BLM #773B

COMPLETION TESTS OF EXCHANGE-AREA CABLES

INTRODUCTION

1. INDEX

1.01 This and associated sections describe completion tests of exchange-area cables.

1.02 The associated sections are:

SECTION	DESCRIPTION
330-300-501	Apparatus, Records and Forms
330-300-502	Preparations
330-300-503	Testing
330-300-504	Analysis and Reports

2. GENERAL

2.01 After an interoffice telephone cable has been placed, spliced and terminated, it should be tested electrically

(a) to detect errors that may have occurred in manufacturing, placing or splicing,

(b) to find out what level of transmission performance can be expected, and

(c) to obtain data for computing the end-section capacitance of the loaded pairs.

2.02 Manufacturing errors that escape detection in the factory are rare, and splicing errors not found before cable completion are few. Still, it takes only a single error such as an omitted loading point to ruin the performance of many pairs. Other types of errors may have less serious, yet undesirable, consequences.

2.03 If errors are not detected, located and corrected, before the cable is placed in service, they are likely to cause poor transmission performance. It would then be a difficult and lengthy job to take the affected pairs out of service, find out what and where the trouble is, and clear it. It is cheaper, and much better practice, to test the cable immediately after it is terminated at the central offices. Corrective work may then be done before service starts.

2.04 The construction forces usually make tests after each few reels of cable are spliced together, in order to verify the correctness of their work. In the past, "megger" tests were included to detect faulty insulation. In view of recent experience and of the extensive use of gas pressure to keep moisture out of cables, no over-all insulation measurements are required as part of the completion tests.

2.05 Since the tests made during construction do not check on transmission quality, tests of the completely spliced and terminated cable are essential.

2.06 The transmission testing program is adequate but fast and inexpensive. It includes measurements of resistance of individual wires, return loss of each loaded pair, and transmission loss of each pair.

2.07 This program is also desirable for older cables that have never been adequately tested, by today's standards, and for rearranged cables. It is particularly recommended for existing facilities about to be repeatered, and also for those that are already repeatered but do not meet requirements.

2.08 Connections for testing may be made to a number of pairs at a time. With the aid of switchboxes at both ends of the cable, it is practicable to measure quickly and accurately each pair of the group. Only two persons are needed, one at each end of the cable. The man who does most of the observing is relieved of data-taking. He is able to make efficient use of his time by reading his observations of dials and meters by telephone to the man at the terminating end. The latter writes down all the data, thus allowing the former to focus on one job.

2.09 If switchboxes are not available, the multiple test leads may be terminated at connecting blocks mounted at the test location. The tester can then shift clip-ended test leads from one pair to another without much loss of time.

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2.10 After a few preparations are made, the following data are taken:

(a) Resistance of each wire in comparison with a reference wire.

(b) Return loss of each loaded pair.

(c) Transmission loss:

(1) Each nonloaded pair at 1 kc and 60 kc.

(2) Each loaded pair at 1 kc.

3. RESISTANCE

3.01 Resistance of the wires changes with temperature, and temperatures of cables, especially aerial ones, can vary widely during the tests. If the wire resistances were measured on an absolute basis, that is, as so many ohms in each wire, temperature changes could introduce a false amount of variation among the wires.

3.02 In order to cancel the effect of temperature changes, comparative measurements are made. Each wire's resistance is measured as so many ohms greater, or less, than that of a reference wire. Since temperature changes affect the reference wire and the other wires equally, the measured variations among the wires are the same as if all wires had been measured at the same time.

3.03 This type of measurement by comparison with a reference offers another advantage. It permits the use of the Wheatstone bridge meter to show the comparison in ohms directly, thus saving the time otherwise needed for bridge balancing. This method is suitable because most measurements fall within a narrow range and because great precision is not needed.

3.04 The meter scale is usually divided into about 30 parts, giving a 30-ohm range. Measurements outside this range take more time since dials must be turned to bring the pointer back on scale. In order to have most readings fall within the 30-ohm range, the reference wire's resistance should be about average for the complement. An appropriate wire is chosen by measuring several and selecting the one nearest their average.

