Transmission Testing
Impulse Noise Measurements

Contents

(continued)

Contents, continued

1. General

I.1 Purpose

This practice provides the:

- Requirements and techniques used in the measurement of impulse **noise.**
- Objectives required to transmit data that is reasonably free from errors caused by impulse noise when dedicated or switched facilities of the telephone network are used as the transmission medium.
- Parameters of impulse **noise** for the:
  - GTD-5.
  - Stromberg-Carlson DCO.
  - Northern Telecom DMS-100.

1.2 Filing Instructions

This practice supersedes issue 4, December 1979, and ail local practices addressing impiuse measurements **in** transmission testing. Remove issue **4** and replace with this issue 5 in the practices set.

1.4 Copyright and Responsibility

This practice was written by the COE Construction Department and published by the Telephone Operations Administrative Services Group. For more information about this practice contact the COE Construction Department.

1.5. **Disclaimer**

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2. **Overview**

2.1 Terms and Definitions

The following chart provides definitions for terms and acronyms used in this practice.

ACRONYM TERM	**DEFINITION**
C-Notch Noise	A **C-notch** noise measurement is comprised of the far end sending a 1004 Hz tone at -16 dBmP to the near end where a narrow notch filter removes the tone ahead of the noise measuring set. The remaining noise is measured using a C-message weighting network.
dB	See Decibel.
dBm	Frequently it is convenient to represent absolute power with a logarithmic unit. One milliwatt is the standard reference in the telephone industry, and signal power can be written as being so many dB above or below this reference power. dBm is defined as 10 log (Pl/Pr) where Pl is the power measured at the point of interest and Pr is the reference power; i.e., 1 milliwatt. By adding a reference point, dBm becomes a measurement of absolute power, rather than just a ratio, and can be readily converted to watts. Examples: 1. 10 dBm indicates a signal IO times greater than 1 milliwatt or 10 milliwatts. 2. A 30 dBm signal applied to an amplifier with 10 dB gain will result in a 40 dBm output. 3. A tone of 0 dBm will be measured as -15 dBm after passing through an attenuator of 15 dB.

(continued)

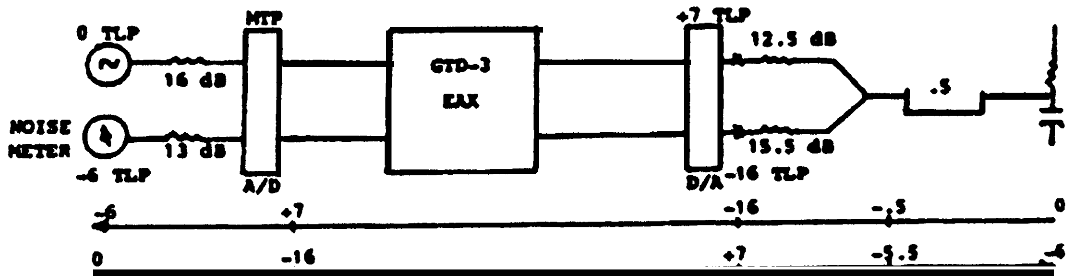
2.1
Terms and Definitions, continued

ACRONYM OR TERM	DEFINITION
dBmO	dBm0 is used to refer **measured** power back to the zero transmission level point. Measurements adjusted to dBm0 indicate what the power would have been, had it been measured at the zero transmission level point. For example, a tone measured at the -16 dB level point with a meter reading of + **8** dBm, is equal to **+24** dBm0.
dBrn	dBrn is a **unit** used to show the relationship between the interfering effect of a noise frequency or band of noise frequencies, and a fixed amount of noise commonly called reference noise. A tone of 1000 Hz having a -90 dBm level was selected as the reference noise: i.e., -90 dBm = 0 dBn.
dBrnC	Message circuit noise is commonly measured in units of dBMC. The “C” notation denotes the frequency weighting scheme used by the noise measuring set. The noise measuring sets indicate the amount of dBrnC on a circuit.
dBrnC0	The amount of “C” weighted noise (dBmC) on a circuit related to the 0 transmission level point. Noise measurements are made at the same point of access used for loss measurements. Since this equates to having the measuring set located at the -EML test level point, adjustments must be made to convert the meter reading to dBrnC0.

(continued)

2.1 Terms and Definitions, continued

ACRONYM OR TERM	DEFINITION
dBrnC0, continued	For example:



This circuit has an EML of 6 dB Assuming the noise originates at the far end, the noise reading will appear 6 dB better than It actually is. Therefore, the meter can be considered at a -6 TLP; to get the amount of noise in dBrnCO, you must add 6 dB to the dBrnC noise figure.

If the noise was measured at the + **7** TLP the noise reading will be 7 dB higher than it actually is. Therefore, in this one case, you would subtract 7 dB to obtain a noise figure in dBmC0.

The following rule can be applied for determining the noise in dBrnC0 at any TLP:

Measure the noise in dBrnC, then subtract the TLP value.

