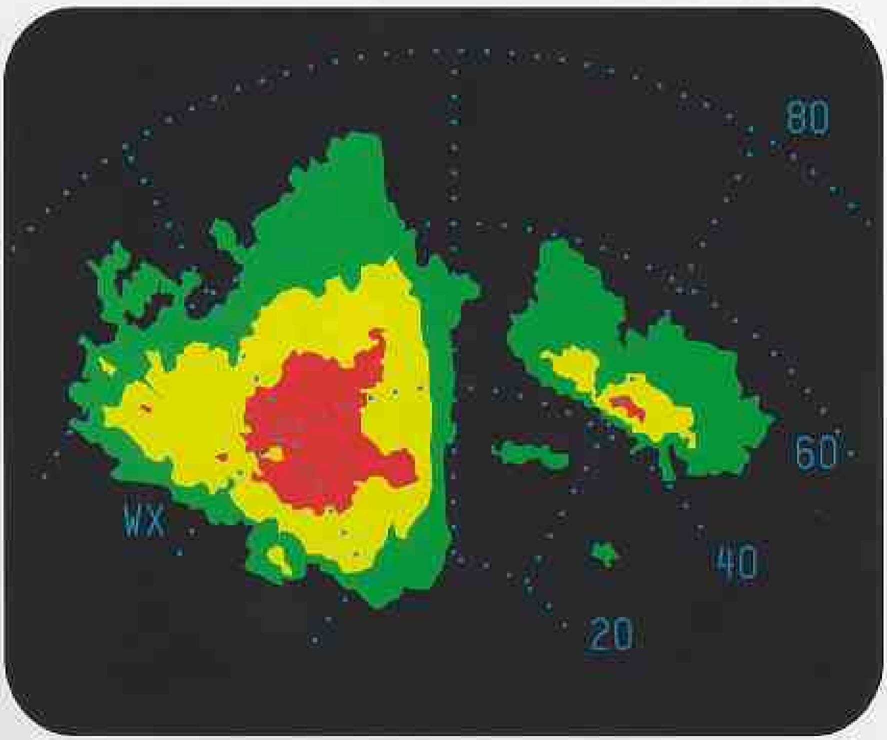
WEATHER OPERATIONS

WEATHER MODE - WX

The RDR 1400C will provide you with target information to a greater degree than ever possible on previous generation weather radars. With a 240 nm maximum display range, you have plenty of time to plan weather avoidance maneuvers.



Typical Weather Display

By pressing the "WX" button on the face of the indicator, you will see a standard weather presentation. Different levels of precipitation are displayed in Green, Yellow and Red. Use the range up/down buttons to select the desired full scale range distance to be displayed. See page 40 for proper Tilt Managment procedures.

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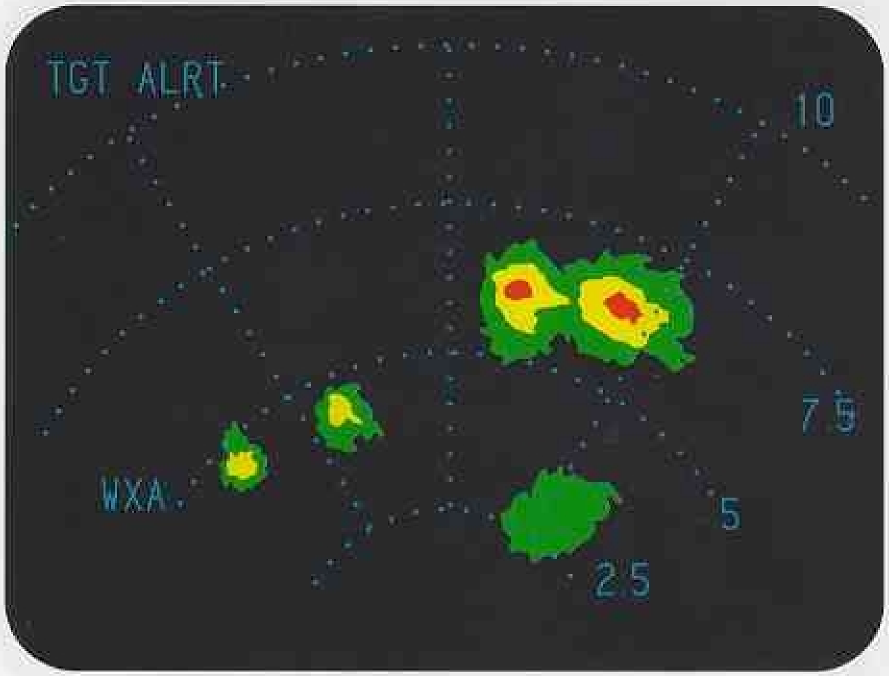
WEATHER ALERT MODE - WXA

In Weather Alert WxA, you will see a standard weather presentation displayed in Green, Yellow and Red, except that the red returns flash between black and red to draw your attention to the heavier activity.

TARGET ALERT

In Weather Alert Mode, WxA, the words TGT ALRT flash if red returns exist within 25 miles beyond the displayed range.



Weather Alert with Target Alert Display

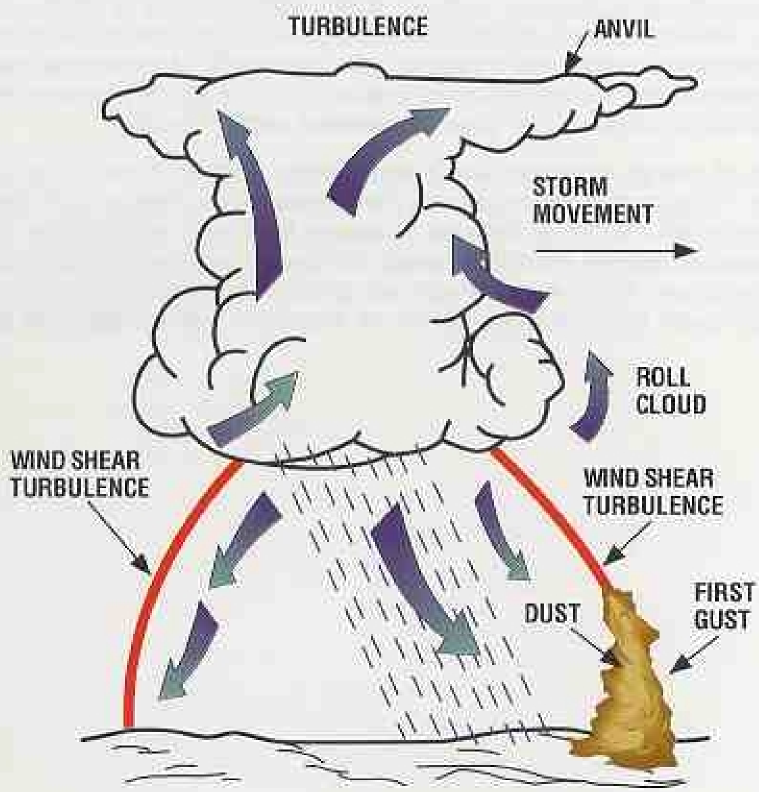
WEATHER MAPPING AND INTERPRETATION

This section contains general information on use of radar for weather interpretation. Review of this information will assist the pilot.

OBSERVING WEATHER

A weather radar is only as good as the operator's interpretation of the echoes that are displayed on the radar indicator. The pilot must combine his knowledge of how radar works and its limitations with such things as the prevailing weather pattern, the geographic location and his personal experience in order to make a sound interpretation of the displayed targets.

As a starting point, the operator should read FAA Advisory Circular number 00-24B, Subject: Thunderstorms. It is also highly recommended that the operator take advantage of one of the commercially available weather radar seminars.



THUNDERSTORMS & TURBULENCE

The RDR 1400C weather radar can give you a clue to the presence of turbulence. Areas of the display where the colors change rapidly over a short distance represent steep rainfall gradients, which are usually associated with severe turbulence.

Turbulence may be divided into two basic types: (1) clear-air turbulence; (2) turbulence associated with thunderstorms and precipitation.

The latter is most common. It is with this type that weather radar is most helpful to the pilot. It is not possible to detect clear air turbulence with this type of radar system. Weather guidance is now available from ground radar stations in some areas. However, this system suffers in comparison with the airborne weather radar when the weather is clearly visible on the pilot's indicator, instantly available for the pilot to act upon, considering his immediate circumstances and future flight planning.

The strong up and down drafts in a thunderstorm create very large raindrops which are usually displayed on a radar as level three.

The probability of turbulence in these strong vertical gusts is great. The National Severe Storms Laboratory (NSSL) has found that the intensity level of the precipitation reflection correlates with the degree of turbulence found in a thunderstorm. The most severe turbulence in the storm, however, may not be at the same place that gives the greatest radar reflectivity.

The rate of change in rainfall rate laterally within a storm is called the rain gradient. This change will appear on the indicator as a change from green to yellow to red. If the rainfall rate increases from level one to three in a short distance, the rain gradient is steep and severe turbulence is often present. Avoid any storm with a steep rain gradient by an extra margin and especially avoid flying near the portion of the storm with the steepest gradient.

