COLLINS WXR-2100 MULTISCAN™ RADAR
FULLY AUTOMATIC WEATHER RADAR

Presented by:
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MULTISCAN OVERVIEW

Introduction

The Collins WXR-2100 MultiScan™ Radar is a revolutionary approach to the way weather information is processed and refined. The WXR-2100 is a fully automatic radar that displays all significant weather without the need for pilots to input tilt or gain settings – all with an essentially clutter-free display. When operated in automatic mode, pilots have the weather information currently available only to the most experienced radar operators, thus standardizing and simplifying crew training requirements. The system's MultiScan Radar functionality significantly reduces pilot work load while enhancing weather-detection capability and passenger/crew safety.

The key to MultiScan operation is the radar's ability to look down towards the bottom reflective portion of a thunderstorm and eliminate the ground clutter with advanced digital signal processing. The system combines multiple radar scans at preselected tilt angles in order to detect short-, mid- and long-range weather. The result is superior weather detection.

The Collins MultiScan Radar eliminates ground clutter with advanced algorithms allowing it to skim the radar horizon and provide pilots with true strategic weather out to 320 nautical miles (nm). The system also provides OverFlight™ Protection, allowing crews to avoid inadvertent thunderstorm top penetrations, which today account for a significant portion of aircraft turbulence encounters. OverFlight Protection ensures any thunderstorm that is a threat to the aircraft will remain on the radar display until it no longer poses a danger to passengers and crew.

Advanced Features

Full Automatic Operation — MultiScan is designed to work in the fully automatic mode. Pilots select only the desired range. Tilt and gain inputs are not required.

Essentially Clutter-free Display — Rockwell Collins' third-generation ground clutter suppression algorithms are utilized to eliminate approximately 98 percent of ground clutter, resulting in the display of threatening weather that is essentially clutter-free.

Optimized Weather Detection at All Ranges and Altitudes — Weather data from multiple scans at varying tilt angles is stored in memory. When the flight crew selects a desired range, information from the various scans is extracted from memory and merged on the display. Since long- and short-range weather information is available due to the use of multiple tilt angles, the display presentation represents an optimized weather picture regardless of the aircraft altitude or the range scale selected.

Strategic Weather — MultiScan provides true 320 nm strategic weather information.

GainPlus™

- MultiScan allows the flight crew to increase and decrease gain during both manual and automatic operation.
- Variable temperature-based gain automatically compensates for low thunderstorm reflectivity during high-altitude cruise.
- Path attenuation compensation and alert (PAC Alert) compensates for attenuation due to intervening weather is provided within 80 nm of the aircraft. When compensation limits are exceeded, a yellow PAC Alert bar is displayed to warn the flight crew of an area of radar shadow.
- OverFlight protection reduces the possibility of inadvertent thunderstorm top penetration at high cruise altitudes. MultiScan's lower beam information and memory capability are utilized to prevent thunderstorms that are a threat to the aircraft from disappearing from the display until they pass behind the aircraft.
- Oceanic thunderstorm correlation automatically compensates for the reduced reflectivity of oceanic thunderstorms to provide a more accurate weather presentation during over-water operations.

Comprehensive Low-altitude Weather — The use of multiple tilt angles at low altitude allows the radar to protect against the energy of vaulted thunderstorms by scanning along the flight path, scanning for growing thunderstorms beneath the aircraft and viewing weather at extended ranges.

Windshear Detection — Automatic forward-looking windshear detection is provided in the landing and takoff environment.

Ground Mapping — Enables the detection of major geographical features such as cities, lakes and coast lines.

Split-Function Control (Boeing Aircraft) — Provides the pilot and co-pilot with independent control of range, gain and mode of operation. When operating in manual mode, independent tilt control is also available.

Simultaneous Display Updates in All Range/Mode Combinations — The flight crew's displays update simultaneously during automatic operation, even when different ranges and modes are selected.

Thunderstorm Reflectivity

Understanding thunderstorm reflectivity is the key to understanding how the Collins MultiScan Radar works. In general, thunderstorm reflectivity can be divided into three parts (see figure 1.1). The bottom third of the storm below the freezing level is composed entirely of water and is the part of the storm that most efficiently reflects radar energy. The middle third of the storm is composed of a combination of super-cooled water and ice crystals. Reflectivity in this part of the storm begins to diminish due to the fact that ice crystals are very poor radar reflectors. The top third of the storm is composed entirely of ice crystals and is almost invisible to radar. In addition, a growing thunderstorm will have a turbulence bow wave above the visible portion of the storm.

