

CABLE TESTING
INSULATION RESISTANCE TESTS
PAPER-INSULATED CABLES

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1. GENERAL

1.01 This section outlines the procedures to follow in making insulation resistance tests during the installation of toll cables and coil cases.

1.02 The section is reissued to omit reference to exchange cables for insulation resistance tests and to revise the figures. Since this reissue covers a general revision, the arrows ordinarily used to indicate changes have been omitted.

1.03 Insulation resistance tests are not required for exchange cables as these are now shipped under pressure, checked for pressure before splicing to be sure they are gastight, and finally the splices are dried with desiccant.

1.04 The tests on toll cables and loading coils should be made with a *400-volt megger*. The *1000- to 2500-volt meggers* available for coaxial testing *should not be used*, as the paper insulation may be damaged.

1.05 The insulation may not be thoroughly dried by the desiccant until 2 or 3 days after application. This should be taken into account in testing spliced sections of cable or wrapped ends.

2. PRECAUTIONS

2.01 In making insulation resistance measurements with a megger, the conductors become charged and must be discharged to prevent shock to the tester. The conductors under test should always be discharged as soon as a test on a group of conductors is completed.

2.02 The arc resulting at the time of discharge is sufficient to ignite explosive mixtures of gas and, therefore, when testing underground conductors, the megger should be kept on the street, and should never be set up in the manhole.

2.03 The conductors should always be discharged at the megger. If the megger is not equipped with a discharge switch, the conductors should be discharged at the megger terminals. Do this by means of a short piece of insulated wire. Attach one end of the insulated wire to the ground post of the megger. Touch the other end of the wire to the line post of the megger to discharge the conductors on completion of a test.

3. INSULATION RESISTANCE REQUIREMENTS

3.01 The insulation resistance required in new cable is 500 megohm-miles between each wire and all the other wires and the sheath of the cable. The insulation resistance varies inversely with the length of the cable; the longer the cable, the lower the insulation resistance. Table A shows the required insulation resistance for each wire in various lengths of cable, based on the requirement of 500 megohm-miles.

LENGTH (feet)	APPROXIMATE INSULATION RESISTANCE (megohms)	LENGTH (feet)	APPROXIMATE INSULATION RESISTANCE (megohms)
500	5000	5000	500
1000	2500	6000	450
1500	1800	7000	400
2000	1300	8000	350
3000	900	9000	300
4000	700	10000	250

Note: When more than one wire is tested at a time, divide the above values in megohms by the number of wires in the group to find the insulation resistance required for the group.

3.02 When toll cables are equipped with carrier loading having relatively short spacing, the insulation resistance of the carrier loaded wires may be somewhat lower than specified above. Since the quads equipped with carrier loading are relatively few, the insulation resistance of the remaining quads will give a good indication of the insulation resistance of the cable. However, if the insulation resistance of any quad is below the value specified, the matter should be referred to the supervisor.

3.03 In testing the insulation resistance of an individual loading coil or of a coil case stub cable, a reading of 1000 megohms is satisfactory. Generally, individual coils and bunches in stub cables will be found to have a higher insulation resistance.

4. NUMBER AND LOCATION OF TESTS

4.01 Toll cables will ordinarily be tested before they are joined to the terminating cables.

4.02 The cables should be tested for insulation resistance at least once every load section. In addition, each group of four load sections should be tested as it is completed. The entire cable should be tested after each group of four load sections is added. However, under unusual circumstances (splices made in wet manholes, during stormy weather, etc), tests for insulation resistance should be made more frequently.

4.03 It is also advisable, whenever practical, to test toll cables daily at the end from which the splicing work was started in order to detect any damage that occurs during the progress of splicing. The daily insulation resistance test need not be made on individual conductors but may be made on groups of conductors, including those in the outside layers of the cable. The tests should be made between groups and from individual groups to ground.

4.04 After a toll cable has been completely spliced, a test should be made between each wire and the remainder of the conductors bunched and grounded.

Loading Coils and Coil Case Stubs

4.05 In testing loading coils and stubs of coil cases, the conductors should be divided into groups of "in" and "out" conductors, one group being cleared in the usual manner and the other group having the ends skinned for testing.

