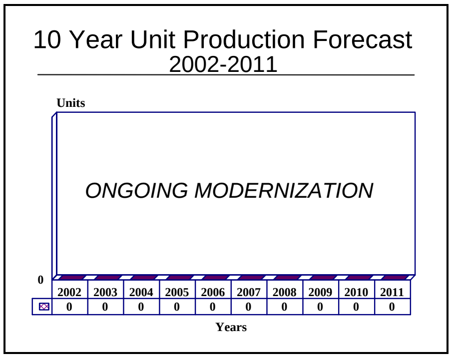
ARSR-4 (FPS-130) - Archived 08/2003

Outlook

- Production/installation complete
- On-going support and upgrades continue
- Integrated into ATC system, supports USAF air-defense system
- September 11 attacks generated renewed interest in ATC/defense radars


10 Year Unit Production Forecast
2002-2011

Orientation

Description. The ARSR-4 is a long-range, 3D, dual-use, fixed-site radar. The military version has the nomenclature FPS-130(V).

Sponsor

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Tel: +1 202 267 3484
Web site: http://www.faa.gov
(lead agency, FARR joint program office)

US Air Force
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Web site: http://www.wpafb.af.mil
(USAF program management, JSS Regional Operations Control Centers)

Contractors

Northrop Grumman Corp
Electronic Sensors & Systems Division
PO Box 17319
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Web site: http://www.northropgrumman.com

Status. Ongoing modernization and logistics support.

Total Produced. A total of 44 ARSR-4s have been produced, and three FPS-130(V) systems procured by Thailand.

Application. Surveillance radars used jointly by the FAA for en route air traffic control and the USAF for air defense. The FPS-130(V) is used for military airspace surveillance and management.

Price Range. Approximately US$6.5 million. Total program cost put at US$800 million, half of which was paid by the DoD.

Technical Data

	Metric	**US**
Characteristics		
Frequency	1,215 to 1,400 MHz (diplex)	
Waveform	NLFM 150 µsec pulse	

	Metric	**US**
	90 and 60 µsec subpulses	
Characteristics (continued)		
Peak Power	65 kW	
Avg Power	3.5 kW	
Range (1m^2 target)	463 km	250 nm
Accuracy	116 m	1/16 nm
Resolution	323 m	1/8 nm
Azimuth	360º	
Azimuth Sidelobes	>-35 dB near >-45 dB far	
Accuracy	0.176º	
Resolution	1.5º	
Height	30,480 m	100,000 ft
Elevation Beams	9 simultaneous up to 30E	
Accuracy	914 m	3,000 ft
Elevation	-7º to 30º	
MTBF	1,500 hr (@122EF, 50EC)	
Availability	0.99742	
Fault Detected	98%	
Fault Isolated		
To 1 LRU	85%	
To 3 or fewer LRUs	95%	
To 8 or fewer LRUs	99.9%	
Scheduled Site Visits	10/yr	
Antenna rotation Interrupt	1/yr	
Preventive Maintenance	24 hr/yr	
IFF (Mode S compatible)	Mode 4	
Military Features	Pulse-to-pulse frequency agility Mode IV IFF Jamming Analysis and Transmit Select (JATS) Blanking Polarization diversity Stealth target detection Low sidelobes Pulse coding Jam strobe processing Sensitive over clutter at speeds from 20 to 3,000 kt	
Detect 0.1 m Target	92 nm against Sea State 5 clutter	

Design Features. The coherent 3D ARSR-4 radar combines high performance with good maintainability The solid-state system was specifically designed for unattended operation and includes remote monitoring as well as fault detection and analysis capabilities. It was designed to meet both FAA air traffic control and military search and tracking needs. Design objectives included provision of superior detection over clutter, high equipment availability, and excellent resolution. A look-down beam and low cross-section detection capability make it possible to detect small, low-flying targets.