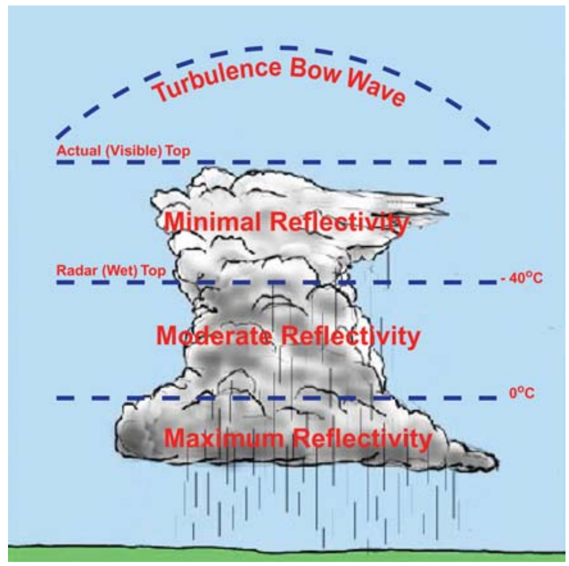

Figure 1.1 - Thunderstorm reflectivity levels.

The pictures in figure 1.2 show an actual thunderstorm and the corresponding radar picture as tilt is increased. In practice, finding the proper tilt angle during manual operation often becomes a compromise between observing the most reflective part of the thunderstorm and reducing ground clutter returns.

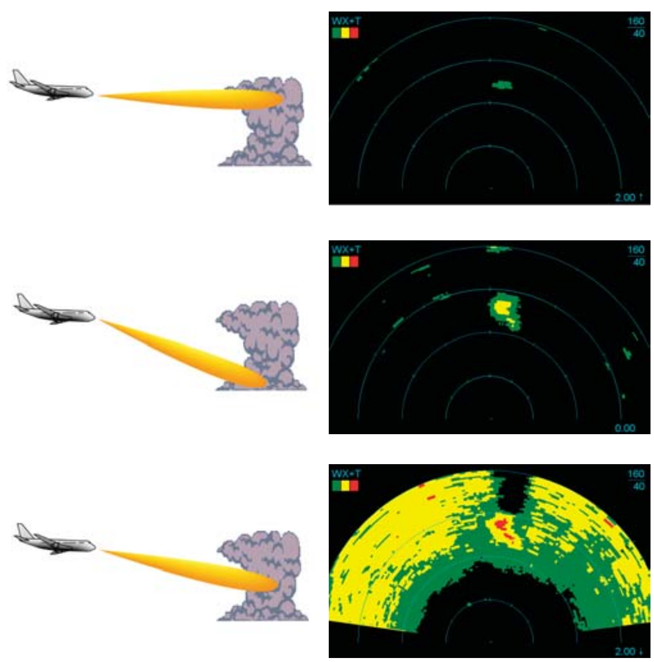

Figure 1.2 - Observed thunderstorm and corresponding radar display at three different tilt settings.

THE IDEAL RADAR BEAM

Understanding thunderstorm reflectivity and the effect that radar tilt angle has on it allows us to envision a hypothetical ideal radar beam for weather threat detection. The ideal radar beam would look directly below the aircraft to detect building thunderstorms and then follow the curvature of the earth out to the radar's maximum range (figure 1.3). Thus, the ideal beam would keep the reflective part of all significant weather in view at all times.

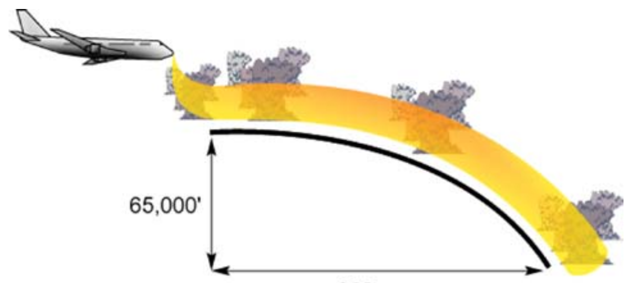

Figure 1.3 - Ideal radar beam (note earth's curvature causes a drop of approximately 65,000 ft over a distance of 320 nm).

MULTISCAN EMULATION OF THE IDEAL RADAR BEAM

The Collins MultiScan Radar emulates an ideal radar beam by taking information from different radar scans and merging the information into a total weather picture. Rockwell Collins' patented ground clutter suppression algorithms are then used to eliminate ground clutter. The result is the ability for flight crews to view all significant weather from 0 - 320 nm on a single display that is essentially clutter-free (figures 1.4 and 1.5).