Example:

1. If TLP is the -16 point, then
   dBrnC0 = dBrnC - (-16)
   = dBrnC + 16

2. If TLP is the +7 point, then
   dBrnC0 = dBrnC - (+7)
   = dBrnC -7

(continued)

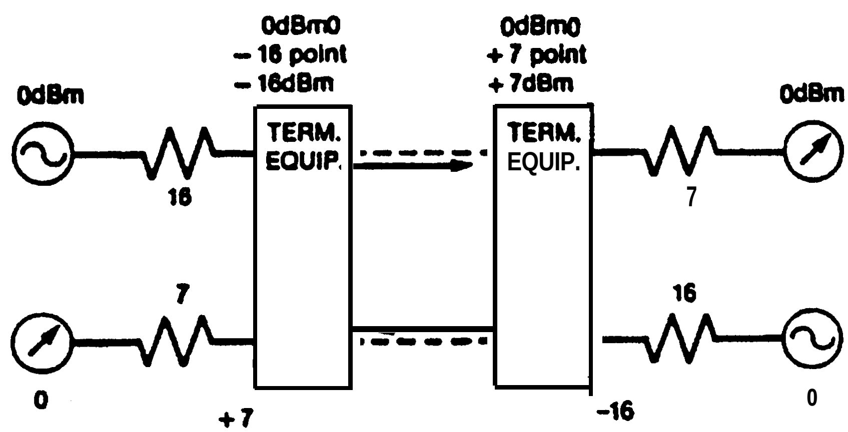
2.1 Terms and Definitions, continued

ACRONYM OR TERM	DEFINITION
Decibel	Decibel (dB) **is the basic unit of measure in communications. Decibel is an** expression of a ratio. Although normally related to power ratios (P2/Pl), it can be used to describe voltage or current ratios. The relationship between any two power values can be calculated in decibels as: **dB =** 10 log (Ps/Pl) where P2 is the larger power for positive values Thus, a given number of decibels is always the relationship between two powers and not an absolute power by itself. For example, the gain in an amplifier or the attenuation of a pad can be expressed in decibels without the knowledge of the input or output power.
Transmission Level Point	In designing transmission circuits and laying them out for operation and maintenance, it is necessary to know the signal amplitude at various points in the system. These values can be determined conveniently by the use of the transmission level point concept. The transmission level at any point in a transmission circuit or system is the ratio, expressed in decibels, of signal power at that point to the power of the same signal at a reference point called the zero transmission level point (0 **TLP) .** Thus, any point in a transmission circuit or system may be referred to as a transmission level point. Such a point is usually designated as a -x dB TLP where x is the designed loss from the 0 TLP to that point.

(continued)

2.1
Terms and Definitions, continued

ACRONYM OR TERM	DEFINITION
Transmission Levei Point, continued	Application of the transmission level point concept begins with the choice of a reference point and the arbitrary assignment of 0 dB transmission level to that point. Other transmission level points in the trunk or system are then related to the reference point by the number of dB of gain from the reference point to that point of interest. The following is an example of the various transmission level points in a circuit.



2.2
Noise

"Noise" is an unwanted signal that:

- Enters or is created within a communication system.

 AND

- interferes with the desired signals on the system.

2.3
Impulse Noise

"Impulse **noise" is one form of noise** described in Paragraph 2.2. impulse **noise consists of short-duration** pulses of unwanted signals which occur randomly in the transmission medium. in the telephone network, transients generated by switching operations and lasting for less than one to a few milliseconds constitute the largest source of impulse noise. With the introduction of data transmission on the telephone network, high amplitude excursions of noise made it necessary to optimize transmission performance for both data and voice communications. impulse noise hits of sufficient magnitude (exceeding the threshold standard) can seriously increase the error rate of a data communication system.

2.4 Causes/Sources of Impulse Noise

Known causes for impulse noise are:

- **The** seizure and release of relays due to lack of spark suppression.
- The FB 10232 grid cards in the NO. 2 EAX central office.
- The release of the H-560298 Selector with the linefinder distribution switch.
- The A and B release relays associated with the linefinder distribution switch.
- Vibration of wipers or reed relays.
- Bridging of equipment wipers.
- Dirty contacts on pulsing and cut-through relays.
- Rotary switches with bad spark suppression resistors.

The most damaging sources of impulse noise are:

- Mechanical vibration of the switch wipers.

  REMEDY Reduce noise caused by wiper vibration by cleaning the switch banks and wipers. This improves the electrical contacts and reduces the chance that mechanical shock may disturb the electrical circuit.

- Bridging of the wiper between adjacent contacts.

  REMEDY Replace worn wipers.

- Pulsing of electrical switch relays.

  REMEDY: Clean and **adjust the** switch. Check and replace the spark suppression networks as required.

2.5 Mitigative **Measures**

In SxS central offices, cleaning and adjusting the switches according to standard practices results in improved performance and reduced impulse noise.

Impulse noise problems in offices other than SxS offices require engineering **assistance** for mitigative measures.

