

CHAPTER V

TRAIN TRAFFIC CONTROL

5.1 GENERAL

5.1.1 RAILWAY CONTROL CIRCUITS: Railway Control Circuits are omnibus telephone circuits which provide communication with each train working point, thus facilitating efficient train operation. They should provide satisfactory and reliable communication between the controller and the various way-side stations, important signal cabins, loco sheds, yard offices etc.

5.1.2. TYPE OF CONTROL SYSTEM: According to traffic requirements and to cater to the needs of Electric Traction area, a section may be provided with one or more Railway Control Circuits as detailed below :

a) SECTION CONTROL / TRAIN CONTROL : This is provided for communication between the Section/Train Controller in the control office and way-side stations, junction station, block cabins, loco sheds and yards in a division for the control of train movements and effective utilisation of section capacity.

b) DEPUTY CONTROL : This is provided for communication between the Deputy Controller in the control office and important stations, junctions & terminal stations, yard master's offices, loco sheds and important signal cabins in a division for supervisory control of traffic operation in general.

c) STOCK / ADM. CONTROL: This is provided for communication between the Stock/Adm. Controller in the control office and yard master's offices at junctions and terminal stations in a division for getting information on the movements of rolling stock.

d) LOCO POWER CONTROL : This is provided for communication between the Loco Power Controller in the control office and the various loco sheds, important stations and yards in a division for the optimum utilisation of the locomotives.

e) TRACTION LOCO CONTROL : Provided between traction loco controller and loco sheds, important Station Master's Offices for optimum utilisation of electric locomotives.

f) TRACTION POWER CONTROL : Provided between traction power controller and SM's Office, FPs/SPs/SSPs for maintenance of OHE system.

g) S&T CONTROL : Provided between test room and way stations for effective maintenance of S&T equipments.

h) EMERGENCY CONTROL: Provided from selected points along the track route for establishing communication between train crew (in case of emergency), traction and permanent way staff with traction power controller. The emergency sockets are provided on rail posts at an interval of 1 Km (Max.) along the route. They are also provided at FP/SP/SSPs isolators in yards and near bridges.

i) **EMERGENCY WIRELESS CONTROL COMMUNICATION:** The following equipments can also be utilized for emergency wireless communication where such system exists:-

- i) Handsets for Mobile Train Radio Communication (MTRC) in sections.
- ii) Walkie-Talkie sets in sections where VHF communication from train to control office has been provided in lieu of any physical medium or MTRC.

Any other form of emergency wireless communication shall have the specific approval of the Railway Board

5.1.3 REQUIREMENTS FOR TRAFFIC TRAIN CONTROL SYSTEM :

5.1.4 Train Control systems shall fulfill the following requirements :-

- a) Rotary keys or push buttons of non locking type shall be provided for selective calling of any station by the controller.
- b) Facilities should be provided for selectively calling one or a group of stations or all stations.
- c) Means shall be provided to automatically inform the controller whenever the bell/buzzer at the station rings in response to the call initiated by him.
- d) The signalling used for selective calling shall not hamper normal telephone conversation on the line.
- e) Feature of prolonged ringing of any way-station shall be provided.
- f) Adjustment and maintenance of the equipments in the control office and way-side stations should be easy.
- g) The equipment should be rugged and capable of intensive use.
- h) The equipment should work satisfactorily within allowable margins of line characteristics without frequent critical adjustments.
- j) The system should be capable of progressive expansion without any replacement.
- k) The system should be compatible with overhead alignment and underground cables as applicable.
- l) Provision of intercommunication facility between several controllers in the same control office may be incorporated in the control key board/panel wherever necessary.
- m) Earth return circuits shall not be retained on AC traction and all Telecom circuits shall work on metallic return.
- n) Facility shall be provided in control office for transferring Emergency Control(wherever exists) to Section Control circuit.
- o) No overhead telecom alignment shall be within 50 meters from the AC electrified track except when running strictly at right angles.

5.1.4 INTERCOMMUNICATION BETWEEN LOCAL TELEPHONE AND CONTROL CIRCUIT

- a) It is also desirable to make provision of an approved type to interconnect the local telephone exchange with important control circuits to enable important officials served by the local telephone exchange to gain access to such control circuits with or without the assistance of an operator.
- b) Such a provision shall not affect the performance of the control circuits from the point of view of signalling or speech.
- c) Whenever interconnection is made through an operator, the manual board shall be provided with necessary supervisory facilities so that the telephone connected to the exchange is disconnected from the control circuit as soon as the conversation is over.
- d) It should be ensured that only important officials have access to control circuits in this manner.

5.1.5 TYPES: Traffic Control Equipments shall be of the following or any other approved type.

- (a) **STC KEY SENDING SYSTEM:** In this system the coded impulses are generated by means of a rotary selector key (4001-A, 4002-A & 4002-B) mounted in a key case being turned at a time to call any particular station. The impulses are received at the way stations by polarized relays or selectors (4301-A) adjusted to close the contact for the local ringing circuit for a particular code.
- (b) **PUSH BUTTON SENDING SYSTEM :** The Push Button Sending System consists of a push button panel and an impulsing unit in the control office. The panel is equipped with 16 push buttons, and any particular station being called by operating 2 buttons corresponding to the first two digits of the code. For prolonged ringing, the long ring key is operated. All stations can be signalled simultaneously by pressing a general call key.
- (c) **DUAL TONE MULTIFREQUENCY SYSTEM:** In this system two frequencies are being transmitted simultaneously as per the standard DTMF Frequencies plan given in Annexure-II with 2 digit code to call either one station at a time or a nominated group at a time or all at the same time.

