# DATA SYSTEM—"DATAPHONE®" SERVICE AND OTHER DATA SERVICES ON THE DIRECT DISTANCE DIALING NETWORK OVERALL DATA TRANSMISSION TEST LIMITS

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## 1. GENERAL

1.01 This section describes the overall transmission considerations and test requirements involved in providing data transmission over the switched telecommunications network (DDD) using loops, trunks, and switching equipment as used in voice service. This section applies to both DATAPHONE® service and to data services using customer-provided equipment (CPE) unless otherwise specified. There are no specific requirements for inductively or acoustically coupled data stations. Specific test requirements for access lines [subscriber, foreign exchange (FX), wide area telecommunications service (WATS), and PBX extentions] used for data transmission are given in Section 314-205-501. The overall minimum acceptable performance (MAP) criteria for the network facilities are given in Section 314-205-503.

*Note:* In this section the term telco applies to all Operating Telephone Companies, Bell System and Independent.

1.02 This section is reissued for the following reasons:

- To update information on customer-provided equipment
- To include voice and data jacks
- To provide information on satellite trunks
- To update test requirements
- To include trunk maintenance and immediate action limits for use in trouble analysis.
- To include information on international data service.

Since this is a general revision, change arrows ordinarily used to indicate changes have been omitted.

**1.03** Data services on switched network are supported to the 50 states and Canada. Other international service is not supported.

**1.04** In general, data transmission calls are handled the same as voice telephone calls. The calling party dials the desired number and the called party answers. When the parties are ready to send or receive data, both parties change their mode of operation from voice to data by the operation of pushbuttons or keys either built into or associated with the data set. It is necessary that the data sets on both ends of the connection be of the same type and be compatible in bit rate, frequency, etc. Upon completion of the data transmission, both parties (by previous agreement) either hang up or return to the voice mode. There are exceptions to this procedure; eg, the called station may be unattended. If the called station is unattended, the calling party receives a tone indicating that the distant end data set has answered and is ready to receive (or send) data. At the end of the call, the distant end will disconnect under the control of the far-end business machine equipment. Another exception is in the use of automatic calling units. These units permit a computer or other similar business machine to "dial" the desired number. These systems are usually associated with the unattended service feature described above, and therefore no person is involved at any time during the sequence of operations.

**1.05** In order to test DATAPHONE services, that is, data services using telco data sets at both ends, a number of 904-type data test centers (DTC) have been established in various locations in the Bell System and are used in conjunction with local and toll test centers. The 904A, B, C, and D data test centers are arranged for remote testing and monitoring of data sets in DATAPHONE service and in voiceband private line services. The 904G and H are arranged for remote testing and monitoring of data sets of the 101-, 103-, or 105-type. Section 807-460-165 contains a description of all 904-type data test centers and references to other sections with additional information on these test centers. Section 314-205-300 provides information on the overall transmission maintenance procedures.

**1.06** The voice or data jacks provide means for registered data sets to be connected to the DDD network. When CPE data set is used with these jacks, neither the error rate performance is specified nor is the data set tested by the DTC or by other telco personnel.

> ***Note:*** After July 1, 1978, only registered data sets may be connected to the network; however, apparatus legally connected to the network before this date (grandfathered apparatus) can remain connected for life.

**1.07** An important characteristic of analog transmission systems is that the adjustment of a component made at any one point will have an effect upon adjustments made at other points. Therefore, it is important in clearing transmission difficulties to correct the basic cause of the trouble rather than to make terminal adjustments to eliminate the symptoms.

## 2. TRANSMISSION ASPECTS OF DATA SERVICES

**2.01** The data subscriber line should meet the objectives given in Section 314-205-501.

**2.02** There are a number of transmission considerations which may affect data transmission over the DDD network. They are as follows:

(a) Maximum transmitting level and overall circuit loss

(b) Attenuation frequency distortion (slope)

(c) Return Loss

(d) C-notched noise ratio

(e) Impulse noise

(f) Peak-to-average signal ratio (P/AR)

(g) Envelope delay distortion

(h) Frequency shift

(i) Nonlinearities (Interdemodulation distortion)

(j) Phase jitter

(k) Hits—gain and phase

(l) Dropouts.

These items are covered in more detail in Parts 3 through 11 of this section.

**2.03** Several of the parameters listed above are primarily controlled by voice requirements. These include overall circuit loss, return loss, slope, and noise. Of the remaining parameters, data requirements are usually controlling.

