§ 1755.405 Voiceband data transmission measurements.

(a) The data transmission measurements listed in this section shall be used to determine the acceptability of trunk and nonloaded subscriber loop circuits for data modem transmission.

(b) *Signal-to-C notched noise (S/CNN) measurement.* (1) When specified by the borrower, S/CNN measurements shall be made on trunk circuits and nonloaded subscriber loops. For trunk circuits, the measurement shall be made between CO locations. For nonloaded subscriber loops, the measurement shall be made from the CO to the station protector of the NID at the customer's access location.

(2) S/CNN is the logarithmic ratio expressed in dB of a 1,004 Hz holding tone signal compared to the C-message weighted noise level. S/CNN is one of the most important transmission parameters affecting the performance of data transmission because proper modem operation requires low noise relative to received power level. Since modulated carriers are used in data communication systems, noise measurements need to be performed with power on the connection to activate equipment having signal-level-dependent noise sources. For 4 kHz channels, a 1,004 Hz holding tone is used to activate the signal-dependent equipment on the channel or connection.

(3) *Method of measurement.* The S/CNN measurement shall be made using a 1,004 Hz holding tone at −13 dBm0 (decibels relative to one milliwatt, referred to a zero transmission level point) and performed in accordance with American National Standards Institute (ANSI) T1.506–1990, American National Standard for Telecommunications—Network Performance—Transmission Specifications for Switched Exchange Access Network including supplement ANSI T1.506a–1992, and American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE) 743–1984, IEEE Standard Methods and Equipment for Measuring the Transmission Characteristics of Analog Voice Frequency Circuits. The ANSI T1.506–1990, American National Standard for Telecommunications—Network Performance—Transmission Specifications for Switched Exchange Access Network is incorporated by reference in accordance with 5 U.S.C. 522(a) and 1 CFR part 51. Copies of ANSI T1.506–1990 are available for inspection during normal business hours at RUS, room 2845, U.S. Department of Agriculture, STOP 1598, Washington, DC 20250–1598, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.* Copies are available from ANSI, Customer Service, 11 West 42nd Street, New York, New York 10036, telephone number (212) 642–4900. The ANSI/IEEE 743–1984, IEEE Standard Methods and Equipment for Measuring the Transmission Characteristics of Analog Voice Frequency Circuits is incorporated by reference in accordance with 5 U.S.C. 522(a) and 1 CFR part 51. Copies of ANSI/IEEE 743–1984 are available for inspection during normal business hours at RUS, room 2845, U.S. Department of Agriculture, STOP 1598, Washington, DC 20250–1598, or at the National Archives and Records Administration. Copies are available from ANSI, Customer Service, 11 West 42nd Street, New York, New York 10036, telephone number (212) 642–4900.

(4) *Test equipment.* The equipment for performing the measurement shall be in accordance with ANSI/IEEE 743–1984.

(5) *Applicable results.* The S/CNN for both trunk and nonloaded subscriber loop circuits shall not be less than 31 dB.

(6) *Data record.* The measurement data shall be recorded. Suggested formats similar to Format VI, Voiceband Data Transmission Tests—Nonloaded Subscriber Loops, and Format VII, Voiceband Data Transmission Tests—Trunk Circuits, in § 1755.407 or formats specified in the applicable construction contract may be used.

(7) *Probable causes for nonconformance.* Some of the causes for failing to obtain the desired results may be due to excessive harmonic distortion, quantizing noise, phase and amplitude jitter, and loss in digital pads used for level settings.

(c) *Signal-to-intermodulation distortion (S/IMD) measurement.* (1) When specified

by the borrower, S/IMD measurements shall be made on trunk circuits and nonloaded subscriber loops. For trunk circuits, the measurement shall be made between CO locations. For nonloaded subscriber loops, the measurement shall be made from the CO to the station protector of the NID at the customer's access location.

(2) S/IMD is a measure of the distortion produced by extraneous frequency cross products, known as intermodulation products, when a multi-tone tone signal is applied to a system.

(3) Intermodulation distortion (IMD) is caused by system nonlinearities acting upon the harmonic frequencies produced from an input of multiple tones. The products resulting from IMD can be more damaging than noise in terms of producing data transmission errors.

(4) IMD is measured as a signal to distortion ratio and is expressed as the logarithmic ratio in dB of the composite power of four resulting test frequencies to the total power of specific higher order distortion products that are produced. The higher order products are measured at both the 2nd order and 3rd order and are designated R2 and R3, respectively. The four frequency testing for IMD is produced with four tones of 857, 863, 1,372, and 1,388 Hz input at a composite power level of −13 dBm0.

(5) *Method of measurement.* The S/IMD measurement shall be performed in accordance with ANSI T1.506–1990 and ANSI/IEEE 743–1984.

