Marconi Radar Systems

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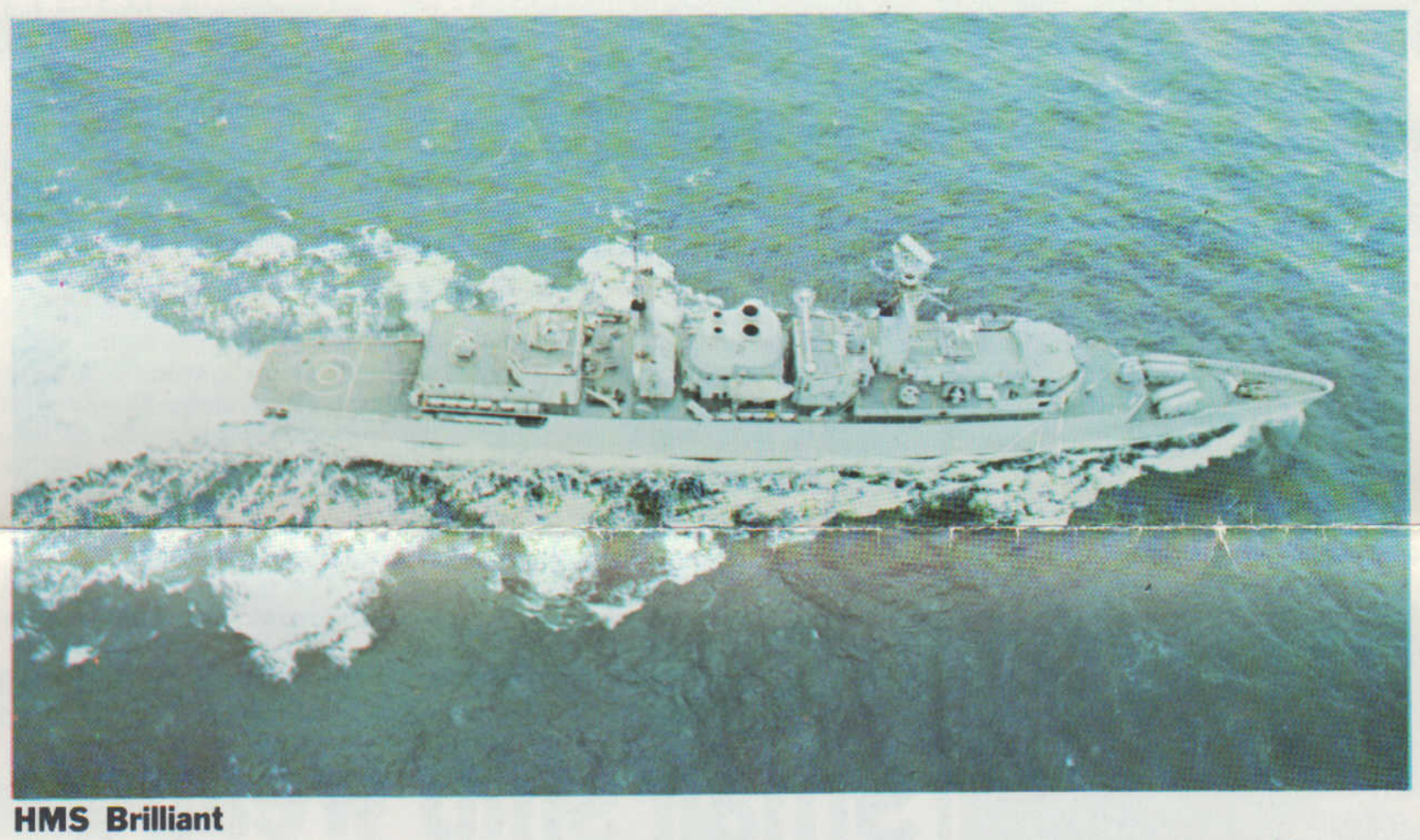
Containerised weapon control and surveillance systems

THE rapid evolution of modern electronic technology, allowing more and more facilities to be accommodated in comparatively small boxes, has combined with equal advances in weapon technology to allow powerful and sophisticated weapon systems to be fitted in relatively small warships. This advance in the offensive capability of small ships, has, unfortunately, a corresponding drawback — the systems are generally very expensive.

To gain the maximum economy in design, development and manufacture, and also minimise logistic and research costs, standardisation of equipment units must be achieved where possible. This approach has been investigated in depth by Marconi Radar, with families of equipments being developed using many common modules, producing optimum solutions for weapons systems fitted to ships from fast strike craft to major units of the fleet — and even merchant ships.

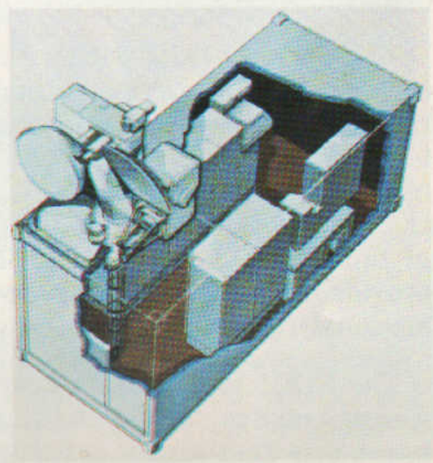
One proven technique for simplifying the problem of installing radar equipment aboard ships is to accommodate the equipment in and on standardised containers. This technique can save installation time and cost and also enables a high percentage of testing to be achieved before installation. Marconi Radar have a long and extensive experience in this type of radar installation.



