

MULTISTATION PRIVATE LINE TELEPHONE CIRCUITS  
 FOR THE FEDERAL AERONAUTICS ADMINISTRATION

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1. GENERAL

1.01 This section describes the service order and routine tests that are to be made at the stations on circuits provided for the Federal Aeronautics Administration (FAA). Also included in this section are the methods to be used when making these transmission tests with Telephone Company personnel at the FAA stations.

2. NOTES ON THE TRANSMISSION TESTING PROCEDURES TO BE USED WHEN MAKING TESTS AT STATION LOCATIONS

2.01 These notes outline some of the considerations involved in making transmission measurements from station locations on the multi-station private lines of the FAA. Although these measurements are made at the direction of the circuit control office, or other STC, the work at the station location is performed by personnel from the local plant forces.

(A) Transmission Measurements from Attendant's Jacks on 102A Key Equipment

Testing Arrangement

2.02 Shown in Fig. 1C is an arrangement that will simplify the sending and receiving at 102A key equipment positions. This arrangement should be wired up locally. Figs. 1A and 1B are simplified schematics of a 2-wire and a 4-wire 102A key equipment station. These are included to illustrate the use and connection of the testing arrangement.

2.03 The induction coil, wired as a transformer, is used to convert the impedance of the 600-ohm oscillator to an impedance of approximately 50 ohms. The output of the induction coil is wired to the tip and ring of a 289B-type plug or equivalent. This is the type of plug normally used with operator's telephone sets. The transmission measuring set is wired directly to the sleeves of the 289B-type plug.

2.04 **Calibration:** The oscillator and transmission measuring sets are calibrated in the standard manner for the type of sets used. When the calibration procedure calls for patching the oscillator output to the transmission measuring set input, the induction coil is not included in the patch. Test procedures and level corrections

assume that the output of the 1000-cycle 600-ohm oscillator is set to the value specified and assume the transmission measuring set will read 0 dbm when a 1MW, 600-ohm, 1000-cycle tone is connected to its input terminals.

**2.05 Connection to a 4-Wire 102A Key Equipment Termination:** When the plug on the testing arrangement is inserted in the AB headset jack of a 4-wire termination, the operation of the line key associated with the private line circuit will connect the measuring equipment to private line termination. The dc path through the 7-8 winding of the induction coil completes the same circuit as does the push-to-talk arrangement normally used. This removes the idle circuit termination and cuts the transmitting path through. The 50-ohm output of the sending arrangement replaces the 50-ohm headset transmitter so there is no extra loss due to impedance mismatch between the testing arrangement oscillator and the level reference point. The 600-ohm transmission measuring set replaces the 600-ohm headset receiver and no extra loss is caused by impedance mismatch in the receiving direction either.

**2.06 Connection to a 2-Wire 102A Key Equipment Termination:** When the testing equipment is connected to a 2-wire termination, the operation is the same except that the 600-ohm transmission measuring set replaces a 300-ohm receiver unit and thus a .5 db reflection loss is caused by the impedance mismatch.

**Tests at ARTCC's with 4-Wire 102A Key Terminations per SD-69167-01, Fig. 83 or SD-69164-01, Fig. 13 or 14**

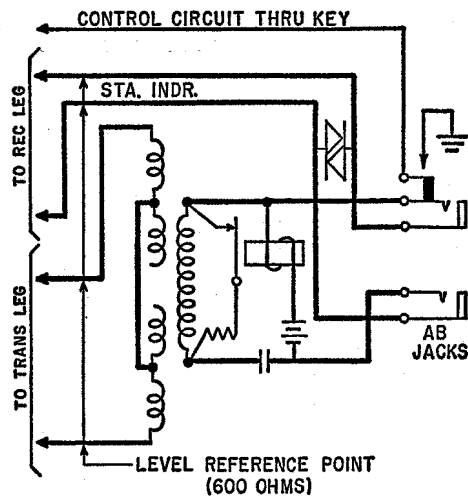
**2.07** Four-wire terminations are always used at ARTCC's and thus no correction need be made for any impedance mismatch. The terminations used at ARTCC's are usually the ones with inequality ratio loop transformers to reduce level variations as telephone sets are bridged on the loops. The losses of the equipment at the station end of loops with this type of termination are engineered assuming the simultaneous connection of three 52-type headsets with one push-to-talk key operated.

