PROTECTIVE RELAYING CHANNEL

INITIAL LINEUP AND MAINTENANCE TEST REQUIREMENTS

CONTENTS PAGE

1. GENERAL

1.01 ▶This section describes the initial, routine, and maintenance test requirements for the protective relaying (PR) channel, which is a voice grade private line channel specifically used in power industry audio tone PR applications. The PR channel provides improved reliability for PR systems during power fault intervals over that obtainable from other voice bandwidth channels. ***If this channel will not be used for audio tone protective relaying applications, do not use the channel design specified in this section; instead, use the design specified in Section 880-420-100.***◀

1.02 This section is reissued to include a discussion of:

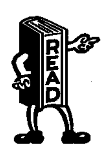
(a) The optional 8 dB PR channel

(b) SARTS and SMAS test access points

(c) Impulse noise as a transmission parameter.

1.03 This section affects Equipment Test Lists.

1.04 Fault conditions of high-voltage transmission lines may be caused in various ways, but whatever the cause, the result can be severely damaging to critical power company equipment. To prevent this, the PR terminal, which terminates each end of the channel, transmits a trip signal from one power station to another. This signal activates power company circuit breakers, which de-energize the faulted transmission line. A more complete description of the PR channel and its operation is covered in Section 310-540-100.



▶***CAUTION: All tests in this section must be performed on an out-of-service basis: no test shall be performed on this channel unless prior coordinated approval for circuit turndown has been given by the authorized***

power utility personnel.◀ Since the tests in this section pertain only to the PR channel, tests should be made from the standpoint that the terminal equipment is functioning properly.

1.05 The following definitions should be helpful:

(a) ***Customer—provided equipment (CPE):*** This includes any customer-provided equipment that is connected to the telephone company equipment or line. In some cases this may be the PR terminal.

(b) ***End link:*** The facility between a central office bridging location and the transmission interface at the customer location. This definition holds regardless of whether the end link consists of only a local channel or of intercity facilities and a local channel (see Fig. 1).

(c) ***Local loop (Local channel):*** The transmission facility between the customer premises and the serving test center (STC).

(d) ***Middle link:*** The facility between the central office and/or bridging locations. The connection between two bridges in the same central office is not considered to be a middle link (see Fig. 1).

(e) ***Plant Control Office (PCO):*** The designated office responsible for all maintenance activities on a circuit or circuit link. The PCO should be informed of all trouble reports and will maintain office records for each circuit or circuit link.

(f) ***Serving Test Center (STC):*** A designated office responsible for testing transmission facilities and apparatus under direction of the PCO. If a PCO has not been designated, the STC is responsible for coordinating maintenance activities and maintaining circuit records.

(g) ***Transmission level point (TLP):*** A reference level point on a circuit numerically equal to the algebraic sum of 1000-Hz gains (+) and losses (-) from an arbitrarily defined reference point (0 TLP) to the point of measurement. Further discussion of transmission level point is given in 3.03 through 3.08.

2. TESTING APPARATUS

2.01 Accurate measurements require accurate test equipment. All equipment should be checked prior to use to ensure that it is calibrated and functioning properly. Ample warm-up time is also important for stable operation of the test equipment.

2.02 ▶Table A provides a partial listing of test sets which may be used. A detailed listing of test equipment is provided in the booklet ***Bell System Transmission Test Equipment—Performance Evaluation.*** Copies of this booklet are furnished to the General Trade Products representative for each operating company.◀

2.03 All transmission measurements, unless otherwise stated, are to be made between balanced 600-ohm resistive terminations. If other than

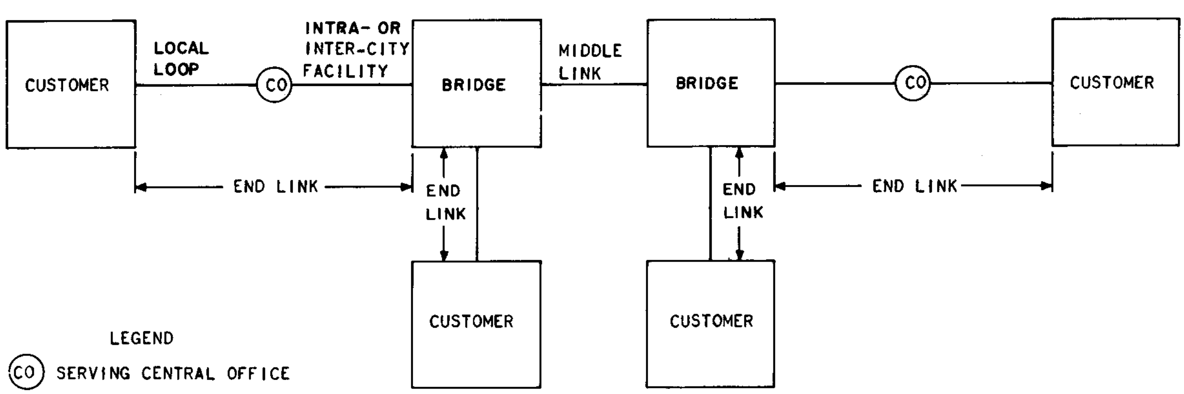


Fig. 1—End Link and Middle Link Definition

◆ TABLE A ◆

TEST EQUIPMENT LIST

FUNCTION	TEST SETS
1000-Hz Loss and Attenuation Distortion*	• Halcyon 515A Data Line Test Set • Hewlett-Packard 3550B Portable Test Set • Hewlett-Packard 4940A Transmission Impairment Measuring Set • KS-20805 Transmission and Noise Measuring Set† • Northeast Electronics Transmission Test Set 4B-NH, or 48-NH-N, or 15B, or 35B • Telecommunication Technology, Inc. 1103A or 1103B Digital Transmission Test Set • Telecommunication Technology, Inc. 1105 Level/Noise Digital Test Set† • WECo 21A Transmission Measuring Set
Sine Wave Oscillators	• Halcyon 515A Data Line Test Set • Hewlett-Packard 3550B Portable Test Set • Hewlett-Packard 4940A Transmission Impairment Measuring Set • KS-19260-L1, KS-19353-L1, or KS-19353-L4 Oscillator • Northeast Electronics Transmission Test Set 4B-NH, or 4B-NH-N, or 15B‡, or 35B • Telecommunication Technology, Inc. 1103A‡ or 1103B Digital Transmission Test Set • WECo 21A-L2 Transmission Measuring Set‡ • WECo 25B Voiceband Gain and Delay Set‡
Envelope Delay*	• Halcyon 515A Data Line Test Set • Hewlett-Packard 4940A Transmission Impairment Measuring Set • WECo 25B Voiceband Gain and Delay Set
C-Message Noise*	• Hewlett-Packard 3555B Transmission and Noise Measuring Set • Hewlett-Packard 4940 A Transmission Impairment Measuring Set • KS-20805 Transmission and Noise Measuring Set • Northeast Electronics TTS 4B-NH-N • Telecommunications Technology, Inc. 1105 Level/Noise Digital Test Set • WECo 3A, 3B, or 3C Noise Measuring Set
C-Notched Noise*	• Hewlett-Packard 4940 A Transmission Impairment Measuring Set • Telecommunications Technology, Inc. 1105 Level/Noise Digital Test Set • WECo 6F or 6FR Voiceband Noise Measuring Set§
Impulse Noise*	• Hewlett-Packard 4940A Transmission Impairment Measuring Set • WECo 6F or 6FR Voiceband Noise Measuring Set • WECo 6H or 6HR Impulse Counter
Single Frequency Int.**	• General Radio 1568-A Wave Analyzer • Hewlett-Packard 302A Wave Analyzer • WECo 4A Frequency Analyzer

▶TABLE A (Cont)◀

TEST EQUIPMENT LIST

FUNCTION	TEST SETS
Frequency Shift*	• Halcyon 515A Data Line Test Set • Hewlett-Packard 4940A Transmission Impairment Measuring Set • KS-20805 Transmission and Noise Measuring Set • Wandel-Goltermann FVM-1 Frequency Shift Meter • WECo 72A Frequency Meter
Local Channel Resistance Unbalance	• KS-14959 Test Set (Portable Wheatstone Bridge)

* These tests may also be performed by the Collins CLA-101A System and Test Signal Generator (TSG).

† Requires a separate sine wave oscillator.

‡ Measure harmonic content of oscillator before using this oscillator as a tone source for harmonic distortion measurements.

§ This set is intended primarily for impulse noise measurements and does not meet certain recent Bell System measurement standards for C-notched noise measurements. It may be used for C-notched noise measurements if other test sets are not available.

** A listening test is normally sufficient for the detection of single tone interference and specialized test equipment is seldom required. The test set listed here may be used for those few cases where specialized test equipment may be required.

standard Bell System test equipment is used, it may be necessary to use an isolation transformer with the proper impedance between the line being tested and the test equipment.