**2.04** The performance of a data set generally deteriorates after the operating limits are exceeded; a small change may degrade the performance from good to intolerable. Maintenance and adjustment of data transmission equipment and facilities should be as close to the optimum point as possible. Proper adjustments to each section in the overall connection will increase the reliability of the service.

## 3. MAXIMUM TRANSMITTING LEVEL AND OVERALL CIRCUIT LOSS

**3.01** The maximum practical transmitting level of data sets is limited primarily by the maximum level that a steady tone or combination of tones which may be applied to a carrier terminal unit without overloading. Most DATAPHONE data sets have been designed so that the maximum transmitting level will not exceed one milliwatt into 900 ohms. Data jacks provide a means to limit, when necessary, the signal power delivered by a data set. In connection with initial installation tests (see Section 314-205-501), the loop insertion loss is measured and recorded. The maximum sending level for any data set is adjusted so as not to exceed -12 dBm at the main frame appearance of the subscriber line at the dial tone office. This will correspond to a maximum data signaling power of -13 dBm0 on toll carrier facilities. The transmit level can be verified by dialing the milliwatt supply from the customer's premises and subtracting the transmission measuring set reading from -12 dBm. Some types of DATAPHONE data sets such as the 400 series, transmit more than one tone simultaneously. The total power of all tones transmitted simultaneously must not be greater than -12 dBm. In order to keep receiving levels within requirements, the data set level should be set so it will be received at the dial tone office as close to the -12 dBm level as possible without exceeding it. Information on the transmit level options is found in the BSP installation section of that particular data set.

## 4. ATTENUATION FREQUENCY DISTORTION

**4.01** Excessive attenuation frequency distortion (also called slope) on voice-frequency data transmission increases the error rate by degrading the signal as it traverses the facility. For the entire station-to-station connection through the DDD network, the attenuation frequency (slope) should not exceed 14 dB between 1004 and 2804 Hz or between 400 and 1004 Hz for satisfactory operation of data sets.

**4.02** Table A gives maintenance and immediate action limits for single facility trunks.

## 5. RETURN LOSS REQUIREMENTS

**5.01** Return loss requirements are important for data services. Listener echo is critical for some data sets because the receiving data set on a connection will interpret the data received through the echo path as interference. Talker echo is not critical on terrestial circuits, but on satillite circuits it may be a problem.

## 6. SIGNAL TO C-NOTCHED NOISE RATIO

**6.01** Quantizing noise in digital carrier systems and the effect of compandors in digital and some analog systems result in signal dependent noise. Signal to C-notched noise ratio is a measure of noise with a signal present.

**6.02** Noise will not be a problem to data if a 24-dB signal-to-C-notched noise ratio is maintained throughout the connection. Single and multiple facility maintenance and immediate action limits are given in Tables B and C.

## 7. IMPULSE NOISE

**7.01** Impulse noise hits are a primary source of errors in data transmission. A 6-type impulse noise counter is used to measure impulse noise on a facility. Information involving the use of the 6-type impulse counter can be found in the 103-6YY-ZZZ series of practices. The magnitude and frequency of the occurrence of the impulse noise voltages are used to specify the impulse noise objective. The objective is expressed as a threshold (referred to the zero transmission level point) which will be exceeded no more than a specified number of times per 15 minutes for individual circuit measurements.

