Overall Efficiency	Decibel Change.
121	+4
110•5	+2
100	-0
90•5	-2
82	-4
74	-6
67	-8
60•5	-10
55	-12
49•5	-14
44	-16

SETTING UP PERFORMANCE METER DESIGN 3.

49. The object of the performance meter is to disclose day to day variations in the performance of the radar installation. It should be used frequently during height finding operations.

50. In setting up, the standard level of performance is taken as 100% but before accepting this it must be verified that the complete 79 or 279 installation is up to the best standard of efficiency obtainable.

51. Setting up Procedure (i). Run the transmitter up to normal H.T. at the normal pulse length (Say 15 kV for 20 microseconds pulse length). Allow it to warm up for about 15 minutes after making usual checks on frequency and tuning.

52. Using the test receiver of the performance meter take a quick rough polar diagram of the transmitting array with its own test aerial. Choose as standard "Reference Bearing" one at which maximum or nearly maximum readings are obtained and where variations in training of $\pm 5^{o}$ produce no greater change than about 1 unit in radiated power. Since the test dipole is attached to the array and rotates with it the polar diagram is theoretically circular, but in practice may be found to be slightly irregular owing to the effect of nearby objects.

53. Set up this radiated power reading on the "Radiated Power" scale of the calculator. It will normally lie between 40 and 85 units.

54. Set the inner scale of the Calculator marked "Reception Sensitivity" so that "250" falls opposite the cursor set at the radiated power reading.

55. Loosen and adjust pointer on "Overall Efficiency" scale to 100% without disturbing setting of "Reception Sensitivity" scale. Tighten up the pointer lock nut.

56. (ii) After warming up the ~~preamplifier and~~ receiver for at least 30 minutes and lining up with the two aerial arrays (where fitted), tune up diode switch, ~~preamplifier~~, and the radar receiver to the transmitter frequency in the normal manner. Switch off transmitter H.T. except under action conditions (see Test Drill).

57. Turn down the P114 gain control to zero. Plug in Patt. 58520 meter unit and switch it on. Adjust the backing off control until the meter reads zero. This setting is important.

58. Increase gain control until a reading of "50" is obtained on the meter unit. Set this with extreme care. THIS IS THE STANDARD "REFERENCE LEVEL" OF NOISE FROM WHICH ALL PERFORMANCE METER OPERATIONS ARE STARTED. Upon the accuracy of setting zero and the gain level depends the accuracy of the performance check. Some practice is necessary to do this exactly; a dozen times are usually enough.

59. Change over the test aerial feeder from the test receiver to the test oscillator output socket. In two masted installations the feeder connector from the receiving array test aerial is used. The performance meter "Heater" Switch should have been "on" during the previous operations or for at least ten minutes.

60. Switch to "Test Osc." and with "Osc. Power" control about half way up, then tune to the Radar frequency using the meter unit as an indicator.

61. Adjust "Osc. Power" control to give a reading of 250 on the meter unit, retuning the test oscillator during adjustments and re-adjusting the zero and noise level as needed. Note the reading on the Patt. W7559 galvanometer. This is a measure of the power output from the test oscillator and is the standard "Power level" at which the test oscillator must be run for all future performance checks. It should be noted in the log book for future reference. Repeat setting of gain and oscillator power controls as above with Transmitter off. The new standard power level should be noted. (See Test Drill).

N.B. To obtain a high degree of accuracy in setting this output level it is often an advantage to flick the Remote-Local switch off and on once or twice when it will be found to be a simple matter to adjust to the reading required, as this overcomes any pointer friction in the galvanometer.

62. The full procedure for taking performance checks is described step by step in Test Drills I and II.

THE ATTENUATOR UNIT, DESIGN 13 PATT. 57279.

63. This is an external attenuator designed to represent approximately the loss in the feeders and in transference from test to receiver aerials and is mainly used for making sure that the aerials are working properly and for checking the gain of the pre-amplifier.

64. The lead attached to the attenuator is plugged into the test oscillator output socket. The input coaxial cable to the pre-amplifier is unplugged from the aerial feeder and then plugged into the socket fitted on the attenuator unit. The test oscillator is thus connected through the attenuator (instead of through the aerial system) to the preamplifier.

65. Back off the standing detector current to zero and set the gain level to 50 units on the 2nd detector meter. Then switch on test oscillator using the "standard level" of test oscillator power, vary the attenuator until a reading of 350 units on the receiver meter is obtained. (It is, of course, understood that the pre-amplifier, radar receiver, and test oscillator are correctly tuned). Do not alter the variable attenuator after this. Checking the gain of the pre-amplifier becomes necessary when the normal reception sensitivity figure has dropped to about 200.

