SECTION 313-130-100
Issue 1, October 1983
Reprinted July 1984**

VOICE AND VOICEBAND DATA CHANNELS

CENTRAL OFFICE TRANSMISSION AND SIGNALING TEST PROCEDURES

CONTENTS PAGE

**Reprinted to comply with modified final judgment.

1. GENERAL

1.01 This section covers procedures for performing transmission and signaling tests on voice and voiceband data channels. These procedures cover the work operations required to test the channels at a central office (CO).

Printed in U.S.A.

1.02 When this section is reissued, the reason(s) for reissue will be given in this paragraph.

1.03 The far end of a channel may be terminated at either another central office or at customer premises (CP). Coordination between locations and possibly dispatches to these locations may be required to complete the tests in this section.

1.04 Customer channels are tested for three major purposes: (1) initially to ensure that the channel meets the parameter limits that have been guaranteed to the customer, (2) thereafter to ensure that the limits are still met, (3) and to locate and correct troubles encountered on the channel.

1.05 For those channels with signaling, the signaling tests should be performed immediately following the transmission ***continuity test*** and prior to the remaining transmission tests. When single frequency (SF) signaling is used, the 1004-Hz loss test must be completed to that portion of the channel carrying the SF signal prior to the signaling test. The transmission tests are often dependent on being able to provide proper signaling on a channel in order to allow end-to-end transmission testing. This section will list the required procedures starting with intraoffice tests and proceeding through interlocation continuity, signaling, and transmission tests.

1.06 All tests are not required on all channels, but the tests that are required for a specific channel should be made in the ***order given in this section***. This is to ensure that each parameter is tested in a manner that gives correct results. Failure of previous test results to meet objectives will require correction before reliable results can be obtained from subsequent tests. For example, if the loss of a channel is not within its prescribed limits, the remaining tests (such as C-message noise) will not truly reflect the performance of the channel because they will be offset from their reference by the error in the loss.

1.07 The required tests and their associated limits for each type of channel can be found in Section 313-120-100 for transmission and Section 313-120-101 for signaling. Transmission and signaling considerations are covered in Sections 313-110-100 and 313-110-101. Testing at customer premises is covered in Section 313-130-101.

1.08 The procedures in this section assume that all tests of individual facilities and equipment have been made and the individual components making up the channel have met specific operating parameters. This includes the verifying of end-to-end loss on a carrier system and whatever carrier system lineup is required, the adjustments to prescription settings on all equipment, and any other requirements established in the facility and equipment sections which are part of preparing the facilities and equipment for use in providing service. The individual components of a channel must meet their own limits prior to testing the channel for its limits.

1.09 Some channels, particularly those associated with switched service networks and tandem networks, require additional tests unique to their service. These tests are usually overall tests of the built-up connection rather than stand-alone tests of the channel. These additional tests are covered in other Practices. A partial list of these sections are as follows:

SECTION	TITLE
309-200-300	Common Control Switching Arrangements
309-200-301	Automatic Voice Network
309-300-300	Enhanced Private Switched Network
309-400-300	Electronic Tandem Network.

1.10 All customer premises equipment (CPE) must be disconnected before tests are performed. The tester should be familiar with the transmission and signaling considerations, requirements, and procedures covered in the following sections:

SECTION	TITLE
313-100-100	General Introduction, Preservice and Maintenance, Voice and Voiceband Data Channels
313-110-100	Transmission, Test Considerations, Voice and Voiceband Data Channels
313-110-101	Signaling, Test Considerations, Voice and Voiceband Data Channels
313-120-100	Transmission Tests, Requirements and Limits, Voice and Voiceband Data Channels

SECTION	TITLE
313-120-101	Voice and Voiceband Data Channels, Signaling Tests Requirements and Limits
313-130-101	Voice and Voiceband Data Channels, Customer Premises Transmission and Signaling Test Procedures.

A. Test Access

1.11 Access to any channel for testing purposes should be at a known impedance and test level. If the impedance or test level is unknown, useful results cannot be obtained from the transmission tests.

1.12 Many central offices are equipped with centralized test and patching positions. These test positions allow the tester to monitor and simulate customer signals and may be equipped for either manual or automated testing capabilities. In offices without this type of access or on channels that are not accessible in this manner, great care must be exercised in choosing a proper test access point.

1.13 Testing of carrier systems can normally be performed at associated voice frequency patch boards provided with the carrier terminals. Some carrier terminals, however, require the use of a channel unit extender at the channel bank.

1.14 Metallic Facility Terminals (MFTs) or equivalent can be accessed with a test extender. Other central office equipment such as repeaters. amplifiers, pads, coils, etc, often have associated voice frequency jacks. Where no such equipment exists, the distributing frame terminations would be the logical test access point.

1.15 Testing at the distributing frame requires physically disconnecting and reconnecting the frame jumper wires, and extreme caution must be used to avoid interrupting other service.

1.16 Many of the test access points mentioned require the use of portable test equipment because of the physical location of the access point. Test access is usually much easier at a testboard or test position since test equipment, channel access jacks, and communication arrangements are all commonly located.

1.17 Other ways of accessing a channel for testing include remote access via the Switched Access Remote Test System (SARTS) and the Switched Maintenance Access System (SMAS). The SARTS is a centralized system capable of remotely accessing test access points associated with SMAS.

1.18 The SMAS test access points are placed to allow channel trouble sectionalization. Minimal placement is considered to be one access per building to ensure at least one access point per facility.

1.19 For portions of channels not accessible by SMAS, an access point should be placed at the last possible point where SMAS can be placed. This will allow the maximum utilization of SMAS and SARTS for sectionalizing channels for testing.

1.20 Additional guidelines for locating, assigning, and cross-connecting SMAS can be found in Section 667-000-001.

B. Test Levels

1.21 The levels used for testing channels vary according to the test method used and the type of channel. The following list gives the proper levels to be used when testing according to this section.

- For manual testing of voice channels, a level of 0 dBm0 is used. If the holding tone is required, use a −13 dBm0.
- For manual testing of voiceband data channels, a level of −13 dBm0 is used. Caution should be taken when testing voiceband data channels because the test levels given may be in decode level points (DLPs) [as found in the work order record and details (WORD)], which has already been converted to −13 dBm0. If this situation exists, the test tone signal would be applied at the level stated on the WORD or equivalent.
- When testing with SARTS, a level of −10 dBm0 is used.
- When testing with Centralized Automatic Reporting on Trunks (CAROT) systems, the test levels are either 0 dBm0 or −16 dBm0. In this case it is necessary to verify with the CAROT personnel which level they will be using.

These levels are all referenced to 0 dBm0.

C. Test Sets

1.22 Test sets used for testing these channels should meet the requirements of AT&T Technical Reference Publications (PUB) 41008, 41009, and 48502. In addition, test equipment must be capable of simulating the electrical characteristics as described in Section 313-120-101.

2. BENCHMARK TESTS

2.01 Benchmarks are measurements made on a loopback (Table A) or 1-way basis when the channel is known to meet all requirements. They are performed immediately following the completion of preservice tests. The results are recorded for later reference purposes.

2.02 For trouble testing, benchmark-type measurements should be made and compared to the benchmarks made during preservice testing. Admittedly, without specified limits (allowable deviation from these benchmark test results), it will be difficult to locate small troubles.

2.03 Section 313-120-100 lists limits and parameter tests for benchmark measurements. The benchmark tests are described in Section 313-110-100.

2.04 The ***benchmark measurements*** are recommended for the following tests.

- Continuity
- 1004-Hz Loss
- Three-Tone Slope
- Peak-to-average ratio (P/AR).

3. INTRAOFFICE TEST PROCEDURES

A. Continuity Test Procedure

3.01 The most convenient way of testing continuity through the office is to use a tone source and an earphone, handset, and speaker or equivalent device to monitor the channel. In testing switched channels, a dial-up milliwatt number can often be used as the tone source. Flowchart 1 gives a brief outline of the required steps for testing a channel at a central office and can be used as a guide. The sections referenced in the flowchart give tests for meeting the requirements.

> ***Note:*** The continuity test is used to check for an uninterrupted connection between the two farthest points in an office. This test does not give any assurance as to the proper installation or adjustment of equipment.