TORNADOES

It is possible that conclusive methods of detecting tornadoes with airborne radar may eventually be developed. However, evidence collected to date indicates tornadoes may be detected if the following echoes are observed:

1. A hook-shaped pendant which may be 5 or more miles long and in the general shape of the numeral 6 strongly suggests the presence of a major tornado, especially if the pendant is a bright one and if it projects from the southwest quadrant (northeast quadrant in the southern hemisphere) of a major thunderstorm moving eastward. The pendant may be lost in ground clutter when viewed on the indicator and in some cases might not be much more than a blunt projection or scalloped edge of the parent thunderstorm echo.

2. A crescent-shaped indentation on the side of a major thunderstorm echo 3 to 7 miles long is another possible identifier of an active or potential tornado in the vicinity.

3. The best procedure is to make wider than usual detours around sharp-edged thunderstorms and especially those which show projections or crescent-shaped indentations.

HAIL

Hail usually has a film of water on its surface; consequently, a hailstone is often reflected as a very large water particle. Because of the film and because hail stones usually are larger than raindrops, thunderstorms with large amounts of wet hail return stronger signals than those with rain. Although wet hail is an excellent reflector of radar energy, some hail shafts are extremely small (100 yards or less). These narrow shafts make poor radar targets.

Hail shafts are usually identified with four different characteristics patterns: (1) fingers and protrusions, (2) hooks, (3) scalloped edges on the cloud outline and (4) U-shaped cloud edges 3 to 7 miles across.

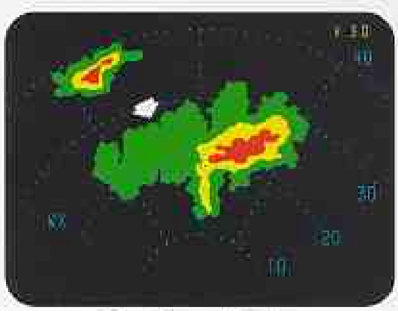
These echoes appear quite suddenly and along any edge of the storm outline. They also change in intensity and shape in a matter of seconds, and for this reason careful monitoring of the display is essential. It must be noted that weak or fuzzy projections are not normally associated with hail; however, such echoes should be watched closely for signs of rapid intensification.

The 40-mile operating range seems best and, with occasional up-tilt to check for fresh hail from above, generally good results can be obtained.

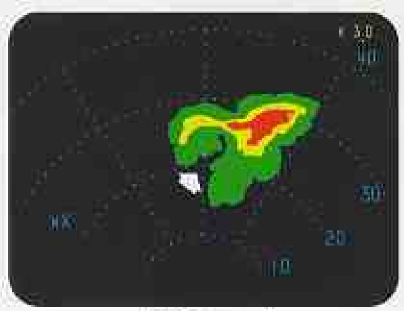
Note: It takes an experienced eye to identify "hooks" and "fingers" and other radar echo characteristics which can indicate hail or tornadoes. However, the pilot can be sure that any echo with very ragged edges or rapid changes in shape or intensity will contain severe turbulence.

Finger

Hook



Scalloped Edge



U-Shaped

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ICING

There is reason to believe that radar will be of assistance in locating areas of heavy icing conditions. However, weather radar has not yet proved its ability to distinguish between super-cooled water droplets and ice crystals, since both are usually quite small. Needless to say, the operational problem in each case would be different. In the first case icing would definitely exist but in the second case the pure crystals would offer no danger.

1. It should be remembered, however, that super-cooled water and ice crystals can co-exist. In each case the radar echo would be small or even nil due to the minute size of the free water particles. At this time, it appears fairly certain that radar is not going to give warning of cloud icing unless it happens to be involved with active precipitation at the time. When precipitation is occurring, however, the areas of maximum ice exposure should appear as sandy or grainy echoes.

2. An icing condition that radar might possibly detect is the intermittent moderate or heavy icing condition associated with unstable air lifted by frontal action or orographic effects. In this situation the cumulus cells are hidden by surrounding cloud layers but could be spotted by radar. This would be of assistance in avoiding the moderate to heavy icing which occasionally occurs in cumulus clouds.

Note: Thunderstorm icing can be extremely hazardous.

SNOW

Dry snowfall has not been detected with any success on weather radar. However, a characteristic sandy or grainy echo identifies the presence of steady moderate to heavy wet snow. Such echoes are not readily obvious and require a little study of the display before they can be seen.

LIGHTNING AND STATIC DISCHARGES

Lightning and static discharges could scatter the display momentarily. However, the general presentation is unaffected and should return to normal within 1 scan.

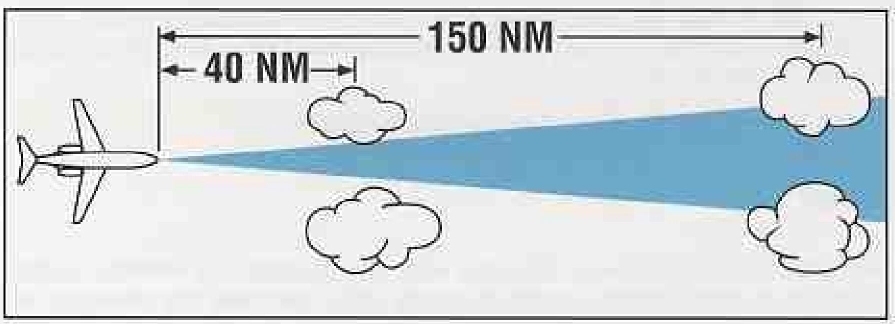
RANGE RESOLUTION

The ability of the radar system to resolve closely spaced targets in range depends on transmitter pulse width. In long range modes, the RDR 1400C can distinguish objects spaced as close as .19nm (385 yds.) apart. In Search 1 (SR1) and Search 2 (SR2) modes on ranges of 20 miles and below, the resolution is improved to .04nm (80yds.).

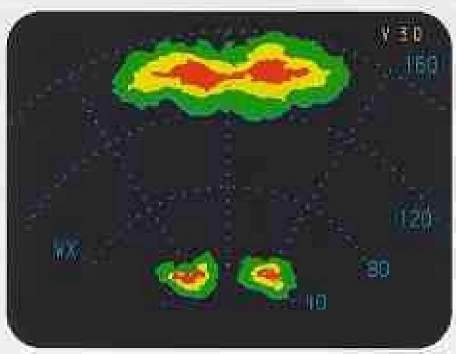
AZIMUTH RESOLUTION

The ability of the radar to resolve adjacent targets in azimuth depends on antenna beam width and range to the target. The diameter of the radiated beam increases as it gets further from the antenna. Larger antennas have narrower beam widths and therefore produce better ground mapping and weather pictures.

Targets separated by a distance less than the beam diameter will merge and appear on the indicator as one.



Antenna Size	Beam Width	25 NM	50 NM	100 NM	200 NM
		Beam Diameter (NM)			
10"	10.0°	4	8	16	32
12"	8.0°	3	6	12	24
18"	5.5°	2	4	8	16



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INDICATOR RESOLUTION

The resolution of the indicator depends on the number of display bits on the screen. The IN 2025B screen matrix is composed of 256 bits horizontally by 256 bits vertically. The display resolution is equal to 1/256 times the display range as shown in the table. The lower the range the better the resolution.

	RESOLUTION		
RANGE (NM)	Miles	Feet	Meters
2.0	.008	48	14.8
5.0	.02	122	37.0
10	.04	243	74.1
20	.08	486	148.2
40	.16	972	296.3
80	.31	1884	574.1

Minimum Distinguishable Target Seperation

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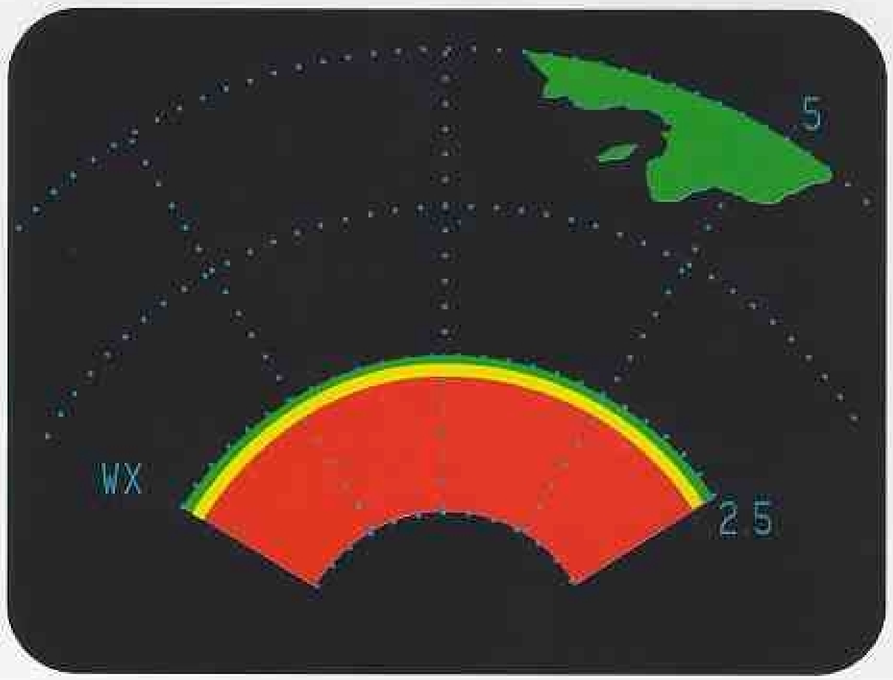
SHORT RANGE DISPLAYS

The RDR 1400C allows the selection of full-scale display ranges of 1.0nm and 0.5nm.