3. TRANSMISSION REQUIREMENTS AND TESTING METHODS

GENERAL

3.01 Accurate measurements of the transmission characteristics of voiceband private line circuits, such as the PR channel, depend upon knowledge of the correct test levels to be transmitted and received. The power of the test signal with respect to the TLP at which it is applied will have a major influence on the test results obtained. The definition of TLP in 1.05 should be read before making the measurements described in this part. In addition, an expanded definition of TLP is given in 3.03 through 3.08.

A. Transmission Level Point (TLP)

3.02 The following is intended to clarify the term "transmission level point" (TLP). An understanding of TLP is neccessary before measurements on private line circuits are made.

3.03 In discussing a channel, it is necessary to describe the power (of the signal, noise, or test tones) present at a particular point in the channel and to compare this power (of the same signal, noise, or test tones) present at other points in the channel. Figure 2 illustrates the relationship between TLPs and signal power in dBm for a simple 2-point PR circuit. The power present at a particular point in a channel is dependent upon the power at the source, where the source is applied, and the loss or gain in the channel between the points in question. Since this information is not always available, it is convenient to describe the power present in a channel by comparing it to some standard reference point in the channel.

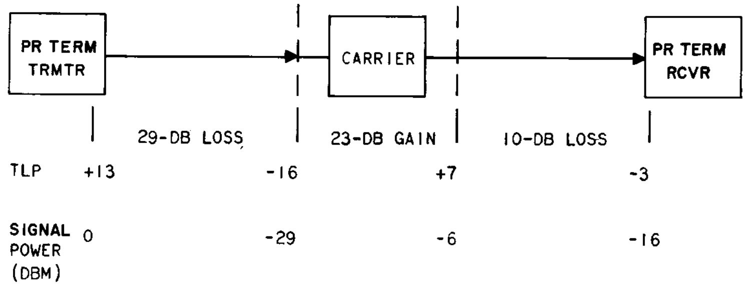


Fig. 2—Relationship Between TLP and Signal Power

3.04 Describing this power is similar to the problem of trying to describe the height of a mountain. To measure the height of a mountain, it is necessary to pick a reference height from which to measure. If the reference height is standardized, then comparison of two mountains can be made even though they are thousands of miles apart. The widely accepted standard reference height for measuring mountains is sea level.

3.05 The standard reference point for measuring power in the Bell System channels is called the zero transmission level point, or 0 TLP. This reference point makes it possible to compare the signal power at two points in the channel even though the points are many miles apart.

3.06 With the establishing of the 0 TLP concept, the power present in a channel is described by stating what this power would be if it were accurately measured at the 0 TLP. The standard notation used to describe the power in this case is dBm0. For example, the term "-13 dBm0" means that the power at the 0 TLP is -13 dBm; if a -13 dBm0 signal were measured at the 0 TLP, the meter would indicate -13 dBm.

3.07 After the power at the 0 TLP is described, the power (from the same source) at any other point in the channel can be determined. For example, if the signal power is -13 dBm when measured at the 0 TLP, it will be 13 dB below the numeric value of any TLP on the channel when measured at that TLP. If the signal is -13 dBm at the 0 TLP, then the power at the -3 TLP would be -16 dBm (-3 - 13 = -16). If this -13 dBm0 signal were measured with a transmission measuring set (TMS) at the -3 TLP, the meter would indicate -16 dBm. Similarly, if a -13 dBm0 signal were measured at the -16 TLP, the meter would indicate -29 dBm (-16 - 13 = -29).

> ***Note:*** The numeric value of the TLP does not describe the power present at that point any more than the elevation of a mountain top above sea level describes how high the mountain rises above the plains that surround it. To know how high the mountain rises above the plains, it is necessary to know the elevation of the plains above sea level as well as the elevation above sea level of the mountain itself. To know the power present at any given TLP, it is necessary to know the power present at some other TLP in the channel. As mentioned previously, the standard way to describe the signal is in terms of its power in dBm at the 0 TLP (dBm0). The signal can be described in dBm0 if the power is known at any TLP. For example, if a -29 dBm signal is applied to the channel at the -16 TLP, the signal is -13 dBm0 [-29 - (-16) = -13]. The power at the -16 TLP is 16 dB lower than the power at the 0 TLP. Therefore, to find the power at the 0 TLP, -16 dB must be subtracted from the power at the -16 TLP.

3.08 Use of the 0-TLP reference also permits transmission objectives and measured results to be stated independently of any specific TLP. For example, the C-notched noise objective is 53 dBrnc0. With this information, the appropriate value at any other TLP can be determined. For measurements at the -3 TLP receive terminal, 3 dB should be subtracted from the objective to determine the absolute value, which is 50 dBrnC. For measurements at the +7 TLP DEMOD OUT jack, 7 dB should be added to the objective to determine the absolute value, which is 60 dBrnC.

B. Test Level

3.09 The circuit layout record (CLR) issued by the companies may indicate the expected 1000-Hz loss of a circuit between various test access points in either or both of two ways:

(a) By the designation of the TLP

(b) By the designation of the signal power (dBm).

It will be necessary to know which method is used before making measurements. Generally the CLR will indicate whether TLP or signal power (dBm) is being specified. If not, the level specified at either the PR terminal transmitter or the MOD IN jack of a 4-wire carrier facility should be noted. If the level at the PR terminal transmitter is given as +12 dB or +13 dB, the CLR is probably written in terms of TLP. If the level at the PR terminal transmitter is given as 0 dBm, it is likely that the CLR is written in terms of signal power (dBm). In this case, or if other than the above values are given, note the level at the MOD IN jacks of a 4-wire carrier facility as follows:

- If the level is given as -16 dB, the CLR is written in terms of TLP.

- If the level is given as -28 dBm or -29 dBm, the CLR is written in terms of signal power (dBm).

3.10 ▶If it is still not possible to determine whether the CLR is written in terms of TLP or signal power (dBm), the engineer responsible for the CLR should be contacted for clarification.◀

All transmission measurements are to be made at levels of signal power that are in accordance with the following: The signal power for the PR channel is a power 13 dBm below the TLP at which the tests are being made. For example at a -16 dB TLP, the signal power would be -29 dBm. A test power of -29 dBm would be applied here.

C. ▶Test Access

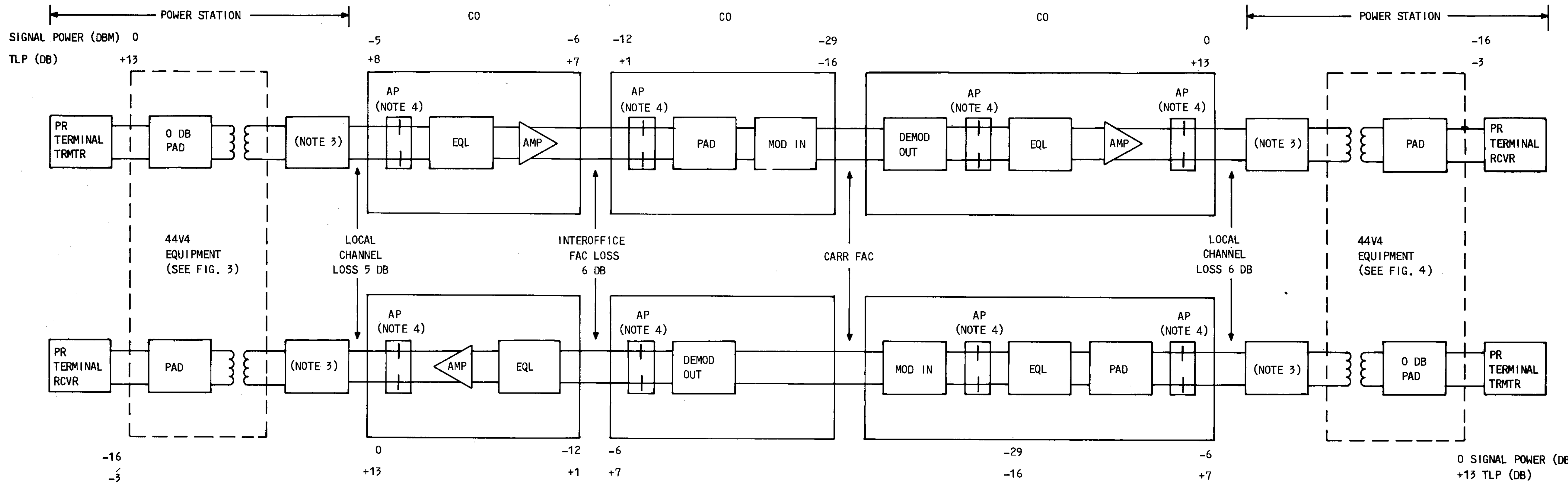
3.11 Switched Maintenance Access Systems (SMAS) provide access for testing PR channels at central office locations either locally or by the Switched Access Remote Testing System (SARTS). Fig. 3 shows the central office locations for the minimum number of access points required to take full advantage of the trouble sectionalization capability of SARTS. SMAS access is not applicable to customer premises (see following information). Additional SMAS information is available in Sections 667-302-102, 667-302-103, 667-302-200, and 667-303-102.