STEP	PROCEDURE
	***These procedures do not include instructions for setting up and operating the particular test sets. Detailed instructions for setting up test arrangements and operating the test equipment can be found in the sections covering procedures for testboards and test centers and the sections covering the test sets.***
1	Examine the circuit record to determine the following: (a) The type of signaling used (b) The test access points to be used (c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable (d) Transmission levels and impedance at the test access points

STEP	PROCEDURE
	(e) Any unique requirements for the particular channel.
2	Access the channel to be tested, and establish the proper signaling conditions, if applicable.
3	At the first transmission test access point in the office, apply a 1004-Hz tone at the correct level in reference to the transmission level point (TLP) shown on the circuit record and test levels in Part 1B.
4	Monitor the channel at the last test access point in the office (using an earphone, handset, and speaker, or equivalent). ***Requirement:*** Tone is heard.
5	If the tone is heard, have it interrupted or otherwise positively identified as the correct tone. ***Requirement:*** Tone is positively identified.
6	If the requirements for Steps 4 and 5 are met, go to Step 8. If the requirement for either Step 4 or 5 is not met, isolate the trouble by monitoring at each test access point between the first test access point and the last. ***Requirement:*** Trouble is isolated to connection or equipment unit.
7	Have the defective connection or equipment repaired or replaced. Repeat Steps 2 through 5.
8	Repeat Steps 2 through 5 for the opposite direction of transmission where applicable.
9	For multipoint channels, repeat Steps 1 through 8 for each leg of the channel going through the office.

B. 1004-Hz Loss Test Procedure

3.02 The 1004-Hz loss measurement is typically made with a suitable transmission measuring set (TMS). If a 1004-Hz tone is on the channel from the previously made continuity test, go directly into the loss test procedures. The loss tests on a switched channel can be made using the dial-up tone generator and the receiving portion of a TMS.

STEP	PROCEDURE

These procedures do not include instructions for setting up and operating the test equipment; neither do they include recommendations for test cords, etc. Detailed information can be found in sections covering procedures for performing tests at testboards or test centers and the sections covering the test sets.

STEP	PROCEDURE
1	If the transmission path is still established from previous test procedures, go to Step 5.
2	At the testboard or equivalent test access point, access the channel to be tested.
3	Provide the necessary supervisory signal to establish and hold the transmission path (ie, simulated off-hook).
4	Using a TMS oscillator, or equivalent, set it to transmit 1004-Hz tone at the correct level and impedance with reference to the TLP shown on the circuit record at the testboard or equivalent access point. (See Test Levels in Part 1B.)
5	Apply the 1004-Hz tone at the testboard (or equivalent) test access point transmitting toward the line facility.
6	Measure the tone at the transmit test access point of the line facility. ***Requirement:*** The correct level is received (see circuit records).
7	If the requirement for Step 6 is not met, correct level deviations by adjusting the appropriate amplifier or correcting the pad values.
8	If the channel is a 4-wire, test the other direction by removing the tone at the testboard and applying 1004 Hz at the line facility receive test access point at the correct level.
9	Measure the tone at the testboard (or equivalent) receive test access point. ***Requirement:*** Same as Step 6.
10	If requirement in Step 9 is not met, adjust amplifiers or correct pad values in the channel to meet the requirement.
11	For multipoint channels, repeat Steps 1 through 10 for each leg of the channel under test.

4. INTERLOCATION TEST PROCEDURES

4.01 The procedures used for interlocation testing are similar to the procedures for intraoffice testing. These test procedures are presented in the recommended order of testing, and this order should be followed. All tests are not required for all channels, and Sections 313-120-100 and 313-120-101 should be consulted for the required tests and their associated limits. Flowchart 1 gives a brief outline of the required steps for testing a channel at a central office and can be used as a guide. The sections referenced in the flowchart give tests for meeting requirements.

A. Continuity Test Procedures

4.02 The most convenient way to test the continuity of a channel is by applying 1004 Hz tone,

from the office milliwatt supply, at one end of the channel or channel segment to be tested and monitoring it at an extreme test access point with an earphone, headset, and speaker, or equivalent. The test tone may be supplied from a tone generator, oscillator, or transmit portion of a TMS. Switched channels may get a test tone from a dial-up milliwatt number or the office milliwatt tone generator supply.

Note: The continuity test is used to check for an uninterrupted connection between two points. It does not give any indication as to whether equipment has been installed or adjusted properly.

STEP	PROCEDURE

These procedures do not include instructions for setting up and operating test equipment such as the tone generator, etc. Neither do they include recommended test cords. This information can be found in the sections covering procedures for performing these tests at a testboard or test center.

1 Examine the circuit record to determine the following:

(a) The type of signaling used

(b) The test access points to be used

(c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable

(d) The transmission levels and impedance at the test access points

(e) Any unique requirements for the particular channel.

2 Access the channel to be tested, and establish the proper signaling conditions, if applicable.

3 At the first transmit test access point in the office, apply 1004-Hz tone at the correct level with reference to the TLP shown on the circuit record. (See Test Levels in Part 1B.)

4 If the distant end has performed continuity tests at that end, have the test person at the distant end monitor the channel at the testboard access point (or equivalent). If the distant end has not performed continuity tests, have the test person monitor at the test access point farthest away from where the tone enters the location.

Requirement: Tone is heard.

5 If the tone is heard, have it interrupted at the originating test point to verify that the correct tone is being heard.

Requirement: Tone interruption is heard.

6 If requirement for Step 4 or 5 is not met, have the distant end determine if the trouble is at that end by monitoring the tone at the receive test access point of the facility.

Requirement: Tone is heard.

STEP	PROCEDURE
7	If the requirement in Step 6 is not met, verify that tone is leaving on the facility toward the distant end.
8	If the tone is leaving your office, have the facility trouble cleared.
9	If the requirement of Step 6 is met, have the distant end isolate trouble by monitoring tone at each test access point between the line facility and the testboard or equivalent test access point. ***Requirement:*** Trouble is isolated to a connection or equipment unit.
10	Have defective connection reconnected or equipment repaired or replaced. Repeat Steps 1 through 5.
11	Have the distant end apply 1004-Hz tone at the correct level with reference to the TLP shown on circuit records at the testboard or equivalent access point.
12	Monitor the tone at the testboard or at equivalent mid central office test access point. ***Requirement:*** Tone is heard.
13	If the tone is heard, have it interrupted to verify that the correct tone is heard. ***Requirement:*** Tone interruption is verified.
14	If the tone is not heard, monitor it at the facility receive test access point. ***Requirement:*** Tone is heard.
15	If requirement in Step 14 is met, isolate the trouble by monitoring at each test access point between the facility and the testboard (or equivalent test position).
16	Clear trouble and repeat Steps 11 through 13.
17	If the requirement for Step 14 is not met, have distant end verify that tone is leaving that location at the facility input test access point. ***Requirement:*** Tone is heard by distant end.
18	If the requirement for Step 17 is not met, have distant end isolate and clear trouble at that location.
19	If the requirement for Step 17 is met, have the facility trouble cleared and repeat Steps 11 through 13.

B. Signaling Test Procedures

4.03 The following procedures cover signaling tests between the central office and the far end of the channel. The far end may be another central office or customer premises. Signaling test requirements and limits are shown in Section 313-120-101.

4.04 Many types of signaling are in use on voice channels today. To test the signaling on a channel, several things must be considered, including the type of signaling, at which end of the channel the test is being conducted, and the direction of signaling that is being tested.

4.05 As an example, a simple loop-start foreign exchange circuit provides −48 Vdc and ground, ringing current, various tones from the originating end, on-hook/off-hook, and pulsing from the terminating end. The conditions that must be applied and detected are therefore different, depending on the direction of signaling being tested. At this time there is no commonly available test set that performs all the required functions for universal signaling testing; however, a variety of existing general purpose and specialized test instruments can be used. (See Section 313-120-101 for detailed circuitry to be used in specialized test instruments for test access and customer premises equipment signal/supervision simulation.)

4.06 The testing objective is to assure that the channel meets the limits and operates satisfactorily. Meeting the limits for all of the applicable signaling tests will verify that the channel operates properly. However, for simple channels [eg, those consisting of bare cable or having only loop signaling extenders/loop signaling repeaters (LSE/LSR) or equivalent], loop current and dial tone tests will suffice for preservice tests. The remaining tests will be performed only as necessary for trouble reports. Complex channels (those with other signaling enhancement equipment in addition to LSE/LSR) will require that all the preservice signaling tests be made.

> ***Note:*** Pulsing tests are excluded except on trouble basis for transmission grades that are classified as line channels. (See Section 313-120-100 for transmission grades.)

4.07 When the channel does not meet the specified limits or does not function properly, the channel must be sectionalized to the specific signaling system or equipment causing the problem. Testing between locations is accomplished by means of SMAS (either local or remote), testboard type jacks, or other access points as available. Once sectionalized, the defective signaling system or equipment will be tested and readjusted in accordance with the applicable Bell System Practices.

STEP	PROCEDURE

These procedures do not include instructions for setting up and operating the particular test sets. Detailed instructions for setting up test arrangements and operating the test equipment can be found in sections covering procedures for testboards and test centers and the sections covering the test sets.