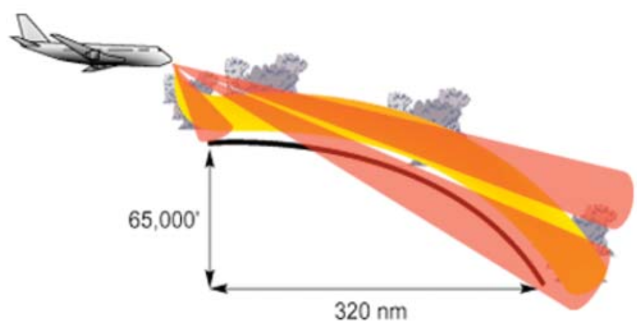

Figure1.4 - MultiScan emulation of ideal beam.

Figure 1.5 illustrates the MultiScan process. Multiple antenna scans are performed. Each scan is optimized for a particular region in front of the aircraft (short-, medium- or long-range weather) by automatically adjusting tilt and gain. The computer merges the data into a digital picture, refines the image and then eliminates ground clutter using Rockwell Collins' patented ground clutter suppression algorithms. Thus, an optimized weather picture is stored in computer memory. The flight crew simply selects the portion (range scale) of the optimized picture that they desire.

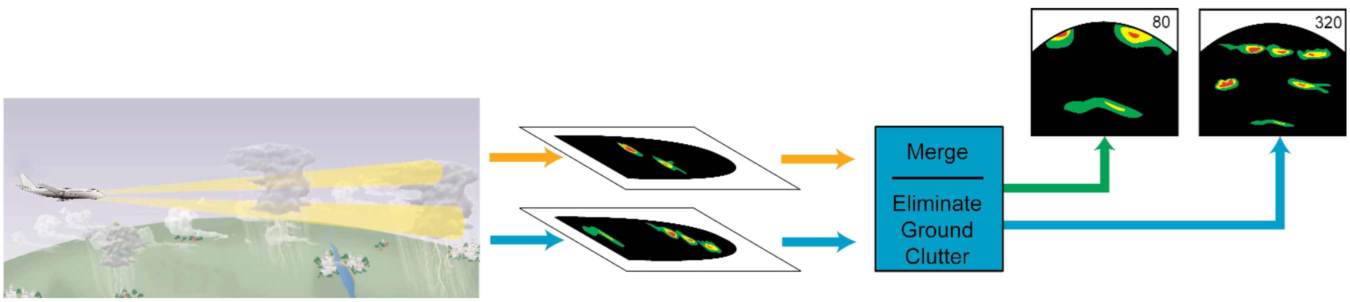

Figure 1.5 - The MultiScan process.

The total time required to complete one cycle of the MultiScan process in all modes except windshear is eight seconds. When in windshear mode the total cycle time for both the MultiScan and windshear processes is 11.2 seconds. Thus, there is no significant change to observed weather during one cycle of the MultiScan process. What does change is the relationship of the aircraft to the weather. To compensate for this, the system translates (figure 1.6a) and rotates (figure 1.6b) the stored digital image to compensate for aircraft movement. The result is that the Collins MultiScan Radar updates all radar displays every four seconds in all modes, except windshear, in which case the displays update every 5.5 seconds. One interesting element of this process is that the antenna scan is no longer tied to the display sweep. This frees the antenna to perform multiple functions without interrupting the pilot's weather presentation.

Aircraft Heading 360°

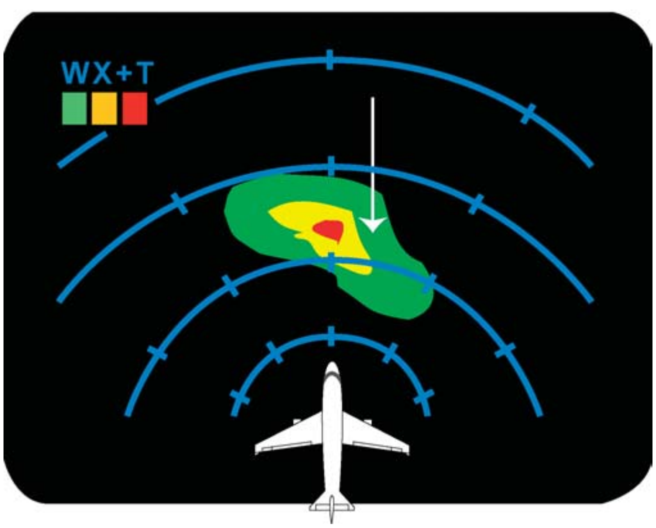

Figure 1.6a - MultiScan Radar translates the stored digital image to compensate for the forward motion of the aircraft.