The first two types are now obsolete and hence will not be described further. Moreover as per policy of Board all overhead alignment system of BSNL as well as Railways should be replaced in phased manner by 2008. However in extreme circumstances where it is required the same should be followed as detailed in old Telecom Manual (1971 edition).

5.1.6 INTERCOMMUNICATION EQUIPMENT: All controllers in a control office shall be provided with an intercommunication system of approved type with facilities for each controller to call any other controller, including Deputy Controller, Chief Controller and the Telecommunication Maintainer/Inspector on duty.

5.1.7 JUNCTION EQUIPMENT: When control circuits originate in electrified section and extend to a non-electrified section or vice versa 4 wire/2 wire OR 2 wire/4 wire Speech Conversion and Junction equipment as per specification IRS: TC-46 shall be provided at the junction.

5.2 SPECIAL PROVISION FOR CONTROL COMMUNICATION WITH UNDERGROUND CABLES AT REPEATER STATION: Repeater Station equipments are housed in Structural Frames and Transformer Bay.

5.2.1 STRUCTURAL FRAME: Structural frame houses

- i) Miscellaneous panel
- ii) V.F. Amplifier panel
- iii) Ringing impulse amplifier panel

Structural frame for equipment bay is a frame work composed of M.S.. angles of size 40 x 40 x 6 mm and 25 x 25 x 3 mm as per the drawing No. TC-15145. Top most rack of the frame is meant for housing miscellaneous panel the requirement of which is one per repeater station. The other racks are of equal sizes and are to be distributed to house amplifier panels and ringing impulse amplifier panels. The required numbers of amplifier panels and ringing impulse amplifier panels is to be decided on the requirement of circuits required for the section.

The size of the structural frame for the equipment bay shall be 615 mm x 250 mm x 1630 mm.

It is to be installed on the channel foundation on the floor of the repeater station building. The details of channel foundation are indicated in the drawing No. RDSO/TC-35027 to 35029.

5.2.2 **Miscellaneous panel:** Miscellaneous panel is provided on the top most rack of the structural frame. It houses U-link panel and fuse panel. It conforms to the drawing No. RDSO/TC-33180.

(i) U-link panel : In the front of the cabinet 5 nos. of U-link panels are provided. Each U-link panel has 32 inlets/outlets. Tag strip provided on the top of the U-link panel is to be connected to the secondary of the isolation transformer in the Transformer bay and the tag strip provided at the bottom is to be connected to the tag block of the amplifier panel or terminal strip of the ringing impulse amplifier panel as the case may be. For isolating, testing and monitoring the U-link provided on the miscellaneous panel is to be used.

(ii) Fuse panel : Fuse panel has the maximum capacity of holding 4 numbers of 10 lines alarm type of fuse. To have an access of the fuse panel rear cover of the miscellaneous panel is to be opened. One fuse block 10 lines is required for each amplifier panel having nine cards. Fuse to be used shall be of 0.5A capacity. One fuse block -10 lines is required for 5 ringing pulse amplifier panel. Fuse used shall be of 1A capacity.

(iii) Cable entry : Two cable entry holes with suitable grommet are provided at the left and right of the rear cover.

(iv) Size : The overall dimensions of the panel shall be 575 mm x 253 mm x 228 mm.

(v) Accessories : The electronic hooter/buzzer shall be supplied as an accessory which is to be mounted on the maintainers table. This hooter shall be connected in such a way to sound whenever any one of the fuses blows out.

5.2.3 **Amplifier Panel :** The amplifier panel houses the printed circuit cards of V.F. buffer amplifier. It conforms to drawing No. TC-15150. The amplifier panel/panels are to be mounted on the rack/racks just beneath the miscellaneous panel in structural frame works of the equipment bay.

One leak amplifier card serves for two circuits so leak amplifier card shall be placed in between two VF amplifier cards for which the leak amplifier is meant.

VF Repeater Amplifier : The 4W VF Repeater amplifier is intended to make good of the losses incurred due to cable attenuation, insertion loss of sectionalizing transformer installed in cable huts. The repeater are spaced at an interval of about 50 KM.

- a) The repeater provides a gain of 24 ± 2 db in the voice frequency range. The gain adjusted in steps of one db.
- b) The nominal input and output impedance of the amplifier is 1120 ohm.
- c) Equalizers are provided for the correction of frequency response characteristics of the cable.
- d) The frequency response shall be flat within ± 0.1 db in the frequency range 300 Hz to 3.4 KHz.
- e) The return loss of the repeater against 1120 ohm is not less than 25 dB in the frequency range of 300 Hz to 3.4 KHz.
- f) The output return loss against 1120 ohm with amplifier set for maximum gain is not less than 20 db over the frequency range 300 Hz to 3.4 KHz.

Leak Amplifiers : Two pairs of conductors are required for each control circuit, one for speaking and another for listening in order to overcome the difficulty likely to be experienced in balancing an omnibus circuit like control circuit. With a four wire circuit conversation between way stations is not possible. However with the provision of a small amplifier (Leak amplifier) at the first repeater station speech at low level is passed from the receive pair to the transmitting pair, thereby enabling the way stations to know whether the line is engaged or not. In addition, a certain amount of speech passes from the receive pair to transmitting pair through the loudspeaker and microphone making communication between way stations possible.

In all four wire control circuits excepting remote control, the leak amplifier shall be provided at the Main (First) repeater station.

