



Assessing the Effects of Sound on Sleep



- ◆ Steady Sound
- ◆ Fluctuating Sound
- ◆ Intrusive Sound

Criteria for Sleep Disturbance by Sounds

Criteria for assessing the effects of sound are found in a 1978 DOD publication, *Planning in the Noise Environment*, and in a 1992 report from the Federal Interagency Committee on Noise (FICAN). These documents provide criteria for three situations:

1. A steady sound, such as from a generator.
2. Fluctuating sounds, such as from highway traffic.
3. Isolated intrusive sounds, such as from a flyover by a loud jet.

Sound and Sleep

Sounds can help people sleep or they can interfere with sleep. Studies with patients have shown benefits from “masking” hospital noises with a “white” noise. Some people find tape recordings of ocean surf or other natural sounds to be helpful. Conversely, intrusive sounds, especially those associated with danger or some other “biologically-meaningful” message, can ruin a good night’s sleep.

Sleep and the Soldier

A soldier’s sleep is important for at least 3-reasons. First, sleep deprivation reduces the ability of the immune system to fight disease. Second, it degrades perception, thus increasing the likelihood of “friendly fire” casualties. Third, it interferes with the highest mental abilities before it degrades motor skills.

Criterion for Steady Sound

The criteria of 40 A-weighted decibels (dBA) in a sleeping space is found in the DOD manual. A-weighting refers to a scale on the sound level meter designed to mimic the sensitivity of human hearing.

Professional judgment is needed in applying the criterion of 40 dBA for sleeping space. For example, if the steady sound includes whines or tones, the level might have to be lower (e.g., 35 dBA). On the other hand, if conversation, such as from a field radio, is intruding into sleeping space, it may be possible to improve sleep by turning up the steady sound and using it as a “masker,” even though the measured level might exceed 40 dBA.

Criterion for Fluctuating Sound

A fluctuating sound environment is measured using a setting on the sound level meter known as the *equivalent level* or **LEQ**. The LEQ represents the continuous noise level that would be equivalent, on an energy basis, with the fluctuating sound signal under consideration. Studies from around the world confirm that LEQ is usually the best descriptor for assessing the overall annoyance of a noisy environment. The DOD’s recommended limit for all noise sources in a sleeping space is an LEQ of 45 dBA.

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Criterion for Isolated Intrusive Sounds

Many people, both from the professional community and the noise-exposed public, believe, that the LEQ underestimates sleep disturbance when a few very noisy events are superimposed on a background of relative quiet. To answer this objection, the U.S. Air Force funded a 1992 review of the world's literature on the effects of noise on sleep. To capture the intrusiveness of the sounds, the noise signals were converted to a measure known as the *sound exposure level or SEL*. Integration of the A-weighted noise level over the period of a single event (such as an aircraft flyover) gives the SEL in dB. The SEL captures both the maximum level and the duration of the sound event as a single number. The following figure shows the relationship between SEL and the probability of awakening.

The solid line represents a predictive curve developed by the Air Force and published by the Federal Interagency Committee on Noise as a recommended interim dose curve.

The studies below the curve come from subjects who were studied in their own bedrooms during sounds that were a normal part of their sleeping environment. The studies above the curve came from subjects who were brought into a laboratory, asked to sleep in an unfamiliar environment, and tested with loud sounds of various kinds. Because of the scatter around the curve, professional judgment is needed in applying this criterion. For example, recent USAF research has shown that people living near airfields fall below the curve. Soldiers recently, deployed would be expected to fall above the curve. For example, about 25 percent of French troops deployed to Bosnia as part of the U.N. force stated that they wore plugs when trying to get to sleep (to mask ongoing noise of combat and other activities.)

