Radar Systems International

MARCONI

No. 11

REALISM WITHOUT RISK

Eurocontrol takes over comprehensive ATC simulator

A £1.5 million system to simulate air traffic control problems and evaluate possible solutions, without endangering lives or putting aircraft at risk, has been handed over to Eurocontrol at Brétigny, near Paris. The system is, in effect, a complete, automated air traffic control system, but working with computer-simulated aircraft rather than actual aircraft. The fifty display units employed in the system are driven by the peripheral computer complex consisting of Marconi MYRIAD II computers. Using data from the main computer complex, a completely realistic radar display is presented to each of the controllers.

In the simulations room at Brétigny (Eurocontrol photograph)

Designed and installed by a consortium of leading European electronics manufacturers, headed by Marconi Radar Systems Limited, the system will enable the operators to develop and evaluate new techniques, and to study air traffic problems in totally realistic conditions, without putting actual aircraft at risk. The system can also be used to train traffic controllers in the use of automated equipment.

All the processes carried out by an operational ATC system can first be put to practical test on this experimental system to assess their effectiveness. This offers the tremendous advantage that software can be de-bugged in the safety and relative calm of an off-line situation.

The European consortium which developed the system is headed by Marconi Radar Systems Limited, and includes Standard Electrik Lorenz A.G. of Germany, and S.A.I.T. Electronics of Belgium. Major consortium sub-contractors are Stansaab of Sweden and C.I.I. of France. The system was accepted recently by the French Minister of Transport, Monsieur R. Galley, acting in his capacity as President of the Eurocontrol Commission of Ministers.

Eurocontrol is now playing an active executive role in providing air traffic services in the upper airspace of its member states. The experimental centre at Brétigny exists to evaluate, develop and carry out operational research into air traffic control measures and procedures. It will also undertake the evaluation of air traffic control equipment and systems. The knowledge and experience so gained will be essential to the operation of the world's first Upper Airspace Traffic Control Centre built by Eurocontrol at Maastricht in Holland. The Brétigny Centre, established in 1963, has reached its present advanced level of simulation facilities in two stages: an air traffic simulator was first installed in 1967 to be followed now by this very advanced Experimental Data Processor (EDP).

The EDP is a fully engineered and fully operational automated air traffic control data processing facility with the capabilities of full flight plan processing, radar data processing, flight plan radar correlation and a certain degree of conflict detection. In the simulated environment of Brétigny, the data source is the air traffic simulator. This is a Telefunken TR4 computer providing radar data and flight plan information in exactly the same formats as would be produced in reality from radar plot extractors and data links. The main ATC data processing system is based on the two C.I.I. 10020 computers.

Although the EDP works in a simulated environment, it has the same radar/flight plan interface and man/machine interfaces as its operational counterparts now being evolved at large air traffic centres in Europe and the USA. It has, however, the advantage that traffic samples and geographic areas can be defined and identified specifically, giving a greater capability for analysis than would be feasible in reality. The same sequences can be repeated at will, to analyse or examine in greater depth the operational consequences of new control procedures. It is also possible to 'freeze' a traffic sample in mid-air in order to take a cross-section of the control situation at an instant in time.

Spotlighting the target

£2 million order for Chieftain tank searchlights

Crown copyright

The sudden shock of gunfire and the severe vibration of a 55 ton tank in motion—this is the environment for more than 500 searchlights ordered for use in Chieftain tanks. This is a major indirect export contract via MoD(PE) worth more than £2m.

The very high intensity light operates as a target illuminator and is mounted directly onto the gun turret. Its output can be normal white light or infra-red with ranges well in excess of 1000 yards.

This brings the total number of searchlights, supplied by the Company for use in Chieftain tanks, to over 1300.

STOP PRESS

Marconi Radar Systems, Leicester, has just received a further order from the Ministry of Defence (PE) for another £420,000 worth of Chieftain tank searchlights and spares.

New look radar for UK

A contract worth some £½ million pounds, to improve the performance and reliability of the 50cm radars which form the major part of the UK Airways en-route radar coverage, has been awarded to Marconi Radar Systems following a comprehensive study programme carried out by the Company in conjunction with the Civil Aviation Authority. The contract is aimed at providing a better radar service for air traffic controllers, both in terms of improving the radar visibility of aircraft, and in significantly reducing the time needed for equipment maintenance.

