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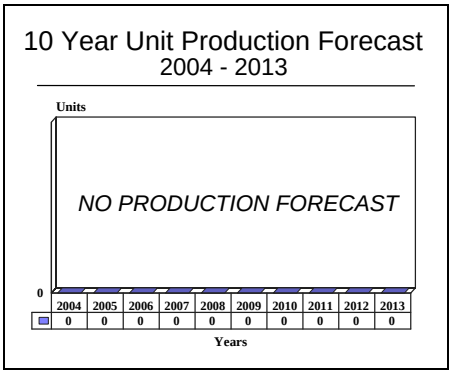
Martello Series (S713/723, S743-D, S753) - Archived 8/2005

Outlook

- Since 1999, no new contracts have been identified
- Last known order was from Oman and is believe to have been completed
- Barring any new information, this report will be archived in the near future



Orientation

Description. The Martello radar family, composed of the S713/723, S743-D, and S753, is a 3-D D-band radar tasked with long-range Air Defense Ground Environment (ADGE) surveillance. These systems are considered NATO Class I radar.

Sponsor

Alenia Marconi Systems (AMS)
Radar Systems Division
Eastwood House, Glebe Road
Chelmsford, Essex CM1 1QW
United Kingdom
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Web site: http://www.amsjv.com

Licensee. No known production licenses have been granted.

Status. In service.

Total Produced. A total of 22 systems are estimated to have been produced through 2003.

Application. The Martello S713 is a long-range 3-D ADGE surveillance radar. It was specifically tailored to RAF requirements as an element within the Improved United Kingdom Air Defense Ground Environment (IUKADGE) system.

The Martello S723 is a long-range 3-D ADGE surveillance radar system of the NATO class I type. The radar can be installed in transportable or static modes. One Danish radar system (on Bornholm) is deployed on top of a 20-meter tower.

The S743-D was believed to have been initially developed for the IUKADGE network but was not chosen for the application.

The S753 is a fully transportable tactical system.

Price Range. The price range for the S723 has varied between US$8 million and US$10 million (mid-1980 dollars). No information is available on the S-713. It is believed that Greece procured the S743-D at a unit cost of approximately US$11 million (1995 dollars).

Contractors

Alenia Marconi Systems (AMS), http://www.amsjv.com, Eastwood House, Glebe Rd, Chelmsford, Essex, CM1 1QW United Kingdom, Tel: + 44 1245 703588, Prime

Technical Data

Characteristics

	S713	S723	S743-D	S753
Frequency	D-band	D-band	D-band	D-band
Bandwidth	100 MHz	10%		130 MHz
Antenna dimensions	10.6 x 6.1 m	7.1 x 12.2 m		6 x 5.1 m
Rotation rate	6 rpm	6 rpm		5 rpm
Azimuth aperture	2.8º	1.4º		2.8º
Elevation aperture	0-30º	0-20º		2.8º
Power max	3 MW	132 kW		
Power mean	8 kW	5 kW		3.3 kW
Performance				
Range (min-max)	1-256 nm	14-256 nm		up to 216 nm
Elevation coverage	30º	20º		
Ceiling	200,000 ft	150,000 ft		100,000 ft

Design Features

S713. The S713 3D D-band radar system is made up of an antenna, a radar housing, a cooling/air conditioning unit, and a power-generation unit. All the units are based on the ISO freight-container concept to facilitate transportation by standard prime movers or by transport aircraft such as the C-130. Setup time upon arrival at a destination is no more than six hours.

The antenna itself comprises 60 identical horizontal linear array elements stacked vertically, each with its own receiver. Antenna rotation is six revolutions per minute, with each array acquiring signal returns that are combined into a passive infrared (IF) beam-forming network. The network forms eight beam patterns to achieve the needed vertical coverage and height-finding accuracy. Coverage is from the radar horizon up to 30º, with height measurement up to 24º elevation. The array is set back on a tilt of about 14º, with the bottom beam flat along the ground and all beams having a fixed elevation. The array is operable in wind conditions of up to 70 knots and is able to withstand wind gusts of up to 120 knots.

S723. In 1984, Marconi came out with two new upgraded versions of the standard S713, called the S723A and S723C. The new versions were based on the techniques used in the S713, but feature enhanced overall performance, requiring less power and offering a longer range detection capability. The most obvious change is its physical appearance, with the antenna now being wider and shorter in height. Also, the S723 uses distributed solid-state transmitters, with the planar array composed of a vertical stack of array elements, each of which is supplied from the transmitters housed in the spine.

Every element in the antenna array has its own high-performance receiver, with each element receiving returns from a target. The separate receiver outputs are then combined into a passive beam-forming network that synthesizes a quantity of elevation beams (eight in the S723A and six in the S723C), matched to the elevation coverage requirements. Data are transmitted to the associated electronics shelter that processes the information in order to display the range, bearing, and height (up to 200,000 ft) of the target. Instrumented range is 270 nautical miles; height and azimuth coverage are 200 feet (61 m) and 360º at 6 rpm. Range and azimuth accuracy figures are 525 feet (160 m) and 0.13º, respectively. The height accuracy figure for the S723A is 1,700 feet (520 m), and the detection range for a small aircraft is 270 nautical miles. For the S723C, the height accuracy is 2,000 feet (610 m), and the small aircraft detection range is 230 nautical miles. The RAF's S723s are referred to as the Type 91.