Note: Some tests will require coordination with the far end. If this is the case, arrangements must be made to ensure that the tester at the far end is available and has the proper test equipment available.

1 Determine the type of signaling used on the channel and the direction of signaling to be tested from the circuit records.

2 Determine the required tests per Section 313-120-101 or the circuit records.

3 Connect the test set(s) to the channel at the test access point.

STEP	PROCEDURE
4	Perform the required tests to verify that the requirements have been met per Section 313-120-101 or in accordance with the applicable practices. Any requirements that are not met must be corrected, and the applicable tests repeated.

C. 1004-Hz Loss Test Procedure

4.08 The 1004-Hz measurement is made with a TMS. Nonswitched channels require a tone source and TMS at both ends of the channel or segment to provide a tone and to measure it in both directions. A switched channel can be tested by using a dial-up tone generator and the receive portion of the TMS.

STEP	PROCEDURE
	 ***These procedures do not include instructions for setting up and operating the test equipment. Neither do they include recommendations for test cords, etc. Detailed information can be found in sections covering procedures for performing tests at testboards or test centers and the sections covering the test sets.***
1	Examine the circuit record to determine the following: (a) The type of signaling used (b) The test access points to be used (c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable (d) The transmission levels and impedance at the test access points (e) Any unique requirements for the particular channel.
2	Access the channel to be tested at the testboard or equivalent test access point.
3	Provide the proper supervisory signal (ie, simulated off-hook) to hold the transmission path for testing, if applicable.
4	At the testboard or equivalent test access point on the channel transmitting toward the distant location, apply 1004-Hz tone at the correct level with reference to the TLP shown on the circuit record for that test point. The 1004-Hz tone may be derived from the transmit portion of the TMS, a separate oscillator, or the office milliwatt supply. (See Test Levels in Part 1B.)
5	Request the distant location to measure the tone.

STEP	PROCEDURE
	Requirement: The measured level shall be correct. Deviation limits are included in Section 313-120-100. If the requirements are met, go to Step 9.
6	If the deviation exceeds the limits, sectionalize the cause of the deviation by making measurements at intermediate access points between the tone origin and the distant location test access point.
7	Have the necessary corrective action taken to bring the level within the required limit.
	Note: The corrective action may require realignment of carrier facilities, MFT equipment, pad adjustments or changes, etc.
8	After corrective action is taken, repeat Steps 2 through 5.
9	At the distant location test access point, have 1004 Hz applied in the opposite direction at the correct level.
10	With the TMS measure the tone at the test access point.
	Requirement: The measurement shall be correct with reference to the TLP shown on the circuit record at that point. (See Section 313-120-100 for deviation limits.) If the requirements are met, go to Step 14.
11	If the deviation in Step 10 exceeds the limit, isolate the cause of the deviation by having the tone measured at intermediate points between the distant end and the point where the measurement was made.
12	Have the necessary corrective action taken to clear the cause of the transmission measurement deviation.
13	After the corrective action is complete, repeat Steps 9 and 10.
14	Record and retain the benchmark test measurement (Section 313-110-100) results on all channels.

D. Three-Tone Slope Test Procedures

4.09 The 3-tone slope test is made for the purpose of comparing levels of a frequency at the lower end of the voiceband (404 Hz) and a frequency at the higher end of the voiceband (2804 Hz) with the test tone at 1004 Hz, which is in the middle of the voiceband. The slope is the difference between 1004 Hz and the higher and lower frequencies.

4.10 Measurements for nonswitched channels are made using a tone transmitter (oscillator) at one end of the channel and the TMS receiver at the other end. Switched channels may use a dial-up step generator for the tone source and a TMS receiver to measure the tones.

4.11 Refer to Section 313-120-100 for required 3-tone slope limits, and note these on your test record.

STEP	PROCEDURE

These procedures do not include instructions for setting up and operating the oscillator and TMS receiver or selecting the proper test cords, etc. Detailed steps for setting up the test equipment can be found in sections covering procedures for testboards and test centers and the sections covering the test sets.

1 Examine the circuit record to determine the following:

(a) The type of signaling used

(b) The test access points to be used

(c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable

(d) The transmission levels and impedance at the test access points

(e) Any unique requirements for the particular channel.

2 Access the channel at a testboard or equivalent test access point.

3 Provide appropriate supervisory signal to hold the channel for test (ie, simulated off-hook), if applicable.

4 Connect a tone transmitter (oscillator) to the channel transmit test jack.

5 Request distant location to connect TMS receiver to the channel receive test access point.

6 Transmit 1004-Hz tone at the correct level with reference to the TLP shown on the circuit records. (See Test Levels in Part 1B.)

7 Request distant end to measure and record reading.

8 Transmit 404 Hz and then 2804 Hz at the same level as the 1004-Hz tone.

9 Have distant end measure and record the level of each tone.

Requirement: The difference between the 1004 Hz and 404 Hz and between 1004 Hz and 2804 Hz measurements shall be within the required limits in Section 313-120-100. If the requirements are met, go to Step 11.

10 If requirement in Step 9 is not met, sectionalize the trouble by repeating Steps 4 through 9 for each section or segment of the channel.

11 Record and retain the benchmark test measurement (Section 313-110-100) results on all channels.

E. Noise Test Procedure

4.12 The objective of the noise test is to determine whether noise exists on the channel above the acceptable levels. If the noise is excessive, the tests are used to isolate the noise to a particular part of the channel.

Note: Noise measurements should be made during network busy hours to represent the worst noise conditions of the channel.

4.13 Noise measurements are made with a noise measuring set equipped with either a C-message (voice channel) or C-Notched (data channels) filter. C-Notched measurements require a holding tone be placed on the channel while the measurement is being made. Noise measurements can be made with the channel looped back or may be made at each end of the channel.

4.14 Refer to Section 313-120-100 for the explanation of the requirements and limits for noise measurements. Record these requirements for use when performing the tests.

Note: The voice frequency cable noise is specified in dBrnC; it should not be converted to dBrnC0. Multiple cable facilities connected in tandem count as one facility. It should be corrected by the value of any gain or loss in equipment between the cable and test set. For this situation, the amount of gain should be subtracted and the amount of loss should be added to the measurement.

STEP	PROCEDURE

These procedures do not include instructions for setting up and operating the noise measuring set. Detailed instructions for setting up test arrangements can be found in the sections covering the procedures for testboards and test centers and the sections covering the test sets.

1 Examine the circuit record to determine the following:

(a) The type of signaling used

(b) The test access points to be used

(c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable

(d) The transmission levels and impedance at the test access points

(e) Any unique requirements for the particular channel.

2 Access the channel to be tested at the testboard or equivalent test access point.

3 Provide the appropriate supervisory signal to hold the channel for testing (ie, simulated off-hook), if applicable.

4 Request the distant location to terminate the channel in 600 ohms (or apply a holding tone for data channel).

5 Connect a noise measuring set to the receive test access point and measure noise.

STEP	PROCEDURE
	Requirement: The noise measurement shall meet the required limits in Section 313-120-100. If the requirements are met, go to Step 9.
6	If requirement in Step 5 is not met, identify the character of the noise by listening to the channel. (See Section 313-110-100 for common causes of the identified noise.)
7	Sectionalize the noise by terminating the voice channel (or applying data channel holding tone) at various intermediate test points.
8	After the noise has been sectionalized and cleared, repeat Step 5.
9	Have the distant end connect a noise set to the receive test access point of the channel, and measure the noise in the opposite direction.
	Requirement: Same as Step 5. If the requirements are met, go to Step 11.
10	If the requirement in Step 9 is not met, repeat Steps 7 and 8 in the opposite direction.
11	Record and maintain all test measurement results.

F. Impedance Balance Procedure

4.15 The impedance balance measurements are required whenever 4-wire (4W) to 2-wire (2W) conversions are in the transmission path. The measurement indicates the presence of echo caused by an impedance mismatch or discontinuity in the channel, causing a part of the signal energy to travel back toward its source.

4.16 Impedance balance measurements are made with a return loss measuring set (RLMS) capable of measuring echo return loss (ERL) and singing return loss (SRL).

4.17 There are several combinations of channels that utilize 2W to 4W conversions in the transmission path. Figures 1 through 3 illustrate some of the most common arrangements with 2W to 4W conversions.

4.18 The impedance balance measurements are made in the 4-wire to 2-wire direction from either a 4-wire or 2-wire point on the channel.

4.19 Before starting the test, examine the circuit record to determine the TLP at the test access points and subtract the transmit level from the receive level. The resulting number is added to the impedance balance requirement in Section 313-120-100, which gives the limit for the actual reading on the RLMS. As an example, if the transmit level at the test access point is −16 dBm and the receive level is +7 dBm, subtracting −16 from +7 gives +23, ie, 7 − (−16) = 23. When this number is added to the limit in Section 313-120-100, the sum is the minimum reading required on the RLMS.