3. **Impulse Noise Requirements**

3.1 Introduction

Impulse noise measurements on trunks need not be made at the **time when circuit** order tests are made; **therefore, no circuit order limits are specified.** Impulse **noise measurements are required** at **the time of the initial lineup of trunk facilltles when so specified in other sections of GTE Telephone Operations Practices.**

Trunks and switching offices are not tested on a routine basis unless trouble conditions indicate the desirability of tests to isolate impulse noise problems affecting customer service.

Impulse noise requirements are listed in Exhibit 1. The requirements are met by using a Type TTS-589A Impulse Noise Counter. The reference level (refer to the LEVEL column in Exhibit 1) is used to set the REF LEVEL DBRN switches on the impulse noise counter.

3.2 Loops

Measurements are made from the CO or referred to another point through the 1,004 Hz loss to the CO.

3.3 Connections

Customer-to-customer connections include two loops and any number of trunks in tandem. These connections make up the transmission path encountered by a customer. The requirement for connections is specified as 5 dB below the received level of the data signal. This level is determined by transmitting a 0 dBm0 test tone at 1,004 Hz from the far end. Since the receive level of the data signal Is -13 dBm0, the level to be set on the impulse noise counter must be 18 dB below the receive level of the test tone.

3.4 Switching Off ices

All switching offices contribute to impulse noise. The degree of contribution varies with the type of office as follows:

SxS Offices - Contact noise in SxS offices has been a known source of impulse noise. Impulse noise in SxS offices varies considerably from office to office and from call to call within an office. Nevertheless, in most cases, the expected data transmission performance is still good. The impulse noise requirements are referred to the level at the switching off ice.

EAX Offices - In keeping with the technical changes and the continuing effort to suppress impulse noise in new equipment, the design objectives for such noise In EAX offices are tighter than the maintenance objectives proposed for older switching equipment. The requirements are referred to the level at the switching office.

3.5 Trunks

Impulse noise requirements for voice-frequency and carrier trunks are referred to the Zero Transmission Level Point (0 TLP). Requirements for trunks consisting of compandored facilities or mixed compandored and noncompandored facilities **are** listed separately in Exhibit 1. Compandored facilities and mixed compandored and noncompandored facilities are measured with **a -13** dBm0 holding tone to operate the expandor. The requirements are based on the statistical behavior of impulse noise across trunk groups and must not be used for individual trunk measurements. Measurements made on any single trunk may be taken as 15 counts in 15 minutes at the level given in Exhibit 1.

3. IMPULSE Noise Requirements, continued

3.6 Facilities

Impulse noise requirements for facilities are applicable only from voice-frequency patch to voice-frequency path bay (or equivalent) and are referenced to 0 TLP Requirements for compandored facilities are stated separately in Exhibit 1 and are measured with a -13 **dBm0 holding tone** to keep the expandor operating at a fixed loss. The requirements are based on the statistical behavior of impulse noise as it affects **facility** groups and **must not be used for individual facility measurements. The requirement for any individual trunk** may be taken as fifteen **counts in** fifteen minutes at the level given **in Exhibit 1.**

4. Measurement of IMPULSE Noise

4.1 Introduction

The characteristics of impulse noise **are such** that the test sets designed to measure message **circuit** noise cannot properly measure impulse **noise.** The Type TTS-58A impulse noise counter is designed to properly **measure impulse noise.**

4.2 **Level Correction**

Levels specified for measurements with **the Type TTS-58A impulse noise** counter are referenced to 0 **TLPO. Points other than 0 TLP are referred to 0 TLP using the loss experienced by a** 1,004 Hz, **OdBmO tone transmitted from the far end to** the point of measurement.

4.3 **Holding** Tone

Measurements made on compandored carrier **systems or mixed** compandored **and noncompandored systems are made with the application of a holding tone at -13 dBm0 (2,800 Hz) applied at the far** end. **A notched filter is used with the Type TTS-58A impulse** noise counter to **block the tone at the impulse noise counter.**

The expandor is operated at a fixed loss by application of the holding tone. The requirements specified for compandored systems account for the fixed expandot loss and are not valid if the holding tone is not applied.

4.4 Measurement lime

Measurements may be made at any time during the normal working day (9:00 a.m. to 430 p.m.). However, in the event that measurements **are** being made because of a particular customer's complaints, the measurements must be made during the hours that the customer observes the trouble condition.

4.5 **Slope**

If impulse noise counts versus threshold level is plotted on semilogarithmic graph paper, the curve approximates a straight line (constant slope). Exhibit 2 shows two such plots:

- An average distribution of 7 **dB** per decade.
- A bad distribution of 20 **dB** per decade.

Exhibit 3 shows the 7 **dB** per decade curves that may be used to convert **from** a given count and threshold to another count and threshold.

