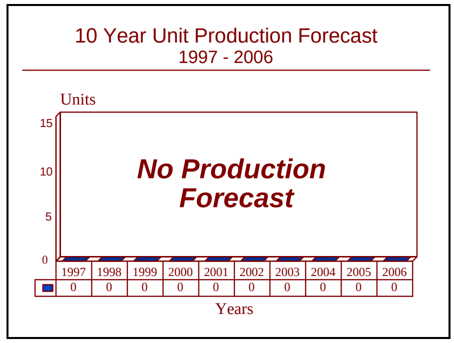
HADR (HR-3000) - Archived 7/98

Outlook

- Likely customers include European NATO allies
- Eastern European countries unlikely to buy
- Used without protective radome in harsh weather conditions



Orientation

Description. 3-D Multi-mode Air Defense Radar.

Sponsor
Private development.

Contractors
Hughes Aircraft Co
Radar & Communications Systems
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[Acquisition by Raytheon in progress.]

Status. In service, in production, ongoing logistics support.

Total Produced. An estimated total of 53 systems have been produced.

Application. HADR was designed for use in national air defense networks, either to fill gaps in an existing system, to augment an existing system's capability, or to replace obsolete equipment.

Price Range. US$8-10 million, depending on configuration.

Technical Data

Dimensions	**Metric**	**US**
Antenna:	4.8 x 6 m	15.7 x 19.7 ft

Characteristics

Frequency:	2 to 4 GHz
Range:	200 nm (1m^2 target)
	310 nm (instrumented)
Antenna Rotation rate:	10 or 12 sec
Altitude coverage:	98,000 ft up to 24^o elevation
Beamwidth:	1.1^o in elevation
	1.7^o in azimuth

Design Features. The HADR (HR-3000) radar provides three-dimensional target information, with azimuth and elevation information developed by beam splitting. Range is measured to a nearest range cell and air defense ground environment (ADGE) system com-puter overloads are reduced by controlling false target reports. A digital mean velocity clutter tracker combines with a single or double delay moving target indication (MTI) canceler to enhance performance in clutter.

The system incorporates a range-gated pulse Doppler waveform and associated processing. Primary or secondary radar target report rates can surpass 400 per scan at the radar output. However, datalink capacity may limit transmission rates to the remote command and control site.

Through computer control of the antenna phase shifters, the HADR antenna scans a pencil beam in the elevation plane. Elevation coverage is achieved by positioning the beam in sequential steps. Complete coverage of the surveillance area is assured because the elevation scan is finished before the antenna moves one beamwidth in azimuth.

In order to optimize management of radar time and energy resources, antenna beamwidth and the transmitted waveform are controlled at each beam position. The beam is steered in elevation by phase scanning and in azimuth by antenna rotation. Therefore, the radar is capable of measuring target range, bearing and altitude with a single antenna.

The secondary surveillance radar (SSR) subsystem includes an IFF interrogator and antenna. There are provisions in the HADR antenna for mounting both the primary IFF antenna and sidelobe blanking IFF antenna as well as routing the RF signals through a rotary joint. Extraction of IFF video and active and passive decoding is accomplished by the beacon video processor which forms part of the multi-function processor.

The beacon video processor provides SSR target report outputs to the radar controller. IFF plot reports and primary radar returns are correlated by the radar controller, which then provides the data as a consolidated output to the command control site.

Operational Characteristics. Tables stored in the computer memory define HADR operational modes. The computer directs the following components for each beam in the search raster:

- Elevation beamwidth
- Peak power
- Waveform
- Instrumented range
- Pulse length
- Plot extraction criteria
- Frequency
- Elevation angle
- Operation changed by software
- Detection criteria

ECM impact is reduced by several techniques. Sophisticated jammers are countered by the coded pulses, frequency agility, multiple pulsewidths, and multiple PRFs. A low sidelobe antenna, pencil beams, high receiver dynamic range, and sharp channel selectivity provide the primary radar with a low vulnerability to jamming. Residual jamming is handled by automatic threshold control, target detection correlation, and sidelobe blanking.