New digital signal processors from the Marconi S600 range will improve the moving target indication (MTI) performance and help to increase the visibility of aircraft to radar in conditions of heavy ground clutter. At the same time, new solid-state receivers, and the replacement of valve circuits in the transmitters by semi-conductors, will also contribute to improved performance and to the overall reliability of the radar system.

Nine Marconi 50cm radar equipments Type S264A will be covered in this modernization programme. These radars have given reliable service for many years and the improvements will extend their life by many more years. They are located at Heathrow, St. Annes, Ash and Ventnor.

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Flight plan processing system goes operational

Europe's most advanced system is handed over

Safety in air travel over England took a major step forward with the handing over in December last, after an extensive period of trials and evaluation, of Europe's most advanced fully automated flight plan processing system for air traffic control.

Designed by Marconi Radar Systems Limited, the £5 million computerized system at West Drayton processes and displays details of pilots' flight intentions in the middle airspace, and allows progressive updating of flight information for the many aircraft under control.

The system is based on triplicated MYRIAD computer systems, each operating independently on line and designed to provide such hardware system reliability that a time out of action of less than thirty seconds in five years is assured.

Speaking about the project, Mr. John Sutherland, Managing Director of Marconi Radar Systems said: 'The completion of this very advanced contract marks an important stage in the development of air traffic control equipment. In common with many other major real-time systems world wide, there were severe problems in the early stages in specifying and assessing the software task, and the computer storage requirement. We have had very considerable experience in air defence data processing systems, having completed thirty-eight major installations in the last decade, and the magnitude of this task has been greater than most.

'The system has now been running continuously for a year during commissioning and testing, and has been employed for many months for operational training by the user. We have demonstrated over this period that the reliability criteria, unprecedented in previous systems, will be fully met in service.

'In the course of this and other contracts, we have developed new hardware and software and have extended our system experience. This will enable us not only to carry out our role in the subsequent development of the British air traffic control facilities of West Drayton, but also to offer a unique and proven solution to this type of problem in any part of the world.'

FPPS computer room

System Operation

The information contained on the flight plans submitted by a pilot, is fed into the system via keyboards. Extensive checks are carried out, and only if the flight plan is fully credible is it accepted. The aircraft's intended route is constricted in terms of the points specified on the flight plan. These points are coded, and displayed along with the calculated arrival time over each point. Any other information, such as wind velocity and height changes affecting the times of arrival, is also fed in and accounted for so that the times are realistic. These times are thus a rationalized account of the aircraft's progress in terms which the computer system can understand, and any deviation can be immediately brought to the controller's attention.

Data displays and inputs are provided for fifteen controllers, with two separate allocator positions and four data-entry-only positions. Each controller has touch-wire displays for himself and an assistant, which provide the main input/output interface with the computers. He also has a 14-inch electronic data display (EDD), on which the details of every flight under his control are displayed.

The touch-wire units consist of an 8½-inch display with a transparent covering mask, into the lower half of which are inserted twenty-four short touch-wires in four rows, each of six wires. Information lists can be displayed to the operator with one item presented above each touch-wire. Data responses can be written electronically, by the computer, in the area above the touch-wire. For instance, the operator has the facility of displaying on demand, a line of data relating to one flight under his control. In the initial or 'rest picture' condition, the call-signs of aircraft pertinent to that control position are displayed, one above each touch-wire. Touching a wire under a particular call-sign will cause a picture change to take place, and a series of options will be displayed, each relating to a particular control operation to be performed on the flight data, e.g., 'amend level'. Making a further touch selection will present the operator with another picture giving the initial parameters required to carry out the input task. Subsequent touches and picture changes enable the input to be completed. Throughout the sequence the total message construction is shown on the 'scribble line', above the touch-wires.