5. Measurement Techniques – Sampling

5.1
Introduction

Impulse noise is **time-variable and ordinarily requires long intervals of testing to establish its existence at impairment levels. Impulse** noise is also facility oriented **rather than** channel **oriented; i.e., impulse** noise induced in lines from external sources affects facility groups of channels rather than Individual channels alone. To shorten test intervals, methods **of sampling** have been developed that take these characteristics into **account. By these methods, several relatively short** tests are made on several channels rather than long tests on single channels.

The following paragraphs **describe procedures** for measurements on trunks, facilities, and CO switches. The sampling technique adaptable to trunk and facility measurements is “sequential sampling,” a procedure of successive tests in which a decision is made after each test on the basis of cumulative results. the CO measurements are made on a small sample of the many possible combinations of paths, and a decision is made on the test results of this sample.

5.2
Trunk and Facility Measurements - Sequential

The basic procedure for evaluation fo impulse noise on trunks and facilities using the sequential sampling technique is **to look at the** cumulative value of some parameter after each test or measurement is completed. On the basis of the cumulant, one of three possible actions may be taken:

- Accept the lot under test.
- Reject the lot under test.
- Make another test.

This method of testing has the advantage of requiring a minimum number of measurements if the population under test meets or fails the acceptance criterion by a considerable margin. Thus, a very good system is accepted or a very poor system rejected after a small number of measurements. However, systems that are borderline may require a large number of tests. By performing the tests, it can be determined whether the median noise count is above or below five. The objective for trunks is five counts in five minutes at the levels given in Exhibit 1. Testing terminates as soon as it has been reasonably well determined that **the** median is five or less (accept the system) or six or more (reject the system).

Two kinds of errors can be made. One may:

- Accept a system that is actually bad.

  OR

- Reject a system that is actually good.

5.2 Trunk and Facility Measurements - Sequential, continued

It is desirable to minimize the probability of either kind **of error. These** probabilities can be made arbitrarily small, but at the **expense of additional testing. In** the procedure described in this practice, **the choice** of a **10 percent** probability of error in the acceptance of rejection of a system has been made. **Once the choice** has been made, the procedure described In this practice determines that upper bound on the number of tests (or the sample size required. However, the testing may terminate before the maximum sample size is achieved. Such a termination in no way affects the error probability; it simply **means that** the performance of the system being tested is somewhat better (or worse) than the objective.

5.3 Testing

To test trunks or facilities, proceed as follows:

NOTE: A test trunk group is defined as all trunks between common test points; e.g., all trunks between testboard appearances would make up an intertoll trunk group.

Step	Testing Trunks or Facilities
1	Use a Noise Impulse Sample Test Sheet - Trunk Groups (Form **000449PS**, Exhibit **4).**

In the column designated:	**Enter:**
CUMULATIVE NUMBER OF TRUNKS MEASURED	The numbers according to the number of trunks being measured.
REMARKS	Either compandored or noncompandored, as required.
TEST LEVEL	The test level (obtain from Exhibit 1).
DECISION NUMBER OF O'S OR 1 'S	The decision number (obtain from Exhibit 5). Note that this value starts with the fourth trunk to be tested. In Exhibit 5, note that all trunk groups containing 44 or more trunks (regardless of the size of the group) will use 26 as the decision number for determining whether a group is good or bad.

(continued)

5.3 Testing, continued

Step	Testing Trunks or Facilities
2	**Terminate** the far end of the trunk (Code 100 or equivalent) and **connect a Type TTS-58A impulse** noise counter to the trunk at the near end. Refer to Paragraph 4.3 for compandored trunks.
3	**Set** the test level on the impulse noise counter by using the REF LEVEL DBRN LO LEVEL switches. Set the MID LEVEL switch 4 dB higher and the HI LEVEL switch another 4 dB higher. For example, set the switches for 66, 70, and 74 dBrn.
4	Set the impulse noise counter registers to 0000.
5	Set the timer for five minutes.
6	At the end of the five-minute test inten/al, observe the readings on the registers. If the total of all registers is 5 or less, enter a 1 in the CUMULATIVE NUMBER OF TRUNKS MEASURED column. If the registers totaled more than 5, enter a 1 in the CUMULATIVE 1 ‘S column opposite the 1 in the CUMULATIVE NUMBER OF TRUNKS MEASURED column.
7	In the same manner as described in Steps 2-6, test the remaining trunks in the group in a random manner. The next trunk measured is entered in either the CUMULATIVE 1 ‘S or CUMULATIVE O’S column, depending on the register total, and a cumulative total for that column is shown. For example, in Exhibit 4, the third trunk was the second trunk with five or less counts to be tested, and the fifth trunk was the second trunk with more than five counts to be tested. Continue testing until either the cumulative 1 ‘s or O’s exceed the decision number. If the exceeding cumulative number appears in the O’s column, accept the group. if the exceeding cumulative number appears in the I’s column, reject the group. if neither O’s or I’s exceed the decision number after the maximum number of tests and there are equal O’s and 1 ‘s, accept the group.

Exhibit 5 is based on a 90 percent confidence level of making the right decision. In the example of Exhibit 4, the group passed after making seven tests. If the actual noise level for the group is at least 2.5 dB above or below the objective, the chance that testing sequences will produce an erroneous conclusion is less than one percent.

