the transmitting office should not normally exceed 50-ft. In the event of it being necessary on fitting-out to exceed this length it is necessary to measure the length of the cable in half wavelengths electrically. This is done by using a Diode Valve Voltmeter (Patt. No. W4998) in order to measure the amplitude of standing waves as the line is cut back in steps to choose a voltage node.

30. Flexible feeders for Pre-Amplifier M101 and Receiver P114.

These are specially screened telcothene cables, cut to half a wavelength and connected from the Junction Box W2932 to the Pre-Amplifier and from the Pre-Amplifier M101 to the Receiver P114 respectively.

Cancelled

THE RECEIVERS AND TRANSMITTER.

31. Receiver P114 Pattern 59718.

This is the receiver used with type 79B/279B. One of its differences from the original Receiver P11 pattern X494 is that one side of its input is earthed. This is done by a small clamp which grips the screen of the telcothene feeder and connects it to earth and the inner conductor to an input terminal.

32. Transmitter.

The transmitter now has the following modifications :-

(a) (i) A jack socket and holder for a milliammeter are fitted in the lower modulator panel 3AA (X447A).

(ii) A milliammeter A.P. W406 is provided to plug in this socket for measuring diode current.

(b) Capacitative coupling is used. Slight modifications have been made so that the pyrotenax feeders may be connected easily. The back of the transmitting panel (upper) has been drilled so that the aerial coupling may be mounted higher up. The aerial coupling circuit should be mounted so that the condenser terminals are on a level with the bend in the anode lines. The leads to the anode lines will then be as short as possible. An earthing clamp connects the outer of the two Pyrotenax feeders close to the termination at the aerial condensers. Cases have occurred in ship fitting where the clamp has been used to clamp the insulating bushes. This is incorrect and must not be done.

The pattern number of the modified transmitting panel (upper) is X450B where only one WA set is fitted. (When 281BQ is fitted in addition, see handbook for that set for details of Synch. series power supply).

(c) (i) A meter mount Design 7 is mounted on the front of the Rectifier Panel (Upper) 3AA below the 30 kV. Voltmeter. The terminals are connected by twin lead cable (Patt. No. 2520D) to the Performance Meter Design 3 in the Receiving Office. The cable in the Receiving Office is terminated in a flexible screened cable which connects to the "REMOTE METER" socket on the Performance Meter.

(ii) A •75 mA. Galvanometer (Patt. 7559) is provided to plug in this socket for remote readings from the Performance Meter.

(d) When Outfit JJ1 is fitted for use in the R.D.R. a Junction Box (Patt: 2411) is secured behind Transmitter panels and a telcothene cable (Patt: 13832) with a jack plug is plugged into the Junction Box. The inner of the other end of this cable is connected to the end of R19 remote from earth (See Fig. 21). The outer of the cable is connected to earth. The junction box (Patt. 2411) is also connected with telcothene cable to a Junction Box (Patt. 7104) which is also connected to a similar Junction Box in the R.D.R. with Pyrotenax Cable (13941).

POWER SUPPLY AND MODIFICATIONS IN WIRING. (Where Type 79B/279B is the only WA set fitted).

33. Owing to the omission of the 5 kVA machines the following modifications in wiring are made :-

(i) Transmitting Office.

(a) All 5 kVA wiring on power boards omitted.

(b) No 5 kVA wiring to machine space.

(c) No 5 kVA wiring from transmitting to receiving office.

(ii) Receiving Office.

(a) Wiring to after mast omitted.

(b) Left-hand aerial training indicator not used and not wired.

(c) 5 kVA wiring to aerial rotating gear supplied from 14 kVA.

In junction box X733, terminals marked 15 kVA Port/Starboard are connected to terminals marked 5 kVA Port/Starboard.

(iii) Automatic Voltage Control.

This is wired as shown in Fig. 14. It is essential that the voltage should be steady in order that the diode heater current should be constant.

FAULTS AND MAINTENANCE.