HMS Brilliant

WAMS, or Wartime Adaption of Merchant Ships, is one particular example where containerised systems can be used in the optimum manner to provide speedily installed defensive capability. In the WAMS system, containerised weapons systems, communications facilities and radars, in particular the Marconi Lightweight Seawolf tracker, are supplied for immediate installation aboard merchant ships. The WAMS systems are provided in standard ISO type containers, enabling the use of the standard ISO lifting facilities. Once fitted to a ship, all that is required is connection to the ship's power supplies, together with interconnection between the various WAMS units. An effective point defence system is then immediately available.

Another use for the containerised type of system is in the coastwatching role. Here the type of radar fitted depends upon the threat envisaged, either surface, air, or both combined. The modular concept adopted by Marconi Radar enables choice to be made from several types of radar systems, often in mixed installations. The containerised format has one additional characteristic. If needed, systems can readily be moved from site to site.



Lightweight Seawolf containerised system

Containerised training faciliities are also highly viable, enabling use either ashore or at sea with equal facility. Electronic warfare simulators and communications facilities are also suitable for containerisation. The container approach is definitely an altogether more realistic approach to warship — and merchant ship — design and installation problems.

TYPE S1840 3-D NAVAL SURVEILLANCE RADAR

THE type S1840 3-D naval planar array radar operates in the 5cm frequency band and is designed to give range and bearing and height on all targets within the instrumented cover. The system also provides increased resistance to jamming, an advantage gained by the multibeam configuration and by careful design.

The technology of the S1840 radar is derived from Marconi Radar's long experience with similar radars, and existing sub-systems have been used wherever possible to minimise cost and development. The 5cm frequency has been chosen to give a good compromise between good weather capability and lightness. This compromise enables the radar to be made compact enough to be fitted in a wide range of warships, while offering an excellent performance.

The design features of the radar include low ship fitting requirements, a lightweight fully stabilised antenna, dual antenna rotation speeds, a multiple beam low sidelobe array, separate processing

S1840 antenna

on all beams and height data for aircraft control and target indication. Other features include a coherent TWT transmitter, frequency agility, dual pulse for long and short ranges, pulse compression, fully adaptive clutter rejection systems, extensive ECCM facilities and operator selectable sector blanking.

The S1840 radar is designed to enable even the smaller warship to be provided with effective, long range, jamming resistant radar protection. The system is robust, light in weight and modern in concept and design.

400 series lightweight radar fire control system

DEFENCE in depth is the current strategy against the sea skimming missile, the final close-in solution being the rapid firing gun. The Marconi solution for adequate control of guns of this type is the 400 series lightweight radar fire control system.

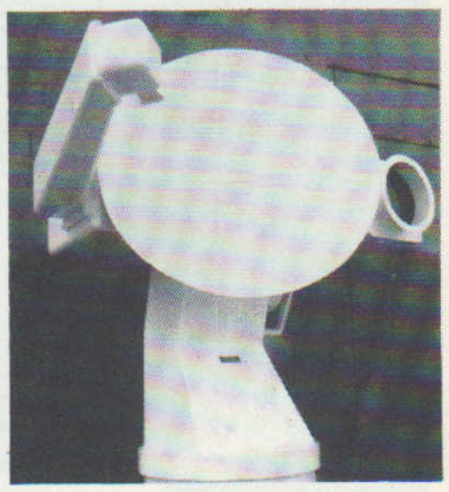
The newly developed 400 series has all the necessary attributes to counter sea skimmers, the radar incorporating self-surveillance with automatic target acquisition, fast reaction time in bringing guns to bear on the target, automatic action, apart from firing the gun, clutter suppression and a multi-path solution, both necessary for accurate gunfire against a sea-skimmer. The system is suitable for guns from 30mm upwards, using either hard kill APDS ammunition or proximity fused ammunition.

The 400 series radar fire control system is an ultra modern equipment using all weather microwave frequencies and employing the latest radar techniques, including frequency over a wide bandwidth, self surveillance at 60 rpm, automatic target acquisition and subsequent track on approaching sea-skimmers and aim-off prediction and provision of continuous gun orders. The system is provided with a full set of ECCM features and is manufactured to recognised military standards. The overall weight is 350kg, the director weight being only 150kg. The power requirements are 1kVA tracking and 4kVA peak for slewing to a target bearing.

In addition to providing semi-autonomous defence against a sea-skimmer, the radar system will also take in target range and bearing from any naval surveillance radar, scan to find the target in elevation, lock-on, track and provide continuous gun orders.

To match the 'last ditch' gunfire defence, the instrumented range of the radar is 12km for surveillance and 10km for tracking, with a tracking accuracy of better than 1m rad rms. In the case of surface targets, the range extends to 24km for surveillance and tracking.

The design of the 400 system is at the



400 series Tracker

forefront of technology to overcome all the known problems of automatically detecting and tracking small fast-moving targets at very low altitude, while maintaining good all-weather radar performance.

Lightweight naval surveillance radars

THE Marconi Radar S800/S1800 series of lightweight naval surveillance and target illuminating radars includes a range of antenna types, all fully stabilised and operating in 10cm band. Radars in the series include the S820, S1824, S1825 and S1826.

The S820 radar uses a conventional horn fed double curvature antenna, the assembly being housed in a weatherproof glass-fibre radome. The design emphasises reliability, maintainability and performance, good target detection being achieved under the conditions of severe levels of clutter and ECM interference encountered in modern naval environments. The antenna reflector is constructed from glass reinforced plastic, giving low weight and high corrosion resistant capabilities.