66. When the setting for the variable attenuator has been found as described above, the gain of the pre-amplifier over that of the receiver alone should be measured as follows :-

67. Using the Pye plug junction supplied with the pre-amplifier join together the coaxial input and output cables of the pre-amplifier. The test oscillator is now connected through the variable attenuator to the receiver alone.

68. Retune the R/F stages of the P114 receiver and the test oscillator. Set backing off control for zero standing current and gain to give 50 units on the receiver meter. Adjust the test

oscillator to the "standard power level", recheck tuning and observe the meter unit reading. This should be less than that obtained when using the preamplifier. From the two readings the gain of the preamplifier is now calculated.

69. It should here be mentioned that the gain of the preamplifier should be between 4 and 5 db. A fall in performance is generally caused by deterioration of the CV53 valve used in the preamplifier.

EXAMPLE.

70. Suppose the reception sensitivity figure for

Preamplifier + Receiver = 280 and that

for Receiver alone = 150

Gain level of Receiver has been adjusted so that the noise level measured on the meter unit is 50 for both the above measurements.

Now the detection law of the P114 is approximately square law and the meter unit readings are therefore proportional to the power developed in the 2nd detector circuit. In comparing the two readings the noise power must first be subtracted from each.

The figures then become 280 - 50 = 230

and 150 - 50 = 100

The power ratio is therefore 230/100 = 2•3

or in decibels = 10 log 2•3 = 3•6

The preamplifier in this example is not giving the correct gain and other CV53 valves should be tried.

MEASUREMENT OF RADAR RECEIVER BANDWIDTH.

71. The bandwidth of the P114 receiver should be between 140 and 240 kc/s.

72. A rough check of the bandwidth can be made using the test oscillator in the following manner.

(i) After usual warming up time, back off meter unit zero and adjust noise level to 50.

(ii) Switch on test oscillator, tune to radar receiver's frequency and adjust test oscillator power to raise meter reading to 250.

(iii) Using the slow motion knob, retune test oscillator on either side of radar frequency until the meter reading falls to 150, noting the two small knob dial readings.

Note 150 - 50 (i.e. 100) is half 250 - 50 (i.e. 200).

73. This slow motion knob is engraved with figures 0 -9 in each quadrant. The main dial is engraved 0 - 100 divisions. Each complete revolution of the slow motion dial is equivalent to 4 divisions on the main dial and therefore each quadrant corresponds to 1 division or 1/100th of the main dial. There is a small plate or label attached to the performance meter and engraved with the "Bandwidth Figure" for the particular performance meter, e.g. 100 kc/s per division. This figure is the approximate range covered by the test oscillator per quarter turn of the slow motion knob, that is, for 1/100th of the main dial.

74. The figure is not constant over the whole radar band (39-42 mc/s) but is accurate enough to give the rough answer required. This will disclose a gradual increase in receiver bandwidth as an explanation of a fall in reception sensitivity.

NOTE ON VACUO JUNCTION.

75. The vacuo junction is easily burned out by a moderate overload.

Therefore :

(i) Do not exceed the full scale deflection of the Patt. W7559 galvanometer.

(ii) Do not run for long periods above a reading of 85 units,

and

(iii) Always unplug the test aerial feeder from the test receiver input immediately after use as W/T interference might be severe enough to damage the vacuo junction and possibly the galvanometer.

NOTE ON FAULT FINDING CHART (Fig. 19).

76. The chart is intended to show how, from the information given by the Performance Meter, the cause of a drop in performance of the Type 79 can be traced to a particular section of the installation.

77. The values which should be obtained by the various tests are given together with tolerances in the Maintenance Schedule. The waveforms to be found at various points in the Modulator and Transmitter circuits are given in Type 279 Handbook. The fault finding chart should be used in conjunction with both of these.

78. After a fault has been cleared, the set should again be checked with the performance meter to ensure that the drop in performance was due to that fault and that no other fault remains.

TEST DRILL

79. I. To check radiated power.

1. Run up Transmitter to normal H.T. at normal pulse length used (15 kV at 20 microseconds). N.B. It is suggested that a mark be placed on the pulse length dial on the Modulation Generator so that measurement can be made at the same setting on each occasion.

2. Set meter changeover switch to "Test Rec."

3. Plug in flexible lead from Transmitter array test aerial to "Test Rec. Input" socket.

N.B. In 79B and 279B there is only one flexible lead and this is used both here and in Test Drill II operation 2.

4. Train aerials from red to green through 180° to the "Standard Reference Bearing", figure is to be supplied by the Fitting Out Officer concerned. It will normally be 000°, see para. 2.