STEP	PROCEDURE

These procedures do not include the instructions for operating the RLMS; nor do they include details for setting up the equipment for test. These instructions can be found in the sections covering procedures for testboards and test centers and the sections covering the test sets.

1 Examine the circuit record to determine the following:

(a) The type of signaling used

(b) The test access points to be used

(c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable

(d) The transmission levels and impedance at the test access points

(e) Any unique requirements for the particular channel.

2 Access the channel at the testboard or equivalent test access point.

3 Provide the appropriate supervisory signal to hold the channel for testing (ie, simulated off-hook), if applicable.

4 Connect an RLMS to the channel at the test access point (Fig. 2).

5 Set the trans-hybrid loss to 0 on the RLMS.

6 Have the far end place a 600 ohm, 2.16 microfarad termination at the far end of the 2-wire section of the channel.

7 Make an ERL measurement.

Requirement: The ERL measurement shall be within the required limits per Section 313-120-100.

8 Make SRL-high and SRL-low measurements.

Note: The lowest of the two measurements is considered the SRL.

Requirement: The SRL measurement shall be within the required limits in Section 313-120-100. If the requirements are met, go to Step 10.

9 If the requirements for Steps 8 and 9 are not met, adjust the network build-out capacitance or the precision balancing network of the 4W hybrid involved.

10 Repeat the impedance balance test for each 4-wire to 2-wire conversion on the channel.

11 Record and maintain all test measurement results for future maintenance reference.

G. Peak-to-Average Ratio Test Procedures

4.20 A P/AR transmitter and receiver are required at each end of the channel to be tested. Attention must be given to the model of test set being used. The versions of the Western Electric 27 series sets earlier than 27F are incompatible with later versions and are susceptible to errors caused by frequency shift and phase distortion on the line.

4.21 Refer to Section 313-120-100 for measurement requirements before starting the test. Record requirements on test sheet.

STEP	PROCEDURE

These instructions do not include instructions for setting up the 27F or equivalent test equipment for performing the P/AR tests. Detailed procedures can be found in sections which provide procedures for testboards and test centers and the sections covering the test sets.

1 Examine the circuit record to determine the following:

(a) The type of signaling used

(b) The test access points to be used

(c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable

(d) The transmission levels and impedance at the test access points

(e) Any unique requirements for the particular channel.

2 Access the channel to be tested at the testboard or equivalent test access point.

3 Provide the appropriate supervisory signal to hold the channel for test (ie, simulated off-hook), if applicable.

4 Connect the P/AR set to the channel and request distant end to do the same.

5 Transmit P/AR test signal and request distant end to measure it.

Requirement: The measurement of the P/AR test signal shall be within the required limits, per Section 313-120-100.

6 Have distant end apply P/AR signal and measure it at testboard or equivalent test access point.

STEP	PROCEDURE
	Requirement: Same as Step 5. If the requirements are met, go to Step 8.
7	If requirement for Step 5 or 6 is not met, perform return loss, envelope delay, or attenuation distortion tests to determine cause of trouble.
8	Record and retain the benchmark test measurement (Section 313-110-100) results on all channels.

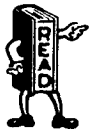
H. Attenuation Distortion Test Procedures

4.22 Attenuation distortion tests are performed on channels with "C" conditioning. The tests are similar to the 3-tone slope tests, except this test procedure compares all frequencies from 300 to 3200 Hz with 1004 Hz. The comparisons are made by measuring the frequencies as shown in Section 313-120-100.

4.23 When testing channels with 2600 Hz single frequency signaling, measurements are made at 2504 and 2704 Hz and interpolated to determine the 2604 Hz measurement.

4.24 A TMS is required at each end for these tests. Refer to Section 313-120-100 for requirements and limits, and record them for reference in the test procedures.

Note: The measurements are not valid if taken from the attenuation meter of an envelope delay test set during an envelope delay distortion test.

STEP	PROCEDURE
	***These procedures do not include instructions for setting up and operating the TMS for performing attenuation distortion tests. Detailed instructions can be found in the sections covering the test procedures for the testboard or test center and the sections covering the test sets.***
1	Examine the circuit record to determine the following: (a) The type of signaling used (b) The test access points to be used (c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable (d) The transmission levels and impedance at the test access points (e) Any unique requirements for the particular channel.
2	Access the channel to be tested at the testboard or equivalent test access point.

STEP	PROCEDURE
3	Provide the appropriate supervisory signal to hold the channel for testing (ie, simulated off-hook), if applicable.
4	Connect signal source (oscillator) to the channel transmit test access point.
5	Request distant end to connect TMS.
6	Transmit each of the frequencies shown in Section 313-120-100 at the correct level with reference to the TLP shown on the circuit record. (See Test Levels in Part 1B.)
7	Request distant end to measure and record each frequency level measurement.
8	Compare level measurements of each frequency in Step 7 with measured level of 1004 Hz (2204 Hz for T1 conditioned channels or TA transmission grade). ***Requirement:*** The attenuation distortion measurements shall be within the required limits, per Section 313-120-100.
9	Have distant end transmit frequencies per Section 313-120-100 at the correct levels with reference to the TLP shown on the circuit record.
10	Measure and record each frequency level.
11	Compare measurements of each frequency with the measured level of 1004 Hz (2204 Hz for T1 conditioned channels or TA transmission grade). ***Requirement:*** Same as Step 8. If the requirements are met, go to Step 15.
12	If the requirements are not met, make attenuation distortion measurements on each facility segment.
13	If facilities meet required limits, equalization is required on the channel. Refer to the channel designer for correction.
14	After equalization is added, repeat Steps 2 through 13.
15	Record and maintain all test measurement results.

I. Envelope Delay Distortion Test Procedures

4.25 The envelope delay distortion measurement is made to determine the difference between the delay at any frequency in the voiceband and the delay at a reference frequency (generally 1804 Hz).

4.26 The envelope delay distortion measurements are made with a voiceband gain and delay set. The attenuation distortion limits must be met before the envelope delay distortion tests are made.

4.27 Refer to Section 313-120-100 for a description of envelope delay distortion requirements and

limits. Note the requirements before starting the tests.

STEP	PROCEDURE
	***These procedures do not include instructions for setting up and operating the test set for making envelope delay distortion tests. Detailed procedures can be found in the sections covering the procedures for testboards or test centers.***
1	Examine the circuit record to determine the following: (a) The type of signaling used (b) The test access points to be used (c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable (d) The transmission levels and impedance at the test access points (e) Any unique requirements for the particular channel.
2	Access the channel to be tested at the testboard or equivalent test access point.
3	Provide the proper supervisory signal to hold the channel operated (ie, simulated off-hook), if applicable.
4	Connect the envelope delay distortion test set to the transmit and receive test access points at both ends of the channel.
5	With the distant end in repeat mode and following the initial setup between the two test sets, transmit the required frequencies per Section 313-120-100 at the correct level in reference to the TLP shown on the circuit record. (See Test Levels in Part 1B.)
6	While sending the required frequencies, measure and record the delay received. ***Note:*** The delay received is, in effect, the delay received at the distant end, and it must be recorded as such.
7	Change the envelope delay distortion test set to repeat mode and have the distant end send the required frequencies per Section 313-120-100 at the correct level in reference to the TLP shown on the circuit record. (See Test Levels in Part 1B.)
8	While the distant end is sending the required frequencies, have the distant end record the delay received.
9	Compare the delay of each frequency measured relative to the 1804-Hz reference frequency with the parameter limit in Section 313-120-100.

STEP	PROCEDURE
	Requirement: The delay shall meet the envelope delay distortion limits in Section 313-120-100. If the requirements are met, go to Step 13.
10	If any limits are not met, test each facility segment to be sure facilities meet the delay distortion requirements. (See Section 313-120-100.)
11	If facilities meet the requirement individually, request the design engineer to add appropriate equalization to the channel.
12	Repeat Steps 2 through 11 after equalization has been added.
13	For multipoint channels, repeat Steps 2 through 12 for each leg of the channel.
14	Record and maintain all test measurement results for future maintenance reference.

J. Impulse Noise Procedures

4.28 Impulse noise is a short interval peak that is above the steady state noise level of a channel. The measurement of impulse noise is the determination of how many of these noise peaks exceed a certain level in a given time and is done with an impulse noise measuring set. The test is usually run for a period of 15 minutes, and the number of peaks exceeding the threshold setting of the impulse noise measuring set are compared with the limits given in Section 313-120-100.