- a) The leak amplifier is provided with an overall loss of 20 ± 0.5 db (fixed)
- b) Nominal input impedance of the amplifier is 50K.
- c) The variable 50 K pads of 1, 2, 4, 8 db induces the necessary leak into the circuit.
- d) 1120 ohm pads of the value 1, 2, 4, 8 db is also provided. It is required only at the main repeater station. Control room equipments is installed in the vicinity of the main repeater station. The level of the incoming speech of the trans pair

will be high. The necessary pads are also inserted to introduce required attention.

e) The frequency response shall be flat within ± 0.2 db in the frequency range of 300 Hz to 3.4 KHz.

f) The normal current drain for each leak amplifier shall be 1.6 mA + 0.1 mA.

5.2.4 **Ring Impulse Amplifier (RIA) Panel :** This panel is provided for amplifying the ringing impulses at the intermediates repeater stations. This houses the printed cards and the allied components of ringing impulse amplifiers. The arrangement of the panel is as per Drg. No. TCA 15135. Each panel consists of two identical sets of amplifier units conforming to Drg. No. TC-15093.

Ring Impulse Amplifier: In order to overcome the drop in signalling voltage due to line resistance, the AC 50 Hz signals interrupted at 3-1/2 cycles per second, are amplified at each repeater station with the aid of ringing impulse amplifier. Each RIA panel consists of two identical amplifier circuits to Drg. No. TC-15093.

Operational Features : An output signal of 50V, 50 Hz can be obtained for varying input signal between 7V & 42V by suitably strapping of the flying load to the tags 'a' or 'b' or 'c' & by adjusting the trimmer.

5.2.5 **Transformer Bay :** Transformer Bay houses

- i) V.F. transformers (1120 : 1120)
- ii) Signalling transformers.

(a) To restrict the induced voltage due to the catenary within the limits specified by CCITT, telecommunication circuits are to be isolated by means of V.F. Transformers. In addition signaling transformers are required for deriving phantom circuits. These transformers provide impedance matching and isolation between balanced and unbalanced circuits at the repeater station.

(b) Transformer Bay is a cabinet which houses the transformers and are installed in cable huts and repeater stations. It conforms to the drawing No. TCA 15202. It is a cabinet made of mild steel sheet and of size 525 mm x 272 mm x 1630 mm with two cable entry holes having suitable rubber grommet provided at the top. To have an access of the equipment, front door provided with suitable locking arrangement is to be opened. In back, it is provided with covers which are three in numbers and are screwed to the body. The distribution of the components in the transformer bay from top to bottom are as follows (1) Lightning arrester base plate (2) Link panels (3) Transformer panel (4) Lightning arrester base plate. An earthing strip is also provided which runs vertically to solder all connections that are to be connected to earth.

(c) The transformer bay can accommodate 6 transformers in one row. The different transformers shall be fixed as detailed below :

- VF transformers (1120 : 1120) shall be fixed at positions 1,3,4 & 6.
- Signalling transformers (1:2) shall be fixed at positions 2 & 5.

(d) Five link panels are required to be provided in the transformer bay. The first 2-1/2 panels from top are required to be connected to the incoming cable and the rest to the outgoing cable.

5.3 DUAL TONE MULTI FREQUENCY CALLING SYSTEM.

5.3.1 (a) This system for train traffic control equipment with voice frequency signaling using Dual Tone Multi Frequency(DTMF) signals for 4 Wire and 2 Wire operation is known as DTMF Calling System.

(b) The control office equipment is normally designed for 4 Wire operation which can be converted into 2 Wire operation by provision of hybrid attachment. The way station equipment shall be different for 4 Wire and 2 Wire working.

5.3.2 **CONTROLLERS EQUIPMENT :** The control office equipment consists of operating console with DTMF code generator and voice communication equipment.

(i) The operating console with code generator has following facilities :

a) Standard DTMF Key Pad for calling 99 stations with two push button operation.

b) Station group code button A, B, C, D.

c) Push button for general call for calling stations simultaneously.

d) Push button LR for extending long ring at way stations.

e) Special push button 'RT' - for repeating last transmitted station code.'RS' - to reset the system 'RC' - for row/column frequency check. 'DL' - for cancellation of code.

(f) Visual indications for “System O.K”., “Display of station code” and “power ON” indication.

(ii) The communication equipment consists of loudspeaker/microphone with amplifiers and hand micro telephone and controllers headset.

5.3.3 **WAY STATION EQUIPMENT:** The way station equipment shall consist of DTMF decoder which can be assigned any DTMF station code/group code selectable with DIP switches, voice communication equipment and 2-Wire/4-Wire desk type control telephone.

5.4 POWER SUPPLIES :

5.4.1 For selective calling system employing DTMF signalling, the following should be provided :

(a) At control office 12V DC supply (with a ripple factor of 2 mV) shall be provided from secondary batteries of 12V/80AH with associated charger.

(b) At Wayside Station 12V DC supply (with a ripple factor of 2 mV) which can vary between +20% to -10% of the nominal value for way station equipment shall be provided from secondary batteries of 12V/40AH with associated charger.

5.4.2 All secondary batteries should be housed exclusively in a separate room with provision of exhaust fans.

5.4.3 Standby diesel generators, wherever, provided, should be sufficiently rated to enable them to take the load of lights and fans during failures of AC mains supply.

5.4.4 All batteries should be adequately insulated from earth.

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5.5 EARTHING: All earth connections shall be of approved type as detailed below :-

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(i) All earth connections shall be approved type obtained by burying a pipe or rail of adequate size in the ground.

