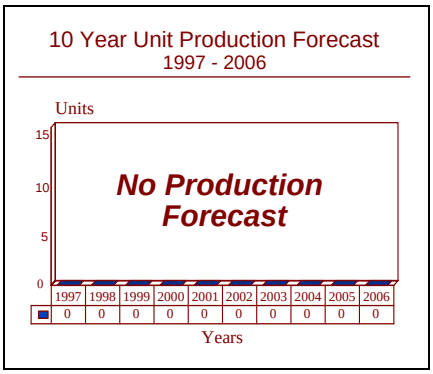
AR-320/325 - Archived 5/98

Outlook

- Approximately 40 systems produced
- No further production of these units is expected
- Trend away from E/F-band mode of operation, to D-band



Orientation

Description. The family of radars based on the AR- 320 and AR-325 are advanced E/F-band, long-range air defense 3D radars. The AR-320 is a NATO Class 1 radar.

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Contractors

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Licensee. No production licenses have been granted.

Status. Production and service.

Total Produced. Approximately 40 systems have been produced.

Application. The AR-320 radar was designed specifically as a Class 1 radar for NATO ADGE to provide long-range air surveillance cover in the E/F-band, with fine resolution, high reliability, easy maintenance and system survivability. The system incorporates very sophisticated ECCM capability and is designed to be integrated easily within an overall Air Defense Ground Environment (ADGE) system. The AR-325 is tailored specifically for the non-NATO market. It is configurable for the same missions, but incorporates less advanced ECCM facilities than the AR-320. All configurations are transportable for rapid field deployment.

Price Range. Based on the most recent UK government contract in November 1995, these radars have a unit cost of approximately US$9 million, including installation and ancillary equipment.

Technical Data

Characteristics	Metric	US
AR-3D (planar array)		
Range 1sq m target	400 km	250 miles
Beamwidth	1.5 x 1.5 degrees	
Elevation scan	0-20 degrees	
Mean power	10 kW	
Frequency	E/F-band	
Noise figure	3 dB	
Polarization	Horizontal	
Receiving channels	8	
AR-320		
Mean power	20 kW	
AR-325		
Beamwidth azimuth	1.4 degrees	
Pulse length	0.4 microseconds	
Range 1 sq m target	470 km	300 miles

Design Features. The AR-320 is a NATO Class 1 radar designed to provide target data on the most modern, highly maneuverable aircraft fitted with active and passive ECM equipment. Data is passed to one or more operations centers for surveillance and weapons control. Features include a powerful transmitter, high- gain antenna, narrow 3-D pencil beam and short pulse length. A compatible identification subsystem permits data correlation with the primary radar on all targets, thus giving maximum target visibility. In addition to primary and secondary radar, AR-320 comprises a radar control and display subsystem, jamming environment simulator and communications equipment for voice and digital data traffic.

The AR-320 provides plot, associated plot, identified plot, strobe and clutter video data and associated video outputs in suitable format for user needs. Remote monitoring and control is possible via a narrow band link. Immunity to active and passive jamming is helped by low sidelobes, wide dynamic range signal processing and Constant False Alarm Rate (CFAR). Other features include frequency agility, pulse compression and Doppler processing. Narrow beam provides good inter-jammer visibility, low sidelobe and high-average transmitted power characteristics. These ECCM features lead to good performance in rain, sea and ground clutter. Continuous operation without a radome in severe conditions of wind, ice-loading, temperature and rain is possible. A stand alone air defense system can be obtained by the addition of a control facility at the radar site.

The AR-320 is suitable for fixed or field deployment. The vehicle group consists of:

--An antenna assembly transported on a flatbed trailer or rail car with the antenna folded flat for transportation and raised hydraulically for operation

--A transmitter cabin containing primary and secondary radar transmitters

--A processing and control cabin containing the radar management suite, processing equipment and simulator; transportable diesel/electric generators able to provide the system's power

--A cabin containing workshop and storage facilities, communications equipment and human support services

Configurations can be developed to meet a wide range of air defense requirements. Where environmental conditions require, the vehicle group can be housed under cover with the antenna protected by a rigid radome. In this configuration, the antenna is hoisted into the radome and supported on structural cross members.

