

REPORT ITU-R M.2081

Test results illustrating compatibility between representative radionavigation systems and radiolocation and EESS systems in the band 8.5-10 GHz

(2006)

1 Background

There is a need for contiguous spectrum in the bands around 9 GHz for the radiolocation service, that is allocated on a primary basis worldwide, in order to provide adequate spectrum for new radar systems to function. Emerging requirements for increased image resolution and increased range accuracy necessitate wider contiguous emission bandwidths than are currently available. This fact was recognized at WRC-03 and agenda item 1.3 was developed to consider the upgrade of the frequency allocations of the radiolocation service in the frequency range 9 000-9 200 MHz and 9 300-9 500 MHz to co-primary status with the radionavigation service in order for existing and planned radar systems to satisfy their required missions.

The band 9 500-9 800 MHz is allocated on a primary basis to the Earth exploration-satellite (EESS) (active), space research (active), radiolocation and radionavigation services, taking into account the constraints of footnote 5.476A (EESS must protect systems in radionavigation and radiolocation services). It is desirable to increase by up to 200 MHz the bandwidth available to the EESS (active) and the space research service (active) to satisfy global environmental monitoring requirements for improved resolution. There are plans to enhance spaceborne synthetic aperture radars (SAR) that operate near 9.6 GHz to improve the spatial resolution to the order of 1 m, which would require up to 500 MHz bandwidth. This additional bandwidth would greatly improve the resolution of the features for global monitoring and for environmental and land-use purposes. To accommodate this desire for additional bandwidth, consideration is being given to both the 9 300-9 500 MHz band, and the 9 800-10 000 MHz band.

2 Representative radionavigation and weather radar systems

Five representative radionavigation systems operating in the 9 000-9 200 and 9 300-9 500 MHz bands were identified to be tested to assess their compatibility with radiolocation and EESS systems. They are: marine radionavigation, precision approach (PAR), airborne weather, and airport surface detection equipment (ASDE) radars. A general description of these systems and how they are used are given in the following paragraphs. The exact technical characteristics of the radionavigation systems that will be tested are also included.

3 Objectives

The objective of these measurements is to:

- a) Collect a parametric set of radar performance data that demonstrated the compatibility of maritime radionavigation, aeronautical radionavigation, meteorological radars, and radiolocation services in the 8.5-10 GHz band. The compatibility of EESS systems with those representative radionavigation systems was also analysed through the testing.
- b) Verify that the radar performance degradation is a function of the interference-to-noise (I/N) ratio at the receiver IF output (detector input) as well as the undesired signal pulse

width and PRF (duty cycle), and perhaps modulation by observing the radar display for lost targets and/or an increase in false targets. Three types of radiolocation waveforms were used for these tests: chirped, phase coded, and un-modulated. Various subsets of each type of radiolocation waveform were tested.

- c) Collect a parametric set of radar performance data that can be used to assess the compatibility of pulsed and digital communications type modulations with radionavigation systems operating in the 9 000-9 200 and 9 300-9-500 MHz bands.

4 Approach

To show that the EESS can have an extension and radiolocation service can be upgraded to a primary allocation status without causing unwanted interference to systems already operating in the radionavigation service, the five representative radionavigation systems that operate in the 9 000-9 200 and 9 300-9 500 MHz bands were tested to show their compatibility with various radiolocation and EESS systems. Since the band contains many types of radiolocation systems mounted on land, ship, and aircraft platforms as shown in the draft new Recommendation entitled “Characteristics of and protection criteria for radars operating in the radiodetermination service in the frequency band 8.5-10.5 GHz”, it was impractical to make measurements using the actual radiolocation system themselves. Therefore, the radionavigation systems were tested with simulated waveforms of representative radiolocation systems contained in the 8.5-10 GHz Recommendation and waveforms of representative EESS systems from other ITU-R documents. For the tests, the radiolocation and EESS waveforms were calibrated at the radiolocation receivers IF to produce peak I/N values of I/N levels of -9 , -6 , -3 , 0 , 3 , 6 , 9 , 12 , 20 , and 40 dB or greater.