TABLE A

ATTENUATION FREQUENCY
DISTORTION (SLOPE) LIMITS

| FACILITY | LOSS IN DB RELATIVE TO 1004 | | | | | |
|---|---|---|---|---|---|---|
| | MAINTENANCE LIMITS | | IMMEDIATE ACTION LIMITS | | TYPICAL | |
| | 400 Hz | 2800 Hz | 400 Hz | 2800 Hz | 400 Hz | 2800 Hz |
| OA, OB, OC, OD | −1.0, +2.5 | −1.5, +2.5 | −2.0, +4.0 | −2.0, +4.0 | ±0.8 | ±1.0 |
| ON | −1.0, +2.0 | −1.0, +2.5 | −2.0, +4.0 | −2.0, +4.0 | ±0.8 | ±1.1 |
| N1 | −1.0, +2.0 | −1.0, +2.5 | −2.0, +4.0 | −2.0, +4.0 | ±0.8 | ±2.3 |
| N2 | −1.0, +1.6 | −1.0, +2.0 | −2.0, +3.0 | −2.0, +3.0 | ±0.7 | ±1.2 |
| N3 | −1.0, +1.5 | −1.0, +1.5 | −2.0, +3.0 | −2.0, +3.0 | ±0.8 | ±0.6 |
| NR | −1.0, +1.6 | −1.0, +1.0 | −2.0, +3.0 | −2.0, +3.0 | ±0.8 | ±0.9 |
| R, LR, L | −1.0, +1.5 | −1.0, +1.0 | −2.0, +3.0 | −2.0, +3.0 | ±1.0 | ±0.6 |
| T1 (Toll) | −1.0, +1.0 | −1.0, +1.0 | −2.0, +3.0 | −2.0, +3.0 | ±0.5 | ±0.5 |
| T1 (Non-Toll) | −1.0, +2.1 | −1.0, +2.0 | −2.0, +3.0 | −2.0, +3.0 | ±2.3 | ±2.2 |
| Metallic (Non-Repeatered) | −1.0, +2.0 | −1.0, +3.0 | −2.0, +3.5 | −3.0, +4.0 | ±0.5 | ±0.5 |
| Metallic (Repeatered) | −1.0, +3.0 | −1.0, +4.5 | −2.0, +4.5 | −2.0, +5.5 | ±0.5 | ±2.0 |

**7.02** Impulse noise exhibits some level variation with the time of day; however, it is permissible to make these measurements any time during the normal business day. Measurements resulting from data transmission service trouble reports should be made during periods when the customer is experiencing trouble, if possible.

**7.03** The impulse noise objectives for trunks and facilities are given in Table D. The maintenance limit is five counts in 5 minutes and the immediate action limit is ten counts in 5 minutes.

**7.04** When measuring impulse noise, a -13 dBm0 holding tone is used. This stabilizes the expandor loss at 9.0 dB and activates quantizers in digital systems.

**7.05** Impulse noise objectives will be met if, throughout the connection, fewer than 15 counts in 15 minutes occur at a threshold 5 dB below the data signal.

## 8. ENVELOPE DELAY DISTORTION AND P/AR

**8.01** Envelope delay distortion (EDD) can seriously affect data transmission on the DDD network. Different frequencies undergo different amounts of delay as they are transmitted over the message network, which will cause the data signal to be distorted. The amount of envelope delay distortion on a voice-frequency trunk depends upon the type of facility and, in the case of cable, the length of the facility. Carrier system EDD is affected by the type of carrier and the multiplex arrangement.

## TABLE B

### C-NOTCH NOISE LIMITS IN d B r n c O*

| FACILITY | HOLDING TONE LEVEL IN dBmO | CIRCUIT LENGTH (MILES) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 – 100 | 101 – 200 | 201 – 400 | 401 – 1000 | 1001 – 1500 | 1501 – 2500 | 2501 – 4000 |
| Noncompandored | any | 32, 38 | 34, 38 | 35, 42 | 38, 42 | 39, 42 | 41, 46 | 43, 48 |
| Mixed Comp. N1, ON | −10 | 51, 54 | 51, 54 | 51, 54 | 51, 54 | 51, 54 | 51, 54 | 52, 54 |
| | −13 | 48, 51 | 48, 51 | 48, 51 | 48, 51 | 48, 51 | 48, 51 | 49, 52 |
| | −16 | 45, 48 | 45, 48 | 45, 48 | 45, 48 | 45, 48 | 45, 48 | 47, 49 |
| Noncomp or comp only N2, 3, 4 | −10 | 44, 47 | 44, 47 | 45, 47 | 45, 47 | 45, 48 | 46, 48 | 47, 48 |
| | −13 | 41, 44 | 42, 44 | 42, 45 | 43, 45 | 43, 45 | 44, 46 | 45, 46 |
| | −16 | 38, 41 | 39, 42 | 40, 42 | 41, 43 | 41, 43 | 43, 44 | 44, 45 |
| T1/D1A, B | −10 | 51, 53 | 51, 53 | 51, 53 | 51, 53 | 51, 53 | 51, 53 | 52, 53 |
| | −13 | 48, 50 | 48, 50 | 48, 50 | 48, 50 | 48, 50 | 48, 50 | 49, 51 |
| | −16 | 45, 47 | 45, 47 | 45, 47 | 45, 47 | 45, 47 | 45, 47 | 47, 48 |
| T1/other | −10 | 44, 45 | 45, 46 | 45, 46 | 46, 48 | 46, 48 | 48, 49 | 48, 49 |
| | −13 | 41, 42 | 42, 43 | 42, 43 | 43, 45 | 43, 45 | 45, 46 | 45, 46 |
| | −16 | 38, 39 | 39, 40 | 39, 40 | 40, 42 | 40, 42 | 42, 43 | 42, 43 |

* First number given in each entry is the maintenance limit and the second number is the immediate action limit.

