

IEEE Standard for the Measurement of Audible Noise From Overhead Transmission Lines

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IEEE Power Engineering Society**

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Abstract: Uniform procedures are established for manual and automatic measurement of audible noise from overhead transmission lines. Their purpose is to allow valid evaluation and comparison of the audible noise performance of various overhead lines. Definitions are provided, and instruments are specified. Measurement procedures are set forth, and precautions are given. Supporting data that should accompany the measurement data are specified, and methods for presenting the latter are described.

Keywords: audible noise, overhead transmission lines

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Foreword

(This foreword is not a part of IEEE Std 656-1992, IEEE Standard for the Measurement of Audible Noise From Overhead Transmission Lines.)

This standard is the result of several years of effort by the Corona Effects Working Group and its predecessor, the Audible Noise Working Group, of the Corona and Field Effects Subcommittee of the Transmission and Distribution Committee of the IEEE Power Engineering Society. This standard is the direct outgrowth of a report that was prepared by a task force of the subcommittee and published as "IEEE Committee Report, Measurement of Audible Noise From Transmission Lines," *IEEE Transactions on Power Apparatus and Systems*, vol. PAS-100, no. 3, Mar. 1981, pp. 1440-1452. The report is recommended as a tutorial for this standard.

The 1992 revision of this standard incorporates minor revisions, based upon application of this standard, and a new appendix that contains the results of work by the Psychoacoustics Task Force on definitions of instrumentation for psychoacoustic testing.

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IEEE Standard for the Measurement of Audible Noise From Overhead Transmission Lines

1. Purpose and Scope

1.1 Purpose. The purpose of this standard is to establish uniform procedures for the measurement of audible noise from overhead transmission lines, using instrumentation that conforms to ANSI S1.4-1983 [1]¹, ANSI S1.6-1984 [2], ANSI/SAE J184-1987 [4], IEC 651 (1979) [5], and IEEE Std 539-1990 [7]. A uniform procedure is a prerequisite to valid evaluation and comparisons of the audible-noise performance of various overhead power transmission lines.

1.2 Scope. This standard covers manual and automatic audible-noise measurements from overhead power transmission lines.

2. References

[1] ANSI S1.4-1983, American National Standard Specification for Sound Level Meters.²

[2] ANSI S1.6-1984 (Reaff 1990), American National Standard Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements.

[3] ANSI S1.11-1986, American National Standard Specifications for Octave-Band and Fractional Octave-Band Analog and Digital Filters.

[4] ANSI/SAE J184-1987, Qualifying a Sound Data Acquisition System.

[5] IEC 651 (1979), Sound level meters.³

[6] IEEE Std 100-1990, The New IEEE Standard Dictionary of Electrical and Electronics Terms.⁴

[7] IEEE Std 539-1990, IEEE Standard Definitions of Terms Relating to Corona and Field Effects of Overhead Power Lines (ANSI).

¹The numbers in brackets correspond to those of the references in Section 2.

²ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

³IEC publications are available from the IEC Sales Department, Case Postale 131, 3 rue de Varembe, CH 1211, Genève 20, Switzerland, Suisse. IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

⁴IEEE publications are available from the Institute of Electrical and Electronics Engineers, Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

3. Definitions

The following definitions are used in this standard. For additional definitions, see IEEE Std 100-1990 [6] and IEEE Std 539-1990 [7].

day-night sound level (L_{dn}). The L_{dn} rating is the average A-weighted sound level, in decibels, integrated over a 24 h period. A 10 db(A) penalty is applied to all sound occurring between 10 P.M. and 7 A.M.

NOTES: (1) L_{dn} is intended to improve upon the L_{eq} rating by adding a correction for nighttime noise intrusions because people are more sensitive to such intrusions.

(2) The L_{dn} can be derived from daytime and nighttime L_{eq} values as follows:

$$L_{dn} = 10 \log \left(\frac{1}{24} \right) \left[15 \text{ antilog} \frac{L_d}{10} + 9 \text{ antilog} \frac{L_n + 10}{10} \right]$$

where

$$\begin{aligned} L_d &= \text{The } L_{eq} \text{ for the 15 daytime hours} \\ L_n &= \text{The } L_{eq} \text{ for the 9 nighttime hours} \end{aligned}$$

(3) The purpose of L_{dn} is to provide a single-number measure of time-carrying noise for a specific time period (24 h).

energy-equivalent sound level (L_{eq}). The average of the sound energy level (usually A-weighted) of a varying sound over a specified period of time.

NOTES: (1) The simplest and most popular method for rating intermittent or fluctuating noise intrusions is to rely upon some measure of the average sound-level magnitude over time. The most common such average is the equivalent sound level, L_{eq} , expressed in decibels.

(2) The term “equivalent” signifies that a steady sound having the same level as the L_{eq} would have the same sound energy as the fluctuating sound. The term “energy” is used because the sound amplitude is averaged on an rms-pressure-squared basis, and the square of the pressure is proportional to energy. For example, two sounds, one of which contains 24 times as much energy as the other but lasts for 1 h instead of 24 h, would have the same energy-equivalent sound level.

(3) Mathematically, the equivalent sound level is defined as

$$L_{eq} = 10 \log \left[\frac{1}{(t_2 - t_1)} \int_{t_1}^{t_2} \frac{p^2(t)}{p_{ref}^2} dt \right]$$

where

$$\begin{aligned} p(t) &= \text{The time-varying A-weighted sound level, in } \mu\text{Pa} \\ p_{ref} &= \text{The reference pressure, } 20 \mu\text{Pa} \\ (t_2 - t_1) &= \text{The time period of interest} \end{aligned}$$

If the cumulative probability distribution of a noise is known, then L_{eq} can be estimated by

$$L_{eq} = 10 \log \left[\frac{1}{100} \sum_{x=0}^n (P_x - P_{x-1}) \text{ antilog} \frac{L_x}{10} \right]$$

where

$$\begin{aligned} P_x, P_{x-1} &= \text{Selected adjacent steps along the probability scale, expressed in percent (\%)} \\ L_x &= \text{The highest noise level in each step} \\ x &= \text{The step number} \\ n &= \text{The total number of steps} \end{aligned}$$

free-field microphone. A microphone that has been designed to have a flat frequency response to sound waves arriving with perpendicular incidence (i.e., straight at the microphone).

frequency spectrum. The distribution of the amplitude (and sometimes the phase) of the frequency components of a signal, as a function of frequency.