The waveforms of the radiolocation and EESS systems were generated and injected into the receiver of the radionavigation systems at the RF level for calibrated levels in the IF bandwidth of the victim receiver, and their performance degradation, if any, was monitored and documented. This Report can be referenced in the WRC-07 Conference Preparatory working (CPM) text to support the upgrade and be available for all administrations for review. A similar method was used for the successful radiolocation upgrade in the 2.9-3.1 GHz band¹ for WRC-03.

5 Performance criteria

The maritime, PAR, and ASDE radars are used to observe point targets in space at some distance from the radar itself. Pilots of aircrafts use the airborne weather radar while in flight, to observe distributed targets such as rain, hail, windshear, and other atmospheric conditions. Therefore, the performance criteria of the weather radar are very different than the criteria of the other radars. The performance criteria of the marine, PAR and ASDE radars and the meteorological radars are discussed in the following paragraphs.

5.1 Maritime, PAR, and ASDE radars performance criteria

The following radar performance criteria were monitored during the measurements to evaluate the effects of the radiolocation, and EESS, type of emissions on the maritime, PAR, and ASDE radar's system performance.

¹ Report ITU-R M.2032 – Tests illustrating the compatibility between maritime radionavigation radars and emissions from radiolocation radars in the band 2 900-3 100 MHz.

- a) *Loss of desired target.* For the marine radar, the power level of the simulated target returns was set to obtain a probability of target detection of 90% without the undesired² signal being present, with the targets non-fluctuating³. This corresponds to a loss of one target per rotation. Twenty rotations were used to set the baseline probability of detection, P_d , without interference being present. With the undesired waveform being present, twenty rotations were also used for each data point with calibrated values of the radiolocation signal set to produce specific I/N levels in the IF of the radionavigation receiver. The number of lost targets per 20 rotations was counted and the P_d was calculated based on 200 total targets generated.
- b) *False targets/strobes.* For the ASDE-X and PAR radars, the display was observed for evidence of false indications and false targets resulting from injection of the undesired signals. This was reflected in the test logs and this Report. The target power for both radars was non-fluctuating as in the case of the marine radar.

Note that these criteria are not based on any particular decrement of P_d . They are based on the increase of signal power required to recover the overall performance of the radar (P_d for a search radar, track precision for a track radar, image resolution for an imaging radar, rainfall rate and wind velocity accuracy for weather radars, etc.) to the values they would have in the absence of interference, *regardless of the size of decrement* in those measures of effectiveness that needs to be recovered. The increase of signal power could occur through decrease in maximum free-space range, loss of coverage in regions to/from which propagation is less favourable, or expensive increase of the radar's power-aperture product. We can show that irrespective of the more gradual falloff of P_d with I/N (to a degree that depends on the particular radar being tested) that attends fluctuating target return relative to steady target return.

5.2 Airborne weather radar performance criteria

The following radar performance criteria will be monitored during the measurements to evaluate the effects of the radiolocation and EESS emissions on the airborne weather radar system performance. ARINC has a performance standard identified as ARINC 708⁴ for airborne weather radar systems. RTCA has also published a specification⁵ for airborne weather radars. The RTCA requirement is that "Transmission from an identical-type radar, operating on an aircraft flying a parallel approach to an adjacent runway or following the equipped aircraft as closely as two nautical miles, shall not cause false alerts, missed detections or other observable interference". The display of the weather radar was observed for effects due to the interference, such as strobes, abrupt colour changes and variations.

² The term undesired signals refers to both the radiolocation and EESS signals.

³ The target power was held constant.

⁴ Airborne Weather Radar with Forward Looking Windshear Detection Capability, ARINC Characteristic 708A-3, November 1999.

⁵ RTCA/D0-220, Minimum Operational Performance Standard for Airborne Weather Radar with Forward-looking Windshear Capability. Section 2.2.2.15. September 1993.