Warning: All tests in this section must be performed on an out-of-service basis; no test shall be performed on this channel unless prior coordinated approval for circuit turn-down has been given by the authorized power utility personnel.

3.12 In the absence of SMAS or SARTS, it is best to limit the choice of test access points to a few locations to be certain of measuring at a known impedance and TLP.◀ Figures 3 and 4 illustrate a typical 4-wire circuit. In this case the best test access points would be at the point where the PR terminal is connected to the channel. This point has been chosen because it is a fixed 600-ohm termination point, and measurements can be made (with the PR terminal disconnected from the circuit) that include all the pads and repeat coils located at the customer location.

3.13 The test equipment should ***not*** be connected directly to the local cable pairs when transmission components (such as pads or repeat coils) are used at the customer location, as this will result in incorrect attenuation distortion and envelope delay distortion as well as other test results. The test equipment should be set to make measurements in a 600-ohm terminated mode unless the CLR specifies a different impedance at this point. Although the cable pair will seldom have a 600-ohm impedance, the transmission measuring equipment will be indicating the characteristics of the circuit with which the terminal (which should also be 600 ohms) is designed to work.

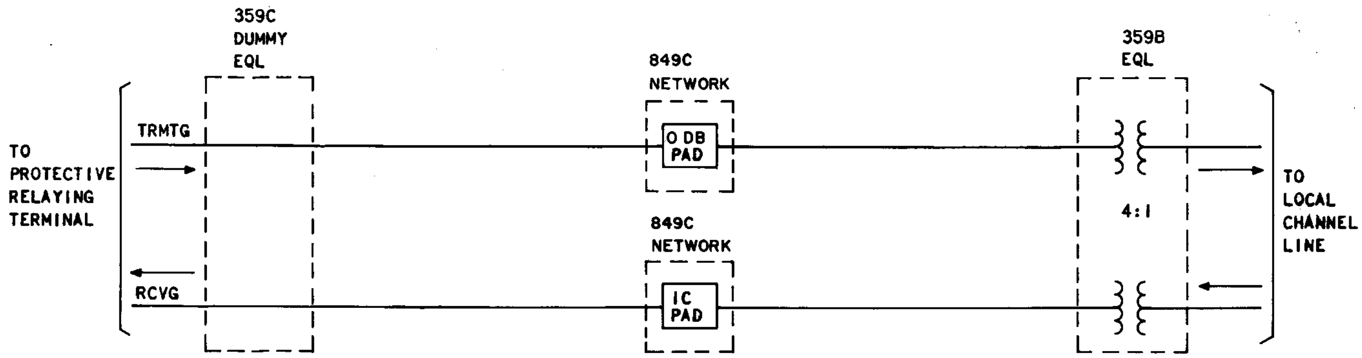
3.14 Figure 5 illustrates a 4-wire multipoint circuit at a central office bridge location. Measurements should be made at the closest test access point to the bridge to measure the effect of all equipment used to make up the end link or middle link. When testing a link off a bridge, that appearance must



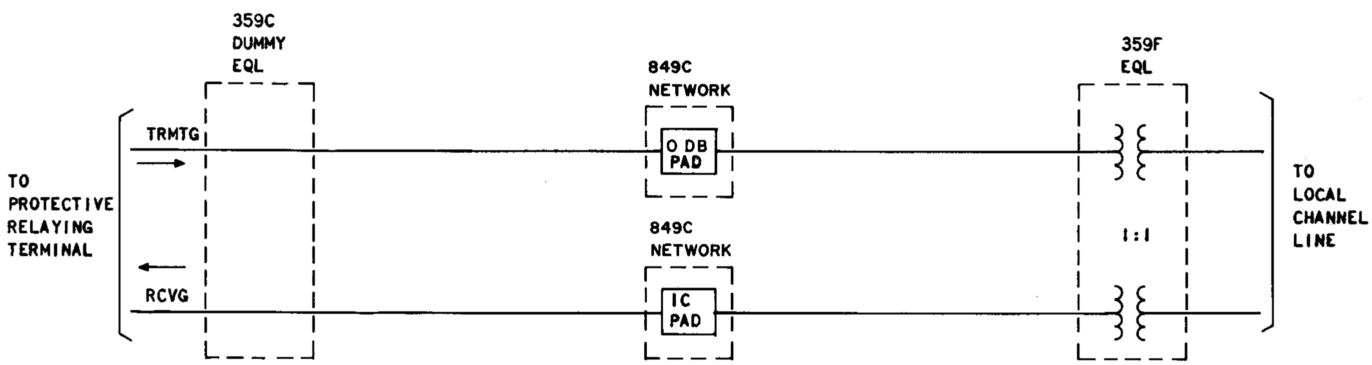
NOTES:

1. 2-POINT, 2-WIRE LAYOUT IS SAME AS ONE HALF OF THIS LAYOUT.
2. THE 16-DB LOSS FROM PR TERMINAL TRANSMITTER TO PR TERMINAL RECEIVER IS MADE UP OF FACILITY LOSS, TRANSFORMER LOSS, EQUALIZATION LOSS IN 44V4 EQUIPMENT, AND PAD LOSS.
3. TWO TYPES OF INTERFACES ARE POSSIBLE AT THIS POINT. THEY ARE: AN ISOLATION TRANSFORMER OR A NEUTRALIZING TRANSFORMER. THEY MAY BE MOUNTED IN A HIGH VOLTAGE INTERFACE UNIT WHICH IS PART OF THE INTERGRATED PROTECTION SYSTEM. BOTH INTERFACES ARE OPTIONAL; THEREFORE IN SOME CASES ONLY A DIRECT PATH MAY EXIST.
4. SMAS ACCESS POINTS - REFER TO SECTION 667-302-102, 667-302-103, 667-302-200 AND 667-303-102 FOR ACCESS CODES, ORIENTATION CODES AND OTHER INFORMATION. THESE ACCESS POINTS MUST BE FLAGGED AS SPECIAL AT TIME OF INSTALLATION. REFER TO BSPS FOR FLAGGING TECHNIQUE. SEE 3.11.

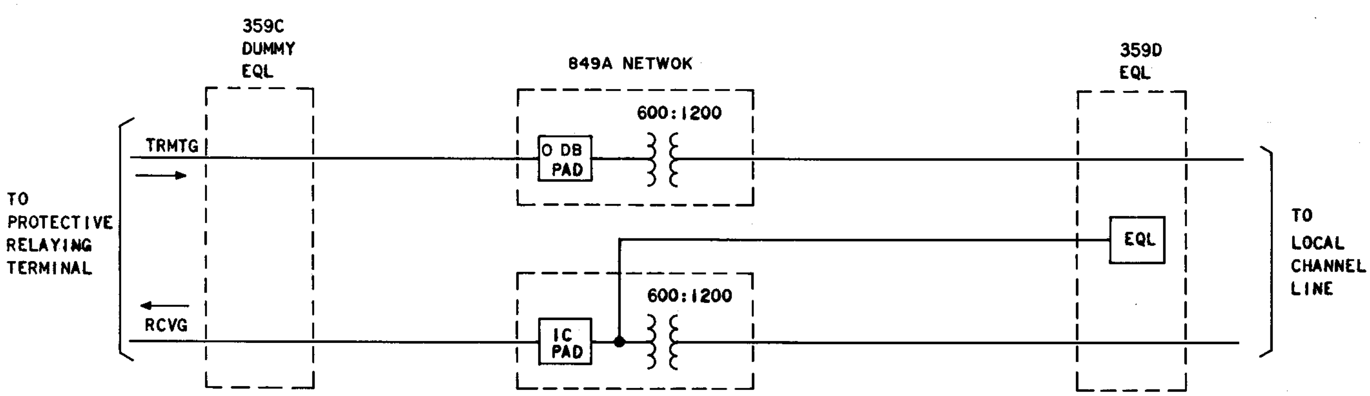
Fig. 3—Typical 2-Point, 4-Wire Layout for Standard 16 dB PR Channel



A. FOR LONG NONLOADED CABLE *



B. FOR SHORT NONLOADED CABLE *



* A DEFINITION FOR SHORT AND LONG CABLE CAN BE FOUND IN BSP 852-307-101.

C. FOR LOADED CABLE *

Fig. 4—44V4 Equipment Arrangement

first be terminated in 600 ohms to avoid unbalancing the bridge.

TRANSMISSION PARAMETERS

3.15 The transmission parameters covered in this part pertain to the PR channel only. Some parameters should be measured routinely to insure channel performance; however, others need to be measured only when transmission difficulties are observed on initial lineup or after repeated trouble reports (see Section 310-540-100). Table B lists the transmission parameters and gives intervals for their required testing, which insures proper channel performance.