While the modular digital extractor and tracker have the capacity to process 800 aircraft and 200 non-aircraft reports per scan, there is a 50-percent reserve capacity, and even this can be expanded. The solid-state transmitter is located below the rotary joint, so repairs can be executed while the radar continues to operate. A secondary surveillance radar is fully integrated and is compatible with the Air Traffic Control Radar Beacon System (ATCRBS), Identification Friend or Foe (IFF), and Mode S.

Solid-state technology and a modular architecture that permits graceful degradation upon failure contribute to high system availability. The radar can operate unattended. Total system downtime for preventive maintenance is 24 hours per year, with the antenna planned for shutdown only once per year.

Operational Characteristics. Circular polarization techniques are employed to reduce false target reports from weather and ground clutter, bird migration clutter, and active jammers. This is especially useful for detecting aircraft in bad weather. A wideband antenna with multiple and selectable receive beams (dual stacks of elevation beams) aid reducing false targets. An array-fed aperture supplies azimuth sidelobes below -35 decibels, and Doppler processing (eight pulse-Doppler filters) is used to suppress clutter out to 400 kilometers (216 nm). Other important features are pulse compression and a unique constant false alarm reporting design.

The look-down beam and low radar cross-section target-detection capabilities are very effective at detecting hostile intruders and drug smuggling aircraft. USAF and US Navy needs are well accommodated by electronic countermeasures (ECM), height detection, and Mode 4 IFF processing features.

The radar was designed to detect a 1-meter-square object out to 250 nautical miles, a 50-nautical-mile increase over previous long-range radars. The target can even be detected during severe weather conditions, including heavy ground and sea interference, or bird migrations. ARSR-4 increased weather processing from two to six levels.

ARSR-4

Source: Northrop Grumman

Variants/Upgrades

FPS-130(V). The militarized version of the radar. The Omnibus Budget Reconciliation Act of 1993 required that 235 MHz of the government's frequency spectrum be transferred to the private sector. The reallocation of the 1,390 MHz to 1,400 MHz band in January 1999 impacted many long-range radars, including the ARSR-4. The radar had to be re-engineered to operate in the reduced spectrum. The FAA has estimated that this could cost over US$565 million to complete.

Program Review

Background. USAF uses the ARSR-4 for air sovereignty and air-defense applications. The radar is particularly valuable to the military since it can produce range, azimuth, and height information with only one radar (the old Joint Surveillance System (JSS) used a separate radar for altitude information).

The altitude data from the radar are not accurate enough for FAA air-traffic control (ATC) applications. Instead, the FAA uses data obtained from Mode C transponders for aircraft altitude information.

Two basic types of ground-based surveillance radar are currently used for US air surveillance: *primary radar,* which relies on reflected energy from targets illuminated by ground radar beams; and *secondary surveillance radar (SSR),* which relies on energy that is transmitted by radar beacons aboard the aircraft in response to ground radar interrogations. These radar beacons include the ATCRBS (Air Traffic Control Radar Beacon System) and the Mode S beacon system that is replacing it. Beacon responses can include encoded information that automatically transmit aircraft pressure altitude. A variety of other types of data transfer via beacon are being evaluated.

The FAA counts on aircraft cooperation in accomplishing its mission, while the Air Force must anticipate stealth, deception, and active countermeasures. There is enough overlap in the two missions, however, to achieve substantial savings by using joint primary radars.

The FAA divides its surveillance mission into terminal and en route segments. These functions are being consolidated into ACFs (area control facilities), supported by a real-time, interactive Advanced Automation System (AAS).

When the National Airspace System Plan was promulgated in December 1981, the ARSR network was made up of radars from many technical generations - mostly maintenance-intensive tube types. Only ARSR-3s were entirely solid state. There was a need to replace a generation of obsolete equipment with a system offering improved coverage, accuracy, reliability, and clutter penetration.