(6) *Test equipment.* The equipment for performing the measurement shall be in accordance with ANSI/IEEE 743–1984.

(7) *Applicable results.* The 2nd order (R2) S/IMD for both trunk and nonloaded subscriber loop circuits shall not be less than 40 dB. The 3rd order (R3) S/IMD for both trunk and nonloaded subscriber loop circuits shall not be less than 40 dB.

(8) *Data record.* The measurement data shall be recorded. Suggested formats similar to Format VI for nonloaded subscriber loops and Format VII for trunk circuits in §1755.407 or formats specified in the applicable construction contract may be used.

(9) *Probable causes for nonconformance.* Some of the causes for failing to obtain the desired results may be due to channel nonlinearities, such as compression and clipping, which cause harmonic and intermodulation distortion in a voiceband signal.

(d) *Envelope delay distortion (EDD) measurement.* (1) When specified by the borrower, EDD measurements shall be made on trunk circuits and nonloaded subscriber loops. For trunk circuits, the measurement shall be made between CO locations. For nonloaded subscriber loops, the measurement shall be made from the CO to the station protector of the NID at the customer's access location.

(2) EDD is a measure of the linearity or uniformity of the phase versus frequency characteristics of a transmission facility. EDD is also known as relative envelope delay (RED).

(3) EDD is specifically defined as the delay relative to the envelope delay at the reference frequency of 1,704 Hz. EDD is typically measured at two frequencies, one low and one high in the voiceband. The low frequency measurement is made at 604 Hz. The high frequency measurement is made at 2,804 Hz.

(4) *Method of measurement.* The EDD measurement shall be performed in accordance with ANSI T1.506–1990 and ANSI/IEEE 743–1984.

(5) *Test equipment.* The equipment for performing the measurement shall be in accordance with ANSI/IEEE 743–1984.

(6) *Applicable results.* The EDD for both trunk and nonloaded subscriber loop circuits at the low frequency of 604 Hz shall not exceed 1,500 microseconds. The EDD for both trunk and nonloaded subscriber loop circuits at the high frequency of 2,804 Hz shall not exceed 1,000 microseconds.

(7) *Data record.* The measurement data shall be recorded. Suggested formats similar to Format VI for nonloaded subscriber loops and Format VII for trunk circuits in §1755.407 or formats specified in the applicable construction contract may be used.

(8) *Probable causes for nonconformance.* Some of the causes for failing to obtain the desired results may be due to nonlinearity of the phase versus frequency

characteristic of the transmission facility. This nonlinear phase versus frequency characteristic of the transmission facility causes the various frequency components to travel at different transit times which results in successively transmitted data pulses to overlap at the receive end. The overlapping of the pulses at the receive end results in distortion of the received signal. Excessive EDD on the transmission facility may be reduced using data modems with equalization or by conditioning the transmission line.

(e) *Amplitude jitter (AJ) measurement.* (1) When specified by the borrower, AJ measurements shall be made on trunk circuits and nonloaded subscriber loops. For trunk circuits, the measurement shall be made between CO locations. For nonloaded subscriber loops, the measurement shall be made from the CO to the station protector of the NID at the customer's access location.

(2) AJ is any fluctuation in the peak amplitude value of a fixed tone signal at 1,004 Hz from its nominal value. AJ is expressed in peak percent amplitude modulation.

(3) AJ is measured in two separate frequency bands, 4–300 Hz and 20–300 Hz. The 4–300 Hz band is important for modems employing echo canceling capabilities. The 20–300 Hz band is used for modems that do not employ echo cancelers.

(4) Amplitude modulation can affect the error performance of voiceband data modems. The measurement of amplitude jitter indicates the total effect on the amplitude of the holding tone of incidental amplitude modulation and other sources including quantizing and message noise, impulse noise, gain hits, phase jitter, and additive tones such as single-frequency interference.

(5) *Method of measurement.* The AJ measurement shall be performed in accordance with ANSI T1.506–1990 and ANSI/IEEE 743–1984.

(6) *Test equipment.* The equipment for performing the measurement shall be in accordance with ANSI/IEEE 743–1984.

(7) *Applicable results.* The AJ for both trunk and nonloaded subscriber loop circuits in the 4–300 Hz frequency band shall not exceed 6%. The AJ for both trunk and nonloaded subscriber loop circuits in the 20–300 Hz frequency band shall not exceed 5%.

(8) *Data record.* The measurement data shall be recorded. Suggested formats similar to Format VI for nonloaded subscriber loops and Format VII for trunk circuits in §1755.407 or formats specified in the applicable construction contract may be used.

