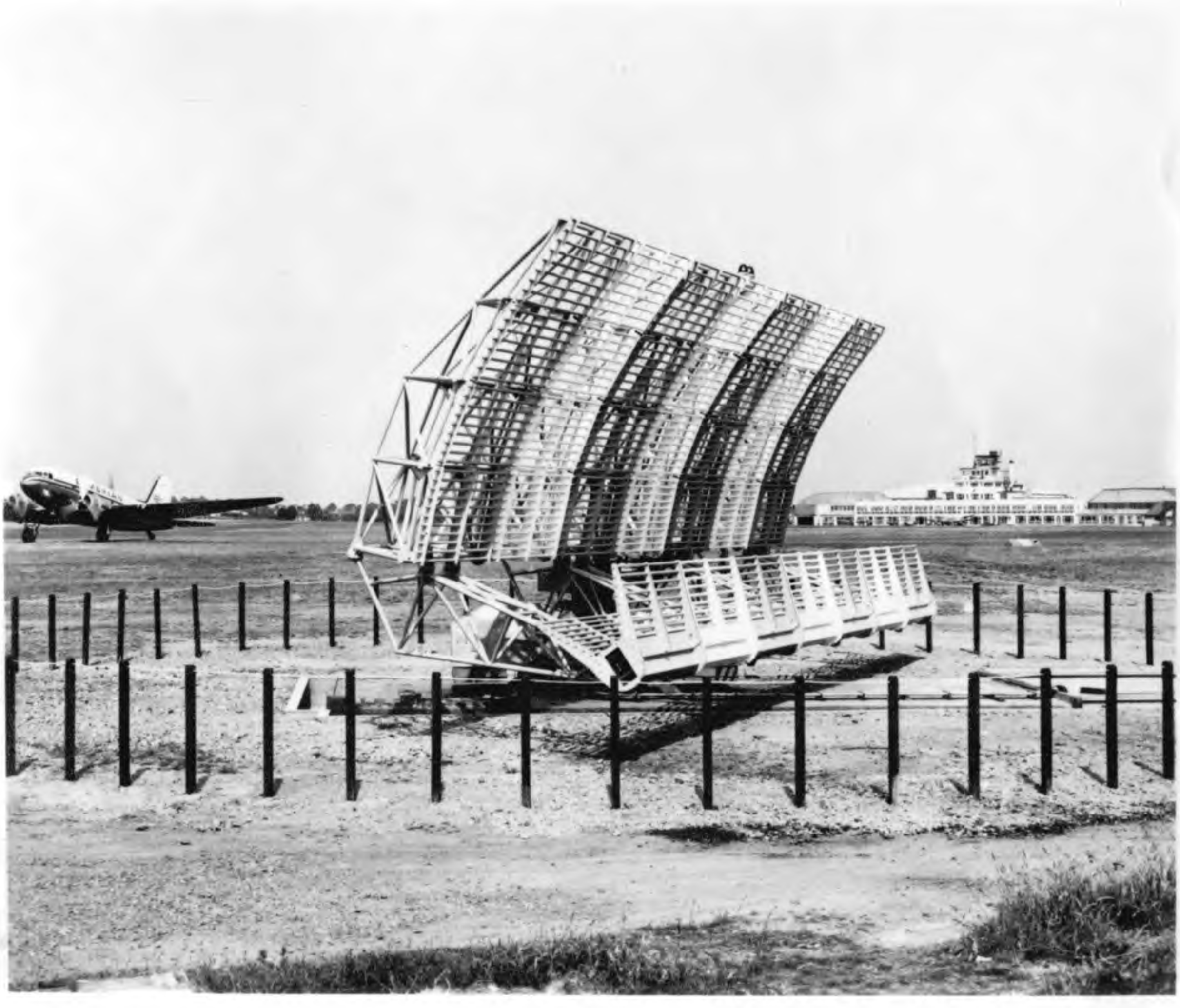
Marconi Radar



JERSEY AIRPORT. - Photographed by permission of the States of Jersey Harbours and Airport Committee.