6 Description of radionavigation radars

6.1 Maritime radionavigation radar

The maritime radionavigation radar used for these tests nominally operates at 9 410 MHz and was introduced into service in 2000. This type of radar is regularly updated with improved software and hardware. It was designed for commercial applications and is an International Maritime Organization (IMO) category radar. Nominal values for the principal parameters of this radar were obtained from regulatory type-approval documents, sales brochures, and technical manuals. This radar is designed for Coastguard and Navy ships and therefore has features not normally available to commercial and recreational radionavigation radars. This includes constant false alarm rate (CFAR) processing, synthetic/enhanced targets, and target tracking. Table 1 contains the pulse characteristics of the radar. The radar is an “upmast” design in that the transmitter and receiver are located directly below the antenna in a sealed housing. The plan position indicator (PPI) and associated radar controls are located away from the housing and connected to it via cabling.

TABLE 1

Marine radionavigation radar characteristics

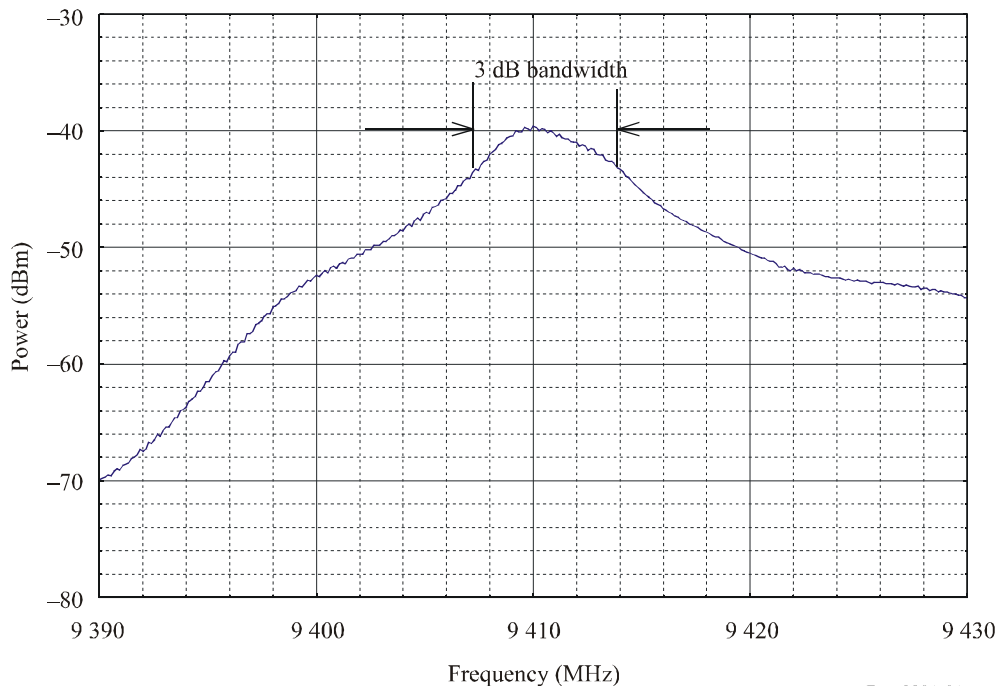
Frequency	Short pulse 1	Short pulse 2	Medium pulse 1	Medium pulse 2	Long pulse
9 410 MHz	80 ns	200 ns	400 ns	700 ns	1.2 μ s
Range					
	0.125-1.5 NM (2-8 km)	0.5-3 NM (0.9-5.6 km)	1.5-6 NM (2.8-11.2 km)	3-24 NM (5.6-44.4 km)	6-72 NM (11.2-133.3 km)
Pulse repetition rate					
	2 200 Hz		1 000 Hz		600 Hz
IF bandwidth	27 MHz	4.5 MHz	3 MHz		

The radar uses a summing multistage logarithmic amplifier with the IF bandwidths given in Table 1 for each pulse width and associated range. A test point was provided that is located at the output of the 3rd amplifier. A CW signal was swept in frequency to determine the response of the receiver and measure the IF bandwidth. The result is shown in Fig. 1. The 3 dB IF bandwidth of the radar when set to short pulse mode 1, which uses a pulse width of 200 ns for a maximum range of three nautical miles, was measured to be about 6 MHz. This mode was used for all of the tests.