TABLE C

SIGNAL – TO – C-NOTCHED NOISE RATIO IN DB*

| FACILITY | | HOLDING TONE LEVEL IN dBmO | CIRCUIT LENGTH (MILES) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0 – 100 | 101 – 200 | 201 – 400 | 401 – 1000 | 1001 – 1500 | 1501 – 2500 | 2501 – 4000 |
| Noncompandored | | –10 | 48, 42 | 46, 42 | 45, 38 | 42, 38 | 41, 38 | 39, 34 | 37, 32 |
| | | –13 | 45, 39 | 43, 39 | 42, 35 | 39, 35 | 38, 35 | 36, 31 | 34, 29 |
| | | –16 | 42, 36 | 40, 36 | 39, 32 | 36, 32 | 35, 32 | 33, 28 | 31, 26 |
| Mixed Comp | N1, ON | –10 | 31, 28 | 31, 28 | 31, 28 | 31, 28 | 31, 28 | 31, 28 | 30, 27 |
| | | –13 | 29, 26 | 29, 26 | 29, 26 | 29, 26 | 29, 26 | 29, 26 | 28, 25 |
| | | –16 | 27, 24 | 27, 24 | 27, 24 | 27, 24 | 27, 24 | 27, 24 | 26, 23 |
| Noncomp or comp only | N2, 3, 4 | –10 | 38, 35 | 37, 35 | 37, 34 | 36, 34 | 36, 34 | 35, 33 | 34, 33 |
| | | –13 | 36, 33 | 35, 33 | 35, 32 | 34, 32 | 34, 32 | 33, 31 | 32, 31 |
| | | –16 | 34, 31 | 33, 31 | 33, 30 | 32, 30 | 32, 30 | 31, 29 | 30, 29 |
| | T1/D1A, B | any | 29, 27 | 29, 27 | 29, 27 | 29, 27 | 29, 27 | 29, 27 | 28, 26 |
| | T1/other | any | 36, 35 | 35, 34 | 35, 34 | 34, 32 | 34, 32 | 32, 31 | 32, 31 |

* First number given in each entry is the maintenance limit and the second number is the immediate action limit.

TABLE D

IMPULSE NOISE OBJECTIVES

| FACILITY | HOLDING TONE LEVEL dBmO | THRESHOLD IN dBrncO | | | |
|---|---|---|---|---|---|
| | | CIRCUIT LENGTH (MILES) | | | |
| | | 0–125 | 126–1000 | 1001–2000 | 2001 AND OVER |
| Metallic | −10<br>−13<br>−16 | 54 | | | |
| Noncompandored | −10<br>−13<br>−16 | 58 | 59 | 61 | 64 |
| N or Mixed<br>N and<br>Noncompandored | −10<br>−13<br>−16 | 67<br>66<br>65 | 67<br>66<br>65 | 67<br>67<br>67 | 68<br>68<br>68 |
| T or Mixed<br>T and<br>Noncompandored | −10<br>−13<br>−16 | 69<br>67<br>64 | 69<br>67<br>64 | 69<br>67<br>65 | 70<br>68<br>66 |
| N3 (With VF amp) | −10<br>−13<br>−16 | 73 | 73 | 73 | 73 |

*Note:* Maintenance Limit: 15 counts in 15 minutes.

Immediate Action Limit: 20 counts in 15 minutes.

**8.02** EDD is usually expressed as the maximum variation of the envelope delay characteristic within a particular frequency band. This measurement is usually expressed as microseconds over the band of interest. With data service, envelope delay distortion should be suspected if high error rates which cannot be attributed to message noise, impulse noise, overall loss, or slope are encountered. The P/AR (peak to average ratio) meter (Section 103-110-110) is useful in determining the condition of a data transmission connection. P/AR measurements are primarily sensitive to EDD, but attenuation distortion and return loss may also have a strong effect on P/AR readings. Table D gives the maintenance and immediate action limits for single and multiple facility trunks. If P/AR limit is met, it should not be necessary to perform the envelope delay distortion test. Requirements for P/AR are given in Table E. Note that P/AR has both maximum and minimum limits.