Type S264 Series

GENERAL DESCRIPTION

OF

RADARS S.264 SERIES

FOR

TERMINAL AREA AND AIRWAYS SURVEILLANCE APPLICATIONS.

Ref: SQ.127/3.

IMPORTANT

This description is only intended as advance information of the leading parameters of the equipment and must NOT be used as a performance specification.

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

MARCONI HOUSE, CHELMSFORD

ESSEX, ENGLAND

GENERAL DESCRIPTION.

This pamphlet is a brief description of the main features of the Marconi Terminal Area and Surveillance Radars S.264 and S.264A. These equipments are essentially a logical development from earlier equipments and represent a considerable advance in the field of civil aviation radar.

When Marconi's Wireless Telegraph Company introduced the Radar Type S.232 in 1954 it was an entirely new concept in terminal area radar. The use of a 50cm. wavelength and crystal control in order to achieve the best possible performance under all weather conditions together with a highly efficient M.T.I. was a fresh approach to the radar problem. The considerable success achieved by this equipment throughout the world and the trouble free operation of the very first production equipment installed at London Airport, has completely justified the use of 50cm. for Air Traffic Control purposes and has proved the reliability of the whole system.

The results achieved inspired the Company further to develop equipment in the 50cm. band to meet the future needs of Air Traffic Control and the world-wide adoption of the S.264 series of radars has confirmed the correctness of the Company's approach to the radar side of the A.T.C. problem.

One of the difficulties facing the designer of radar equipment which has to operate all over the world is to ensure that it can meet a wide variety of different operational and technical requirements without modification to the main units of the system. This has been achieved in the case of the S.264 radars by ensuring that the system is built up from a number of different elements which may be flexibly arranged in a variety of different ways.

Basically there are four different radars which are built up from two different aerial systems and two different transmitters. These are as follows:-

Radar S.264	- uses a parabolic aerial and has a peak power of 50 - 60 KW.
Radar S.264/H	- uses a specially shaped aerial for additional high cover and has a peak power of 50 - 60 KW.
Radar S.264A	- uses a parabolic aerial and has a peak power of 500 KW.
Radar S.264A/H	- uses a specially shaped aerial for additional high cover and has a peak power of 500 KW.

The outstanding feature of radars operating in the 50cm. (600 Mc/s) band is their comparative immunity to precipitation clutter. At this wavelength the energy back-scattered from rain, snow and clouds is 28 db less than at 10cm. and it is therefore only rarely that rain is heavy enough to obscure aircraft echoes on the display although the severe cumulo-nimbus type of storms generally backscatter enough energy to be seen and to allow controllers to direct aircraft around them. This feature means that polarisers need not be used and there is therefore no performance degradation in bad weather when the radar is most needed

The S.264 and S.264/H can be used for the following functions in or near a terminal area:-

(a) Monitoring aircraft on airways at the approach to the control zone.

(b) Control of aircraft in the holding stacks and feeding them from the stacks into the I.L.S. or P.A.R. gate.

(c) Providing limited P.P.I. controlled approach to runways in the event of failure of I.L.S. and/or P.A.R.

(d) Taking control of outbound aircraft and feeding them on to the airways. As aircraft can be seen as soon as they are airborne, due to the good M.T.I., identification procedure is not required and traffic may therefore be rapidly cleared from the terminal area.

The S.264A can be used for all the above terminal area functions and in addition the increased performance provides cover out to a greater range along the airways. It is also particularly suitable as a long range surveillance radar for monitoring airways where the air traffic density is high.

Up until the present, airways radars have generally been modified military equipments which are not only costly but are not entirely suitable for the purpose. Both terminal area and airways radars need to provide unbroken cover down to low angles of elevation and must be unaffected by rain, snow and other forms of precipitation.