34. Faults.

(a) Failure of diode.

As the diode fails its resistance increases and the voltage across it increases. Intermittent sparking occurs inside the valve and it ceases to act as a rectifier thus affecting the reading of the milliammeter. The increased voltage across the valve, will also produce an increased voltage across the receiver feeder.

Signs of Failure.

The milliammeter will flicker and the scan may show signs of "jitter". Sparking may occur in the ~~Pre Amplifier~~ RECEIVER. Test the filament voltage of the diode (see Chapter 2 para. 2 (a)) and the bias supply. If these are correct, change the valve.

It is important that the diode should be changed as soon as it starts to fail otherwise the ~~Pre-Amplifier valve~~ RECEIVER may be damaged.

(b) <u>Breakdown in the diode circuit.</u>

The blocking condenser F (Fig. 11) in the diode circuit may fail if the voltage across the diode is excessive. A breakdown will short circuit the bias, and earth the cathode of the diode. The milliammeter will therefore read the output current of the rectifier which is in the opposite direction to the diode current.

<u>Signs of Failure.</u>

The milliammeter current will be reversed.

35. <u>Maintenance.</u>

(a) <u>Aerials.</u>

(i) <u>Flexible Connections. Patt. W3228.</u>

These have a short life (one to two months) and should be tested whenever possible. Unfortunately in "B" sets the only way of doing this is to disconnect the flexible feeders at the masthead bracket and test with an avometer. The resistance should be about ·5 ohm. The test should be carried out whenever the ship is in harbour.

(ii) <u>Insulation.</u>

The insulation of the pyrotenax can only be tested when the flexible connections are disconnected, and this test should therefore be carried out at the same time as (i). Both receivers must be disconnected from the aerial and the resistance tested between the centre and case of the pyrotenax with a 500 volt megger. If the resistance shows any sign of dropping, action should be taken, as this indicates that damp is getting into the pyrotenax. The matching transformer and diode switch should be disconnected in turn, tested and if faulty, dried out as in para. 5 (b) and re-sealed. The insulation should never be allowed to fall below 1 megohm and should normally be 20 megohms.

(b) <u>Diode.</u>

The diode filament voltages and the bias should be checked daily as described in Chapter 2, para. 2 (a).

CHAPTER 6.

PERFORMANCE METER DES. 3, PATT. 53914.

PURPOSE AND SCOPE OF THE EQUIPMENT.

1. The object of the performance meter is to enable the performance of Types 79/279 and 79B/279B to be checked frequently.

2. After a height finding calibration it is essential that the set remains at a constant performance level, and in order to check this, the performance meter is used during the calibration runs and daily (or more often) thereafter. Any change in performance level of the installation as a whole is displayed on the calculator provided and from this the probable effect can be estimated. The performance meter is set up originally by the Fitting Out Officer and is always used for checking the radar set even if no height finding runs have been carried out, since it also provides a check on the maximum range obtainable.

3. The performance meter has two main uses. These are :-

   (i) Checking the performance of the Radar Transmitter and its associated feeder and aerial system.

   (ii) Checking the signal to noise ratio of the Radar receiver and losses in its feeder and aerial array.

4. In addition, a sufficiently accurate measurement of the Radar receiver bandwidth is obtainable, as an aid to fault finding. When experience of the performance meter has been gained, other uses will be apparent, e.g. as an aid to tuning.

5. A test aerial is fitted in both the transmitting and receiving arrays but in the common transmitting/receiving system of type 79B and 279B, only one test aerial is required. (See Fig. 25).

EQUIPMENT REQUIRED.