4. RETURN LOSS

4.01 In loaded cables, the characteristic known as return loss is an excellent measure of the uniformity of the cable and of the regularity of the loading spacing. The better these are, the greater the return loss should be.

4.02 A major loading fault produced by placing a loading coil at the wrong point, by connecting it in the wrong way, or by omitting it entirely, reduces the return loss appreciably. When a measured return loss is somewhat below the expected figure, therefore, the presence of a major fault is indicated.

5. TRANSMISSION LOSS

5.01 At carrier frequencies, transmission loss is sensitive to structural irregularities, hence serves two purposes: (1) to detect faults and (2) to furnish data for the circuit-layout forces.

5.02 Transmission loss at 1 kc is not very sensitive to structural faults and is measured to furnish data to the circuit-layout forces.

6. END SECTION

6.01 The end section of a loaded pair is the cable between the point of termination in an office (usually the main distributing frame — MDF) and the first loading coil. In circuit-layout work, it is important to know the mutual capacitance in this portion of the cable, but direct measurements are seldom feasible. Indirect measurements are practicable, however, as a by-product of completion tests.

6.02 The method used is one of comparison. A pair with unknown end section is balanced (for maximum return loss) against a precision network whose end section is known precisely. Best balance is sought by building out the end section of the cable pair or the simulated pair by known amounts. When the best balance is attained, the two end sections are equal, and the end-section capacitance of the cable can be computed.

7. RESULTS

7.01 Completion-test data should be worked up without delay. Then, if signs of trouble show up, further tests can be made at once to aid in diagnosing, locating, and correcting the cause.

7.02 In analyzing test data, bear in mind that pairs and wires naturally vary a little among themselves in every characteristic. A simple tally like the one in Fig. 1 shows the sort of variation expected in the results for a complement of pairs.

7.03 Note that the dashed line drawn to enclose all the tally marks is bell-shaped. This shape is expected for the return loss of a group of pairs affected by small random variations in the cable pairs themselves and by variations in loading spacing. Whenever the shape is like this and the average is about right, you can be pretty sure there is no major structural fault in the group. The width of the bell may vary from cable to cable; such variation is not an indication of trouble as long as the average is in the right range.

7.04 A major fault generally causes two changes in the tally: it reduces the average, and it narrows the spread. Fig. 2 shows a tally for a complement that has 21 pairs in trouble. The pairs in the top bell look good; those in the smaller bell with an average between 25 and 26 db have a common fault causing them to cluster around those figures; and one pair down at 16 db has a more serious fault.

7.05 Early action in the form of impedance-frequency runs must be taken to locate faults. This procedure is described in other sections of practices. In the case illustrated in Fig. 2, an impedance-frequency run must be made on a pair from the group of 20, and another on the pair having a return loss of 16 db.

7.06 Tallies of resistance measurements are also useful in judging the performance of a group of pairs. But remember that a wire whose measured resistance sets it apart from the rest of the group may not be faulty; it is not unusual, in picking up wires for test, to make a poor contact at the main distributing frame. For this reason, such connections should be checked whenever resistances measured initially seem too high.

7.07 Transmission loss of nonloaded pairs at 60 kc is relied on to detect faults such as bridged taps, loading coils not removed, etc. Tallies of 60-kc loss are strongly recommended. Transmission loss at 1 kc will almost certainly be in the expected range if the resistance and return loss are in their expected ranges. A tally of 1-kc transmission losses is recommended as an aid to the circuit-layout forces.

7.08 Faults detected by 60-kc measurements are located by a technique somewhat like that used for detecting loading faults. In general, the technique includes making impedance-frequency or crosstalk-frequency runs. Frequencies at which peaks and valleys occur are used in calculating the distance to the fault. This locating technique will be available in other sections of practices.

8. REPORTS

8.01 Reports of tests are prepared for two purposes: (1) to inform the supervisory force of any faults detected, so that action can be taken to clear them; (2) to inform the circuit-layout forces of the quality levels of the cable after clearance of faults.