FIGURE 1

Marine radar IF response curve

IF frequency response of marine radionavigation radar to CW signal



Rap 2081-01

6.1.1 Marine radar video displays

The marine radar has the ability to display various types of targets in different combinations. The radar is able to display amorphous “blips” (known as image display and what people typically see when looking at a ppi display) and synthetic targets that are processed “blips”. For these types of targets, the radar itself has declared the “blips” as targets and they appear as an “o” on the PPI overlaid onto the “blip”. Targets that are tracked by the radar appear as an “x” on the PPI. The brightness of the video image targets corresponds to the level of the target return. Targets that have a brighter “blip” have a greater return echo. The synthetic targets required about 2-3 dB of additional desired power than the video targets to obtain the same P_d when operating at MDS level, but do not change their brightness in correspondence to the reflected signal strength. That is to say that if the target power for the 90% P_d for image or “blip” display was -90 dBm, then the power level to achieve the P_d of 90% for the synthetic targets would be about -88 dBm. Adding signal power does not change the intensity of the display of the synthetic targets. For synthetic targets the radar has a built in target counter that counts the number of targets per scan and display that value on the PPI.

6.1.2 Marine radar test target characteristics

The targets for these tests were generated using a variety of test equipment including RF signal generators, arbitrary waveform generators, and pulse generators. Ten equally spaced targets at the same azimuth were generated for each scan⁶ with the farthest target being located at the maximum range of 3-nmi. Each target was comprised of 18-19 pulses with the characteristics of the short pulse 2 mode setting. Each target on the radial had the same power level. That power level was held

⁶ A scan is a 360° rotation of the antenna.

constant. When the radiolocation and EESS signals were injected into the radar, they were at the same azimuth of the targets for a duration time equal to the antenna beam sweeping across a stationary object.

A number of trials were performed to determine the target signal power that would result in a P_d of 90% *without* the radiolocation or EESS waveforms being present. This value was found to be about -70 dBm at the panel display of the target generator. The target power supplied to the low noise amplifier (LNA) input of the radar receiver due to RF losses from the test set-up was -88 dBm. The noise figure was measured to be about 9 dB. This results in a calculated noise power of about -97 dBm in the 6 MHz IF bandwidth of the radar receiver. Therefore, the signal-to-noise value to achieve the P_d of 90% was about 8-10 dB. Note that the accuracy of this measurement is probably within ± 2 dB.

The receiver's noise power measured at the IF test point using the spectrum analyser in zero span mode without any targets, radiolocation, or EESS waveforms present in the bandwidth was about -57 dBm. This shows a nominal gain of about 40-42 dB. The gain compression point⁷ using an on-tune CW signal was found to be -25 dBm on the panel display or -43 dBm at the LNA input. It should be noted that the interference suppression circuitry and/or software of the radar can not mitigate the effects of receiver saturation.

6.1.3 Marine radar interference suppression circuitry/software

The radar uses the following features to minimize clutter breakthrough and electromagnetic RF interference: sensitivity time control (STC), fast time constant (FTC), order statistic constant false alarm rate (CFAR), spike suppression, clutter mapping, and scan-to-scan correlation. The STC and FTC were disabled for the tests, since they are used to discriminate sea clutter returns from target returns and to offset the effects of rain, respectively. Obviously, sea clutter and rain did not affect these measurements as they were performed on a test bench. A brief description of the other interference mitigation features follows.

The spike suppression circuitry provides a means of instantaneously filtering interference from other transmitters by detecting and eliminating spikes that occur at a given range over three adjacent sweeps based on a maximum rise and fall criteria. The circuit substitutes the spike value with the average of the amplitudes on the previous and subsequent sweeps.