The FAA conducted a coordinated, three-element effort to improve the en route radar network. The first element extended the life of obsolete equipment, replacing selected portions of 76 vacuum-tube radars still in service with solid-state hardware, and repairing and refurbishing other portions. The second element, performed jointly with the Air Force, entailed procuring 44 new ARSR-4 radars (including one for field support and training) to replace all of the old JSS Air Force (FPS-20/60) and FAA (ARSR-1/2) radars. The third element leapfrogged 10 ARSR-3 radars from JSS sites to replace older equipment at other locations, added Remote Maintenance Monitoring (RMM) at all ARSR-3 facilities, and relocated other long-range radars (LRR) as required.

The ARSR-4 Request for Proposals (RFP) announced in July 1987 called for production of 34 systems, with options for an additional 18. The companies submitting proposals were General Electric, Raytheon/Marconi, and Westinghouse.

The ARSR-4 contract was awarded in July 1988, and the first delivery was made in early 1993, following integration and testing. The ARSR-4 negotiated contract was for 40 systems with options for 12 more. In 1991, the US Navy picked up the option for two systems. The basic program was later expanded to 44 radars, including one for field support and training, and was reportedly valued at US$700 million.

In April 1996, the FAA officially commissioned the first ARSR-4 radar at Tamiami, Florida. It replaced an ARSR-1 at Richmond, Florida, which had been destroyed by Hurricane Andrew. Because of delays in completing factory/field tests and completing repair actions, the commissioning took place 15 months behind schedule. In December 1997, Typhoon Paka severely damaged the Guam radar.

Below are the known locations of ARSR-4 radars:

Ajo, Arizona (AZ)
Buck’s Harbor, Maine (ME)
Crescent City, California (CA)
Cross City, Florida (FL)
El Paso, Texas (TX)
Ellington, Texas (TX)
Empire, Michigan (MI)
Finley, North Dakota (ND)
Fort Fisher, North Carolina (NC)
Fort Lonesome, Florida (FL)
Gibbsboro, New Jersey (NJ)
Guam
Guantanamo Bay, Cuba
Jedburg, South Carolina (SC)
Lake Charles, Louisiana (LA)
Lakeside, Montana (MT)
Makah, Washington (WA)
Malmstorm AFB, Montana (MT)
Mica Peak, Washington (WA)
Mill Valley, California (CA)
Mount Kaala, Hawaii (HI)
Mount Laguna, California (CA)
Mount Santa Rosa, Guam
Naswauk, Minnesota (MN)
North Truro, Massachusetts (MA)
Oceana, Virginia (VA)
Odessa, Texas (TX)
Oilton, Texas (TX)
Oklahoma City, Oklahoma (OK)
  (training system)
Paso Robles, California (CA)
Patrick AFB, Florida (FL)
Richmond, Florida (FL)
Riverhead (LI), New York (NY)
Salem, Oregon (OR)
San Clemente, California (CA)
Silver City, New Mexico (NM)
Slidell, Louisiana (LA)
Sonora, Texas (TX)
Tamiami, Florida (FL)
Tyndall AFB, Florida (FL)
Utica, New York (NY)
Watford City, North Dakota (ND)
Whitehouse, Georgia (GA)

The last of the 44 ARSR-4 radars, that at Ajo, Arizona, was formally accepted by the FAA and Air Force in July 1999. This was two months ahead of schedule, with the radar being delivered early and stored while planners overcame site preparation delays. Work continued in order to re-establish the operational capability of the Guam site. The FAA considered the deployment of the ARSR-4 complete in May 2000, as the last installation was completed.

Funding for the modernization of the system was provided under PE#0102325F, Joint Surveillance System, Project 2996 FAA/AF Radar Replacement (FAAR). The Joint Surveillance System (JSS) provided command, control, and communications (C^3) capability in support of CINC NORAD's (North American Aerospace Defense) Atmospheric Tactical Warning and Attack Assessment (ATW/AA) air sovereignty and air-defense requirements. The JSS Connectivity (JSS-C) program improved this capability by integrating new sensor data and enhancing communications capabilities via a advanced interface control unit (AICU). It complemented the FAA/Air Force Radar Replacement (FARR) program.