		Number
1.	Performance Meter Des. 3, Patt. 53914	One
2.	Meter Unit Des. 5, Patt. 58520	One
3.	Meter Mount Design 7 Patt. 53651	One
4.	Galvanometer 0·75 mA Patt. 7559	Two
5.	Galvanometer $2\frac{1}{2}$" dia. plug-in type) 25 microamps F.S.D.) Patt. 58637	One
6.	Calculator Des. 1 Patt. 54978	One
7.	Attenuator Unit Des. 13 Patt. 57279	One
8.	Plug single way shielded $\frac{1}{4}$" Patt. W6913 and Ring retaining Patt. 7083	One One
9.	Connection flexible 3 ft. long Patt. 55285	One for Types 79B & 279B Two for Types 79 and 279
10.	Connection flexible screened 4 way 2 ft. long Patt. 58521	One

11.	Aerial Dipole Design 4, Patt. 58893.	One for Types 79B & 279B Two for Types 79 and 279.
12.	Socket, 4 way flange mounting Patt. 7383.	One
13.	Bracket, supporting Patt. 59312.	One

CABLES AND JUNCTION BOXES. (See Figs. 15 and 16).

7. Pyrotenax cable Patt. 13934 - 0·375" dia. 43 ohms.

Box junction Patt. W7969	Two per Type 79B and 279B.
Remote meter lead.	Not more than 20 feet of Patt. 9084 cable in Receiving Office. Office to Office wiring to be of lead covered twin core 10-15 amp cable (Patt. 2520D).

DESCRIPTION.

8. The performance meter consists of a test receiver and a test oscillator. The test receiver is fed from the test aerial in the transmitting array, and used to check the radar transmitter, feeder and aerials. The test oscillator feeds into the test aerial in the receiving array and provides a check on any changes in the signal to noise ratio of the receiving equipment and losses in the diode switch, feeders or receiving aerials.

The various items of the equipment are described below:-

TEST AERIALS.

9. Each test aerial is a single horizontal dipole fitted halfway along the feeder support arm at the centre of the array. In order to obtain a balanced dipole while using coaxial cable, the inner conductor of the tail lead is connected directly to one arm, and to the opposite arm by means of a length of coaxial cable equivalent to a half wavelength. The arms are also joined together by means of a 180 ohm resistor, inserted for matching purposes.

10. The tail lead of Patt. 13804 cable connects by means of a Patt. W7969 box, junction to a length of Patt. 13934 pyrotenax cable (43 ohms) sufficient to reach a convenient point in the receiving office. It is there terminated in another Patt. W7969 box, junction to which is also run the flexible connection Patt. 55285. The plug at the other end of this lead is inserted in the "Test Rec. Input" or "Osc. Output" socket on the performance meter, as required. Where Types 79 and 279 (separate aerials) are installed, there will of course, be two test aerials, feeders and connections.

11. Special care must be taken in fitting, drying out and sealing the test aerial feeders and junction boxes and an effort should be made to run an unbroken length of pyrotenax cable from the masthead to the receiving office. The reliability of the apparatus is increased as the number of junction boxes is reduced. All junction boxes should, wherever possible, be conveniently situated and well under cover. A little extra trouble in avoiding the use of additional junction boxes will be well worth while as it will result in much greater reliability.

12. The feeders should be meggered frequently but if the correct technique in filling and sealing has been adopted, no trouble should be experienced.

TEST RECEIVER.

13. This consists of a tuned circuit with the input tapped on to the coil via the heater of a Patt. W3313 vacuo junction and a matching resistance of 15 ohms. The circuit is tuned to give maximum output from the vacuo junction. Maximum output occurs just before the reading falls to zero, but tuning is fairly flat. This output is observed on the Patt. W7559 galvanometer mounted on the front panel. A similar galvanometer is fitted on a panel in the Transmitting office so that readings may be observed while adjustments are being made to the transmitter. A switch selects the required galvanometer. The connection between the performance meter and the remote galvanometer in the Transmitting Office should be of heavy screened cable, preferably of 15 ampere capacity so that its resistance is as small as possible. Despite all such precautions however, the readings obtained from the remote galvanometer will be less than those from the panel meter, but a simple calibration can easily be made, if required.