The CFAR uses an ordered statistic (OS) technique. This adaptive technique minimizes clutter breakthrough in large homogeneous clutter areas. It permits target returns near or above the peak noise plus clutter level to be detected while eliminating the bulk of the noise and clutter. The OS CFAR operates by automatically adjusting the detection threshold based on an instantaneously derived estimate of the predominant noise plus clutter level in the vicinity of the test cell. A programmable guard cell region allows the OS CFAR to accommodate targets of extended range run length, like a super tanker, without loss of sensitivity while still discriminating against clutter.

The clutter mapping compensates for unique spatially distributed clutter situations, such as ones that might be caused by multi-path, grazing angle versus sea state, or a combination of such conditions. The radar operator is provided a means of biasing the OS CFAR derived threshold on an area-by-area basis through the use of the threshold bias map (TBM). The threshold offset stored in the TBM for a particular area is added to the OS CFAR computed threshold for all detections occurring in that area. There are 16 TBM areas centred around the antenna's position which permit the specification of an annulus clutter filter area, which may be used to counter the effects that are

⁷ The gain compression point is the value where the LNA is saturated by the input signal and will no longer give a linear relationship between the input and output signals.

range dependent but bearing independent. The TBM area may be defined to negatively bias the OS CFAR generated threshold to increase sensitivity or completely mask returns such as those from land mass. The TBM is organized as a table of 1 024 range cells by 1 024 azimuth cells.

The scan-to-scan correlator takes advantage of the fact that sea clutter is correlated on a pulse-by-pulse basis, but decorrelated on a scan-by-scan basis. Clutter that is permitted to pass through all previous clutter suppression stages is processed through a temporal-spatial decorrelation filter, the retrospective processor. This processor performs scan-to-scan correlation, maintaining as many as nine scans of data.

6.1.4 Marine radar test methods

The tests were performed in a conducted manner, using RF cables, RF combiners, and waveguide-to-cable adapters to join the RF signals containing the targets and radiolocation and EESS waveforms, and then send them into the RF front end of the radar receiver at the LNA input. The radar was tested in the laboratory on a workbench so that monitoring the IF card test points and connecting to the LNA were easier to accomplish. The antenna was not used for the tests, however the appropriate signals from the antenna position resolver circuitry was supplied to the radar receiver so that its normal operation was mimicked.

A more complete description of the test methods is contained in Annex 1.

6.2 Precision approach radars

The PAR is used by a ground controlled approach (GCA) operator to provide accurate navigational information for guiding an aircraft to a GCA landing during both clear weather and instrument flight rules (IFR) weather conditions. The PAR detects and tracks aircraft approaching a runway for landing. The system consists of a Beta scan display, transmitter, receiver, signal processing equipment and antenna assembly. The radar set generates data that displays the position of the aircraft relative to the glide path (angle and distance) of a selected airport runway. The displayed data includes real time video of aircraft in the sector scanned by the radar antenna, synthetically generated symbols designating the locations of aircraft during final approach, glideslope, decision height, and safety zone specified for the selected runway. The antenna and RF equipment is located in a shelter at the end of the runways. There is display equipment located in the shelter, or a display can be located away from the shelter, connected via a coaxial cable or fibre optic link.

The technical characteristics of the PAR are shown in Table 2.

TABLE 2

PAR characteristics

Operating frequency	9.0 to 9.2 GHz
Pulse repetition rate	Multiple PRFs (see Appendix C)
Pulse width	1 μ s
IF bandwidth	2.0 MHz
Noise figure	3.25 dB
Antenna type	Limited scan, hyperbolic section reflector with an offset, phased array steered monopulse feed
Antenna gain	42 dB
Antenna polarization	Circular
Antenna beamwidth	Elevation 0.75° Azimuth 1.3°
Receiver types	Normal Coherent MTI Non-coherent MTI Range track Angle track

The PAR includes several features to improve its ability to detect targets. These include the use of: frequency diversity techniques, use of coherent and non-coherent MTI processing techniques, enhancement of weak target echoes, second return rejection, STC, and FTC.

In the normal receiver, the radar can operate in the limiting mode. This mode provides hard limiting on noise followed by narrow band pass filtering which is effective in obtaining good distinction between aircraft and wideband noise. This method is also known as a “dickie fix” circuit and functions as a type of CFAR processing.

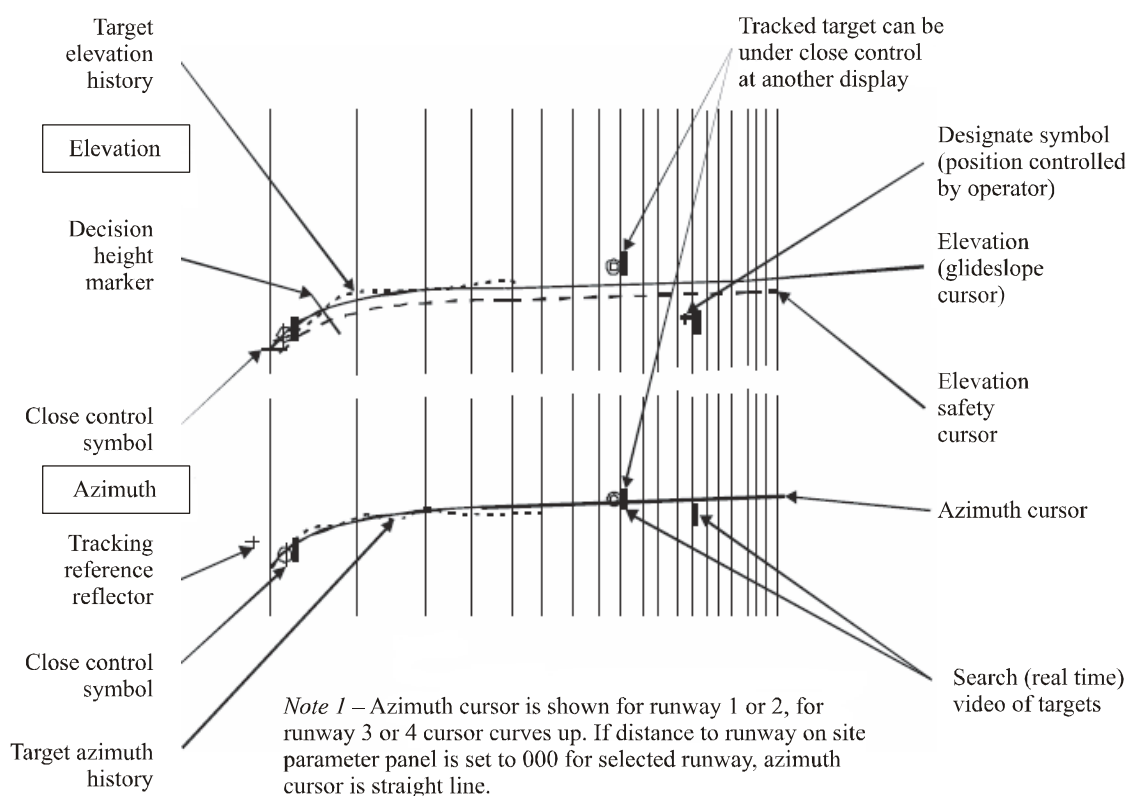
The radar steps in the -10 to $+10$ degree azimuth and -1 to $+7$ degree elevation volume, in 439 discrete steps utilizing a two dimensional raster scan. The entire volume is scanned in approximately 0.5 s (20 NM range) and 0.4 s (8-15 NM (15-28 km) range mode). In scan mode, the PAR operates on two sets of two distinct frequencies, called (A1, A2) and (B1, B2). These frequencies are A1 = 9.02 GHz, A2 = 9.057 GHz, B1 = 9.143 GHz, and B2 = 9.180 GHz. From the RF, the radar has dual first IF frequencies, 592 MHz and 629 MHz, leading to two separate IF channels, labelled in the radar as Scan 1 and Scan 2. Pulses A1 and B1 are taken to 592 MHz, while A2 and B2 are taken to 629 MHz. The frequency separation is sufficient to not allow any effects of one frequency into the other channel. The second IF of each channel is 74 MHz. The 74 MHz IF signal is then converted to video (baseband) with a detector. After conversion to baseband video, the signal is then processed according to the radar operating mode: coherent MTI, non-coherent MTI, or normal. In this test, only normal mode will be considered. In this mode, the radar pulses are non-coherently integrated and the results are displayed on the radar display.

6.2.1 PAR radar beta-scan display

The radar utilizes a beta-scan display type, and a typical display is shown in Fig. 2. The top portion of the display shows the aircraft's elevation relative to the glide slope cursor (optimal approach path), represented by the solid curved line on the display. The line is curved even though the path is straight in space because the antenna is placed beyond the runway and offset in azimuth. The vertical bars are mark range, in a logarithmic scale.

FIGURE 2

Typical parameters of PAR beta-scan display



Rap 2081-02

The vertical axis represents elevation angle relative to the antenna, and is plotted linearly. The bottom portion of the display shows aircraft azimuth relative to the glide path (or azimuth cursor, representing an extension of the runway's centre line). Again, the line is curved because of the azimuth offset of the antenna from the runway. The vertical bars here also mark range in a logarithmic scale. Other things the display shows include: elevation and azimuth history data from the tracker, an elevation safety cursor, and a decision height marker.

A target that has been detected shows up on the display as a rectangular "blip", labelled as "Search (Real Time) Video of Targets". Once the target has been selected for tracking and has been acquired, it is shown with two concentric circles. A circle with a vertical line represents a target being tracked under close approach, meaning the aircraft is about to land. Blinking track symbols indicate that the track was lost and that the radar has begun to predict the future location of the aircraft, and will attempt to re-acquire the track if possible. Up to six targets can be tracked at once. The tracking reference reflector is used by the tracker as a reference to allow calibration of the elevation and azimuth error calculations.

6.3 Airborne weather radar

The airborne weather radar that was tested is typical of those operated on transport aircraft and may also be used on some commercial aircraft. It has been in production for a number of years and is still in production with updates and is still being installed on aircraft. The radar's antenna is placed in the nose of the aircraft and the receiver/transmitter unit is located directly behind it. The radar has a colour display and control unit located in the cockpit of the aircraft. The colour display shows the weather phenomena on the display as variations of colours. The control unit allows the pilot to change some of the operational parameters of the system such as range and scanning angle. Table 3 lists the technical parameters of the radar.

TABLE 3

Airborne weather radar characteristics

Operating frequency	9 310 MHz to 9 410 MHz
Pulse repetition frequency	230 to 2 000 pps
Pulse width	0.19 μ s to 234 μ s
3 dB IF bandwidth	400 kHz (short pulse)
Sensitivity	–110 dBm typical
Antenna scan angle	$\pm 15^\circ$ to $\pm 135^\circ$
Antenna scan rate	60°/s
Antenna gain	32.0 dBi
Antenna beamwidth	2.7° Horizontal 4.0° Vertical

The airborne weather radar tested was designed to randomly (uniform distribution) hop every pulse in its operating band, in 5 MHz increments. This hopping was done for interference rejection and to reduce frequency dependent effects of the weather targets. For the interference tests, the radar was placed in an operator-defined single frequency mode (9 335 MHz was arbitrarily chosen). The single frequency mode was tested rather than the hopping mode because in that mode, the radar would automatically delete a given channel from the hopset if it detected interference on that channel. Another reason for choosing the single frequency mode is that most weather radars operate on a single frequency.