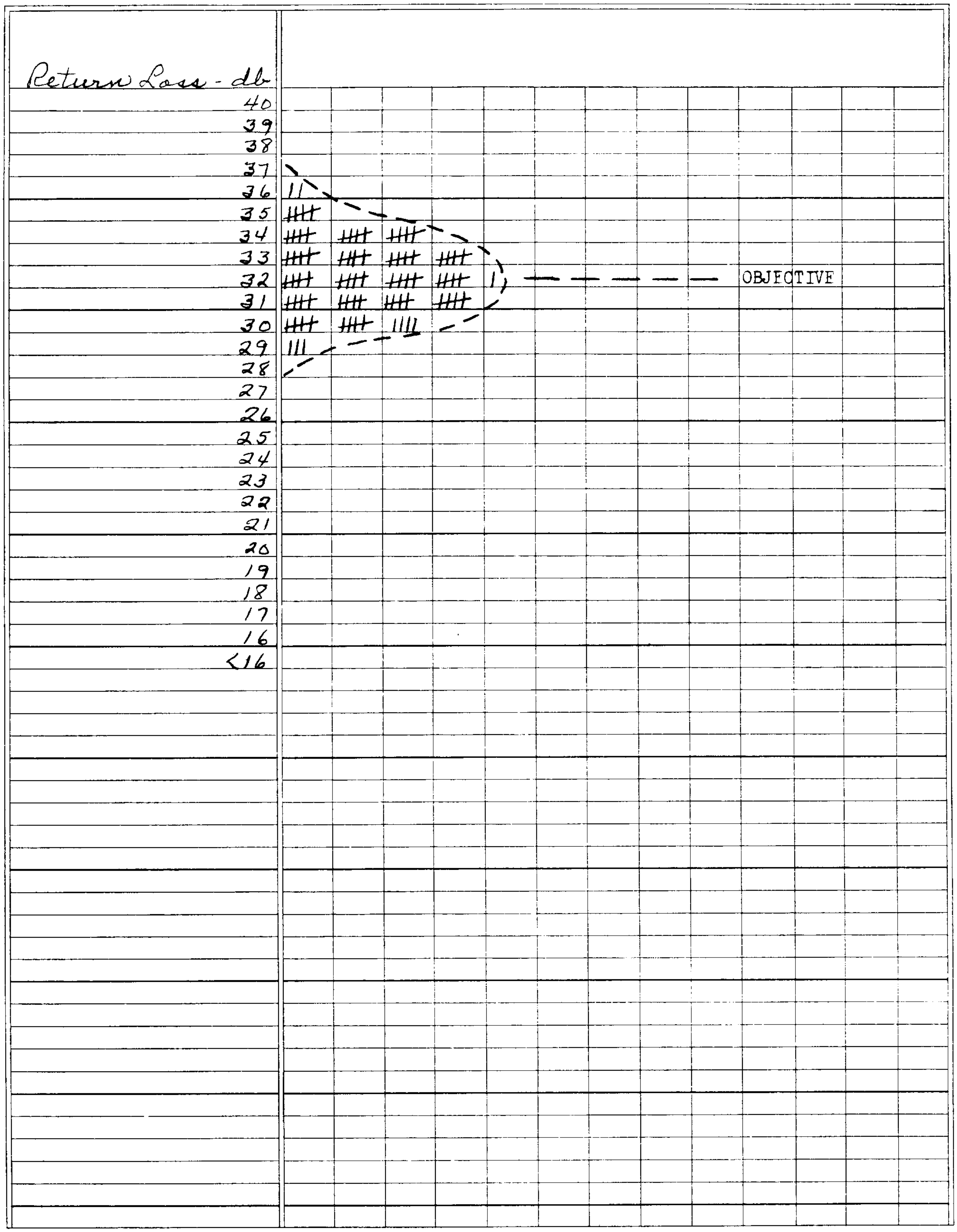

Fig. 1 – Tally of Return Losses — Complement of 100 Pairs