Another factor favouring the use of a 50cm. wavelength is the fact that a comparitively low transmitter power is needed to obtain a relatively high performance compared to the use of shorter wavelengths. It is necessary of course to use a larger aerial system, but this is compensated as far as cost is concerned by lower tolerances required on the various dimensions and the fact that the reflector can be made with a much more 'open' construction. In addition, as polarisers are not necessary to remove rain clutter, the reflector can be conveniently constructed of light alloy tubes. There are considerable advantages in being able to employ a low power transmitter: not only is the capital cost much less but greater reliablity is easier to achieve; cooling arrangements are simpler and the cost of replacement valves and components is less.

Radar type S.264 employs a transmitter having triode output stages whilst the S.264A uses a 3 stage power klystron with a gain of 30 db. The valves used in the remainder of the transmitter and receiver are conventional and the whole equipment is designed to give trouble-free service for many years.

The vertical cover diagrams at the end of this Pamphlet show the cover which can be expected from Radars S.264 and S.264A with a mean aerial height of 12 ft. (3.7 metres) (Drg. No. RS/B1843). The second diagram (Drg. No. RS/B1842) shows the cover obtainable with the specially shaped aerial system which has a smaller cone of silence at the expense of some loss of forward range. These diagrams are based on the latest information and the previously issued ones are obsolete.

As can be seen from the diagram the performance of S264, with a power output of 60 KW, is as good, if not better than that obtainable with much greater power on shorter wavelengths. The performance of the S.264A is adequate for civil aviation needs for many years to come.

Although the diagrams are drawn with a reflector tilt of $+4^{o}$ or 6^{o} this may be readily altered to any angle between -1^{o} and $+10^{o}$. The effect of changing the tilt angle is to alter the relative sizes of the upper and lower lobes but nor their elevation angles. These are determined by the electrical height of the aerial above ground and the nature of the topography around the radar site.

The S.264 and S.264A employ a fully locked and coherent M.T.I. system which is both more stable and more efficient than the conventional coho-stalo techniques normally used. In addition clutter fluctuations are relatively smaller at 50 cm and M.T.I. performance is further enhanced. The transmitter, reference oscillator and trigger pulse generator are all crystal controlled. No automatic frequency control is required as the receiver is locked to the same crystal as that which determines the final frequency of the transmitter. The stability and simplicity of the whole system together with its outstanding M.T.I. performance are unique. The low power S.264 can readily be converted into the higher power S.264A retrospectively.

The whole equipment may be broadly divided into two parts - the Aerial Head - and the Display Equipment. The aerial consists of a small concrete building which houses the Transmitter, Receiver and Control Rack and carries the rotating aerial system on the roof. The display equipment comprises the Radar Distribution Unit and the P.P.I. displays, the former being a single rack cabinet. The aerial head may be located up to 5,000 yards (4.6 Km) from the display equipment and is fully remote controlled for unattended operation.

The P.P.I. displays may be either of the fixed coil or moving coil type. The moving coil display Unit type SD.701 is a selfcontained console with a 12" (30 cm) diameter cathode ray tube with a magnesium fluoride screen. The Display is of an advanced type and has a number of special facilities which greatly enhance its usefulness. It is fully described in Marconi pamphlet reference TD.225. Up to eight Display Units type SD.701 may be used with a single aerial head.

A moving coil display is capable of providing a radar picture of high accuracy and is the most economic and suitable for applications where the radar information is read directly from the cathode ray tube itself. However in cases where data handling is required of where a large number of integrated P.P.I. displays are needed, there are considerable advantages in the use of fixed coil displays. The Marconi SD.1000 series of displays comprise of floor mounting console with a 12" (30 cm) diameter tube, a very compact table-top display with a 12" (30 cm) tube, another table-top display with a 15" (38 cm) tube.

All the above fixed coil displays can be provided with a number of Joystick controlled strobe markers or leading lines and rate-aiding facilities are available. The display system is broadly described in Marconi pamphlet SD219 although improvements are continually being made in the number of facilities provided in order to meet the rapidly increasing demands of air traffic control.