3.16 ♦Following the discussion of requirements for each of the transmission parameters beginning in 3.17, an example is given using the test points defined above for standard 16 dB 4-wire PR channel at the customer location and the STC.♦ The results given in the example are recorded on a sample form as shown in Fig. 6. The use of the form is described in Part 4.

A. 1000-Hz Loss

3.17 ♦The 1000-Hz loss of the standard PR channel is 16 dB measured end-to-end. The 1000 Hz loss of the optional PR channel is 8 dB measured end-to-end (see Sections 310-540-100 and 851-201-101 for local channel requirements for the optional channel). The required end-to-end loss is listed on the CLR as the expected measured loss (EML).♦

3.18 Table C indicates the maximum loss deviation requirements for the PR channel, ie, maximum deviation from the EML. All loss measurements should be made and adjusted within requirements before any other transmission parameters are measured. This is necessary because many of the other transmission parameters are level sensitive. Loss measurements must be made at the level of signal power.

3.19 If adjustments must be made to an end link for the 1000-Hz loss requirement, they ***must*** be made at certain locations. In the transmitting end link, adjustments should be made at the CO; in the receiving end link, adjustments should be made at the power station end.

3.20 ***Example of test:*** An oscillator is connected at an interface point in place of the PR terminal transmitter (+13 TLP). A transmission measuring set is placed at the distant terminal in place of the receiver (-3 TLP). The meter reads -16.4 dBm. Since the correct signal level at the -3 TLP should be -16 dBm, the loss deviation is +0.4 dB [-16 - (-16.4) = +0.4] and is within the requirement in Table C. This loss deviation value should be entered on the form shown in Fig. 6.

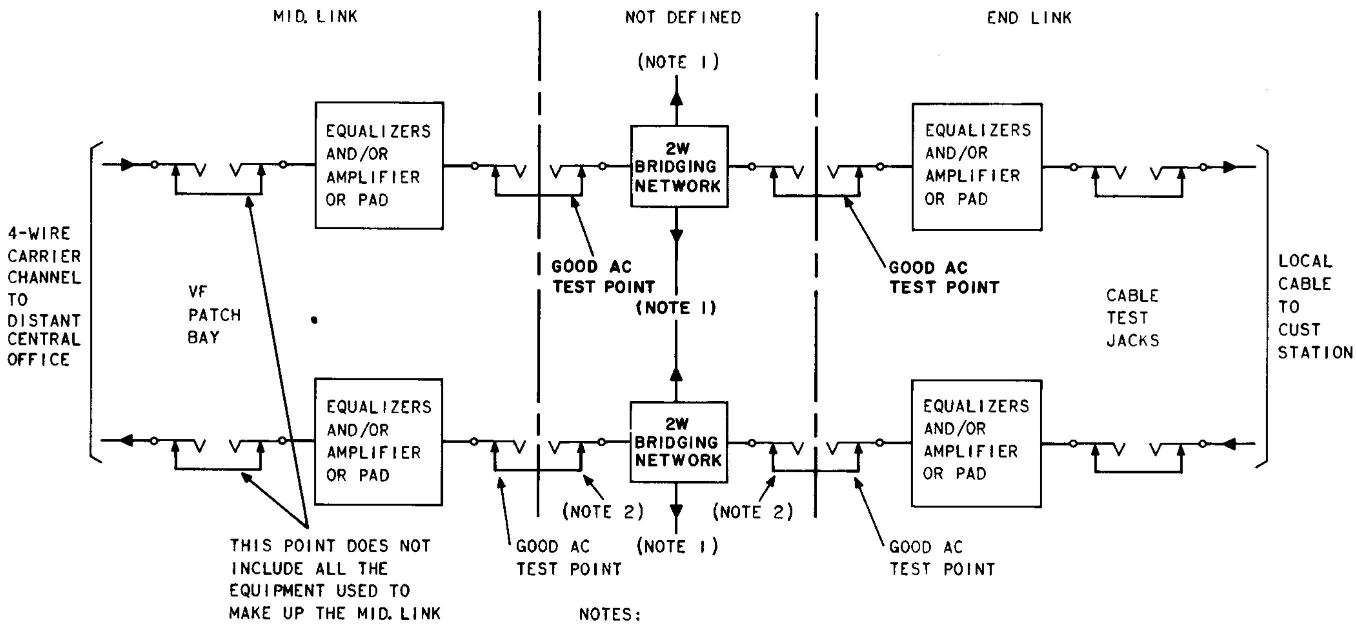
B. Attenuation Distortion (Frequency Response)

3.21 The attenuation distortion requirements for the PR channel are given in Table D. Measurements are made at the interface (customer terminal) location using the measurement frequencies given in Table E.

3.22 As indicated in Fig. 3 and 4 a 44V4 equipment package is usually installed at the power station for level adjustment and equalization. This equipment also serves as a coupling arrangement for connecting customer-owned PR equipment to telephone company facilities. ♦***It is essential that the PR channel be terminated in power station locations using arrangements of 44V4 or equivalent equipment. Channel terminating arrangements with such devices as Data Auxiliary Sets (828-type or 829-type), 150A Channel Service Units, 31B Voice Couplers, or Metallic Facility Terminal (MFT) equipment must not be employed.***♦ An additional high-voltage isolating transformer is provided at those locations where a high ground potential rise occurs during fault conditions.

3.23 Figure 7 illustrates the attenuation distortion requirements for the PR channel. Measurements falling within the outlined area are considered to be meeting requirements, whereas measurements falling outside the outlined area are out of limits. The attenuation distortion of a circuit may be measured and adjusted at the same time that the 1000-Hz loss measurements are made. The distortion is stated in terms of the loss at a particular frequency referenced to the loss at 1000 Hz. The convention used is (+) for more loss and (-) for less loss.

3.24 Attenuation distortion is usually corrected by means of 359-type equalizers. A number of codes are available for use with various types of cable plant. The 359A, D, G, H, K, L, and P equalizers are adjustable and may be used to correct for slope or for excessive gain at the low end of the band or for excessive loss at the high end of



NOTES:
1. OTHER END-LINK APPEARANCE ON BRIDGE.
2. TERMINATE BRIDGE IN 600 OHMS HERE WHILE TESTING END OR MID. LINK. USE SMAS ACCESS, IF AVAILABLE, INSTEAD OF JACKS.

Fig. 5—Test Access Points on 4-Wire Multipoint Circuit at Bridge Location

TABLE B

PARAMETERS AND INTERVALS FOR TEST

TEST PARAMETERS	INITIAL	ROUTINE	ROUTINE INTERVAL	INITIAL TROUBLE REPORT	CHRONIC TROUBLE REPORT
1000-Hz Loss	Yes	Yes	12 Mon	(1)	(3)
Attenuation Distortion	Yes	Yes	12 Mon	(1)	(3)
Envelope Delay Distortion	No	No	None	(1)	Yes
C-Message Noise	Yes	Yes	12 Mon	(1)	(3)
C-Notched Noise	(1)	No	None	(1)	Yes
Single-Frequency Interference	(2)	No	None	(2)	Yes
Frequency Shift	(1)	No	None	(1)	Yes
Local Channel Resistance Unbalance	Yes	Yes	12 Mon	(1)	(3)
Impulse Noise	Yes	No	None	(1)	Yes

Numbers in parentheses refer to the following notes:
(1) If suspicion exists that this may be a problem.
(2) A listening test will normally be sufficient.
(3) This test is required after repeated trouble reports have been received and the source of the problem can not be determined.

the band. Other types of equalizers may be necessary to compensate for excessive ripple in the middle of the band.

3.25 Information on the attenuation distortion characteristics of the 359-type equalizers is given in the 332-116-ZZZ series of Bell System Practices. Some information on the adjustment of these equalizers is given in Part 8 of Section 332-104-500 and in Section 314-016-125.

3.26 The attenuation distortion equalizers on multipoint circuits should be adjusted to give the best frequency response on the overall circuit within limits. This is necessary because it is possible on multipoint circuits to meet the attenuation distortion limits on any individual link, but not meet the end-to-end limits. Since the control office is responsible to the customer for end-to-end limits, adjustments of the equalizers to obtain the best frequency response initially may eliminate the need to re-equalize multipoint circuits later.

3.27 In some instances it may not be possible to meet the attenuation distortion requirements with the specified equalizers. Two possible sources of poor high-frequency response are bridge taps on the local channel cable pairs or the use of older N2 carrier channel service units with LC channel bandpass filters. The gain of N2 carrier channels at 3 kHz should not be more than 3 dB below the gain at 1 kHz. If the channel does not meet these limits, a channel service unit with ***crystal*** filters may be needed.

3.28 If a D1 channel bank (used on T-carrier) is used, 4079 BD transmitting gates and filters must be used. The older filters have a poorer high-frequency response and should not be used for the PR channel.

3.29 If attenuation distortion requirements cannot be met and the problem cannot be isolated, engineering assistance should be requested. A record of measurements made should be kept to aid engineering in arriving at a solution.