(ii) The resistance of an earth shall not be more than 10 ohms.

(iii) 4 mm diameter galvanised iron wire adequately supported or secured and free from bends and spirals should be used.

(iv) The earth wire should be soldered to the wire connected to the earth terminal on the test panel.. Similarly, it should be securely connected to the earth electrode.

(v) The ground surrounding the earth electrode should be kept moist by periodically pouring saline water.

(vi) Where more than one earth has to be installed, they should be separated by a distance of not less than 2300 mm from each other.

(vii) Where a number of telegraph instruments are provided in the same telegraph office, separate earth leads shall be provided for each instrument.

(viii) An earth wire should be run from one end to the other, beneath the tables, so that the earth connection for each instrument is as short as possible. For this purpose, earth wire of 3 SWG copper should be used.

(ix) Separate earths shall be provided for the return circuits and lightning discharges. The earth provided on the test panel for testing the circuits shall also be separate.

5.6 At junctions where two or more control circuits are required to be interconnected frequently, automatic interconnection, preferably of an approved type should be provided in lieu of normally operated jack boxes/boards.

5.7 INSTRUCTIONS FOR INSTALLATION

5.7.1 LAYOUT OF CONTROL OFFICE :

a) Control offices and the attached test rooms shall be air-conditioned.

b) The layout of the control office shall, as far as possible, conform to the layout shown in Annexure III. They should be located, as far as possible, in the ground floor.

c) Control offices, especially the controller's booths, shall be acoustically treated to eliminate disturbing noises, echoes, etc., to enable use of microphones and loudspeakers. The reverberation constant of the booth shall not be more than 0.4 seconds.

d) i) The minimum floor area of the controller's booth shall be 12 sq. metres.

ii) The booths shall be provided with diffused lighting by artificial illumination, avoiding pockets of shadows. The artificial illumination shall

provide an illumination of not less than 110 metre candles on the controller's table.

- iii) The booth shall be colour treated to avoid fatigue to the eyes and shall be aesthetically pleasing.
 - iv) The floor shall be covered with linoleum.
 - v) The doors and sides of booths facing the Chief/Deputy Controller shall be provided with glass panels on the upper half.
 - vi) Doors of booths shall be single-leaf, teak-wood flush fitting, self-closing type.
- e) Controller's tables and chairs shall be designed to give maximum facility for efficient discharge of their duties.
- f) A false ceiling shall be provided preferably of an acoustic material such as 'Cellotex', perfotile sheets, etc., to provide good acoustic and thermal insulation. The ceiling height shall not be less than 3.25m.
- g) All equipments except those required for operation by the controllers, especially equipments producing noise during operation, shall be located in a different room outside the control office.
- h) Batteries, especially secondary cells, shall be located in a separate room outside the control office.
- i) The test room shall be located as close to the control office as possible to enable the test room staff to attend to any fault promptly.
- j) The test room shall have enough floor area to accommodate the test panel and maintenance spares required for the various equipments. It shall also accommodate tables and chair for the maintenance staff to carry out overhauling, repairs and maintenance.
- k) While planning a control office, space required for future additions and alterations should be kept in view.
- l) Adequate space should also be earmarked for stationery and filing cases.

5.7.2 INSIDE WIRING IN CONTROL OFFICE:

- a) Wire runs to the controller's table shall be terminated on a terminal strip of approved type, fixed at a suitable place in the rear. The terminal strip shall be protected by a suitable cover.
- b) Wiring for the controller's telephone set, telephone sockets and the selector key case/push button panel/operating console shall be underneath the table top in a concealed manner.
- c) The selector key case/push button panel/operating console shall be installed on the left-hand side.
- d) Separate conduits or runways shall be provided for communication and high voltage electric wires.

- e) Before constructing a building for a control office, distributing systems for communication wires shall be included in the building specifications.
- f) Facilities for provision of communication wire should be made during construction of the building to enable concealment of cables and wires, thereby improving the general appearance of the control office.
- g) Mechanical protection should, as far as possible, be provided for cables and wires to achieve trouble-free service.
- h) Terminal and junction boxes should be located suitable to enable maximum flexibility while carrying out additions or alterations.
- i) All incoming line wires underground cables shall be terminated in the test room before extending them to control office.
- j) Where direct termination in the test room is not possible, they should be terminated on a termination box of approved type and extended to the test room in a duct or a conduit through the wall.
- k) It should be ensured that the entrance cable is not susceptible to damage due to proximity of water pipes, steam pipes, engine exhausts, electric light or power circuits, elevator shafts, storage dumps or inflammable materials, etc.
- l) The entry should be planned so that it is not objectionable from the stand point of appearance.
- m) All line wires/communication cables entering the building from outside and all inside wiring shall be terminated in the test room with facilities for cross-connection and distribution.
- n) Test rooms shall be free from overhead piping and the walls should be fire-proof.
- o) Provision of outlets for soldering iron and portable lights shall be made in test rooms.
- p) The area surrounding the test room shall be dry and clear and shall be constructed so that there is no possibility of the basement getting flooded.
- q) Where loudspeakers and microphones are provided for the controller, the loudspeaker shall be provided with the volume control easily accessible to the controller. The microphone shall be fitted on an adjustable bracket on arm.
- r) Foot switches shall be fixed sufficiently above the floor to prevent water getting into them.
- s) On control circuits, lighting protectors shall be of gas discharge type and they shall be connected on an earth of approved type.
- t) Test panel of an approved type shall be provided in the test room for incoming wires and inside wires for localising faults.
- u) In the case of circuits for which outside line wires/underground cables are maintained by the P&T Department, the outside wires shall be terminated on a panel to serve as a demarcating point.
- v) Terminals on the panels shall be properly labeled.

w) All apparatus cases and ringing rectifiers for high voltage DC signalling shall be mounted on a rack of approved type with a minimum clearance of 0.5m all round and from the floor level.

x) Cable racks, if any, shall be made of longitudinal strips iron or angle iron with horizontal cross pieces of light material. The size of the material shall be decided on the basis of the ultimate weight that the rack is expected to carry.

y) Cable racks shall be located so as to be accessible and laid out for the shortest practicable runs between the various units.