A particularly useful additional equipment is the Video Map type SD.100. This produces two electronic Maps simultaneously and facilities are provided on the P.P.I. display for the operators to select either map at will. The map can show any information which may be useful such as airways, reporting points, holding stacks, extended runway centre lines and the locating of obstructions.

To summarise the S.264 and S.264A have the following features:-

* 50 cm. band gives freedom from precipitation clutter without the need for polarisers.

* Highly efficient and stable M.T.I. due to crystal control throughout.

* Excellent performance with comparitively low power.

* High degree of reliability due to conservative component ratings.

* Rugged construction to military standards.

* The low power S.264 can be easily converted to the higher power S.264A to meet expanding traffic densities.

* Fully meets I.C.A.O. standards for definition and accuracy.

* Extremely flexible display systems of the most advanced type.

* Aerial head may be sited up to 5,000 yards (4600 metres) from displays and operates unattended.

* Extremely flexible system to meet widely varying requirements.

* Long service life which will be extended by modification kits as new techniques and higher performance units are developed.

* The equipment is backed by the unique radar experience and resources of the Marconi Company.

ASSOCIATED MARCONI PUBLICATIONS

The following pamphlets describe equipment which is associated with Marconi Radars Types S.264 and S.264A.

Ref. TD.219/2	Fixed Coil Display Equipment, SD.1000 series
Ref. TD.225	Display Unit (Moving Coil) Type SD.701.
Ref. TD.238	Radar Link Type SK.101
Ref. TD.242	Video Map Type SD.100

DATA SUMMARY

A.M.T.I. RADAR.

Radio Frequency:	Radar Type S.264	Radar Type S.264A
	585 - 610 Mc/s	585 - 610 Mc/s
Peak Power Output	50 - 60 KW	500 KW
Pulse Recurrence Frequency and pulse length	500 - 800 p.p.s. at 2 or 4 μs	260 - 400 p.p.s. at 4 μs or 3 μs 500 - 550 p.p.s. at 3 μs.
Receiver Noise Factor	7 - 8 db	
Receiver Intermediate Frequency	44.25 Mc/s	
I.F. Characteristic	Linear with variable I.A.G.C.	
Receiver Bandwidths (overall)	400 Kc/s at 3 db. down (M.T.I. Channel) 1.2 Mc/s at 3 db. down (Normal Channel)	
Swept Gain	Inverse 4th power law. Range adjustable	
Permanent Echo Suppression (Static)	Better than 40 db.	
Sub-Clutter Visibility;	approximately 28 at 5 r.p.m. and 540 p.p.s.	
M.T.I. Gate Range	Adjustable from zero to 2/3 max. range.	
Aerial System;	Parabolic reflector with off-set slotted linear waveguide radiator.	
Horizontal Beamwidth:	Approx. 2.1° at 3 db down (measured one way only)	
Vertical Cover:	See diagrams (also dependant upon site)	
Polarisation:	Horizontal	
Side Lobes:	Approx. 23 db. down on main lobe amplitude.	

Back-front ratio	Better than 30 db.
Tilt:	-1° to $+10^{\circ}$ to the horizontal
<u>Turning Gear</u>	
Drive:	Twin A.C. Motors approx. 35 h.p. each
Rotation Speeds:	10 r.p.m. and 5 r.p.m.
Max. wind speeds:	60 knots at 10 r.p.m. 90 knots at 5 r.p.m. 130 knots max. survival.
<u>Power Supplies</u>	380 to 440 volts ± 10% (exact voltage to be specified) 3 phase, 4 wire
Turning Gear	-78 K.V.A. max. (running under full wired load) -156 K.V.A. max. (starting under full wind load) for 30 secs.
Radar:	S.264 - 220 to 240 volts ± 6% (+ 10% to order) single phase- 4 K.V.A. + 10% S.264 . - 380 to 440 volts (exact voltage to be specified) 3 phase, 4 wire, 10 K.V.A.
<u>Dimensions:</u>	
Aerial System: (Normal Aerial)	Length of reflector $52\frac{1}{2}$ ft. (16.5 metres) Height of reflector 12 ft. (3.6 metres) Overall height including turning gear, approx. 19 ft. (6.2 metres) Total weight including turning gear - 8 tons (8100 Kg)