Special modes for use in an ECM environment are burn-through and automatic frequency selection. In the burn-through mode, the radar spotlights a target, either to designate for escort aircraft or to overcome jamming.

The range for single-pulse moving target indication is 60 nautical miles and for two-pulse MTI is 100 nautical miles. Rain or chaff clutter is suppressed by the use of seven-pulse, range-gated pulse Doppler (RGPD) techniques.

At the operator's discretion, the HADR can scan the available operational channels and select the one that has the least interference.

Variants/Upgrades

HR-3000. In 1985, Hughes won the competition to supply NATO with ten long-range, 3-D phased-array radars for air defense protection of its southern borders. The HR-3000 radar is a derivative of HADR.

HR-3000 improvements included increased electronic counter-countermeasures capability, wider receiver bandwidth, improved clutter-rejection waveforms, and a faster antenna rotation speed to meet NATO's requirements for a higher data rate.

The use of a Varian extended-interaction klystron, instead of the more traditional TWT driving a crossed-field amplifier, resulted in a very wide 400 Mhz bandwidth along with a gain of 30dB+. Using a klystron resulted in higher reliability, a lower price, and a more compact configuration; which means that the transmitter needs only a single ISO container.

The new low-maintenance radars feature transportability and easy assembly. The antenna is sealed, eliminating the need for a radome. The HR-3000 is blast-resistant and shielded to protect it from electromagnetic pulse damage.

The radar can be used for air traffic control and has excellent performance characteristics for supporting military missions. Features include the ability to detect oncoming hostile threats from several directions at once, even in bad weather and ECM. Range is more than 470 kilometers (292 miles). The radars will operate on concrete platforms without supporting towers or radomes.

The first HR-3000 systems were delivered in late 1992. According to reports, transmitter reliability problems hindered initial acceptance of the radars. Since fielding, an active spare parts market has continued.

Program Review

Background. The HADR's technology originated with the SPS-52(V) naval radar. The HR-3000 radar was selected to upgrade the NATO southern flank. The contract called for radars for Greece, Italy, Portugal and Turkey. These were to be supplied with two different antenna configurations and transportable.

The primary radar was interfaced with Hazeltine TPX-54(V) secondary surveillance interrogators. The Hazeltine subcontract from Hughes included an order for ten systems, with an option for as many as eight more.

Other HADR customers included the Federal Republic of Germany, Malaysia and Norway. Germany purchased four HADRs, of which two are being used in conjunction with the NATO Air Defense Ground Environment and are known as GEADGE (German ADGE). They replaced outdated FPS-7 radars of the 412L radar network.

Norway procured three HADRs to enhance its air defenses. The HR-3000 was competing against the FPS-117 and the TPS-70 for the Royal Thai Air Defense System, an integrated network of fixed 3D air defense radars. Thailand selected the TPS-70 for the first requirements. Later phase upgrades will use Martello radars.

The Turkish airports administration drew up a requirement for a radar of the HR-3000 class (along with two air traffic control centers) for joint military/civilian use. Hughes was competing with Selenia and Thomson-CSF. Turkey selected the Thomson radar.

Three HADRs were ordered by an unnamed Asian nation.

In 1985, Malaysia began operating a new automated air defense system called MADGE (Malaysian Air Defense Ground Environment). The system featured an HADR and integrated advanced data processing equipment, large screen displays, and new communications systems.

MADGE provides Malaysian Air Force commanders with an accurate second-by-second display of all aircraft in or near Malaysian airspace. Commanders can order fighter interceptors to scramble should aircraft be identified as threats. MADGE forwards target information to a command center where the data are computer-processed and displayed for review. Commanders in the air defense center can directly communicate with air bases to control their forces.

