THREE-CHANNEL CARRIER TELEPHONE TERMINALS

ROUTINE TESTS

1. GENERAL.

1.1 This E.I. gives details of the periodicity and types of tests to be conducted on three-channel carrier telephone terminals.

1.2 The methods used, and the procedure to be adopted, in carrying out the tests referred to herein will vary according to the types of systems employed. Unless otherwise stated in this E.I., existing methods will continue to be used pending the issue of further E.I.'s giving specific details of the procedure to be followed in conducting tests on particular systems.

1.3 Paragraphs 3.3 and 3.4 of General Engineering Circular No. 17 are cancelled forthwith.

2. RECORDS OF TESTS.

2.1 It will be seen that the results of most tests are to lie within limits specified in other instructions applicable to particular types of systems, and, provided that the requirements are met, the actual results need not be recorded.

2.2 The levels obtained on the quarterly over-all line up shall be recorded in duplicate on Form T.R.M.51 or T.R.M.52. One copy shall be filed at the control terminal station and one copy forwarded through the local Divisional Engineer to the Long Line Equipment Maintenance Divisional Engineer.

2.3 The following forms are now cancelled -

T.R.M.1	Carrier Telephone Systems - Type B. Terminal Line Up. Weekly and Monthly.
T.R.M.2	Carrier Telephone Systems - Type B. Record of Hourly Readings.
T.R.M.13	Type C Three-Channel Carrier Telephone Systems. Daily Record of Measurements and Adjustments. (System with Repeaters.)
T.R.M.14	Type C Three-Channel Carrier Telephone Systems. Daily Record of Measurements and Adjustments. (System without Repeaters.)
T.R.M.15A	Type C Three-Channel Carrier Telephone Systems. Record of Periodic Measurements - Terminal Station.
T.R.M.16	Type CN3 and CS3 Carrier Telephone Systems. Daily Record of Adjustments.

2.4 Abnormal Results. Abnormal results may in general be defined as those not in accordance with the results which the relevant handbooks, E.I.'s, laboratory reports or measurements on other systems of similar type indicate should apply to the particular system.

In the case of channel overall quality all systems of the C5 type and practically all postwar systems should meet the limits set out on TRM56.

If abnormal results are suspected, a thorough investigation of possible causes should be made. Abnormal frequency responses may for instance be due to alterations to bearer circuits, omission of line filter equalisers, etc. If the cause cannot be found and rectified, the Long Line Equipment Maintenance Engineer should be advised through the local Divisional Engineer. The Maintenance Engineer should make appropriate investigations, and if abnormal conditions, which he is unable to rectify, should exist, the Engineer-in-Chief should be advised.

3. DAILY TEST. (Unregulated Systems.)

3.1 Transmission Equivalent Test. The over-all transmission equivalent of each channel shall be measured between the HYB. LINE jacks at each terminal.

With a test signal of 800 c/s, each channel shall be adjusted to a zero equivalent between hybrid line jacks when switching pads are out of circuit.

4. DAILY TEST. (Regulated Systems.)

4.1 Regulator Check. Using the manual control, the indicator shall be moved five scale divisions up and down and observed for correct operation.

5. WEEKLY TEST.

5.1 Carrier Leak (Valve Modulators). Each modulator of the valve type shall be adjusted for a minimum value of carrier leak, which shall be not greater than the specified limit.

6. MONTHLY TESTS.

6.1 Before commencing the following tests, the station battery voltages shall be checked.

6.2 Filament and Plate Current Measurements. The filament and plate currents of all tubes shall be measured. If plate current readings fall outside the limits specified for the equipment, the tubes shall be checked in a mutual conductance type tube checker, and any tubes which record less than 60 per cent. of the specified mutual conductance shall be destroyed.

Tubes which have a mutual conductance greater than 60 per cent. of the specified value shall be restored, and further tests conducted to locate any possible circuit faults in the unit tested.

6.3 Grid Bias Measurement. Where grid bias batteries are employed, the bias voltages shall be measured and, where necessary, the batteries shall be changed to bring the voltages within the prescribed range.

6.4 Carrier Leak. Each modulator shall be balanced to obtain a minimum value of Carrier Leak, which shall be not greater than the specified limit.