**8.03** On occasion, envelope delay distortion will be too high within the DDD network for data transmission operation between two particular points on the network. Information about the situation should be forwarded through the lines of organization for reassignment or further investigation. It may be necessary to provide additional equalization at the data set location or to install a remote exchange (RX) line to bypass part of the network until better facilities can be provided.

## 9. FREQUENCY SHIFT

**9.01** Frequency shift (sometimes called frequency offset) beyond the capabilities of the data

TABLE E

P/AR REQUIREMENTS

| SINGLE AND MULTIPLE FACILITY TRUNKS | | | |
|---|---|---|---|
| FACILITY* | MAINTENANCE LIMITS** | | TYPICAL |
| | MAXIMUM | MINIMUM | |
| O, ON, N3 | 94 | 86 | 90 |
| N1 | 98 | 86 | 92 |
| L or Radio | 99 | 87 | 93 |
| N2 | 101 | 93 | 97 |
| T1 | 102 | 93 | 97 |
| 2T1 | 97 | 88 | 92 |
| 2N3 | 93 | 83 | 88 |
| 2N2 | 96 | 88 | 92 |
| 2N1 | 93 | 85 | 89 |
| T1 + N3 | 95 | 87 | 91 |
| T1 +N2 | 96 | 88 | 92 |
| N1 + N3 | 97 | 87 | 92 |
| ON + T1 | 96 | 87 | 91 |
| ON + A | 93 | 83 | 88 |
| ON + N3 | 93 | 83 | 88 |
| ON + N2 | 96 | 88 | 92 |
| ON + N1 | 96 | 88 | 92 |
| 2 ON | 91 | 83 | 87 |
| T1 + N1 | 96 | 87 | 91 |
| N2 + N3 | 97 | 87 | 92 |
| N1 + N2 | 95 | 87 | 91 |
| 2 "A" Type | 92 | 82 | 87 |
| A + T1 | 95 | 86 | 90 |
| A + N3 | 91 | 83 | 87 |
| A + N2 | 96 | 86 | 91 |
| A + N1 | 96 | 86 | 91 |
| 3A | 83 | 74 | 78 |
| NONREPEATERED CABLE | | | |
| Nonloaded (0—18 kft) | | 97 | |
| H88 (0—18 kft) | | 94 | |
| REPEATERED CABLE | | | |
| Nonloaded (0—18 kft) | | 90 | |
| H88 (0—36 kft) | | 90 | |
| H88 ( >36 kft) | | 80 | |

* For No. 4 ESS with analog trunking, single facility, use values for T1 + facility under consideration. For No. 4 ESS with T1 carrier interfacing via a digroup terminal, use T1 values.

** Immediate Action Limits reduce maintenance limits by 1 for single facility, 2 for 2—facility and 3 for 3—facility trunks.

set will result in high error rate. If the symptoms occur and the cause cannot be readily attributed to loss, attenuation frequency distortion, steady or impulse noise, envelope delay, phase jitter or intermodulation distortion, the possibility of frequency shift should be investigated.

**9.02** On carrier systems used in connection with data services, the overall carrier frequency error should be kept to ±5 Hz or less. Individual carrier facility sections should have carrier frequency errors of no more than ±2 Hz.

**9.03** There will not be a frequency error problem on the "transmitted carrier" type of carrier systems, such as the Western Electric "N" (only even numbered channels with N3), "O", and "ON". With this type of carrier system, the carrier signal that is used for modulation is transmitted directly to the distant terminal for demodulation. Western Electric "J", "K", and "L" systems are of the suppressed carrier type, in which the carrier is suppressed at the transmitting terminal and resupplied at the receiving terminal. When this function is accomplished by the use of a generator that is held in synchronization with the generator at the transmitting end, frequency shift will be at a minimum and should not cause data distortion.

**9.04** Frequency shift exists primarily in suppressed carrier systems where there has been no provision for synchronizing the carrier terminals at the ends of the system. Nonsynchronized Western Electric type "J", "K", "L", and "C" systems use carrier supply generators with long-term stability. These systems should not present any frequency shift problems provided they are adequately aligned and maintained at the intervals specified in the practices. Western Electric type "C" (vacuum tube modulator type) and "H" carrier systems may present more serious problems, depending upon operational environment and the maintenance routines.