The Region and Sector Air Operations Center (R/SAOC) modernization program upgraded the C^4I system with enhanced data-integration capabilities. The system can now integrate data from civil and military defense surveillance systems into a comprehensive recognized air picture. This enhances CINC NORAD's capability to conduct peacetime air sovereignty, and would aid in conventional warfare in the event of aggression toward the North American Continent.

In October 1994, the Royal Thai Air Force announced plans to contract for a system to extend the country's early-warning and air-defense capabilities deep into the Gulf of Thailand, the Andaman Sea, and the Strait of Malacca. The program, titled Royal Thai Air Defense System Phase III (RTADS III) and valued at approximately US$200 million, was to include three W-2100 radar (FPS-130(V)) and integrated command and control stations for early warning, air superiority, and SAM fire-control operations. The first site was declared operational ahead of schedule in January 1999.

In July 1999, the US Navy announced plans to negotiate on a sole-source basis with Arcata Associates Inc, North Las Vegas, Nevada, for a radar video compression system (RVCS). The requirement was for a firm fixed-price contract for an RVCS, including options for four more. This system consists of the transmitter and receiver required to process and transmit raw search radar data over a single DS1 (T1) circuit from a remote radar site. The data at the receive end are processed and sent to the Plan Position Indicators (PPI). The video available at the PPI must be real time, replicating the video available at the remote site. Raw radar data to be processed include normal video, moving target indicator (MTI), azimuth change pulses (ACP), azimuth reference pulses (ARP), radar trigger, radar pre-trigger IFF mode, IFF video, and IFF pre-trigger.

The RVCS system would have to be compatible with the ARSR-4 and SPS-67(V) radars. Each unit, transmitter, and receiver must be able to be mounted in a standard 19-inch cabinet and operate on 120 VAC, single-phase power. Turnkey installation is required for sites in Jacksonville, Florida; San Clemente, California; and Pearl Harbor, Hawaii. Service-ready replacement module kits are required.

In FY00, the FAA planned to remove surplus radar equipment and existing towers that could restrict coverage at new ARSR-4 sites.

The FAA *National Airspace System Capital Investment Plan Fiscal Years 2002-2006* said that the plan was to begin developing a General-Purpose Interface Bus (GPIB) and ARSR-4/Mode 4 interface. This was planned for completion in FY03/04.

In a June 18, 2002, *Federal Business Opportunities*, the FAA AMQ-210 Aeronautical Center (AMQ) announced that it intended to purchase 1,100 LOW noise Amplifiers (LNAs), the first stage of the amplification to the ARSR-4. The LNA assembly is used on each of the 23 azimuth assemblies for the receive target paths, and in the receive weather and receive reference paths to provide gain to the receive signals. Among the technical requirements, the units must operate within specified limits over the frequency range of 1250 to 1400 MHz and have a gain of 23 decibels, with a deviation no greater than 0.5 decibels. They must have a minimum MTBF of 20,000 hours. Responses were due by June 18, 2002.

Funding

Ongoing funding is supplied by Operations & Maintenance accounts.

Recent Contracts

No recent contracts over US$5 million recorded.

