



# The Effects of Noise on People

The World Health Organization (WHO) defines health as “A state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.” This broad definition of health embraces the concept of well-being, and thereby renders noise impacts “health” issues. We separate noise effects into two broad categories: auditory (noise-induced hearing loss) and non-auditory (behavioral and physiological effects). Behavioral effects are those that are associated with activity interference. This includes interference with communication, rest or and sleep, and learning; or that produces annoyance. Non-auditory physiological health effects include such things as cardiovascular disease and hypertension. These categories of effects are examined in the following sections.

## Noise-Induced Hearing Loss

Hearing loss is measured as "threshold shift". Threshold refers to the quietest sound a person can hear. When a threshold shift occurs, the sound must be louder before it can be heard - a person's hearing is not as sensitive as it was before the threshold shift. The natural decrease of hearing sensitivity with age is called presbycusis. For hundreds of years it has been known that excessive exposure to loud noises can lead to noise-induced temporary threshold shifts, which in time can result in permanent hearing impairment, causing individuals to experience difficulty in understanding speech.

A temporary threshold shift (TTS) usually precedes a noise-induced permanent threshold shift (NIPTS); i.e. after exposure to high noise levels for a short time or lower noise levels for a much longer time, a person's threshold of audibility is temporarily shifted to higher levels. After continuous noise exposure on an eight-hour shift, such TTS can amount to over 20 dB. However, as its name indicates, it is only temporary, and the ear recovers fully after several hours. If such exposures are repeated daily, or if the ear is not allowed to recover, TTS can lead to a permanent threshold shift (PTS). Because aircraft noise is relatively intermittent, it is extremely unlikely that aircraft noise around airports could ever produce hearing loss.

## Community Annoyance

Social survey data have long made it clear that individual reactions to noise vary widely for a given noise level. Nevertheless, as a group, people's aggregate response to factors such as speech and sleep interference and desire for an acceptable environment is predictable and relates well to measures of cumulative noise exposure such as DNL. The most widely recognized relationship between noise and annoyance is shown in Figure 1.

## Speech Interference

One of the primary effects of aircraft noise is its tendency to drown out or "mask" speech, making it difficult or impossible to carry on a normal conversation without interruption. The sound level of speech decreases as distance between a talker and listener increases. As the level of speech decreases in the presence of background noise, it becomes harder and harder to hear. As the background level increases, the talker must raise his/her voice, or the individuals must get closer together to continue their conversation.

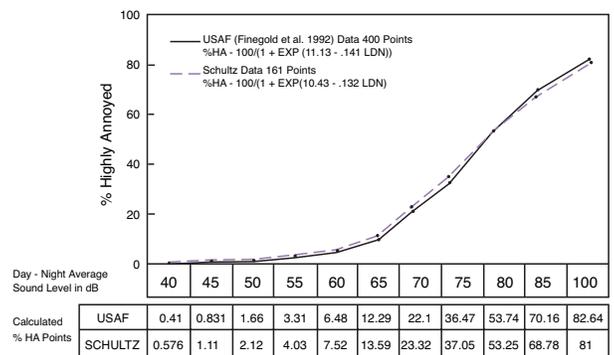


Figure 1. Noise Level vs. Annoyance<sup>1</sup>

## Sleep Interference

The effect of aviation noise on sleep is a long-recognized concern of those interested in addressing the impacts of noise on people. Historical studies of sleep disturbance were conducted mainly in laboratories; field studies also were conducted, in which subjects were exposed to noise in their own homes, using real or simulated noise. The data from these field studies show a consistent pattern, with considerably less percent of the exposed population expected to be behaviorally awakened than had been shown with laboratory studies.

In 1997, the Federal Interagency Committee on Aviation Noise (FICAN) recommended a new dose-response curve for predicting awakening, based on the results of the field studies described above. This curve is presented in Figure 2.

Recently, data used to produce the type of dose-response curve recommended by FICAN has been used to develop a method that accounts not only for the awakening effects of a full night of operations but also for person-to-person variability in awakening. The method was derived through re-analysis of data from a detailed sleep study conducted by the U.S. Air Force. The separate dose-response curves for every individual who participated in the sleep study were combined with standard Integrated Noise Model (INM) output to

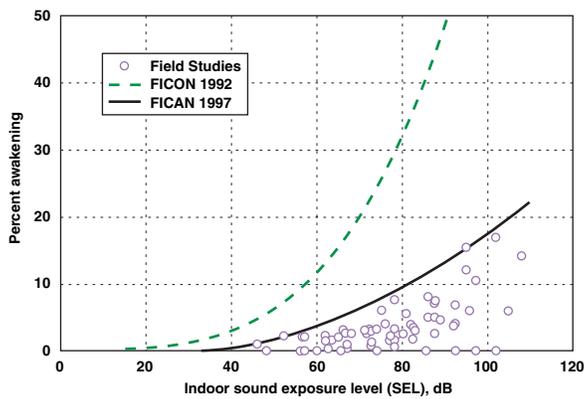


Figure 2. Recommended Sleep Disturbance Dose-Response Relationship <sup>2</sup>

compute populations awakened by night operations. Using this new method it is possible to produce percent-awakened contours around the airports or tabulations of numbers or percents of people awakened by neighborhoods. One strength of this approach is the ability to compare the awakening results from one scenario to another – of particular use in EIS's and other studies that consider a range of alternatives. Another benefit is that the INM already is capable of computing the necessary aircraft sound level information – no special model or changes to the INM are necessary.

### Non-Auditory Health Effects

In spite of considerable worldwide research, there is little solid evidence supporting a claim that noise affects human physical and mental health in the workplace or in communities. Our scientific

understanding is far from being able to reliably demonstrate a cause-effect relationship. Researchers have based such claims on laboratory studies of extremely high noise levels or of animals. Many effects observed with intense noises, capable of harming our hearing in a short time, cannot be assumed to occur at moderate and low levels, or to manifest themselves in chronic clinical effects at moderate and low levels.

For practical noise control considerations, the present status of our knowledge means that the criteria for evaluating noise impact, with respect to its direct and indirect effects on health, are the same criteria as those applied to prevent any hearing impairment. In other words, by using criteria that prevent noise induced hearing loss, minimize speech and sleep disruption, and minimize community reactions and annoyance, any effects on health will also be prevented.

### The Effects of Noise on Children's Learning

There has been much attention focused recently on the issue of the effects of aviation noise on children and their learning. The research suggests that there are effects in the areas of reading, motivation, language and speech, and memory. One common theory for the causes of these problems is speech interference: if children who are learning to read cannot understand their teacher, they may develop reading problems. These problems appear to be aggravated in vulnerable populations, such as children for whom English is a second language. FICAN is conducting a pilot study to determine whether changes in aircraft noise levels can be associated with changes in academic performance, as measured by standardized test scores.

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- 1 Federal Interagency Committee on Noise (FICON), *Federal Agency Review of Selected Airport Noise Analysis Issues*, August, 1992.
  - 2 Federal Interagency Committee on Aviation Noise (FICAN), *Effects of Aviation Noise on Awakenings from Sleep*, June, 1997.
  - 3 S. Fidell et al, "Field study of noise-induced sleep disturbance," *Journal of the Acoustical Society of America*, 98 (2), Pt. 1, August 1995

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