CABLE TESTING
L CARRIER TYPE COAXIAL CABLE
PREPARATION AND COMPLETION TESTS
L1 AND L3 COAXIAL CONDUCTORS

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1. GENERAL

1.01 This section contains preparation and completion tests for L1 and L3 coaxials, tests for converting an L1 repeatered line to an L3 repeatered line, and tests for L1 and L3 routes which will continue to be on L1 and L3 routes when purchased by another operating company. Also included are tests which should be made when a new section of L1 or L3 cable is spliced to existing cable for the purpose of replacing damaged cable and rerouted cable.

1.02 Previously installed L1 cables may not have been adequately tested by present standards. Therefore, when L1 routes are converted to L3 routes or when L1 routes are purchased by another operating company which intends to use them as L1 routes, they should be tested by the completion tests described in this section. The tests ensure that cable splices are still in good condition and provide information on terminal cleanliness and susceptibility to corona noise.

1.03 L1 cable should be tested for corona as if it were an L3 cable with a repeater installed every four miles. In other words, an L1 power section containing eight repeaters would be tested by the corona test which is presently used for an L3 power section containing 16 repeaters.

1.04 Corona tests made because of cable replacement will not eliminate future testing of L1 lines if they are converted to L3 or L4 at a later date. It is anticipated that any troubles involving the coaxials will be eliminated at the time the tests are made.

1.05 When conversion from one type carrier system to another type carrier system is required, generally only one or two pairs of coaxials can be released from service at one time; consequently, multiple repeater visits are required to complete cable conversion. When the power on all coaxials can be turned off, less testing time will be required because cable completion tests can be made on all coaxials in the cable at each test repeater station with one visit.

1.06 L1 or L3 cables usually will require installation of some new cable to provide terminal facilities or interconnection facilities. When a full repeater section is provided with new cable, the repeater section is tested by the coaxial cable completion tests specified in Section 330-200-502 (L4 carrier requirements) without regard for the type of service to be applied.

1.07 When a full repeater section includes previously installed cable and new cable, the full repeater section should be tested to determine if it can meet L4 carrier test requirements. If L4 carrier requirements cannot be met without extensive rework, the mixed cable must meet the tests required for the type of service provided. Any lowering of test requirements should be submitted to engineering review for approval. Future message growth should be anticipated since routes now being tested may require conversion in the future

1.08 When cables are converted from L1 to L3 use, long power sections requiring high line voltage may require that the cable be pressurized with sulphur hexafloride (SF6) gas before completion test requirements can be met. L1 lines, which are tested as L3 lines and would require a pressurization with SF6 before L3 completion test requirements can be met, are not to be pressurized with SF6 solely for the purpose of testing. However, all other completion tests shall be met. Pressurization with SF6 will be made only when final conversion to L3 use is made and the higher voltages are applied.

1.09 L4 power sections are limited to approximately 150 miles; therefore, it is not anticipated that L3 coaxials converted to L4 use will require further SF6 cable pressurization. Minimize gassing with SF6 whenever possible even though additional fault location measurements and cable openings may be necessary. The halogen gases are highly corrosive under certain conditions, they are expensive, and they can present several nuisance factors, such as elevation correction and gas pressure differentials in the SF6 gassed section.

1.10 This test is concerned primarily with 0.375-inch coaxial; however, some L1 routes which use 0.270-inch coaxials may be converted to L3 or L4 use, or may be involved in cable reroutes, reuse, or replacements. Therefore, completion test requirements for this cable size are provided separately. Reference to this information is made when it is different from the 0.375-inch coaxial information.

1.11 Various types of cable may be used on L1 and L3 routes. The typical 0.375-inch coaxial cable system employs several coaxials. Each coaxial consists of a 100.3-mil copper center conductor encased in a cylindrical conductor with an inside diameter of approximately 0.375 inch. The center conductor is held in place by insulating discs spaced about 1 inch apart. Layers of steel tape are spiraled around the copper tube outer conductor for strength and electrical shielding. Additional coaxials, interstitial conductors, other noncoaxial insulated pairs, and quads are further bound and encased in a polythylene-protected lead sheath designed for pressurization.

1.12 New cable is received under pressure from the factory to prevent contamination by moisture. It is pressurized after installation by dry air or nitrogen.

1.13 The coaxial conductors are tested in repeater sections, 8-mile sections for L1 systems, and 4-mile sections for L3 systems. When two or more adjacent L3 repeater 4-mile sections are to be tested, the intermediate repeater location coaxial conductors can be connected through the intermediate repeater and tested in 8-mile sections. L3 crosstalk tests are made in 4-mile sections only.

1.14 The preparation and completion tests described in this section are made after the following conditions have been met.

(a) New repeater stations are installed.

(b) Coaxial cables are spliced to coaxial terminals.

(c) Repeating equipment and power networks have been disconnected from cable terminals.

(d) Newly installed cable has been fully pressurized with dry air or nitrogen for a two-week period.

1.15 Resistance unbalance tests are made using loop resistance measurements. In this test, a coaxial or noncoaxial conductor is measured in such a manner as to determine its resistance. Then this conductor is used as one conductor in a loop. Its known resistance is subtracted from the measured value of the loop conductor resistance to find the resistance of each coaxial. The loop unbalance of the pair of coaxials forming a power loop is then determined by comparing the total resistance of the coaxials that form each section of the power loop.

1.16 Insulation resistance tests should then be performed using a Megger® test set. Since newly spliced cable may falsely indicate trouble and corona testing may change the final insulation resistance, any coaxial not meeting the requirements of this test should be marked for resurvey after corona tests are completed. Failure to meet requirements after cororna tests have been made indicates that a cable fault exists.