With a trained crew, the AR-320 can be dismantled, set up and brought into service again in less than six hours. For the NATO Southern Flank requirement, the AR-320 was proposed with the antenna and associated electronic subsystems fixed in a below-ground shelter or silo. The antenna would have raised and unfolded hydraulically for operational deployment and was to be mounted on an elevator capable of rapid retraction into the silo when necessary. The radar hardware in this configuration was to be arranged in an equipment room in conjunction with associated power supplies, heating and ventilation equipment.

Operational Characteristics. The AR-320 has been designed to supply data on today's most up-to-date,

highly maneuverable planes equipped with active and passive ECM gear. Superior long range detection and accurate, high resolution plot data within each scan period are ensured by the combination of the short effective pulse length, high gain antenna, powerful transmitter and narrow 3-D scanning pencil beam on both transmit and receive. Maximum target visibility is obtained through a compatible identification subsystem which permits information correlation with the primary radar on all targets. Besides the primary and secondary radars, the AR-320 also includes a radar control and display subsystem, a jamming environmental simulator, and communications gear for voice and digital data traffic.

The AR-320 supplies plot, associated plot, identified plot, strobe and clutter data and associated video outputs in appropriate format for the particular user requirements. A narrow band link provides a remote monitoring and control capability.

The radar is resistant to active and passive jamming because of the very low antenna sidelobes in azimuth and elevation, in conjunction with signal processing possessing wide dynamic range and CFAR, frequency agility, pulse compression and Doppler processing. The narrow antenna beam, low sidelobe and high average transmitted power characteristics make for superior inter-jammer visibility. Even in the presence of rain, sea and ground clutter, the aforementioned ECCM features demonstrate excellent performance.

The AR-320 is able to continuously perform without a radome in severe conditions of wind, icing, temperature and rain. The system is proofed against Electro-Magnetic Pulse (EMP) by the careful selection of components.

Variants/Upgrades

AR-3D. This is the original radar upon which the more modern members of the family are based. The AR-3D is a completely mobile air defense radar system which features a primary radar with integrated IFF (SSR). It has advanced signal processing and data processing capability. The system's performance in the presence of active and passive jamming is derived from a number of characteristics including narrow radiated beam, low sidelobes in azimuth and elevation, frequency scanning, pulse compression and advanced primary radar signal processing. These characteristics endow the equipment with a high detection probability in the presence of clutter and ECM, with accurate three dimensional (height, range and bearing) coordinates on all plots.

AR-3D comprises a transmitter/receiver cabin with choice of linear or planar array antenna deployed on a separate trailer. The cabin incorporates primary radar with secondary radar integration. The coherent E/F-band transmitter uses two stages, each employing linear beam pulse microwave tubes. Both tubes are designed for good phase, noise and amplitude performance commensurate with the pulse compression and MTI requirements. Signals received from the antenna are amplified in a wide-band (200 MHz) amplifier. After amplification the signals are separated into channels representing elevation bands of approximately 2 degrees (band-width 20 MHz per channel). The signals are then time-compressed to 0.1 ms and their frequencies measured to enable the fine elevation within each beam to be obtained.

The second cabin, known as the processing and control cabin, features a maximum of five operator consoles and a data processing subsystem. The plot extractor housed in this cabin detects target which meet certain software-controlled criteria. Target information is then fed to tracking and display equipment in the form of digital words containing three dimensional positional information as polar coordinates. The on-line processor stores the positional data, carries out azimuth and height calculation while also making adjustments for various corrective data produced by the system. Plot and track information is passed to local displays or to remote command and control stations.

A third cabin houses communication equipment and comprises air-ground-air and point-to-point radio systems. The system is served by mobile power generators which, like the cabins, are configured for transport by land, sea or air. As a reporting post AR-3D is equipped with two operator consoles, providing automatic plot extraction and reporting to a remote center of up to 40 plots per aerial rotation. The control and reporting post configuration will carry out the same function, but with the additional capability of carrying out eight simultaneous computer-aided interceptions, simulation providing 30 tracks (16 of which are controllable) and automatic flight plan/track correlation of 150 plans. The command and control post configuration carries all this with the exception of automatic track data reporting, instead carrying out autonomous computer aided control of its own aircraft and weapons. The antenna and transmitter cabin are common to all configurations.

The original AR-3D antenna, which combined mechanical scanning in azimuth and electronic scanning in elevation,

comprised a compact circular polarized linear array positioned at the focus of a simple parabolic cylinder reflector. The reflector had a height of 4.9 m and a width of 7.1 m.