The S1824, S1825, S1826 trio of radars includes versions that range from a simple squintless feed antenna to a sophisticated multi-antenna system. This group of radars enables a variety of differing radar covers to be provided, to meet varying operational requirements.

The S1825 radar has an aperture of 4 metres, the design being unusual in that a dual reflector system is incorporated, enabling the use of a simple horn feed. The antenna has a good wide angle sidelobe performance, switchable circular polarisation being available as an option. The weight of the overall assembly is greatly reduced by the use of a unique system of stabilisation.

The S1824 radar uses a single beam system, the antenna being a squintless feed of 5 metres aperture producing a vertical beamwidth of 34°, the beam-shape being parabolic.

The S1826 radar is a combination of the features of types S1824 and S1825, the whole accommodated on a common mount. Vertical cover to 40° is provided by the 4 metre cassegrain antenna of S1825, high angle cover being supplied by the linear feed of S1824. For applications where missiles having a high cruise altitude together with a steep terminal dive are a threat, a second linear feed may be incorporated to provide cover in this region.

To provide versatile power requirements, three transmitters are available, all fully coherent with wide bandwidths and chirped for pulse compression. The low power version gives an output of 800 Watts mean and is ideal for fitting in small strike craft. The medium power transmitter provides 2kW mean power, is air cooled and includes a solid state modulator. The high power transmitter gives 6kW of mean power. All units are of efficient design to minimise demands on the ship's power and waste heat cooling systems. A short pulse is transmitted following the main pulse in all cases to provide short range cover when operating inshore, for surveillance of helicopter sorties and when station keeping.

SIGNAL PROCESSOR

The signal processor has two parallel channels. One has a digital double canceller MTI system with automatic velocity compensation. This operates on an area basis and requires no external input of ship's motion. The non-MTI channel has log processing and gives excellent Dicke Fix action against swept jamming. Videos are available at the output of the signal processing system which are suitable for display in command and control systems.

Outputs in the form of binary quantised video are available for feeding to a plot extractor, the outputs of which can also be displayed to reduce the load on the operators working in the combat information centre. As an option, the outputs from the plot extractor can be interfaced to a track processor which is fully automatic and presents smooth accurate labelled tracks to the ship's command and control system. Both the plot extractor and track forming system are interactive with the radar so that the total radar system will always be set to its optimum operating state depending upon the environment in which it is working.

Fast patrol boat

The Marconi 805 family of lightweight naval radars

THE Marconi 805 family of lightweight naval tracker radars includes versions capable of controlling the majority of modern gun and missile systems. Based upon the Marconi S800 series of lightweight trackers and upon the wide experience gained by the company over many years of designing and manufacturing tracker systems for the Royal Navy, the 805 radars are suitable for use aboard naval vessels ranging in size from small fast patrol boats to major units of the fleet.

The systems incorporate centimetric and millimetric radars, infra-red and television cameras and lasers, all combined to provide the required combination of features to suit the ship's specified weapon fit.

The 805 radars are built around a common mount, engineered to enable the different variants to be accommodated with minimal change. Using this mount as a basis, various types are built up, each assembled to meet a specific group of requirements. The systems are modular in format, enabling additional versions to be produced to meet new requirements as they arise.

The range at present includes 805SW, for Lightweight Seawolf, 805SD, the Lightweight Sea Dart tracker, 805AS, for the Aspide missile and 805 SS for Sea Sparrow. All the missile radars can also control medium and fast firing guns to provide the ship with extra channels of fire.

805SW

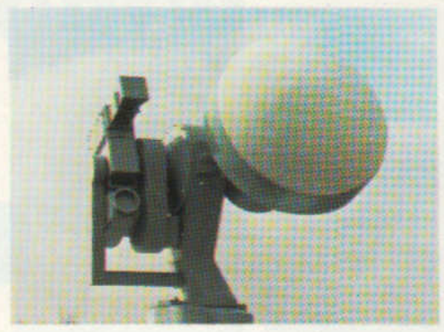
805SW is the tracker radar for the Royal Navy's new lightweight Seawolf weapon control system, GWS25 Mod 3. It is a dual frequency tracking system which includes a command link to control the missile in flight. The centimetric radar and transmitter form part of the Marconi S800 range and the signal processing uses techniques to ensure effective operation in severe clutter. The millimetric part of the system is a version of the Rapier blindfire radar, used to control the British Aerospace Rapier missile. The radar provides accurate tracking at low angles of sight against targets close to the surface such as sea-skimming missiles and low-flying aircraft.

805SD

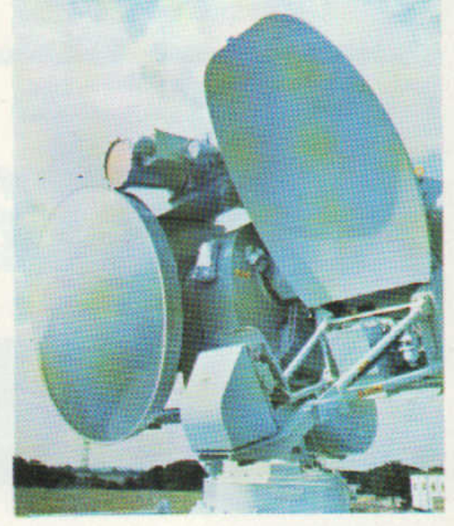
Designed to control the Sea Dart missile, 805SD incorporates proven components from the Radar Type 909 and S800 weapon control systems and combines the tracking and illuminating functions required by the semi-active Sea Dart missile. The Sea Dart missile when controlled by 805SD has a capability against surface targets to the radar horizon and a range against air targets such that it can provide area defence to ships in consort.