6. Central Office Measurements

6.1 Introduction

The sampling plan for measuring impulse noise in COs requires that the office be defined as being inclusive of all of the equipment and cable that is required to complete a connection from one termination on the Main Distributing Frame (MDF) to some other termination on the MO For ease of administration, a single office is defined as only those MDF terminations assigned to a single exchange number, even though more than one such number may exist for a given switching system.

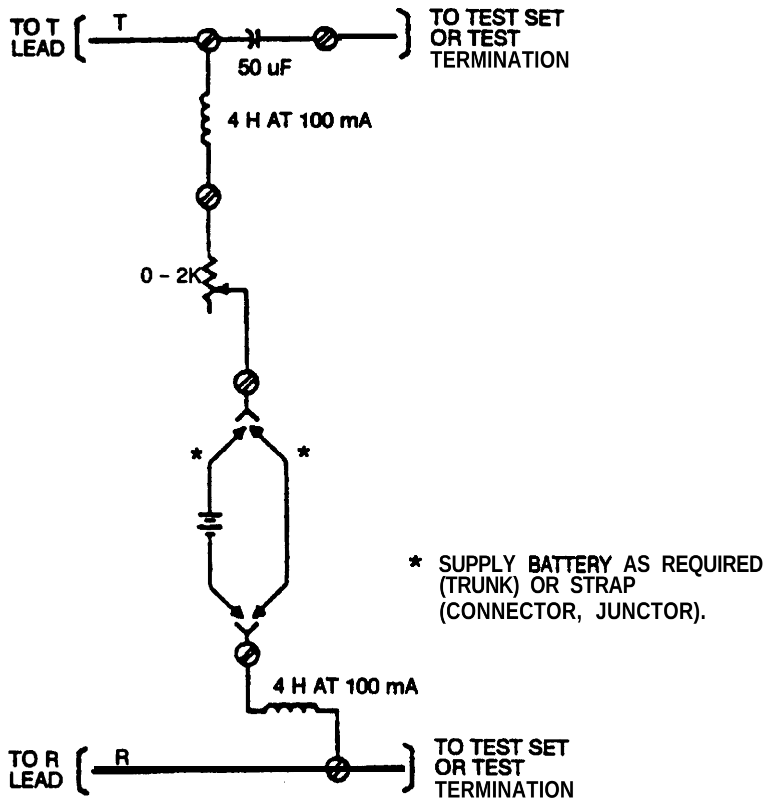
Since there Is a large number of possible paths that may be taken for a connection between two arbitrary MDF terminations, and since there are n (n-1) possible termination pairs (where n is the total number of such terminations), a sampling plan is required to evaluate the noise encountered on connections through an office.

The population from which a test sample is drawn is all the spare MDF terminations included in a single exchange number. Two linefinder groups or two trunk link frames are picked at random. One spare terminal in each group is assigned a directory number and designated the called terminal. A total of IO other spares are picked arbitrarily within each group. In offices with a high fill, 11 spares may not be available in any group. In these cases, any 22 spares may be used. Calls are established sequentially from each of the 10 spares within each group to the called terminal within the group.

6.2
Testing

Perform the test as described in the following chart.

Step	Measuring Impulse Noise in COs
1	Fabricate two boxes locally. A circuit of a typical test box is shown below.



Step	Measuring Impulse Noise in COs
2	Connect one test box to the calling line.
3	Connect one test box to the called line.
4	Connect the Type TTS-58A impulse noise counter to the test box on the called line, and a 900-ohm plus 2.16 microfarad test termination to the test box on the calling line.
5	Set the test level on the impulse noise counter by using the REF LEVEL DBRN LO LEVEL switches. Set the MID LEVEL switch another **4** dB higher.
6	Establish a connection to the called line.

(continued)

6.2
Testing, continued

Step	**Measuring Impulse Noise in COs**
7	**Set** the impulse noise counter registers to 0000, and set the timer for five minutes.
a	At the end of the five-minute test interval, observe the readings on the registers. If the total of all registers is 5 or less, record a 0 for that measurement. if the total is more than 5, record a 1.
9	Connect a Type TJS-37B noise measuring set to the line and test for C-message weighted noise. The C-message weighted noise should not exceed 18 dBrnC on trunks and **20** dBrnC on loops.
10	Repeat this test procedure until 20 measurements have been made.

The office is acceptable from an impulse noise standpoint if no more than six 1's are recorded in either of the two groups of 10 measurements. This criterion ensures that 50 percent of calls through the office will have five counts or less in five minutes with 90 percent confidence.

Since it is proposed that an office be evaluated only after a specific noise complaint has been traced to the office, the results of the measurements should be forwarded to the appropriate evaluation group for follow-up action.