1.17 Corona survey tests include sliver burning and aging of the cable at corona-producing voltages. Sliver burning will normally increase the arc-over voltage of the coaxials by burning out impurities. Corona aging will cause the threshold of corona voltage and usually the insulation resistance of the coaxial to increase.

1.18 The final test is for near-end crosstalk at each repeater location measured in both directions, except as noted in 6.01. A test frequency is applied to one of the coaxials. The coaxials that are in close physical proximity are then measured for crosstalk. This test is then repeated, as required, until all coaxial combinations which are subject to crosstalk have been measured.

1.19 If several consecutive abnormally low or high measurements are obtained during any test, the patch cords used to connect the test equipment to the coaxial under test should be tested for insulation breakdown and continuity.

1.20 Cable completion tests should be performed in the sequence presented in this section. By following this procedure,the effects of corona and sliver burning can be related to insulation resistance, which is necessary in test evaluation.

1.21 The safety precautions described in Section 634-320-010 and Section 620-140-501 should be strictly observed. Because of the hazardous voltages employed in these tests, personnel should be trained in the safety precautions described. ***ALL PRECAUTIONS MUST BE OBSERVED.***

2. 0.270-INCH COAXIALS AND L1 ROUTES

2.01 Two types of 0.270-inch coaxial cable have been manufactured: the rubber-insulated coaxial and the polyethylene-insulated coaxial. The same test requirements will be used on both types. The rubber-insulated coaxial usually is not converted to L3 or L4 use. Routes so equipped will usually remain L1 routes. Nominal repeater spacing on the rubber-insulated coaxial is 5.25 miles. Nominal repeater spacing on the polyethylene-insulated coaxial is 5.45 miles. Because of the closer repeater spacing, the voltage drop in a 5.25-mile repeatered rubber-insulated coaxial line is 2 volts less than for 5.45-mile polyethylene-insulated coaxial lines.

2.02 The tests described in Parts 3, 4, and 5 of this section are specifically designed for either L1 or L3 carrier system completion tests which use 0.375-inch coaxial line. The tests are also applicable to 0.270-inch coaxials except where modification of the information is required because of lower permissible voltages, closer repeater spacing, and increased voltage drop per mile.

2.03 Separate test values and tables for 0.270-inch coaxials and L1 routes are presented in this part in Table A. Application of this information is limited; therefore, the information presented in this part will be referred to when modification of test value and tables is necessary.

2.04 The resistance of the center conductor of a 0.270-inch coaxial line is almost double that of the 0.375-inch coaxial line. The resistance of 0.270-inch coaxial line at 55°F is 10.2 ohms per mile. However, normal spacing on the L1 routes that used 0.270-inch coaxial line was 5.45 miles; therefore, normal spacing on a converted L3 route will usually be 2.73 miles. This spacing represents a voltage drop in each cable section, for P1 power, of 38 volts (6 volts greater per converted section) and, for P2 power, of 43.5 volts (6.5 volts greater per converted section).

2.05 The maximum voltage that can be applied to a 0.270-inch coaxial line for testing is 2000 volts RMS. Since the operating margin of safety is 500 volts under the breakdown voltages, the maximum working carrier system voltage applied to 0.270-inch coaxial cable at a power feed point should not exceed 1500 volts unless SF6 gassing is provided in the sections of line operating in excess of this voltage.

2.06 All sections should be tested for corona. The maximum applied voltage should be limited to 2000 volts RMS even though corona inception has not occured. If corona occurs and if application of corona-producing voltages for 15 minutes cannot increase the minimum corona level 200 volts above the maximum listed operating voltage to be applied to that section of line, the fault must be located and cleared. Normal corona aging time is 3 to 5 minutes. Table A is provided to determine the approximate voltage to be found at each section of repeatered L1 line.

2.07 Measurement of insulation resistance on 0.270-inch cable requires that the voltage from the Megger test set to be limited to the ***1250-volt*** or ***1500-volt*** output. The 2500-volt range used in testing 0.375-inch cables exceeds the maximum voltage rating of the 0.270-inch cable.

2.08 The maximum resistance unbalance allowed between center conductors for 0.270-inch coaxials is the same as the unbalance allowed for the 0.375-inch coaxials.

3. CENTER CONDUCTOR RESISTANCE UNBALANCE

3.01 The center conductor of each coaxial is tested to ensure that the resistance of all splices meets minimum requirements. The dc resistance of the center conductor should be tested using approximately 4.5 volts applied to the Wheatstone bridge. The use of this low voltage ensures that temporary clearing of high resistance contacts does not occur. L3 routes using 0.375-inch coaxials are tested in 4- or 8-mile sections and L1 routes in 8-mile sections.

3.02 Instructions on the use of several types of Wheatstone bridges are provided in the 634-300- series of Bell System Practices. The terminal designations of these bridges may vary; however, the operations are essentially the same. To avoid confusion, designations assigned to the KS-14959 test set are used in this section. The diagram of Fig. 1 illustrates a typical center-conductor resistance test using the KS-14959 test set.

3.03 Loop resistance measurements, commonly called the single-wire method, are used for accurately measuring the resistance unbalance in each power loop. The results of the test should be recorded on the form shown in Fig. 5.

