RIGID COAXIAL TRANSMISSION LINES AND CONNECTORS

50 OHMS

(From EIA Standard TR-13.4 and Standard Proposals No. 517 and No. 587 formulated under the cognizance of the EIA Subcommittee TR-21.2 (formerly SQ-11.2) on Air Dielectric Coaxial Lines and Fittings, and TR-21 (formerly SQ-11) Committee on Transmission Lines and Fittings and the Special Quality Components Panel).

SCOPE: This standard pertains exclusively to gas filled rigid coaxial transmission lines and their connectors containing electrically transparent supporting structures. This standard does not apply to any semiflexible transmission lines or connectors.

It is the intent of this standard to provide complete mechanical interchangeability for all lines and connectors. The drawings referred to in the standard do not in any way restrict electrical design parameters and are referred to for the purpose of confining the manufacturer within the necessary mechanical limits to make his electrical compensation, while still providing mechanical interchangeability.

1. SIZE

1.1 Definition: The SIZE of a coaxial line is defined as the nominal outside diameter of the line, expressed in inches. The SIZE of the connector is defined by the nominal outside diameter of the line with which it is used.

1.2 Standard: The standard line sizes are specified in Table I. The standard connector sizes are given in working drawings 1, 2, 3 and 4.

2. DIMENSIONS

2.1 Definitions:

2.1.1 AVERAGE WALL THICKNESS is one-half the difference between the corresponding inside and outside diameters at any cross-section perpendicular to the axis.

2.1.2 MAXIMUM DEVIATION of the wall thickness from the average wall thickness (eccentricity) at any cross-section is the difference between the average wall thickness and either the maximum or minimum wall thickness, whichever difference is greater.

2.2 Standard: Dimensions and tolerances for the lines are specified in Table I and for the connectors on drawings 1, 2, 3 and 4.

3. CHARACTERISTIC IMPEDANCE

3.1 Definition: The characteristic impedance of a coaxial transmission line is the driving impedance of the forward traveling transverse electromagnetic wave.

3.2 Standard: The characteristic impedance for each line size is shown in Table I.

3.3 Method of Determination:

3.3.1 – For a structurally uniform section of transmission line the characteristic impedance shall be calculated from the appropriate theoretical expression.

3.3.2 – For a structurally non-uniform line having electrically transparent individual supports, the characteristic impedance shall be determined experimentally with measuring equipment or by conventional transmission line and network theory of the necessary accuracy.

3.3.3 – For a structurally non-uniform line achieving electrical transparency by means of a systematic supporting structure, the characteristic impedance shall be determined between groups of supports.

NOTE: Connectors shall be included as part of the transmission line and shall comply with the requirements specified for the transmission line.

4. ATTENUATION PER UNIT LENGTH

4.1 Definition: The attenuation is the decrease with distance in the direction of propagation of a quantity associated with a traveling transverse electromagnetic wave.

4.2 Standard: Attenuation shall be expressed as a power ratio in decibels per unit length of line at a specified frequency and with specified conductor temperature.

4.3 Method of Determination: Attenuation shall be determined by a suitable method of measurement.

5. STANDING WAVE RATIO

5.1 Definition: The STANDING WAVE RATIO is the ratio of the amplitude of a standing wave at an anti-node to the amplitude at a node.

NOTE: The standing wave ratio S in a uniform transmission line is given by:

$$S = \frac{1 + p}{1 - p}$$

Where p is the magnitude of the reflection coefficient of the load.

5.2 Standard: Standing wave ratio shall be expressed as a voltage ratio and shall be as required for the application.

5.3 Method of Determination: The standing wave ratio of any line section with connectors shall be determined by connecting it between a uniform line and a load which are equal respectively to the nominal characteristic impedances of the line under test. The SWR of the section under test shall be that SWR measured in the uniform line.

6. POWER AND VOLTAGE RATINGS

6.1. Definition: The POWER RATING or VOLTAGE RATING of a line and connectors is that value of transmitted power or voltage which permits satisfactory operation of the line

assembly and provides an adequate safety factor below the point where injury or appreciably shortened life will occur.