805AS

805AS has been developed in co-operation with Selenia, as a lightweight tracking radar for use with the surface-to-air Aspide missile. The system uses the Selenia illuminating transmitter and has been designed to take full advantage of the complete envelope of the missile. The radar can also be used for gun control. The 805AS tracker when integrated with the Selenia CW transmitter and launcher is known as the Albatross Mk 10 system.



805SD



805SW

805SS

The 805SS has been designed in collaboration with Raytheon for use with the Sea Sparrow missile. It uses the Raytheon illuminating transmitter, is extremely lightweight and can control the Sea Sparrow missile when vertically launched or fired from a conventional eight barrel launcher.

Small ship weapon systems

A RANGE of lightweight high technology radars has been developed by Marconi Radar. Known as the S800 series, the radars are ideally suited for use on fast patrol craft and other vessels up to the size of frigates and destroyers. Over 30 of the S800 radars have been sold to customers around the world.

The S800 series radars are modular and lightweight, and the weapon systems provide efficient surveillance, successful detection, rapid acquisition and accurate target tracking. The systems are provided complete with computer driven PPI displays and all necessary interface equipment, to control guns of all calibres up to 130mm and a range of surface-to-surface missiles.

The systems comprise surveillance radars in both 3cm and 10cm bands, tracking radars, supplemented with optronic devices, weapon control consoles incorporating radar display systems, fire control predictors and vertical reference equipment, etc. Marconi Radar training aids are also available.

Surveillance radars

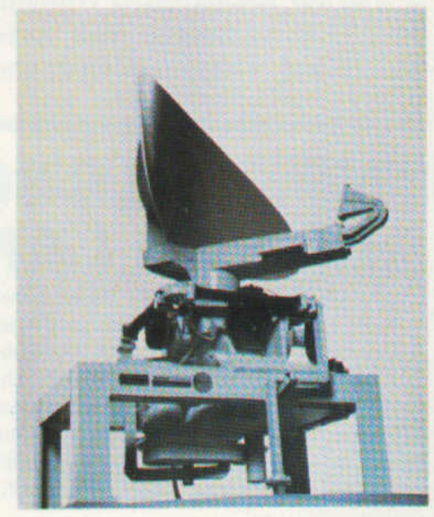
Surveillance radars S810 (general purpose) and S810P (anti-sea-skimmer) are lightweight stabilised 3cm band radars for the smaller craft. The radars have detection capability to the radar horizon on surface targets and considerably longer range than this on air targets. The S810 has increased detection capability and a higher data rate to counter the sea-skimmer threat. Target detection and allocation is carried out at the tactical command suite, in which are mounted 50cm computer driven displays providing automatic and rate aided tracking of the targets and also track labelling. The surveillance radars also provide accurate target data to surface-to-surface missile systems.

Surveillance radar S820 operates in 10cm band, having a greater range performance on air targets. The system is suitable for the larger class of vessel.

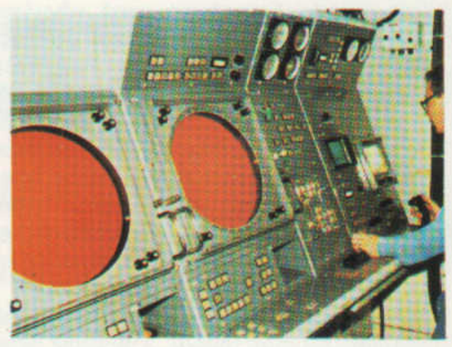
Tracking radar

The ST802 fully automatic tracking radar gives accurate space-stabilised target data for a variety of weapons. The radar is autonomous and generates its own stabilised search patterns based on target indication data provided by the surveillance radar via the command suite. The ST802 radar also has a continuous rotation self-surveillance mode to augment the sea-skimmer detection capability of the surveillance system. The tracker can be fitted with an autotrack television system, an autotrack thermal imager system and a laser range finder.

ST802 lightweight tracker with IR camera



S810 lightweight surveillance antenna



Tactical command suite

TEPIGEN image generating system

TEPIGEN is the system for generating and controlling visual scenes by computer, designed and developed by the Instrumentation and Training Systems Division of Marconi Radar.

TEPIGEN uses the technique of computer generated imagery, and presents a picture which is wholly computer generated. The synthesized picture is constantly composed at television rate and can be provided in full colour or in black and white. The television scene can be displayed as seen from any point by suitable mathematical processing of the stored co-ordinates; it alters in accordance with the operation of the controls, without the limitations of cameras and models.

Scenery produced by TEPIGEN is suited to both training and assessment simulators, for applications such as ship handling, periscope viewing, vehicle driving, aircraft flying, weapon aiming and optical tracking.

Applications of TEPIGEN developed by Marconi Radar and in service in the United Kingdom and other countries include:

GUN AIMER TRAINER

The gun aimer trainer system provides practical aiming and tracking instruction in the use of gunsights and gunlaying apparatus for crews of anti-aircraft and anti-ship weapons. The trainer can also provide simulated battle conditions and environment.

