Designation: G 165 – 99

Standard Practice for Determining Rail-to-Earth Resistance[1]

This standard is issued under the fixed designation G 165; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the procedures necessary to follow for measuring resistance-to-earth of the running rails which are used as the conductors for returning the train operating current to the substation in electric mass transit systems.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

G 15 Terminology Relating to Corrosion and Corrosion Testing[2]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *direct fixation fastener*—a device for fastening running rails to their support structures.

3.1.2 *cross bond*—insulated copper cables that connected between adjacent sections of track to ensure electrical continuity between them.

3.1.3 *impedance bond*—a device connected to running rails for automatic train operations.

3.1.4 The terminology used herein, if not specifically defined otherwise, shall be in accordance with Terminology G 15. Definitions provided, herein, and not given in Terminology G 15 are limited to this practice.

4. Significance and Use

4.1 Low resistance between the rails and earth could result in large magnitudes of stray earth currents with the attendant corrosion damage to underground metallic structures.

4.2 These measurements are of a low voltage type and are not designed to evaluate the high voltage dielectric characteristics of the rail insulating elements.

4.3 Sections of track with rail-to-earth resistances less than acceptable minimums must be tested in greater detail to determine the reason(s) for this condition. Determination of the reason(s) for any low rail-to-earth resistance may require the use of special testing techniques or special instruments, or both, beyond the scope of this practice.

4.4 The electrical tests call for the use of electric meters that have varying characteristics depending on cost, manufacture, and generic type. It is assumed that any person employing the test procedures contained herein will know how to determine and apply proper correction factors and that they will have sufficient knowledge to ensure reasonable accuracy in the data obtained.

4.5 This practice does not encompass all possible field conditions to obtain rail-to-earth resistance characteristics. No general set of test procedures will be applicable to all situations.

5. Equipment

5.1 Indicating dc, high impedance (minimum ten megohm) voltmeter (two required), multi-scale, capable of reading positive and negative values without removing test leads and covering at least the following full scale ranges:

5.1.1 0 to 10 mV,

5.1.2 0 to 100 mV,

5.1.3 0 to 1 V,

5.1.4 0 to 10 V, and

5.1.5 0 to 100 V.

5.1.6 Meters shall be accurate within 1 % of full scale.

5.2 Direct current ammeter, multi-scale, covering the following full scale ranges:

5.2.1 0 to 1 A,

5.2.2 0 to 10 A, and

5.2.3 0 to 100 A.

5.3 Direct current milliammeter, multi-scale, covering the following full scale ranges:

5.3.1 0 to 15 mA,

5.3.2 0 to 150 mA, and

5.3.3 0 to 1500 mA,

5.4 An alternative to the ammeter and milliammeter is a millivolt meter and external shunts covering the listed current ranges. Meters (and shunt combinations if used) shall be accurate to within 1 % of full scale.

---

[1] This practice is under the jurisdiction of ASTM Committee G-1 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.10 on Corrosion in Soils.

Current edition approved Dec. 10, 1999. Published February 2000.

[2] *Annual Book of ASTM Standards*, Vol 03.02.

5.5 Direct current power source with control circuits. Generally, 6 or 12 V automotive type wet cell batteries will suffice.

5.6 Test wires, assorted lengths and sizes, to suit field conditions. Wires should have minimum 600 V insulation in perfect condition (no visible cuts or abrasions) and be multistrand copper conductors for flexibility.

5.7 Miscellaneous tools as required for making wire connections, splicing and so forth.

5.8 Vehicle to transport equipment and personnel along track to facilitate testing.

6. Visual Inspection

6.1 The track section to be tested should be visually examined to ensure the insulating components have been installed and there is no debris, water, or other conductive material in electrical contact with the metallic track components that could result in the lowering of the effective track-to-earth resistance thus producing incorrect data.

7. Electrical Tests

7.1 Electrically isolate sections of track (see typical arrangements in Figs. 1 and 2). Length of track section to be tested is dependent upon the locations of rail insulators. Rail insulators are found at the ends of turnouts and single and double crossovers. The lengths of the track sections will vary within the general range of 60 to 2750 m (200 to 9000 ft).