At any time during the sequence of messages, the operator may back-track to the previous picture, or reject the whole message and return to the rest picture. When the message is completed, it is entered into the computer for appropriate action. If the message processing is acceptable, the display will revert to the rest picture. If the processor detects an error, the operator is presented with an error response above the touch-wires, and an error picture enabling him to reject the sequence. A typical error response is 'CAN'T PROCESS—HAND-OVER IN PROGRESS'.

The data display consists of a 14-inch EDD which displays a line of data for each flight pertinent to that control position. Columns of information might typically consist of: Call-sign, R/T channel, SSR code, cleared flight level, route details, etc.

System Reliability

The specification calls for four system reliability requirements as follows:

1. not more than one interruption in processing, lasting less than 30 seconds in one year:
2. not more than one interruption in processing, lasting longer than 30 seconds, in five years:
3. data must not be mutilated by power supply failures:
4. faults must be repaired, or faulty equipment replaced, within ten minutes in the operations room, and within two hours in the equipment room.

Calculations of hardware reliability of the triplicated Myriad system indicate that, with adequate spares holdings, a performance better than the above can be expected, and these calculations are supported by the equipment reliability experienced so far.

Central Computer Complex

The FPPS central computer complex consists of three identical processing 'prongs', each of which receives all input data and performs all FPPS calculations. Only one prong outputs to peripherals, this is known as the 'control prong', and the other two are known as 'check prongs'. Input data from peripherals is compared between all prongs, transferring messages via the computer transfer modules, and only if they all agree will the data be accepted. After processing, the results from all three prongs are compared. A 'majority voting' system is employed, so that if two prongs agree, and the third disagrees, the disagreeing prong is deemed to be wrong, and appropriate action is taken to ensure that incorrect data is not displayed to operators.

ALL ABOARD THE BRISTOL

£3 million role of GEC-Marconi in RN's new destroyer

Just entering service, the Royal Navy's largest guided missile destroyer, HMS Bristol, carries an impressive range of electronic equipment, supplied by companies within the GEC-Marconi Electronics Group. The Companies contracts for this ship exceed £3 million and include radar, weapon, communication and ancillary systems which make HMS Bristol one of the most potent ships of its type in the world.

Surveillance and tracking radars, remote power control systems for all the main armament, hull protection equipment and static power supplies have been supplied by Marconi Radar Systems Limited.

The ship's communications system is largely made up of equipment from Marconi Communication Systems Limited, and provision is made on the vessel for the satellite communications system, SCOT, developed and built by Marconi Space and Defence Systems Limited. The complete homing system for the Sea Dart missile together with shipborne check-out and automatic test equipment is also provided by Marconi Space and Defence Systems.

Radars

Radar information on ship and aircraft targets is fed to the ship's tactical nerve centre, the Operations Room, from the Type 992Q target indication radar providing accurate space stabilized data for the ship's weapon systems.

The long range aircraft warning radar on HMS Bristol is the Type 965, which has a long history of reliable service. It is a high-power, metric radar for the long range requirement, and is fitted with equipment enabling it to differentiate between aircraft echoes and clutter. It also incorporates an identification system (SIF) to discriminate between friendly and enemy aircraft.

Weapon Systems

The Sea Dart missile radar is the Type 909, developed and produced by Marconi Radar Systems. Although designed specifically for the Sea Dart, it is used in HMS Bristol for gun control as well. A target is tracked automatically by the 909 radar after its initial detection by the Type 992Q. A Sea Dart missile, launched against the target, will then home on the signals from this radar reflected from the target. The Type 909 system incorporates a number of features to reduce the effect of counter-measures or decoy techniques. Twin 909 radars are installed on board HMS Bristol in radomes situated fore and aft of the main superstructure.

Power and Ancillary Equipment

Remote power control systems have been supplied by Marconi Radar Systems for the electric steering gear as well as for all the weapon systems on board HMS Bristol. These include the systems for the IKARA anti-submarine missile and the Anti-Submarine Mk 10 mortar as well as the Sea Dart launcher and the Vickers 4.5-inch Mk 8 gun. Cathodic protection equipment has also been supplied by the Company to give automatic protection from corrosion of the ship's hull. Motor thermal protection units, static frequency changers and automatic voltage regulators have been provided for various applications on board, including the power supply for the Mk 19 Compass.