S743-D. The S743-D continues in the tradition of its parent systems as a D-band, 3-D stacked-beam radar incorporating a parallel receiving system for height finding. The antenna is based on a planar-array concept with identical horizontal linear elements that are vertically stacked. A low sidelobe is achieved via the precise control of the amplitude and phase that is sent to each array element.

Target returns are received from all arrays, while the individual outputs are formed into a passive beam-forming network that is synthesized to cover the required elevation. All beams employ pulse compression and are fully adaptive out to the S743-D's maximum range. The threat bearing and altitude are automatically calculated from the individual returns, which are then fed through the plot-forming algorithms. However, the radar does not rely on the use of frequency or phase change to achieve height data, thereby permitting the system to operate in either single-spot or agile mode as the situation warrants.

The S743-D further employs a fully solid-state transmitter module that gives a wider bandwidth capability and improved reliability. The integration of Inmus transputers has provided a massive increase to the processing power and overall flexibility of the system. The radar is composed of 4,000 transputers that provide 80 computing modes.

The system also incorporates a second radar that is used primarily as an Identification Friend or Foe (IFF) interrogator with a secondary surveillance function.

Although the system is nominally transportable, it is not designed for either a quick breakdown or a quick setup. A total of three or four hours are needed to complete either the assembly or disassembly of this radar.

S753. The S753 entered the initial R&D phase around 1993. In 1999, the system was believed to be in the late developmental stage. This radar is known to be based on the S743-D, but is being specifically designed for rapid transport as befits a tactical system. Total setup can reportedly be accomplished in an hour, due to its built-in handling and lift equipment. The system is also transportable by C-130 aircraft and heavy-lift helicopters.

The radar incorporates a choice of waveform and processing configurations. The inclusion of a moving target indicator (MTI) results in increased long-range performance, as well as multi-filter processing at medium ranges.

The unit can operate on a single frequency of no more than 5 MHz instantaneous bandwidth (normal conditions) or can be switched to dual-frequency operation to improve detection capability (alert conditions). The S753 is stated as having full frequency agility, either pulse-to-pulse or in bursts, in order to retain a coherent processing capability.

Operational Characteristics. The systems are transportable by C-130 Hercules aircraft. Excluding the antenna, the whole system is configured in standard ISO containers. If a satcom is deployed with the radar, an extra vehicle will be added to the convoy.

Bearing, range, and elevation are available on every target for every antenna revolution. The planar-array antenna is a vertical stack of identical linear elements, each with its own receiver. Narrow beam width in azimuth is achieved through the use of shaped amplitude distribution. Low sidelobes are featured. Returns from all elevations are received by all array elements, then combined in a simple passive beam-forming network. This serves to synthesize a cosecant surveillance pattern and eight elevation patterns matched to the required elevation coverage. The system is self-adaptive to the radar environment. The radar manager has comprehensive facilities for monitoring system performance and retaining complete control of all the system's parameters.

The Martello family is fully transportable, consisting of a trailer-mounted antenna group, and two ISO containers for the transmitter, power supply, processors, and radar manager's console. When deployed with a satcom unit, the road convoy will be enlarged to four prime mover/load units. The S713/723 system can be operational six hours from arrival at a prepared site, while the S743-D requires three to four hours setup time at any unprepared but firm location. The S753 can be operational within one hour of reaching its location.

Variants/Upgrades

S713. The S713 is the original D-band system developed in the late 1970s. This system is no longer in production.

S723. The S723 is based on the original S713, but has a completely different appearance. The most obvious difference is the shorter vertical but wider horizontal aperture. The S723 is available in either the A model, composed of eight elevation beams, or the C model, which uses six beams. This system was developed in the mid-1980s and is no longer in production.

S743-D. The S743-D is a major update to the S713/723 system. This system was developed in the late 1980s, and is currently in production.

S753. The S753 is a highly mobile, tactical version of the S743-D radar. Various enhancements have been incorporated to significantly decrease setup times, waveform, and processing configuration choices. The S753 is believed to have completed initial trials and is currently in production.

Martello Radar System

Source: Alenia Marconi Systems

Program Review

Background. Martello is the fifth generation of ground environment air surveillance radars to be supplied by GEC-Marconi (now Alenia Marconi Systems) to the U.K. Ministry of Defence. Two of the systems ordered were in response to Air Staff Requirement (ASR) 1586. This is a U.K.-funded program involving two D-band and three E/F-band radar systems for the Improved United Kingdom Air Defense Ground Environment (IUKADGE) system. Plessey supplied the AR-320 E/F-band radar. The other three systems were procured with NATO infrastructure funding (80 percent) and form part of the NATO Air Defense Ground Environment (NADGE) chain. The first of three Martello S713 radars was handed over to the RAF in March 1982.