**2.08** It is desirable in this case to make tests at this type of termination from an operator's headset jack. (Headsets are always used at ARTCC's.) It is also desirable to make these tests under the conditions which were engineered for the circuit; i.e., with three headsets connected. The manner of connecting the three sets is covered later in Part 3 of this practice. Table I shows the levels to use for testing. Single station test levels are also included; since, because of operating conditions in the center, the three set condition may be difficult to achieve at times. The sending levels include a 1.7 db correction for the loss of the two induction coils between the oscillator and the level reference point.

TABLE I

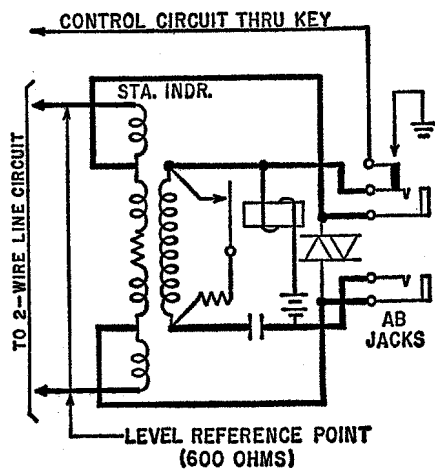
Test	Testing Level (dbm)	Level at Reference Point as Shown on Circuit Layout Card
Sending— Line-up Condition (3 stations multiplied)	+ 1.7	0 *
Sending— Single Station Only	+ 0.3	0 *
Receiving— Line-up Condition (3 stations multiplied)	-16.0	-16.0*
Receiving— Single Station Only	-14.4	-16.0*

\*Levels shown on Circuit Layout Card are based on 3 102A key positions being bridged at ARTCC locations.



4-WIRE 102A KEY TERMINATION

Fig. 1A



2-WIRE 102A KEY TERMINATION

Fig. 1B

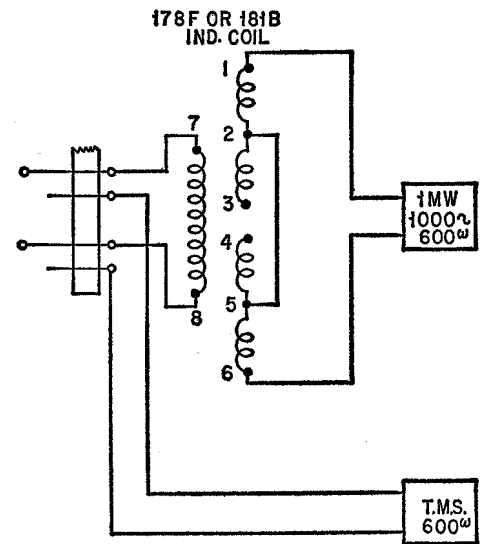


Fig. 1C

Fig. 1 — Arrangement for Connecting Transmission Measuring Equipment to 102A Key Equipment Headset Jacks

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**2.09** The levels given in Table I, and Table II are based on the use of a 1000 cps test frequency and 600-ohm measuring apparatus. In the receiving direction the level given is that which will be indicated by a 600-ohm transmission measuring set connected to the station jacks when the correct level exists at the layout reference point, that is, the input to the station receiver. In the transmitting direction the level given is the oscillator output measured across 600 ohms. After being set to this value the oscillator can be connected to the station jacks through the test transformer and the correct line-up level will appear at the layout reference point.

**2.10** The receiving power should not be allowed to exceed -10 dbm at the receiver jack circuit since the limiting action of the varistor is likely to cause transmission losses as a result of the application of higher levels. If the sending office sends at circuit level, this difficulty will not be encountered.

