▲ An artist's impression of the new *Martello* radar deployment.

It has been evident for some time that the days of the massive, fixed-base defense radar are numbered. Apart from the natural vulnerability of a fixed position which can be pre-targeted, and which emits a radar signature like a lighthouse, many of the present military radars round the world have exhausted their development and modification potential as far as Electronic Counter Counter Measures (ECCM) are concerned. They are also limited in low-level cover.

Air attack can now be conducted with considerable precision, using a variety of sophisticated conventional weapons delivered from any altitude between 100 ft and over 45,000 ft, while the armoury of airborne electronic jammers is constantly expanding.

Marconi Radar Systems has now developed a new-generation radar, Type S713 3-D *Martello*, which is intended to operate under the most severe conditions of attack and electronic countermeasures. The name *Martello* comes from the 'Martello towers which formed an earlier defense system for the British Isles.

The *Martello* radar is based on the following basic requirements:

- Long-range cover
- Compatible height performance
- Continuous position and height data
- Full ECCM
- Transportability

The technical methods of achieving these goals came as a result of many years of research and the production of a large range of fixed-base and mobile radars for military use which have been employed in many parts of the world.

Frequency scanning was fully investigated in the early 1960s and a Royal Navy-sponsored 5-cm "Multi-Regime Frequency Scanner" was built. The basic disadvantage was that with a fixed frequency at any one angle of elevation, an enemy could identify the frequency and jam the band involved. Because of the size of the MRFS another system was built with a planar array, linear polarisation and up to six frequencies on the same angle of elevation.

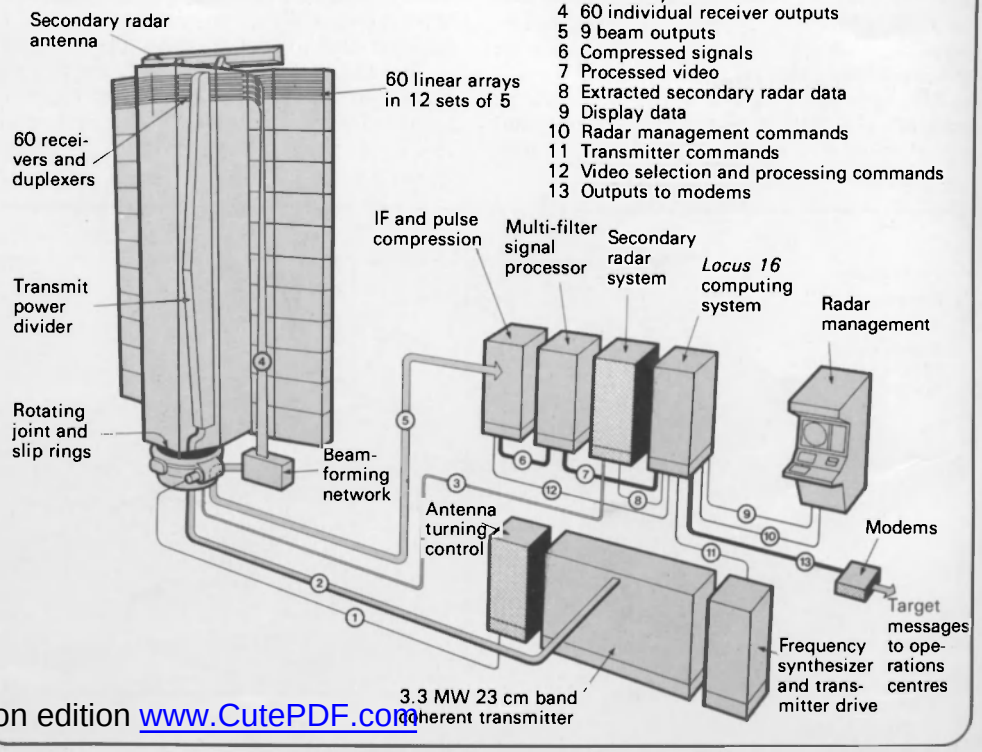
Also constructed and tested was a 23-cm interferometer 3-D radar, but this was very much a fixed-base system.

One fundamental piece of research behind the evolution of *Martello* was the Storage Array Radar (STAR), the idea for which originated with the Royal Radar Establishment. STAR began as a 2-D surveillance radar and was later converted to 3-D. In this system the whole angle of elevation had to be scanned in a ¼ microsecond pulse length and this necessitated processing the output on any one beamwidth in an exceptionally short time. It is considered that it will be years before technology has advanced to the stage of allowing processing at that speed.