GUIDED WEAPON TRAINER

This is a single position trainer for aimers whose task is to control anti-aircraft or anti-tank weapons to intercept a target which is already being tracked. The appropriate eyepiece is used to view a TEPIGEN picture of the target following a course which may be programmed into the computer by the instructor.

MULTI-POSITION TRAINER

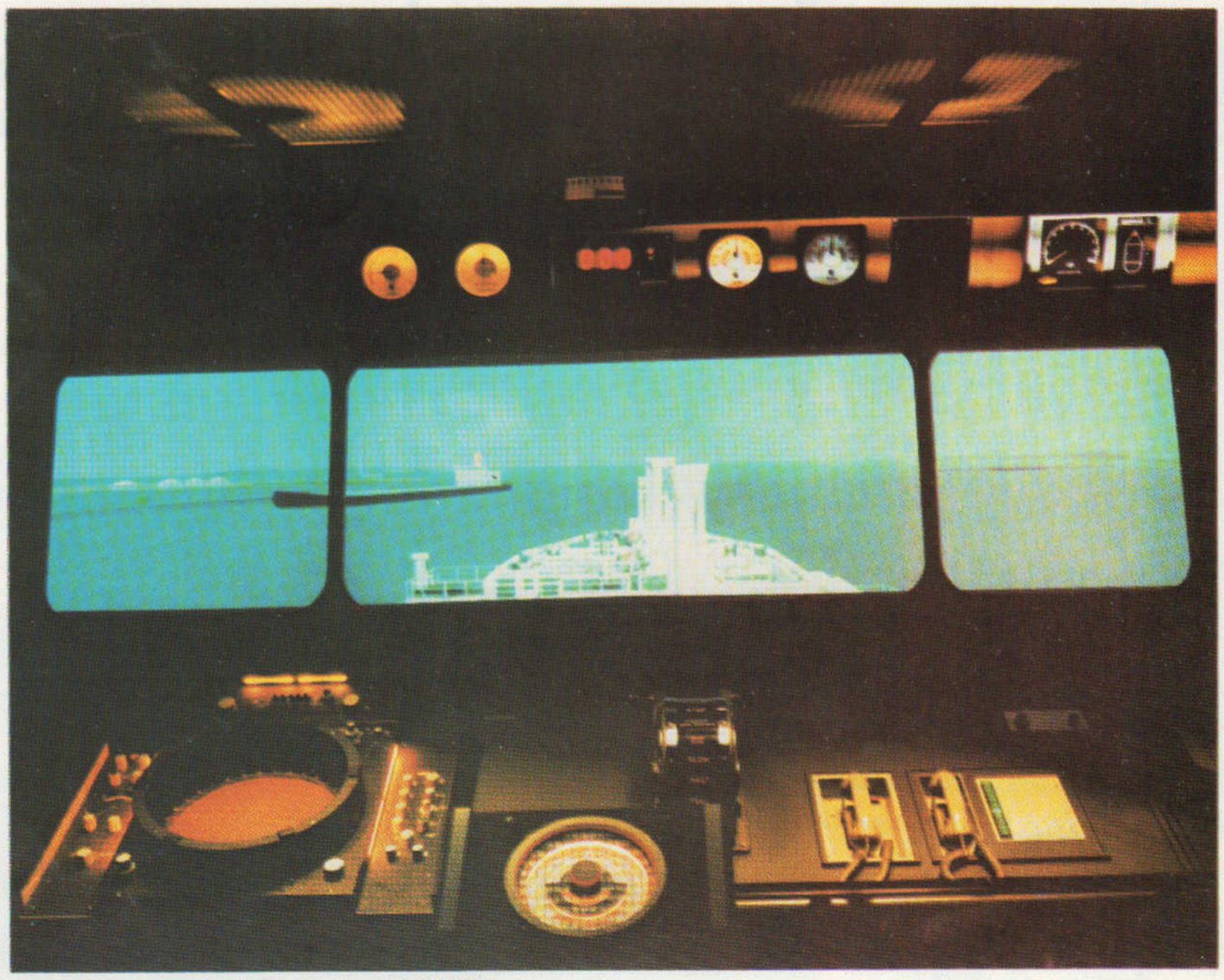
The multi-position (classroom) trainer for trackers and aimers uses the actual operator controls and eyepiece interfaced to a common TEPIGEN system. The exercise presented to each operator is the same but the necessary degree of independence is given to each position for the performance to be assessed individually. Optical tracking of most forms is covered by the trainer.

SHIP SIMULATOR

This simulates the bridge of a ship, complete with controls, instruments, radar, navaids, etc., where the external view is provided by a wide angle TEPIGEN display. Bridge teams can practice ship handling manoeuvres, rules of the road, navigation, radar and communications procedures, equipment failures and emergencies.

FLIGHT SIMULATOR

The advantages of computer generated imagery for flight simulators — flexibility, inter-action, control of moving target, light or visibility conditions — are now well established. These, combined with features unique to the TEPIGEN system, provide the important visual cues normally available to the pilot in different light and weather conditions, and allow him to make those decisions, often the most critical, which result from what he sees outside the cockpit. Not only can take-off, approach and landing be made more realistic, but low level flight, navigation, ground attack and weapon delivery can be added to the training role of the simulator.



CASSIM ship simulator using TEPIGEN

Sea-Watch and Accord radar beacons

500 Sea-Watch Racons have now been delivered to 35 territories around the world. Installed as radar beacons in areas as wide apart as the Antarctic, Arctic and the tropics, they mark lighthouses, buoys, oil-rigs and other navigational hazards. Installed as transponders, they mark pilot boats, range safety craft and other units such as light aircraft.