AR-325 Commander**.** The Commander or AR-325 is also a long range (470 km) 3-D air defense radar, albeit somewhat smaller than other family members in order to increase mobility. This includes the need for only one shelter in most cases, compared with an average of three for the AR-320. Another feature is the use of an ultra-low sidelobe planar array antenna that has a very narrow vertical beamwidth and an azimuth beamwidth of 1.4 degrees. When deployed in its tactical configuration, the radar includes full point-to- point and air-ground-air communications capabilities. Siemens-Plessey Radar has invested some 250 man years in developing the software and hardware associated with the data handling and display systems of the AR-325 Commander. The AR-325 console has been developed from the Watchman display.

AR-326 Commander. Derivative of the AR-325 with enhanced electronic counter-countermeasures facilities. These improvements are claimed to make the AR-326 radar a NATO Class 1 system, implying that the AR-325 is not.

AR-327 Commander. Enhanced mobility version of the AR-325. The AR-327 has a maximum range of 470 km and can monitor altitudes in excess of 100,000 feet. The radar features a traveling wave tube to transmit a pair of pencil beams (with similar elevation angles but different azimuths to achieve frequency diversity gain. This gain derives from the detection advantages resulting from the independent sampling. The antenna rotates at 6 rpm. The system selects pulse pairs from a stored list of 32 pairs determined to maximize the uniformity of azimuth illuminations. In addition to the normal diversity mode, an agility mode counters responsive jammers. This mode also uses 32 frequency pairs and provides subpulse-to-subpulse, pulse-to-pulse and burst-to-burst frequency agility.

AR-328 Commander. Tactically mobile NATO Class 1 radar.

HPR Announced during the 1992 Farnborough Air Exhibition, the new High Power Radar is a joint Hughes/ Siemens-Plessey development using MESAR technology. The High Performance Radar (HPR) was designed to act as a primary sensor for the ADSAMS proposal to meet the British Medium Range Surface to Air Missile System (MSAMS) Requirement. The HPR is a single-faced radar mechanically-rotating at 10 rpm and operating in the E/F-band. The gallium arsenide technology developed as a part of the MESAR program will be combined with signals processing software from Hughes to produce the new radar. Although the MSAMS requirement was canceled, the Hughes/Siemens-Plessey agreement covers the use of HPR for any suitable program. It is likely that it will be developed into a new AR-320 replacement.

Program Review

Background. Two AR-3D systems were ordered by the United Kingdom Ministry of Defence after the Falklands conflict. They are now deployed on the Falklands Islands and manned by the RAF. Since then a further operational system has been acquired and a full training rig. Siemens-Plessey's AR-3D radar also achieved notable success in the export market. The AR-320 was launched as a result of a 1983 UK MoD order for six systems. These were the last major sensors ordered for the IUKADGE air defense system. The update called for the procurement of six D-band radars (Martello) and six E/F-band radars (AR-320). In early 1986 the first antenna and transmitter sub-systems were delivered by ITT-Gilfillan to the UK for integration with the AR-320 system. All six have now been delivered and are in full operational service.

The AR-320 is the result of collaboration between Plessey Radar and ITT-Gilfillan and was designed specifically for NATO requirements. The radar is a combination of the ITT-Gilfillan series 320/3-D antenna and transmitter with the Plessey AR-3D receiver, signal processor, displays and software. The ITT-Gilfillan 320 series includes such systems as AN/SPS-48 and AN/TPS-32, both of which are in service with the US armed forces and a number of foreign countries. The AR-320 radar was proposed for the NATO E/F-band bulk buy to update the NADGE network on NATO's southern flank but was unsuccessful.

In December 1986 it was revealed that Plessey had been awarded a contract by the Iranian government for the supply of six 3-D radar systems at a value of 240 million pounds. Most reports indicate that the systems concerned were AR-3D radars, but it is possible that AR-325 Commander systems were ordered. Following the steady deterioration of Anglo-Iranian relations the contract was canceled in May 1987. An attempt was made to revive it in December 1988, but further dramatic deteriorations in diplomatic relationships ruled this out. In the present icy political environment, the resurrection of the sale seems highly improbable.

The AR-325 system was finally launched in 1989 when Indonesia placed an order for two radars. This contract included the provision of a major air defense C3I center

at Halim Air Force Base. This was the last order to have been received by Siemens-Plessey for the AR-320/325 prior to the introduction of upgraded members of the family in 1992.