(9) *Probable causes for nonconformance.* Some of the causes for failing to obtain the desired results may be due to excessive S/CNN, impulse noise, and phase jitter.

(f) *Phase jitter (PJ) measurement.* (1) When specified by the borrower, PJ measurements shall be made on trunk circuits and nonloaded subscriber loops. For trunk circuits, the measurement shall be made between CO locations. For nonloaded subscriber loops, the measurement shall be made from the CO to the station protector of the NID at the customer's access location.

(2) PJ is any fluctuation in the zero crossings of a fixed tone signal (usually 1,004 Hz) from their nominal position in time within the voiceband. PJ is expressed in terms of either degrees peak-to-peak (° p-p) or in terms of a Unit Interval (UI). One UI is equal to 360° p-p.

(3) PJ measurements are typically performed in two nominal frequency bands. The frequency bands are 20–300 Hz band and either the 2–300 Hz band or the 4–300 Hz band. The 20–300 Hz band is important to all phase-detecting modems. The 4–300 Hz band or the 2–300 Hz band is important for modems employing echo canceling capabilities.

(4) Phase jitter can affect the error performance of voiceband data modems that use phase detection techniques. The measurement of phase jitter indicates the total effect on the holding tone of incidental phase modulation and other sources including quantizing and message noise, impulse noise, phase hits, additive tones such as single-frequency interference, and digital timing jitter.

(5) *Method of measurement.* The PJ measurement shall be performed in accordance with ANSI T1.506–1990 and ANSI/IEEE 743–1984.

(6) *Test equipment.* The equipment for performing the measurement shall be in accordance with ANSI/IEEE 743–1984.

(7) *Applicable results.* The PJ for both trunk and nonloaded subscriber loop circuits in the 4–300 Hz frequency band shall not exceed 6.5° p-p. The PJ for both trunk and nonloaded subscriber loop circuits in the 20–300 Hz frequency band shall not exceed 10.0° p-p.

(8) *Data record.* The measurement data shall be recorded. Suggested formats similar to Format VI for nonloaded subscriber loops and Format VII for trunk circuits in § 1755.407 or formats specified in the applicable construction contract may be used.

(9) *Probable causes for nonconformance.* Some of the causes for failing to obtain the desired results may be due to excessive S/CNN, impulse noise, and amplitude jitter.

(g) *Impulse noise measurement.* (1) When specified by the borrower, impulse noise measurements shall be made on trunk circuits and nonloaded subscriber loops. For trunk circuits, the measurement shall be made between CO locations. For nonloaded subscriber loops, the measurement shall be made from the CO to the station protector of the NID at the customer's access location.

(2) Impulse noise is a measure of the presence of unusually large noise excursions of short duration that are beyond the normal background noise levels on a facility. Impulse noise is typically measured by counting the number of occurrences beyond a particular noise reference threshold in a given time interval. The noise reference level is C-message weighted.

(3) *Method of measurement.* The impulse noise measurement shall be performed using a 1,004 Hz tone at –13 dBm0 and in accordance with ANSI T1.506–1990 and ANSI/IEEE 743–1984.

(4) *Test equipment.* The equipment for performing the measurement shall be in accordance with ANSI/IEEE 743–1984.

(5) *Applicable results.* The impulse noise for both trunk and nonloaded subscriber loop circuits shall not exceed 65 dBrnC0 (decibels relative to one picowatt reference noise level, measured with C-message frequency weighting, referred to a zero transmission level point). The impulse noise requirement shall be based upon a maximum of 5 counts in a 5 minute period at equal to or greater than the indicated noise thresholds.

(6) *Data record.* The measurement data shall be recorded. Suggested formats similar to Format VI for nonloaded subscriber loops and Format VII for trunk circuits in § 1755.407 or formats specified in the applicable construction contract may be used.

(7) *Probable causes for nonconformance.* Some of the causes for failing to obtain the desired results may be due to excessive transient signals originating from the various switching operations.

[62 FR 23996, May 2, 1997, as amended at 69 FR 18803, Apr. 9, 2004]

§ 1755.406 Shield or armor ground resistance measurements.

(a) Shield or armor ground resistance measurements shall be made on completed lengths of copper cable and wire plant and fiber optic cable plant.

(b) *Method of measurement.* (1) The shield or armor ground resistance measurement shall be made between the copper cable and wire shield and ground and between the fiber optic cable armor and ground, respectively. The measurement shall be made either on cable and wire lengths before splicing and before any ground connections are made to the cable or wire shields or armors. Optionally, the measurement may be made on cable and wire lengths after splicing, but all ground connections must be removed from the section under test.

(2) The method of measurement using either an insulation resistance test set or a dc bridge type megohmmeter shall be as shown in Figure 18 as follows: