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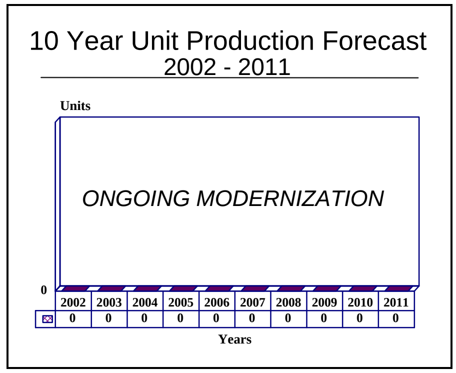
ASR-9 - Archived 08/2003

Outlook

- In service, ongoing logistics support
- Weather Processor (ASR/WSP) enhances capabilities
- Emergency ASR-8 antenna replacement being studied
- SLEP money added in FY02



Orientation

Description. Primary Airport Terminal Surveillance Radar for medium- to heavy-traffic installations.

Sponsor
Federal Aviation Administration
800 Independence Ave SW
Washington, DC 20591
USA
Tel: +1 202 267 3484
Web site: http://www.faa.gov

Contractors
Northrop Grumman Corp
Electronic Sensors & Systems Division
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Baltimore, Maryland (MD) 21203-7319
USA
Tel: +1 410 765 1000
Fax: +1 410 993 8771
Web site: http://www.northropgrumman.com

Status. In service and production, with ongoing support.

Total Produced. An estimated 152 radars have been produced.

Application. Airspace surveillance in Terminal Control Areas.

Price Range. Estimated unit cost is US$3,700,000.

Price is estimated based on an analysis of contracting data and other available cost information, and a comparison with equivalent items. It represents the best-guess price of a typical system. Individual acquisitions may vary, depending on program factors.

Technical Data

Characteristics

Frequency	2,700 to 2,900 MHz
MTD Filters	8 and 10 alternately
Peak Power	1.3 MW per channel
Average Power	1.5 kW

Pulse Width	1 µsec
PRF	980, 1,250 pps
MTI Improvement (scanning)	55 dB
Dynamic Range	12 bit A/D, processed signals 63 dB above noise without distortion
Range	50 nm (118 km)
Characteristics (continued)	
Coverage	360º
Scan Rate	12.5 rpm
Polarization	Circular/Linear
Beamwidth	1.4º
Range	60 nm (111.18 km)
MTBF	3,500 hr
Availability (planned)	99.98 percent (4 hr downtime per year)
(demonstrated)	99.6 percent
Features	Simultaneous weather and target data
	Six-level weather output
	Advanced moving target detection (MTD)
	Constant false alarm rate (CFAR) processing
	Transmitter stability
	Remote monitoring and control
	Unattended operation
	Mode S Compatible

Design Features. The ASR-9 is the primary airport terminal surveillance radar installed at major US airports to provide air traffic controllers with the ability to see all aircraft in the Terminal Control Area airspace clearly, simultaneously, and without interference. It capitalizes on state-of-the-art components and processors to produce a reliable, high-performance terminal control radar that provides air traffic controllers with accurate position information under all weather or clutter conditions.

Design engineers played particular attention to azimuth resolution. A sophisticated algorithm compares the actual return with a reference return expected from a single aircraft. If the actual return does not match the broad parameters of the reference return, the system reports the detection as two separate aircraft. This was done to help controllers maintain the safe separation of aircraft flying close together in azimuth.

Range resolution is accomplished by means of a special technique which can detect a small aircraft flying close to a large plane. Circuits and processing prevent the return from the large aircraft from masking the return from the smaller one.

The ASR-9 uses special processing algorithms to improve detection of aircraft flying tangentially to the radar. This target geometry potentially causes a zero radial velocity at the Moving Target Indicator and the return may be rejected as ground clutter. The ASR-9 Moving Target Detector uses double zero-velocity Doppler filters combined with a 500,000-cell fine-grain clutter map to ensure that all aircraft are detected and displayed continuously.

The radar also processes and displays important weather information. Intensity information is included, with the weather areas directly displayed to the controller. The radar can combine linear and circular polarization to enhance the ability to detect aircraft by a factor of up to 1,000-to-1 over current systems. Doppler processing eliminates ground clutter from the weather data. A new processor will enhance the overall weather performance and enable windshear and microburst activity to be detected.

The system uses proven, tested, solid-state components to reduce the likelihood of failure. It also has built-in redundancy of critical components, including dual-drive motors and azimuth pulse generators. Modular sub-systems are designed to degrade gracefully, providing "fail-soft" operation. The modulator is capable of operating at full power even after losing 20 percent of its switching modules.

In addition, an extensive built-in test and error detection system is interfaced with a Remote Maintenance System (RMS) that continuously monitors radar performance, equipment status, and power/security status. The RMS can detect and isolate problems in real time, reporting to maintenance and operations personnel. The average Mean Time Between Outages (MTBO) is 3,500 hours. This equates to four hours of downtime per year.

The ASR-9 was designed to interface with ARTS-IIA, ARTS-IIIA, EARTS, and future AAS/ACF/ARTCC processing and display systems. It also interfaces with the Northrop Grumman AMS-1000 and AMS-2000 ATC processing and display systems, which are popular on the international market. The radar is compatible with existing secondary surveillance radar (SSR) equipment, including Mode S. The rotary joint includes three D-band SSR channels, making it compatible with any secondary surveillance monopulse system. A Beacon Target Detector (BTD) is included as part of the design to process the output of a beacon system.

Operational Characteristics. The ASR-9 incorporated operational features that enhance the ability of air traffic controllers to monitor aircraft flying in the Terminal Control Area (i.e., the 60-nautical-mile radius surrounding an airport). Controllers use the radar data to manage traffic into and out of terminal areas and maintain safe separation. The system has an advanced ability to distinguish between aircraft flying close to one another and to display aircraft flying in weather clutter accurately and reliably. Position accuracy and reliability are very high.

A major improvement over the old systems is the ability to display aircraft flying in heavy weather or clutter and give controllers more information than past systems. It provides better information on the location and intensity of precipitation. This was important because in 1986, weather was cited as a factor in 44 percent of aircraft accidents. The system generates six levels of weather intensity information. Operators can select any two levels for display through the target channel. Aircraft are displayed even in heavy weather clutter. The FAA Weather Processing System is emphasizing the ability to use the weather data generated by the ASR-9 as an addition to its weather forecasting/weather data system.

The Moving Target Detection function does not experience target drop-out when an aircraft is flying tangentially to the radar. Processing effectively controls the false alarm rate, presenting controllers with a clean, digitized display. The display provides valid target and weather data, with specific features selectable by the operator.

Maintenance is easier, faster and less costly than for earlier systems. A built-in, computer-aided "expert maintenance technician" monitors status and operation continually. It can be controlled from a central maintenance or operations facility.

ASR-9 Surveillance Radar

Source: FAA

Variants/Upgrades

Retrofit. In October 1993, the FAA purchased 134 retrofit kits to modify transmitter units that were experiencing a higher-than-expected failure rate.

9-PAC. In October 1997, the FAA awarded Northrop Grumman ESSD a US$4.2 million contract to produce 134 modification kits for existing radars. Called the Processor Augmentation Card, the kit enhances the performance and capacity of existing radars, incorporating new hardware and software to increase processing power. It improves the radar's performance by reducing false target reflections and increases operator target detection. It also extends the useful life of the system.

Under the contract, 432 processor boards were produced and delivered by December 1998. The last upgrade installation was completed in January 1999.

ASR/WSP (Airport Surveillance Radar/Weather System Processor). The FAA is providing the ASR-9 with a Doppler conversion capability so the radar can detect microburst and windshear activity by analyzing the air movement velocity structure of storms. This is accomplished by adding processors and software to provide wind shear alerts at airports not scheduled to receive the Terminal Doppler Weather Radar (TDWR).

A Phase II demonstration evaluation took place in 1996. The operational requirements were validated and a full-scale development contract awarded in FY97. The first upgrade is anticipated to go into service sometime in the next several years, with all installations planned to be completed by early FY03.

In February 1998, Northrop Grumman was selected to compete for the low-rate initial production (LRIP) phase of the program planned for mid-1998. In September 1998, the FAA awarded Northrop Grumman a US$49 million award for the development and production of the Airport Surveillance Radar/Weather Systems Processor (ASR/ WSP). Once the initial five developmental/test systems were completed, up to 37 units (34 operational, 3 support systems) were expected to be produced. The original contract was awarded in September 1998.

The ASR/WSP integrates new software algorithms into a core commercial processor and implements a new digital RF receiver system. The systems are intended for sites that experience significant windshear and microburst activity, but do not have other detection systems installed.

In March 2000, the ASR/WSP contract was modified to exercise an option to complete the design and initiate production on 33 production systems. The first was scheduled for September 2000.

<u>Transportable ASR-9</u>. The FAA modified the ASR-9 contract to provide for a transportable version of the radar.

<u>Growth and Decay Tracker</u>. The Massachusetts Institute of Technology developed Growth and Decay Tracker software which uses Doppler radar data to project storm line movement. The software analyzes data in order to determine and predict movement. Demonstrations at the Dallas-Ft. Worth airport showed that the new system can predict short-term (10 min to 2 hr) storm front movement and position. Initial attention is on perfecting 30-minute projections, later expanding to 60 and eventually 120 minutes. The system appears to be particularly effective with lines of thunderstorms, but is not as effective predicting air mass storms.

Although the DFW NEXRAD was used for the March 1998 Terminal Convective Weather Forecast Demonstration, plans are to incorporate TDWR and ASR-9 as well. More accurate predictions from this system will be particularly helpful in making decisions regarding gate closures and runway changes, for example. Making changes too early or too late can be expensive and create unnecessary delays in traffic flow.

If successful, the Growth Decay and Tracker will be added as a preplanned product improvement to the Integrated Terminal Weather System (ITWS) being developed for the FAA.

Program Review

Background. With the advent of the National Airspace System Plan (renamed the Capital Investment Plan [CIP]) in the early 1980s, planners determined that the radars in service at high-traffic facilities needed to be improved. Maintenance and repair of the ASR-4/5/6 radars were a problem. The FAA anticipated the situation becoming critical by 1989. The older radars were limited in the weather information they could provide. Although they could provide controllers with basic indications of where poor weather conditions existed, they could not provide information on intensity. Additionally, aircraft flying in weather clutter would not always be displayed.

Planners decided to replace 96 of the vacuum-tube ASR-4/5/6 radars. Sixteen existing solid-state ASR-7 and 40 ASR-8 radars would be relocated to ASR-4/5/6 sites and replaced by a new solid-state radar, the ASR-9. This process was called “leapfrogging.” Radar service would be established at airports with sufficient volume of traffic to warrant acquiring the new radar.

A US$372 million initial contract for 101 ASR-9 radars was awarded in September 1983. Eight additional radars were separately funded by the DoD. Development and delivery delays were experienced due to hardware and software problems. The first ASR-9 was commissioned at Huntsville, Alabama, in May 1989 - two-and-a-half years behind the original contract schedule. Engineers reported solving the problems. By June 1989, five radars had been delivered, and the rest were shipped at a rate of three per month through the rest of the contract period.

In October 1989, the GAO issued a report criticizing the FAA for not making full use of the improved weather information available from the ASR-9 and other state-of-the-art weather detection systems. FAA controllers noted that the capabilities of the radar so exceeded what they were used to working with that they had not established plans for effective dissemination of the information to pilots.

International marketing of the system has been successful. When the USSR dissolved and Eastern Europe began to form independent states, (then) Westinghouse formed a partnership with RADWAR of Poland. This successfully moved the ASR-9 into the international arena with a 1990 contract to provide an Airspace Management System (AMS-2000) and ASR-9 for the Warsaw airport. Commissioning took place in spring 1993.

Taiwan selected the ASR-9 as part of its complete national airspace management upgrade. Other successful marketing efforts put a radar in Morocco.

In early 1993, India awarded a contract for four ASR-9 radars. Tunisia ordered one of the surveillance radars in February 1993, with Panama procuring one of the systems in the same time frame. All of these customers are actively upgrading their air traffic control systems.

In June, Belgium ordered an ASR-9 for the Brussels airport. This was the first ASR-9 ordered in support of the Western European ATC system being developed by EUROCONTROL under European Union sponsorship. Operational status was planned for mid-1994.

In late 1993, Panama ordered an ASR-9 with ancillary systems, claiming to be a pioneer in Latin American air traffic control. A second radar arrived in November. The system was scheduled to be operational in August 1994.

In April 1995, Westinghouse won a contract to provide an ASR-9 ATC radar co-mounted with a Monopulse Secondary Surveillance Radar (MSSR) for the new Long Dong Bao airport under construction in Guiyang, China. The system was to be installed and operational by mid-1996. In early 1996, there were complaints about China's "bargain hunting" approach to upgrading its air traffic control system. Planners revealed that the company would probably lose money on the showcase project and that ATC chaos could ensue if the upgrade efforts continued they way they were going.

In October 1995, the company installed an ASR-9 at the Ezeiza International Airport in Buenos Aires. Company reports indicated that the radar was shipped and brought to full operational status in only eight weeks.

In February 1996, the TDWR, ASR-9 and ASDE-3 radars were dedicated at Atlanta's Hartsfield International Airport; it became the fifth US airport to have completely new ground, air, and weather radar systems installed as a complete package. The improvements were made to help the airport cope with the heavy air traffic expected during the 1996 Olympics.

In 1996, the FAA delivered ASR-9 systems at Columbia, Missouri; Roswell, New Mexico; Ft. Hood, Texas; and Fayetteville, North Carolina. Radars were commissioned for Sarasota, Florida; Charleston, South Carolina; Jacksonville, Florida; Albany, New York; Charlottesville, Virginia; Dallas-Ft. Worth #4, Texas; Ft. Hood, Texas; and Gainesville, Florida.

In 1996, the FAA also awarded a contract for the ASR-11 Digital Surveillance Radar. This system was to replace most of the older ASR-7s and ASR-8s, as well as many military terminal sensors. It combines an ASR-10 solid-state-radar and Monopulse Secondary Surveillance Radar.

In October 1997, the FAA awarded Northrop Grumman ESSD a US$4.2 million contract to produce 134 modification kits for existing radars. Called 9-PAC (Processor Augmentation Card), each kit enhances the performance and capacity of existing radars. The upgrade incorporates new hardware and software to increase the sensor's processing power. It improves the ASR-9's performance by reducing false target reflections, and improves target detection by the operator. It also extends the useful life of the system.

The contract produced 432 processor boards and the last upgrade was completed in January 1999, three months ahead of schedule.

The FAA selected Northrop Grumman to compete for the low-rate initial production (LRIP) phase of the Airport Surveillance Radar/Weather Systems Processor (ASR/ WSP) program. The new system will improve the weather detecting capabilities of the ASR-9, and make it possible to display aircraft and weather simultaneously. This will help traffic controllers guide aircraft through weather and approach/departure traffic.

This selection qualified Northrop Grumman to compete for the expected mid-1998, four-unit LRIP phase of the effort. The LRIP systems were to be installed by mid-1999. Production was planned for late 2001 through early 2003. The contract, valued at US$48 million, was awarded in late 1998. Once an initial five ASR/WSP systems had been completed for testing, up to 37 units were expected to be produced.

This addition makes it possible for controllers to pinpoint the location of possible wind shear events without a separate, stand-alone TDWR radar. Forty sites have been identified for the upgrade.

In March 1998, Tunisia officially declared the new NG Airspace Management System fully operational. The effort included an ASR-9 and MSSR at the Tunis-Carthage airport and a stand-alone MSSR at Sidi Zid.

In FY00, Congress added US$4 million to the Department of Transportation budget request recommending that the FAA evaluate the benefits of siting ASR-9 systems at the Eagle County Regional Airport, Colorado; Mid-Delta Regional Airport, Greenville, Mississippi; and Bethel, Alaska.

On April 22, 2000, the antenna on the ASR-9 at the Boston Logan International Airport was severely damaged when winds twisted the 36' x 17' sail off its mount. Officials were uncertain whether metal fatigue or an intense, localized wind event had caused the failure. The antenna has been tested to withstand 85 knot winds. Microbursts had been reported in the area.

The FAA flew a replacement antenna to Boston and the system was returned to service on April 24. As a result of the problem, the FAA began a series of evaluations of the performance of the ASR-9 using an ASR-8 antenna. The agency is short of ASR-9 replacement antennas, but has a supply of ASR-8 parts on hand. The findings would help determine a repair approach should antenna failures occur in the future. The Boston incident represented the first ASR-9 to experience such a failure.

In July 2000, the Moroccan Office National des Aeroports commissioned its turnkey ATC system at the Mohamed V International Airport. In the Moroccan system configuration, the ASR-9 is co-mounted with an MSSR secondary surveillance radar (at the Casablanca site), and three MSSRs at Ifrane, Safi, and Agadir. En route automation, display and communications, along with civil works and support, were included in the contract.

The Department of Transportation appropriations bill for FY2001 added US$6.4 million to the budget request, bringing funding to US$11.122 million. US$4 million was specifically earmarked for a transportable/ shelterized ASR-9 with a co-mounted MSSR for Palm Springs Regional Airport, California. The appropriations committee noted that there was a history of radar coverage problems and that the FAA had failed to put forth to a solution. The radar was considered an interim solution to the problem.

In the FY02 budget, Congress added US$10 million for initiating an ASR-9 SLEP (Service Life Extension Program).

Funding

US FUNDING

	FY00		FY01		FY02		FY03(Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
F&E (FAA)								
ASR-9	-	4.0*	-	11.1*	-	22.8*	-	TBD

NOTE: In the FY00 budget, Congress added funds to evaluate the benefits of siting ASR-9 systems at several regional airports. Congress added US$6.4 million for a transportable system for Palm Springs Regional Airport, California, in FY01. In FY02, Congress added US$10 million to begin a SLEP effort.

All US$ are in millions.

Recent Contracts

No recent contracts over US$5 million have been recorded.

Timetable

Month	Year	Major Development
Sep	1983	Contract award
	1985	Deliveries planned to begin
May	1989	First radar commissioned
	1990	Poland procurement contracted
Jun	1992	IOC of Polish system
	1993	India, Tunisia, Panama contract awards announced
Jun	1993	Belgium orders ASR-9 for Brussels
early	1993	Commissioned in Warsaw, Poland

Month	**Year**	**Major Development**
late	1993	Panama orders systems
Mar	1994	Last of the 134 US systems at the factory
	1995	Weather Systems Processor concept tested at Albuquerque, NM
Apr	1995	China orders ASR-9 for Long Dong Bao airport
Oct	1995	Radar installed in Buenos Aires
	1996	RFP for Weather Systems Processor
4Q	FY98	Last Operational Readiness Demonstration (ORD) F&E program ends
late	FY98	Weather Systems Processor (ASR/WSP) LRIP contract awarded
Dec	1998	Last 9-PAC cards delivered
Jan	1999	Last 9-PAC upgrade completed
3Q	1999	ASR/WSP LRIP installations (five units) completed, last ASR-9 relocation/ORD completed
Mar	2000	Contract modification to initiate production of ASR/WSP for 33 systems
Apr	2000	Weather damages Boston's Logan International Airport radar
Sep	2000	First production ASR/WSP delivery
4Q	FY01	ASR-WSP 1st ORD
1Q	FY02	ASR-WSP last ORD

Worldwide Distribution

In addition to the **United States**, the ASR-9 air traffic control systems have been procured by or are in use in **Aruba**, **Belgium**, **Botswana**, **Buenos Aires**, **India**, **Morocco**, **Panama**, **Poland**, **Taiwan**, **Tunisia** and **People's Republic of China**.

Forecast Rationale

The ASR-9 was a significant improvement over the old terminal radars in service. The 31 ASR-7s are beyond their useful life, and the 64 ASR-8s are more than 20 years old. The performance and maintenance improvements were noteworthy, although there were some early transmitter problems. The ability to accurately provide more detailed weather information to air traffic controllers was the single most important contribution this radar made to air safety. It gave air traffic controllers a tool to cope with a major hazard to air travel: the lack of discrete, localized information on dangerous weather conditions. This was especially important at airports that did not have the new weather radars, TDWR or NEXRAD. The ASR/WSP will improve this capability even further.

The terminal radar's operational performance and maintenance improvements set the standard for terminal radar performance. The follow-on ASR-12 is essentially an updated ASR-9 with a solid-state transmitter.

US deliveries and installations are complete, although upgrades and enhancements will continue. Selection of the ASR-11 system to replace older ASR7/8 systems eliminated the ASR-9 from that market. This selection was primarily driven by the technology designed into the new radars, not deficiencies in the ASR-9. Northrop Grumman switched production to the ASR-12, a basic ASR-9 with a new solid-state transmitter. Thomson-CSF (now Thales) established a firm foothold in the European and Asian markets, and although the ASR-9/12 is very capable, cost and previous history will close some markets to it.

The events of 9/11 renewed the FAA's and DoD's interest in raw radar data from the nation's radar system. There is an increased interest in making sure that all radars have an effective raw video track capability, and any plans to replace a primary radar with a secondary radar only may be scrapped or significantly modified. Money for aviation security will hit many of the FAA's efforts, but this is one that should be funded if a request is made. Being able to track a noncooperative aircraft has taken on a new importance.

Ten-Year Outlook

No further production expected.

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