Built at the Wallsend Shipyard of Swan Hunter Limited, HMS Bristol has a full load displacement of 6,750 tons, an overall length of 507ft and a maximum speed of 30knots.

HMS Bristol

Successful trials of 23cm Radar

The latest clutter-free radar system to be developed by Marconi is the 23cm radar Type S654 which has recently been subjected to extensive tests and proving trials at the Marconi test site at Bushy Hill, Essex. In this version the peak power of the radar is limited to 610kW which enhances the suitability of the radar in an airfield approach and departure role by limiting unnecessary radiation and unwanted returns. Successful flight trials were carried out at Bushy Hill with the CAA in June 1972 and a report has been issued by the CAA confirming the suitability of this radar in a TMA role. During these trials, approach and departure procedures were carried out by aircraft simulating the flight patterns of Heathrow airport.

23cm radar

The Type S654 has been developed to give similar performance to 50cm radar giving the customer a choice of either 50cm or 23cm in the Marconi range—both providing clutter-free performance. A higher powered version of this radar, with a peak power of 2.3MW, is already in operational use by the Canadian Forces at air bases in Canada and West Germany.

Special features of the system include a twin-horn aerial feed, circular polarization, p.r.f. stagger and p.r.f. discrimination. Due to extremely low pulse-to-pulse amplitude variations and exceptional frequency stability, this 23cm radar has an excellent MTI performance. The use of a dual beam extends the low-angle coverage, improves the radar returns from small aircraft and gives a much enhanced signal-to-clutter ratio.

TOP CAA MEN AT MARCONI

Following the successful completion by Marconi of two of Europe's most advanced, computer-controlled air traffic control systems, a group of the country's foremost experts from the Civil Aviation Authority, including the Chief Scientist, the Director of Technical R&D and the Director General of Telecommunications, spent a day at Marconi Radar Systems.

Discussions and demonstrations during the visit covered a wide range of subjects in the field of air traffic control radar systems, including the application of new techniques for signal processing and data handling and the participation by Marconi Radar Systems in the future development of the UK Air Traffic Control system.

The party, shown here with the Company's MYRIAD III computer are, Right to Left: *Mr. D. E. Morris*, CAA Chief Scientist, *Mr. J. W. Sutherland*, Managing Director, Marconi Radar, *Mr. T. J. McWiggan*, CAA Director General of Telecommunications, *Mr. R. W. Simons*, Technical Director, Marconi Radar, *Mr. I. F. Donaldson*, Technical Manager, Marconi Radar and *Mr. O. B. St. John*, CAA Director of Technical Research and Development.

Lightweight champions of the world

Compact weapon radar systems

Display aircraft at Farnborough, ranging from the Concorde to small high-speed aerobatic aircraft, were automatically tracked in a continuous demonstration of the Type ST801 weapon radar, with its automatic television control system. Also on show, from the same 800 series of compact, lightweight 3cm (X band) weapon radars, was the Type S810 surveillance radar.

A replica of part of a ship's superstructure provided a realistic setting for the Type ST801. The radar director, with its television camera aligned with the radar beam, was mounted on the bridge. Situated alongside was a lightweight Short TIGERCAT launcher, loaded with three dummy missiles, as an example of the type of weapon for which this new radar can provide the auto-tracking function.

During the demonstration, target acquisition and tracking sequences were initiated by an operator seated at the ST801 control console in the main pavilion. A window overlooking the equipment compound enabled visitors to see the motion of the radar aerial, either in response to the operator's commands or during automatic tracking of the target. Pictures of target aircraft on the television monitor clearly demonstrated the speed of radar acquisition and the accuracy of target tracking.

ST801 television console

Normal shipborne operation of the ST801 is entirely 'hands off' and a separate radar operator is not required. The director incorporates a 1 metre diameter antenna aligned with a television camera which is locked onto the target during tracking. Initiation of the target acquisition and tracking sequences is carried out by the ship's threat evaluation and weapon assignment system which selects an appropriate weapon to engage the target and transfers the control of the ST801 to a master programming unit.