**9.05** Carrier systems that are not supplied by the Western Electric Company can be roughly classified in the same way as the Western Electric systems. Actual frequency shift performance of any system in the questionable category should be determined prior to the start of data service over that system and corrective action instituted if necessary.

## 10. INTERMODULATION DISTORTION

**10.01** Intermodulation distortion is the generation of sum and difference frequencies due to nonlinearities in a channel. It is measured by transmitting four equal level tones, consisting of two pairs of tones, with a composite signal power at nominal data signal level. Two of these tones are closely spaced around a center frequency "A" (860 Hz) and the other two tones are centered around a center frequency "B" (1380 Hz). The second order distortion is determined from the B-A and B+A frequencies while the third order distortion is determined from the 2B-A frequency. Requirements are given in Table F.

## 11. PHASE JITTER

**11.01** Various sources cause the instantaneous phase, or zero crossings, of a signal to "jitter" at rates normally less than 300 Hz. This phase jitter is typically caused by ripple in the dc power supply appearing in the master oscillator of long-haul carriers and then passing through many stages of frequency multipliers. Some phase jitter occurs in short-haul systems from incomplete filtering of image sidebands. Digital carrier systems also will exhibit phase jitter at certain input frequencies. The most common jitter frequencies are 20 Hz (ringing current) and 60 Hz (commercial power) and the second through fifth harmonics of each of these.

**11.02** Noise may strongly influence phase jitter measurements; therefore, measurements should be made with a test tone at data level. Requirements are given in Tables G and H.

## 12. GAIN HITS, PHASE HITS, AND DROPOUTS

**12.01** Gain hits and phase hits are defined to be changes in the amplitude or phase of a signal lasting for at least 4 ms and returning to the original value within 150 ms. Changes in amplitude or phase which last for more than 150 ms are referred to as gain or phase changes. Changes that last for less than 4 ms are classified as impulse noise. Objectives for these parameters are given in Table I.

**12.02** A dropout is a decrease in level $\geq$ 12 dB which lasts for at least 10 ms. Deep fading of radio facilities and defective components can cause dropouts. Since dropouts tend to be long

TABLE F

INTERMODULATION
DISTORTION LIMITS

| FACILITIES | RATIO OF DISTORTION PRODUCT TO FUNDAMENTAL IN dB (FOUR TONE METHOD)* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N1 | N2 | N3 | ON | T/DIA DIB | T/DID, D2, D3 | L, RADIO WITH F SIGNALING | L, RADIO WITH E SIGNALING |
| Second Order | | | | | | | | |
| Minimum | 28, 26 | 34, 32 | 40, 38 | 30, 28 | 32, 30 | 50, 47 | 51, 50 | 44, 41 |
| Typical | 36 | 42 | 46 | 41 | 40 | 55 | 57 | 45 |
| Third Order | | | | | | | | |
| Minimum | 31, 30 | 44, 42 | 38, 36 | 34, 33 | 39, 38 | 54, 53 | 51, 50 | |
| Typical | 36 | 51 | 45 | 38 | 47 | 58 | 55 | |
| TRUNKS: | | | | | | | | |
| Second Order | | | | | | | | |
| Minimum | 28, 26 | 34, 32 | 40, 38 | 30, 28 | 32, 30 | 50, 47 | 44, 41 | 47, 41 |
| Typical | 36 | 42 | 46 | 41 | 40 | 55 | 45 | 46 |
| Third Order | | | | | | | | |
| Minimum | 30, 29 | 42, 40 | 37, 35 | 33, 32 | 39, 38 | 54, 53 | 47, 46 | |
| Typical | 36 | 49 | 44 | 37 | 47 | 58 | 46 | |

* First number given in each entry is the maintenance limit and the second number is the immediate action limit.

TABLE G

PHASE JITTER LIMITS

| END-TO-END LIMITS | |
|---|---|
| FREQUENCY BAND | LIMIT |
| 4 - 20 Hz | < 10 |
| 20 — 300 Hz | < 10 |

TABLE H

FACILITY AND TRUNK
LIMITS
(20 – 300 Hz)

| N. ON D1 (T1 CARRIER CHANNELS) | |
|---|---|
| NO. OF CHANNELS | LIMIT |
| ALL | <1.0° |
| LMX CARRIER | |
| MILEAGE BAND | LIMIT |
| 0-250 | <4.0° |
| 251-500 | <5.0° |
| 501-1000 | <6.0° |
| 1001-2000 | <7.0° |
| 2001-4000 | <8.0° |

with more than 40 percent in excess of 200 ms, they frequently are responsible for serious performance degradations. The objective for this parameter is no dropouts in 15 minutes or 1 dropout in 30 minutes. If one dropout occurs during a 15-minute test, continue the test for a second 15-minute interval not necessarily consecutive with the first