These unique short range selections are especially useful during approaches and surveillance operations, because it keeps the target from getting lost in the clutter at the vertex of the display.

When operating in either short range mode, certain features become unavailable. They are: Moving Map with Waypoints, BeaconTrac and Beacon Identification. All other modes are still accessible.



Short Range Display

The RDR 1400C is unable to ascertain radar returns from as close in as 0.1nm. On the short range displays, the RDR 1400C paints a red arc in this range to depict the dead band area.

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PATH PLANNING

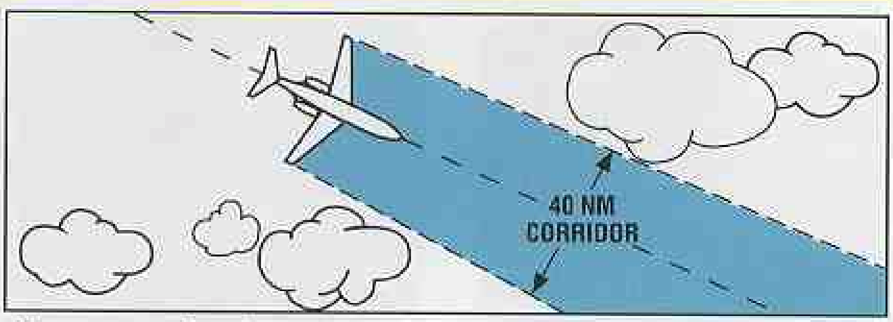
Remember to plan a deviation path early. Simply skirting the red portion of a cell is not enough. Plan an avoidance path for all weather echoes which appear beyond 100 miles since this indicates they are quite intense.

The most intense echoes are severe thunderstorms. Remember that hail may fall several miles from the cloud, and hazardous turbulence may extend as much as 20 miles from the storm. Avoid the most intense echoes by at least 20 miles, that is, echoes should be seperated by at least 40 miles before you fly between them. As echoes diminish in intensity, you can reduce the distance by which you avoid them.

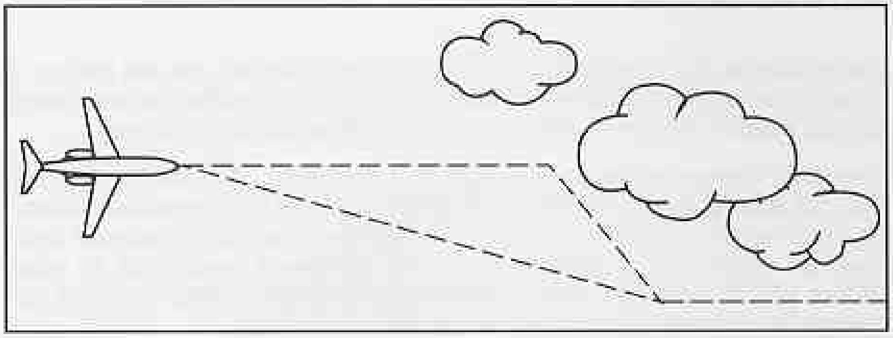
PATH PLANNING CONSIDERATIONS

- Avoid cells containing red areas by at least 20 miles.
- Do not deviate downwind unless absolutely necessary. Your chances of encountering severe turbulence and damaging hail are greatly reduced by selecting the upwind side of the storm.
- If looking for a corridor, remember corridors between two cells con taining red areas should be at least 40 miles wide from the outer fringes of the radar echo.

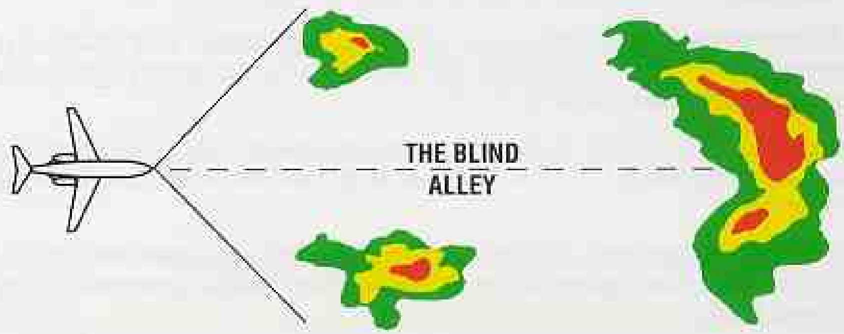
NOTE: Do not approach a storm cell containing red any closer than 20 nm. Echoes should be seperated by at least 40 nm before attempting to fly between them.

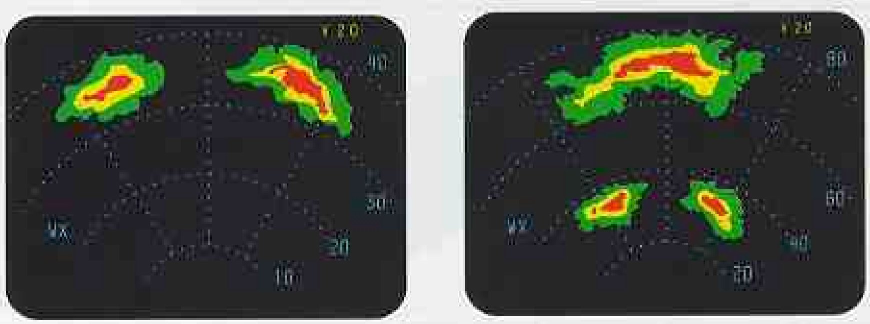


When a complete detour is impractical, penetration of weather patterns may be required. Avoid adjacent cells by at least 20 miles.



Cells beyond 75 miles are areas of substantial rainfall; do not wait for red to appear. Plan and execute evasive action quickly to minimize "doglegging."





A "Blind Alley" or "Box Canyon" situation can be very dangerous when viewing the short ranges, periodically switch to longer range displays to observe distant conditions. As shown above, the short-range returns show an obvious corridor between two areas of heavy rainfall, but the long-range setting shows a larger area of heavy rainfall.

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Above all, remember: Never regard any thunderstorm as LIGHT, even when radar observers report the echoes are of light intensity. Avoiding thunderstorms is the best policy.

DON'T attempt to preflight plan a course between closely spaced echoes.

DON'T land or take off in the face of a thunderstorm in the projected flight path. A sudden wind shift or low level turbulence could cause loss of control.

DON'T attempt to fly under a thunderstorm even if you can see through to the other side. Turbulence under the storm could be severe.

DON'T try to navigate between thunderstorms that cover 6/10 or more of the display. Fly around the storm system by a wide margin.

DON'T fly without airborne radar into a cloud mass containing scattered embedded thunderstorms. Scattered thunderstorms not embedded usually can be visually circumnavigated.

DO avoid by at least 20 miles any thunderstorm identified as severe or giving an intense radar echo. This is especially true under the anvil of a large cumulonimbus.

DO clear the top of a known or suspected severe thunderstorm by at least 10,000 feet altitude. This may exceed the altitude capability of the aircraft.

DO remember that vivid and frequent lightning indicates a severe thunderstorm.

DO regard as severe any thunderstorm with tops 35,000 feet or higher whether the top is visually sighted or determined by radar.

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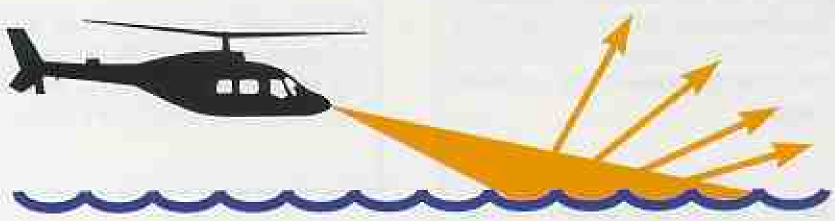
SEARCH OPERATIONS

GROUND MAPPING

A secondary objective of the radar system is gathering and presentation of terrain data. This data is represented in the form of a topographical map that can be employed as a supplement to standard navigation procedures. Target quality affects the indicator display in various situations. Use of the SRCH gain control and TILT knob will often improve picture contrast so specific ground targets are more readily recognizable.

Over Terrain - Illumination of terrain results in a "diffused" reflection of the beam. A portion of this reflected energy is scattered back toward the antenna resulting in the prominent display of land features as well as lakes, large rivers, shore lines and ships.



Over Water - Calm water or water with swells does not provide good returns. The energy is reflected in a forward scatter angle with inadequate portions being returned. The resulting display is "no target." Choppy water provides better returns from the downwind side of the waves. The resulting display is a target whose intensity will vary with the degree to choppiness.

