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BELL SYSTEM PRACTICES
Outside Plant Construction and Maintenance

SECTION G50.205.1
Issue 2, June, 1954
AT&T Co Standard

CABLE TESTING—
INSULATION RESISTANCE TESTS—
PAPER INSULATED CABLES

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1. GENERAL

1.01 This section replaces Issue 1 and outlines the procedure to be followed in making insulation resistance tests during installation of strip paper or pulp insulated cables, loading coil cases or splice loading coils.

1.02 This section has been reissued to cover both hand and power operated meggers; their descriptions are covered in another section of the Practices.

1.03 The tests on these 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.

1.04 If desiccant is used in the splices, the insulation may not be thoroughly dry until two or three days after application. This should be taken into account in testing spliced sections of cable or wrapped ends.

1.05 Splices that have been boiled with paraffin should be allowed to cool before insulation tests are made on the conductors.

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 by means of a short piece of insulated wire, one end of which is attached to the ground post of the megger. The other end of the wire is touched 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. The following table shows the required insulation resistance for each wire in various lengths of cable, based on the requirement of 500 megohm-miles:

Required Insulation Resistance Per Conductor			
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

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 for his consideration.

3.03 In testing the insulation resistance of an individual loading coil or of a loading 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 The number of insulation resistance tests which should be made during the splicing of a cable will depend upon its length, size and type. The number of tests suggested below will usually be sufficient. However, under unusual circumstances (splices made in wet manholes, during stormy weather, etc.) the tests for insulation resistance should be made more frequently.

4.02 When a new cable is to be spliced to an existing cable it should be tested for insulation resistance after it is completely spliced and before it is joined to the existing cable. If low insulation is found in the new cable, the trouble should be cleared before the connecting splice is made.

4.03 Both exchange and toll cables will ordinarily be tested before they are joined to the terminating cables.

Exchange Cables

4.04 Insulation resistance tests on exchange cables should be made at least once every 8 to 10 sections.

Toll Cables

4.05 Toll cables should be tested for insulation resistance at least once in every loading section. In addition, each group of four loading sections should be tested as it is completed. The entire cable should be tested after each group of four loading sections is added.

4.06 It is also advisable, whenever practicable, 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.

4.07 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 Loading Coil Stub Cables

4.08 In testing loading coils and loading coil stub cables the conductors should be divided in 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

Exchange and Toll Cables

5.01 Clear the ends of the conductors at the far end of the cable. Dry out 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 of the conductors into bunches of approximately 100 pairs according to color groups; on toll cables, bind the bare ends into bunches of about 20 quads.

Individual Loading Coil Cases and Loading Coil Case Stub Cables

5.04 In testing individual loading 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 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.

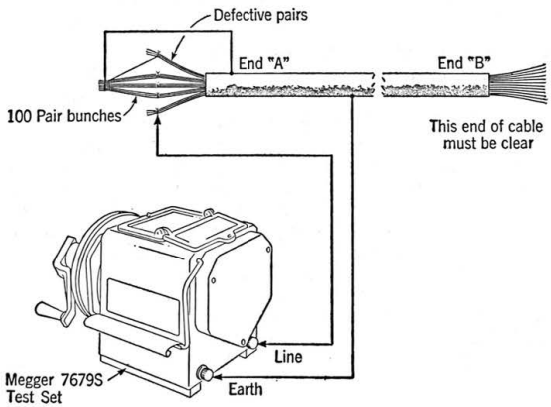
5.08 If the conductors are terminated on jacks at a test-board it will be necessary to ground by means of test cords each pair of the complement not under test.

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.

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.



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.

7.02 After taking the reading, turn the discharge switch to the "Discharge" position. When the switch is in this position, the megger operator will advise the other man, who then can disconnect the megger lead and connect it 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, after which the other man can change connections safely.

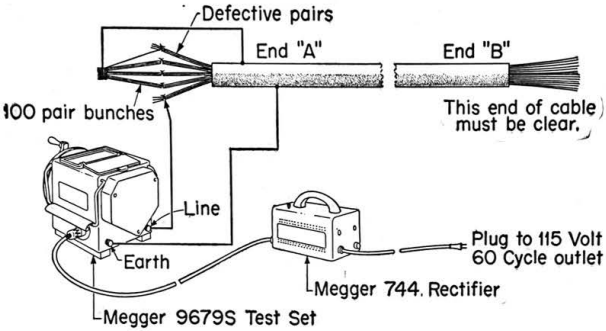
7.04 If the insulation is satisfactory the reading on the dial of the megger will usually be above 1000 megohms for short sections, and for long sections it will generally be above the values given in the table of required insulation resistance. If the reading on the dial of the megger is less than that 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.

8.02 As indicated below, 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 Paragraphs 6.01 to 6.03.



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 lead sleeve 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 pairs 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 in the manner just described, 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 loading coil stub cables 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.