**Tests at Other 102A Key Terminations**

**2.11** Table II contains test levels to be applied in testing lines terminated in 102A key equipment with line circuits in accordance with SD-69164-01, Figs. 2, 5, 6, or 7, or SD-69167-01, Fig. 61. Depending on the local key equipment arrangements, the levels may or may not be constant as the number of connected headsets or handsets varies. For this reason, when line-ups are made, only one line key should be operated unless notes to the contrary appear on the circuit layout card. These levels have been computed for either F1A handsets or 52-type headsets since either or both may be used at points with the above line circuits. When the point being tested is equipped with both types of instruments, the tests should be based on the one for which the station levels were engineered. The type instrument that was used for a reference in engineering the station levels can be determined by comparing the levels shown on the circuit layout card or sketch with the levels shown in the right-hand column of Table II.

**TABLE II**

<b>Test</b>	<b>Testing Level (dbm)</b>	<b>Level at Reference Point as Shown on Circuit Layout Card</b>
Sending— F1A Handset— 4-wire Station	+ 4.7	+ 3.0
Sending— 52-type Headset— 4-wire Station	+ 1.7	0
Sending— F1A Handset— 2-wire Station	+ 4.7	0
Sending— 52-type Headset— 2-wire Station	+ 1.7	- 3.0
Receiving— F1A Handset— 4-wire Station	-13.0	-13.0
Receiving— 52-type Headset— 4-wire Station	-16.0	-16.0
Receiving— F1A Handset— 2-wire Station	-12.5*	-10.0
Receiving— 52-type Headset— 2-wire Station	-15.5*	-13.0

\*Includes 0.5 db reflection loss.

**(B) Transmission Measurements from the Connecting Block at Attendant's Telephone Set on 111A Key Equipment**

**2.12** Because the 111A key equipment does not include jacks for the attendant's telephone set it is not practicable to utilize the plug-in testing arrangement shown in Fig. 1C in making transmission measurements on such equipment. It will be necessary in such cases, therefore, to disconnect the attendant's telephone set from its connecting block and to wire from the transmitter terminals of this block to the testing apparatus shown in Fig. 1C. For transmission measurements the line key associated with the particular circuit under test must, of course, be operated.

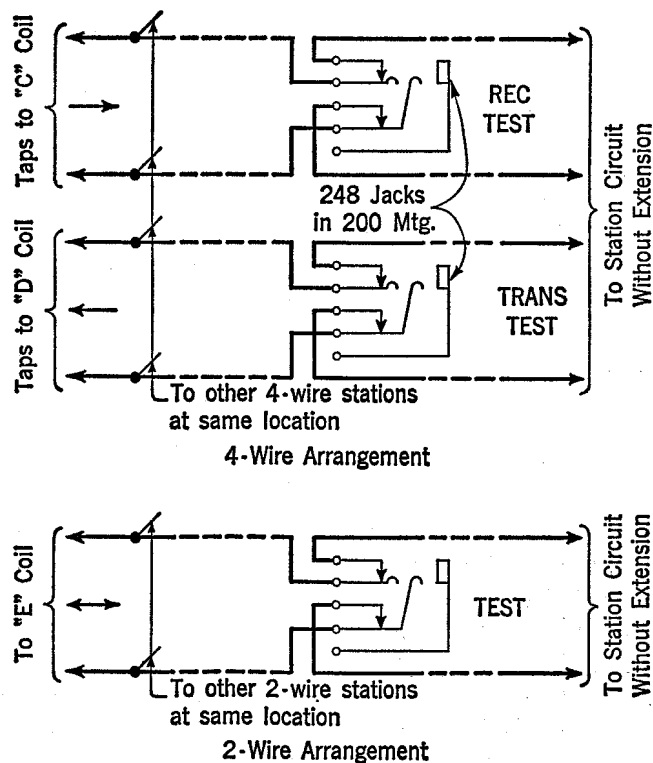
**2.13** Measurements of transmission in the receiving direction on the 111A key equipment can be made by wiring from the transmission measuring set to the receiver terminals on the connecting block for the attendant's telephone set. It will, of course, be necessary to operate the line key associated with the circuit under test.

**2.14** As noted in connection with tests on 102A key equipment, the level at the receiver terminals should not be allowed to exceed  $-10$  dbm because of the limiting action of the varistors in the receiver circuit for high volume levels.

**2.15** The same net loss and level corrections will apply for the 111A key equipment as tabulated previously for the 102A key equipment in Table II.

**(C) Transmission Measurements from Stations Equipped with Test Jacks per Fig. 2**

**2.16** At locations with one or more stations, none of which is terminated in 102A equipment, the technique of making transmission measurements from the location is simplified where a test jack as shown in Fig. 2 has been installed. A jack circuit of this type is not provided on standard drawings but may be installed on a local basis. When installed the jacks will usually be located with the common line terminating and grouping equipment and connected into the wiring to the closest station on the same premises which does not have an extension station.



**Fig. 2 — Test Jack Circuit Arrangements**

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**2.17** The 600-ohm measuring apparatus may be connected directly to these jacks which correspond to the reference level point of the circuit. Since the test transformer is not used and the station apparatus is disconnected, no net loss or level corrections are required between the test equipment and reference point.

### (D) Transmission Measurements from Stations without 102A Key Equipment or Test Jacks

**2.18** At locations with one or more stations, none of which is terminated in 102A key equipment or equipped with a test jack circuit (per Fig. 2), measurements can be made as outlined in Section C71.834.1 or one of the station circuits can be disconnected at the common bridging point and the 600-ohm measuring apparatus connected in place of the disconnected station.

**2.19** If there is a possibility that the station may be required for service, the station circuit and the transmission measuring apparatus might be connected to the outside terminals of a DPDT switch and the midpoint of the switch connected to the common bridging point. In this way service could be rapidly restored if desired.

**2.20** This testing location corresponds to the transmission reference point of the circuit and no net loss or level corrections are required for the local test equipment and disconnected station circuit.

### (E) Older Station Arrangements

**Per SD-69158-01 (Option F): or S-8800 (Long Lines Department): or 601-131 (O. & E. Department)**

**2.21** This is a 4-wire station arrangement terminating in a telephone set without key equipment. The most practical method of making transmission measurements from such stations is to disconnect the station circuit from the line terminating circuit and connect the measuring apparatus at this location, which corresponds to the reference level point.

**2.22** The station telephone circuit is comprised of a 63-type induction coil with an F1 transmitter and HA1 receiver (150 ohms). The

induction coil as used in the transmitting circuit has an approximate impedance ratio of 1:16 from the transmitter to the line, and the line impedance at the line terminals of the induction coil may be taken as 600 ohms. The same conditions also apply in arrangements of this older circuit where a 13-type induction coil has been used instead of the 63-type induction coil.

**2.23** The 150-ohm receiver used with this circuit is approximately matched to the 600-ohm line by the specified strapping of transformer C in the toll line terminal at the station. Consequently, the measurements made on the receiver leg at the station should include a 1:4 ratio transformer between the measuring point and the 600-ohm transmission measuring apparatus, and the observed results should be corrected by an amount corresponding to the loss of this ratio transformer. If a transformer is not used the measurement should be corrected by  $-2.0$  db to care for the effect of the reflection loss.

### Per SD-69123-01 and SD-69150-01

**2.24** These two circuits are arranged to terminate in 102A key equipment and specify the use of the attendant's telephone set consisting of an F1 transmitter and HA2 (300 ohms) receiver unit. SD-69123-01 provides for only a 2-wire termination, and SD-69150-01, which is a modification of the former, provides for either a 2-wire or 4-wire termination. With either circuit, transmission tests can be made conveniently from the attendant's telephone set jacks of the 102A key equipment as discussed below.

**2.25** **Sending: 2-wire and 4-wire Stations:** With the 102- or 178-type induction coils provided with these circuits, the impedance of the transmitter circuit at the jacks is of the order of 40 ohms. The 600-ohm source of testing power should therefore be connected to the jacks through an approximate 600:40 ohms ratio coil. The transformer arrangement as shown in Fig. 1 will be satisfactory for this purpose. Net loss and level corrections which may be applied are given in Table III. These corrections include a 3 db loss for the antisidetone loss of the station induction coil, which is still effective in the 4-wire arrangement.

