O’HARE INTERNATIONAL AIRPORT

NOISE METRICS

Given the multiple dimensions of sound, a variety of descriptors, or metrics, have been developed for describing sound and noise. Some of the most commonly used metrics are discussed in this section. They include:

- Maximum Level (Lmax)
- Sound Exposure Level (SEL)
- Equivalent Sound Level (Leq)
- Day-Night Average Sound Level (DNL)

MAXIMUM LEVEL (Lmax)

Lmax is simply the highest sound level recorded during an event or over a given period of time (i.e. the peak of a noise event curve). It provides a simple and understandable way to describe a sound event and compare it with other events. In addition to describing the peak sound level, Lmax can be reported on an appropriately weighted decibel scale (A-weighted, for example) so that it can disclose information about the frequency range of the sound event in addition to the loudness. Lmax is described in units of decibels (dB).

Lmax, however, fails to provide any information about the duration of the sound event. This can be a critical shortcoming when comparing different sounds. Even if they have identical Lmax values, events of greater duration contain more sound energy than those of shorter duration. Further, in a real world situation, the loudest event may be infrequent, while slightly less loud events may occur often. Research has demonstrated that for many kinds of sound effects, the total sound energy, not just the peak sound level, is a critical consideration.

SOUND EXPOSURE LEVEL (SEL)

The sound exposure level (SEL) metric provides a way of describing the total sound energy of a single event. In computing the SEL value, all sound energy occurring during the event that is within 10 dB of the peak level (Lmax) is mathematically integrated over one second. (Very little information is lost by discarding the sound below the 10 dB cut-off, since the highest sound levels completely dominate the integration calculation.) Consequently, the SEL is always greater than the Lmax for events with a duration greater than one second. SELs for aircraft overflights typically range from 5 dB to 10 dB higher than the Lmax for the event. SEL is described in units of decibels (dB).

EQUIVALENT SOUND LEVEL (LEQ)

The equivalent sound level (Leq) metric may be used to define cumulative noise dosage, or noise exposure, over a period of time. In computing Leq, the logarithmically calculated total noise energy over a given period of time, during which numerous events may have occurred, is averaged over the time period. The Leq represents the steady sound level that is equivalent to the varying sound levels actually occurring during the period of observation. For example, an 8-hour Leq of 67 dB indicates that the amount of sound energy in all the peaks and valleys that occurred in the 8-hour period is equivalent to the energy in a continuous sound level of 67 dB. Leq is typically computed for measurement periods of one hour, eight hours, or 24 hours, although any time period can be specified. It is also frequently computed for a single noise event. LEQ is described in units of decibels (dB).

Leq is a critical noise metric for many kinds of analysis where total noise dosage, or noise exposure, is under investigation. As already noted, noise dosage is important in understanding the effects of noise on both animals and people. Indeed, research has led to the formulation of the “equal energy rule.” This rule states that it is the total acoustical energy to which people are
exposed that explains the effects the noise will have on them. That is, a very loud noise with a short duration will have the same effect as a lesser noise with a longer duration if they have the same total sound energy.

**DAY-NIGHT AVERAGE SOUND LEVEL (DNL)**

The DNL metric is a special variation of the 24-hour Leq metric. Like Leq, the DNL metric describes the total noise exposure during a given period. Unlike Leq, however, DNL, by definition, can only be applied to a 24-hour period. In computing DNL, an extra weighting of 10 dB is assigned to any sound levels occurring between the hours of 10:00:00 p.m. and 6:59:59 a.m. This penalty is intended to account for the greater annoyance that nighttime noise is presumed to cause for most people. Recalling the logarithmic nature of the dB scale, this extra weight treats one nighttime noise event as equivalent to ten daytime events of the same magnitude. DNL is described in units of decibels (dB).

As with Leq, DNL values are strongly influenced by the loud events. For example, 30 seconds of sound of 100 dB, followed by 23 hours, 59 minutes, and 30 seconds of silence would compute to a DNL value of 65 dB. If the 30 seconds occurred at night, the same example would yield a DNL of 75 dB.

This example can be roughly equated to an airport noise environment. Recall that an SEL is the mathematical compression of a noise event into one second. Thus, 30 SELs of 100 dB during a 24-hour period would equal DNL 65 dB or DNL 75 dB if they all occurred at night. This situation could actually occur in places around a real airport. If the area experienced 30 overflights during the day, each of which produced an SEL of 100 dB, it would be exposed to DNL 65 dB. Recalling the relationship of SEL to the peak noise level (Lmax) of an aircraft overflight, the Lmax recorded for each of those overflights (the peak level a person would actually hear) would typically range from 90 dB to 95 dB.

DNL is the standard metric used for environmental noise analysis in the U.S. This metric was accepted by the USEPA in 1974 and by the FAA in 1981.