5.7.3 WAY STATIONS :

a) In 2-Wire Overhead Alignment territory all way stations served by STC Keying System or Push Button System control circuit should be provided with a test panel of approved type.

b) In 2-Wire Overhead Alignment territory served by STC Keying System or Push Button System for way stations served by Deputy Control Circuit in addition to section control circuit, patching facilities should be provided by means of a patching panel of approved type.

c) In 2-Wire Overhead Alignment territory served by STC Keying System or Push Button System at wayside stations which are served by control circuits, operating instructions for operation of test panels for testing and patching where provided shall be laid down and exhibited for the guidance of the operating staff.

d) Inside wiring in way stations should be carried out in accordance with relevant instructions under Para 5.7.2.

e) All earths should be of approved type as detailed in Para 5.5.

f) In 2-Wire Overhead Alignment territory for selective calling systems employing 3.5 Hz DC signalling, three dry cells should be provided as power supply for each control telephone with selector. Alternatively, six lead acid cells of 40 AH capacity shall be provided with a battery charger incorporating a smoothing filter. For push button sending systems, eight dry cells of heavy duty type should be provided at each way station for the selector equipment. The required voltage for the telephone may be obtained by choosing a suitable tap from the dry cells provided for the selector equipment or arranged separately through 3 dry cells.

g) In 2-Wire Overhead Alignment territory served by STC Keying System or Push Button System at way stations provided with more than one control telephone with selective calling arrangements, the bells/buzzers should be adjusted to give a distinct sound to enable identifications of the circuit on which the station staff are required to attend.

5.8 INSTRUCTIONS FOR MAINTENANCE :

5.8.1 DUAL TONE MULTI FREQUENCY CALLING SYSTEM

CONTROL OFFICE EQUIPMENT

a) For equipments with DTMF signalling proper functioning of the following keys shall be checked.

i) Group codes A, B, C and D

ii) Long ring LR

iii) General call

iv) Special purpose keys

Reset - RS

Delete - DL

Repeat - RT

b) All visual indications provided on equipment shall be checked.

c) Monthly Maintenance: The following shall be checked:

i) Proper functioning of all station codes including special codes shall be checked.

ii) Current Drain (max) on 12V DC side shall be as under:

Quiescent	:	150 mA
Working	:	500 mA

iii) Current consumption of transmitter of Controller's head set and HMT shall be between 100 and 150mA.

iv) DTMF signalling code level shall be between 0 dBm to - 7dBm across a load of 600 ohms.

v) Row/column DTMF frequency shall be checked by pressing the 'RC' button and shall be within the specified limits.

d) Quarterly Maintenance:

(i) Insulation resistance at room temperature of the office wiring when measured with a 500V megger shall be more than 10 megohms between conductor to conductor and more than 20 mega ohms between conductor and Earth.

WAY STATION EQUIPMENT

e) Weekly Maintenance: The following shall be covered :

i) Proper decoding of the set code of the equipment and actuation of buzzer/ loudspeaker Ring back and LED on the control telephone.

ii) LED indication on telephone shall clear after hand set is lifted of the cradle.

iii) Correct fitting of fuses and their rating.

- iv) Cleaning and proper termination of wires on the terminals on the rosette and CT box.
 - v) Telephone cord is in good condition and connected properly.
 - vi) Specific gravity of battery shall be 1210 and battery voltage shall be 12 volts - 10%, + 20%.
 - vii) Cleaning of battery terminals and vent plugs.
- f) Monthly Maintenance : The following shall be covered :
- insertion loss shall not exceed the following values
- i) 0.1 db with the handset 'on' cradle switch.
 - ii) 0.3 db with the handset 'off' cradle switch.
 - iii) 1.0 db with the press to talk switch pressed.
 - iv) Current drain (Max) on 12V dc side shall be as under:
- | | |
|-----------|----------|
| Quiescent | Actuated |
| 20mA | 100mA |
- v) Conversation between the controller and way station shall be checked for satisfactory audibility and clarity.
- g) Quarterly Maintenance : The following shall be covered :
- i) The transmitter inset in telephone should be in good condition and fitted properly inside. The resistance of inset shall be checked to be between 150 and 200 Ohms.
 - ii) The receive inset in telephone shall be fitted properly and resistance shall be 150 ohms to 200 Ohms.
 - iii) Insulation resistance at ambient temperature of inside wiring shall be more than 20 megohms between conductor to earth and more than 10 megohms between conductor to conductor when tested with a 500V megger.

5.9 TESTING OF CONTROL CIRCUITS

5.91 TEST PANEL: A test panel of approved type should be installed in all control offices for the use of the maintenance staff to facilitate the following :

- a) Disconnection of control office equipment to enable independent testing of control circuits with either the way station equipments or the control office equipments.
- b) Patching facilities for substitution by radio patch, of deputy control or spare lines to restore communication on interrupted circuits.
- c) Monitoring of all circuits without interruption to the normal working of circuits.