These three new members of the AR-325 Commander family were designated the AR-326, AR-327 and AR-328. They use a modular approach to provide a range of operational, electronic and mobility characteristics. This upgrade to the existing system was linked to the announcement, in January 1993, of UK MoD invitations to tender for the supply of two long-range mobile air defense radars to replace the TPS-592 systems. Companies invited to bid for this requirement, SRA.918, include Marconi Radar Systems, Siemens-Plessey, Alenia, Thomson-CSF, TST, General Electric and Westinghouse.

This contract was won by Siemens-Plessey, who received a US$35 million contract for three AR-327 radars in January 1994. This was followed by a repeat order for three additional AR-327 radars, valued at US$27.6 million, in November 1995. These three radars are intended to support rapid deployments by British forces outside the area covered by IUKADGE.

Funding

Development of the AR-320 radar was funded jointly by Plessey and ITT-Gilfillan.

Recent Contracts

Contractor	Award ($ millions)	Date/Description
Siemens-Plessey Radar		June 1987 — Spares for AR-3D radars.
Siemens-Plessey Radar		May 1989 — UK MoD Initial spares and support for the AR-320 radars deployed as part of the IUKADGE system.
Siemens-Plessey Radar		Oct 1989 — 2 AR-325 radars plus air defense command center to be built at Halim AFB.
Siemens-Plessey Radar	35.0	Jan 1994 — 3 AR-327 radars to replace TPS-592 systems used in IUKADGE.
Siemens-Plessey Radar	27.0	Nov 1995 — 3 AR-327 radars to provide radar coverage of deployment operations outside the IUKADGE area.

*No major contracts since November 1995 have been identified for this equipment.

Timetable

Jun	1974	Experimental model in an advanced development state of the AR3D publicly demonstrated
	1975	ITT Gilfillan introduced the Series 320 family
	1980	Gilfillan received contracts for four Series 320 radars from International Technical Products NV, to be delivered to the Philippines
Jan	1983	Plessey won an order for six AR-320 radars from Britain's Ministry of Defence
Jul	1983	ITT Gilfillan won a US$25 million subcontract from Plessey to manufacture the planar array antenna and high-power wideband transmitter for the AR-320 radar
Aug	1986	ITT Gilfillan delivered first antenna and transmitter subsystem for AR-320
	1986	Marconi conducted study to determine suitable transportable earth terminals for use with RAF AR-320s. Plessey introduced AR 325 Commander offshoot of AR-320
Late	1987	First AR-320 delivered to MoD
Oct	1989	AR-325 ordered by Indonesia
Sep	1992	AR-326, AR-327 and AR-328 radars announced
Jan	1993	Bids for TPS-592 replacement requested
Jan	1994	TPS-592 replacement contract awarded to Siemens-Plessey

Worldwide Distribution

Chile (1 AR-3D)
Egypt (3 AR-3D)
Indonesia (2 AR-325)
Kuwait (6 AR-3D now destroyed)
South Africa (12 AR-3D)
UK (4 AR-3D, 6 AR-320, 6 AR-327 on order)

Forecast Rationale

The available market for these radars is very limited and further constrained by current defense spending economies which mitigate against procurement of expensive systems of this type. Additionally, the AR-320 and AR-325 both operate in E/F-band. A major trend in long-range surveillance radars has been leaning in the direction of the adoption of the D-band solution. This leaning is a direct result of advanced antenna design overcoming the size disadvantages previously inherent in D-band operation and technological improvements in signals processing using today's more powerful computers.

The AR-320 and AR-325 are medium-range systems directly comparable to the Thomson-CSF TRS-2215 and TRS-2230 systems, the Alenia RAT-31, and the (D-band) GEC-Marconi Martello. Consequently, four competitive systems are sharing the market for these types of radars, though none has a production run large enough to benefit from economy of scale.

The two big losers in this situation have been Alenia and Siemens-Plessey. Requirements for these large and complex radars are limited, and those which are in prospect are opting either for the D-band Marconi Martello or the E/F-band Thomson-CSF TRS-22XX radars. From an industrial point of view this ensures continued development of those two successful families.

While the AR family of radars has never been extremely popular, they now have the added stigma of being out of date technologically. In light of the fact that there have been no new contracts for this equipment in the past few years, it is probable that the radars have finished their production run. No more production is expected.

Ten-Year Outlook

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