**2.26 Receiving: 2-wire Stations:** Although the impedance of the receiver circuit at the jacks is 300 ohms, no substantial advantage will be obtained by the use of 2:1 ratio transformer in the measuring circuit since the reflection loss is of the same order of magnitude as the coil loss. The net loss correction given in Table III assumes that no transformer will be used and includes 0.5 db for the reflection loss.

**3.02** On tests to and from customer station locations, the testboardman participating in or coordinating the tests should be familiar with the transmission features of the type of station circuit involved in order that proper net loss and the level corrections may be determined and applied to the observed results. This will be of assistance to the local testing forces. The transmission features

TABLE III

**Net Loss and Level Corrections**

(For 102A Key Equipment — Per SD-69123-01 and SD-69150-01 — Using Test Arrangements of Fig. 1)

Test	Loss Between 600-ohm Measuring Apparatus and Reference Point
Sending on 4-wire Station	4.7 db
Sending on 2-wire Station	4.7 db
Receiving on 4-wire Station	0 db
Receiving on 2-wire Station	4.5 db*

\*Includes 0.5 db for reflection loss due to 600-ohm measuring set connected to 300-ohm receiver circuit.

**2.27 Receiving: 4-wire Stations:** The impedance of the receiver circuit at the jacks is 600 ohms to which the measuring set may be directly connected without special considerations.

**2.28** The corrections to be applied to the net loss and level measurements when transmission tests are made from the attendant's jacks of either of these station circuits as above would be as shown in Table III.

### 3. SERVICE ORDER TESTS

**3.01** Where exceptions to the provisions of this section or to the usual service order tests are made or appear desirable for any reason, the substitute action taken should be reported to the proper supervisory personnel through the lines of organization.

of typical station arrangements as they apply to such tests are discussed in Part 2 of this section.

**3.03** The central office man will be responsible for recording the results of all transmission measurements made to and from a customer's station. The local testing forces should consult the control office or the Serving Test Centers (STC's) to determine if the circuit requirements are met.

**3.04** The tests outlined herein are listed in the sequence that it is suggested they be performed.

**3.05** In cases where changes on existing circuits are made, service order tests should be made only on those stations and/or sections affected by the changes.

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### (A) Branch and Loop Tests

#### General

**3.06** These tests will usually be made with the cooperation of the toll test personnel who will be located at the central office and who will be equipped with the circuit transmission data. The test room attendant participating in these measurements will consult with local tester concerning the results of the measurements.

**3.07** Tests of loops and branches should be made between one station of each group of stations multiplied at the same location and the STC that serves the station.

#### 4-Wire Branches and Loops — Direct Path

**3.08** Measure the 1000-cycle net loss between the central office and the station. Measurements should be made in both the transmitting and receiving directions.

**3.09** One station of each group of stations multiplied at the same location should be selected for the measurement on the branch. A discussion of the technique for making these measurements at the station is given in Part 2 of this section. The measurement from the station should include the losses of any pads in the legs at the station. When measuring the loss of a branch terminating in a 102A key position at an ARTCC, bridge two additional positions (52-type headsets) on the circuit. The push-to-talk keys of the headsets in the two bridged positions should be in the "OFF" position. In making this measurement care should be exercised that no stations other than these three are inadvertently bridged across the branch during the test. The "AB" jacks of a "D" position and its associated "A" position may be used to provide two bridged stations. The "AB" jacks of another "D" position may then be used to provide a third station. The "A" position associated with this second "D" position should be bridged on some other circuit by operating a line key, otherwise this headset will be multiplied with the second "D" position. The line keys of the three positions used should be operated, all other line keys in the center associated with the branch under

test should be normal. When measuring a branch terminating at a way station, all normally connected stations should be bridged on the branch. When measuring from 102A key equipment in towers, the line key at the measuring position only should be operated.

**3.10** Where the loop divides at an intermediate point to serve stations at different locations, similar tests should be made from one station at each location.

**3.11 Requirements:** Loop facilities only involved: The measured loss should be within 1 db of the computed values as determined from the circuit layout record card.