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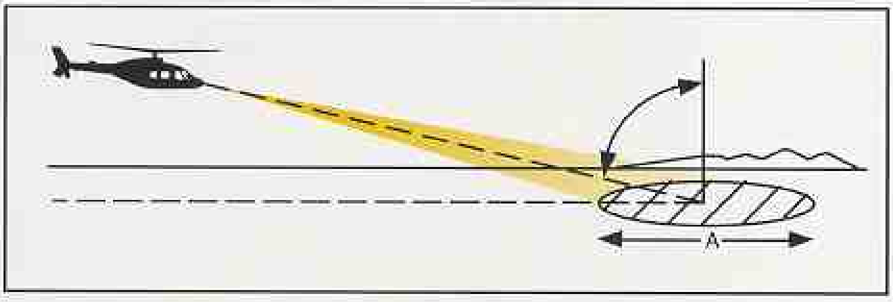
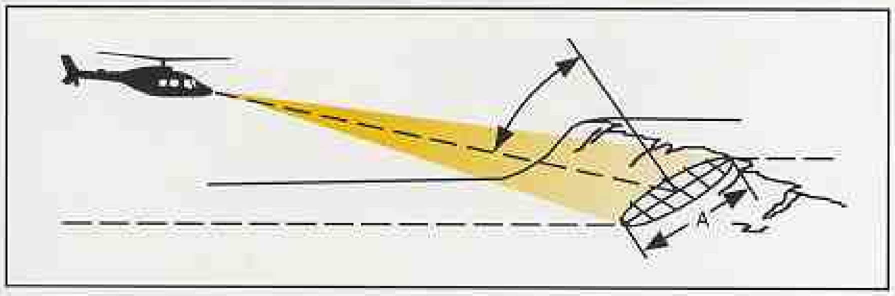
LOOKING ANGLE

The incident angle at which the terrain is illuminated has a direct bearing on the detectable range and the area of illumination. A large incident angle gives the radar system a smaller detectable range of operation (due to a minimized reflection of direct radar energy). However, the illuminated area "A" is larger.



A smaller incident angle gives the radar a larger detectable range of operation because of an increase of direct radar energy reflected from the target to the antenna. The area of illumination ("A") is smaller.



Concentration of the beam energy on a small area of terrain increases the magnitude of the echo intercepted by the antenna. The resulting detectable range is therefore increased for mountainous terrain; the maximum distance at which this terrain can be monitored is greater because of the more direct reflection (or radar echo) produced. Illuminating the backslope of hills stretches the area of coverage beyond the flat terrain coverage.

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OTHER AIRCRAFT

Tests show that only with extreme careful observation and at relatively short ranges can other aircraft be detected by this type of radar equipment. The character of this echo is such that this type of radar system cannot be considered adequate for this purpose.

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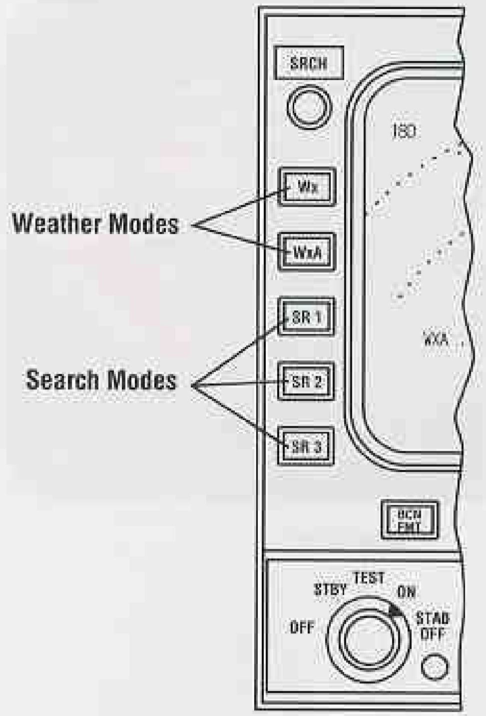
SEARCH MODE

An advantage of this radar system is the enhancement of short range mapping capability. This facilitates locating specific targets on land or sea and provides a navigational map as a supplement to standard navigation procedures.

DIFFERENCE BETWEEN WEATHER AND SEARCH MODES

In the weather modes, the receiver gain is preset and cannot be changed by the pilot. In the search modes, the pilot controls receiver gain with the SRCH knob on the indicator front panel for best display resolution. Additionally, in search modes on ranges below 20 miles, the transmitter pulse is changed to enhance target resolution.

When operating in weather or search modes, both weather and ground returns can appear on the screen at the same time.



Wx and SRCH buttons on faceplate.

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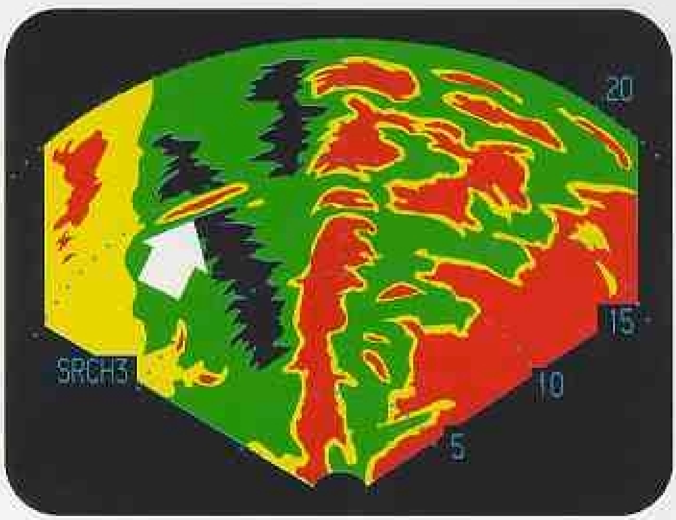
SEARCH MODES COMPARED

In the photographs below, the aircraft is flying southwest along the Florida Keys. Florida's marshy coast is on the right and the islands are in the center of the screen. Strong boat target returns are on the left. Tilt and search gain are adjusted for optimum display. Note that in SRCH 3, the land masses blend together while in SRCH 2 and SRCH 1, a small boat (arrow) target can be extracted from heavy seas.

SEARCH 3

Conventional ground map mode. Beyond 20 mile range, SR 1 and SR 2 are the same as SR3.

The radar's long range mapping compatibility may be used to recognize known, well defined targets such as mountains, lakes, rivers, or cities. Use of gain and tilt controls will often improve picture quality.



SEARCH 3

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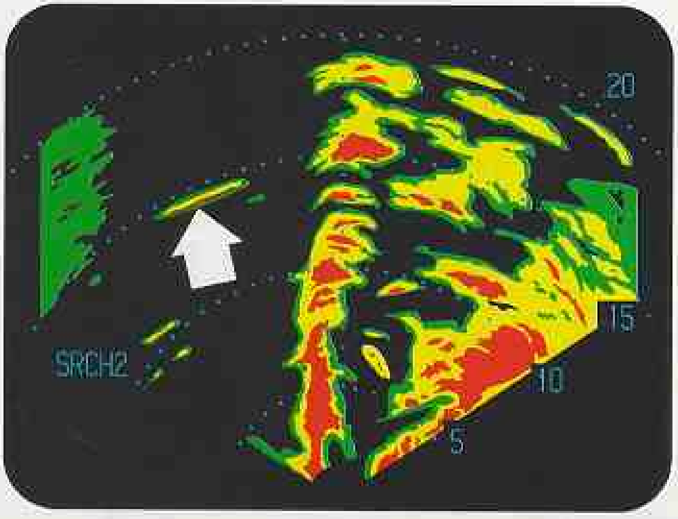
SEARCH 2

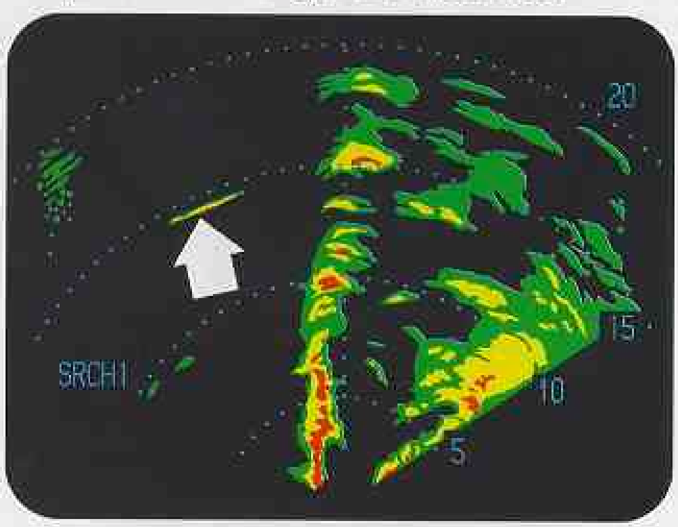
Short range precision mapping on ranges of 20 miles or less.



SEARCH 2

SEARCH 1

Sea clutter rejection effect on ranges of 20 miles or less.