5. Tune test receiver to obtain maximum reading on the galvanometer Patt. W7559. Tune slowly through 360° to ensure this.

6. Observe reading and enter in performance meter log book in appropriate column. Set cursor on "Radiated Power" scale of Calculator to this figure.

7. UNPLUG AND STOW CABLE FROM "TEST REC. INPUT" SOCKET. (This is important as W/T interference is sometimes sufficient to damage the vacuo junction and galvanometer.)

80. II. To check reception sensitivity. Note. For checking under routine or action conditions run Transmitter at normal H.T. and the pulse length and use special standard test oscillator output power figure.

1. Switch off Transmitter and turn up H.T. and pulse length control to position of Test Drill I.

2. Set heater switch to "ON".

3. Plug flexible lead from receiving array test aerial into "Osc. Output" socket (See Test Drill I operation 3 note).

4. Check that (both) aerials are at "Reference Bearing" (See Test Drill I operation 4).

5. Allow apparatus 15 minutes to settle down.

6. Plug and switch on meter unit Design 5, Patt. 58520.

7. Turn P114 gain to zero.

8. Using backing off control on meter unit, set meter reading to zero.

9. Adjust gain to give reading of 50 on meter unit.

10. Set meter changeover switch to "Test Osc."

11. Tune Test Oscillator to give maximum meter unit reading.

12. Set "Osc. Power" control to give reading of on Patt. W7559 galvanometer on the performance meter. (This reading is the Standard Reference of power level for the installation and is filled in here and in the performance meter log book by the Fitting Out Officer. The Ship's Radar Officer should amend the figures if it should be changed at any time). Separate figures are required for Transmitter ON and OFF.

13. Retune test oscillator if necessary.

14. Observe reading of Meter Unit Design 5. This is the Reception Sensitivity and should be entered in the performance meter log book in the appropriate column. The calculator dial should now be rotated until this figure falls opposite the Radiated Power reading.

15. Set meter changeover switch to "Test Rec."

16. Set "Heater" switch to "Off".

17. Unplug Meter Unit Des. 5 and switch off.

NOTE:- The routine or action measurements will be subject to an inaccuracy of up to about 20%. Very accurate measurements when required are to be made with the Transmitter off.

81. III. To check bandwidth of radar receiver.

1. Carry out Test Drill II up to and including operation 10.

2. Set "Osc. Power" control for meter unit reading of 250.

3. Using lower knob on "Osc. Tuning" control, detune on side of maximum until the meter reading falls to 150.

4. Now tune through maximum to the position on the other side where the same reading is obtained. Note the number of divisions of the main dial to cover the range, using engravings on the small knob. One quarter rotation of the lower knob is equivalent to one division of the dial.

5. Enter this figure in the log book.

CHAPTER 7.

TYPES 79B/279B WITH OUTFIT JJ1

INTRODUCTION.

Outfit JJ1, fitted in the R.D.R., consists of Panel L43 and Sector Selector S.E.1 together with Aerial and Gyro Repeater (Patt: 57698). Two "M" type transmitters (part of Transmitter "M" Type Attachment Design 5) fitted to the Control Unit in the Receiving Office) transmit relative and compass bearings to the R.D.R.

2. Panel L43 has a low impedance input and requires a signal of 6 volts (peak) with ·3 Volts noise. Receiver P11 has been modified to give a suitable output, the modified Receiver, with other modifications, being renamed P114.

3. The sync: pulse for Outfit JJ1 comes from the modulator. It is fed from the Transmitting Office by a low impedance line. IMPORTANT NOTE. When outfit JJ1 is used with Types 79B/279B the input resistance of Panel L43 which terminates the incoming line should have been altered at fitting out from 68 ohms to 270 ohms. This resistance is R95 in the circuit diagram of L43 (see ~~RH679~~ BR/1512/1A Preliminary Handbook of Indicator Outfits JH1, JH2 and JJ1, Fig. 8). The new resistance is 270 ohms, 1 watt, of tolerance ± 5% and the shorting link connected to it must be clamped in the "IN" position.

TRANSMITTER "M" TYPE ATTACHMENT, DESIGN 5.

4. This Transmitter Attachment, Patt: 57664, is required when Outfit JJ1 is fitted. It provides "M" type transmission of aerial relative bearing and compass bearing in half degree steps.

5. The unit is bolted to the left hand side of the body of Control Unit 20 AX, on the surface previously occupied by the Selsyn controlling switches, lamp dimming resistance and gyro switch. These items are removed before the fitting takes place and are replaced by similar components which are a part of the Attachment.