6.2 Standard: The power rating, at unity standing wave ratio unless otherwise limited, either shall not exceed that which will result in an inner conductor temperature of 100° C for copper conductors at an ambient temperature of 50° C and shall include a statement of all applicable limiting factors, or the rating shall be suitable for the application.

6.3 Method of Determination: The power or voltage ratings of a line including connectors shall be determined experimentally by breakdown, life and related tests.

7. UPPER FREQUENCY LIMIT

7.1 Definition: The UPPER FREQUENCY LIMIT is determined by the cut-off frequency of higher order "waveguide" modes of propagation, and the effect which they have on the impedance and transmission characteristics of the normal TEM coaxial transmission line mode. The lowest cut-off frequency occurs with the TE_{11} mode, and this cut-off frequency in air dielectric line is the upper frequency limit of a practical transmission line. How closely the TE_{11} mode cut-off frequency can be approached depends on the application.

7.2 Standard: In general it does not seem advisable to use coaxial line frequencies greater than 0.95 of the TE_{11} mode cut-off frequency. Supporting structures will further decrease the upper frequency limit. Practical experience has indicated that 0.95 of the TE_{11} mode cut-off frequency in the overcut, undercut, or overcut-undercut insulator portion of the line will serve as a useful limit for most applications. The TE_{11} mode cut-off frequency, for air dielectric, Teflon and polystyrene overcut and undercut insulators is specified in Table I.

7.3 Method of Determination: The TE_{11} mode cut-off frequency can be readily estimated by assuming the mean circumference calculated from the outer conductor inside diameter and inner conductor outside diameter is equal to one wavelength at the cut-off frequency. This will be in error less than 3% for 50 ohm coaxial line with insulating materials ordinarily utilized in high frequency coaxial lines. Appropriate theoretical expressions may be used for calculating the TE_{11} mode cut-off frequency of the particular line selected for the application.

NOTE: Connectors shall be included as part of the transmission line and shall comply with the requirements for the transmission line.

8. CURVATURE

8.1 Definition: CURVATURE is the radial departure from a straight line between any two points on the external surface of a conductor.

8.2 Standard: Curvature shall not exceed ½" for any ten foot portion of the total length.

8.3 Method of Determination: Measurement of curvature shall not be altered by gravity or any other forces.

9. ROUNDNESS

9.1 Definition: OUT-OF-ROUNDNESS is the difference between the major and minor diameters at any one cross-section of a conductor.

9.2 Standard: Roundness shall conform to best commercial practice.

10. MATERIAL AND WORKMANSHIP

10.1 Material: To be specified by user.

10.2 Workmanship: The interior surface of the outer conductor, the exterior surface of the inner conductor, and all mating surfaces of connectors and conductors shall be as free as possible from detrimental holes, burrs, die marks, or chatter marks.

11. PACKAGING AND PACKING

11.1 Each length of transmission line assembly shall have protective covering at both ends.

11.2 Packing shall be such as to assure that after shipping and handling the transmission line assembly shall meet the requirement of this standard.

12. PRESSURIZATION

12.1 Definition: Pressurization is the application of a positive pressure of dry gas internal to a coaxial line and connector assembly commonly used to prevent the entrance of moisture or other foreign material.

12.2 Minimum Standard: The outer conductor and connector shall be capable of withstanding a pressure up to 60 lbs. per square inch without disruption.

12.3 Method of Measurement: The pressure shall be measured in pounds per square inch above the maximum atmospheric pressure.

13. DESIGNATION

13.1 The designation for coaxial lines in accordance with this standard shall include the line size and the nominal characteristic impedance. For example for a 6 1/8 line it shall be as follows:

6 1/8 (50)

13.2 The impedance and size of the anchor insulators included with the connectors in this standard shall be marked as above. For example for a 3 1/8 connector it shall be as follows:

3 1/8 (50)

13.3 The designation numbers shall be marked on the outside surface of the outer conductor of each length of finished coaxial line in such a way as not to deform the inside surface of the conductor.