SEARCH 1

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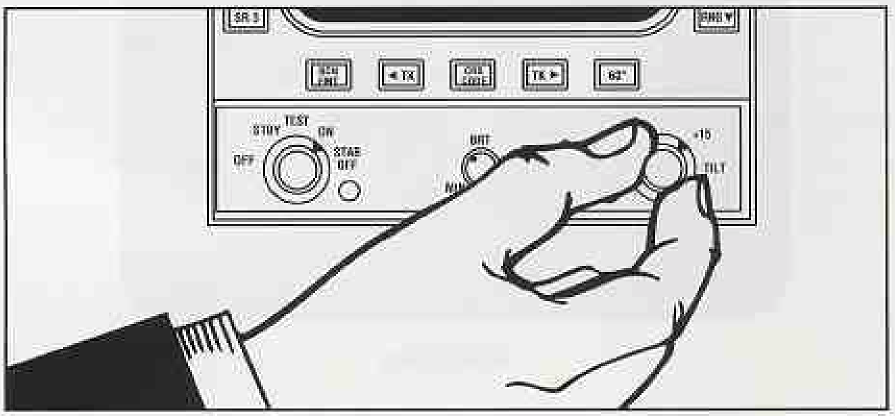
TILT MANAGEMENT

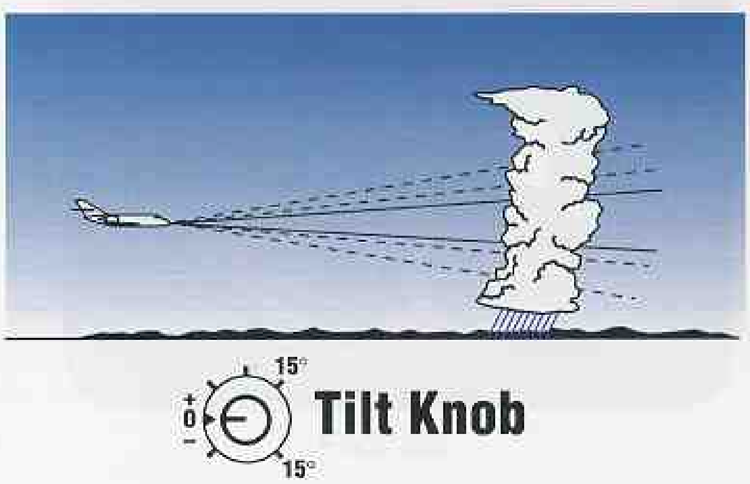
TILT CONTROL

One of the most important factors in improving your expertise in using your radar is antenna tilt management. Control of the vertical movement of the antenna, and hence the radar beam, is through the antenna tilt knob. Proper antenna tilt management provides information of the storm's approximate size and relative direction of movement.



Antenna Tilt Knob

The correct procedure for weather avoidance is to aim the antenna directly at the storm, not above it, or at the ground. The tilt control permits positioning the antenna in small increments up or down, to keep the antenna intersecting the storm area. Also changes in pitch attitude can be compensated for by adjusting the antenna tilt.



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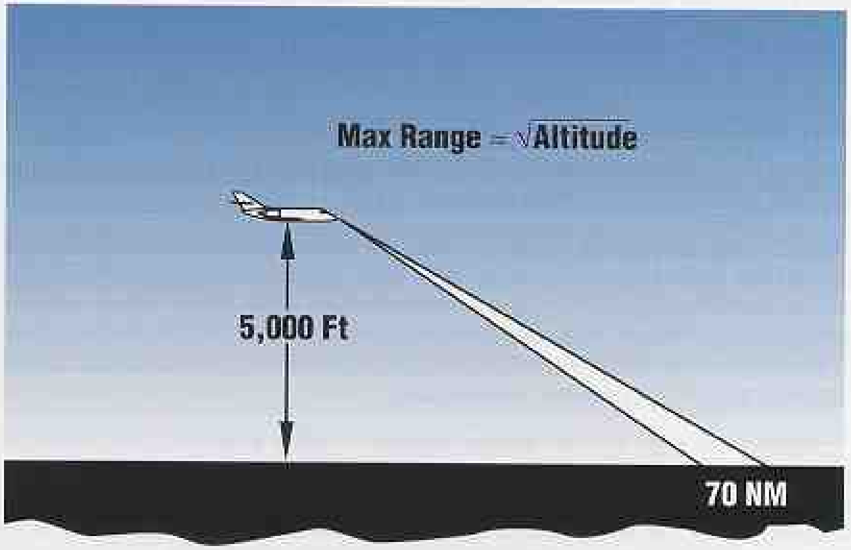
TILT PERFORMANCE CHECK

A good performance check of your radar system in flight is to lower the tilt slowly and observe the maximum range of solid ground returns. As a rule of thumb this range in miles should approximate the square root of your operational altitude.



Altitude vs. Range

For example, at 5,000 ft. the maximum displayed ground target range should be about 70 nautical miles. You should perform this test on every flight. Don't wait until you're penetrating severe weather to discover that your system is not providing optimum performance.

If the radar is operating normally when you reach cruising altitude, select the longest display range and lower the antenna tilt until ground targets are displayed. Now, slowly raise the tilt until the ground returns disappear. This will give you the optimum tilt setting for your cruise altitude. Each time a new range is selected, however, the tilt control must be readjusted, down for a shorter range, and up for a longer one.

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EARLY DETECTION OF EN ROUTE WEATHER

To set the Antenna Tilt to optimize the radar's ability to quickly identify significant weather, follow these steps:

1. Select the Wx (Weather) or WxA (Weather Alert) mode of operation. Adjust brightness control as desired.

2. Select the 40 or 80 nm range.

3. Adjust the Antenna Tilt control down until the entire display is filled with ground returns.

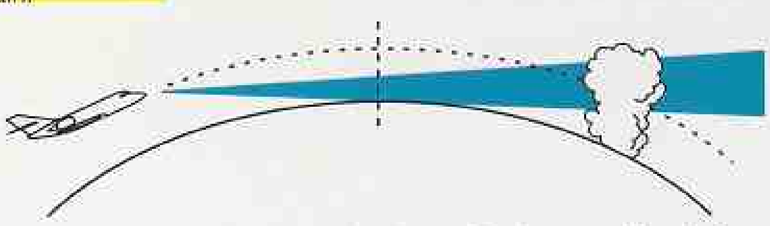
4. Slowly work the Antenna Tilt up so that ground returns are painted on or about the outer one third of the indicator area.

5. Watch the strongest returns seen on the display. If, as they are approached, they become weaker and fade out after working back inside the near limit of the general ground return pattern, they are probably ground returns or insignificant weather. If they continue strong after working down into the lower half of the indicator, you are approaching a hazardous storm or storms, and should deviate immediately.

6. Examine the area behind strong targets. If radar shadows are detected, you are approaching a hazardous storm or storms, and should deviate immediately. Regardless of the aircraft's altitude, if weather is being detected, move the Antenna Tilt control up and down in small increments until the return object is optimized. At that angle, the most active vertical level of the storm is being displayed.

NOTE: The TILT position in Step 4 should be that shown in the chart. The exact setting will depend upon the aircraft's pitch attitude and the flatness of the terrain.

Altitude (ft)	Antenna Tilt Angle 10"	12"	18"	Line-of-Sight Range (SM)
5,000	+7.0°	+6.0°	+5.0°	87
10,000	6.0°	5.0°	4.0°	123
15,000	5.5°	4.0°	3.0°	150
20,000	4.5°	3.5°	2.5°	174
25,000	4.0°	3.0°	2.0°	194
30,000	3.5°	2.5°	1.5°	213
35,000	3.0°	2.0°	1.0°	230
40,000	2.5°	1.5°	0.5°	246



If target is shown at or beyond the line-of-sight range listed above, the chances are good that it is a weather target.

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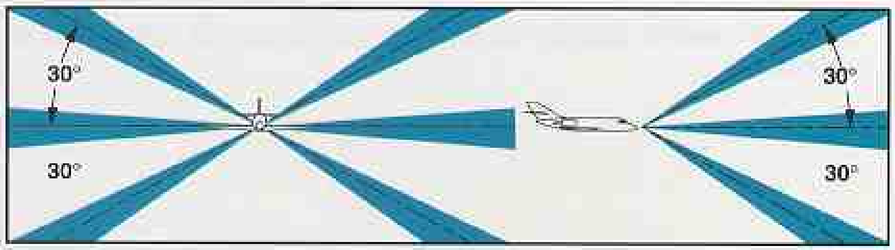
ANTENNA STABILIZATION

Airborne radar antennas are stabilized to preserve a normal cockpit display when the aircraft is climbing, descending or turning. When the aircraft departs from straight and level flight, the stabilization system automatically adjusts the antenna position to compensate for the change. Both limits and errors associated with antenna stabilization are important to the pilot.

LIMITS

The limits of antenna stabilization are different for climbing or descending and turning while climbing or descending. For straight ahead climbs and descents, the limits are simply the mechanical stops at 30 degrees. When turning, the tilt and bank angles determine the stabilization limits (the rule of thumb is a total of 30 degrees) so moderate turns combined with moderate climbs and descents will stay within limits.



Aircraft Pitching/Rolling ±30°

ERRORS

There are two sources of stabilization errors: acceleration and drift. Accelerations and decelerations cause the gyro to process in pitch. The pilot may not notice a small temporary discrepancy between the altitude indicator and visible horizon, but on the radar screen the antenna pitch precession will appear as exaggeration of the desired tilt. Drift errors (appearing on the attitude indicator as pitch and roll precession accumulate in turns) disappear slowly after the aircraft returns to straight and level. Gyro precession errors directly affect radar stabilization and the quality of the return displayed on the screen.

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COMPENSATION

There are some compensations the pilot can use for antenna stabilization errors. When the system has been operating properly in level flight, the pilot may be able to correct for ground return showing on one side and not the other by tilting the antenna up until all ground returns are cleared. During takeoff, the pilot can raise the antenna tilt to clear the ground returns caused by gyro acceleration error, then as the airplane stops accelerating, readjust the antenna tilt back toward level. Adjusting antenna tilt is also the remedy for ground returns that appear because of gyro precession in a prolonged turn. Good operating practices include:

- Adjust radar and obtain weather picture before takeoff.
- Compensate antenna tilt for gyro precession.
- Evaluate weather in the immediate sphere of operation.
- Do not "over-scan" weather targets.
- During excessive aircraft maneuvers, recognize the limitations of stabilization.