3.30 ***Example of test:*** A 25B voiceband gain and delay set is connected in place of the PR terminal transmitter and set for an output level of 0 dBm at the +13 TLP. Another 25B set is connected in place of the terminal receiver (-3 TLP) at the distant location. The received level in the transmit direction is measured and recorded as shown in Table F. Calculation of attenuation distortion is made by using the information in Note 2 of Table F. Figure 8 illustrates the determination of the attenuation distortion shown in Table F. From the measurements it can be determined that the attenuation distortion for this example is:

300—3000 Hz -0.4 to +2.1 dB

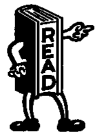
500—2800 Hz -0.4 to +1.1 dB

These values are well within the requirements stated and therefore should be recorded on the form as shown in Fig. 6.

C. Envelope Delay Distortion

3.31 Envelope delay distortion for the PR channel must be less than 2000 μs over a frequency band of 800 to 2600 Hz. Delay equalizers, if provided, should be specified on the CLR. They are usually of the nonadjustable variety with two major exceptions, the 385A and 385B. The specified equalizers will normally be adequate to meet delay distortion requirements.

> ***Note:*** If changes are required in the equalizers, it will be necessary to recheck the 1000-Hz loss and the attenuation distortion since changes in the delay equalizers will have some effect on these parameters. Changes may be made in the step settings of the 385A and 385B equalizers without rechecking the attenuation distortion.



Measurements of envelope delay are generally only made in the event of chronic trouble reports (see Table B). If these measurements are required, Table F and the accompanying Note 1 may be used. These measurements are made at the PR terminal location using the measurement frequencies given in Table E.

3.32 Information on the 384- and 385-type delay equalizers may be found in Section 314-820-104. Information on the 200-type delay equalizer may be found in Section 314-820-100.

D. Message Circuit Noise (C-Message Noise)

3.33 Message circuit noise is the background noise on a channel in the absence of a signal. The usual measurement is frequency weighted by a C-message filter, and the result is called C-message noise. A more detailed discussion of this noise is covered in Section 310-540-100. The C-message noise limits for this channel are given in Table G.

3.34 ***Monitor the circuit with the noise set receiver while making the noise measurement.*** If intelligible crosstalk of identifiable signals at the noise measurement level is heard, it is an indication of crosstalk, which should be corrected. If a single-frequency tone or tones of long duration are heard, single-frequency interference may be present and should be measured (refer to 3.53). If compandored facilities are employed in the circuit being measured, a C-notched noise measurement will be required (refer to 3.39).

3.35 A standard reference of noise used throughout the Bell System is -90 dBm. The measurement of noise is expressed in dB above this reference, ie, dBrn. A 1000-Hz tone at a level of -90 dBm will be equal to a 0-dBrn reading on an NMS. From this we have the relationship of 0 dBm = 90 dBrn at 1000 Hz. This relationship applies to any frequency in a flat weighted passband, but only at, or very near to, 1000 Hz in the C-message weighted band. To get the reference level for other specific frequencies, the effect of the C-message weighting curve must be subtracted. The notation "dBrnC" is commonly used to express noise measured through a C-message weighting network.

CIRCUIT NUMBER (1)	TRANSMISSION HISTORY RECORD								LINK NUMBER (2)			
TEST DATE	(3)		(3)		(3)		(3)		(3)		(3)	
CIRCUIT ORDER NUMBER: (4)	TRMT		RCV		TRMT		RCV		TRMT		RCV	
	ENV DELAY	ATTEN DIST	ENV DELAY	ATTEN DIST	ENV DELAY	ATTEN DIST	ENV DELAY	ATTEN DIST	ENV DELAY	ATTEN DIST	ENV DELAY	ATTEN DIST
300		(5)		(5)		(5)		(5)		(5)		(5)
500												
600												
800	(6)		(6)		(6)		(6)		(6)		(6)	
1000												
1200												
1400												
1600												
1800												
2000												
2200												
2400												
2500												
2600												
2700												
2800												
3000												
Frequency Shift Hz	(7)		(7)		(7)		(7)		(7)		(7)	
Single Frequency Interference dBrnc0	(8)		(8)		(8)		(8)		(8)		(8)	
C-Notched Noise dBrnc0	(9)		(9)		(9)		(9)		(9)		(9)	
Local Channel Resistance Unbalance %	(10)		(10)		(10)		(10)		(10)		(10)	
C-Message Noise dBrnc0	(11)		(11)		(11)		(11)		(11)		(11)	
1000-Hz Loss dB	(12)		(12)		(12)		(12)		(12)		(12)	
IMPULSE NOISE Ref. __ dBrnc0 Counts in 15 minutes — COUNTER 1 COUNT	(13)		(13)		(13)		(13)		(13)		(13)	
2 COUNT	(13)		(13)		(13)		(13)		(13)		(13)	
3 COUNT	(13)		(13)		(13)		(13)		(13)		(13)	
Special Notes or Instructions												

Fig. 6—Transmission History Record

TABLE C

1000-Hz LOSS DEVIATION MAXIMUM DEVIATION FROM EML STATED ON CIRCUIT LAYOUT RECORD

	INITIAL	ROUTINE OR TROUBLE ISOLATION
End Link	±0.5 dB	±2.0 dB
Middle Link	±0.5 dB	±1.0 dB
Overall (STA—STA)	±1.0 dB	±4.0 dB

TABLE D

ATTENUATION DISTORTION REQUIREMENTS*

FREQUENCY RANGE (Hz)	VARIATION (dB)
300 — 3000	—2 to +6
500 — 2800	—1 to +3

*Referenced to 1000 Hz.

TABLE E

MEASUREMENT FREQUENCIES

FREQUENCY (Hz)	FREQ RESP	ENV DELAY
300	X	
500	X	
600	X	
800	X	X
1000	X	X
1200	X	X
1400	X	X
1600	X	X
1800	X	X
2000	X	X
2200	X	X
2400	X	X
2500	X	X
2600	X	X
2700	X	
2800	X	
3000	X	

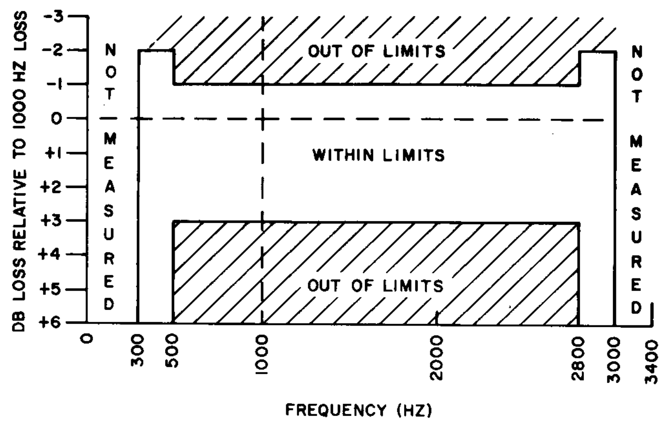


Fig. 7—Graphical Representation of Attenuation Distortion Requirements

3.36 The measured noise must be corrected to the 0-TLP reference point to determine whether requirements are being met, ie, for comparison to the requirements stated in dBrnc0.

> ***Example:*** When measuring at a +7 TLP, subtract 7 dB from the reading; when measuring at a -16 TLP, subtract -16 dB from the reading.

3.37 If the CLR specified the signal level, the signal power should be converted to TLP by adding 13 dB to the signal level. At the -29 dBm signal power point, 13 dB must be added to convert to a -16 TLP.

3.38 ***Example of Test:*** A 600-ohm termination or a 3C noise measuring set (NMS) is connected across the input to the circuit in place of the PR terminal transmitter. At the distant customer location, a 3C NMS is connected to the circuit in place of the PR terminal receiver. A reading of 31 dBrnC is taken from the 3C NMS at the receive end. So that this reading may be adjusted to dBrnc0, the TLP (-3 dB) is subtracted from the reading; the result is 34 dBrnc0. The circuit has a length of 60 miles of both N and T carrier facilities. According to the information in Table G, the requirement is met. The corrected measured value is entered on the Form XXXX as shown in Fig. 6.

TABLE F

SAMPLE MEASUREMENT RESULTS

MEASURED FREQUENCY	ENVELOPE DELAY	RECEIVED LEVEL	LOSS WITH RESPECT TO 1000 Hz
300		—16.9	+1.1
500		—16.0	+0.2
600		—15.7	—0.1
800	180	—15.7	—0.1
1000	150	—15.8	0
1200	85	—15.4	—0.4
1400	25	—15.6	—0.2
1600	10	—15.7	—0.1
1800	0	—15.8	0
2000	—15	—15.8	0
2200	—35	—15.9	+0.1
2400	—10	—16.0	+0.2
2600	15	—16.2	+0.4
2800		—16.9	+1.1
3000		—17.9	+2.1

Note 1: To calculate the envelope delay distortion between 800 Hz and 2600 Hz, determine the maximum envelope delay (180 μsec) and the minimum envelope delay (—35 μsec) between those frequencies. The envelope delay distortion is the difference between those values 180 — (—35) = 215 μsec.