Where modulators which have no means of adjustment are used, the carrier leak shall be checked to ensure that it is not greater than the specified limit.

6.5 Synchronising Test. Each channel shall be synchronised by adjusting the frequency of the demodulator oscillator to that of the modulator oscillator of the distant terminal. This test shall not be applied to systems using crystal-controlled oscillators.

6.6 Alarms. All alarms associated with each system shall be checked for correct operation, including operation of the station master alarm.

6.7 Transmission Equivalent Test. (Regulated Systems.) The over-all transmission equivalent of each channel shall be measured between the HYB. LINE jacks at each terminal.

With a test signal of 800 c/s, each channel shall be adjusted to a zero equivalent between HYB. LINE jacks when switching pads are out of circuit.

7. QUARTERLY TESTS.

7.1 Over-all Line Up. The line up of the complete system shall be checked by measuring the output of the transmitting amplifier at the transmitting terminal, the input to and the output of each repeater, and the levels at the incoming line, the receive amp. out, the demod. amps. out and the hybrid line of the receive terminal, while sending test current at the correct value on each channel in turn.

This test shall be performed with the system operating on its normal physical circuit. The results shall be recorded in accordance with Paragraph 2.2.

7.2 Linearity Check. The over-all system shall be checked for linearity in the following manner.

Patch the output of a carrier frequency oscillator through a variable attenuator to the input of the transmitting amplifier. The frequency of the oscillator shall be

set at the sideband frequency of the mid-frequency channel.

Adjust the value of the attenuator until the output of the transmitting amplifier, taken as a "LOSS" measurement, is +18 dbm.

The output of the receive amplifier at the receiving end should be measured as a "LOSS" measurement and noted.

The amount of attenuation in the variable attenuator at the sending end should be reduced by 8 db, and the new level at the "receive amplifier out" measured.

The level should be 8 db ± 0.5 db greater than the previous value.

7.3 Noise Measurement. With the far end of each channel terminated in 600 ohms, the testing officer shall listen with his telephone set at the HYB. LINE jacks of each channel.

Because of the present shortage of bearer circuits, many channels are used for traffic even though the limit of -58 dbm noise is exceeded. However, if the noise on any channel is noticeably bad, it shall be measured on a noise measuring set or estimated from its reading on the A.P.O. transmission measuring set.

The value obtained shall be reported to the Long Line Equipment Maintenance Divisional Engineer, who will decide what corrective action shall be taken.

7.4 Attenuation of Extensions to Switchboard. The attenuation of the circuits, between the hybrid line of the system and the switchboard appearances, shall be measured with the switching pads in and out. If the network is also extended, its attenuation shall be measured and should have the same value.

8. ANNUAL TESTS.

8.1 In addition to the above tests, the following tests shall be performed under the direction of a Supervising Technician attached to the Staff of the Long Line Equipment Maintenance Divisional Engineer.

8.2 Meter Calibration. The calibration of all meters associated with the terminal under test shall be checked against sub-standard meters.

8.3 Modulator Oscillator Frequency. The modulator oscillator frequency of each channel shall be checked and, if necessary, retuned to the correct frequency.

8.4 Modulator and Demodulator Oscillator Level. The output level of each modulator and demodulator oscillator shall be measured and checked against the prescribed value. Any necessary adjustments shall be effected.

8.5 Synchronisation Check. (Crystal Oscillators.) The frequency of the demodulator oscillator shall be checked against the modulator oscillator of the distant terminal, and any variation greater than 5 c/s shall be regarded as abnormal.

8.6 Amplifier Gain. The maximum gain of the transmitting and receiving amplifiers shall be measured to ensure that it is within the specified limits.

This test shall use the appropriate sideband frequencies for each channel. The gain shall be measured at an output level of +18 dbm.

8.7 Volume Limiters. Volume Limiters associated with each channel shall be tested for correct operation as described in the relevant Instruction.

8.8 Quality. The over-all quality of each channel shall be measured between terminals at the following frequencies -

300, 400, 600, 800, 1,000, 1,600, 2,000,
2,200, 2,400, 2,500, 2,600, 2,700, 2,800 c/s.