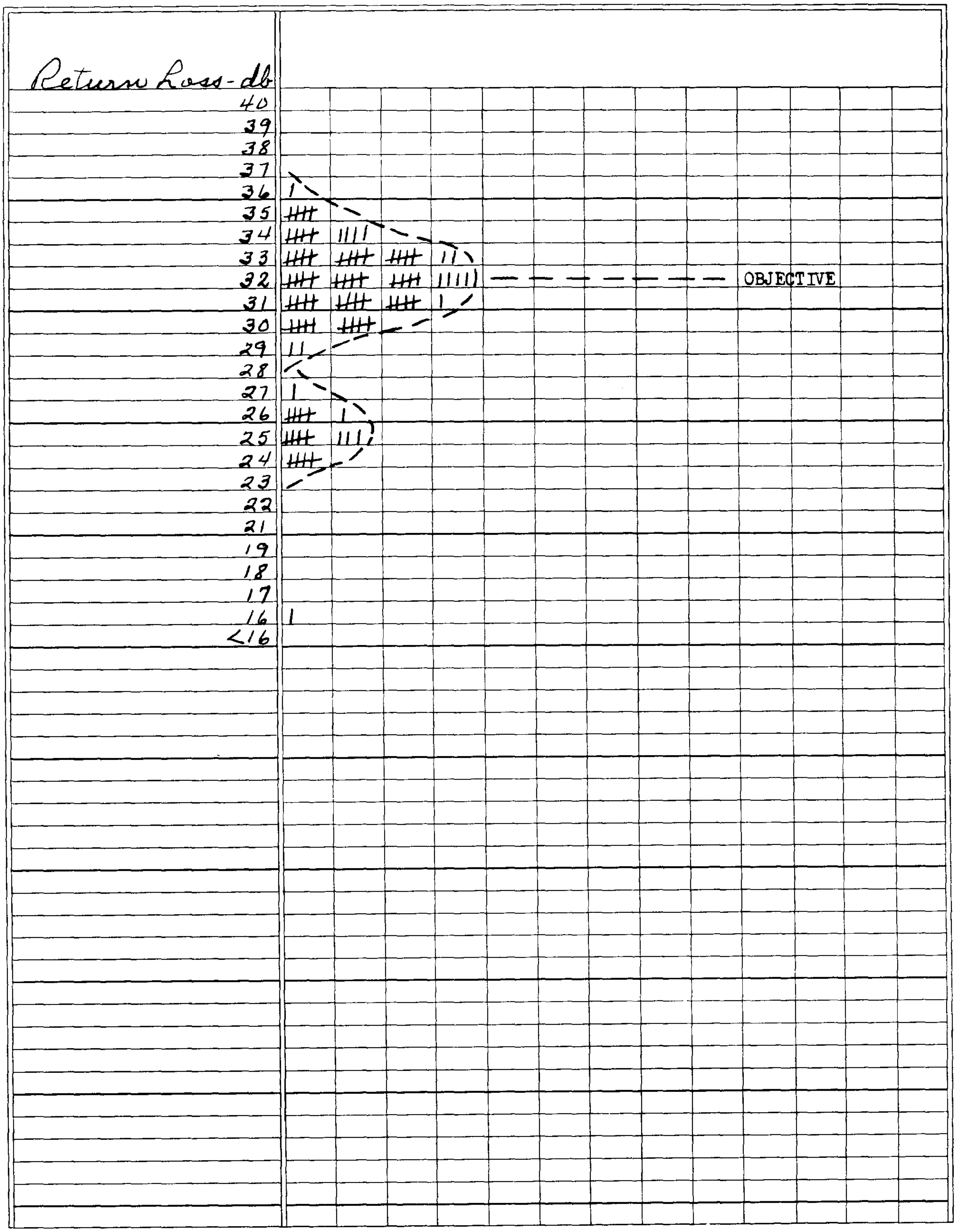

Fig. 2 – Tally of Return Losses — Complement of 100 Pairs