Transmitter (S.264)	Height 5 ft. 4 ins. (1.6m) Width 2 ft. 6 ins. (0.77m) Depth 2 ft. 6 ins. (0.77m)
Receiver (S.264)	Height 7 ft. (2.13m) Width 2 ft. 6 ins. (0.77m) Depth 2 ft. 7 ins. (0.78m)
Transmitter/Receiver (S.264A)	Height 7 ft. (2.13m) Width 10 ft. (3.0m) Depth 2 ft. 7 ins. (0.78m)

DISPLAY EQUIPMENT

RADAR DISTRIBUTION UNIT TYPE SJ.1000

Intermediate Frequency Inputs:	44.25 Mc/s
Video Outputs:	
(1) Cancelled Video Outputs:	3 separate outputs each. 3 volts signal 1 volt noise into 80 ohm impedance
(2) Uncancelled Video Outputs:	3 separate outputs each: 3 volts signal 1 volt noise into 80 ohm impedance.
Synch. Pulse Outputs to Transmitter:	30 volts positive into 80 ohms 40 µs duration (2 separate outputs)
Synch. Pulse Outputs to P.P.I. Displays.	15 volts positive into 80 ohms 2 µs duration (3 separate outputs)
Range Marks Outputs to P.P.I. Displays	10 volts positive into 80 ohms marks of 1 µs duration at 1 and 10 nautical mile intervals with every 5 and 50-miles mark of greater amplitude (kms. and statute miles can also be provided).
Azimuth Marks Outputs to P.P.I. Displays	5 volts positive into 80 ohms Marks of 2 µs duration over 10° of aerial rotation.
Power Supply for Relays in P.P.I. Displays	50 volts at 2 amps.
Maximum number of P.P.I. Displays useable with Radar	Limited by Selsyn in Aerial Head and distance from displays. Normal Maximum: 6. (Moving Coil) (An almost unlimited number of fixed coil displays may be used).

Power Supply Requirements:		230 volts, ± 6% single phase. 50 cycles, 1 KVA
Air-Cooling:		Built-in blower and filter.
Dimensions		Height 8 ft. 0 ins. (2.45m)
		Width 2 ft. 0 ins. (0.6m)
		Depth 1 ft. 10 ins. (0.56m)
Delay Cell	S.264	Water Cell having a variable delay from 1.25mS to 4 mS for use with PRF from 500 to 800 p.p.s. (nominal).
	S.264A.	4 Water Cells in series for PRF for 260 to 400 p.p.s.
P.P.I. Displays		Moving coil or fixed coil types are available, the latter with a comprehensive data handling system. They are described in the associated publications listed on Page 6 of the General Description.