The results of these tests shall be recorded and graphed in duplicate on Form T.R.M.56. One copy shall be retained at the control station and one copy filed by the Long Line Equipment Maintenance Divisional Engineer.

8.9 Output Impedance. With test current applied to the mid-frequency channel, the output of the directional filters shall be measured on a T.M. Set in the "Level" and "Loss" condition.

The difference between the two readings shall be 6 db ± 0.5 db.

8.10 Return Loss of System against Line Equipment. Send test current as for test 8.9. By means of a system of parallel jacks, patch the T.M. Set across the output of the directional filters and set it for a level measurement. Record the level measured, firstly, when the system is connected to the line equipment in its normal condition, and, secondly, when the line equipment is disconnected, that is, the system is terminated in a high impedance.

The difference between these readings shall be 6 db ± 1.0 db.

8.11 Hybrid Balance and Network Test. Terminate the "hybrid line" jacks in 600 ohms. Under this condition, the line side of the hybrid coil will be terminated in 600 ohms and the network side in its normal network. The balance of the hybrid coil windings and the correctness of the network termination shall be tested by measuring the loss at 800 c/s between the "hybrid in" and "hybrid out" jacks.

The loss shall be greater than 30 db.

8.12 Pilot Oscillator Adjustment. (Regulated Systems Only.) The frequency and power output of the pilot oscillator at each terminal shall be checked and adjusted if necessary.

8.13 Regulator Tuning Adjustment. (Regulated Systems only.) After the pilot oscillator frequency and output have been adjusted at the preceding station, the pilot pick-off filter should be tuned by adjusting for maximum deflection on the pilot indicator. The sensitivity of the pilot circuit should then be adjusted to give a zero reading on the pilot indicator.

8.14 Regulator Operating Adjustment. (Regulated Systems only.) The regulating equipment shall be checked for correct operation, including the operation of the alarm circuits.

8.15 Equipment Inspection. Each bay of equipment shall be thoroughly examined to detect any defects in wiring or in any items of equipment.

9. TESTING SCHEDULES.

9.1 Schedules of tests for regulated and unregulated terminals, showing tests to be performed by the local staff and by staff under the control of the headquarters staff of the Long Line Equipment Maintenance Section, are shown in Tables 1 and 2.

SCHEDULE OF TESTS.

(To be performed by local staff.)

UNREGULATED SYSTEMS			
Daily	Weekly	Monthly	Quarterly
Transmission Equivalent.	Carrier Leak (Valve Mods.).	Carrier Leak. Grid Bias. Filament and Plate Currents. Synchronisation. Alarms.	Over-all Line Up. Linearity. Noise. Switchboard Extensions.
REGULATED SYSTEMS			
Daily	Weekly	Monthly	Quarterly
Regulator Check.	Carrier Leak (Valve Mods.).	Carrier Leak. Grid Bias. Filament and Plate Currents. Synchronisation. Alarms. Transmission Equivalent.	Over-all Line Up. Linearity. Noise. Switchboard Extensions.

TABLE 1.

ANNUAL TESTS.

These tests will be carried out under the direction of a Supervising Technician attached to the Headquarters of the Long Line Equipment Maintenance Engineer.

Test No.	Described in Paragraph	All Systems	Regulated Systems
1	8.2	Meter Calibration.	
2	6.3	Grid Bias.	
3	6.2	Filament and Plate Currents.	
4	8.3	Modulator Oscillator Frequency.	
5	8.4	Oscillator Levels.	
6	6.4	Carrier Leak.	
7	8.7	Volume Limiters.	
8	8.6	Amplifier Gain.	
9	6.6	Alarms.	
10	8.11	Hybrid Balance and Network Check.	
11	7.4	Switchboard Extensions.	
12	6.5 and 8.5	Synchronising.	
13	8.9	Impedance.	
14	8.10	Return Loss.	
15	7.1	Over-all Line Up.	
16	7.2	Linearity.	
17	7.3	Noise.	
18	8.8	Quality.	
19	8.12		Pilot Oscillator Adjustment.
20	8.13		Regulator Tuning Adjustment.
21	8.14		Regulator Operating Adjustment.
22	8.15	Equipment Inspection.	

TABLE 2.

END.