Note 2: To calculate the attenuation distortion, reference all loss measurements with respect to 1000 Hz. The attenuation distortion between 500 Hz and 2800 Hz would be the minimum loss(—) and maximum loss (+) between those frequencies (—0.4 to +1.1 dB). The attenuation distortion between 300 Hz and 3000 Hz is —04. to +2.1 dB.

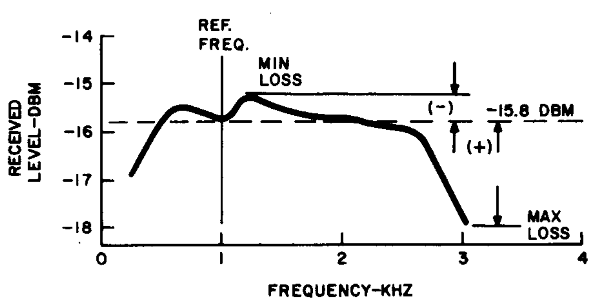


Fig. 8—Attenuation Distortion for 300- to 3000-Hz Band

E. C-Notched Noise

3.39 The C-message noise discussed in the above paragraphs is not necessarily the noise experienced when a signal is present. Quantizing noise in digital carrier systems and the effect of compandors in both analog and digital systems results in signal-dependent noise. Because this noise is signal dependent, it is impossible to approximate the signal to noise (S/N) ratio, which is important in PR channels, from received level and C-message noise measurements alone.

3.40 C-notched noise is a measure of the amount of noise on a channel when a signal is present. In making this measurement, a

➧ TABLE G ➧

C-MESSAGE NOISE LIMITS

	STANDARD 16 dB CHANNEL		OPTIONAL 8 dB CHANNEL	
FACILITY LENGTH (MILES)	NOISE (dBrnC0)	NOISE AT RECEIVER (−3 TLP)	NOISE (dBrnC0)	NOISE AT RECEIVER (+5 TLP)
0 — 50	31	28	31	36
51 — 100	34	31	34	39
101 — 400	37	34	37	42
401 — 1000	41	38	41	46

single-frequency holding tone is applied at the transmitting end of the channel to act as a signal. This tone operates compandors and other signal-dependent devices. At the receiving end, the tone is removed by a narrowband elimination filter (notch filter) and the noise is then measured through a C-message filter. The ratio of the received 1000-Hz power to the C-notched noise is a good approximation to the S/N ratio. However, the S/N ratio could be better than indicated by the approximation.

3.41 The S/N ratio limit as defined in 3.40 is 24 dB for the PR channel. Since the standard receiving power is -16 dBm (or 74 dBrnC), the C-notched noise must be at least 24 dB less at the receiver. This establishes a C-notched limit of 50 dBrnC (74 - 24). (Note that 50 dBrnC at a -3 TLP is equivalent to 53 dBrnC0.) ➧For the optional channel the receiving power is -8 dBm (82 dBrnC). Again, the C-notched noise must be at least 24 dB less at the receiver. So the C-notched noise for the option 8 dB channel is 58 dBrnC (82-24).➧

3.42 To sectionalize C-notched noise troubles, the C-message noise should be measured on each N, O, or ON channel used to make up the overall circuit. This will prevent the higher apparent noise from masking the noise on the compandored channels. The limits in Table G should be used.

3.43 A conventional noise measurement on a channel in a D1 channel bank used on T1 carrier will not reveal a possible C-notched noise problem on that channel. If a channel in a D1 channel bank is suspected of causing the problem because of high quantizing noise, it will be necessary to request a distortion test on that channel. More information on this measurement can be found in 3.20 through 3.33.

3.44 ***Example of test:*** At the customer location, an oscillator is connected to the channel in place of the PR terminal transmitter and is adjusted to send a single-frequency holding tone at a level of 0 dBm (+13 TLP). At the distant customer location, an NMS is connected to the channel in place of the PR terminal receiver (-3 TLP). A reading of 41 dBrnC is taken. Correcting the figure to the value for a 0 TLP, a final figure of 44 dBrnC0 is obtained. ➧This value is better than the stated requirement of 53 dBrnC0 at the receiver and is entered on the form as shown in Fig. 6.

F. Impulse Noise

3.45 The threshold settings for impulse noise are as follows:

End Link	67 dBrnC0
Middle Link	Use mileage limits from Table H
Overall	71 dBrnC0

3.46 Impulse noise is characterized by large peaks or impulses in the total noise waveform. It is measured with an instrument such as the 6F or 6H impulse noise counter which counts impulses greater than a threshold value, using an electromechanical counter having a maximum counting rate of 7 counts per second. Measurements are made through a C-message filter. A holding tone is transmitted and notched out at the receiver.

3.47 Impulse noise should be measured with a holding tone of 1004-1020 Hz, 2804 Hz, or 2750 Hz. A holding tone frequency of 1004-1020 Hz is the new Bell System standard. If the WECo 6F or 6H impulse counters are used, a holding tone frequency of 2750 Hz is used with the 497E network, and 2804 Hz with the 497G network inserted in the impulse noise counter. The threshold setting on the impulse noise counter should be set to a level corresponding to the threshold requirement in dBrnC0 plus the TLP at the point of measurement. For example, at a +7 TLP when measuring a midlink consisting of a 100-mile LMX carrier channel, adjust the threshold setting of the impulse counter to 58 (from Table H) + 7 = 65. If the same channel were measured at a -16 TLP, the threshold would be set at 58 - 16 = 42. If the CLRC specified data level (-13 dBm 0), add 13 dB to the data level to obtain the TLP. Then determine the threshold setting using the same procedure. The same channel measured at a data level point of -16 would correspond to a TLP of -16 + 13 = -3. The threshold setting would be 58 - 3 = 55. This procedure is merely correcting from dBrnC0 to dBrnC.

3.48 When impulse noise is measured overall from one customer station to another, a threshold setting of 71 dBrnc0 should be used regardless of facility type or mileage. The overall 1000-Hz loss must be adjusted to within 1 dB in order to obtain an accurate impulse noise count. Table H may be used to isolate troubles to a facility section. In the event of a trouble report involving an excessive error rate between two specific data stations, an overall impulse noise test must be made between the reported stations since the end link/midlink impulse noise thresholds given in 3.45 do not offer complete assurance that the overall impulse noise requirements will be met. If the overall impulse noise requirements are met between stations it will not be necessary to meet end link/midlink or facility impulse noise requirements.

3.49 ***Example of Test:*** An overall impulse noise measurement is to be made between station A and station B. At station A, an oscillator is connected in place of the PR terminal transmitter (+13 TLP) and adjusted for an output of 0 dBm at 2804 Hz. The 2804-Hz loss deviation was previously measured between stations A and B and was determined to be within ±2 dB of the 1004-Hz loss of the example given in 3.20. At station B, a 6H impulse noise counter is connected in place of the data set receiver (-3 TLP). The reference level for the threshold control is set at 71 - 3 = 68 dBrnC. In a 15-minute period, 7 counts are recorded on the counter. This figure is within limits and is recorded on the form as shown in Fig. 6.

3.50 The distribution of impulse noise voltage levels on typical telephone facilities is such that for each 7-dB increase in the threshold, the expected number of counts decreases by an average factor of 10. A channel just meeting the limit of 15 counts in 15 minutes at 71 dBrnC0 would have an estimated 1.5 counts in 15 minutes at 78 dBrnC0.

3.51 In some cases it may be necessary to measure the impulse noise distribution in order to verify that the number of very high level impulses is within reasonable limits. In such a case a multiple level 6F impulse noise counter or equivalent should be used. The first counter circuit in the 6F set should be set to the same threshold level that would be chosen from 3.45 if normal impulse noise measurements were made. This will be referred to as the reference threshold level. For example, for overall measurements, the reference threshold level would be 71 dBrnC0. The COUNTER SEPARATION switch should be set to 4 dB. This will place the second counter circuit 4 dB above the reference threshold level and the third counter circuit 8 dB above the reference threshold limit. The fourth counter circuit is not used.

TABLE H

**IMPULSE NOISE
THRESHOLD SETTINGS IN dBrnc0**

LENGTH (MILES)	TYPE FACILITY		
	(1)	(2)	(3)
0-59	54	67	58
60-124	54	67	58
125-249	54	67	59
250-499	—	—	59
500-999	—	—	59

(1) Voice frequency cable facilities only.

(2) N, O, ON, N3L junction facilities or T carrier facilities.

(3) C, K, L, or R carrier facilities.

Note 1: These thresholds assume the use of a —13 dBm0 holding tone. Do not use other holding tone levels as the above thresholds for type 2 (compandored) facilities would be incorrect.