TABLE I

GAIN AND PHASE HIT AND DROPOUT OBJECTIVES

| | SHORT-HALL FACILITES (N, ON OR T) | COAXIAL CABLE, RADIO OR SHORT-HAUL RADIO (TJ) |
|---|---|---|
| Gain Hits ( $\geq$ 3dB) | 0 in 15 minutes | No more than 2 in 15 minutes* |
| Phase Hits ( $\geq$ 20) | 0 in 15 minutes | No more than 2 in 15 minutes |
| Dropouts | No more than 1 in 30 minutes | No more than 1 in 30 minutes |

* No more than 1 in 15 minutes for counters with 4 dB threshold.

test. If no additional dropouts occur, the facility is acceptable. If additional dropouts occur (or if more than one dropout occurred in the first test), maintenance is required.

## 13. INVESTIGATION OF NETWORK TROUBLES

**13.01** Data transmission requires control of more parameters than does voice transmission. Limits for the parameters required for data transmission are given in Tables A through I. The additional requirements described in Parts 4 through 13 of this section should then be applied to the facilities, as required, in order to accommodate the more stringent objectives of data transmission.

**13.02** On a connection over the DDD network, the effects of such items as overall loss, attenuation frequency distortion, envelope delay distortion, etc, are cumulative as the length of the circuit and the number of links involved increase. All types of switched facilities are subject to some interruptions, which may be due to equipment failures, facility failures, or human errors. The object of maintenance testing for data services is to determine the location of troubles which can cause actual failures in data transmission over the message network. The malfunction may be of very short duration, measured in microseconds, fading or drop-outs which can extend seconds or minutes, or actual facility failures which will interrupt service for a considerable length of time. It is important to note that service should be restored as quickly as possible. For example, a data service operating at 1200 bps is capable of transmitting or receiving over four million bits of information in one hour. An outage of one hour due to a facility malfunction can cost the customer a considerable amount of money in lost "computer time," obsolescence of information, and extra time consumed in storing and recovering data which has accumulated during the disruption of service. Duration of intermittent interruptions is an important factor in the detection of trouble since complete failures are more readily found than momentary troubles. The message network is so arranged that a complete failure of a cable, carrier channel, or central office terminal equipment will usually be detected by means of automatic alarm systems. In connection with interruptions of shorter duration, the shorter the time interval, the more difficult will be the problem of detection. The line evaluation test covering the particular data set under test is described in the installation performance procedures of the 590 series of practices. Errors received and peak distortion determine the quality of the circuit under test.

**13.03** Analysis of station record cards may give an indication as to the source of repeated data troubles. When it is possible, the circuit or connection should be "held" at the serving office and the call traced and tested through its various links in order to detect the malfunction. (See Section 314-205-300 and 590-010-300 for procedures.) Since it is not always possible to continue to "hold" the suspected circuit for immediate testing, a record should be made of the links involved and arrangements made to test the circuit at the first appropriate opportunity. A line evaluation test should be made from the "sending end" data set location. Use the suspected circuit for the test. Both locations should be equipped with digital test sets such as the 914-type data test sets.

**13.04** When tests are made between the serving office and the data set location, maximum use should be made of test signal sources such as

milliwatt sources, quiet terminations, and 107-type test lines when available.

**13.05** An analysis of possible results of the circuit evaluation test is shown in Table J. The result of the tests may be used as a guide for locating transmission difficulties encountered with data services.

**13.06** Any trouble reports involving international service should be immediately escalated to the appropriate International Service Coordination Center. These centers and their areas of responsibility are given in Tables K and L.