6. A three core cable is required for the "M" type motor and a five core cable for each of the Transmitters. The supply to the "M" type Motor is taken from the Gyro compass repeater circuit and a switch should be fitted in the office to isolate the motor when the unit is not in use.

MAINTENANCE

7. The side cover of the Unit should be removed occasionally and a thin oil applied sparingly to the differential gear mechanism. The driving shafts of the Transmitters are carried on ball bearings which are initially packed with grease and should not therefore require attention for a long time.

8. Access to the Transmitters and "M" type motor for examination or renewal is obtained when the top cover is removed.

9. The wiring diagram is shown in Fig. 23, and details of the unit in Figs. 25 and 26.

RECEIVER P114 OUTPUT STAGE FOR USE WITH OUTFIT JJ1.

10. Receiver P11 previously used with type 79 series, has required considerable modification to the video output stages so that the Video Filter unit Design 15 and the Outfit JJ1 may be fitted. When these modifications (and others required in addition when ~~the Pre-Amplifier M101 and~~ the Performance Meter Design 3 are fitted) have been carried out the Receiver becomes P114 (see Fig. 20).

11. A negative going low impedance signal input is required to the Video Filter Unit and the output pentode stage (Valve 117 in Fig. 20) has been converted to a modified pentode cathode follower for this purpose. There is a stage gain of this valve and it is used to provide an adequate signal to the succeeding triode stage (Valve 118 in Fig. 20). This stage has also been converted into a cathode follower which provides a positive going low impedance signal to Panel L43. It is important that the value of the anode load (item 17 in Fig. 20) is correct in order that the voltage developed across it may produce a suitable signal to the grid of Valve 118. A limiting diode (136 in Fig. 20) has been inserted to limit signals above an excessive amplitude so that signals in excess of 8 Volts (peak) may not be fed to the input of Panel L43, which would result in paralysis. The required limiting value is obtained with the resistances shewn in the potential divider (Resistances 130 and 131 in Fig. 20). Condenser 81 is shunted with condenser 135 to obtain a satisfactory time constant value.

12. It will be observed from the circuit diagram of Receiver P114 (Fig. 20) that the output of the triode cathode follower stage (item 118 in Fig. 20) is taken from the junction of resistances 133 and 134 with a D.C. connection to the output jack 122. When Outfit JJ1 is used this output is connected by flexible cables and pyrotenax cable to Panel L43 in the R.D.R. The input to Panel L43 is terminated with a 270 ohms resistance connected to earth. Consequently when Outfit JJ1 is used and the jack plug is inserted, the bias to the valve (item 118) is developed across the resistance, 133 and the input resistance to Panel L43 (the effect of the resistance 134 (2000 ohms) in shunt with the input resistance being negligible). If the jack plug is inadvertently removed from the remote display output socket the bias is developed across resistance 133 and resistance 134 which limits the anode current to a reasonable value.

SYNCHRONISING PULSE FOR OUTFIT JJ1.

13. A positive pulse of 2 - 20 volts across an impedance of 40 - 60 ohms is needed to synchronise Outfit JJ1. Such a pulse can be found across the 4 ohm resistance in the modulator (item 19 in Fig. 21). The pulse is taken off by a screened lead connected at one end to the live end of this resistance and at the other end to a jack mounted on the modulator framework at the back. The inside conductor is connected to the jack tip; the braiding is earthed and connected to the jack sleeve. Patt: 13832 cable is used for the lead from the resistance to the jack and Patt: 13941 pyrotenax cable is to be used between the jack box in the Transmitting Office and the junction box (Patt: 7104) in the R.D.R for the flexible connection to Outfit JJ1.

CHAPTER 8

Routine Maintenance Directions

1. *To be done every watch by the Receiving Operator*
   - H1. Check all communications.
   - H2. Check display calibration.
   - *H3. Check aerial repeater, rotate aerial through 360 degrees and recheck.
   - *H4. Check that gyro repeater is lined up with main gyro.
   - H5. Check tuning of receiver ~~and pre-amplifier~~.

2. *To be done every watch by the Transmitting Operator*
   - H6. Check communications to Receiving Office.
   - H7. (Every half hour) : Check and log meter readings.
   - H8. Log reading of transmitter power on remote meter of performance meter.
   - H9. Log diode current reading.
   - H10. Check and log transmitter frequency.
   - H11. Inspect transmitter valves through windows. Check that blowers are operating.
   - *H12. (Every twelve hours) : Change over alternators.