- d) Provision for a universal calling device to call any station on any circuit.
- e) Provision for calling attention of the maintenance staff by the controllers.
- f) Provision of a line test set to provide for the following tests :
 - i) Voltage measurements of test, local and line signalling batteries.
 - ii) Measurement of line resistance.
 - iii) Measurement of leakage to earth
 - iv) Location of earth faults.
 - v) Measurement of foreign voltage on line.
 - vi) Impulse ratio check during signalling.
 - vii) Line leakage measurements.
 - viii) Telephone communication with line under test.

5.9.2 TEST OSCILLATOR.: A standard line test oscillator with a dB meter should be provided to carry out measurement of line transmission loss and equipment insertion loss.

5.9.3 MEGGER: A 100/500 volt megger should be provided to carry out insulation tests on internal wiring and external lines.

5.9.4 PERIODIC TESTS:

- a) All control circuits should be periodically tested by the inspector incharge to check the condition of inside wiring in control offices and way-stations, external line and cables, and control office and wayside station equipment.
- b) Inside wiring should be tested for insulation once in three months with a 500V megger. This should include cross insulation between conductors and leakage to earth. The cross insulation should be above 10 megohms and the insulation to earth should not be less than 20 megohms.
- c) Circuits transmission loss should be measured at intervals not exceeding three months.
- d) Line loop resistance should also be measured once in three months. The loop resistance and disparity between each limb shall not exceed 5% of normal calculated value.
- e) Equipment insertion losses due to magneto bells, bridging coils and manual exchange boards should not exceed the maximum permissible losses.
- f) Insertion loss of control telephones should be measured once in three months to ensure that the maximum permissible losses are not exceeded from the limits given in IRS specifications .
- g) In the case of lines maintained by the P&T deptt. the above tests should be carried out jointly with their representatives.

h) Result of such tests should be entered in a register maintained separately at each sectional inspector's headquarters and in the office of DSTE/Sr.DSTE.

i) Any defects noticed during such tests should be rectified on the spot and the circuit retested before proceeding with further tests.

j) All loss measurements should be carried out by means of a test set provided with an audio oscillator giving a variable output from -10 dB to +10 dB with reference to 1 milliwatt across 600 ohms, between 300 and 3000 Hz. The dB meter should have a sensitivity of -30 dB with reference to 1 milliwatt across 600 ohms.

k) All tests should preferably be carried out for the smallest subsections.

5.9.5 Testing at VF Repeater :

a) The insulation of the windings of transformers with respect to earth shall be checked using the bottom tag of each link and the earth strip (under discharger connected condition) and the value so measured shall not be less than 10,000 Megohms, when tested with a 500V insulation tester.

b) A tone of 1 KHz at 0 dbm shall be fed to the primary of the transformer of side circuit 1 at the respective terminal of the link. The level shall be measured at the secondary at the respective link terminal. The loss shall be less than 0.6 db. The secondary of side circuit 2 shall have no influence of the tone.

c) The limbs of side circuit 1 & the side circuit 2 shall be shorted individually and to this the tone of 1 KHz shall be fed. The tone shall be available between 5 & 6 of the phantom transformer. This tone shall have no influence at terminals 5 & 8 of the both 1120:1120 transformer connected to the side circuits.

d) These tests shall be repeated for all the quad connections.

5.10 CONTROL INTERRUPTIONS

5.10.1 PROCEDURE

a) As soon as interruption such as complete ringing failure, very low speech, hum, noise or heavy induction on a control circuit for more than 10 minutes, the controller on duty shall proceed to localise the shortest faulty section with the help of the way station operating staff and other section controllers.

b) Technical staff in the control office and way-station may be called upon to assist in the localisation whenever any technical difficulty arise.

c) As soon as the faulty section is localised, the matter should be brought to the notice of the Telecommunication maintainer on duty, who will confirm the faulty section.

d) This should be followed up by the issue of a 'XI' message by the controller, addressed to the concerned lineman, EST, SDOT,DET or the P&T sub-division concerned as also to the inspector incharge of the control office. Inspector incharge of the section under which the interruption has taken place, and the ASTE/DSTE

giving details of time of interruption, name of circuit, interrupted section and the nature of interruption/fault. Where the cable/overhead alignment is owned by the railway, similar action shall be taken, intimation of faults in this case should be given only to the concerned railway officials.

e) Besides a message, the lineman should also be ordered to patrol the interruption section through a telephonic advice to the station master of the headquarters station of the lineman.

f) Lineman at headquarters on either side of the interrupted section should be advised as possible to enable patrolling from both directions.

g) In the event of any delay in the patrolling of the interrupted section for any reason, the fact should be brought to the notice of the EST/SDOT/DET by the Maintainer/Inspector incharge of the control office.

h) After confirming the faulty section, the maintainer should proceed to arrange for substitution of the Deputy Control/Spare line to restore the interrupted circuit with the assistance of the controller.

i) Restoration of the circuit after substitution can be taken as a confirmation that the office equipments connected to the interrupted circuit are not defective.

j) If a substitution is not possible for any reason or the circuit is not restored even after substitution, the section maintainer/inspector should be called upon to check the office equipments in the interrupted section and promptly rectify the defects, if any.

k) On rectification of the fault, the controller shall issue XR/XT message to all concerned giving details of the time of interruption, name of circuit, interrupted section and the time of removal of fault.

l) In the event of the lineman reporting 'no fault found' after patrolling, in spite of the interruption persisting as observed by the controller of the telecommunication maintainer in the control office, the interrupted section should be jointly tested by the Telecommunication Inspector incharge of the said section with the concerned EST of the P&T Department.

m) A similar joint test should also be undertaken in the case of repeated interruptions in the same section.