MADGE replaced the S-600 Marconi mobile air defense system commissioned in 1971, although the latter will continue in operation temporarily as a supplement to MADGE.

<u>US Air Force Independent Evaluation</u>. In 1982, the US Air Force 4754th Radar Evaluation Squadron independently tested HADR.. The team carried out all flight planning, data collection, and analysis, emphasizing the measurement of maximum and minimum detection ranges against high-altitude targets, tracking capability in ground clutter and at long range, height-finding precision, and correlation with secondary surveillance radar returns.

During the two-week test against a Cessna Citation (representing a small fighter), HADR performed at least to specifications, if not better. The USAF team concluded that the maximum HADR detection range against typical targets is more than 206 miles, all HADR methods (including coherent processing modes) provided reliable tracking over clutter; HADR probability of determining an accurate height measurement of a target exceeds that of a stand-alone nodding beam height finder radar at near and far ranges, and HADR's ability to determine map position of targets at 150 miles was better than the radar's specified standards.

Funding

No US funding has been recorded.

Recent Contracts

There are no contracts recorded. Orders for support continue.

Timetable

	1979	Development began
Jan	1981	Hughes announced contract for three HADRs to Norway
Oct	1982	First HADR went on-line in Germany, US evaluation
	1984	HADR went on-line in Germany
	1985	First Norwegian HADR operational Malaysian HADR became operational. Hughes won NADGE Southern Flank competition with HR-3000 derivative of HADR

Worldwide Distribution

Germany. Germany purchased four HADRs; two for the NATO Air Defense Ground Environment (NADGE) and are known as GEADGE (German ADGE).

Malaysia. In 1985 Malaysia began operating a new automated air defense system called MADGE (Malaysian Air Defense Ground Environment). The system uses the HADR and integrates advanced data processing equipment, large screen displays, and new communications systems with the radar.

NATO. Ten HR-3000s will make up the update program of NATO's southern flank surveillance capability.

Greece purchased two HR-3000s.

Italy purchased three HR-3000 radars.

Portugal purchased two radars.

Taiwan. The Republic of China procured an unspecified number of HR-3000 systems.

Turkey installed three HR-3000 systems.

Norway. Norway procured three HADRs to enhance its air defense capability. All three are housed in shelters built into mountaintops. The antennas are elevator-mounted so that they can be retracted into environmentally controlled areas to carry out routine maintenance. Norway's first HADR became operational in 1985.

NATO's long-range air space surveillance in the Arctic regions will be enhanced by HADR, since it is designed to operate in the polar region's severe climatic conditions. HADR will be deployed without a protective radome because the antenna has a minimum number of recesses or apertures that could ice up and diminish the radar's effectiveness.

Forecast Rationale

The HADR and the HR-3000 provide NATO and other nations with replacements for hardware designed and built in the 1950s. Its marketing success can be attributed to attempts to standardize hardware used in a coordinated defense network.

Users were motivated to seek tactical, mobile radars instead of changing their fixed networks. Updates to the system can be accomplished by software enhancements to the processing system and interim hardware updates to the radars themselves, usually involving technology insertion.

While evaluating the system for the Royal Thai Air Defense System, the Thai Air Force reported that the severe weather performance of the HADR was less than optimum. This may impact the areas where future purchases are possible, especially in the Pacific Rim region.

Limited information is available on this radar; but the prospects for HADR and its derivative the HR-3000 continue to be good. There is competition from European radar manufacturers, but the Hughes radars are configured so they do not need radomes or enclosures, a popular feature with customers who have to accommodate severe environmental conditions.. The Norwegian radars were deployed without a protective radome, a testament to the radar's survivability.

Although there is a potential market in the former communist nations of Eastern Europe, it is unlikely that a major acquisition for the HADR will develop. These nations, once hard currency becomes available, need to upgrade their air traffic control systems first for economic priorities rather than security improvements. They will probably select other, more appropriate systems for this.

Ten-Year Outlook

No further production is forecast.

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