STEP	PROCEDURE
	Note: This test applies to both 0.270-inch and 0.375-inch coaxials.
	Caution: Before entering any repeater manhole, personnel should follow the manhole testing and ventilating procedures described in Section 620-140-501 and any local instructions.
	At the Testing and Far Terminals
1	Enter the stations and establish a talk circuit between the testing terminal and the far terminal.
2	Determine the location of the coaxials to be tested and remove any attachments to the terminals.
3	If three or more coaxials are not available for testing, select a noncoaxial conductor for use as conductor 1 and designate coaxials 1 and 2 as conductors 2 and 3. If three or more coaxials are available, use one available coaxial as conductor 1. At the far terminal, connect conductor 1 to conductor 2.
	At the Testing Terminal
4	Connect conductor 1 to the X1 terminal of the Wheatstone bridge.
5	Connect conductor 2 to the X2 terminal of the Wheatstone bridge.
6	Set the GA key to the R.V.M. position and the BA key to the IN or OUT position, depending upon whether an internal or external battery is used. If an external battery is used, the voltage should not exceed 4.5 volts.
7	Set the loop key to RES.
8	Select the MULTIPLY BY range 1/100 if conductor 1 is coaxial and range 1/10 if conductor 1 is noncoaxial.

STEP **PROCEDURE**

9 Balance the bridge by adjusting the R arm. Measure and record the loop resistance of conductors 1 and 2 in the LOOP column under RESISTANCE-CONDUCTOR NO. 1 portion of the COAXIAL CABLE COMPLETION TEST form (see Fig. 5).

10 Remove conductor 2 from the X2 terminal and connect conductor 3 to the X2 terminal.

At the Far Terminal

11 For the remainder of this test, the talk circuit is used to determine which conductors are being connected to the X1 and X2 bridge terminals at the testing terminal. These same conductors are to be connected at the far terminal to form a testing loop circuit, as shown in Fig. 1.

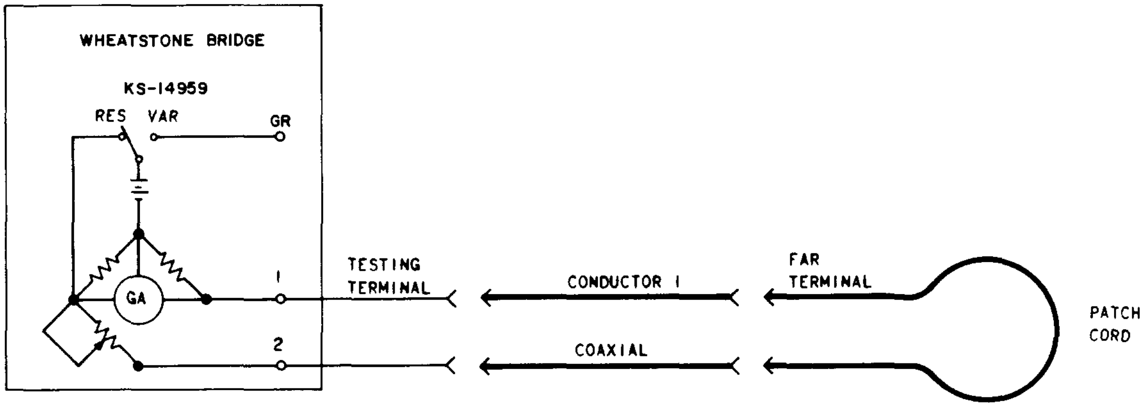


Fig. 1—Center Conductor Resistance Test

At the Testing Terminal

12 Measure and record the loop resistance for conductors 1 and 3 as prescribed in Step 9.

13 Remove conductor 1 from the X1 terminal and connect conductor 2 to the X1 terminal.

14 Measure and record the loop resistance of conductors 2 and 3 as prescribed in Step 9.

15 Complete the RESISTANCE-CONDUCTOR NO. 1 portion of the COAXIAL CABLE COMPLETION TEST form by computing the sum, difference, and one-half difference resistance values.

16 If coaxial 1 was used as conductor 1, enter the DIFF/2 value in the OHMS column under RESISTANCE INNER CONDUCTOR.

17 If a noncoaxial was used as conductor 1, subtract the DIFF/2 value from the 1-2 Ohms value in the LOOP column. Record this value in the OHMS column for coaxial 1.

18 Remove conductor 2 from the X1 terminal and connect conductor 1 to the X1 terminal.

STEP	PROCEDURE
19	Connect each coaxial, to be tested in the sequence shown in the COAXIAL OHMS column, to the X2 terminal. Record each value in the LOOP OHMS column.
20	Subtract the DIFF/2 value from each loop ohms value.
21	Record this value in the COAXIAL OHMS column. ***Requirement:*** The maximum difference between the coaxial with the greatest resistance and the coaxial with the least resistance shall not exceed 0.2 ohms in either 4- or 8-mile cable lengths.
22	If any coaxial does not meet the requirement in Step 21, the coaxial with the greatest resistance is defective. The defect must be located and cleared. The defect can usually be traced to cable splices and cable terminals.
23	Remove the test and looping patches and restore the patching to normal.

4. MEASUREMENT OF INSULATION RESISTANCE

4.01 Insulation resistance tests on each coaxial should be made on each 8-mile section of L1 line and on each 4- or 8-mile section of L3 line. The tests described in Part 3 of this section should be completed before starting this test.