#### 4-Wire Branches and Loops — Talk-back Path

**3.12** Make a 1000-cycle measurement from the transmitting terminals to the receiving terminals of the station set. This loss should include the losses of any pads in the legs at the station. At a 102A key equipment position in an ARTCC the measurement should also include the bridging loss of two additional positions. (Note precautions given in Paragraph 3.09 for measurements at the ARTCC.) At other points, it should include the bridging loss of all normally connected stations. At tower 102A key equipment the line key of the measuring position only should be operated.

**3.13** On 4-wire branches connected to 2-wire bridges the talk-back path is obtained through the hybrid transformer on the 2-wire side of the 4-wire to 2-wire repeater or 4-wire terminating set. The value of the balancing resistance in the network on this hybrid transformer is adjusted to give a specified 1000-cycle return loss which, with the net loss of the transmitting and receiving legs, will provide the proper received level at the stations on the branch.

**3.14 Requirements:** The measured loss should be within 2 db of the computed loss as determined from the circuit layout record card.

**Note:** This test which involves both sending and receiving at the station will usually be made by local test personnel who may not be equipped with circuit layout record card. The



test room attendant will cooperate with the local tester and advise him concerning the results of the measurement.

### **2-Wire Branches and Loops**

**3.15** The same procedures used for testing 4-wire branches and loops should be followed when testing 2-wire branches and loops. Where the facilities under test include repeaters or hybrid arrangements to change from 4-wire to 2-wire are included in the tests, transmission tests should be made in both directions. Otherwise, tests in one direction only will be satisfactory.

**3.16 Requirements:** Same as for 4-wire branches and loops given in 3.11.

### **Branches and Loops — Talking Tests**

**3.17** Make talking tests from each station to the attendant at the STC or at the test room designated by the STC. If available, a volume indicator should be used for this test. The operation of the loudspeaker circuit should be checked at this time.

**3.18 Requirements:** Transmission to and from each station should be comparable to that obtained from the station from which the 1000-cycle net loss of the branch was checked at the same location.

### **(B) Over-all Tests**

**3.19** After the circuit and service order tests have been completed on the component parts of each multistation line, the following tests should be made on the over-all circuit before it is furnished to the customer for service.

### **1000-cycle Measurements**

**3.20** Make 1000-cycle net loss measurements in each direction between the ARTCC and at least one of the more remote points on the interphone circuit. This measurement should be made with three operating positions bridged on the loop at the ARTCC and all normally bridged stations

on the loop at the remote point. (Note precautions in Paragraph 3.09.) During this testing interval transmission level measurements should be made at each bridge point to check the over-all transmission line-up of the circuit.

**3.21** The over-all net loss for these circuits is expressed as the loss from the line terminals of the station induction coil at the transmitting end to, (a) the line terminals of the station induction coils of 2-wire stations, or (b) up to the receiver terminals for 4-wire stations, at the receiving end. The over-all net loss measured between an ARTCC and a way station will, in general, be different for the two directions of transmission since different type instruments are normally used at the two locations. Intercenter lines, ARTCC to ARTCC, will have the same net loss in each direction of transmission.

**3.22 Requirements:** The measured net loss and the corrected levels should agree with corresponding values specified on the circuit layout record card, within the limits specified.

### **Talking and Signaling Tests**

**3.23** Make over-all talking tests between all stations on a conference basis, signaling tests from each station to the ARTCC and between ARTCC's when more than one control center is involved on the same circuit. When a line termination per Drawing SD-69164-01 or equivalent is provided at the ARTCC, ringing signals of less than 1.5 seconds and in excess of 3.5 seconds should be given in order to check the operation of the selective features of the signal receiving system. When the line termination per Drawing SD-69164-01 is modified by Information Drawing B-759841, the following three ringing signals should be checked: (1) a single one-second ring, (2) two one-second rings with the spacing between rings not exceeding one second, (3) three one-second rings with the spacing between rings not exceeding one second. The loudspeaker output at each station should be checked at this time to determine that satisfactory volume is obtained at the attendant's position. The existing room noise conditions should be verified as typical. If the existing room noise is higher than anticipated as normal, it should be determined that there is

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additional range in the gain control of the loudspeaker to compensate for a higher level of room noise. The operation of the reduced gain key associated with the loudspeaker circuit, if one is provided, should also be checked.

