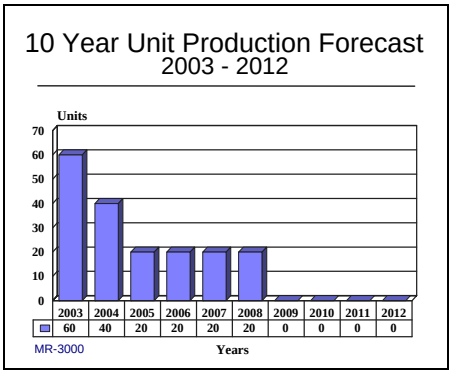
MR-3000 - Archived 10/2004

Outlook

- In production, with ongoing logistics support
- FAA Supplemental Type Certification received
- APN-241(V) military version is being installed in new-production C-130s, including the C-130J, and under the C-130 Avionics Modernization Program



Orientation

Description. Airborne navigation/weather radar.

Sponsor. Company-sponsored.

Contractors

Northrop Grumman Corp
Electronic Systems Sector
PO Box 17319
Baltimore, Maryland (MD) 21203-7319
USA
Tel: +1 410 765 1000
Fax: +1 410 993 8771
Web site: http://www.northropgrumman.com
(Prime)

Status. In production, ongoing support developing.

Total Produced. Through 2002, an estimated 289 units had been produced.

Application. Commercial transport aircraft.

Price Range. Unit cost ranges from US$190,000 to US$210,000.

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

	Metric	U.S.
Dimensions		
Weight		
RTP	16.3 kg	36 lb
Color Indicator	6.4 kg	14 lb
Antenna	10.9 kg	24.1 lb
Antenna		
35.5 dB	76 cm	30 in
33 dB	61 cm	24 in
Characteristics		
Frequency	9.345 to 9.375 GHz	
Power	138 W (peak)	

Pulse Width	0.05 to 32µsec
PRF	211, 482, 958, and 1,900 pps

Characteristics (continued)

Range	
Turbulence Detection	50 nm
Windshear	10 nm
Warnings	Aural Visual
Form Factor	ARINC 708,8 MCU
MTBF	>5,000 hr
System Interfaces	Self-Contained Navigation System LTN-92 INS LTN-72 INS TCAS Radar Altimeter ARINC 429 RS170
Common Modules	Transmitter Receiver Exciter/Reference Source General-Purpose Processor Digital Signal Processor Processor Synchronizer Exciter-Upconverter

Design Features. One of a family of modular radars, the design capitalized on the APG-66/68(V) fire-control radar design to create a multifunction weather/ navigation radar that would be a lightweight, low-power unit having growth potential.

The Modular Radar (MODAR) MR-3000 was developed to meet the specific needs of commercial air transports and compete with radars such as the RDR-4B and WXR-700X. Pulse Doppler technology detects wet microbursts, a prime indicator of dangerous windshear. The system features a "weather-through-weather" detection scheme and provides long-range weather hazard awareness.

The architecture is flexible and expandable, with a common set of electronic modules supporting the system's basic functions, and with specialized features added. The common modules make high-volume production and economies of scale possible, simplifying logistics support. Unique modules provide space for additional modes, interfaces, and processing. The antenna, controls, and displays are form, fit, and function replacements for existing systems.

A Westinghouse-patented, full-spectrum pulse-Doppler processing technique has been developed, making windshear detection possible and improving general weather detection significantly. The radar's advanced modular design meets all ARINC 708 specifications.

The MR-3000 has a 670-nautical-mile (242.1 dB) ARINC weather avoidance performance index. This index provides turbulence detection up to 50 nautical miles and weather echo compensation. The MR-3000 employs "two-beam" windshear detection and uses advanced processing algorithms. The system map processes analyze outflow headwinds and tailwinds as well as microburst cores and downdrafts, providing accurate hazard projection along the flight path.

Forward-looking windshear detection is provided at up to 10 nautical miles with a 99.6 percent probability of detection. The system has a 10^{-5}/flight-hour probability of missed detection and $<4X1^{-4}$/flight-hour probability of nuisance alert. False alert probability (clutter) is $<10^{-4}$/flight-hour. Fast Fourier Transforms and powerful processing keep clutter below the system noise level.

Maintenance is facilitated by automatic Built-In Testing (BIT) and simplified module replacement. Modular growth potential is built into the system.

Operational Characteristics. The MR-3000 provides early, accurate, and reliable information on weather, especially windshear, ahead of an aircraft. It detects rather than predicts windshear and can support head-up and head-down displays for improved situational awareness. Reducing radio frequency mutual interference produces cleaner, more sharply defined displays that are easier to interpret.