4.29 Impulse noise measurements are made through a C-message filter. A holding tone is transmitted and notched out at the receiver.

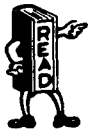
STEP	PROCEDURE
	***These procedures do not include instructions for setting up and operating the test sets. Detailed instructions for setting up test arrangements and operating the test equipment can be found in the sections covering procedures for testboards and test centers and the sections covering the test sets.***
1	Examine the circuit record to determine the following: (a) The type of signaling used (b) The test access points to be used (c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable (d) The transmission levels and impedance at the test access points

STEP	PROCEDURE
	(e) The presence of compandored facilities on the channel
	(f) Any unique requirements for the particular channel.
2	Access the channel to be tested, and establish the proper signaling conditions, if applicable.
3	Set the threshold of the impulse measuring set to the limit given in Section 313-120-100.
4	Have the far end terminate the channel, or apply a holding tone at the proper level for channels with compandored facilities. (See Test Levels in Part 1B.)
5	Set the test set timer to 15 minutes and start the test. (If the test set does not have a timer, start the test and manually stop it at the end of 15 minutes.)
6	At the completion of the test, compare the number of impulses shown on the test set to the limit in Section 313-120-100.
	Requirement: The limit should not be exceeded. If the requirements are met, go to Step 9.
7	If the reading is above the limit, sectionalize the trouble by taking impulse noise measurements on the channel segments and have the trouble corrected.
8	Once the trouble is corrected, repeat the impulse noise test to verify that the channel is now within limits.
9	Perform the impulse noise test in the opposite direction of transmission.
10	Record and maintain all test measurement results.

K. Phase Jitter Procedures

4.30 Phase jitter is the instantaneous shifting of the phase or zero crossings of a signal. It is measured in degrees using a phase jitter test set, and the limits are given in Section 313-120-100.

4.31 Since phase jitter tests are adversely affected by noise, C-notched noise measurements should always be made before phase jitter measurements. If the C-notched noise is not within the limits in Section 313-120-100, it must be brought within these limits before the phase jitter measurements are made.

STEP	PROCEDURE
	***These procedures do not include instructions for setting up and operating the test equipment. Detailed information can be found in sections covering procedures for performing tests at testboards or test centers and the sections covering the test sets.***
1	Examine the circuit record to determine the following: (a) The type of signaling used (b) The test access points to be used (c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable (d) The transmission levels and impedance at the test access points (e) Any unique requirements for the particular channel.
2	Access the channel to be tested and establish the proper signaling conditions, if applicable.
3	Have the far end apply a 1004-Hz tone at the proper level. (See Test Levels in Part 1B.)
4	Read the phase jitter and compare the reading with the limits in Section 313-120-100. ***Requirement:*** The reading is within the limits. If the requirements are met, go to Step 7.
5	If the reading is not within the limits, sectionalize the trouble by taking phase jitter measurements on the intermediate segments of the channel.
6	Have the facility problems corrected, and repeat the phase jitter tests to verify that the channel is now within limits.
7	Make phase jitter measurements in the opposite direction of transmission.
8	Record and maintain all test measurement results.

L. Intermodulation Distortion Procedures

4.32 Intermodulation distortion is the term used to describe channel nonlinearities. The method used to measure these nonlinearities involves sending four specific tones of equal level and detecting the resultant intermodulation products and displaying these products as levels, in dB, below the signal level.

STEP	PROCEDURE

These procedures do not include instructions for setting up and operating the test equipment. Detailed information can be found in sections covering procedures for performing tests at testboards or test centers and the sections covering the test sets.

1 Examine the circuit record to determine the following:

(a) The type of signaling used

(b) The test access points to be used

(c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable

(d) The transmission levels and impedance at the test access points

(e) Any unique requirements for the particular channel.

2 Access the channel to be tested and establish the proper signaling conditions, if applicable.

3 Connect the test set at the test access points chosen and have the far end do the same.

4 Adjust the transmit level of the test set to produce a total power output to the proper level at the test access point and send the tones ("A" tones are 857- and 863-Hz; "B" tones are 1372- and 1388-Hz). (See Test Levels in Part 1B.)

5 Repeat Step 4 at the far end.

6 Observe the second and third order readings for 30 to 60 seconds, and note their average readings.

7 Remove the "B" tones (high tones), and raise the level of the "A" tones (low tones) by 3 dB.

8 Repeat Step 7 at the far end.

9 Observe the resulting noise reading and go to Table B to determine the correction factor to be subtracted from the distortion measurements.

Requirement: The readings at both ends are within the limits in Section 313-120-100. If the requirements are met, go to Step 12.

10 If the readings are not within limits, sectionalize the trouble and have it repaired.

11 Once the trouble has been corrected, repeat the intermodulation distortion tests to verify proper operation.

12 Record and maintain all test measurement results.

M. Frequency Shift Procedures

4.33 The modulation/demodulation method used in some carrier systems can result in the shifting of all received voice frequencies either up or down from their transmitted frequencies.

4.34 To test for frequency shift, a tone source (oscillator) accurate to within ±0.000001 Hz and a frequency counter accurate to within ±0.01 Hz are required. The limits for frequency shift are given in Section 313-120-100.

STEP	PROCEDURE
	 ***These procedures do not include instructions for setting up and operating the test equipment. Detailed instructions for setting up test arrangements and operating the test equipment can be found in the sections covering procedures for testboards and test centers and the sections covering the test equipment.***
1	Examine the circuit record to determine the following: (a) The type of signaling used (b) The test access points to be used (c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable (d) The transmission levels and impedance at the test access points (e) Any unique requirements for the particular channel.
2	Access the channel to be tested and establish the proper signaling conditions, if applicable.
3	Connect the oscillator to the channel, and send a 1004-Hz tone at the proper level. (See Test Levels in Part 1B.)
4	Have the far end read the receive frequency. ***Requirement:*** The reading must be within the limits in Section 313-120-100.
5	Perform Steps 1 through 4 in the opposite direction of transmission. ***Requirement:*** Same as Step 4. If the requirements are met, go to Step 8.
6	If the readings are not within the limits, sectionalize the trouble by doing frequency shift tests at intermediate test points.
7	Have the facility trouble corrected and retest the channel for frequency shift.
8	Record and maintain all test measurement results.

N. Gain Hit, Phase Hit, and Dropout Procedures

4.35 Gain hits are sudden variations in signal level greater than 3 dB, phase hits are abrupt variations in signal phase greater than 20 degrees, and dropouts are decreases in level greater than 12 dB. Limits for these three parameters can be found in Section 313-120-100.

4.36 A test set capable of recording occurrences of these impairments must be used for these tests.

STEP	PROCEDURE
	***These procedures do not include instructions for setting up and operating the test sets. Detailed instructions for setting up test arrangements and operating the test sets can be found in the sections covering procedures for testboards and test centers and the sections covering the test sets.***
1	Examine the circuit record to determine the following: (a) The type of signaling used (b) The test access points to be used (c) The required supervisory signal to establish and hold the transmission path for testing (simulated off-hook condition), if applicable (d) The transmission levels and impedance at the test access points (e) Any unique requirements for the particular channel.
2	Access the channel to be tested and establish the proper signaling conditions, if applicable.
3	Connect the test sets to the receive test access point at each end of the channel.
4	At each end transmit a 1004-Hz tone at the proper level. (See Test Levels in Part 1B.)
5	Set the timers on the test sets for a 15 minute test duration and start the test.
6	At the completion of the timed interval, compare the accumulated readings at each end with the limits in Section 313-120-100. ***Requirement:*** The readings are within the limits. If the requirements are met, go to Step 9.
7	If the channel does not meet the limits, sectionalize the trouble by doing these tests at intermediate points.
8	Have the trouble corrected and retest the channel to verify that the trouble was cleared.
9	Record and maintain all test measurement results.

5. TROUBLE TESTING

5.01 During initial testing of a channel, problems will sometimes be encountered (ie, exceeding the immediate action limits of Section 313-120-100 or preservice limits of Section 313-120-101) that require additional testing to determine the cause of the problem. This requires a methodical and logical approach and is best done by persons with a thorough knowledge of the components involved in the channel.

5.02 The type of transmission tests and the order in which they are done varies with the type of problem encountered. Section 313-110-100 gives information about common causes of various impairments and can be used as a guide in selecting the proper tests and where they should be made.

5.03 Some signaling troubles can also be caused by the transmission impairments. Once ascertained that the proper transmission has been established, signaling equipment components, as required, should be verified. Section 313-110-101 provides some information about signaling, but appropriate circuit equipment practices should also be consulted.

5.04 Flowchart 1 gives a brief outline of the required steps for testing a channel at a central office and can be used as a guide. The sections referenced in the flowchart give tests for meeting requirements.