5.10.2 CHART OF JURISDICTION OF BSNL/MTNL AND RAILWAY OFFICIALS.

A chart showing the jurisdiction of concerned P&T and railway officials shall be provided in the control office for guidance of the controller.

5.10.3 QUARTERLY MEETINGS.

Wherever Overhead Alignment is maintained by BSNL/MTNL, quarterly meeting may be held at CSTE/Dy.CSTE level with GM/DGM concerned to discuss and reconcile the line interruption reports, failure records and initiate suitable action in respect of minimising the number and duration of interruptions.

5.11 INSPECTION RECORDS AND REPORTS

5.11.1 RECORD AND REPORTS BY INSPECTORS : The inspector incharge of the control office shall :

a) Keep a record of all interruptions on control line as well as failure of way station and control office equipments.

b) Prepare a monthly line interruption and failure report and submit it to the Divisional Signal & Telecommunication Engineer in duplicate.

5.11.2 RECORD AND REPORTS BY DSTE/Sr.DSTE.

The Sr. Divisional Signal & Telecommunication Engineer shall

a) Discuss the monthly line interruption report in a joint meeting with the Divisional Engineer (Telegraphs)so that suitable action in respect of minimising the duration and the number of interruptions is taken promptly.

b) Forward one copy of the report to the Chief Signal & Telecommunication Engineer for his information after scrutiny of the line interruption and failure reports.

c) Maintain record of control interruptions, preferably graphically, showing

i) The total number of interruptions and their duration, and

ii) The efficiency of line operation.

The efficiency is calculated as under :

$$\text{Efficiency} = \frac{A-B}{A} \times 100$$

Where A = Total working hours in a month

B = Total working hours lost on account of line interruptions.

ANNEXURE I

CALCULATION OF APPROXIMATE LENGTH AND NUMBER OF STATIONS ON A CONTROL CIRCUIT

Considering the restriction of 20 dB as the permissible loss on control circuits, the length of the circuit for satisfactory speech can be estimated after allowing for the insertion loss of telephone and the wiring at the stations. In a hypothetical case where one station is talking to the controller and two others listening in, the permissible line loss will be 15.6 dB (allowing for 3 dB insertion loss of telephone in speaking condition and 0.2 dB while listening and 1 dB for wiring at stations. This loss is obtained on a 400 km circuit with 57 kg/km copper wire.

However, for determining the number of stations that can be connected in the circuit signalling voltage is an important factor and from the graph attached it can be seen that for 400 km line (2200 ohm loop resistance) with 240 V Signalling voltage, about 60 selectors (or telephones) can be connected and with 200 V, it can be 40 selectors.

Similar calculations can be made for other requirements of Signalling voltage.

ANNEXURE – II

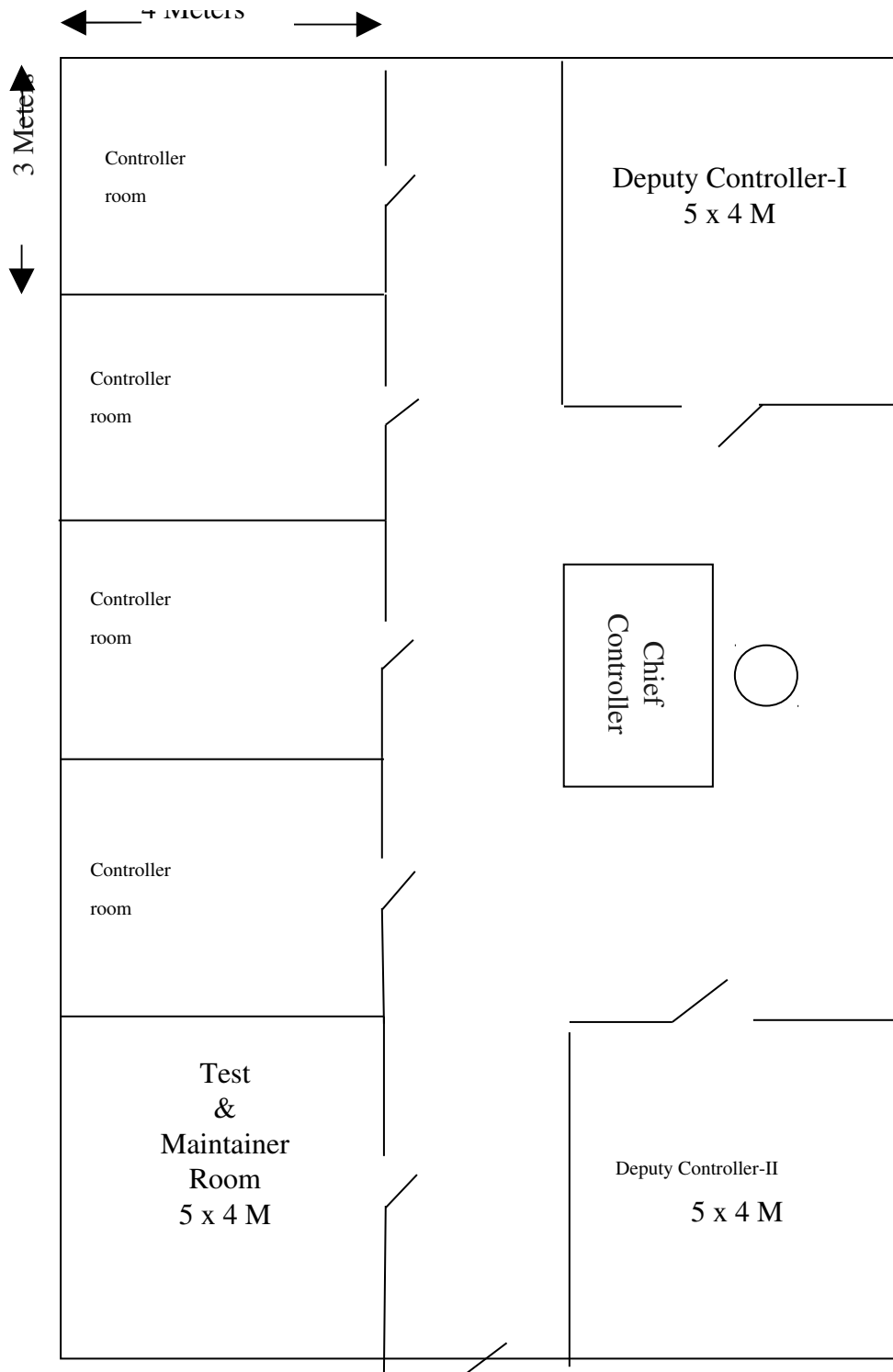
RS	DL	RT	RC		
1	2	3	A	697	LOW GROUP FREQUENCY (Hz)
4	5	6	B	770	
7	8	9	C	852	
G	0	LR	D	941	
1209	1336	1447	1633		