In Canada, the Canadian Coastguard has acquired further Racons to augment those already marking channels in Arctic waters, some north of 70° latitude. These radar beacons mark the difficult approaches to the oil fields and offshore mineral prospects in the North West Territories. They will shortly be joined by more Sea-Watch 300's supplied to Dome Petroleum, users of Marconi beacons since 1975.

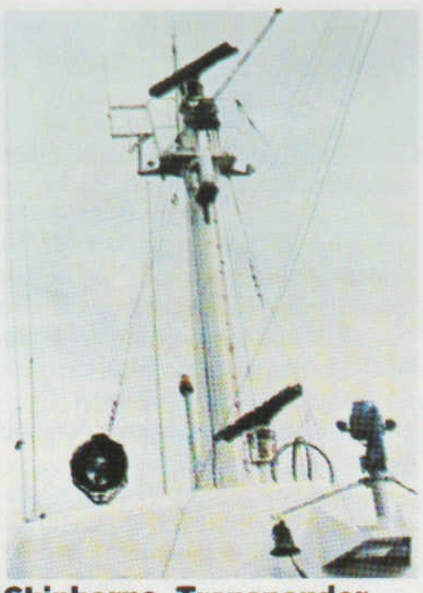
PAN-CLIMATIC

There is even a Marconi Radar marine transponder in the hostile environment of the Antarctic. This Sea-Watch 300 Racon, recently installed on a drifting buoy, forms the point of reference about which the Royal Research Ship John Biscoe executes sweep patterns in its important plankton sampling studies in southern waters. The purpose of the Racon is to aid perception of the buoy in clutter and to facilitate retrieval should contact be lost in the area's frequent storms.

The pan-climatic utility of the design is illustrated by the delivery to tropical New Guinea of their first Racon, the modest power consumption and high reliability of the design being particularly welcome to authorities deploying beacons in remote and inaccessable areas.

SEA-WATCH ACCORD

The Sea-Watch Accord Racon is a new generation device which responds at interrogation frequency and displays much more frequently than previously. With the extensive assistance of the Northern Lighthouse Board, trials were recently held off St. Abbs Head lighthouse, where the performance of the Accord Racon was compared with fixed and swept frequency versions of Sea-Watch 300. The improved design of Accord, coupled with its higher power and sensitive superheterodyne receiver, significantly extended the range, a particularly important feature for use in traffic separation schemes for offshore use and for vessels making landfall. The frequent display updating is particularly useful in harbours and other short range stations.