7.1.1 Remove cable connections from across rail insulators.

7.1.2 Disconnect cross bonds within section of track being tested and other track.

7.1.3 Disconnect power traction substation negative feeder cables from track section being tested.

NOTE 1—Switches within substation can be opened.

7.2 Ensure electrical continuity between the rails within the insulated track section being tested by the use of the existing cables at impedance bonds or by installing temporary wire connections between the rails.

7.3 Track-to-earth resistance measurements will be obtained as shown on Fig. 3 for main track sections and as shown on Fig. 4 for main track sections containing double crossovers. Measurements on track sections containing turnouts and single crossovers will be similar to that shown on Fig. 4 with the number of test points being determined by the electrical configuration of insulating joints and bonding cables.

7.4 The track-to-earth resistance measurements for the track in the train storage yards will require special consideration for each section to be tested because of the number and location of insulating joints resulting from the type of signal system being used within the yard area and because of the number of cross bonds and other bonding cables used within the yard.

7.5 All data shall be recorded.

7.6 A sketch showing location of the test and the electrical test set-up used shall be included.

7.7 The number of readings taken to determine an electrical constant or property must be sufficient to ensure that random factors due to human error in reading the instruments and transient disturbances in the electrical network have negligible influence on final results. A minimum of three readings should be obtained but additional readings may be required depending upon the exact circumstances of the test. The adequacy of data generally can be established by the tester. Once the specified minimum number of readings have been obtained, data should be examined to see that removal of neither the highest nor the lowest value will alter the arithmetic average of group by more than 3 %. If the average is altered by more than 3 %, one more complete set of data should be taken and the results combined with the first set. If the test of the data still produces a change in the average value greater than 3 %, it may indicate an unstable condition in the system.

7.8 *Measurements Procedure*— (Fig. 3 for main track section, Fig. 4 for crossovers and turnouts).

7.8.1 Establish current circuit (I_1).

7.8.2 Establish rail-to-earth voltage (E_1) measuring circuit.

7.8.3 Obtain change in (E_1) per ampere of test current (I_1) (number of readings obtained to be in accordance with 7.7).

7.8.4 Calculate the effective track-to-earth resistance, $R_{1.1}$, (ohms) as change in (E_1(volts) per ampere of (I_1):

$$R_{1.1} = \frac{\text{delta } E_1}{\text{delta } I_1} \quad (1)$$

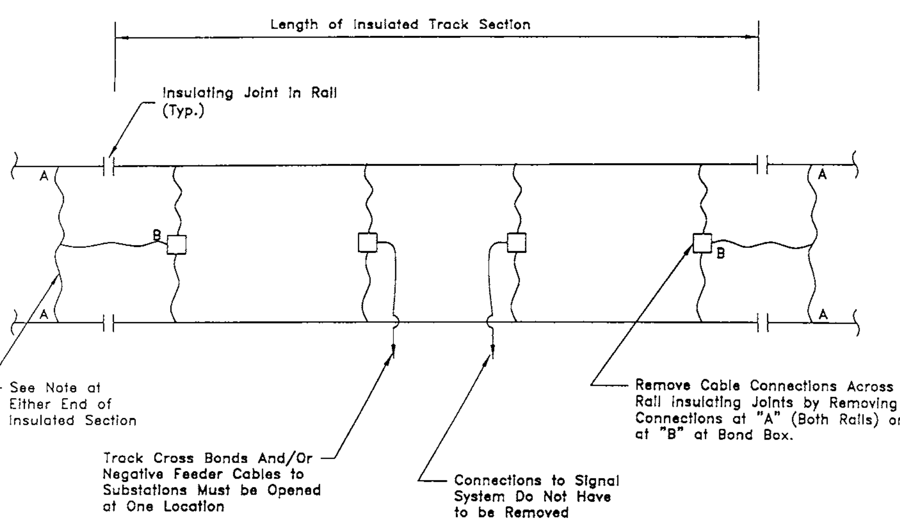

FIG. 1 Schematic Diagram — Typical Mainline Track Section