**3.24 Requirements—Talking Tests:** Satisfactory transmission should be obtained on both the receiver of the telephone set, and on the loudspeaker, when it is connected. There should be no observable echo or hollowness on the circuit. A generally uniform volume of transmission should be observed at each station on transmission from all other stations.

**3.25 Requirements—Signaling Tests:** Proper operation of the incoming signaling circuit at the ARTCC should be obtained when a ring of approximately one-second duration is applied at the airways station. Where selective signaling per SD-69164-01 is provided, the ring of less than 1.5 seconds should signal the Controller position and the ring of more than 3.5 seconds should signal the Assistant Controller or Communicator positions at the ARTCC. When the selective signaling arrangement is modified by Information Drawing B-759841, a single ring should signal the Controller positions, two rings the Assistant Controller or Communicator positions, and three rings a third position as specified by the circuit order. When 600-1500-cycle selective signaling equipment is employed, each station equipped for outward dialing should be able to dial each station that has a code assigned to it. The control office should monitor the dialing and measure (preferably with a volume indicator) the level of the two tones from each station. Any dial tone level not within 3 db of circuit level should be investigated. Initial tests on the 600-1500-cycle selective signaling equipment at the customer's location should be made per Section E27.255.

### Tests of Relay Switching Equipment

**3.26** The testman at an airways station which controls a switching arrangement for interconnecting two interphone circuits should check its operation. While the two circuits are interconnected, the testman at the ARTCC should talk with

the FAA representative at the adjacent ARTCC over the switched connection observing the quality of transmission. The testman at the airways station should monitor to be sure that the designated branch remains connected to the bridge during the switched period. The circuit control offices should also monitor to ascertain that the switching is correct and that transmission is satisfactory.

## 4. PERIODIC TESTS

### (A) Station Inspections

**4.01** Each station should be inspected every three months, particularly for loudspeaker operation, talking battery supply and physical condition of the equipment. This inspection, to be conducted by the local maintenance forces, will be made in accordance with the information and instruction in the "C" Series of Practices.

### Loudspeaker Sets

**4.02** All tubes in the amplifiers associated with the loudspeaker should be replaced with tubes known to be satisfactory. Tubes removed from amplifiers may be tested at the most convenient telephone office and discarded or placed in stock depending on the results of the tests.

**4.03** It will not be necessary to obtain a release on the circuit during the period the loudspeaker is inoperative. However, it will be necessary for the station attendant to continuously monitor with the hand receiver during the test period to assure that no calls for that station are missed.

### Talking Battery Supply

**4.04** Where the talking battery is supplied by dry cells, their condition should be checked and the batteries replaced, if necessary. At some stations it may be found that the volume of traffic is heavy enough to require frequent battery re-

placements. Such cases should be reported through the lines of organization, with the record of the battery replacements, in order that the need for a more substantial battery supply may be determined.

#### **600-1500-Cycle Selective Signaling Equipment**

**4.05** Where 600-1500-cycle selective signaling equipment is employed, routine tests should be made per Section E27.255. These tests usually require short releases of the signaling equipment but not of the talking path.

#### **Physical Condition of Equipment**

**4.06** The physical condition of the station equipment should be inspected and any broken or loose parts repaired or replaced.

### **5. TRANSMISSION TESTS ON AN IN-SERVICE BASIS**

**5.01** Quite often trouble reports or other indications are received that indicate the need for transmission tests. While the tests that follow are termed "in-service" tests, they are only made with permission from the ARTCC. The circuit should be monitored during these tests so that it can be restored to service immediately upon request by the FAA.

**5.02** A preferred method of connecting the testing power is to send at 20 db below circuit level at the input terminals of a spare side of a 4-wire bridge. All receiving points should apply a 20 db correction to observed readings. This reduced testing level is desirable to minimize the acoustic disturbance from the loudspeakers at stations still connected with normal levels, and also to enable recognition of any calls passed over the circuit while the testing tone is still applied.