## 14. REFERENCES

**14.01** Bell System Practices mentioned in this section which cover various equipment are listed as follows:

| SECTION | TITLE |
|---|---|
| 010-521-100 | Data Technical (DATEC) Support |
| 103-110-110 | J94027F and G Par Meter Generator and Receiver, Description, Operation, and Maintenance |
| 107-101-100 | 914-Type Data Test Sets, Description and Operation |
| 107-420-100 | 921 Data Test Set Description and Operation |
| 314-205-300 | Data Systems—DATAPHONE® Service on Direct Distance Dialing Network, Overall Transmission Maintenance Procedures |
| 314-205-501 | Data Systems—DATAPHONE® Service and Other Data Services on the Direct Distance Dialing Network—Test Requirements for Subscribers, Foreign Exchange and WATS Lines |
| 314-205-503 | Data Systems—"DATAPHONE"® Service and Other Data Services on the Direct Distance Dialing Network—Minimum Acceptable Performance Criteria and Test Procedures |
| 314-820-100 | Envelope Delay Characteristics of 200-Type Delay Equalizers |
| 314-820-103 | Envelope Delay Characteristics of 366- and 367-Type Equalizers |
| 314-820-104 | Envelope Delay Characteristics of 384- and 385-Type Equalizers |
| 851-300-100 | Transmission Design Consideration and Objectives, Switched Special Services and PBX Services. |

TABLE J

CIRCUIT EVALUATION TEST – RESULTS USING
900-TYPE DATA TEST SETS – RECEIVING END OF CIRCUIT

| TROUBLE CONDITION | REMARKS | TRANSMISSION IMPAIRMENTS (CHECK ITEMS IN SEQUENCE AS SHOWN) | REFERENCE |
|---|---|---|---|
| High distortion and high-error rate | Distortion reading is high and steady. | Attenuation Frequency Distortion<br>C-Message and C-Notched Noise<br>Return Loss Requirements<br>P/AR<br>Envelope Delay Distortion | Part 5<br>Part 7<br>Part 6<br>Part 9<br>Part 9 |
| High distortion and high-error rate | Distortion reading is high and unsteady. | Overall Circuit Loss | Part 4 |
| High-error rate and normal distortion | Distortion reading shows frequent peaks. | Impulse Noise<br>C-Message and C-Notched Noise | Part 8<br>Part 7 |
| High distortion and high-error rate | Distortion reading may shift gradually. | Frequency Shift | Part 10 |

## TABLE K

## INTERNATIONAL SERVICE COORDINATION CENTERS

HEADQUARTERS ISCC

American Telephone and Telegraph Co.
Long Lines
Room 3B—111
Bedminster, New Jersey 07921

Tel: (201)234—6734
ADnet: LOS—885

ATLANTIC BASIN

American Telephone and Telegraph Co.
32 Avenue of the Americas
Room 1542
New York, New York 10013

Tel: (212)334—6314
ADnet: LYO—885

American Telephone and Telegraph Co.
635 Grant Street
9th Floor
Pittsburgh, Pennsylvania 15219

Tel: (412)644—7592
ADnet: LEO—885

American Telephone and Telegraph Co.
440 Hamilton Avenue
Room 1200C
White Plains, New York 10601

Tel: (914)320—2611
ADnet: LNO—885

CARIBBEAN BASIN
CENTRAL AMERICA
VENEZUELA

American Telephone and Telegraph Co.
400 West Ashley Street
Room 703
Jacksonville, Florida 32202

Tel: (904)353—3713
Tel: (904)355—7596
ADnet: LSO—885

PACIFIC BASIN

American Telephone and Telegraph Co.
1881 Pierce Street
Lakewood, Colorado 80214

Tel: (303)233—3601
ADnet: LWO—885

## TABLE L

### COUNTRY RESPONSIBILITY BY ISCC

NEW YORK

Austria
Belgium
Brazil
Chile
Cuba
Cyprus
Denmark
Ecuador
Finland
Germany
Greece
Iran
Israel
Italy
Ivory Coast
Kuwait
Lebanon
Liberia
Luxembourg
Netherlands
Netherlands Antilles North/South
Norway
Peru
Portugal
Saudi Arabia
Senegal
S. Africa
Surinam
Sweden
Switzerland
U.S.S.R.
Uruguay
Yugoslavia

JACKSONVILLE

Belize
Costa Rica
El Salvadore
French West Indies
Guatemala
Haiti
Honduras
Nicaragua
Panama
Venezuela

PITTSBURGH

Argentina
Cameroon
Columbia
France
Ireland
Spain

WHITE PLAINS

India
Iraq
Kenya
Nigeria
United Kingdom

DENVER LAKEWOOD

American Samoa
Australia
China (Peking)
China (Taipei)
Fiji Island
Guam
Hong Kong
Indonesia
Japan
Korea
Malaysia
New Caledonia
New Zeland
Papua New Guinea
Philippines
Singapore
Tahiti
Thailand

***NOTES***