6. GLOSSARY OF TERMS

6.01 The following abbreviations (terms) are used in this section.

TERM	DEFINITION
CAROT	Centralized automatic reporting on trunks
CO	Central office
CP	Customer premises
CPE	Customer premises equipment
DLP	Decode level point
ERL	Echo return loss
LSE	Loop signaling extenders
LSR	Loop signaling repeaters
MFT	Metallic facility terminal
NET	Network of hybrid
NI	Network interface
P/AR	Peak-to-average ratio
RLMS	Return loss measuring set
SARTS	Switched Access Remote Test System
SF	Single frequency
SMAS	Switched Maintenance Access System
SRL	Singing return loss
TLP	Transmission level point
TMS	Transmission measuring set
WORD	Work order record and details
2W	2-wire
4W	4-wire.

TABLE A

TYPICAL LOOPBACK OPERATION

MODEL	ACTUATING SIGNAL	RELEASE SIGNAL
806A1	–48 Volts dc and Ground	Removal of –48 Volts and Ground
806A2 (Without A Option)	2800 Hz* (Continuously Applied)	Removal of 2800-Hz* Signal
806A2 (With A Option)	5- to 10-Second Burst of 2300-Hz Tone*	5- to 10-Second Burst of 2800-Hz Tone*
806A3 (Without A Option)	2400-Hz* (Continuously Applied)	Removal of 2400-Hz* Signal
806A3 (With A Option)	5- to 10-Second Burst 2400-Hz Tone*	5- to 10-Second Burst 2400-Hz Tone*
828A-L1	–48 Volts dc and Ground	Removal of –48 Volts and Ground
828A-L1 With 44A1 Data United Installed	5-Second Burst of 2713-Hz Tone* From A406 Generator	5-Second Burst of 2713-Hz Tone*
829A-L1 Data United Installed	5-Second Bursts of 2713-Hz Tone* From A406 Generator	5-Second Burst of 2713-Hz Tone*
229B Key Telephone Unit	–48 Volts dc and Ground	Removal of –48 Volts and Ground
6017 Key	Operation of Key	Release of Key

* All tones are applied 10 dB below transmission level point. (See Test Levels in Part 1B.)

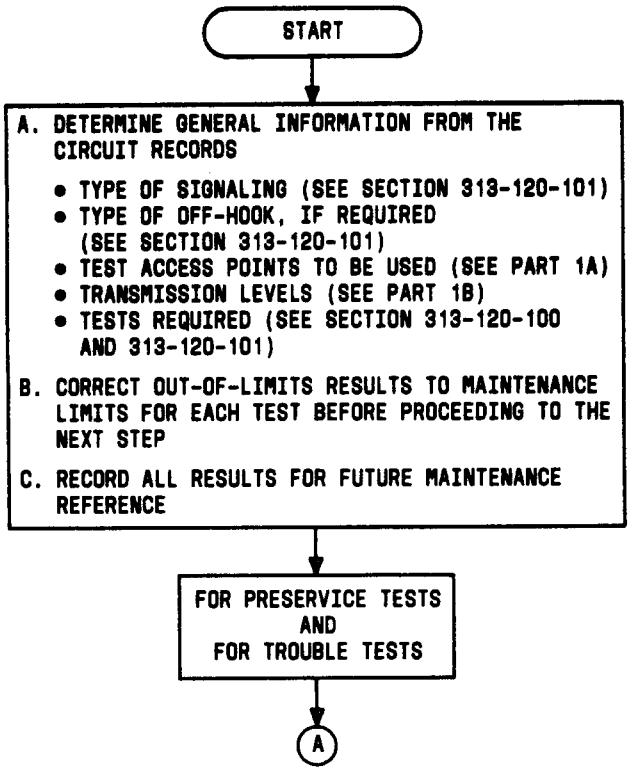
TABLE B

INTERMODULATION DISTORTION NOISE CORRECTIONS (NOTE)

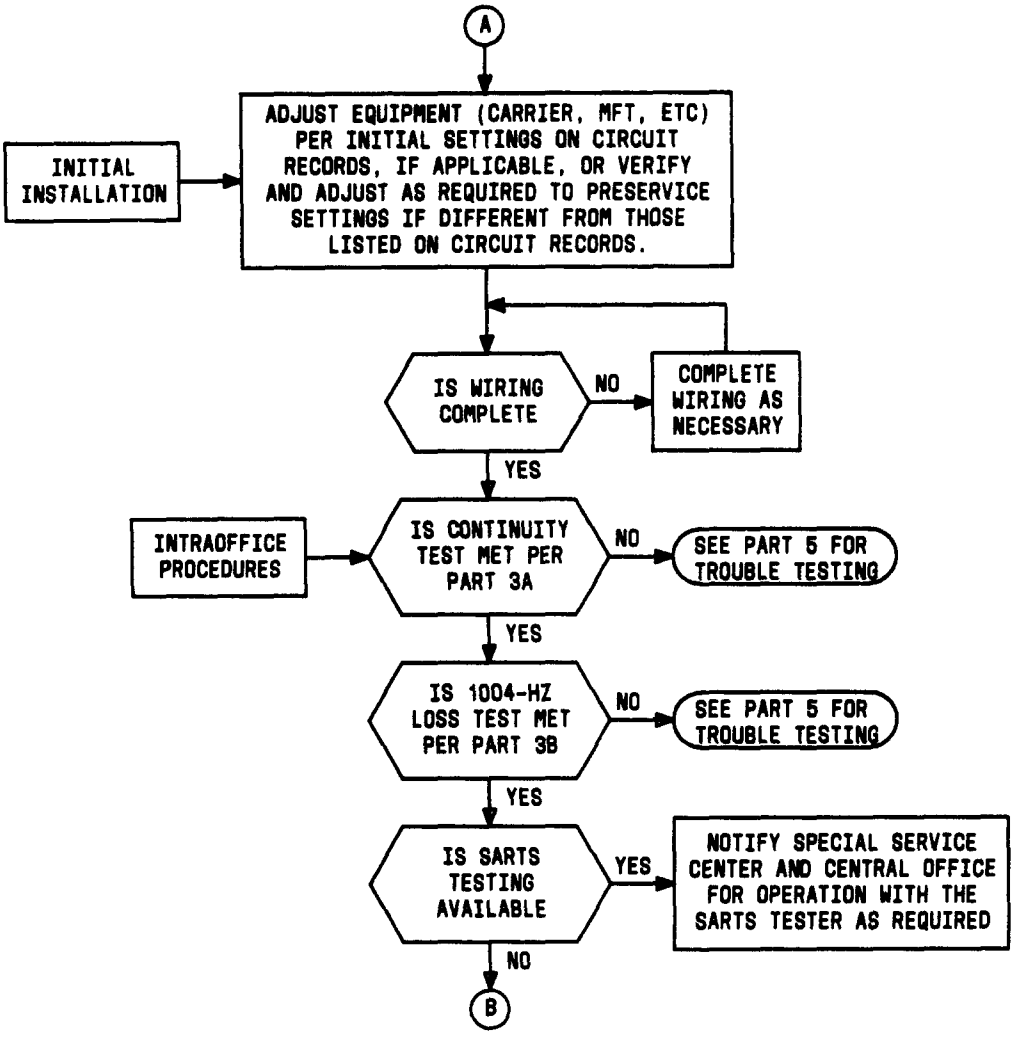
SIGNAL-TO-NOISE MEASUREMENT IN DB ABOVE SIGNAL-TO-DISTORTION MEASUREMENT	DB TO BE SUBTRACTED FROM SIGNAL-TO-DISTORTION MEASUREMENT
0	*
1	7
2	4
3	3
4-5	2
6-8	1
over 8	0

Note: Correction factor is to be made to second and third order readings. Measurements are to correct for presence of noise.