NAV MODE

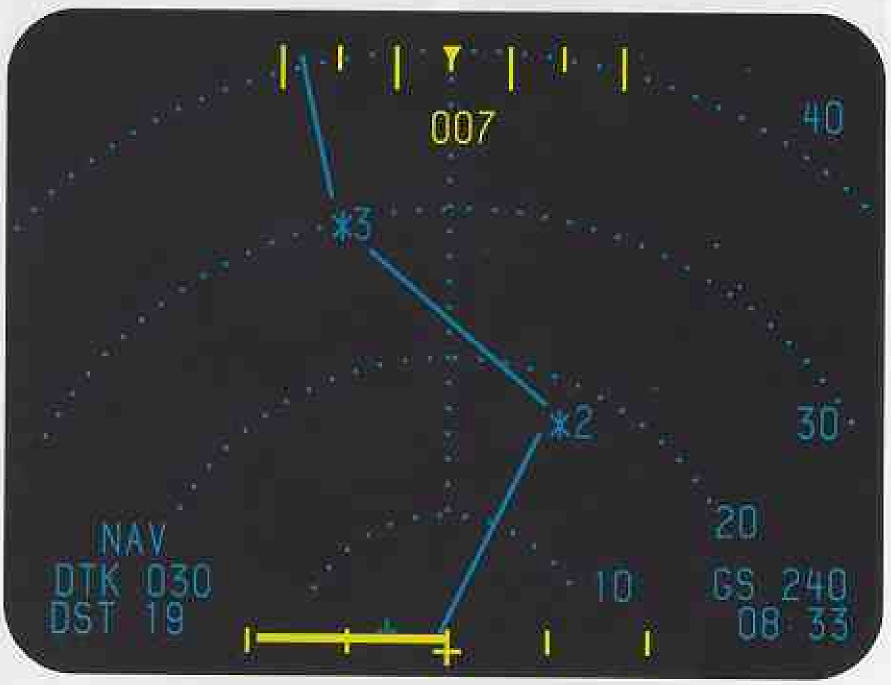
NAV AND FLIGHT LOG DISPLAYS

When a navigation system interface unit is installed, the moving map display adds the dimension of tracking flight progress. Nav data can be displayed by itself or superimposed over beacon, weather or search modes to show the pilot if the selected route will intercept significant weather. While operating in weather or search modes, the radar is slightly subdued, providing a high contrast of the Nav data overlay.

Positions of vortacs and RNAV waypoints in use within the sector scan will be shown relative to the aircraft's position. A waypoint is indicated with an asterisk, a VOR as V. Inbound and outbound course plots lead to and from the waypoints.

Heading information from the compass system is displayed at the top of the screen. Under the heading pointer are seven azimuth marks spaced five degrees apart. A yellow deviation bar with standard scale representation is at the bottom of the screen.

The moving map display appears when NAV is pressed. Nav is superimposed over another mode by pressing that mode button.



NAV DISPLAY

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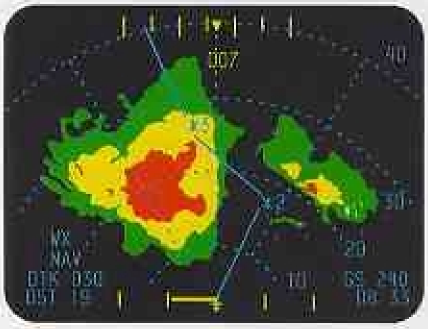
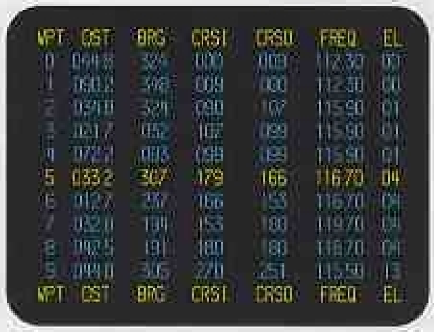
LOG MODE

The flight log display is a program file of up to ten waypoints stored in the RNAV or Long Range Nav System computer. The active waypoint is highlighted in yellow while the others are shown in blue. Column headings are permanently programmed into the system.

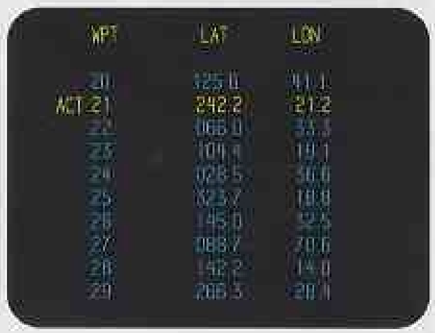


NAV DISPLAY OVER WEATHER



BX 2000 LOG

OMEGA LOG



RNS-3500 LOG

The flight log overrides all radar modes when LOG is pressed. Previous mode returns when LOG is pressed again.

BEACON MODES

In the Beacon (BCN) mode, the RDR-1400C can interrogate, receive and display signals from fixed transponder beacons on all ranges. The beacon itself is displayed as curved "slashes", with the position of the beacon located approximately in the center of the closest slash.

The RDR-1400C will also display the bearing and radar distance to any selected beacon; this information is displayed in the lower left corner of the indicator display.

For greater flexibility, the beacon mode may be operated alone or in combination with the weather or search modes.

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BEACON FORMAT SELECTION

The RDR 1400C will always display all beacon signals on the screen as they respond to the radar interrogation, regardless of the format selection.

To identify a particular beacon and place an identification number beside it, you must first identify whether the beacon is the standard or DO-172 format. This is accomplished by observing the beacon response.

If the beacon is of the standard format, there will always be only 2 "slashes" on the display spaced 7 nm apart or more. The 1400C can identify any one of nine standard beacons in this mode.

STANDARD BEACON

DO-172

A selected beacon utilizing the DO-172 format will have two framing "slashes" which are positioned approximately 2nm apart. Within these two "frames" will be a combination of up to four slashes. Varying the combinations of the inner slashes makes it possible to identify any one of fifteen different DO-172 beacon codes. This feature is especially beneficial when operating in areas of multiple beacon activity.

DO-172

After the beacon type has been identified and the proper format selected, the operator may now select the desired beacon number by pressing the COURSE/CODE (CRS CODE) button the proper number of times.

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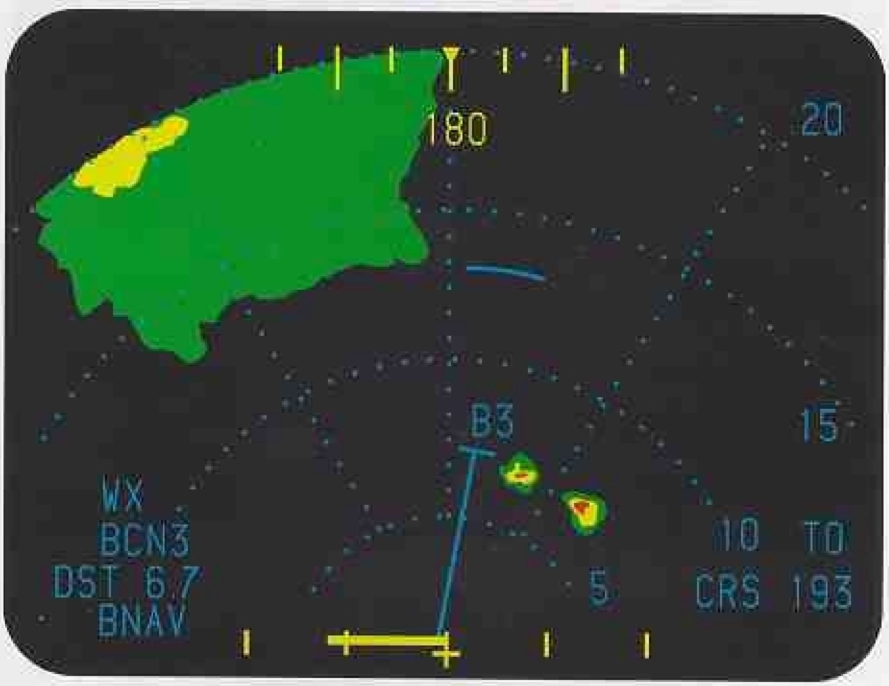
BEACONTRAC

With the addition of a Bendix/King Interface Unit and an HSI or optional synchro, the pilot can call on the RDR-1400C's BeaconTrac capability. Whenever the beacon is at the 80nm range or below and after the Beacon Code is properly identified, the BeaconTrac mode provides a white course line which extends from the center of the beacon location. This course line is rotatable 360° around the beacon with the HSI course selector knob (or a synchro knob).

Radar distance and course to the beacon are shown in the lower corners of the screen with aircraft heading at the top. Also, a yellow deviation bar is provided at the bottom of the screen which provides for left/right steering guidance to the beacon. BeaconTrac operates similar to flying towards an RNAV waypoint. BeaconTrac also operates independently of other navigational aids such as VORTACS and OMEGA.