Designed for small ships down to fast patrol boat size, the ST801 consists of a director mounted on the superstructure, with the transmitter/receiver and control consoles below. The overall weight is only just over a ton and all units are fully ruggedized for the maritime environment.

Development of the 800 series has been carried out entirely as a private venture in a period of less than two years.

Swedish forces shown S600

A party of senior officials from the Swedish armed forces visited Marconi Radar Systems Limited at Chelmsford, where they met directors and other senior members of the Company. Various aspects of S600 mobile radar systems were demonstrated, including plot extraction in conjunction with the S5014 operations cabin. The picture shows the visitors leaving the cabin. Left to right are *Mr. J. Wild*, *Major General N. G. Skold*, Chief of Army Materiel Department, *Lieutenant Colonel B. B. S. G. Akerhielm*, Chief of Technical Intelligence Staff, *Director General Sten Wahlin*, Chief of Materiel Administration, *Mr. H. N. C. Ellis-Robinson*, *Mr. J. W. Sutherland*, Managing Director of Marconi Radar Systems, *Captain A. E. Farnell*, Chief of the Director General's Staff and *Mr. M. T. Daniells*.

Marconi measures the visibility

IVR Operational at Three Major UK Airports

Aircraft at Heathrow, Gatwick, and Manchester Airports can now be operated confidently at minimum permissible runway visual range. This follows the introduction into full service of the Marconi IVR-1 system at these three major airports. This system automatically measures the visual range along the runway, with a high degree of accuracy, and presents a continuously updated reading of this range as conditions vary without any operator intervention. Similar systems at Glasgow and Liverpool are expected to be operational shortly and a further system is being purchased by the Civil Aviation Authority.

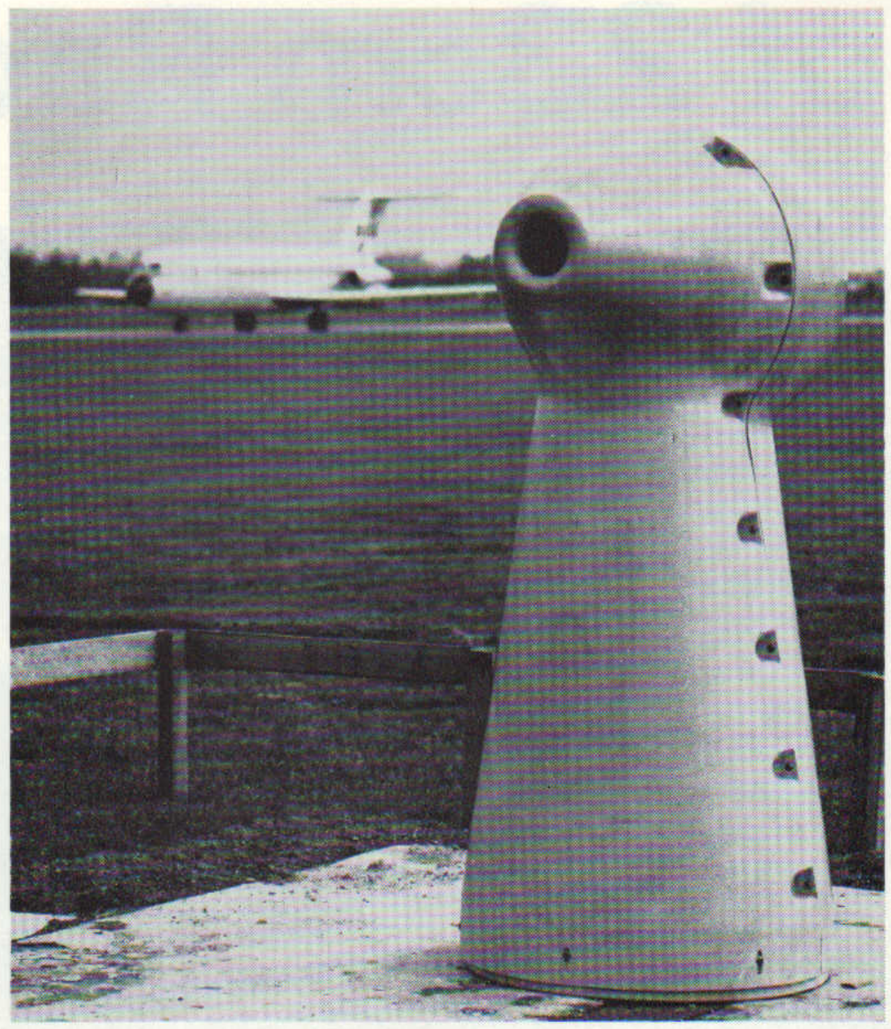
Flying operations are divided into three categories. In each case, there is a minimum value of runway visual range (RVR) below which operation is not permitted. The Marconi IVR-1 system is the first in the world to be certificated for use in all three categories of landing operations and for take-off in low visibility conditions.