3.52 The maximum number of counts that may be recorded in 15 minutes is as follows:

COUNTER CIRCUIT		MAXIMUM COUNTS
1	Reference Level	15
2	Reference Level + 4 dB	9
3	Reference Level + 8 dB	5

G. Single-Frequency Interference

3.53 The overall facility requirements for single-frequency interference are given in Table I.

3.54 Spurious single-frequency tones may interfere with the narrowband signals that are normally used on a PR channel. Since the output of the PR channel must meet the voiceband channel signal power requirements, the signal power in a narrowband channel may be close to the voiceband channel noise power. The narrowband channel noise will be less than the voiceband noise, but if a single-frequency tone is in the narrowband channel, it may interfere with the desired signal. (Unlike the noise, the power of the tone is not decreased when passed through the narrowband channel filter.) The limit for single-frequency interference is that any spurious single-frequency tone will be at least 3 dB below the C-message noise power limit.

3.55 A listening test is required to check for single-frequency interference while the C-message noise measurement is being made as discussed above. A C-message weighting network must be used when making this test. If message noise can be heard, but noticeable tones are not heard, the circuit is probably good. If tones are heard, a measurement of the interference should be made as described in 3.57.

3.56 A level measurement of the interference may be made using a frequency selective voltmeter. The voltmeter should be tuned to the interfering tones between the frequency range of 300 to 3200 Hz and the level in dBm should be measured. This value may be converted to dBrnC0 by using the following procedure.

▶ TABLE I ◀

SINGLE-FREQUENCY INTERFERENCE LIMITS

	STANDARD 16 dB CHANNEL		OPTIONAL 8 dB CHANNEL	
FACILITY LENGTH (MILES)	SF LIMIT (dBrnc0)	SF LIMIT AT RECEIVER (−3 TLP)	SF LIMIT (dBrnc0)	SF LIMIT AT RECEIVER (+5 TLP)
0 — 50	28	25	28	33
51 — 100	31	28	31	36
101 — 400	34	31	34	39
401 — 1000	38	35	38	43

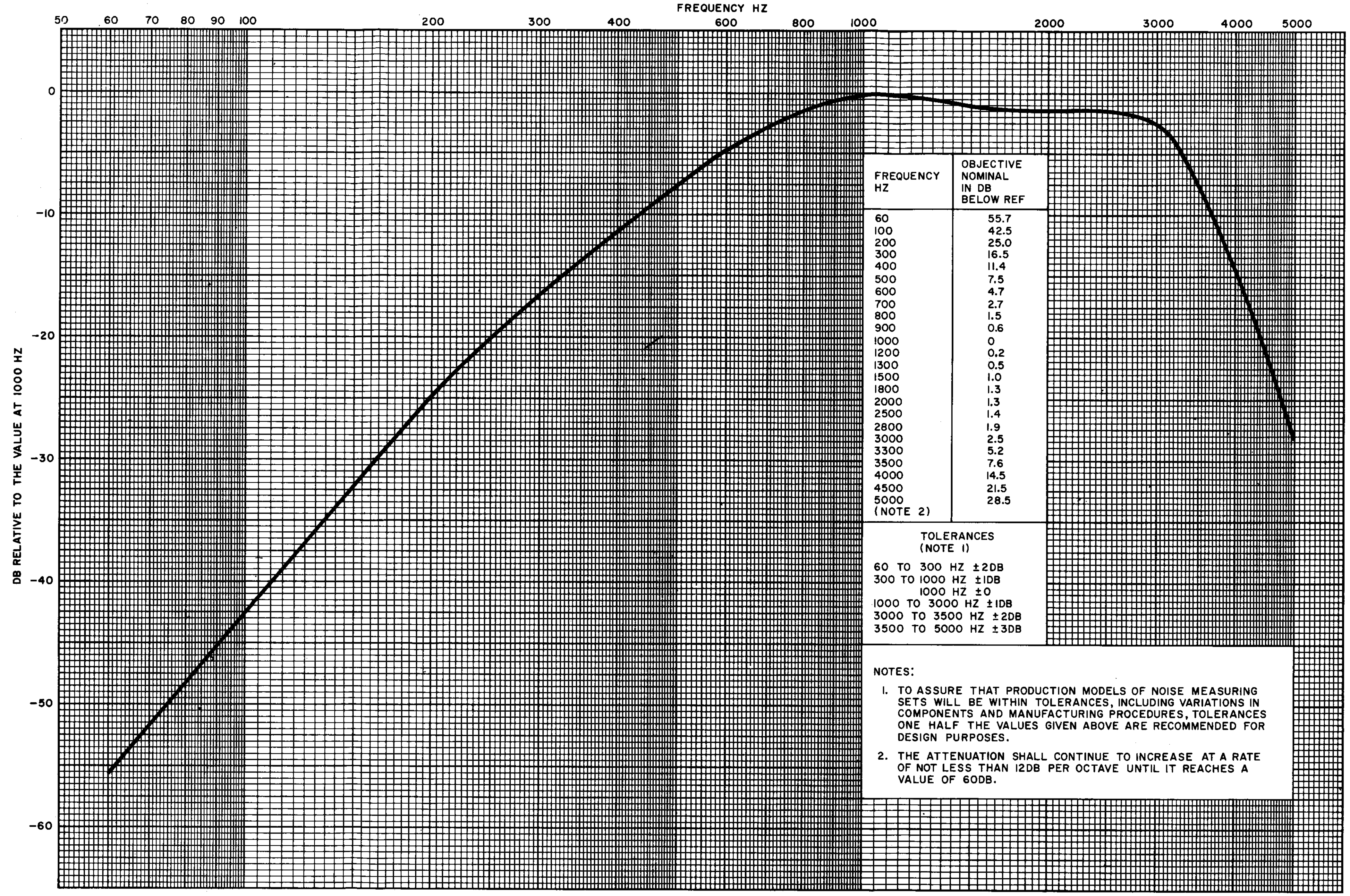
STEP	PROCEDURE
1	Convert the level measurement to dBm0 by algebraically subtracting the TLP at the point of measurement from the reading obtained on the meter. If the CLR specifies signal power (dBm) instead of TLP, add 13 to the signal power (dBm) shown on the CLR to obtain the TLP.
2	Convert from dBm0 to dBrn0 by adding 90 dB to the dBm0 value.
3	Calculate the C-message weighting factor by using the curve in Fig. 9. Determine the frequency of the interference from the dial setting on the frequency selective voltmeter. Determine the C-message loss at this frequency from Fig. 9. Subtract this loss from the value in dBrn0 (Step 2) to obtain the value in dBrnc0 and compare this value against the requirement table.

3.57 ***Example of test:*** ▶Single-frequency interference is heard when a listening test is made at the PR terminal receiver which with the standard 16 dB channel is a -16 dBm signal power or -3 TLP.◀ A frequency selective voltmeter is connected at this point (after the C-message filter is removed), and a reading of -60 dBm at a frequency of 600 Hz is obtained. A termination is applied to the distant end of the circuit, which is approximately 90 miles long. To convert the level measurement from dBm to dBm0, the TLP is subtracted from the level measurement: -60 dBm - (-3 TLP) = -57 dBm0. Convert the dBm0 value to dBrn0 by adding 90: -57 dBm0 + 90 = 33 dBrn0. By referring to Fig. 9, it is apparent that the loss at 600 Hz as compared with 1000 Hz is 4.7 dB. Convert the dBrn0 value to dBrnc0 by subtracting the loss at 600 Hz: 33 dBrn0 - 4.7 dBm = 28.3 dBrnc0. Although the interference can be heard, it falls within the requirement of 31 dBrnc0 for a 90-mile circuit and therefore need not be corrected. This value should be entered on Form XXXX as shown in Fig. 6. If the listening test has revealed no single-frequency interference, the notation "OK" may be made on the form, and a level measurement will not be required.

H. Frequency Shift

3.58 The overall circuit requirement for frequency shift is ±5 Hz end-to-end. Frequency shift measurements are only required on the carrier channel portion of the circuit and do not normally include the metallic facility to the customer location. Frequency shift measurements are only required in the event of repeated customer trouble reports.

3.59 Frequency shift of carrier facilities will seldom be a serious problem for most PR applications. It cannot appear on physical plant



FREQUENCY HZ	OBJECTIVE NOMINAL IN DB BELOW REF
60	55.7
100	42.5
200	25.0
300	16.5
400	11.4
500	7.5
600	4.7
700	2.7
800	1.5
900	0.6
1000	0
1200	0.2
1300	0.5
1500	1.0
1800	1.3
2000	1.3
2500	1.4
2800	1.9
3000	2.5
3300	5.2
3500	7.6
4000	14.5
4500	21.5
5000 (NOTE 2)	28.5

TOLERANCES (NOTE 1)

60 TO 300 HZ ±2DB
300 TO 1000 HZ ±1DB
1000 HZ ±0
1000 TO 3000 HZ ±1DB
3000 TO 3500 HZ ±2DB
3500 TO 5000 HZ ±3DB

NOTES:

1. TO ASSURE THAT PRODUCTION MODELS OF NOISE MEASURING SETS WILL BE WITHIN TOLERANCES, INCLUDING VARIATIONS IN COMPONENTS AND MANUFACTURING PROCEDURES, TOLERANCES ONE HALF THE VALUES GIVEN ABOVE ARE RECOMMENDED FOR DESIGN PURPOSES.
2. THE ATTENUATION SHALL CONTINUE TO INCREASE AT A RATE OF NOT LESS THAN 12DB PER OCTAVE UNTIL IT REACHES A VALUE OF 60DB.