The radar utilizes a triple down-conversion heterodyne receiver, with a 5 dB noise figure. The RF is mixed down to 870 MHz, and the first IF filter is matched to the narrowest sub-pulse bandwidth. The second IF, at 90 MHz, is filtered with either an 800 kHz or 120 MHz filter (depending on the selected range scale), and then down-converted to the third IF stage, which is baseband video, in the 0 to 50 MHz range. The baseband video is then detected and sampled with either an 8 or 11 bit A/D converter that is dependent on the selected radar range scale. This radar utilizes a CFAR processor to reduce the effects of noise and clutter.

The airborne weather radar uses three range dependent waveform modulations, depending on the user-defined range setting. For short range, unmodulated pulses are used. For medium range, a 5-chip binary Barker coded waveform is employed, leading to a pulse compression ratio (linear) of 5. For the longer ranges, a 13-chip binary Barker coded waveform is used, and the pulse compression ratio (linear) becomes 13. As shown in Table 4, the pulse bandwidth is also a function of the user-selected range.

6.4 Airport surface detection radars (ASDE-X)

The ASDE-X is a primary radar system that provides a comprehensive view of the airport movement as well as other areas of interest on the airport surface and approach corridors. The radar monitors targets of interest in the coverage volume (typically airport movement area, the airport surface, and approach corridors) and generates target plots for tracking, data fusion, and display to an operator. The targets are overlaid onto an electronic map of the runway for the operator allowing them to assist in avoidance of ground traffic incidents by clarifying the relative positions of aircraft and other vehicles under difficult viewing conditions.

The ASDE-X consists of an antenna, transceiver assembly, and radar data processor. The technical characteristics of the radar are shown in Table 4.

TABLE 4
ASDE-X characteristics

Detection specification	0.90 P_d for target of > 3.2 RCS with a pfa of 10^{-6}
Frequency	9.0-9.2 GHz with frequency diversity (4 channels) Channel separation – 39 MHz
Pulse width	40 ns for short range (608-4 050 ft.) (0.2-1.4 km) 4 μ s with LFM 50 MHz chirp for ranges from (4 050-14 500 ft) (1.4-5 km)
Pulse repetition frequency	4 kHz (4 096 pps)
Range	24 000 ft. (8.4 km)
Scan rate	60 rpm (adjustable to trim out vibrations)
Azimuth beamwidth	0.36°
Elevation beamwidth	18°/fan beam
Polarization	Circular

6.4.1 ASDE-X signal processing

The radar receiver is a standard dual down conversion receiver with a limiter, filter, and low-noise amplifier along with a receiver blanking switch that protects the receiver during transmitter pulse time. The radar uses a 4 pulse non-coherent integration with STC in the short pulse coverage region (608-4 050 ft).

The radar has both a target detector and a static reflector. The ASDE-X target detector uses a variety of signal processing techniques to reduce or eliminate the effects of interference. This includes a primary and secondary CFAR. The primary CFAR provides an adaptive threshold for the airport movement areas and the secondary CFAR provides an adaptive threshold for areas on interest that are not part of the movement areas. Both primary and secondary CFAR contain:

- *Fixed CFAR* – A fixed threshold that is a function of range
- *Adaptive CFAR* – A dynamic threshold used to reduce the effects of changing airport clutter conditions
- *Clutter thresholds* – Thresholds used to reduce clutter from persistent sources of clutter.

The static reflector function requires the following thresholds:

- *Adaptive threshold* – Used to compute the static reflector threshold from a spatial average of the clutter map
- *Fixed threshold* – The threshold regions designed to balance static reflector declarations to enable effective multi-path target elimination.

The radar video amplitude is compared with the thresholds. If the amplitude is greater, then a potential target is declared out of the threshold function. The target detector and static reflector are internally similar, but the output is different. The target detector provides the tracker with plots for use in target decision/tracking. The static reflector provides the multi-path logic with potential static reflectors for use in multi-path target elimination.

7 Representative radiolocation systems

The tests were performed with radiolocation waveforms that are representative of the radiolocation systems that operate in the 9 000-9 200 and 9 300-9 500 MHz bands. The technical characteristics