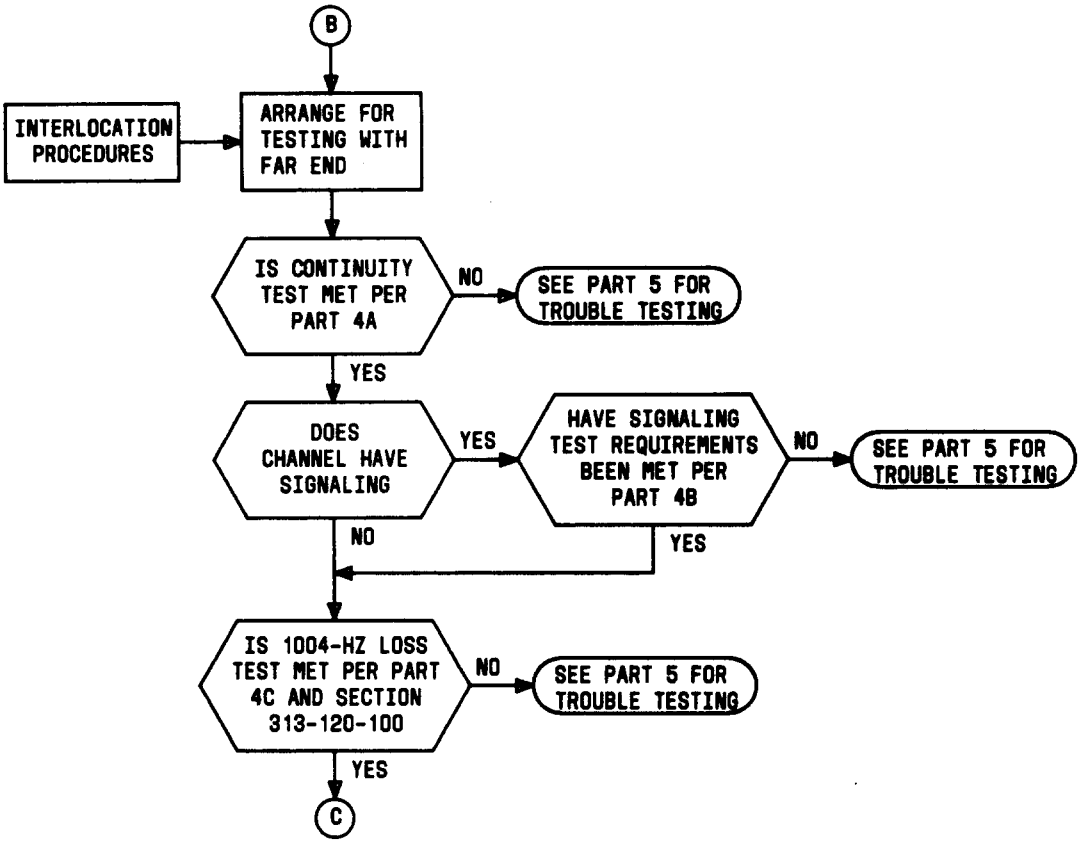
* Zero difference indicates that distortion level is buried in noise. This can be interpreted as either extremely low distortion or extremely high noise and should be further investigated.



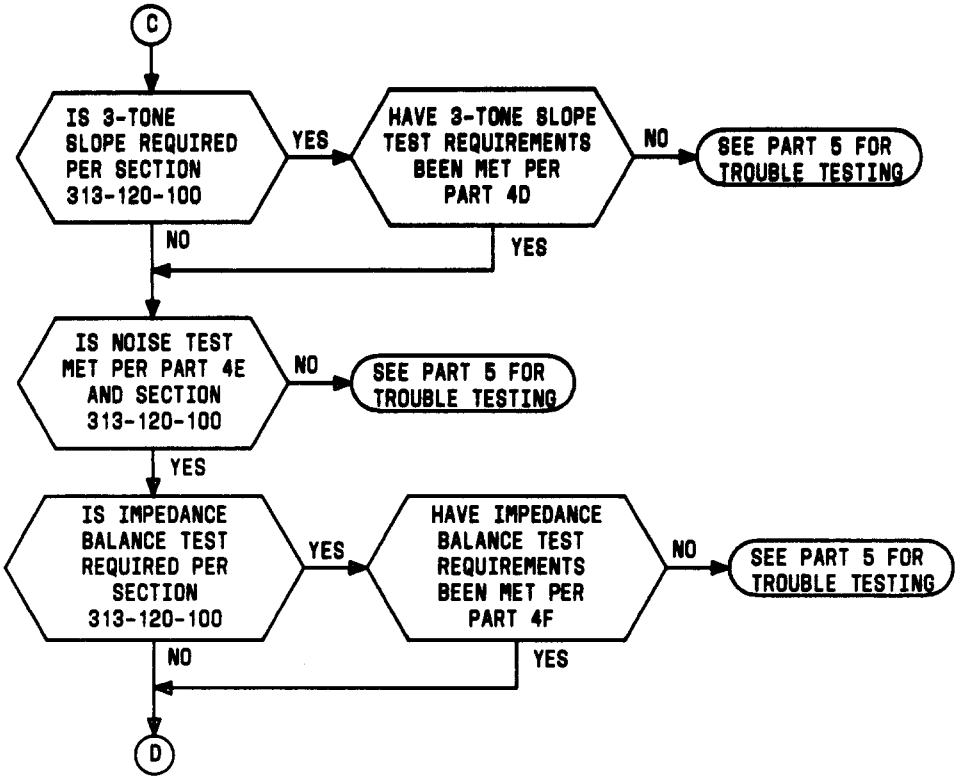
Flowchart 1—Required Preservice and Trouble Tests (Sheet 1 of 7)



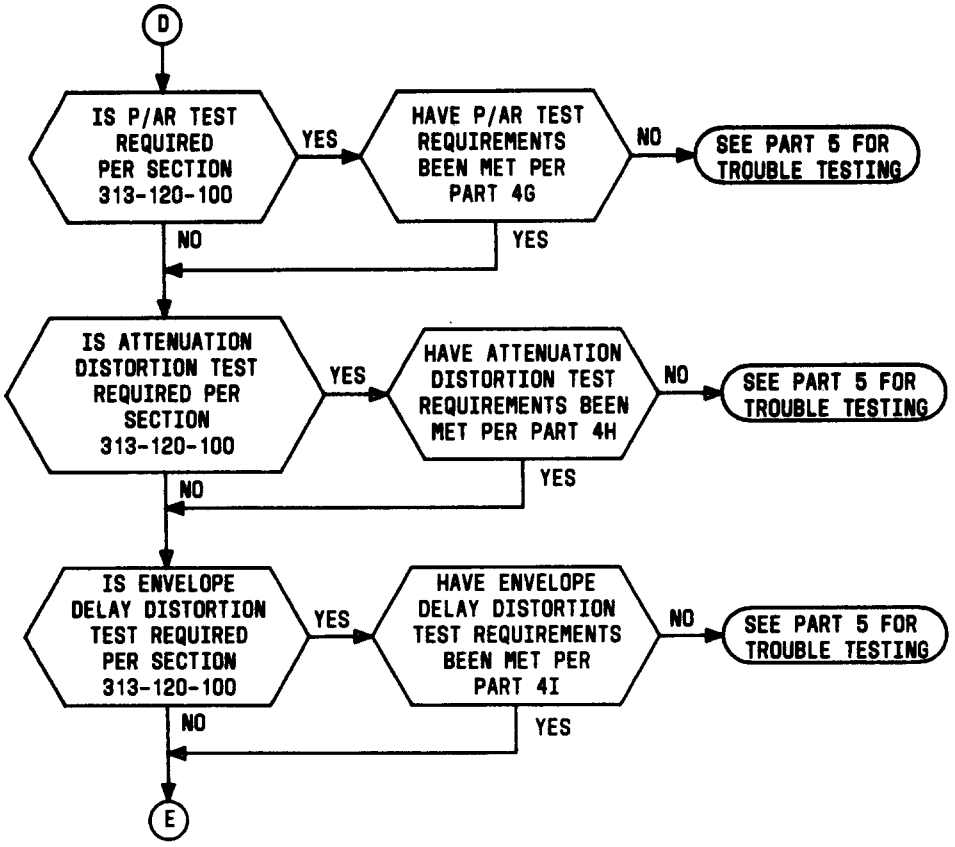
Flowchart 1—Required Preservice and Trouble Tests (Sheet 2 of 7)