The U.K. Royal Air Force also became interested in the Martello and procured four Martello S723 systems during the mid-1980s. The first of these radars was delivered in June 1986 and is located at a site on the east coast of England. The remaining three were delivered by the end of 1986, and are now operational as part of the IUKADGE system.

The first contract for Martello radars to a non-NATO country, the Sultanate of Oman, was awarded in July 1985. Oman awarded Marconi a contract for approximately GBP20 million to GBP38 million for two Martello S713 3-D radars. The contract also reportedly included Mace display and data-handling systems, communications equipment, and associated software. The two radars were delivered around 1987/88.

In 1986, Jordan ordered Martello radars for the Jordanian Royal Air Force. The quantity and the Martello variant ordered are unknown.

In 1988, the United Kingdom signed a deal with Malaysia, worth a reported GBP2 billion, for an extensive defense package. This deal was expected to include Tornado aircraft, Rapier surface-to-air missiles, and Marconi's Martello radars. In 1990, Malaysia awarded Marconi a contract for two Martello radars of an unknown variant. GEC-Marconi Radar Systems was to supply the Malaysian Air Defense Ground Environment (MADGE) with two Martello radars, the MARDIS supporting display and data-handling system, and new communications systems. One of the Martello radar systems was expected to act as a second air operations center (AOC). The first Martello radar was delivered in June 1992; the second, in November 1992.

Greece became the third NATO country to order the Martello radar, with a March 1990 order for two systems. This was the first time that GEC-Marconi had underbid GE (U.S.) on a tender of this type for many years. The large U.S. military orders placed with GE had put the company in a position to quote low prices on its equipment. The bid terms on the Greek contract included an option for a third radar.

Thailand then placed an order for two Martello S743-D systems in September 1990. Previously, the country had committed to U.S.-built radar and had ordered three FPS-117 D-band systems for its latest requirement. The adoption of the British radar was motivated by a detailed evaluation of the two systems, which had demonstrated that the two Martellos provided coverage superior to three FPS-117s under Thailand's prevailing conditions.

Marconi Radar Systems introduced the new, lightweight S753 derivative of the S743 at the September 1992 Farnborough Air Show. It was presented as a more mobile and simplified radar, aimed at customers not needing the full performance spectrum provided by the S743.

Greece exercised its option to purchase a third Martello radar in March 1995 following satisfactory performance of the first pair of systems during trials in severe weather conditions. GEC-Marconi was also reported to be bidding the S743-D radar to meet a UAE requirement of three to five long-range radars. It is not known who was awarded the contract, or when, for these three radars.

GEC-Marconi and Alenia-Finmeccanica entered into negotiations in 1998 to form a joint venture company, Alenia Marconi Systems. In 1999, the newly formed Alenia Marconi landed its first Martello deal, supplying two S743-D radars to Oman in what was described by a company spokesperson as a "three-year, multi-million British pound project." These systems are said to have been delivered in 2002. No sales have been detected since this order.

Funding

The Martello family radars were developed by GEC-Marconi, largely using corporate funding, but using government contracts as a basis for the work. GEC-Marconi and Alenia-Finmeccanica formed a joint venture in 1998 called Alenia Marconi Systems, the company now officially charged with Martello funding.

Recent Contracts

Contractor	Award (US$ millions)	Date/Description
Alenia Marconi	Undisclosed	June 1999 – Omani order for two S743-D radar systems.

Timetable

Month	Year	Major Development
Jan	1990	Malaysia awards contract for two Martello radars of unknown variant
Mar	1990	Greece orders two Martello S743-Ds
Sep	1990	Thailand orders two Martello S743-Ds
Jun	1992	First of two Martello radars installed in Malaysia
Nov	1992	Second Martello radar delivered to Malaysia
Dec	1992	Perceived start of S753 R&D
Mar	1995	Greek order for an additional S743-D system
Jun	1999	Oman orders S743-D systems
	2002	Delivery of systems to Oman

Worldwide Distribution

Martello variants are currently maintained by **Denmark**, **Greece**, **Jordan**, **Malaysia**, **Oman**, **Thailand**, and the **United Kingdom**.

Forecast Rationale

Since 1999 there have not been any known orders for the Martello system. The last order, from Oman for two S743-D radar systems, was completed in 2002. Although the Martello system is still being promoted, it seems that AMS is having more success with its RAT-31DL system. Since this variant of the RAT-31 was completed, Alenia Marconi has sold several of the RAT-31DL systems to members of NATO in order to upgrade the NATO Air Defense Ground Environment (NADGE) network. Even Malaysia, a former customer of the Martello system, purchased the RAT-31 in 2001.

The production life of the Martello system appears to have come to an end. With the RAT-31DL dominating the European market, it is unlikely there will be any further sales to NATO members. Some sales to non-NATO countries may occur, but with no new contracts being publicized, these sales will be difficult to track. Barring any new information, this report will be archived in the near future.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level				Good Confidence Level				Speculative			
Designation	**Application**	**Thru 03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**Total 04-13**
MARTELLO	Prior Prod'n:	22	0	0	0	0	0	0	0	0	0	0	0