5. PREPARATION OF CONDUCTORS

General

5.01 Clear the ends of the conductors at the far end of the cable. Dry and wrap the conductors in accordance with the standard procedure.

5.02 At the end of the cable where the testing is to be done, strip off about 12 inches of sheath, and skin the insulation from the ends of the wires for a distance of about 3 inches.

5.03 Bind the bare ends into bunches of about 20 quads.

Individual Coil Cases and Coil Case Stubs

5.04 In testing individual coil cases, the ends of the "out" conductors should be cleared and the ends of the "in" conductors skinned for a distance of about 3 inches.

5.05 To prepare the stub cable, remove about 12 inches of sheath from the end of the cable. Divide the conductors into two groups ("in" and "out" conductors). Clear and wrap the ends of the "out" conductors in the usual manner. Skin the insulation from the ends of the "in" conductors and bind the bare ends of the conductors into groups of about 40 pairs or 20 quads.

Testing Terminated Conductors

5.06 To test conductors on a protector-type frame, the carbon blocks should be removed on all of the pairs, thereby bunching and grounding them. The blocks should be placed on each pair as it is tested, and removed after the test is completed.

5.07 If the pairs are terminated on other than protector-type frames, strap all the terminals with bare copper wire, ground the straps, and then remove the strap from each conductor or group of conductors when preparing it for test. If the pairs are terminated on binding posts, the conductors should be strapped in a similar manner.

5.08 If the conductors are terminated on jacks at a testboard, ground by means of test cords each pair of the complement not under test.

6. PREPARATION FOR TESTING

6.01 Connect well insulated test leads to the terminals of the megger marked "Earth" and "Line".

6.02 Then connect the "Line" lead to the bare end of the wire or bunch under test and separate this wire or wires from the other bunches. Bind the bare ends of all the wires not under test with bare copper wire and connect them to the metallic sheath of the cable. See Fig. 1 and 2.

6.03 Connect the "Earth" lead to the metallic sheath of the cable. Where the metallic sheath is covered by polyethylene, use bare copper wire to bond the metallic sheath either to a lead sheath cable or to the cable hangers or pulling-in irons if in a manhole, or to the strand if in the air. In cables with metallic tapes or wire protection over the sheath, bond the metallic protection to the sheath.

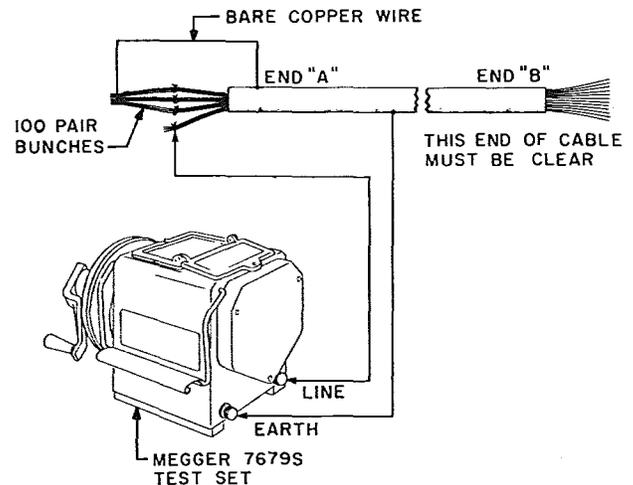


Fig. 1 — Testing Cable Using Megger 7679S Test Set

7. TESTING PROCEDURE — MEGGER OPERATED BY CRANK

7.01 Set the discharge switch on the megger to the "Test" position. Turn the crank of the megger rapidly, until the clutch slips and the crank turns easily, without much pressure. Keep turning the crank at the same speed until the indicator on the dial of the megger reaches a point where it remains fairly constant. If the insulation resistance is low, the needle usually reaches a steady position quickly and does not fluctuate. However, if the insulation resistance is high, it will usually take a little time for the needle of the indicator to reach a steady position on the dial. Take the reading on the dial while the crank is still being turned.

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7.02 After taking the reading, turn the discharge switch to the "Discharge" position. When the switch is in this position, the megger lead can be transferred to another group of conductors.