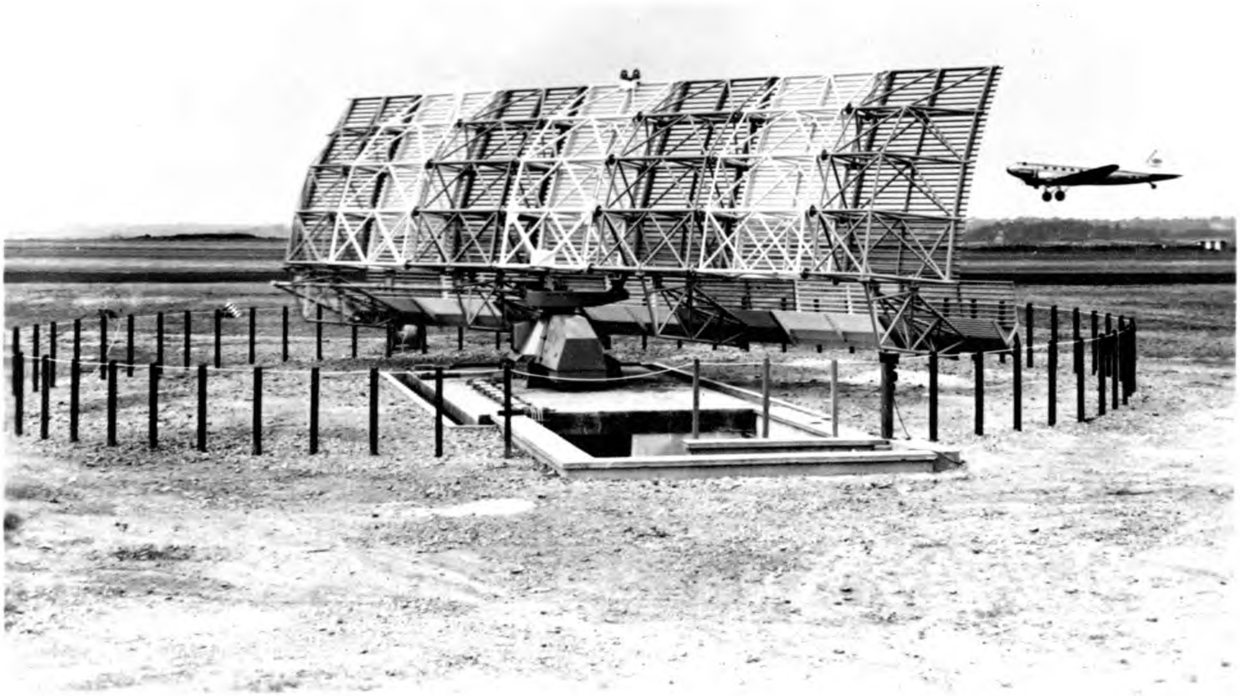
50750

RADAR S.264A AT WELLINGTON, NEW ZEALAND.
THIS IS A TYPICAL "FREE SPACE" SITE.

43596/1

AERIAL PHOTOGRAPH OF NEW ZEALAND "SURVEILLANCE RADAR SYSTEM"
WELLINGTON, NEW ZEALAND

A. SITE OF RADAR S.264A
B. SITE OF PASSIVE REFLECTOR
C. COOK STRAIT AREA CONTROL CENTRE
D. RANGOTAI AIRPORT



RADAR TYPE S.264 INSTALLATION AT JERSEY AIRPORT - REAR VIEW OF AERIAL SYSTEM AND ENTRANCE TO UNDERGROUND RADAR BUILDING 48940