3. *To be done daily by the Radio Mechanic*
   - D1. Check shape and amplitude of monitor pictures. Log results weekly (*see* Test W1).
   - D2. Check transmitter frequency.
   - *D3. Check that blowers are operating correctly.
   - D4. Clean and dust interior of modulator, oscillator and H.T. panels. Ensure that oscillator circuit shorting bars and aerial taps are tightly clamped.
   - D5. Check diode filament voltage on filament leads with avometer.
   - D6. Check the relation between transmitter pulse length (as measured from NT57T grid pulse on monitor) and mod. gen. control setting.
   - D7. Check all panel controls for correct operation.
   - D8. Check transmitter output power with performance meter.
   - D9. Check reception sensitivity with performance meter.
   - ~~D10. Check reception sensitivity as D9, but without pre-amplifier (i.e. with input and output Pye plugs of M101 short-circuited)~~.

4. *To be done weekly by the Radio Mechanic*
   - W1. Carry out daily routine as above (omitting Tests D8, D9 ~~and D10~~, which are covered by W10) and log on Performance Record Sheet the results of Tests D1, D2 and D6.
   - W2. Using avometer, check calibration of meters in the A.C. supply and distribution boards.
   - W3. Using avometer, check filament voltages, on the filament leads, of oscillator, modulator and rectifier valves. Compare with readings on filament voltmeters and recalibrate if necessary.
   - W4. Check that H.T. rectifier, modulator and oscillator valve leads are securely held by their terminals, and that no burning has taken place due to loose contacts.
   - W5. Tune diode switch ; measure and log filament and bias voltages.
   - W6. Check and log readings of diode current :—
     - (*a*) with H.T. at 20 kV. and pulse length set to 15 microsecs.
     - (*b*) with H.T. at 20 kV. and pulse length set to maximum (30 microsecs.).
   - W7. Check carbon pile voltage regulators for adequate control and freedom from overheating.
   - W8. Clean interior of all panels in the receiving office.
   - W9. Check continuity of both pulse lines from the receiver to the transmitter, and examine all inter-connecting leads in the receiving office.
   - W10. Carry out complete performance tests with performance meter, including checking of receiver band-width.
   - W11. Log (in Valve History Sheet of the Radio Equipment Log) the total hours of service of the following valves :—

Type	*Function*	*No. in Equipment*
CV8	Diode switch	1

   - W12. Check and adjust aerial training indicator with aerials.
   - W13. Inspect aerial array, clean insulators. Disconnect flexible feeder and check continuity while rotating aerial. Check rotational freedom of feeder. Tighten all accessible nuts and bolts in the aerial system.
   - W14. Megger main pyrotenax feeder while flexible feeder is disconnected ; log reading.
   - W15. Megger performance meter test aerial ; log reading.

5. *To be done monthly by the Radio Mechanic*

M1. Check monitoring resistances in transmitter. Replace if more than 25 per cent. out ; allow for any variation less than this when interpreting pictures.

*M2. Inspect aerial control unit 20AX. Check that bolts, nuts and screws are tight, that gears are well lubricated, and that electrical connections are good.

*M3. Remove aerial pedestal covers, inspect for corrosion. If necessary, clean thoroughly and repaint.

*M4. Inspect oil level in aerial gearbox and lubrication of running parts. Check that locking pin is operating freely.

*M5. Inspect cable ends inside pedestal for rotting of the rubber by oil. Check that electrical connections at the terminal blocks are good. Replace aerial pedestal covers.

M6. TOP UP ALL OIL FILLED TRANSFORMERS WITH DRY A.P. 109B OIL.

6. *To be done quarterly by the Radio Mechanic*

Q1. Strike mast to remove aerial dipoles and connections for cleaning. Remove outriggers of flexible feeder, clean and grease their runners. Repaint dipoles and connections, after thorough cleaning, with anti-sulphuric paint (or, if this is unprocurable, with any non-lead based paint).

Q2. After replacing aerial component parts, grease all nuts and bolts thoroughly and paint carefully over the grease. (Aerials treated in this way can be dismantled without trouble from corrosion and rust).

Q3. Check calibration of avometer (facilities exist in most dockyards).

Q4. Check, with avometer, the calibration of meters in the transmitter panels.

Q5. Examine and clean all switch contacts in the transmitter.

Q6. Check all emergency spares in the offices.

Also—Carefully overhaul every unit quarterly ; clean and check for dry joints, possible shorts, leaking electrolytic condensers, burnt resistors, etc. Arrange to do this with one unit at a time when in harbour, so that the whole set is completely overhauled once in every three months.

* Although routine tests so marked are carried out by the Radio Mechanic, they concern parts of the set for which the Torpedo Branch is responsible. Radio Mechanics should, therefore, report any defects discovered as a result of these tests to the Torpedo Office.