Several factors affect the range of vision of a human observer and automatic assessment of visual range is not a straightforward task. For instance, during the day the problem is one of recognizing objects in contrast to their background, whereas at night or in foggy conditions recognition is based on the perception of primary or secondary light sources. In the past, runway visual range has been estimated from the number of runway lights visible to a ground observer. In the IVR-1 system, background luminance, atmospheric transmission and intensity of lighting are taken into account and measurements are usually made at three different positions along the runway.

Considerable technical difficulties have been overcome in achieving safe and accurate assessment of visual range and particularly in the method of processing measured visibility data to provide an accurate and stable RVR display. The optical system is situated in a specially developed air flushed housing. A computer scales the optical data against built-in references and displays the visual range in digital form. The accuracy with which photometric measurements are carried out at the unattended field sites is extremely high and a maximum error of 0.25% is regularly achieved. This figure does great credit to the optics, made by Erwin Sick of Munich.

In order to accommodate rapid fluctuations in atmospheric transmissivity data, the system samples the visibility at a rate well in excess of 10Hz, which is the highest frequency component of fog, and then applies analogue smoothing. Computer calculation of a running mean further improves the output until it is decidedly better to use than the reports of human observers, who do not have powers of quantitative association between one reading and the next.

Marconi Radar Systems of Leicester has designed IVR-1 to the specification of the United Kingdom Civil Aviation Authority (CAA) and development has been conducted in liaison with the CAA. After an evaluation period extending through two winters at four major UK airports (the interim report issued by the Department of Trade and Industry was discussed in the No. 7 edition of this journal), the IVR-1 system has adequately demonstrated the advantages of automatic RVR assessment and display. Reports from more than 90,000 machine hours of use has enabled the assembly of a unique collection of 'fog' data which is being analyzed so that further advances in the utilization of visibility data can be implemented.



IVR at Gatwick

Remote displays

RADAR BY TELEPHONE

Telephone lines link displays and remote radar site

Comprehensive radar displays linked only by ordinary telephone lines to a remote radar site are made possible by the Company's new primary radar plot extractor, Type S7200. This new system was demonstrated at Farnborough when plot extracted information from a radar site some eighty miles distant was displayed without any loss of detail.

By using a MYRIAD III computer to correlate successive positions of each target echo, the displays at Farnborough were able to present the current position, direction and speed of aircraft flying over the whole of South-East England.

The radar video signals were originated at Rivenhall, in Essex, by a Marconi 50cm radar, Type S650, providing radar cover over the south-east of England. These signals were fed to the S7200 which extracted the current position of all the targets and transmitted this information as a narrow bandwidth signal over a standard, switched telephone line to the display system at Farnborough. Plan position and tabular displays were provided at each operator position together with a tracker ball and light pen to enable the operator to communicate with the computer when detailed information was required concerning any particular target echo.

This demonstration clearly presented the advantages of plot extraction, in that optimum system performance can be obtained at all times during operation and is not affected by the ability and concentration of the operator. Variables such as 'probability of detection' can be accurately set and maintained for as long as necessary with absolute consistency.

The displays provide a bright presentation, because, unlike the normal radar picture which is painted only once during each aerial rotation, all displayed information is computer generated and can be refreshed at a high rate. A video map indicating an area of controlled airspace can also be presented from data stored in the display computer system.

