ENVIRONMENTAL NOISE

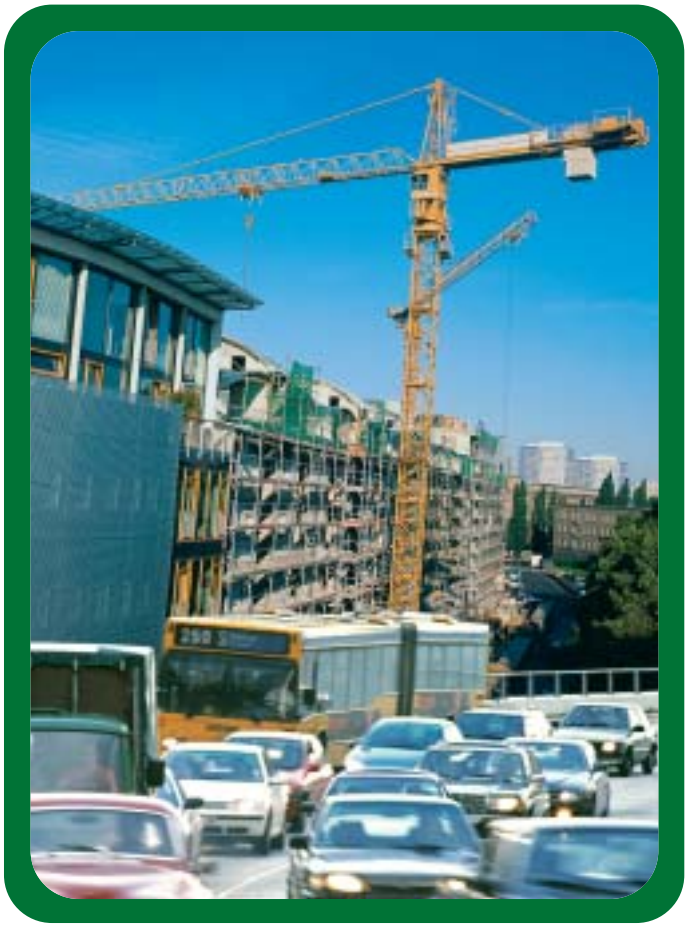
ISO 1996 – RATING LEVEL

The International Standard for Assessment of Environmental Noise

ISO 1996 "Acoustics – Description and Measurement of Environmental Noise" is a central standard within environmental noise assessment, acting as a reference work on the subject. It is divided into 3 parts:

- ISO 1996 Part 1 1982: Basic quantities and procedures
- ISO 1996 Part 2 1987: Acquisition of data pertinent to land use (amended 1998)
- ISO 1996 Part 3 1987: Application to noise limits

It defines the basic terminology including the Rating Level parameter and describes best practices for assessing environmental noise.



ISO 1996 – Latest Developments

ISO 1996 is currently under revision with focus on updating measurement techniques to modern instrumentation, improving procedures, such as for identifying tones, and providing information on research in the effects of noise levels from different sources.

Rating Level – Annoyance and Penalties

The annoyance due to a given noise source is perceived very differently from person to person, and is also dependent upon many non-acoustic factors such as the prominence of the source, its importance to the listener's economy and his or her personal opinion of the source. For many years, acousticians have attempted to quantify this to enable objective assessment of noise nuisances and implement acceptable noise limits. When large numbers of people are involved, reactions tend to be distributed around a mean, and the Rating Level (L_R) parameter has been developed in an attempt to put a numerical value on a noise that describes its annoyance in relation to a population.

Rating Level is defined in the ISO 1996–2 standard. It is basically a measure of the noise exposure corrected for factors known to increase annoyance. It is used to compare measured levels with noise limits that usually vary depending on the use of the property under investigation (see Section 15 of the standard). The basic parameter is the A-weighted equivalent continuous sound pressure level or L_{Aeq}. The formula for the Rating Level is (in general terms):

$L_R = L_{Aeq} + K_I + K_T + K_R + K_S$

where:
K_I is a penalty for impulses
K_T is a penalty for tone and information content
K_R is a penalty for time of day
K_S is a penalty (positive or negative) for certain sources and situations

ISO 1996–2 states that the Rating Level has to be determined over reference time intervals related to the characteristics of the source(s) and receiver(s). These reference time intervals are often defined in national/local legislation and standards.