49054

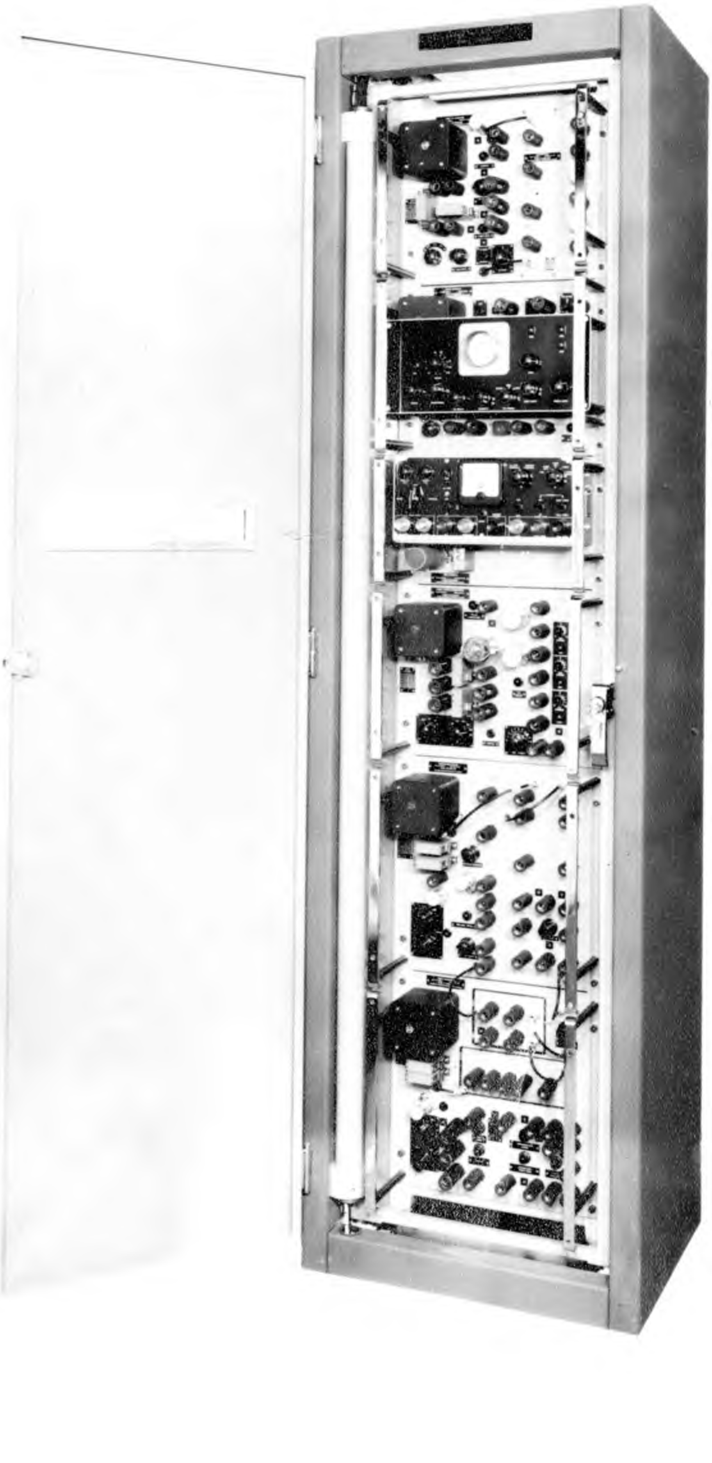
50 CM TRANSMITTER - RECEIVER SR.100

FRONT VIEW WITH DOORS OPEN

COMPARTMENTS FROM LEFT TO RIGHT ARE :- MAIN HT, MODULATOR, KLYSTRON ASSEMBLY, RECEIVER AND RF DRIVE

49515

TRANSMITTER TYPE T.3605/MWT



DISTRIBUTION AND CANCELLATION RACK SJ.1000 47673

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VERTICAL COVER DIAGRAMS

RADARS TYPE S.264 AND S.264A.

REFLECTOR TILT + 4°

	S.264	S 264A.
PEAK POWER	60 K W.	500 K W.
PULSE RECURRENCE FREQUENCY	550 P.P.S	400 P.P.S.
PULSE LENGTH	4 µ S.	4 µ S.
RECEIVER NOISE FACTOR	7 - 8 dB.	7 - 8 dB.
TARGET SIZE	10 SQ METRES	10 SQ METRES.
SIGNAL/NOISE RATIO.	2 : 1	2 : 1
GROUND REFELCTION COEFFICIENT	- 0.8	- 0.8
SOLID LINE ————	FLAT SITE	FLAT SITE
DOTTED LINE — — — — —	FREE SPACE	FREE SPACE