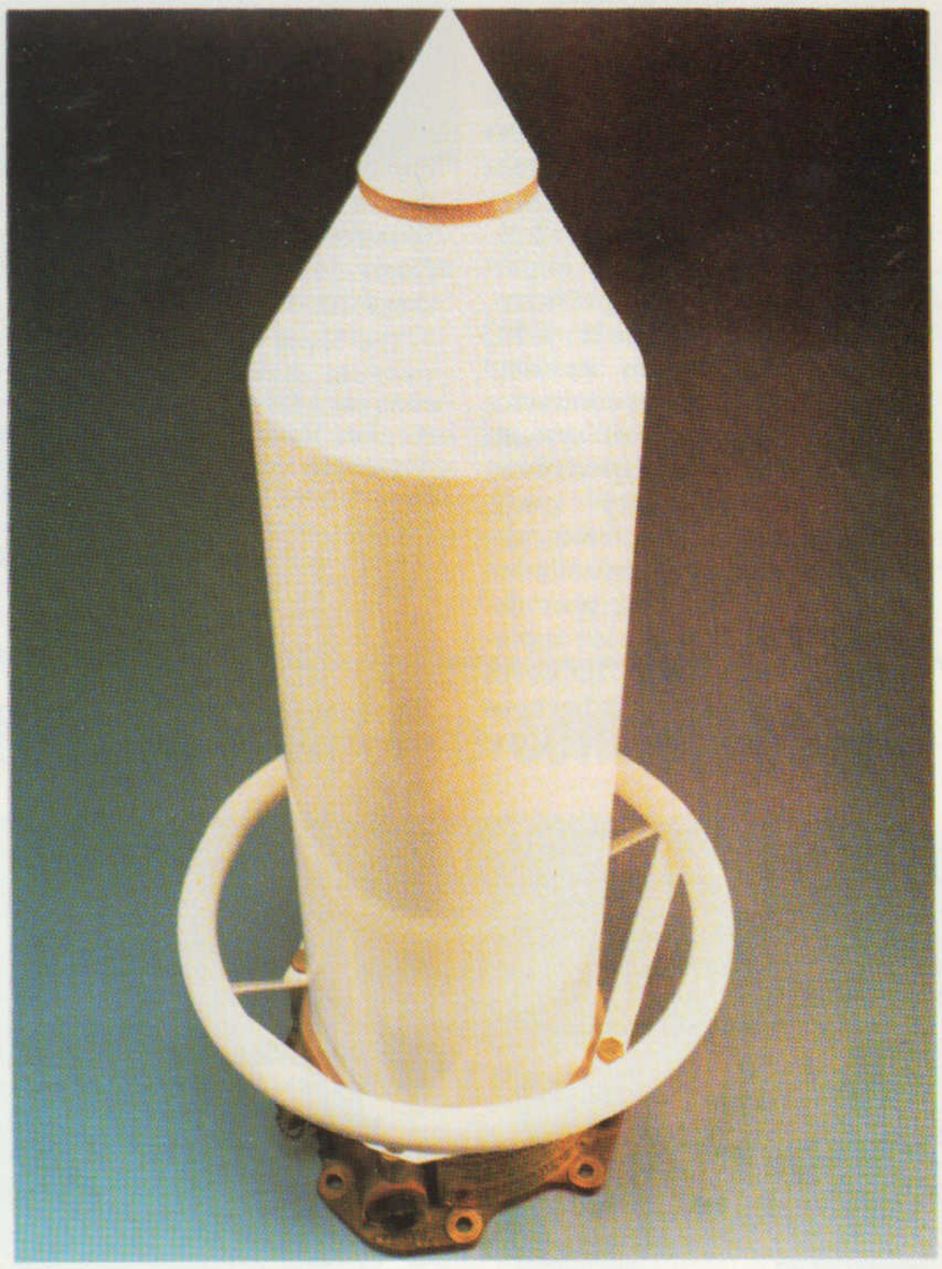


Shipborne Transponder installation

Trials were also made of the Accord sidelobe suppression system, this being an important fea ture for conditions where there is heavy traffic at short range, such as a harbour thronged with radar equipped yachts.

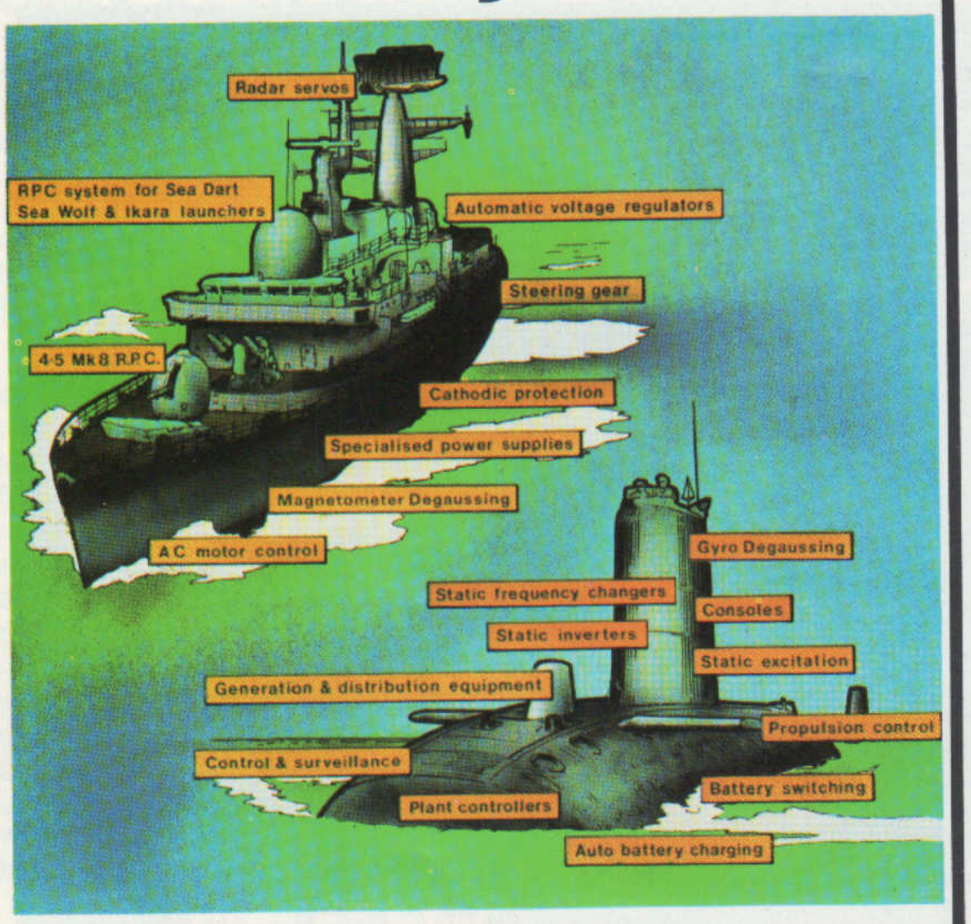
Opportunity was also taken to compare Accord, working in the newly developed fixed offset frequency mode (FOF), with fixed frequency (FF) Sea-Watch 300 Racons type 5B. FOF responses are offset some 50 MHz from radar frequency, FF responses being at band edge, 9310 MHz. The new mode obviates technical difficulties which prevent general introduction of a fixed frequency Racon service.

Retained are the three forms of presentation available to the observer of a suitably equipped radar: radar/Racon returns on alternative scans, the normal pre sentation; radar only, used when the Racon station has been fixed: Racon only, where radar returns are temporarily suppressed to permit detailed examination of Racon traces unimpeded by clutter.



Sea Watch 300 Racon

Marconi electric control systems



Marconi Control Systems capability

THE Naval Control Systems Department of Marconi Radar, associated with naval equipment since the 1930's, designs and manufactures a wide range of weapon servos and electrical control systems to meet the stringent requirements of defence specifications and standards. Most of these designs have been sponsored or subsequently adopted by the British Ministry of Defence (Navy).

Apart from the main group of products such as weapon servos, power generation, conversion, distribution and protection equipment, expertise is also available to design special purpose systems for such purposes as degaussing, cathodic protection and specific plant control.