4.02 Megger test sets, of the type required for making insulation measurements, are described in Section 106-220-111.

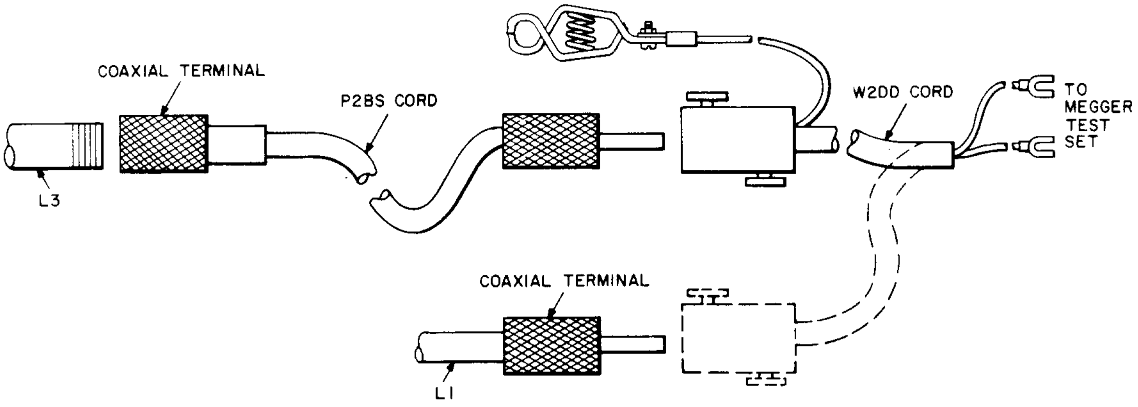
4.03 High voltages are generated by Megger test sets. Personnel must be familiar with Section 634-320-010 before testing can proceed.

4.04 The insulation resistance of the cord used to connect the coaxial under test to the Megger test set should be tested if several consecutive measurements indicate low resistance or infinity.

4.05 Newly spliced cable may test below the insulation-resistance requirement because of moisture or contamination that may clear with time, sliver buring, or corona testing. Therefore, fault location should not be attempted until further tests indicate a fault.

4.06 Coaxial cables not meeting the insulation requirements should be retested after corona tests are completed. If the insulation requirements still are not met, the fault must be located and cleared.

4.07 The insulation resistance connections to L1 or L3 coaxial terminals and the types of test cord employed to connect coaxial terminals to the Megger test set are shown in Fig. 2.

STEP	PROCEDURE
	Note: Consult Part 2 of this section for modification of this test if 0.270-inch coaxial cable is to be tested.
	Caution: Before entering any repeater manhole, personnel should follow the ventilating and testing procedures described in Section 620-140-501 and any local instructions.
1	Enter the station and establish a talk circuit between the testing repeater and the far repeater.
	Warning: Extreme care should be exercised while performing the procedures in this section. Voltages as high as 2500 volts are generated by Megger test sets. Safety rules are described in Section 634-320-010.
2	Determine the locations of the coaxials to be tested and disconnect any attachments to the terminals.
	At the Testing Terminal
3	Connect the Megger test set to the coaxial to be tested. Refer to Fig. 2 for Megger-to-terminal connections.
	 **Fig. 2—Insulation Resistance Test**
4	Adjust the Megger test set to deliver 2500 volts. Operation and adjustment of the Megger test set is described in Section 106-220-111.
5	Measure and record the insulation resistance of each coaxial to be tested. Use the COAXIAL CABLE COMPLETION TEST form shown in Fig. 5.
6	Multiply the megohm reading obtained in Step 5 by the number of miles of the coaxial section being tested. The result will be in megohm miles. Record these values.
	Requirement: Not less than 20 megohm miles.
	Note: Any coaxial section that does not meet the requirement of Step 6 must be tested again at the conclusion of the corona test.
7	If the requirement of Step 6 is not met after corona tests are made, the fault must be located and cleared.

5. CORONA SURVEY

5.01 Corona tests of L3 lines should be performed using mobile corona survey apparatus. Procedures for apparatus operation and interpretations of results are described in the 106-370- and 634-320-series of Bell System Practices.

5.02 On newly installed 0.375-inch coaxial cables, a relatively mild sliver-burning treatment by the corona test set and a few minutes aging at corona-producing voltage are usually sufficient (for most cases) to raise the corona threshold to 2000 volts and the breakdown potential to 2500 volts.

5.03 Rerouted or replaced L3 cable that contains sections of old and new cable should be tested to determine if the coaxial can meet L4 carrier requirements. If the coaxial can meet L4 carrier requirements, the log should be marked. If L4 carrier cable requirements cannot be met, the coaxials must meet the requirements for L3 coaxials using Table B and the requirements described in this section.

5.04 L1 coaxials should meet minimum L3 requirements. All L1 repeater stations in a power loop should be multiplied by two to determine L3 test voltage requirements. The maximum RMS voltage listed in the appropriate P1 power column of Table B should be used for the test as described. If any portion of an L1 coaxial does not meet the L3 requirments of Table B, but does meet the requirements of Table A, submit the test results to transmission engineering for evaluation. In all cases the cable must meet the corona and breakdown requirements of Table A.

5.05 When low corona and breakdown voltages are encountered, the corona test set is used as a mild sliver burner. The breakdown arc produced by the corona test set seldom causes coaxial contamination. This type of sliver burning may be used freely as long as the breakdown voltage continues to increase.

5.06 Occasionally a sliver will be found which cannot be cleared by using the corona test set. When this condition occurs, a regular sliver burner should be used to clear the sliver. The sliver burner should be used sparingly to prevent accidental contamination of insulator discs due to the arc provided by this sliver burner. Sliver burners are described in the 106-series. If the sliver burner cannot clear the coaxial, locate the fault as prescribed in Section 660-819-500.

5.07 It normally will not be necessary for terminals to be cleaned prior to the corona survey; however, it is important to stress that contaminated or moist coaxial terminals may be the reason for a low corona inception condition.

5.08 On routes converted from L1 to L3 use, or reused L1 or L3 routes, many of the relatively low-voltage corona thresholds discovered in surveys have been improved by cleaning the cable terminals. The cleaning procedure varies with the type of terminal and is more difficult on the older rubber-sealed terminals on L1 routes, as compared to the newer glass-bead types.

