

The Standards of Noise Measurement

ISO 9613 is the primary international standard series used for calculating the attenuation of sound as it propagates outdoors. It provides an engineering method to predict environmental noise levels at receiver locations from known sources. In the James City County Data Center Policy, sound studies must follow ISO 9613 acoustics standards for modeling maximum sound levels from the facility, topography, layout, buildings, and ancillary equipment (including backup generators).

Structure of the Standard

ISO 9613 has two main parts:

ISO 9613-1:1993 — *Acoustics — Attenuation of sound during propagation outdoors — Part 1: Calculation of the absorption of sound by the atmosphere*

- Focuses exclusively on atmospheric absorption.
- Provides analytical formulas and tabulated attenuation coefficients (in dB/km) as a function of:
 - Frequency (typically 50 Hz to 10 kHz)
 - Temperature (−20 °C to +50 °C)
 - Relative humidity (10 % to 100 %)
 - Atmospheric pressure (reference 101.325 kPa)
- Still current and used as an input to Part 2.

ISO 9613-2:2024 — *Acoustics — Attenuation of sound during propagation outdoors — Part 2: Engineering method for the prediction of sound pressure levels outdoors*

- This is the core engineering method referenced for environmental and industrial noise modeling (including data centers).
- Second edition (published 2024) replaces the widely used 1996 version. It includes technical revisions for better handling of extended sources, software implementation, and related refinements.
- Predicts the equivalent continuous A-weighted sound pressure level (L_{Aeq}) under meteorological conditions *favorable to propagation* (downwind or under a moderate ground-based temperature inversion, typical of clear, calm nights).
- Also supports calculation of long-term average levels with a meteorological correction (C_{met}).
- Works in octave bands with nominal center frequencies from 63 Hz to 8 kHz.
- Applicable to point sources or assemblies of point sources. Extended sources (e.g., equipment yards, building façades, generator arrays) are subdivided into point sources.

- Suitable for industrial facilities, construction, road/rail traffic, and similar ground-based sources. It does *not* apply to aircraft in flight or blast waves.

Core Calculation Method (ISO 9613-2)

The equivalent continuous downwind octave-band sound pressure level at a receiver is calculated as:

$$L_{fT}(DW) = L_w + D_C - A$$

Where:

- L_w = octave-band sound power level of the source (re 1 pW)
- D_C = directivity correction
- A = total attenuation = $A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}$

Attenuation terms:

Term	Description	Key Factors
A_{div}	Geometric divergence (spherical spreading)	Distance d ; approximately $20 \log_{10}(d / 1 \text{ m}) + 11 \text{ dB}$
A_{atm}	Atmospheric absorption	Frequency, temperature, humidity (from ISO 9613-1)
A_{gr}	Ground effect (interference of direct and reflected paths)	Ground type (hard $G=0$ or porous/soft $G=1$), source & receiver heights, frequency; calculated separately for source, middle, and receiver regions
A_{bar}	Screening / barrier attenuation (diffraction)	Obstacle height, path-length difference, surface density $\geq 10 \text{ kg/m}^2$, closed surface without large gaps
A_{misc}	Miscellaneous effects	Foliage, industrial-site scattering, housing, reflections from surfaces (detailed in Annex A)

A meteorological correction can be applied for long-term averages to account for varying wind and temperature conditions.

Relevance to Data Center Noise Studies

In the James City County policy, the required sound modeling study must demonstrate maximum sound levels (including all ancillary equipment at full capacity) specific to the proposed site topography, layout, building type/scale/height/construction, and equipment. ISO 9613-2 provides a standardized, conservative (favorable-propagation) method for these predictions at the property corners or proposed property lines. This supports evaluation against the 55 dB (or ambient) limit.

Accurate source sound power levels (L_w) for cooling equipment, generators, transformers, etc., are essential inputs—typically obtained from manufacturer data or measurement standards such as the ISO 3740 series.

Accuracy, Limitations, and Practical Notes

- Engineering-grade accuracy (commonly cited around ± 3 dB under the specified conditions when inputs are reliable).
- Assumes favorable propagation conditions, which is intentionally conservative for compliance assessments.
- Does not fully capture complex multipath reflections in dense urban settings or strong upward-refracting (upwind) conditions.
- Extended sources require careful subdivision into point sources for accurate results (improved in the 2024 edition).
- Commonly implemented in commercial noise-modeling software (e.g., CadnaA, SoundPLAN, and others).

The 2024 revision of ISO 9613-2 modernizes the 1996 method while retaining the same fundamental physical framework, making it the current reference for outdoor industrial and environmental noise predictions worldwide.