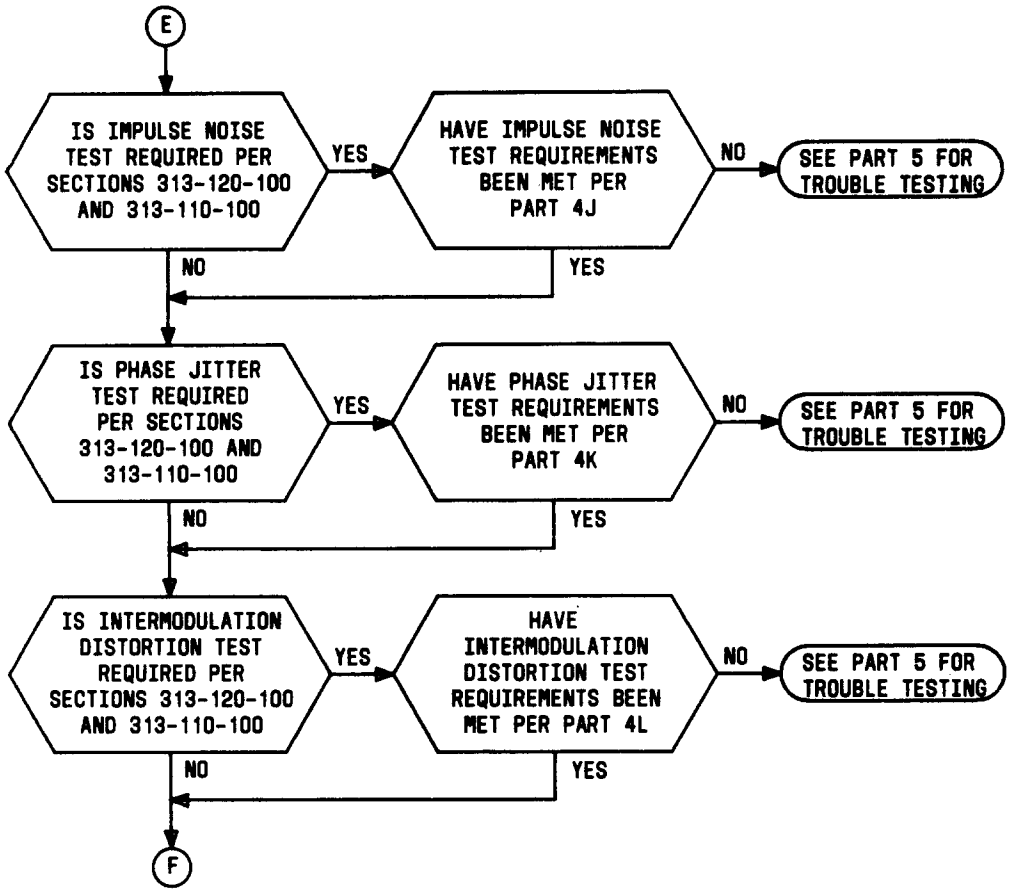
Flowchart 1—Required Preservice and Trouble Tests (Sheet 3 of 7)



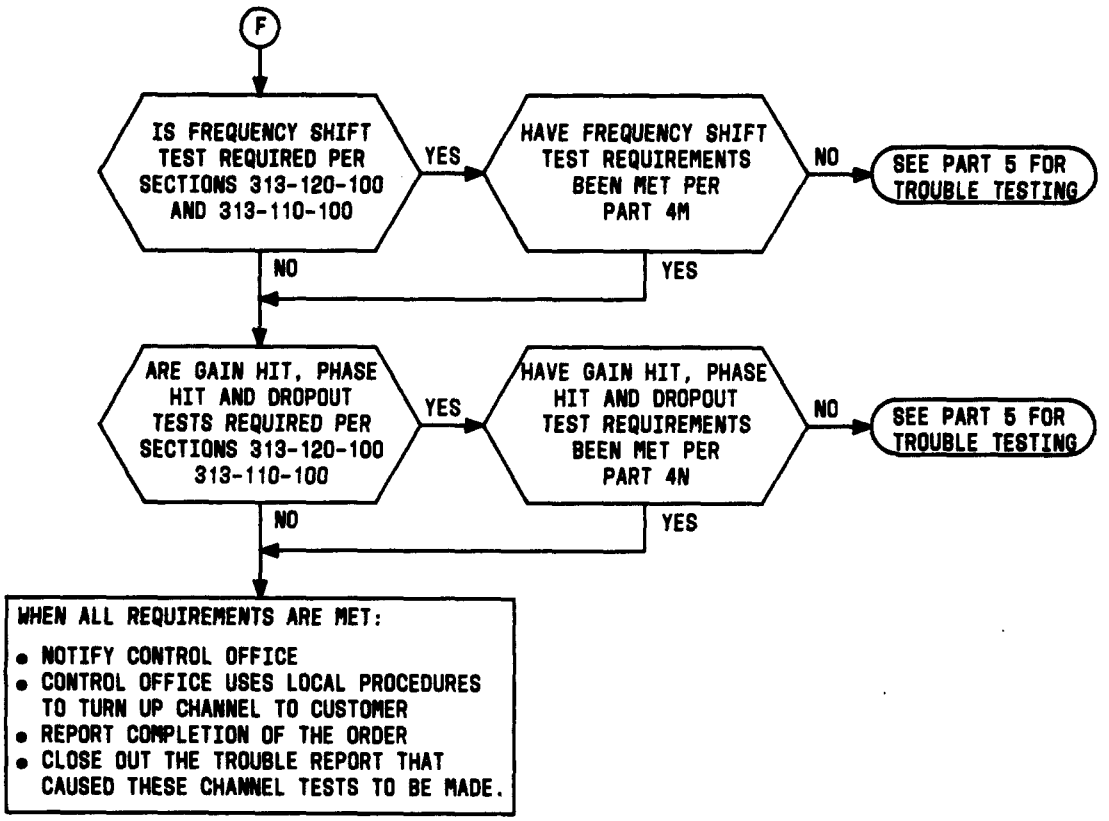
Flowchart 1—Required Preservice and Trouble Tests (Sheet 4 of 7)



Flowchart 1—Required Preservice and Trouble Tests (Sheet 5 of 7)



Flowchart 1—Required Preservice and Trouble Tests (Sheet 6 of 7)



Flowchart 1—Required Preservice and Trouble Tests (Sheet 7 of 7)

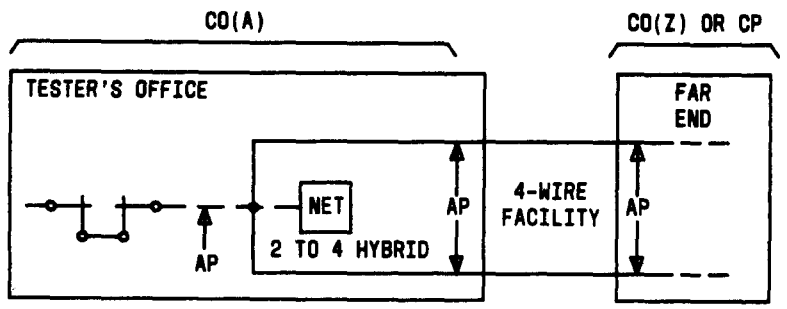
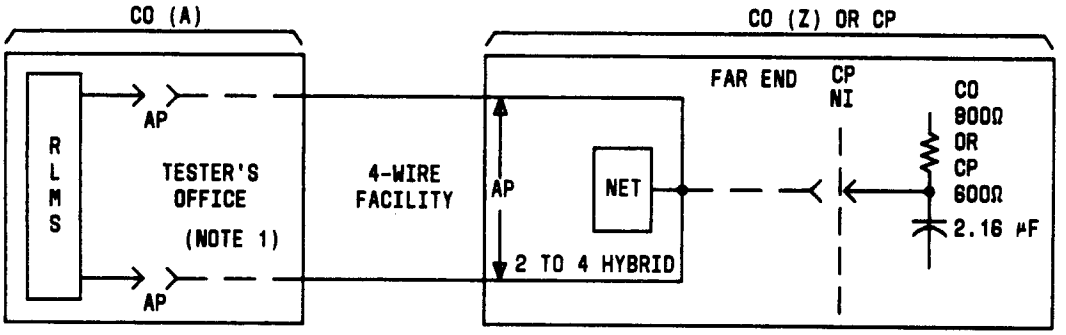


Fig. 1—2-Wire to 4-Wire Conversion at Tester's Office



NOTE:
1. PROVIDE 4-WIRE TEST HYBRID ON 2-WIRE.

Fig. 2—2-Wire to 4-Wire Conversion at Far End

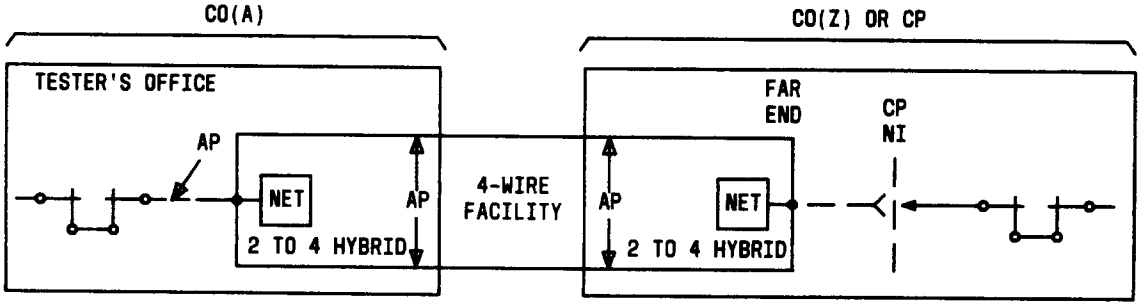


Fig. 3—2-Wire to 4-Wire Conversion at Both Ends