HIGH GROUP FREQUENCY (Hz)

- Note :
1. The frequency tolerance is $\pm 1.5\%$
 2. ABCD For Group Calling
 3. LR For Long Ring
 4. G For General Call
 5. RS Reset
 6. DL Cancel
 7. RT Last Code Repeat
 8. RC Row/Column Frequency

STANDARD DTMF FREQUENCY

Typical layout of a control office



Note: Power plant room shall be located outside

ANNEXURE - IV

LIMITS OF LOSSES ON TELEPHONE LINES

1. Subscribers' line Type of exchange	Transmission standard Exchange Voltage	Maximum permissible loop resistance of sub- scribers line in Ohms.
Magneto	00	375
CB Manual	40 V	375
AUTO	24 V	325
AUTO	40 V	450
AUTO	48 or 50 V	600

The maximum loop resistance of 375 Ohms for Magneto and semi-CB Exchanges is permissible with local batteries of not less than 2 V with a maximum internal resistance of 6 Ohms. For subscriber line with loop resistance of 375 to 450 ohms, local battery should have 3 cells of not less than 3 V with internal resistance not exceeding 3 ohms.

2. Junction Lines	Maximum Loop Resistance
(a) Junction lines connecting two local exchanges Of any type.	350 Ohms
(b) Junction lines from Trunk Exchange to local exchange of any type.	350 Ohms
(c) Junction lines plus subscriber line from local in (b) if latter is connected to a second local exchange.	300 Ohms

NOTE:-- It will be observed that the standard for 1 and 2 are stated in terms of permissible maximum loop resistance instead of being given as limits of transmission loss in decibels. This is to allow for losses which occur due the conditions of operation of subscribers' instruments and line loss only.

9. Trunk lines

Maximum permissible transmission loss is 8.7 dB at 800 Hz including repeating coils main lines (connecting main trunk centres)

Maximum permissible loss at 800 Hz for secondary lines (connecting small exchanges or RAXs to trunk centres) is 10 dB.

4. Non-exchange connections (applicable in railway control circuits) ...25 dB.

5. The overall transmission loss from one subscriber to another in any part of a telephone system shall not exceed 32 dB.

When trunks and junctions form part of a telephone system, they shall be so arranged that the built-up circuit over which conversation is to take place shall not exceed 28 dB. An allowance of one decibel must be made for each magneto exchange included in the built up circuit and 1.5 decibel for each CB exchange.

Circuits shall be designed so that equivalent length of the circuit in terms of loss does not exceed :

Subscriber loop to exchange of all types	... 4.5 dB.
Trunks between two trunk exchanges	...12.0 dB.
Junction between two exchanges	... 4.5 dB.

6. Table of transmission equivalents of instruments and exchange

(a) Apparatus connected in shunt across telephone circuits :

	dB.
Bell magneto 1,000 ohms	.. 0.461
Bell magneto 1,000 ohms in series with 2 μ F condenser	.. 0.461
Coil bridging 600 ohms.	.. 0.922
Coil bridging 1,000 ohms	.. 0.461
Coil bridging 600 +600ohms	.. 0.461
Coil retardation 1,000 ohms	.. 0.461
Indicators (tubular type) 100 ohms.	.. 0.461
Coil repeating 4006 – A	.. 0.692
Coil repeating VTR Gd.	.. 0.300
Coil repeating AT 4128 – 2	.. 0.326
(b) Trunk exchange cord circuit *	.. 0.462 to 0.922
(c) Magneto Exchange cord circuit*	0. 462 to 0.922
(d) Junction line cord circuits*	0.22

* These assume that the operator is not listening in on the line. With ordinary cord circuits and the operator's key thrown to speak, the loss will increase from 0.922dB to 4.61dB, unless provision is made for a high efficiency monitoring circuit on the trunk exchange cord circuits, in which case the operators can listen in without causing large loss which occurs when the 'speak' key is thrown.