STD FMT

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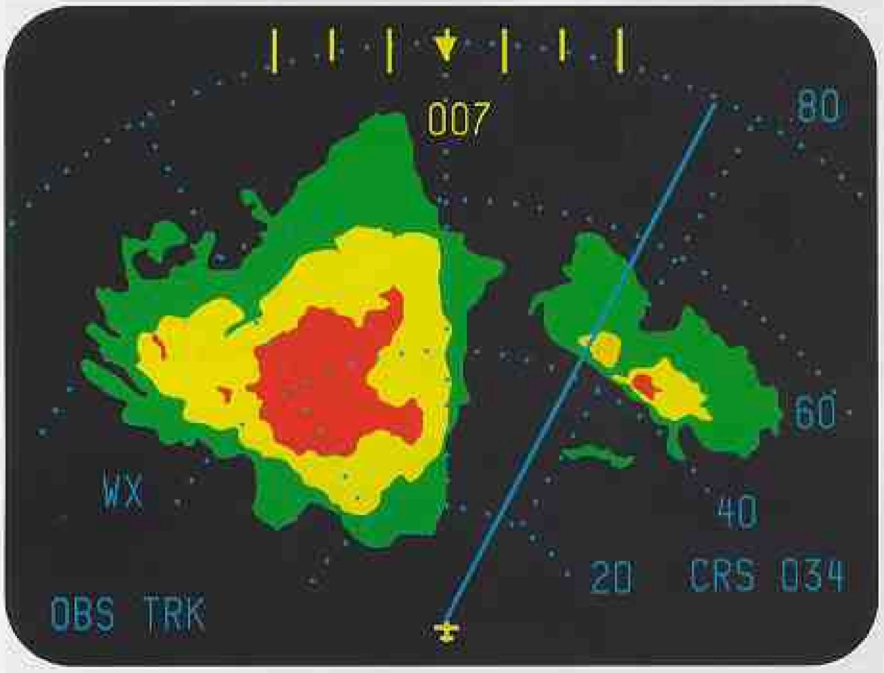
COURSE BEARING CURSOR



OBS-TRK

The white Course Bearing Cursor, OBS-TRK, is useful in approaching an oil rig or other target along a preselected course when BeaconTrac is not used. The OBS-TRK line, available when an HSI and Interface unit are installed (and BCN and NAV modes are not in use), operates by pressing the CRS CODE button. OBS-TRK appears at the lower left and selected course at the lower right in any weather or search mode at any range.

The method for getting into the course bearing cursor (OBS-TRK) mode is as follows:

Using the pilot's manual as a guide, display either weather (Wx, WxA) or a search mode (SR) presentation alone. It is important that no other option is called up at this time. By pressing the CRS CODE button once, the course bearing cursor will appear on the screen.

The course bearing cursor is electrically tied to the HSI course selector control (or optional synchro). It is a line or cursor displayed on the screen, originating at the aircraft location. The angle of the cursor is controlled by the pilot with the HSI course selector knob (or synchro). The azimuth of the line displayed will be magnetic bearing from the aircraft.

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The selected azimuth angle is displayed digitally in the lower right hand corner.

When it is desired to fly from a point in space to a specific site with no other navigation aids, the course bearing cursor provides a means for avoiding the classic "curved path" approach. Recall that this problem is often cited in using ADF equipment for navigation purposes.

The course bearing cursor display accomplishes this task in the following way:

The pilot first turns the aircraft to the course of the desired track, and in this example will be 090°.

He initiates the course bearing cursor by pressing the course code (CRS CODE) button on the indicator face, and should have the ultimate landing site on the radar display; it may be specific oil rig in a cluster of rigs. He rotates the HSI course knob (or synchro) to 090°, and will get confirmation on the screen, digitally and graphically, that he has selected that magnetic heading.

Unless he is extremely fortunate, the cursor will not cross over the intended landing site, initially. By changing the direction of fight, the cursor can be made to overlay the desired site. The pilot simply flies the plane to maintain this situation. If the wind tries to move the aircraft to the left, the site will appear to move to the right of the cursor. The cursor will maintain the 090° magnetic course presentation. The pilot should then compensate by turning the aircraft to the right and fly in that direction until the cursor overlays the site.

This technique provides a convenient method to establish the proper crab angle to fly a straight line to the destination.

EQUIPMENT REQUIRED FOR OBS-TRK

The "course bearing cursor" identified in FAA circular AC-90-80 is available as an option to the Bendix RDR-1400C Colorvision system and is called OBS-TRK. With the addition of any interface unit of the series IU-2023 ( ), an HSI (or synchro), this capability is available. Be aware that no other navigation system is required; only the RDR-1400C Colorvision, an HSI (or synchro), and the interface unit.

The IU-2023( ) interface unit will do substantially more than provide the OBS-TRK cursor feature. It can provide waypoints and flight paths when connected to certain on-board navigation systems, but these are not necessary to the operation of the course bearing cursor (OBS-TRK).

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AC 90-80

The FAA allows lower minimums in radar approaches to clusters of rigs, when both the radar altimeter and "course bearing cursor" are operating and are used as described in AC 90-80. For details on minimum approach heights and distances, refer to FAA AC 90-80.

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MULTIPLE INDICATORS

An additional system unit, the IU-1405A is required for multiple indicator installations.

Since all controls for the radar system are located on the indicator, it is necessary to designate one as the master and the remaining indicators as slaves. The flight crew can select which indicator will be the master. The master indicator controls the following:

1) operating modes, 2) Search and beacon gain, 3) Antenna tilt angle, and 4) Antenna scan angle.

All indicators independently control:

1) Display range, 2) Desired brightness level, 3) Hold function, 4) Track lines, 5) Beacon code, and 6) Flight log.

The slave indicator can select either Wx or WxA when the master indicator is in either weather mode.

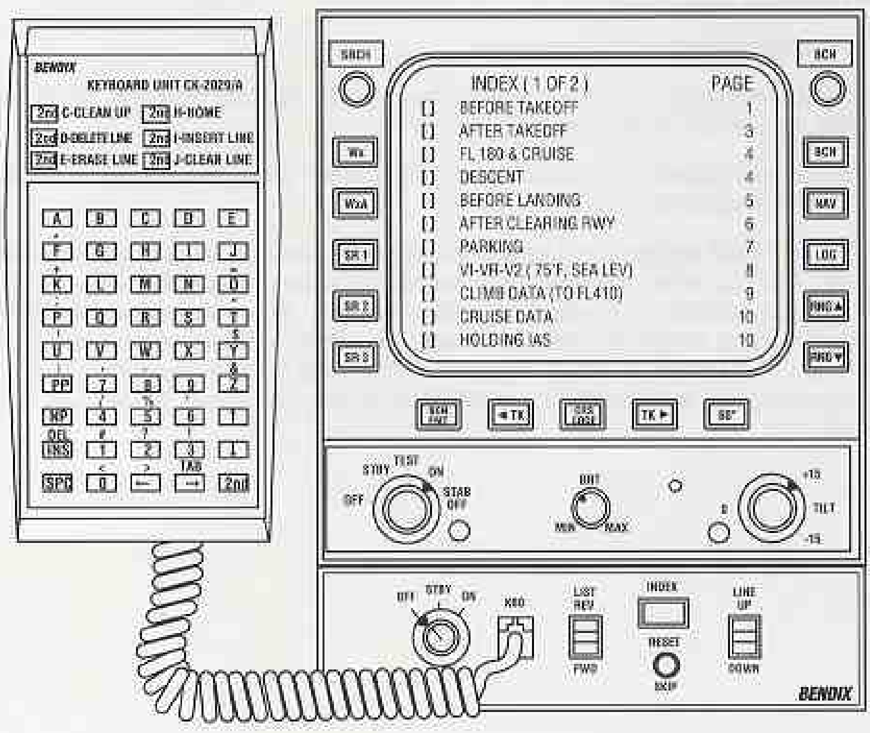
SR1 and SR2 ranges must be compatible between master and slave indicators. That is, when the system is operating on any range 20 miles or less, the slave indicator is limited to 20 miles or less. When the system is operating on any range 40 miles or more, the slave indicator can display on ranges of 40 miles or more. Each indicator may have its own checklist or, depending on system wiring, a single checklist may drive more than one indicator.

CHECKLIST OPERATION

The radar screen will display checklists or other information in the TEST or ON modes. TEST position is used to prevent the system from transmitting.

NOTE: The checklist will override any display on the indicator. To restore control to the radar system, turn the checklist off or to standby.

Refer to the Checklist Control Unit and Keyboard pilot manual for system programming and operating instructions.



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SYSTEM SPECIFICATIONS

RT-1401B RT UNIT

Frequency: 9375 MHz 5 Xmit/Rec; 9310 MHz BCN REC

RF Power Output: 10 KW Peak Power

PRF/Pulse Width: Short Range Search 720 P.P.S./0.5 sec.

Long Range Search and Beacon; 240 P.P.S./2.35 sec.

Altitude: 50,000 ft.

Temperature: -50°C to +55°C

Size: 5"w X6 1/4"h X 13 7/8"d (1/2 ATRI)

Weight: 14.5 Lbs. (6.6 kg)

TSO: C63b

DA-1203A ANTENNA DRIVE ASSEMBLY

Reflector Size: 10", 12", or 18" Flat Plate

Scan Angle: 120° or 60°

Tilt Angle: 15°

Scan Rate: 28°/sec

Stabilization Accuracy: 1°

Altitude: 50,000 ft.

Temperature: -50°C to +55°C

Weight: 10", 0.88 Lbs. (4 Kgs), 12"; 1.1 Lbs. (498 Kgs), 18": 2.2 Lbs.(1.0 Kgs)

Drive Assembly: 6.5 Lbs. (2.95 Kgs)

Counterbalanced Drive Assembly; 9.5 Lbs. (4.32 Kgs)

TSO: C63b

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IN 2025B INDICATOR DISPLAY

Screen Type and Size: Full Color CRT; 4.34" X 3.33"

Storage: Digital Memory

Display Modes: Weather/Search MODES: Wx, WxA, SR1, SR2, SR3

Beacon modes; BCN only, BCN with NAV and/or Wx, WxA, SR1, SR2, SR3

OBS-TRK Modes; Wx, WxA, SR1, SR2, SR3

Alphanumerics: Mode, Range Marks, Beacon Code, Navigation Information Checklists, and Flight Log

Max Range: 10" Antenna; 185nm

12" Antenna; 240nm

18" Antenna; 322nm

Minimum Tracking Range: 200 yds.