Since the Department is part of the main Marconi Group, itself part of the large GEC organisation, it is in an ideal position to act as main contractor for complete electrical systems and to undertake all aspects from the initial feasibility study, through project definition, design, manufacture, installation and commissioning to post design services. World-wide representation not only improves liaison but also allows indigenous manufacture or supply of some items. The Department also undertakes the project management and overall responsibility for complete control systems. All work is subject to strict quality assurance and Defence Standard procedures.

The main areas of interest, shown on the illustration, are concerned with primary and auxiliary plant controls for surface ships and submarines, including power generation, distribution and conversion, and with system controls for guns, antennas and missile launchers.

Remote power control (RPC) systems have been designed, developed and manufactured for the launchers and mountings of the Royal Navy's latest weapon systems including those for Sea Dart, Seawolf, RN Ikara, and those for the 4.5 Mk 8 gun.

The Naval Control Systems Department is the nominated main contractor for the degaussing system for the Royal Navy. Recently, a degaussing system has been ordered by a United States shipbuilder. A versatile impressed-current cathodic protection system is available and suitable for fitting in vessels of 100 tons or more. The system is designed to full British Ministry of Defence (Navy) standards and can be installed during the shipbuilding phase or during a normal refit.

HMS Brecon

Marconi environmental transmissometer

MET-3, the Marconi environmental transmissometer, is a folded baseline instrument designed for measuring atmospheric transmission in a wide variety of environments. MET-3 is rugged, simple to install and requires the minimum of maintenance. The techniques used for providing operator useable visibility information have been developed and proven over the years in the Marconi IVR-Met instrumental visual range systems.

MET-3 includes its own electronic processor unit, making it suitable for applications where central processors are not required. The design also enables it to be incorporated into other meteorological systems with the minimum of interface problems.

The outstanding feature of all the Marconi instrumented visual range systems is the technique used of enclosing the optical photometer in a computer loop, making the instrument self calibrating. This improves measurement accuracy by a factor of ten, and enables slow degredation to be calibrated out, enabling the system to be operated within specified accuracy, for months without attention.

The availability of MET-3, a compact and rugged transmissometer, provides the answer to many of the visibility dependant decisions required to be taken on board ships. Watch keeping thresholds can be safely assessed by on-board instrumentation when other ship and land references are absent. Naval aircraft operations also benefit directly from on-board instrumentation which can be tailored to suit the particular approach lighting system.

Current recommendations for the operations of helicopters to and from oil and gas platforms call for the use of visibility assessment. MET-3, in its marine configuration, provides the platform controller with a continuous and up to date presentation of visibility. Where approach lighting arrays for night operation are employed, the 'lights' visibility can be provided. The platform instrumentation can also be extended to include cloud base assessment equipment and other sensors.

MET-3 Environmental Transmissometer

IVR-Met Test Site

Submarine Control Systems

THE naval and civil control systems department of Marconi Radar possesses a wide range of experience relating to the provision of submarine systems and equipment. Based on a history of involvement dating back to before the 1939-45 war, the department also has access to the expertise possessed by the overall GEC and Marconi organisations.

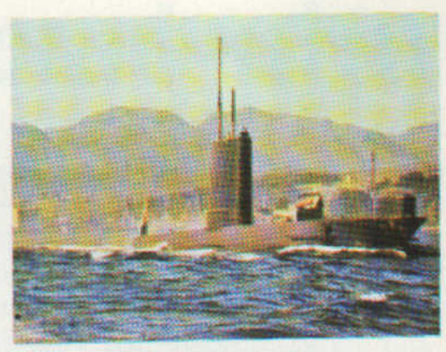
Submarine equipment has been supplied to countries all around the world. The department has also undertaken numerous major equipment studies, using advanced modern techniques. Trained personnel are available to deal with all facets of a design or system, with expertise also available to allow the department to act as main contractor for major submarine projects; for example, overall systems design, project co-ordination and supply of the propulsion system for the Royal Navy's Type 2400 patrol submarine.

The Company supplies a wide variety of equipment for submarines. For slow speed propulsion, a static drive unit is produced to give variable armature supply. Judicious setting of armature and field levels gives high efficiency at slow speeds. The static drive unit consists of a remotely controlled uni-directional thyristor chopper.

A propulsion system is provided to give automatic control of the main motor in all propulstion states. The system controls the starting and grouping camshafts and the field and armature drive units, provides and/or checks the interlocks and provides the automatic acquisition of desired speeds. Alternatively, a micro-processor based control system is available, offering full closed loop speed control and incorporating extensive self-checking and in-built test facilities.

For automatic battery charging routines, Marconi Radar supply a micro-processor based control system. This utilises the same hardware as the propulsion control electronics, but with a different software package. The charger controls the battery charging generator via the automatic voltage regulator. Less sophisticated battery charge control regulators are also supplied, all designed to charge the battery safely in the minimum time.

Static inverters are also supplied to provide main a.c. supplies. These inverters convert the battery variable voltage d.c. supply to 440V 60Hz three phase supply for distribution throughout the vessel. The converters are designed to have excellent transient performance and high efficiency.



RN patrol submarine HMS Osiris

Other devices provided by the department are machinery control and surveillance equipment; power generation; switchboards and distribution; control consoles, battery monitoring and switching; data transmission; analogue and digital plant controls; motor controllers, cathodic protection; degaussing; regulators for turbo generators: battery earth fault detection, regulators and reversible machines, and actuators.

Marconi
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