The lowest prf and highest power was required to enable small targets, long ranges and high altitudes to be covered, with maximum clutter suppression and good ECCM. The 23 cm band was chosen, as opposed to 10 cm, to provide improved performance in bad weather and other clutter conditions. This also has the advantage that jammers at that frequency must be physically larger, although this also applies to the radar aerial, which has turned out to be 20 ft wide and 35 ft high. Over a decade before, Marconi had decided that sidelobe reduction was vital in overcoming the ef-

Schematic diagram of *Martello* system

1 Turning control
2 Primary feed
3 Secondary radar feed
4 60 individual receiver outputs
5 9 beam outputs
6 Compressed signals
7 Processed video
8 Extracted secondary radar data
9 Display data
10 Radar management commands
11 Transmitter commands
12 Video selection and processing commands
13 Outputs to modems



Design aim specification for Martello

Horizontal beamwidth	2.8°
Vertical beamwidth	1.5°
Polarisation	linear
Gain	
transmit	32 dB
receive	38 dB
Sidelobes	
horizontal (1st sidelobe)	30 dB
horizontal (15° off main beam)	45 dB
vertical	30 dB
Vertical cover	0–30° (heights to 24°)
Rotation rate	6 rpm
Pulse width (effective)	0.25 sec
Receiver noise figure	4 dB
Cancellation (ground clutter)	40–55 dB
Instrumented cover up to	200,000 ft
Height accuracy (single look)	1,000 ft RMS at 100 nm
Time into action	5 h

formed' beam channels are processed in phase and in quadrature, using digital Doppler multi-filter MTI processing with self-adaptive plot and height extraction.

Plot range, azimuth and height on all targets are correlated every 10 seconds with extracted IFF/SSR data for onward transmission to the operations centre. The computing system uses a *Locus 16* processor. This signal processor forms the clutter map which is stored for eight minutes and is continuously up-dated.

At the heart of the system is the *Twystron* valve, developed by the Directorate of Components, Valves and Devices, Ministry of Defence, and manufactured by EMI-Varian. Basically capable of 7 MW peak power, the valve is "de-rated" to 3.3 MW peak power, with the object of providing a 10,000-h life.

and anti-spoof jitter. The use of a large number of parallel receivers dilutes the jammer power, while pulse compression with digital Doppler, multi-filter MTI provides additional protection, as does chaff and clutter suppression. Automatic radar management with manual intervention facilities are provided, with ECCM management on a sector basis.

Martello is described as "redeployable in a reasonable space of time". This means that a new site can be installed and operating in less than 5 h using six men. The basic equipment is carried on three 40 ft long standard ISO articulated vehicles. A site layout consists of antenna, radar container, services container and generator. Because of its unique construction, it should be possible to replace damaged arrays, either

fects of ECM and a linear array with equal path length feed had been developed by the company as part of the S600 series of private-venture radars and was subsequently adopted by the Royal Navy for new surveillance radars.

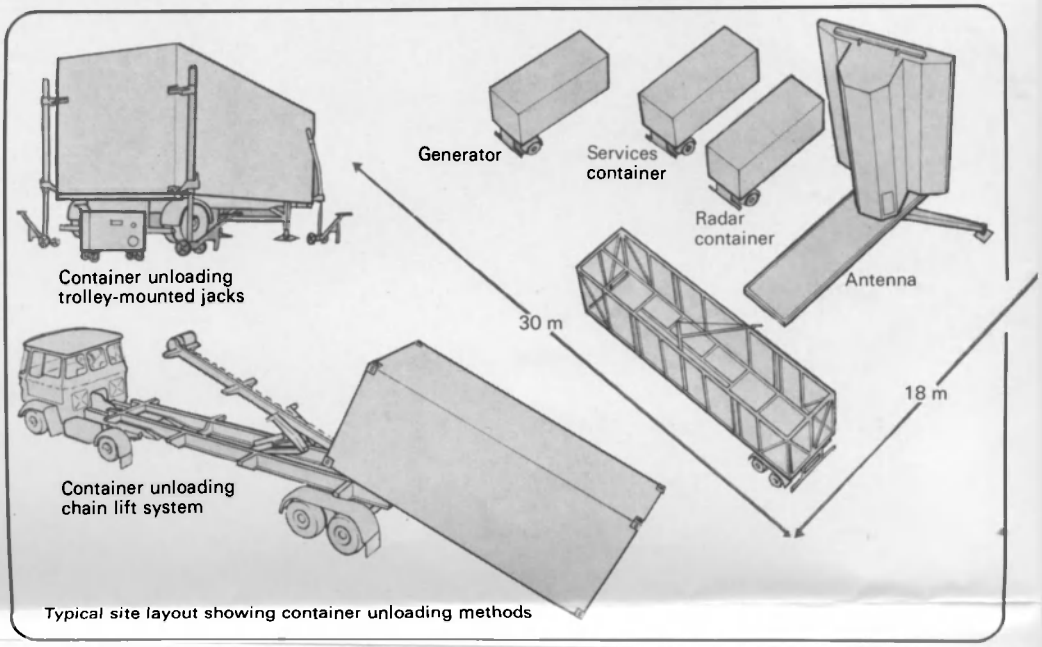
From this work Marconi planned *Martello* to have:

a) A planar array with minimum sidelobes
b) Parallel output phased-array technique
c) Manifold receiver processing ensuring high dynamic signal capability.