Fig. 9—C-Message Weighting Curve

and will be insignificant on carrier systems that have a transmitted carrier modulation scheme, such as N- or O-type. Frequency shift may appear on every other channel of an N3. In this case, a different channel on the N3 should be chosen. Frequency shift will not be found on D1 or D2 channel banks of T Carrier Systems. The LMX channels of L-type carrier should normally hold frequency shift well within the ±5 Hz end-to-end limit. An exception to this may be the result of improperly performed maintenance on the primary frequency supplies, especially when deviations in excess of 10 Hz for a number of hours have been observed. If such trouble is suspected, an inquiry regarding maintenance associated with primary frequency supplies on the route should be made and supervisory assistance requested to ensure that the work is carefully done to avoid interfering with transmission. The C or H carrier channel may exhibit large amounts of frequency shift and should be avoided.

3.60 To measure the frequency shift parameter, a frequency counter is used at both ends of the circuit to compare the frequency of a tone, which is sent from one end to the other. The 72A frequency meter may also be used to observe the frequency shift.

3.61 ***Example of test:*** When frequency shift is suspected on a circuit, an oscillator is connected at signal power (dBm) at the STC serving the customer location. A frequency counter is then bridged across the output. Another frequency counter is bridged across the circuit at the STC serving the distant customer location. A frequency of 958 Hz is read at both STCs at the same time. The frequency shift is therefore 0 Hz. This value should be recorded on the form as shown in Fig. 6.

I. Local Channel Resistance Balance

3.62 The local channel portion (end link) of the PR channel must have a resistance unbalance of 1 percent or less.

3.63 Since the conversion of longitudinal noise to metallic noise depends directly on the resistance balance of the cable pairs, the above requirement must be met.

3.64 Various procedures for making resistance balance measurements may be used; however, the ones given below are recommended for the PR channel. Since the channel may be provided with different types of interface facilities (see Fig. 3, Note 3), a somewhat different test procedure is provided for each case.

Neutralizing Transformer

3.65 When a neutralizing transformer is used for protection and reduction of noise at the power station location, the resistance unbalance should be measured as in the following procedure.

Warning: Any talk circuit used for testing should be established from the station side of the neutralizing transformer.

STEP	PROCEDURE
1	On the station side of the neutralizing transformer, short together all four conductors of the pair to be measured and a spare pair.
2	At the CO, short together the tip and ring conductors of the spare pair. This will be designated as "common" in the following steps.
3	With a wheatstone bridge at the CO, measure the resistance between the tip conductor of the desired pair and the common.
4	Now measure the resistance between the ring conductor of the desired pair and the common.

STEP	PROCEDURE
5	Finally, measure the resistance between the tip and ring conductors of the desired pair. See 3.69 for procedure of calculating percent of resistance unbalance.

Isolation Transformer

3.66 When an isolation transformer is used, the procedure is the same as above except that the four conductors should be shorted together on the CO side of the isolation transformer.

Integrated Protection System

3.67 Where the integrated protection system arrangement is employed on the PR channel, the following procedure should be used.

STEP	PROCEDURE
1	Ensure that black,personnel-protector plugs are in the proper position at both the high-voltage interface unit (HVIU) and the remote drainage unit (RDU).
2	At the HVIU, insert "red high potential" test plugs into the REM DRNG CA jack that corresponds both to the pair to be tested and to the spare pair.
3	At the RDU and the CO terminating unit (COTU), remove the shorting protection blocks for both pairs.
4	At the CO, short together the tip and ring conductors of the spare pair. This will be used as a common in the following steps.
5	Using a wheatstone bridge at the CO, measure the resistance between the tip conductor of the desired pair and the common.
6	Now measure the resistance between the ring conductor of the desired pair and the common.
7	Finally measure the resistance between the tip and ring conductors of the desired pair. See 3.69 for procedure of calculating the percentage of unbalance.

No Interface Unit or Transformer

3.68 When there is no interface unit or transformer used either for safety or noise reduction, there should be a direct path between power station and CO. The procedure for testing resistance unbalance will be the same as in 3.65 except that there is no neutralizing transformer, and the shorting of conductors at the power station location should be done as close to the terminating unit as possible. Again, 3.69 should be consulted for a procedure of calculating resistance unbalance percentage.

3.69 In each of the above procedures, three resistance values are obtained. Use the formula below and these values to determine the percentage of resistance unbalance.

(a) Tip and Common = (T + C)

(b) Ring and Common = (R + C)

(c) Tip and Ring = (T + R)

$$\frac{(T + C) - (R + C)}{(T + R)} \times 200\% = \text{Percent Unbalance}$$

3.70 ***Example of test:*** A spare pair of conductors is selected, and the pair to be tested is chosen. The appropriate procedure above is completed to obtain the following measurement results:

Tip plus Common	750 ohms
Ring plus Common	746 ohms
Tip plus Ring	1000 ohms

Following the procedure in 3.69.

$$\frac{750 - 746}{1000} \times 200\% = 0.8\%$$

The resulting percentage of unbalance for the measured pair is within the limit, and the value shown should be recorded on Form XXXX as shown in Fig. 6.

4. USE OF CIRCUIT TRANSMISSION HISTORY RECORD

4.01 The tests to be performed to insure proper operation of the PR channel are given in Table B. These measurements should be made and the results recorded for future reference. A form is provided for this purpose, and since its use is optional, a reproducible copy (Fig. 10) is provided with this section.

4.02 The following is an explanation of entries for the Circuit Transmission History Record (Fig. 6). The number beside each item corresponds to the line number on the form:

1. Circuit number
2. Link or section of circuit if straightaway measurements are recorded.
3. Date of test
4. Circuit order number
5. Results of attenuation-distortion measurements (loss with respect to 1000 Hz)
6. Results of envelope delay distortion measurements (if needed)
7. Results of frequency shift measurements
8. Results of single-frequency interference measurements
9. Results of C-notched noise measurements
10. Results of local channel resistance unbalance
11. Results of C-message noise measurements
12. Results of 1000-Hz loss measurements
13. ◆Results of impulse noise measurement.◆

5. REFERENCES

5.01 The list below contains BSPs that are related to the PR channel and that may contain helpful information:

201-211-101	CO Terminating Unit For Integrated Protection System (IPS)—◆Description, Installation and Maintenance◆
310-540-100	Protective Relaying Channel—Description
638-600-100	◆Integrated Protection System for Power Station Communications—Description and Placing

638-600-101	Integrated Protection System for Power Station Communications–Installation
638-600-102	Integrated Protection System for Power Station Communications–High Potential and Resistance Unbalance Testing
638-600-103	Integrated Protection System for Power Station Communications–Assignment Charts and Circuit Establishment
638-600-104	Integrated Protection System for Power Station Communications–Installation Inspection, Test and Maintenance Requirements
667-302-102	SMAS-4A Access Point Locations
667-302-103	SMAS-4A Access Point Assignment
667-302-200	SMAS-4A Access Point Cross Connections
667-303-102	SMAS-5A Access Point Rules◄

CIRCUIT NUMBER	TRANSMISSION HISTORY RECORD								LINK NUMBER			
TEST DATE												
CIRCUIT ORDER NUMBER:	TRMT		RCV		TRMT		RCV		TRMT		RCV	
	ENV DELAY	ATTEN DIST	ENV DELAY	ATTEN DIST	ENV DELAY	ATTEN DIST	ENV DELAY	ATTEN DIST	ENV DELAY	ATTEN DIST	ENV DELAY	ATTEN DIST
300	X		X		X		X		X		X	
500	X		X		X		X		X		X	
600	X		X		X		X		X		X	
800												
1000												
1200												
1400												
1600												
1800												
2000												
2200												
2400												
2500												
2600												
2700	X		X		X		X		X		X	
2800	X		X		X		X		X		X	
3000	X		X		X		X		X		X	
Frequency Shift Hz												
Single-Frequency Interference dBrnc0												
C-Notched Noise dBrnc0												
Local Channel Resistance Unbalance %												
C-Message Noise dBrnc0												
1000-Hz Loss dB												
IMPULSE NOISE Ref — dBrnc0 Counts in 15 minutes — COUNTER: 1 COUNT												
2 COUNT												
3 COUNT												
Special Notes or Instructions:												

Fig. 10—Reproducible Copy of Transmission History Record