IMPULSE NOISE REQUIREMENTS

PARAMETER	CONDITIONS	LEVEL	
Loop	No more than 15 counts in 15 minutes on all loop6. level at CO or referred to level at CO through loss of 1,OOOHz tone.	59 dBmC	
Connection	No more than 15 counts in 15 minutes on at least 50% of calls.	5 dB below signal level	
co	No more than 5 counts in 5 minutes on 50% of test calls.	sxs	59 dBmC
	Immediate action limit: 100 counts of mom in 5 minutes.	EAX GTD-5 SC-DC0 DMS-100	47 dBmC 45 dBmC0 52 dBrnC0 53dBmC0
	Level at CO.		
Voice Frequency And Carrier Trunk	No more than 5 counts in 5 minutes on 50% of trunks in the group.	Voice frequency	54dBmC0
	Requirement on any single channel or trunk is 15 counts in 15 minutes.	Compandored or mixed	66 dBmCO *
		PCM carrier	62 dBmCO (See Note)
	Immediate action limit: 100 count8 in 5 minutes.	Noncompandored 1 to 125 miles 125 to 1,000 miles 1,000 to 2,000 miles Over 2,000 miles	56 dBmCO 59 dBmCO 61 dBmCO 64 dBmCO
		• With -13 dBm0 (2,600 Hz) holding tone.	
Facilities	No more than 5 counts in 5 minutes cm 50% of trunks.	Voice frequency	52 dBmCO
	Immediate action limit: 100 counts in 5 minutes.	Compandored or mixed	64 dBmCO •
		PCM carrier	60 dBmCO
		* With -13 dBm0 (2,800 Hz) holding tone.	
	125 to 1,000	Noncompandored 0 to 125 miles 125 to 1,000 miles 1,000 to 2,000 miles Over 2,000 miles	 56 dBmCO 57 dBmCO 59 dBmCO 62 dBmCO
Private Lines	Refer to the 800-100 subdivision of AG Communication Systems practices..		

NOTE: Do not us8 holding ton8 when measuring trunks on PCM carrier facilities.