The way to measure and evaluate the penalties is different from country to country, but the basic principles are the same.

Environmental Noise Sources

When assessing noise, the noise source determines which standard and limits are to be used. The most common noise sources (sometimes called applications) in the environment are:

- Traffic noise (road, rail, aircraft)
- Industrial noise (from plants and industries)
- Recreational noise
- Noise from neighbours
- Noise from construction sites

Road Traffic Noise

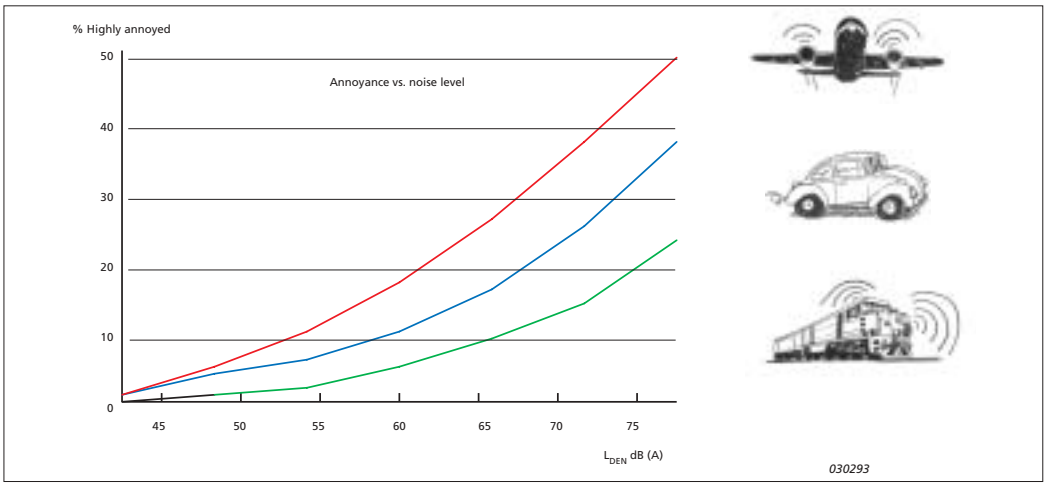
Road traffic is the most widespread source of noise in all countries and the most prevalent cause of annoyance and interference. Therefore, traffic noise reduction measures have the highest priority.

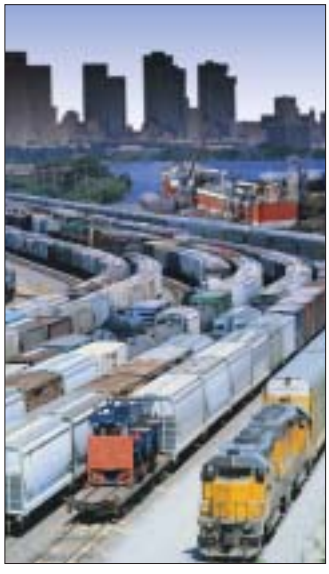
L_{Aeq} is the preferred noise index, but Rating Level L_R and percentile levels L_{AF10} and L_{AF50} are also used. For dense traffic, it can be assumed that L_{AF10} is about 3 dB above L_{Aeq}, and L_{AF50} about 1 – 2 dB lower. Assessment is carried out using various reference time intervals depending on the country. These intervals range from one 24-hour period to three separate intervals for day, rest and night. Generally the night limits are the most difficult to fulfill. The planning limits for new roads in various countries are often above the level of 50 – 55 dB(A) recommended by WHO (World Health Organisation), so the expansion of "grey" areas is inevitable almost everywhere.

Rail Traffic Noise

As with road traffic noise, L_{Aeq} is the preferred index for rail traffic noise. In some countries, Rating Levels are calculated from L_{Aeq} by subtracting (normally) 5 dB, the so-called railway bonus. In Japan, L_{ASmax} is used for the Shinkansen high-speed line. Generally, using maximum levels as the only limit has the disadvantage of disregarding the number of trains. Assessment is carried out using various reference time intervals depending on country. These intervals range from one 24-hour period to three separate intervals for day, rest and night. The noise limits for new lines in residential areas vary between 60 and 70 dB. In some countries, the railway bonus is included in the limit values. The railway bonus is based on social surveys from several countries, comparing the annoyance from road and rail traffic. The effect is more pronounced at higher levels.