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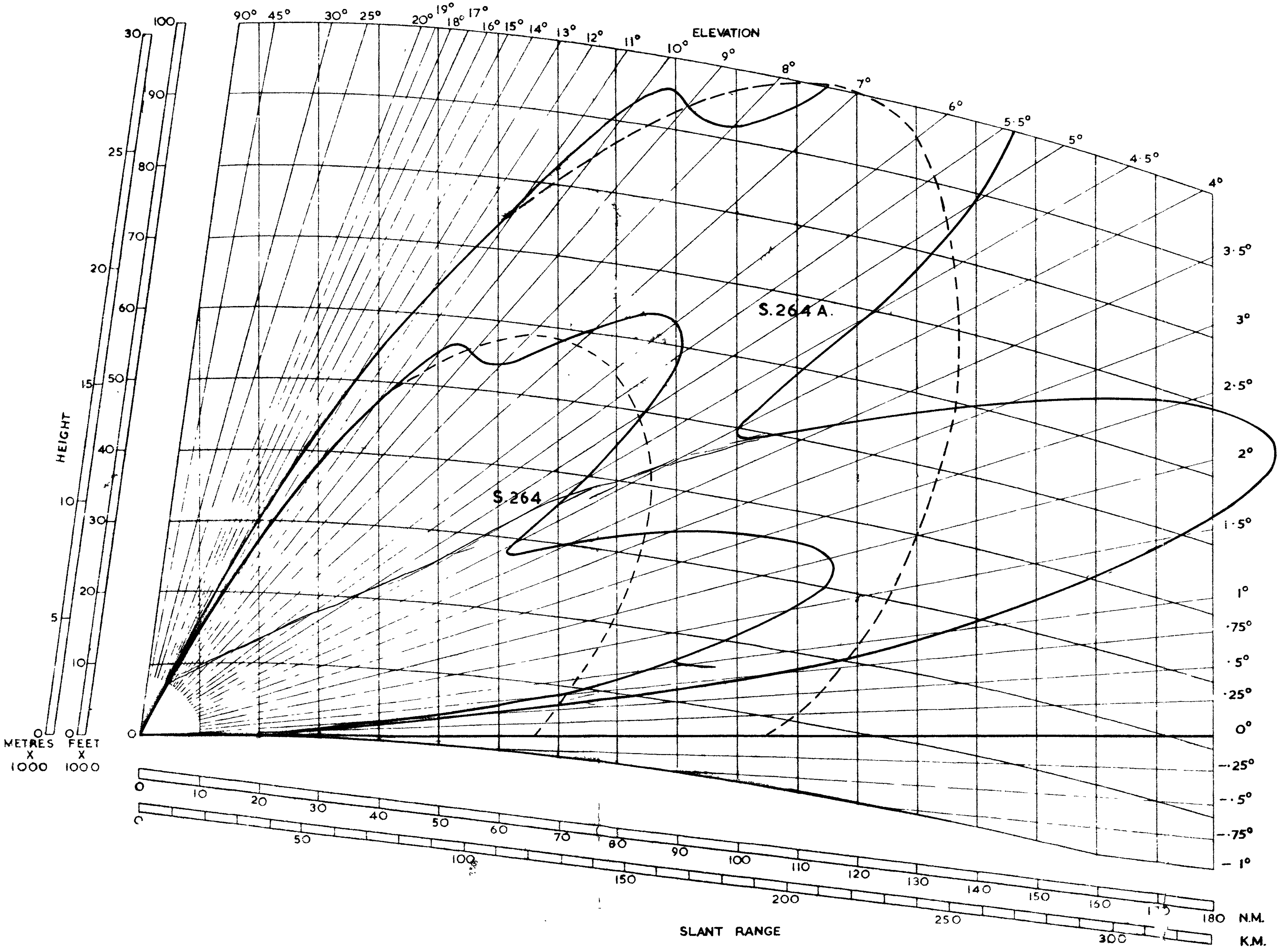

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VERTICAL COVER DIAGRAMS

RADARS TYPE S.264 /H AND S264 A / H

REFLECTOR TILT + 6°

	S264 / H	S264 A / H
PEAK POWER	60 KW	500 KW
PULSE RECURRENCE FREQUENCY	550 PPS	400 PPS
PULSE LENGTH	4 μ SEC	4 μ SEC
RECEIVER NOISE FACTOR	7-8db	7-8db
AERIAL HEIGHT	12 FT.	12 FT.
GROUND REFLECTION COEFFICIENT	-0·8	-0·8
SIGNAL/NOISE RATIO	2/1	2/1
TARGET SIZE	10 SQ. METRES	10 SQ. METRES
SOLID LINE ————	FLAT SITE	FLAT SITE
DOTTED LINE - - - - - - - -	FREE SPACE	FREE SPACE

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