Display Range/Range Marks: 0.5/0.125, 1.0/0.25, 2.0/0.5nm, 5.0/1.25nm, 10/2.5nm, 20/5nm, 40/10nm, 80/20 nm, 160/40nm, 240/60nm

Altitude: To 20,000 ft. unpressurized

Temperature: -15°C to +55°C

Size: 6.25" X 6.25" X10.87"

Weight: 11.5 Lbs. (5.2 Kgs)

TSO: C63b

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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration, Washington, D.C.

Recommended radiation safety precautions for ground operation of airborne weather radar

Initiated by: AFO-512

PURPOSE.

This circular sets forth recommended radiation safety precautions to be taken by personnel when operating airborne weather radar on the ground.

CANCELLATION.

AC 20-68A, dated April 11, 1975, is canceled.

RELATED READING MATERIAL.

- Barnes and Taylor, Radiation Hazards and Protection (London: George Newnes Limited, 1963), p. 211.
- U.S. Department of Health, Education and Welfare, Public Health Service, Consumer Protection and Environmental Health Service, "Environmental health microwaves, ultraviolet radiation and radiation from lasers and television receivers - An Annotated Bibliography", FS 2.300: RH-35, Washington, U.S. Government Printing Office, pp. 56-57.
- Mumford, W.W., "Some technical aspects of microwave radiation hazards", Proceedings of the IRE, Washington, U.S. Government Printing Office, February 1961, pp. 427-447.

BACKGROUND.

Dangers from ground operation of airborne weather radar include the possibility of human body damage and ignition of combustible materials by radiated energy. Low tolerance parts of the body include the eyes and testes.

PRECAUTIONS:

Management and supervisory personnel should establish procedure for advising personnel of dangers from operating airborne weather radars on the ground. Precautionary signs should be displayed in affected areas to alert personnel of ground testing.

General.

- Airborne weather radar should be operated on the ground only by qualified personnel.

- Installed airborne radar should not be operated while the aircraft is in a hangar or other enclosure unless the radar transmitter is not operating, or the energy is directed toward an absorption shield which dissipates the radio frequency energy. Otherwise, radiation within the enclosure can be reflected throughout the area.

Body Damage. To prevent possible human body damage, the following precautions should be taken:

- Personnel should never stand nearby and in front of radar antenna which is transmitting. When the antenna is not scanning, the danger increases.

- A recommended safe distance from operating airborne weather radars should be established. A safe distance can be determined by using the equations in Appendix 1 or the graphs of figures 1 and 2. This criterion is now accepted by many industrial organizations and is based on limiting exposure of humans to an average power density not greater than 10 milliwatts per square centimeter.

- Personnel should be advised to avoid the end of an open wave guide unless the radar is turned off.

- Personnel should be advised to avoid looking into a wave guide, or into the open end of a coaxial connector or line connector to a radar transmitter output, as severe eye damage may result.

- Personnel should be advised that when power radar transmitters are operated out of their protective cases, X-rays may be emitted. Stray X-rays may emanate from the glass envelope type pulsar, oscillator, clipper, or rectifier tubes, as well as magnetrons.

Combustible Materials. To prevent possible fuel ignition, an installed airborne weather radar should not be operated while an aircraft is being refueled or defueled.

M.C. Beard

Director of Airworthiness

AC 20-68B 8/8/80

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APPENDIX 1.SAFE DISTANCE DETERMINATION

The following information can be used in establishing a minimum safe distance from the antenna for personnel near an operating airborne weather radar. An applicable graph is shown in figure 1.

NEAR FIELD/FAR FIELD INTERSECTION.

The distance to the near field/far field intersection can be computed by:

Ri=G

(1)=8

where Ri=Intersection distance from the antenna (in meters)

=Wave length (in meters)

=Antenna gain

DISTANCE TO 10 MW/CM2 SAFE LIMIT.

For a far field power density of 10 mw/cm2, the distance (in meters) from the antenna may be calculated by:

Rs=GP/400

where Rs=The minimum safe distance in meters.

P=Transmitted average power in watts.

G=Antenna gain

An applicable graph is shown in figure 2.

PROCEDURES.

The above formulas or the graphs of figures 1 and 2 may be used to determine the minimum safe distance. In either case, the following procedures apply:

a. Determine the distance (Ri) to the near field/far field intersection (paragraph 1).

b. Determine the distance (Rs) to 10 mw/cm^2 power density (paragraph 2).

c. If the distance (Rs) determined in b above is less than (Ri) found in a above, use distance (Ri) as the minimum safe distance.

d. If the distance (Rs) determined in b above is greater than (Ri) found in a above, use distance (Rs) as the minimum safe distance.

EXAMPLE.

Appendix

Data. The following is typical data for the airborne weather radar.

Antenna Diameter	:22 inches=56 cm
Transmitter Frequency	:9375 +30 Mhz
Wave Length	:3.2 cm
Pulse Length	:1.5 microseconds (search)
Pulse Repetition	:400 Hz
Peak Power	:40 kilowatts
Average Power	:24 watts (search)
Antenna Gain	:1000 (30 db)

Calculations:

(1) Distance (Ri) to the near field/far field intersection.

Ri=G

=8

Ri=1000 x 0.032

8

=1.27 meters=4.2 feet

(2) Distance (Rs) to 10 mw/cm2 safe limit.

Rs=GP/400

=1000 X 24/400

=4.37 meters=14.3 feet

The distance (Rs) is greater than (Ri), therefore, the minimum safe distance is 14.3 feet.

8/8/80 AC-2068B

Appendix 1

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Radiation

WARNING

This instrument generates microwave radiation.
DO NOT OPERATE UNTIL YOU HAVE READ AND CAREFULLY FOLLOWED ALL SAFETY PRECAUTIONS AND INSTRUCTIONS IN THE OPERATING AND SERVICE MANUALS.

IMPROPER USE OR EXPOSURE MAY CAUSE SERIOUS BODILY INJURY

CAUTION

a. MAINTAIN PRESCRIBED SAFE DISTANCE WHEN STANDING IN FRONT OF RADIATING ANTENNA.*

b. NEVER EXPOSE EYES OR ANY PART OF THE BODY TO AN UNTERMINATED WAVE GUIDE.

*Reference FAA Advisory Circular #20-68

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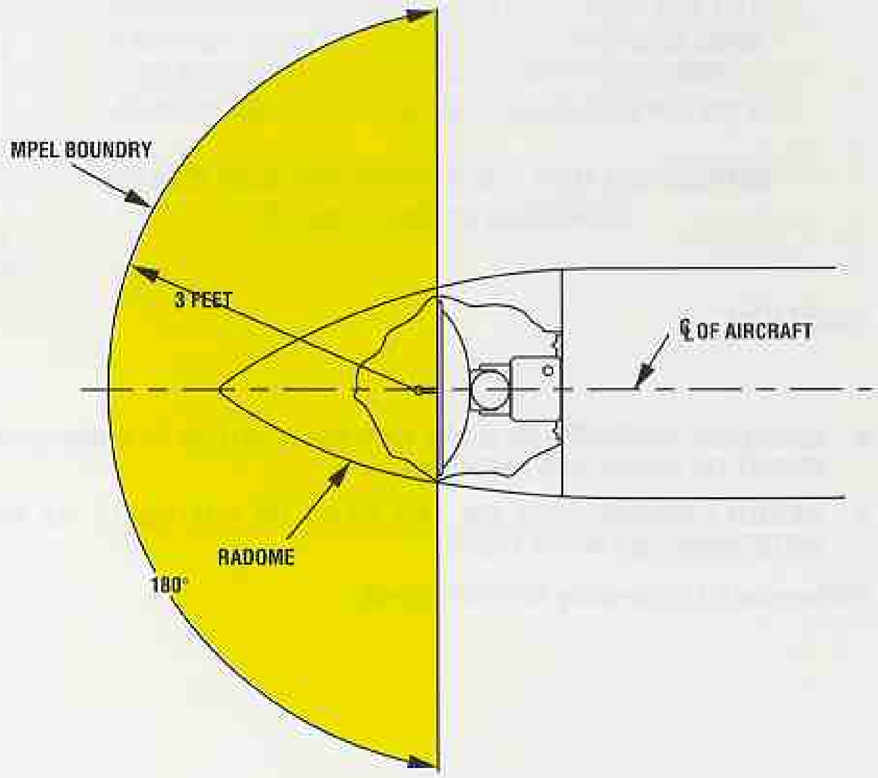
MAXIMUM PERMISSIBLE EXPOSURE LEVEL (MPEL)

In order to avoid the envelope in which the radiation level exceeds the U.S. Government standard of 10 mW per square centimeter, all personnel should remain beyond the distance indicated in the illustration below. The distance to the MPEL boundary is calculated upon the basis of the largest antenna available with the RDR-1400 system, rated output power of the transmitter and in the non-rotating or boresight position of the antenna. With a scanning beam, the power density at the MPEL boundary is significantly reduced.



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