5.09 If trouble is encountered in corona survey, the resistance unbalance and insulation resistance measurements, previously recorded on the COAXIAL CABLE COMPLETION TEST form, should be studied for clues that may indicate the type of trouble.

5.10 At the conclusion of the corona survey, any coaxial which required the use of a sliver burner or which did not meet the insulation requirements in Part 4 of this section should be retested for insulation resistance. If the insulation resistance requirements still are not met, the coaxial trouble must be located and cleared.

STEP	PROCEDURE
	Note: Consult Part 2 of this section for modification of this test if 0.270-inch coaxial is to be tested.
	Caution: Before entering any repeater manhole, personnel should follow the ventilating and testing procedures described in Section 620-140-501 and any local instructions.
1	Enter the repeater station and establish a talk circuit between the testing repeater and the far repeater.
	Warning: Extreme care should be exercised while performing the procedures in this test. Voltages as high as 3000 volts can be generated by the corona test set. Safety rules are described in Section 634-320-010.
2	Determine the locations of the coaxials to be tested and disconnect any attachments to the terminals.
3	Determine the maximum center conductor RMS volts to ground from Table A or B and record in the column provided on the COAXIAL CABLE COMPLETION TEST form.
4	Connect the corona survey test equipment to the coaxial to be tested as described in the 634-320- series.
5	Determine the maximum breakdown voltage and corona inception voltage which can be obtained.
	Note: Do not use the plug on the end of the 50-foot test cord from the test van to make contact with any of the access jacks. The constant connecting and disconnecting will cause the plug to fail. Consequently, all testing must stop while the end of the test cord is trimmed back and soldered, and the cable is reassembled. An adapter is provided for this purpose.
6	The breakdown and corona inception voltage for all new coaxials shall be as follows: ***Requirements:*** (a) Breakdown—2500 volts (b) Corona inception—2000 volts.
7	If the requirements of Step 6 are met for any line (old or new), enter L4 in the TYPE OF LINE column of the COAXIAL CABLE COMPLETION TEST form.
8	The breakdown and corona inception voltage for old coaxials used on L3 routes must test over the coaxial operating voltage listed in Table B by the following amount: ***Requirements:*** (a) Breakdown—500 volts (b) Corona inception—200 volts.
9	If the requirements of Step 8 are met when L1 is tested as L3 or for L3 lines, enter L3 in the TYPE OF LINE column.

STEP	PROCEDURE
10	The breakdown and corona inception voltage for old or reused coaxials used on L1 routes must test over the coaxial operating voltage listed in Table A by the following amount: ***Requirements:*** (a) Breakdown—500 volts (b) Corona inception—200 volts.
11	If the requirement of Step 10 is met, enter L1 in the TYPE OF LINE column.
12	If any coaxial does not meet the requirements, a sliver burner may be used sparingly. Record use of the sliver burner in the space provided for remarks.
13	If a sliver burner was used in Step 12, repeat Steps 4 through 11. If the requirements cannot be met, the coaxial is defective and must be cleared.
14	Consult the COAXIAL CABLE COMPLETION TEST form. Any coaxial which was subjected to sliver burning or did not meet the megohm-mile requirement should be retested for insulation resistance using the procedure described in Part 4 of this section.
15	Disconnect the test equipment and connect the attachments removed in Step 2.

6. CROSSTALK MEASUREMENTS

6.01 Near-end crosstalk measurements are made from both terminals of each repeater section. Crosstalk measurements are not required on L carrier lines when all coaxial terminals in the test section are equipped with 66A1-type terminals. If coaxials are equipped with older type terminals such as the 35, 41A, or 42A, they must be tested for crosstalk. Tests are limited to near-end crosstalk measurements unless crosstalk is detected.

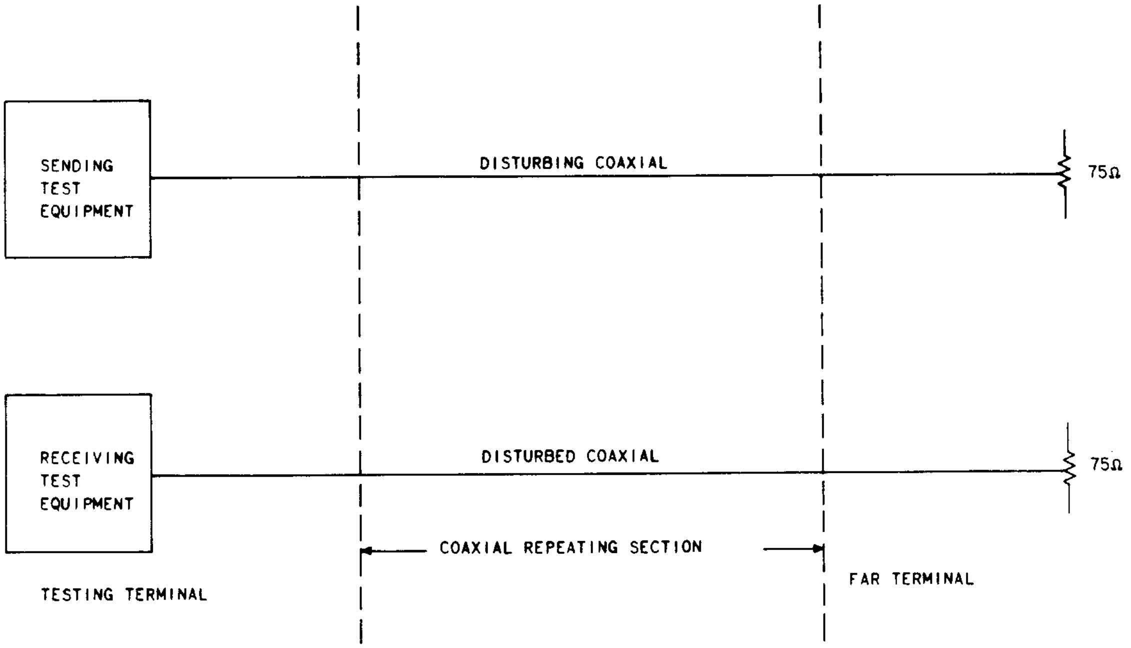
6.02 Near-end crosstalk tests are made, as shown in Fig. 3, by connecting a test frequency to one of the coaxial tubes. The coaxials which are in close physical proximity are then measured for crosstalk. Since the majority of crosstalk occurs at terminals, the terminals must not be patched through repeater sections; therefore, L1 coaxials are tested in 8-mile sections; coaxial, in 4-mile sections. The COAXIAL CABLE CROSSTALK TEST form shown in Fig. 6 lists the required combinations for an abbreviated crosstalk test which can be applied, as required, for up to 22 coaxial combinations.