The graph below shows dose-effect relationships for air, rail and road traffic. The percentage of highly annoyed persons is plotted against L_{DEN} levels (L_{Aeq} with a 10 dB penalty for night-time exposure between 22:00 and 07:00). It illustrates the lower annoyance caused by railway noise and the higher annoyance caused by air traffic noise, compared to road traffic noise for the same value of L_{DEN}. Due to the large spread of the underlying data, the graph is for illustration only.





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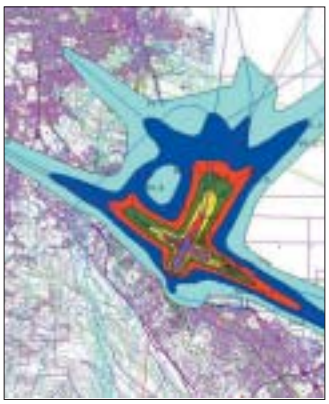


Aircraft Noise

The most important tool for noise control at airports is noise zoning for land-use, planning and noise insulation programmes. Noise from commercial aircraft is primarily a problem around airports as this is where aircraft converge at low altitude and high engine power. Increasing air traffic and city expansion will exacerbate the noise problems, while aircraft noise reduction, and traffic and flight path restrictions can alleviate them. As a last resort, existing dwellings can be protected against noise by improving windows and roofs.

Noise contours are used to show the extent and location of noise problem areas. The number shown with each contour indicates the noise level exceeded within that contour. Superimposed on a map, and compared to noise limits, they pinpoint areas in need of noise reduction measures.

Noise footprints show the noise contours for a single aircraft or class of aircraft. Noise footprints can be calculated from noise data for each aircraft and take into consideration flight path, aircraft operation and landscape features. They serve to assess the present and projected noise impact and help plan noise reduction measures.

Industrial Noise

Almost all countries use the Rating Level L_R according to ISO 1996 when assessing industrial noise. However, in Japan, L_{AF50} is used, while Belgium uses L_{AF95}. The limit is normally in the 50 – 55 dB(A) range.