14. The input socket of the test receiver is on the right hand side of the panel and is marked "Test Rec. Input".

15. Readings are taken with the aerials trained on a stated reference bearing (usually 000°) since there may be small variations between the pick-up at different bearings. The aerials should always be brought to the reference bearing by first training for at least 90° in the "red" direction and back again. This reduces to negligible proportions any small changes due to flexible feeder twist, and applies to both common and separate aerial arrangements.

16. The galvanometer scale reading is proportional to the square root of the mean radiated power. The reading is set up on the Calculator.

17. The output of the transmitter may rise slightly for about 30 minutes after switching on. The effect of severe sparking or bad contacts in the transmitting array is usually shown by rapidly fluctuating readings of radiated power.

18. If there is an exceptionally short feeder length between the transmitting array and the performance meter, it may well be that a reading in excess of 85 units will be obtained. The sensitivity of the test receiver can be reduced in such a case, by connecting a resistor (suggest 68 ohms) between the heater pins of the valve holder used for mounting the W3313 vacuo junction. The heater pins are both marked 'H' on the base of the vacuo junction. It may be that the value of the resistor will have to be determined by experiment. A galvanometer reading of about 60 units should be aimed at using full working power and normal working pulse length.

19. As the test receiver may sometimes be sensitive to W/T transmissions on widely different frequencies this interference is often strong enough to damage the vacuo junction and galvanometer. <u>For this reason the test aerial feeder must be unplugged from the test receiver immediately after use.</u>

NOTE. The Performance Meter can also be used as an aid towards getting the maximum power output from the Transmitter but care must be taken to ensure that measurements are all made at the same frequency and that the Test Receiver is kept in tune (see Chapter 2, Para. 2 (c)).

TEST OSCILLATOR.

20. This is a low power C.W. oscillator built around a CV6 valve. In order to prevent leakage of R/F from the oscillator direct to the

Radar receiver, the second harmonic (36-46 mc/s) is used for testing the 79 receiving equipment, the fundamental frequency range being 18-23 mc/s. If the oscillator were working on the Radar frequency it would be necessary greatly to attenuate its output before it could be applied to the sensitive Radar receiver. Screening difficulties would be severe and the leakage of even a small proportion of the oscillation might be appreciable compared with the wanted output and would almost certainly cause errors. By using the second harmonic of an oscillator tuned to half the Radar frequency, the oscillator can be regarded as a weaker oscillator at the fundamental Radar frequency and, while the leakage at this frequency is negligible, the total power generated is adequate to supply the monitoring vacuo junction circuit required for setting the output power to a standard level.

21. No filter is provided for the 18-23 mc/s signal which passes, including harmonics and after considerable attenuation, to the test aerials. The Radar receiver is not effected by this since it is normally sensitive only to oscillations in the 39 to 42 mc/s band.

22. Interference with other services is negligible since, apart from the fact that the power radiated, is extremely small, the test oscillator is normally in operation only for a few seconds at a time.

23. The output from the test oscillator compartment is fed via a small isolating condenser through an internal attenuator to the output socket fitted on the left hand side of the front panel marked "OSC. OUTPUT". The signal is passed through the receiving array test aerial feeder to the test aerial, is picked up by the Radar receiving aerial and fed back to the Radar receiver, causing a change in its second detector current. This current is read from the meter unit screwed to the Radar receiver front panel.

24. The test oscillator is sometimes used plugged into an external attenuator instead of the test aerial and as the far side of the attenuator is connected to the receiving equipment a performance check can be made omitting the aerial system (see paragraph 61).

25. It is possible that an error in reception sensitivity figures may occur in heavily landlocked waters. This occurs when strong return signals cause a small increase in the 2nd detector current which then no longer represents a pure noise level and also by break through from the diode switch. Thus the setting of the gain control for the standard gain level of 50 units is affected. The result is shown of a slight but variable reduction in the reception sensitivity in landlocked waters. Setting-up and reception sensitivity should therefore be made with the Transmitter H.T. off except under action condition (see Test Drill).

INTERNAL ATTENUATOR.