6.03 When near-end crosstalk measurements are made and crosstalk is detected, supplementary far-end measurements should be made and the results submitted for engineering evaluation.

6.04 The crosstalk test described in this section requires suitable transmission test equipment. Refer to Section 356-010-500 and select, from available equipment, sending and receiving equipment having the following capabilities:

> ***Sending test equipment*** capable of delivering, into 75-ohm circuits, signals between 64 kHz and 556 kHz at a power level of 0 dBm
>
> ***Receiving test equipment*** capable of detecting, from 75-ohm circuits, signals between 64 kHz and 556 kHz at a power level of -115 dBm.

6.05 The measuring test set should be tested prior to this test. The requirement of -115 dBm is not obtainable with noisy test equipment. The usual method of testing is to determine the threshold of noise of the receiving test equipment by terminating the input in a 75-ohm test load and measuring the internal noise using maximum sensitivity. If the noise is not at or below -120 dBm, the receiving test equipment is not satisfactory for this test.

STEP	PROCEDURE
	A. Near-End Crosstalk Measurements
	Note 1: Before beginning this test, the receiving test equipment should be tested for internal noise.
	Note 2: This test is applicable for testing 0.270-inch coaxials.
	Caution: Before entering any repeater manhole, personnel should follow the manhole testing and ventilating procedures described in Section 620-140-501 and any local instructions.
1	Enter the station and establish a talk circuit between the testing terminal and the far terminal.
2	Determine the location of the coaxials to be tested and remove any attachments to the terminals.
	At the Far Terminal
3	Terminate the disturbed and disturbing coaxials in 75 ohms as shown in Fig. 3. Use the COAXIAL CABLE CROSSTALK TEST form shown in Fig. 6 for identifying the coaxial and the testing sequence to be followed.
	 **Fig. 3—Near-End Crosstalk Measurement**

STEP	PROCEDURE
	At the Testing Terminal
4	Connect the sending and receiving test equipment to the disturbed and disturbing coaxials. Use Fig. 3 and the COAXIAL CABLE CROSSTALK TEST form to identify the disturbed and disturbing coaxials and testing sequence to be followed.
5	Adjust the sending test set to deliver 556 kHz at 0 dBm to the disturbing coaxial.
6	Measure the crosstalk power in the disturbed coaxial and record any measurements which do not meet the requirement.
	Requirement: Less than -115 dBm (-120 dBm is less).
7	If the requirement is met for all combinations listed in the COAXIAL CABLE CROSSTALK TEST form, the crosstalk measurement is concluded.
8	Repeat Steps 3 through 6 for any combination not meeting the requirement of Step 6 using a frequency of 2064 kHz. Record the measurement in the column provided in the NEAR-END/FAR-END CROSSTALK TESTS form.
	B. Far-End Crosstalk Measurements
	Note: Far-end crosstalk measurements are required only on coaxial cables not meeting near-end crosstalk requirements.
	At the Far Terminal
9	Connect the sending test set as shown in Fig. 2 to the disturbing coaxial. Adjust the frequency to 64 kHz and the output power to 0 dBm. Terminate the disturbed coaxial in 75 ohms.
	At the Testing Terminal
10	Make patch designated (1) in Fig. 4 to connect the receiving test set to the disturbing coaxial.
11	Measure and record the received power of the disturbing coaxial cable in the column provided in the NEAR-END/FAR-END CROSSTALK TESTS form.
12	Remove patch designated (1) and make patches designated (2) and (3) to terminate the disturbing coaxial in 75 ohms and to connect the receiving test set to the disturbed coaxial.
13	Measure and record the received power on the disturbed coaxial.
14	Repeat Steps 9 through 13 at frequencies of 100 and 556 kHz.
15	Repeat Steps 9 through 14 for all other disturbing and disturbed coaxials.
16	Subtract the disturbing coaxial measurements obtained in Step 11 from the disturbed coaxial measurements obtained in Step 13.