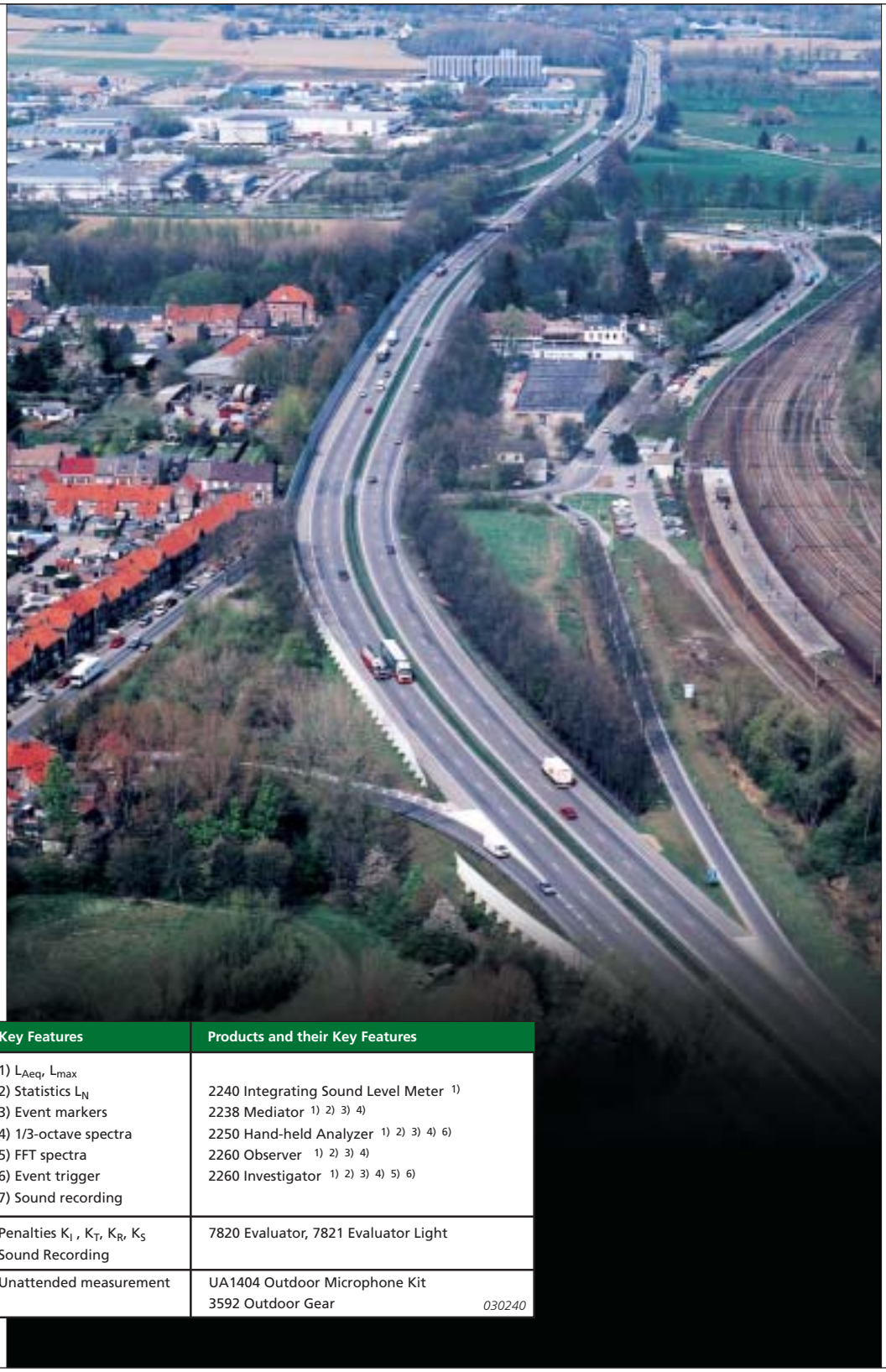
The **reference time periods** vary from country to country. Some use just day and night, some combine day and night, and others have resting periods as well. Different assessment procedures are used for each reference time period. A **loudest time period** is used in some countries to penalise intermittent noise. The duration of this period ranges from 5 minutes to one hour, depending on the country.

The **penalty for tones** varies between 0 dB (no penalty) and 6 dB. Some countries use a single penalty value of 5 dB, while other countries use two or more steps. In most cases, the presence of tones is determined subjectively, but objective methods are increasingly used. These methods are based on ⅓-octave or FFT (Fast Fourier Transform) analysis.

The **maximum penalty for impulsiveness** can vary up to 7 dB between countries, and both subjective and objective methods are used. The objective methods are based on the difference between a fast reacting and a slower reacting measurement parameter (for example, between Impulse and Fast A-weighted levels) or it can be based on the type of source, using a list enumerating noise sources (such as hammering, explosives, etc.).

Other Noise Sources

Recreational noise (noise coming from recreational activities such as rock concerts, motor cross and football), noise from neighbours and noise from construction sites are handled in ways similar to those described above, but are not described in detail here.



Product Guide

Brüel & Kjær offers solutions to all the previously mentioned applications. Please use this table as a guide to relevant products.

Application	Key Features	Products and their Key Features
Road Traffic Noise Rail Traffic Noise Aircraft Noise* Industrial Noise Recreational Noise Noise from Neighbours Noise from Construction Sites	1) L_{Aeq}, L_{max} 2) Statistics L_N 3) Event markers 4) 1/3-octave spectra 5) FFT spectra 6) Event trigger 7) Sound recording	2240 Integrating Sound Level Meter [1] 2238 Mediator [1] [2] [3] [4] 2250 Hand-held Analyzer [1] [2] [3] [4] [6] 2260 Observer [1] [2] [3] [4] 2260 Investigator [1] [2] [3] [4] [5] [6]
Rating Level L_R	Penalties K_I, K_T, K_R, K_S Sound Recording	7820 Evaluator, 7821 Evaluator Light
	Unattended measurement	UA1404 Outdoor Microphone Kit 3592 Outdoor Gear

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*See also Noise Monitoring Systems on page 60