Timetable

Month	Year	Major Development
	FY68	Expansion of Long-Range Radar (LRR) coverage proposed
	FY82	National Airspace System Plan published
	FY86	ARSR-4 draft RFP issued
Jul	1987	ARSR-4 RFP issued
Jul	1988	ARSR-4 production contract awarded to Westinghouse
	1988	ARSR-4 first site implementation
	1989	Westinghouse announces W-2100 variant of ARSR-4
	1991	Two systems optioned by the Navy
	1992	System integration and testing scheduled to be completed
May	1993	First production system delivered to Mount Laguna, California
Oct	1993	Software qualification testing initiated
Jan	1994	Field DT&E at Mount Laguna completed
Apr	1994	OT&E at Mount Laguna begun
Jun	1994	DT&E completed
Jul	1994	OT&E at Mount Laguna completed
Dec	1994	FAA/USAF final acceptance of Mount Laguna first site implementation
4Q	FY94	DT&E (USAF)
1Q	FY95	OT&E (USAF)
3Q	FY95	First Operational Readiness Demonstration (ORD) (USAF)
Apr	1996	First ARSR-4 commissioned
1Q	FY96	Final acceptance of systems 21-26 (USAF)
2Q	FY96	Final acceptance of systems 27-33
3Q	FY96	Final acceptance of systems 34-40
4Q	FY96	Final acceptance of systems 41-42
3Q	FY97	FAA last ORD
1Q	FY98	USAF begins FARR follow-on support, including baselining/commissioning before FAA final acceptance
Jan	1999	Thailand declared first FPS-130 operational
Jul	1999	Last ARSR-4 installation and checkout completed (Ajo, AZ); system accepted
4Q	FY99	Old radar removals based on ARSR-4 installations completed, USAF ends FARR follow-on support
May	2000	FAA deployment considered complete
	2000	Surplus radars/towers interfering with ARSR-4 coverage removed
	FY01	ARSR-4/Mode 4 interface begun
	2003/04	ARSR-4/Mode 4 interface delivered
1Q	FY03	LRR sustainment; primary radar to be deactivated at some locations
4Q	FY05	LRR deactivations to be completed

Worldwide Distribution

Thailand contracted for three FPS-130(V) radars for the RTADS III program.

A radar was installed in **Guam**.

Forecast Rationale

The ARSR-4 was an important upgrade to the vital en route radar surveillance network. From the time that the 1950s-vintage radars were built, planners took advantage of technology advances, especially in processing and data communications capabilities. Most of the radars are located around the perimeter of the US and support en route navigation, air-defense and drug-interdiction operations.

Military operations need a three-dimensional radar so the USAF can track uncooperative targets. The integral height-finding capability of these radars does not benefit the FAA, however, because it relies on the more accurate Mode C transponders for precise altitude information.

The basic performance envelope of the ARSR-4s is not much larger than its predecessor, the ARSR-3; but reliability, performance, and maintainability were improved significantly.

The FAA is continuing to develop a non-radar approach to navigation and air-traffic control. It is testing and validating the equipment and procedures needed to move from ground-based air-traffic control to satellite-based, collaborative air-traffic management. Pilots will be able to choose their own routes, reducing fuel costs.

This system will not replace radars, though. There is a continuing need to be able to monitor air traffic and react to emergency situations. Radars remain the only way to monitor aircraft that do not carry transponders or whose transponders have failed.

The events of September 11th called attention to the need to skin-paint and track aircraft that have shut of their transponders for hostile purposes. This will have an impact on plans to shut down some older radars and convert to IFF-only tracking in some areas, and will create a need to increase the ability of the Department of Defense and the newly-created Northern Command (USNORTHCOM) to monitor air traffic and control interceptors. One of the major revelations of the terrorist hijackers attacks on New York and Washington was that the defense early warning system was focused outward and unable to effectively follow the flights of hijacked airliners flying in the nation's internal airspace. Better interfaces with ATC systems has been a priority; but planners will be looking at the overall system to see if further improvements are needed.

There is significant international interest in international air-route development/upgrade projects. The ARSR-4 is proving too sophisticated and expensive for many potential users. Ultra-high reliability and 3D capability comes at a price.

Given the nature of the budding ATC environment for many users, new terminal radars are considered more necessary, while in some instances the long range of the ARSR-4 is not. Their lower cost and direct tie to air-traffic management systems developed by the same companies make it possible for nations to maximize what they can get for a limited budget, and there are other, less expensive competitors available.

Because of the maturity of the product, the increasing competition that is developing from foreign manufacturers, and the challenge that is being presented by alternate GPS technology, we are not forecasting any additional sales at this time. Efforts to upgrade and enhance the radars will continue, especially in the processing arena.

Ten-Year Outlook

No production expected. System upgrades continue.

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