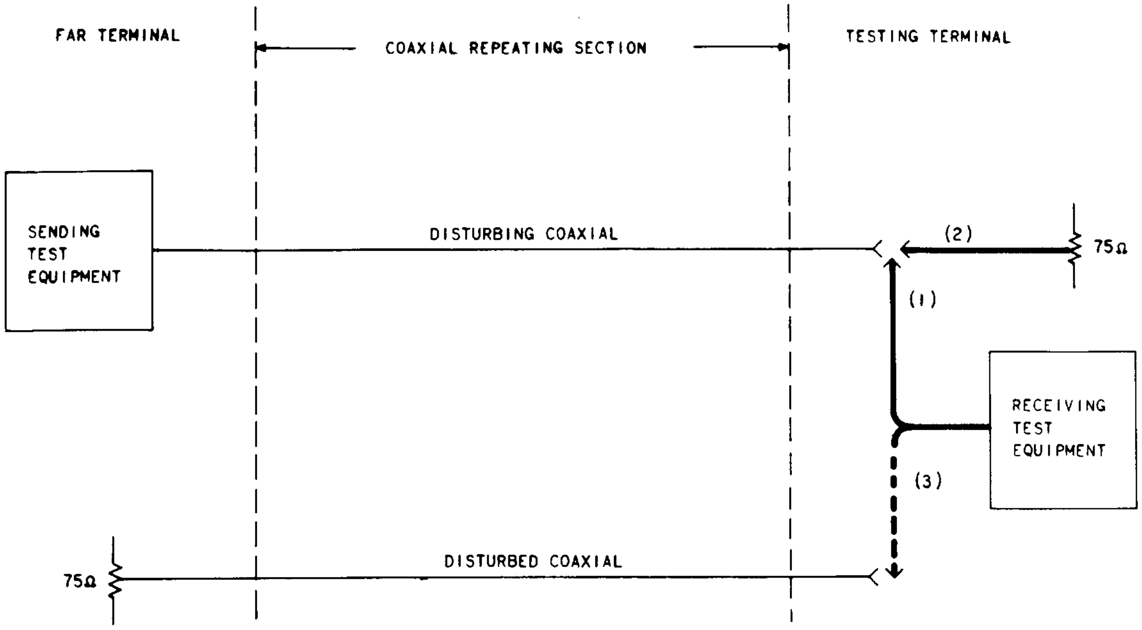
<table>
<tr><th>STEP</th><th>PROCEDURE</th></tr>
<tr><td></td><td>


Fig. 4—Far-End Crosstalk Measurement
</td></tr>
<tr><td>17</td><td>
Far-end crosstalk requirements are listed in the following table:

<table>
<tr><th>FREQUENCY (KHZ)</th><th>ADJACENT COAXIAL CROSSTALK (DB)</th><th>NONADJACENT COAXIAL CROSSTALK (DB)</th></tr>
<tr><td>64</td><td>80</td><td>96</td></tr>
<tr><td>100</td><td>82</td><td>98</td></tr>
<tr><td>556*</td><td>115</td><td></td></tr>
<tr><td colspan="3">*Omit 556 kHz measurement if 64 and 100 kHz do not indicate trouble.</td></tr>
</table>
</td></tr>
<tr><td>18</td><td>If any values are recorded in the NEAR-END/FAR-END CROSSTALK TESTS form, submit the form to transmission engineering for evaluation.</td></tr>
</table>

COAXIAL CABLE COMPLETION TEST

E-5960

TESTERS____ **DATE**________________

TEST SECTION________________ **ROUTE**________________ **MANHOLE/REPEATER**________________

FROM____________________ **TO**______________________________ **MILES**____________

RESISTANCE INNER CONDUCTOR				INSULATION TEST			CORONA TEST (VOLTS)				L1-L3	
							INCEPTION		BREAKDOWN		COAXIAL OPERAT-ING VOLTAGE	TYPE OF LINE
LOOP	OHMS	COAXIAL	OHMS	COAXIAL	MEG	MEG-MI	INITIAL	FINAL	INITIAL	FINAL		
—	—	1		1								
1-2		2		2								
1-3		3		3								
1-4		4		4								
1-5		5		5								
1-6		6		6								
1-7		7		7								
1-8		8		8								
1-9		9		9								
1-10		10		10								
1-11		11		11								
1-12		12		12								
1-13		13		13								
1-14		14		14								
1-15		15		15								
1-16		16		16								
1-17		17		17								
1-18		18		18								
1-19		19		19								
1-20		20		20								
1-21		21		21								
1-22		22		22								

RESISTANCE — CONDUCTOR NO. 1		
LOOP		OHMS
1-2	—	
1-3	—	
—	SUM	
2-3	—	
—	DIFF	
—	DIFF/2	

REMARKS____

Fig. 5—COAXIAL CABLE COMPLETION TEST Form

COAXIAL CABLE CROSSTALK TEST

E-5961

TESTERS__________ DATE__________

TEST SECTION__________ ROUTE__________ MANHOLE/REPEATER__________

FROM__________ TO__________ MILES__________

DISTURBING COAXIAL	DISTURBED COAXIAL	NEAR END CROSSTALK AT 556 KHZ (DBM)	DISTURBING COAXIAL	DISTURBED COAXIAL	NEAR END CROSSTALK AT 556 KHZ (DBM)
1	2		10	11	
1	3		10	12	
1	4		11	12	
1	8		13	14	
2	3		13	15	
2	4		13	16	
3	4		14	15	
5	6		14	16	
5	7		15	16	
5	8		17	18	
6	7		17	19	
6	8		17	20	
7	8		18	19	
9	10		18	20	
9	11		19	20	
9	12		20	21	
9	20		20	22	
9	22		21	22	

NEAR-END/FAR-END CROSSTALK TESTS

	COAXIAL NUMBER	NEAR END (DBM)	FAR END (DBM)		
		2064 KHZ	64 KHZ	100 KHZ	556 KHZ
DISTURBING COAXIAL		—			
DISTURBED COAXIAL		—			
CROSSTALK	—				
DISTURBING COAXIAL		—			
DISTURBED COAXIAL		—			
CROSSTALK	—				
DISTURBING COAXIAL		—			
DISTURBED COAXIAL		—			
CROSSTALK	—				

