

**DIVISION III.—ERECTION, CONSTRUCTION, AND USE OF SYSTEMS OF SUPPLY.**

**PART 31.—CONDITIONS OF SUPPLY.**

**CONNECTION OF A.C. SYSTEMS WITH EARTH.**

31-01. In medium pressure or any lower pressure alternating current systems the connection of circuits with earth shall be made in accordance with the following requirements:—

- (a) The neutral conductor of a three-phase four-wire system, and the middle conductor of a single-phase three-wire system shall be earthed in multiple—that is, at the source of supply and at one or more other points along the distribution-line or service-line in addition to any connection with earth which may be on a consumer's premises.
- (b) The resistance between any point of the middle or neutral conductor and earth shall not exceed the limits prescribed by Regulation 51-01 hereof.
- (c) The neutral point of a star-connected or delta-connected three-phase three-wire system shall be earthed at the source of supply.

31-02. In high pressure and extra-high pressure three-phase alternating-current systems the connections of the circuits with earth shall be made in accordance with the following requirements:—

**Star-connected systems with earthed neutral—**

- (a) The neutral point shall be earthed at the source of supply and it may be earthed at any other point, provided that no interference of any description is caused by such earthing.
- (b) In the event of an appreciable harmonic current flowing in the neutral connection so as to cause interference with communication circuits, the generator or transformer neutral shall not be earthed, but a suitable earthing-transformer shall be used.
- (c) In generating-stations or substations supplying aerial electric lines, if such stations or substations are not continuously attended, earth-leakage relays shall be provided so that in the event of a leak to earth occurring either the faulty line will be made dead or the whole of the system supplied from this station or substation will be made dead.
- (d) The earth-leakage relays shall be set to operate with a time-lag not exceeding five seconds.
- (e) The maximum permissible setting of the earth-leakage equipment shall be such that operation of same will take place at the undermentioned values of the fault current to earth—

Pressure.	Primary Earth-leakage Current.
Not exceeding 25,000 volts	12½ per cent. of the rated full-load of the feeder (as determined by the current transformer ratio).
Exceeding 25,000 volts, but not exceeding 36,000 volts .. .. .	30 amperes.

For pressures exceeding 36,000 volts the primary earth-leakage current shall be prescribed by the Chief Electrical Engineer.

- (f) Should the full-load rating of the lines (as determined by the current transformer ratio) operating at less than 25,000 volts be such that the 12½ per cent. leakage current requirement will render the relays unduly sensitive, the following maximum values for earth-leakage current will be permitted—

Up to 3,300 volts .. .. .	1.5 amperes.
Over 3,300 volts but not over 6,600 volts .. .. .	2.0 amperes.
Over 6,600 volts but not over 11,000 volts .. .. .	2.5 amperes.

- (g) The Chief Electrical Engineer may give consent to the omission of earth-leakage relays:—

- (i) Where conditions are such that their use is impracticable; or
- (ii) Where some other suitable method is used or proposed to be used.

Every such consent shall be in writing and shall specify what special work (if any) the Chief Electrical Engineer deems necessary to secure reasonable freedom from electrical hazard.

- (h) In continuously attended generating-stations or substations supplying aerial electric lines a visual and audible indicator may be used in place of automatic disconnection of supply. The sensitivity of the indicator shall be such that operation thereof will take place on the occurrence of a fault current to earth of the respective values prescribed by paragraphs (e) and (f) of this regulation. Upon the operation of such indicator immediate steps shall be taken to remove the fault or disconnect the faulty feeder or line.

Delta-connected systems or star-connected systems with isolated neutrals—

- (i) In the case of delta-connected systems or star-connected systems with isolated neutrals, earthing-transformers or other approved means shall be provided to give an artificial neutral point, which shall be earthed. Earthing equipment shall be of sufficient capacity to ensure the effective operation of the protective apparatus.
- (j) Similar leakage protection or indication shall be provided for these systems to that specified in paragraphs (c) to (h) of this regulation for systems with earthed neutrals.

31-03. High pressure or extra-high pressure single-phase systems shall be earthed in an approved manner.

31-04. When the return current of any individual distribution transformer does not exceed 2 amperes, and the transformer supplying the lines and any distribution transformer supplied by such lines are not less than six miles from any telephone exchange, the earth may, with the previous consent in writing of the Minister of Telegraphs, be used to carry the return current of the distribution transformer.

**CONNECTION OF D.C. SYSTEMS WITH EARTH.**

31-11. In medium pressure or any lower pressure direct current systems the connections of circuits with earth shall be made in accordance with the following requirements:—

- (a) In a direct current three-wire system the middle conductor shall be earthed at the generating-station only, and the current from the middle conductor to earth shall be continuously recorded by means of a recording ammeter, and if at any time the current exceeds one-thousandth part of the maximum supply-current immediate steps shall be taken to improve the insulation of the system.
- (b) Where the middle conductor is earthed by means of a circuit-breaker with a resistance connected in parallel the resistance shall not exceed 10 ohms, and, on the opening of the circuit-breaker, immediate steps shall be taken to improve the insulation of the system, and the circuit-breaker shall be reclosed as soon as possible.
- (c) The resistance shall be used only as a protection for the ammeter in case of earths on the system and until such earths are removed. Immediate steps shall be taken to locate and remove the earth.

**CONNECTION WITH EARTH IN GENERAL.**

31-21. Where any part of a supply system is normally connected with earth—

- (a) The connection with earth shall be efficiently maintained, except when it is interrupted for the purpose of periodical tests; and
- (b) No switch, fuse-link, or circuit-breaker shall, except as provided in Regulation 22-25 of the Electrical Wiring Regulations, 1935, be inserted in the earthed conductor, or in any conductor connected thereto.

31-22. Notwithstanding anything contained in the last preceding regulation, systems including more than one three-phase star-connected generator operating in parallel may have the neutral conductor disconnected when necessary to prevent the circulation of local currents:

Provided that where all the generators are located in one power-house at least one generator in operation shall have its neutral point connected to earth:

Provided further that where the generators are contained in more than one power-house and the power-houses are interconnected, a neutral point shall be provided at each power-house and earthed, and all such neutral points shall be so arranged that no earth-circulating current will flow between the power-houses.

31-23. Notwithstanding anything contained in Regulation 31-21 hereof, the middle conductor of a three-wire direct current system may be earthed through a circuit-breaker with a resistance of not over 10 ohms in parallel, in accordance with Regulation 31-11 hereof.

31-24. Notwithstanding anything contained in Regulation 31-21 hereof, in the case of a traction system a circuit-breaker may be inserted in the conductor which is in contact with earth.

**EARTHING-LEADS AND CONNECTIONS.**

31-31. (1) Every earthing-lead shall be of copper, and of a cross-sectional area not less than 0.02 square inches (1/160 in. No. 8 S.W.G. 7/064 in. or 7/16 S.W.G. or their equivalent) outdoors, or 0.0045 square inches (1/08 in. No. 14 S.W.G. or 7/029 in. or their equivalent) indoors.

Provided that galvanized-iron strip not less in cross-section than 1 in. by 1/8 in. or stranded steel cable or copper-covered steel not less in cross-sectional area than 0.02 square inches (7/064 in. or 7/16 S.W.G.) may be used for earthing line hardware, earthing-bars or stay-wires.