7.03 If the megger does not have a discharge switch, one end of a short piece of well insulated wire is connected to the "Earth" post of the megger. The megger operator should allow the generator to come to a stop and then momentarily place the exposed end of the "Earth" wire to the line terminal. This will discharge the conductors and permit connections to be changed safely.

7.04 If the insulation is satisfactory, the reading on the dial of the megger will usually be above 1000 megohms for short sections and, for long sections, it will generally be above the values given in Table A. If the reading on the dial of the megger is less than that given in the table, separate the bunch of wires which is low and test individual wires of this bunch against all other wires grounded to the sheath. Each wire should then give a reading at least as high as that given in the table. If, however, the reading for any individual wire is less than that given in the table, test that wire against the other bunches (after first disconnecting the bunches from the sheath), and then test the individual wire against the sheath alone. This will show whether the trouble is between wires or between the wire and the sheath, or both.

7.05 Test each of the remaining bunches in the same way, connecting the "Line" terminal to the bunch under test, and the "Earth" terminal to the cable sheath and the rest of the bunches. After testing all the bunches, test a few wires of each bunch against the rest of the wires of the same bunch in order to determine whether there is any low insulation within the bunches.

8. SETTING UP MEGGER AND RECTIFIER FOR TEST

8.01 The Megger 9679S Test Set and the Megger 744 Rectifier may be used together where commercial 115-volt 60-cycle power is available. See Fig. 2.

8.02 Remove the dust cap from the receptacle on the megger, and plug in the rectifier cord. Connect the rectifier cord to the source of power. Make the test lead connections to the megger as outlined in Part 6.

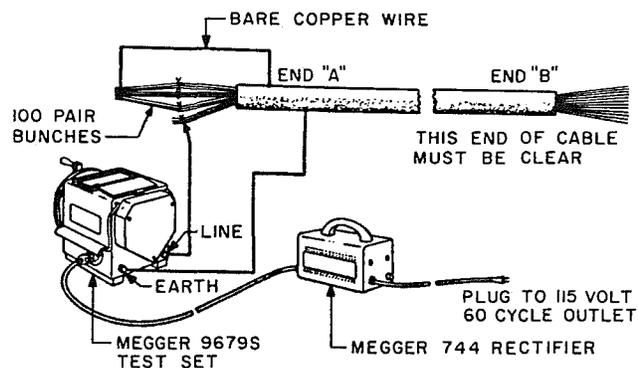


Fig. 2 — Testing Cable Using Megger 9679S Test Set and Megger 744 Rectifier

9. TESTING WITH MEGGER AND RECTIFIER

9.01 Turn the rectifier on by depressing the power switch.

9.02 Make the tests as outlined in Part 7, except that the hand crank magneto generator is not used as the megger is operated from the rectifier.

10. LOCATING LOW INSULATION

10.01 If the insulation resistance is low enough to permit locating the trouble by means of Wheatstone bridge or exploring coil tests, it should be so located; otherwise, remove the splice closure and muslin wrapping from the splice nearest the middle of the section in which the low insulation has been found. Pick out and open several of the conductors on which low insulation was found in the first test, and test these pairs in both directions to see on which side of the splice the trouble locates. After determining this, splice the opened conductors and close the splice. Open the splice halfway between the middle splice and the end of the section in trouble and continue opening and closing splices in this manner until the faulty splice is found.

10.02 The faulty splice should be dried and wrapped in accordance with the standard procedure.

10.03 Under certain conditions it may not be necessary to open splices as described in 10.01 if in the supervisor's judgment the conditions under which the cable has been spliced make it seem likely that the trouble is at some particular splice.

10.04 If the insulation resistance tests on spliced sections show that the low insulation is confined to the wires at the center of the cable, the trouble may be due to insufficient drying of the conductors at one or more of the splices. If the low insulation is found in pairs in the outside layer of the cable, the failure may be due to sheath trouble.

10.05 If tests on stubs of coil cases indicate that the trouble is inside the case or that it cannot be cleared in the field, the case should be replaced in accordance with local practice.