Fig. 6—COAXIAL CABLE CROSSTALK TEST Form

TABLE A

L1 ROUTE

ZONE*	CABLE SECTION (NUMBERED FROM POWER LOOP TO POWER FEED)	MAXIMUM INNER CONDUCTOR RMS VOLTS TO GROUND†							
		ALL AUX REPEATERS				ONE SW OR EQ AUX STATION‡			
		POWER LOOP AT AUX REPEATER COAXIAL SIZE		POWER LOOP AT NEXT AUX REPEATER COAXIAL SIZE		POWER LOOP AT AUX REPEATER COAXIAL SIZE		POWER LOOP AT NEXT AUX REPEATER COAXIAL SIZE	
		0.375″	0.270″	0.375″	0.270″	0.375″	0.270″	0.375″	0.270″
1	1	131	141	167	188	226	237	262	284
	2	263	282	299	329	357	380	393	427
	3	394	423	430	470	490	522	526	569
	4	526	564	562	611	622	664	658	711
	5	657	705	693	752	753	806	789	853
2	6	789	846	825	893	885	942	921	989
	7	925	992	961	1039	1021	1088	1057	1135
	8	1062	1138	1098	1185	1158	1234	1194	1281
3	9	1198	1284	1234	1331	1294	1380	1330	1427
	10	1335	1430	1371	1477	1431	1524	1467	1571
	11	1471	1587	1507	1634	1577	1683	1603	1730
4	12	1607	1633	1613	1680	1703	1829	1739	1876

*Zone 1: No trouble anticipated.
Zone 2: Possible fault location and repair.
Zone 3: Fault location and repair expected. Possible SF6 gassing of 0.270″ coaxials expected.
Zone 4: Fault location and repair expected. Possible SF6 gassing of 0.375″ coaxials. SF6 gas required for 0.270″ coaxials.

†Data used for computing voltages in this table are as follows:

7.9 miles of 0.375″ coaxial cable	36V
5.45 miles of 0.270″ coaxial cable	47V
Auxiliary repeater without power loading	95V
Auxiliary repeater with power loading	100V

‡SW or EQ AUX station. Power not looped. 190V

TABLE B

L3 ROUTE*

ZONE†	CABLE SECTION (NUMBERED FROM POWER LOOP TO POWER FEED)	MAXIMUM INNER CONDUCTOR RMS VOLTS TO GROUND‡							
		ALL AUX REPEATERS				ONE EQ AUX REPEATER AND REMAINDER AUX REPEATERS			
		POWER SYSTEM AND COAXIAL SIZE				POWER SYSTEM AND COAXIAL SIZE			
		P1		P2		P1		P2	
		0.375″	0.270″	0.375″	0.270″	0.375″	0.270″	0.375″	0.270″
1	1	86	92	93	99	242	248	287	293
	2	164	176	186	199	328	340	380	393
	3	242	260	279	299	406	414	473	493
	4	320	344	372	393	484	508	556	582
	5	406	436	465	497	562	592	659	691
	6	484	520	558	597	648	684	752	784
	7	562	604	651	696	726	762	845	884
	8	640	688	744	796	804	852	936	988
2	9	726	780	837	895	882	936	1031	1089
	10	804	864	930	995	968	1028	1124	1189
	11	882	948	1023	1094	1046	1112	1217	1288
	12	960	1032	1116	1194	1124	1202	1310	1388
	13	1046	1124	1209	1293	1202	1280	1403	1487
3	14	1124	1208	1302	1393	1288	1372	1496	1587
	15	1202	1292	1395	1492	1366	1456	1589	1686
	16	1280§	1376	1488	1592	1444	1540	1682	1786
	17	1366§	1468	1581	1691	1522	1624	1775	1885
	18	1444§	1552	1674	1791	1608	1716	1868	1985
4	19	1522§	1636	1767	1890	1686	1700	1961	2084
	20	1600§	1720	1806	1936	1764	1884	2054	2184
	21					1842	1968	2147	2283

TABLE B (Cont.)

ZONE†	CABLE SECTION (NUMBERED FROM POWER LOOP TO POWER FEED)	MAXIMUM INNER CONDUCTOR RMS VOLTS TO GROUND‡							
		ALL AUX REPEATERS				ONE EQ AUX REPEATER AND REMAINDER AUX REPEATERS			
		POWER SYSTEM AND COAXIAL SIZE				POWER SYSTEM AND COAXIAL SIZE			
		P1		P2		P1		P2	
		0.375"	0.270"	0.375"	0.270"	0.375"	0.270"	0.375"	0.270"
4	22					1928	2060	2240	2383
	23					2006	2144	2333	2482
	24					2084	2228	2426	2582
	25					2162	2312	2519	2681

*This table has been prepared to show every fourth repeater as a pilot controlled repeater.

†Zone 1: No trouble anticipated.
Zone 2: Possible fault location and repair. No SF6 gassing expected.
Zone 3: Fault location and repair expected. Possible SF6 gassing of 0.270″ coaxials expected.
Zone 4: Fault location and repair expected. Possible SF6 gassing of 0.375″ coaxials expected. SF6 gas required for 0.270″ coaxials.

When P2 power is not fed to a looping repeater, subtract 56 volts.

‡Data used for computing voltages in this table are as follows:

	P1	*P2*
4 miles of 0.375″ coaxial cable	32	37
2.7 miles of 0.270″ coaxial cable	38	43.5
Pilot regulated auxiliary repeater	54	56
Thermometer regulated auxiliary repeater	46	56
Equalizing auxiliary repeater	210	250

§Normal cable repeater layout requires an equalizing auxiliary repeater to be added at the 16th repeater; equalizing auxiliary has not been added in this column.