Generation of display tracks is achieved without any operator intervention. For more information on any one aircraft being tracked, an operator can point his light pen to a particular track and obtain a readout on the tabular display of precise speed, direction, position and any other relevant information.

In air defence, automatic plot extraction enables the flight paths of hostile aircraft to be quickly and accurately predicted and presented on a display without any dependence on the operator. In air traffic control, it provides the means of achieving the high standard of flight prediction necessary for safety in air travel.

Raiders routed

Marconi radar contributes to success of Far East air defence exercises.

Marconi Radar Systems has supplied three transportable defence radar systems to the Royal Malaysian Air Force which play a vital role in Malaysia's defence capability. The contracts for this equipment were placed following the visit to Marconi at Chelmsford of a high level delegation led by Air Commodore (now Air Vice Marshal) Sulaiman bin Sujak, A.M.N., Chief of Air Staff, Royal Malaysian Air Force.

The transportable radars are based on the S600 series and the contracts included the training of RMAF personnel at Marconi College in Chelmsford. The S600 series of radar consists of compatible radar units and auxiliary units all of which can be air lifted. Applications range from simple surveillance for early warning, gap filling and coast-watching to complex air defence systems.

The Malaysian 'Straits Times' dated November 25th 1972, in an article headed 'Key role of radar in air exercises' reported:

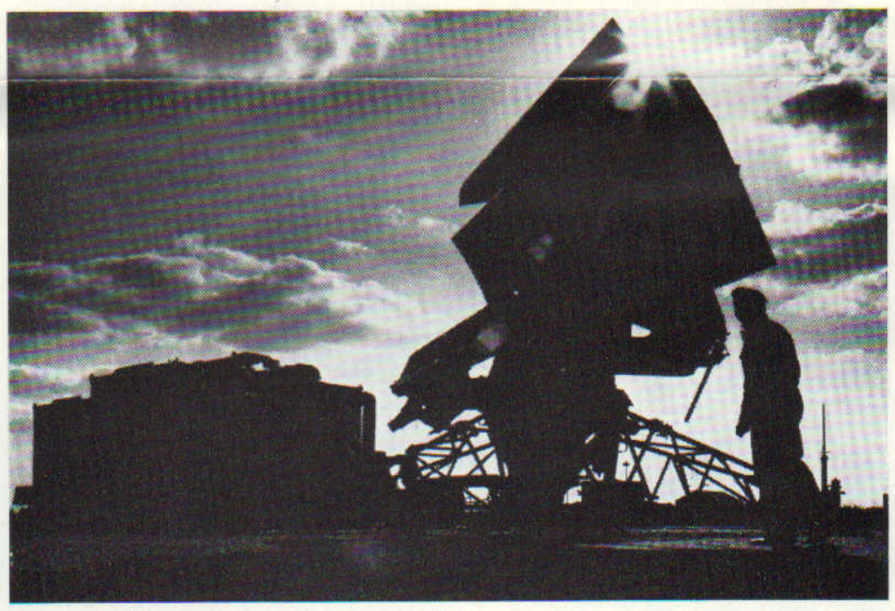
'Two new RMAF radar installations at Kuala Lumpur and Kuantan were introduced to tie in with the radar networks at Bukit Gombak, Singapore, and Butterworth during the two-day air defence exercises which ended yesterday.

"Their introduction has extended radar coverage of the whole of Malaysia and Singapore, and has contributed significantly to the success of exercise *Bersedia Lima*," Flt. Lt. J. W. Lanham, spokesman for the five-nation Integrated Air Defence System, which held the exercise, said.

'IADS commander Air Vice-Marshall R. T. Susans said "Bersedia Lima" was by far the most successful of air defence exercises held so far.

'During the exercise, Butterworth and Tengah airfields were subjected to nearly 150 "raids" involving 170 aircraft from the member nations—Australia, Malaysia, New Zealand, Singapore and Britain.

'Early analysis indicated that 95 per cent of the attacking aircraft were successfully intercepted by the fighter force, or "shot down" by ground fire before reaching their targets.'



S600 surveillance aerial and operations cabin

 Designed by London Typographical Designers Limited and printed in England by Raithby, Lawrence & Company Ltd, Leicester 8 m 3/73. 3097