The display was developed to provide 175 percent more useable screen area, 25 percent more down-range viewing area, and 36 percent better resolution – and to be 50 percent brighter. The radar compensates for weather echo and maintains correct weather color portrayals at long range and in all weather.

The system gives aircrews up to 90 seconds to make in-flight windshear avoidance corrections. It allows crews to plan safer, more comfortable, and more fuel-efficient flight paths when faced with inclement weather.

Variants/Upgrades

There are no variants as yet. Planners are considering X-band beam sharpening, millimeter-wave radar, infrared, or laser radar (LIDAR) options for future systems.

APN-241(V). This color weather radar features a windshear detection and navigation capability for military transport and tanker aircraft. It is installed on new-production C-130s and the new C-130J. The company is making the system available for upgrading most military tanker/transport aircraft, and a tanker/transport variant is being developed for the Australian Air Force.

APN-241(V) is a strong contender for the USAF C-130 Avionics Modernization Program (AMP). AMP integration and EMD contracts were awarded to McDonnell Douglas on July 30, 2001.

Program Review

Background. A family of modular aviation radars was introduced in 1991, featuring a core set of electronic modules for basic radar functions. Software and hardware add-ons accommodate advanced and specialized capabilities. These radars capitalized on technological developments to increase performance and reliability, provide growth capabilities, and reduce procurement costs.

The commercial airliner and military transport/tanker radars (MR-3000 and APN-241(V)) were made available in 1992. Deliveries of APN-241(V) systems to Lockheed Martin for installation in C-130H aircraft started during the second half of 1993. In mid-1993, Arrow Air, a carrier operating out of Miami International Airport, ordered 20 MR-3000 radars, with an option for 100 additional systems. Installation on DC-8 and B-727 aircraft began in 1994. Arrow Air's sister company, International Air Leases Inc, held an option for 100 systems.

In October 1995, the FAA granted Supplemental Type Certification to the MR-3000. This followed a two-year evaluation. The flight demonstrations were completed in Orlando, Florida, using the company airborne testbed fitted with a Class D Category II radome. Company and FAA pilots encountered two windshear alerts in convective activity. By using a degraded, Class D radome, the tests validated that the radar could be used either as a forward-fit installation or retrofitted to older aircraft without having to replace the radome.

Funding

This was a company-funded development. Procurement will be from aircraft production lines.

Recent Contracts

Since this is a civilian system, few (if any) government contracts will be recorded.

Timetable

Month	Year	Major Development
Jun	1991	Modular Radar family announced
	1992	MR-3000 and MR-4000 systems become available
	1993	First deliveries for Arrow Air
	1994	First DC-8 and B-727 installations
	1993	Certification flight tests begin
Oct	1995	FAA Supplemental Type Certification

Month	Year	Major Development
	2000s	Production continues

Worldwide Distribution

This product is for sale internationally.

Forecast Rationale

Northrop Grumman moved aggressively into the non-fighter airborne radar market, capitalizing on its MODAR (Modular Radar) line with the MR-3000 specifically targeted at civilian applications. The MR-3000 does not include the mapping and beacon capabilities of the APN-241(V) installed on military transports but features other technical characteristics.

Commercial and transport radars have not seen the same growth as fire control and combat systems, but capability advancement was needed. Windshear avoidance is a crucial concern to both the FAA and aircraft operators. A family of cost-competitive systems was developed by capitalizing on developed hardware and software, as well as proven production capacity.

A key to the MR-3000 is its increased performance, especially the improved weather modes, with windshear detection adding a badly needed capability. Microburst and windshear have caused many crashes, so accurate advance warning of the actual existence of windshear significantly improves flight safety.

The MR-3000 competes directly with other commercial windshear detection/weather radars. The MR-3000 had to prove it was competitive with the long-time standard radars produced by Collins and Bendix King. Those systems are well known in the aviation community, whereas Northrop Grumman was associated with the military market. The windshear detection/prediction capability is a major selling point but did not make it unique. Both major competitors have an equivalent capability, so Northrop Grumman's marketing had to spotlight any competitive advantages the system might have.

Although the initial order was significant, fiscal concerns prevent many carriers from retrofitting avionics unless absolutely necessary. When possible, carriers are beginning to purchase new aircraft instead of spending significant funds to renovate older airframes that lack the amenities demanded by customers.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level				Good Confidence Level			Speculative			
Designation	Application	Thru 02	03	04	05	06	07	08	09	10	11	12	Total 03-12
MR-3000 RADAR	VARIOUS (VARIOUS)	289	60	40	20	20	20	20	0	0	0	0	180