Exhibit 1 – Impulse Noise Requirements

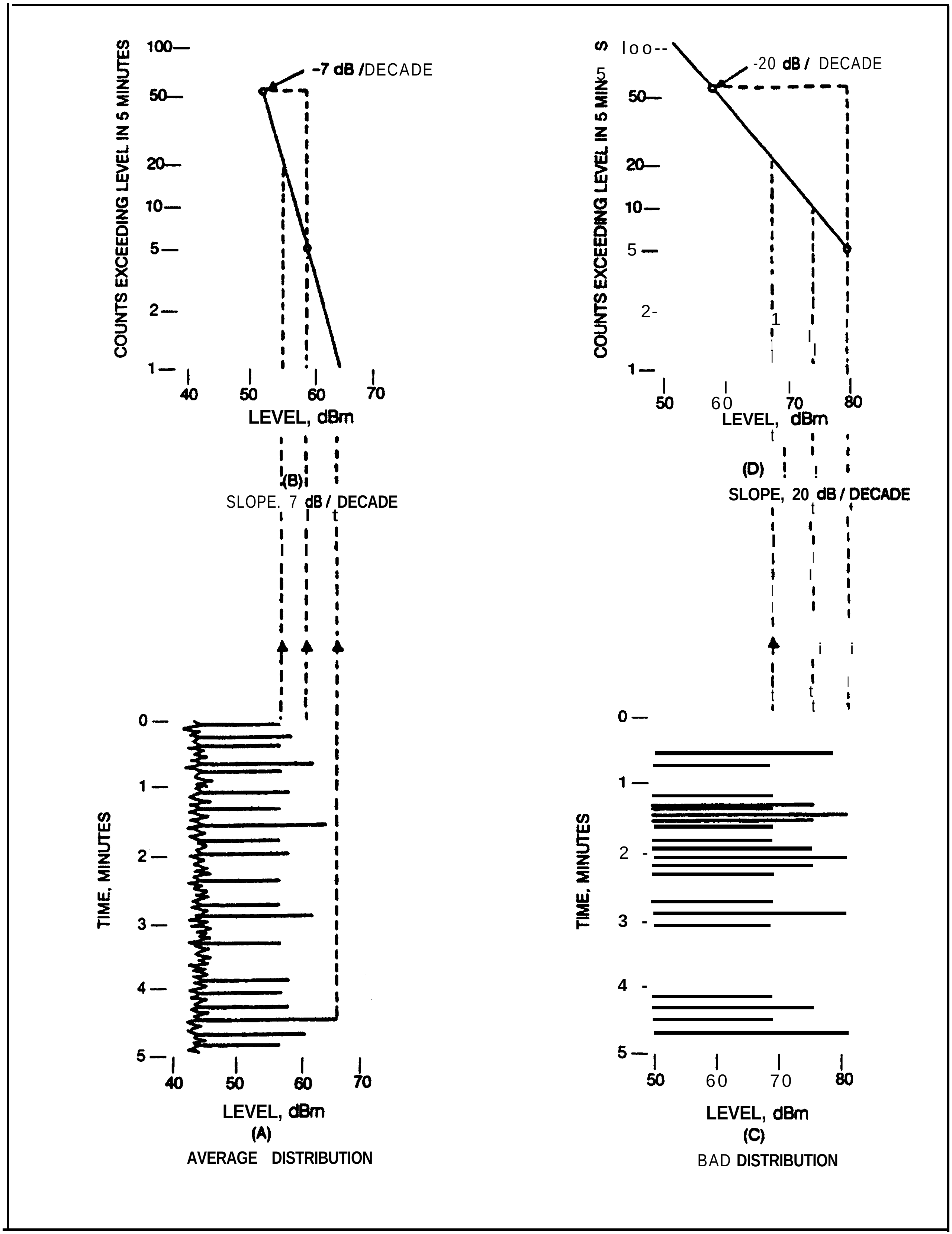


Exhibit 2 – Relationship Between Distribution and Slope

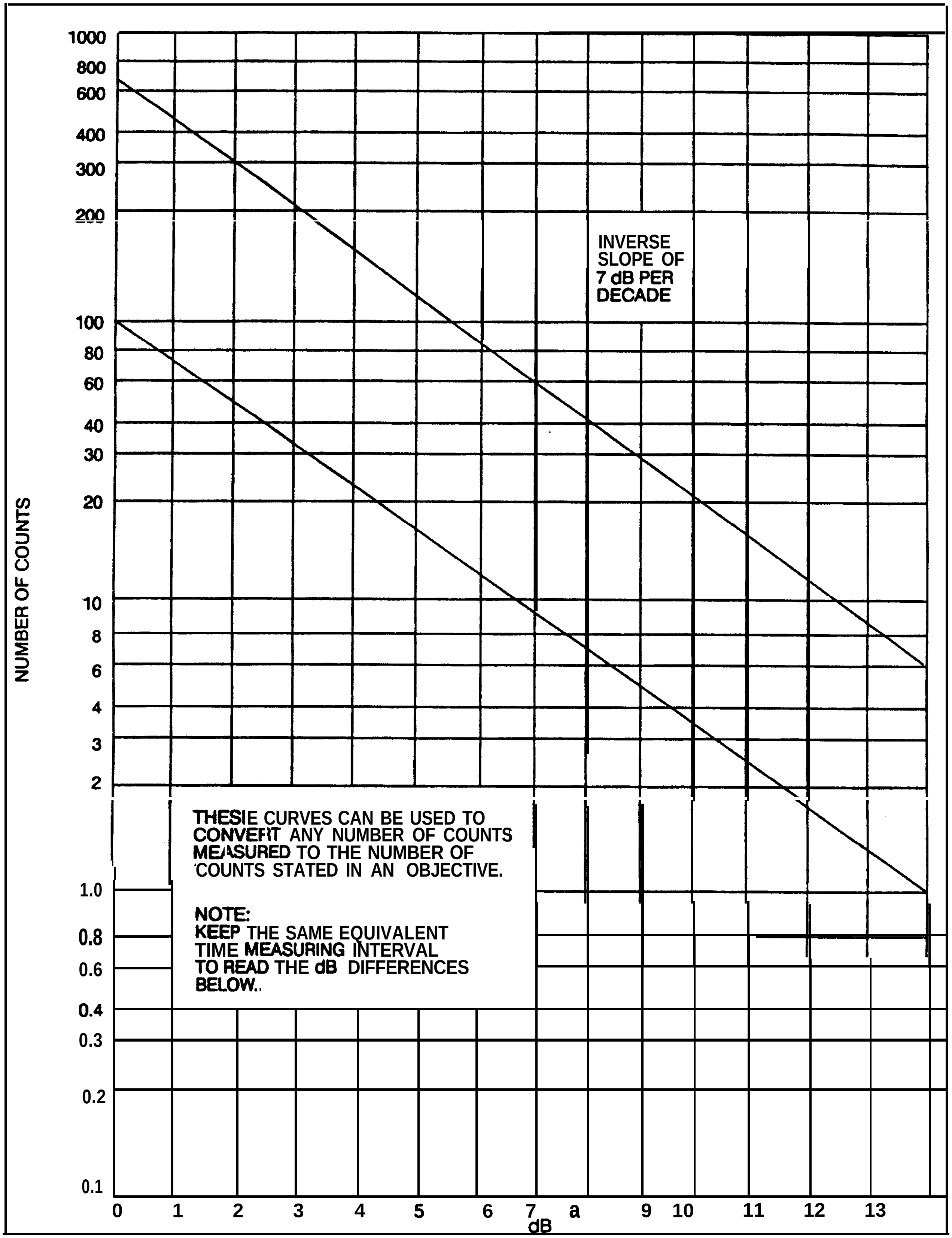


Exhibit 3 – Conversion Chart (Page 1 of 2)

EXAMPLE 1:

If **60** counts in **30** minutes are measured at a level of 50 dBmC, how many counts in **5** minutes can be measured at **47** dBmC?