26. It is necessary to reduce the output power of the test oscillator in order to obtain a suitable level for injection into the Radar receiver. This is done by means of an internal attenuator consisting of two arms, one being 1500 and the other 39 ohms. It is difficult to supply a fixed attenuator suitable for all installations and it is possible that the attenuation value may have to be changed.

27. The attenuation value is found for a standard power level. This should be about 60 units on the Patt. 7559 galvanometer when it is used to monitor the test oscillator power output level. Unfortunately the monitoring point has to come before the attenuator and this means that the actual output from the attenuator has to be adjusted to suit each installation. As any power level from 50 to 80 units is suitable to take as a standard power level, it is a simple matter to adjust the attenuator to give a satisfactory output at a reasonable power level.

28. If a small variation is required, the 1500 ohm resistor should be replaced by one of the required value but should not be increased beyond 6800 ohms as the self-capacity of the resistor then almost nullifies any further increase in value.

29. A large increase in attenuation is more easily obtained by connecting a low value resistor between the oscillator side of the 1500 ohm resistor and the common earthing tag. This should not be less than 39 ohms.

30. In no case should the 39 ohm resistor fitted at the output socket end of the 1500 ohms resistor be replaced by one of another value.

31. If any alteration is made to the attenuator, the new values and note of the alteration should be made in the performance meter log book.

GENERAL LAYOUT.

32. The test oscillator and test receiver are each enclosed in separate screening boxes behind the front panel. The test oscillator is contained in the larger box on the left hand side of the chassis.

33. On the rear of the front panel, immediately behind the power supply socket, a small screening box is situated containing the power supply filter circuit.

34. Controls on the front panel :-

(a) Slow motion dial in the top left hand corner labelled "Osc. Tuning".

(b) Direct drive tuning control, in the top right hand corner, labelled "Test Rec. Tuning".

(c) Heater, ON/OFF switch for switching the heater circuit of the CV6 oscillator valve.

(d) A toggle switch, working horizontally, in the centre of the lower half of the panel labelled "OSC-TEST-REC". This is the change-over switch connecting the galvanometer either to the test receiver or to the monitoring vacuo junction in the test oscillator circuit. In the "OSC" position the H.T. supply to the test oscillator is also switched on.

(e) A toggle switch working horizontally for transferring the outputs of the vacuo junctions in the performance meter from the galvanometer on the front panel to the remote galvanometer in the Transmitter Office.

(f) Knob controlling oscillator power, on the right of the lower half of the panel.

(g) Also on the panel are :-

(i) Patt. W7559 Galvanometer on resilient mounting.

(ii) 4 pin W-type socket for mains supply lead.

(iii) Two coaxial sockets for test oscillator output and test receiver input, fitted respectively on the left and right of the panel.

(iv) One cannon socket to take the lead for the remote galvanometer.

POWER SUPPLY.

35. A 230v. 50 c.p.s. transformer in the performance meter gives 6v. for the heater of the CV6 valve. The test oscillator requires 250-300 volts D.C. stabilised. These supplies are fed into the performance meter through the 4 core screened lead (Patt. 58521) supplied.

36. Both supplies are obtained from a Niphan type socket Patt.7383 which has to be fitted to the front of the P114 (Modified P11) receiver near the Test Jack. This socket is wired to suitable points in the receiver. The H.T.+ point is the high voltage end of the 300 ohm resistor R19 (See Fig. 20). The correct end is that to which a red covered lead runs from the power supply in the sub chassis. The other two leads from this socket run through the final compartment of the P114 to the mains input junction box on the rear of the P114. The red and black leads of the four core cable are connected to H.T.+ and H.T.-. The green and white leads carry the 230 volts 50 cycle supply through the flexible connection Patt. 58521.

FITTING OF SPARES.

37. A spare CV6 valve and a Patt. W3313 vacuo junction are mounted under the chassis. They have been selected for the particular performance meter. If reasonable care is taken, the apparatus will last for many years of normal use without the spares being needed.