Martello has been evolved with a vertical-stack, triplate glass-fibre antenna with 60 identical horizontal linear array elements, each with its own receiver. All arrays have the same shaped amplitude distribution offering a narrow azimuth beamwidth. Low sidelobes are obtained by precision control of the amplitude and phase feed to each array.

All arrays receive returns from a target and receiver outputs are assembled into a passive beam-forming network at the intermediate frequency. This synthesizes eight elevation beams and a cosec² surveillance beam, matched to the required elevation coverage. All nine beams are processed simultaneously to give azimuth, range and height information on all targets in every revolution of the aerial. Cover is provided through 360°, from the radar horizon up to 30° in elevation, with height measurement up to 24° elevation. Detection of intruders is possible at ranges in excess of 300 nautical miles and altitudes of over 100,000 ft.

All received signals are pulse-compressed to 0.25 microseconds to optimise signal/clutter ratio. Thereafter, the



Typical site layout showing container unloading methods

Power from the *Twystron* is fed via a power distribution network, through duplexers to the aerial array. The aerial array itself has 61 receivers, including one for reference and balancing. The array is tilted backwards at 14°, the bottom beam being directed along the ground. It is designed to operate in a 70-kt wind and survive gusts of up to 120 kt.

The ECCM facilities of *Martello* are thus based on high power output, unrestricted frequency agility within the 23-cm band, low antenna sidelobes, random prf stagger

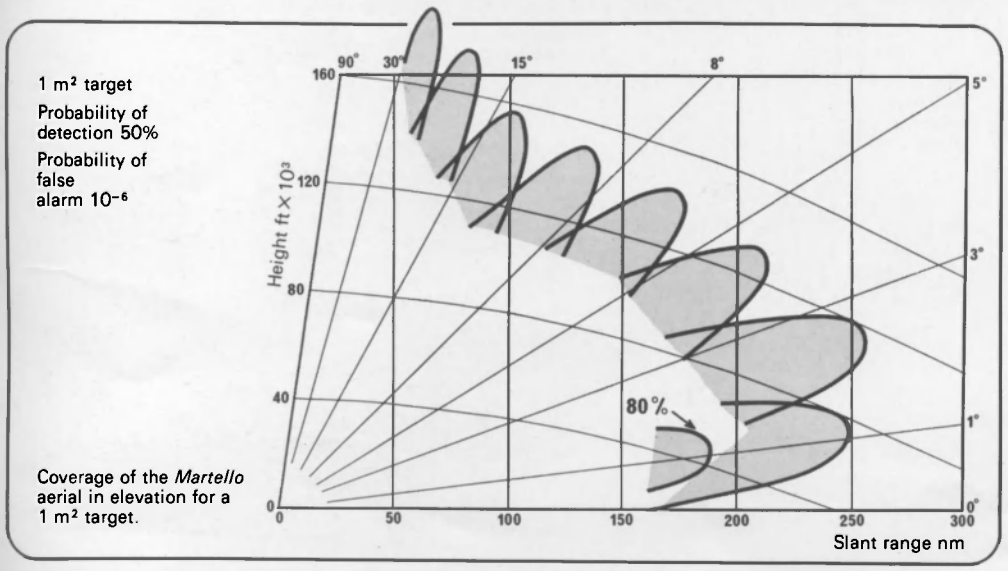
singly or as a complete assembly, from a reserve vehicle. In addition, a number of pre-planned sites could be available for installation which would allow for flexibility and "gap filling", as well as provide considerable confusion for any enemy.

The radar picture from a *Martello* site can be relayed by simple digital communications link to a sector operations centre or to a local facility, or simultaneously to both. Marconi expects to define a total standard mobile package for display and data handling, based in a 30 ft or 40 ft container. All the hardware required has already been developed and a mobile unit could probably handle inputs from up to three *Martello* radars. The system is of course suitable for either mobile or fixed applications.

Martello has been designed for minimum technical support and has built-in fault diagnosis.

An environmental test model is likely to be on show at the SBAC show at Farnborough, while a full model for complete electrical evaluation of the aerial will begin tests early in 1979. Marconi's program envisages first production units being available by late 1980 or early 1981.

Martello represents a multi-million pound investment by Marconi which should yield good dividends in both home and overseas markets in the 1980s, when mobility and resistance to jamming will be prime requirements for the replacement of existing military radar systems. ✦✦



Coverage of the *Martello* aerial in elevation for a 1 m² target.

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