Aircraft Heading 045°

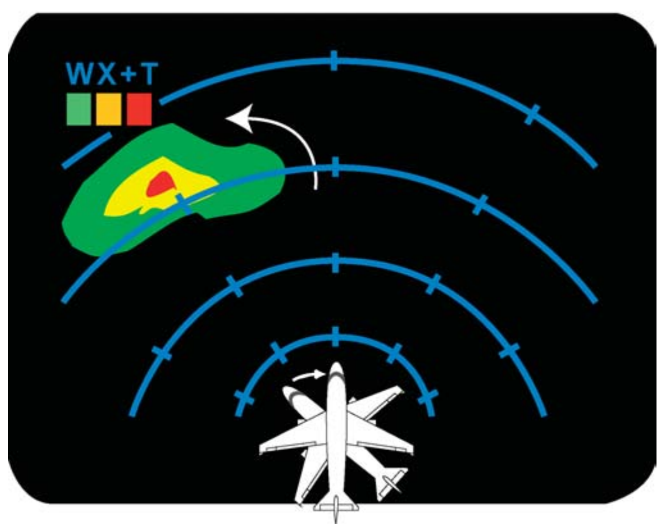

Figure 1.6b - MultiScan Radar rotates the stored digital image to compensate for aircraft turns.

AUTOMATIC GAIN

During automatic operation the MultiScan Radar uses variable gain based on atmospheric temperature profiles to compensate for variations in geographic location, time of day and altitude, resulting in optimized weather returns in all phases of flight. Gain is thus adjusted to best suit the environment in which the aircraft is flying and provide the optimum weather picture in the prevailing conditions.

THE END RESULT

Because the MultiScan Radar can examine the weather in front of the aircraft using multiple tilt settings and is able to look down into the ground clutter to pick out significant weather (figure 1.7a), it is able to display all the weather from 0-320 nm that will affect the aircraft on a single, essentially clutter-free, display (figure 1.7b). And the whole process is entirely automatic, freeing the flight crew to concentrate on weather avoidance rather than weather detection and interpretation.

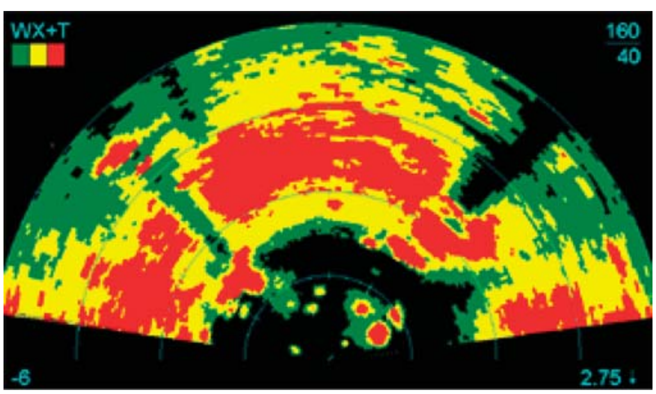

Figure 1.7a - MultiScan Radar is able to look down into ground clutter to detect the reflective portion of thunderstorms. The picture above (1.7a) shows the radar picture with the ground clutter suppression turned off. Weather is masked by the ground clutter.

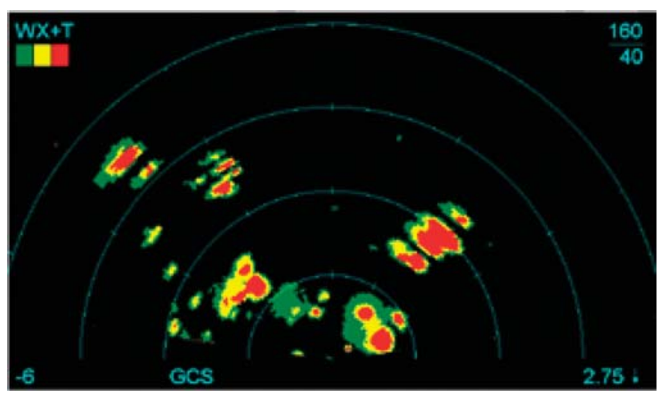

Figure 1.7b - When Ground Clutter Suppression (GCS) is activated, all significant weather (in this case from right in front of the aircraft out to 160 nm) is visible on a single, essentially clutter free, display. Significantly, the radar operator no longer needs to compromise between a tilt that will eliminate ground clutter and a tilt that will give the best weather returns.

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