38. The screening cover for the test oscillator should not be removed or loosened in any way unless it is quite clear that an internal fault has developed. After replacement of the cover and interference with the wiring, it may be that the output of the test oscillator at the Radar frequency will not be the same for a given power level, although such variations are normally quite small. In this event a new standard power level must be established.

39. When refitting the lid, make sure that the moving vane of the tuning condenser can rotate without fouling the side of the screening cover.

40. The performance meter had been made as simple and reliable as possible and should not need to be tampered with in any way. The oscillator compartment should only be opened up as the last resort.

41. It is as well to mention that the relation between the second harmonic at a given frequency and the galvanometer reading for setting the "standard power level", is known to be sensibly constant for periods well beyond the normal life of the oscillator valve and the whole equipment.

METER UNIT DESIGN 5, PATT. 58520.

42. The meter unit is provided to read the second detector current of the Radar receiver when checking the reception sensitivity i.e. signal to noise ratio. It consists of an Patt. 58637 galvanometer and an arrangement to back off the normal 30-50 microamps second detector standing current to zero. The unit is screwed on the front panel of the Radar receiver P114.

43. The stabilised 250-300 volt Radar receiver supply is used to provide a backing off voltage. The unterminated screened lead from the unit is connected through a hole drilled in the front panel of the P114 receiver to that end of the resistor R23 (See Fig. 20), remote from the anode lead to valve 117. The braiding is kept clear of the inner conductor and bound up with wire or tape.

44. A toggle switch on the side of the meter unit allows the meter to be switched off if it should seem likely that the meter will be damaged, e.g. during jamming. A P.O. type plug with a short lead is also provided and is plugged into the "TEST" jack when the meter unit is used.

CALCULATOR DESIGN 1, PATT. 54978.

45. This is a device for combining the figures obtained with the test receiver and test oscillator into one figure expressing the "Overall Efficiency" of the radar installation. The calculator consists of two circular scales, one of which rotates within the other. The upper part of the outer scale is marked "Radiated Power" and its figures correspond with scale readings of the galvanometer when used for checking the power radiated from the transmitting array. The lower part of the outer scale is marked "Overall Efficiency" and is graduated in percentage.

46. The upper part of the inner scale is marked "Reception Sensitivity" and carries figures corresponding to part of the scale of the 0-500 microammeter in the Meter Unit. The lower part of the inner scale carries a pointer which moves over the "Overall Efficiency" scale. This pointer is arranged so that it can be moved along a slot during setting up and then clamped in position.

47. A cursor runs along the upper part of the computor and connects the "Radiated Power" and "Reception Sensitivity" scales.

Use the calculator as follows :-

(a) Set the cursor to the value for radiated power obtained in Test Drill I, on the "Radiated Power" scale (say 60 units).

(b) Rotate inner scale until the value obtained for reception sensitivity in Test Drill II is opposite the cursor.

(c) Read off efficiency on "Overall Efficiency" scale opposite the pointer. This reading will be entered in the performance meter log book.

NOTE:- When originally setting up or when resetting after height-finding calibrations, the reading in (b) for reception sensitivity will be 250 units. If necessary, the standard power figure for the test oscillator will be varied to obtain this value for the 2nd detector current, and a new standard established. The figure for radiated power is set against this figure and the pointer on the Overall Efficiency scale is then reset to read 100% without disturbing the relative positions of the scales. Any later deviation in subsequent performance of the installation will be displayed as change in "Overall Efficiency".

USE OF CALCULATOR WITH VERTICAL COVERAGE DIAGRAM.

48. The following table gives a comparison between the overall efficiency figures, obtained from the Calculator, and changes in overall set performance. If vertical coverage diagrams are made, and the positions of lobes for various decibel changes are shown, an alternative lobe may be used if the performance of the set is found to be a given number of decibels different from standard. This table is corrected for slight inaccuracies arising from the use of Calculator Design 1, with the receiver type P114 as it was designed particularly for use with receivers P13, 23 and 107 (Type 281).