(A) Find **60** counts on the upper slope line (note that this corresponds to approximately 7.5 dB relative).

(B) **47** dBrnC (the new value is 34 dB less than 50 dBrnC. Subtract 3 dB from the **7.5 dB** relative found in (a). The new **dB** relative value **(7.5 dB** relative -3 **dB)** = **4.5 dB** relative.

(C) Enter the chart at **4.5 dB** relative and read approximately 150 counts on the upper slope line (remember that the 150 counts are for 30 minutes).

(D) To convert 150 counts in **30** minutes to the equivalent number of counts in **5** minutes, divide by 6 **(i.e.**, 30 minutes divided by 5 minutes = 6). Therefore, 6 is the divisor, and 150 counts in 30 minutes equals 25 counts in **5** minutes.

EXAMPLE 2:

If 40 counts in 30 minutes are measured at a level of 52 **dBrnC,** at what level would **we** expect to read 5 counts in 5 minutes?

(A) First make the time interval the same. Multiply 5 counts in 5 minutes by 6 to get 30 counts in 30 minutes.

(B) Enter either the upper slope or the lower slope line at 40 counts. For this example, use the lower slope line. This equals approximately 2.8 **dB** relative.

(C) Move down the slope line to 30 counts and read approximately 3.6 **dB** relative.

(D) Since we moved to the right from 2.8 **dB** relative to 3.6 **dB** relative, add the difference to the original level of 52 **dB** to find the new level (3.6 **dB** relative minus 2.8 **dB** relative = 0.8 **dB** or **1 dB** rounded off).

(E) The new level value is 52 **dBrnC** + 1 **dB** = 53 **dBrnC.** At 53 **dBrnC,** we would expect to read **5** counts in 5 minutes.

Exhibit 3 – Conversion Chart (Page 2 of 2)

NOISE IMPULSE SAMPLE TEST SHEET
TRUNK GROUPS
FORM 000449PS
REF. 331-365-510

TRUNK GROUP	DATE	
MAIN - SOUTH	7-19-89	
OFFICE	ACCEPT	REJECT
FTW MAIN	X	

CUMULATIVE NUMBER OF TRUNKS MEASURED	REMARKS	TEST LEVEL	DECISION NUMBER OF 0's OR 1's	CUMULATIVE	
				0's	1's
1	Compandored	64	-	1	-
2	Compandored	64	-	-	1
3	Compandored	64	-	2	-
4	Noncompandored	52	3	3	-
5	Noncompandored	52	3	-	2
6	Noncompandored	52	4	4	-
7	Compandored	64	4	5	-
8			5	-	-
9			5	-	-
10			6	-	-
11			6	-	-
12					

Accept if 0's exceed Decision Number	Reject if 1's exceed Decision Number

Accept if equal 0's and 1's after maximum number of tests

Exhibit 4 – EXAMPLE – Impulse Noise Sample Test Sheet – Trunk Groups, Form **000449PS**

Decision Numbers of O's and 1's for Various Trunk Group Sizes (Page 1 of 2)

CUMULATIVE NUMBER OF TRUNKS TESTED	SIZE OF TRUNK GROUP					
	5T0 12	13 TO 18	19 TO 24	25 TO 30	31 TO 43	44 OR MORE
4	3	3	3	3	3	
5	3	4	4	4	4	5
6	4	4	4	4	4	6
7	4	5	5	5	5	6
8	5	5	5	5	6	7
9	5	6	6	6	6	7
10	6	6	6	6	7	8
11	6	7	7	7	7	9
12	6	7	7	7	8	9
13		7	8	8	8	10
14		8	8	9	9	10
15		8	9	9	9	11
16		9	9	10	10	12
17		9	10	10	10	12
18		9	10	11	11	13
19			10	11	11	13
20			11	12	12	14
21			11	12	13	14
22			12	12	13	15
23			12	13	14	16
24			12	13	14	16
25				14	14	17
26				14	15	17
27				15	15	18
28				15	16	18

Exhibit 5 – Decision Numbers of O's and I's for Various Trunk Group Sizes (Page 1 of 2)

Decision Numbers of O's and 1's for Various Trunk Group Sizes (Page 2 of 2)

CUMULATIVE NUMBER OF TRUNKS TESTED	SIZE OF TRUNK GROUP					
	5 TO 12	13 TO 18	19 TO 24	25 TO 30	31 TO 43	44 OR MORE
29				15	16	19
30				15	17	19
31					17	20
32					la	21
33					la	21
34					19	22
35					19	22
36					20	23
37					20	23
36					20	24
39					21	24
40					21	25
41					21	26
42					21	26
43					21	26
44						26
45						26
46						26
47						26
46						26
49						26
50						26

NOTES:
1. Accept group if O's exceed decision number.
2. Reject group if 1's exceed decision number.
3. Accept group if equal O's and 1's after maximum tests.

Exhibit 5 - Decision Numbers of O's and l's for Various Trunk Group Sizes (Page 2 of 2)