Annoyance

The following section was compiled by researchers at Wyle Laboratory

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One of the primary effect of aircraft noise on exposed communities is long-term annoyance. Noise annoyance has been defined by the Environmental Protection Agency (EPA) as any negative subjective reaction on the part of an individual or group.

The scientific community adopted the use of long-term annoyance as a primary indicator of community response because it attempts to account for all negative aspects of effects from noise, e.g., increased annoyance due to being awakened the previous night by aircraft, and interference with everyday conversation.

Numerous laboratory studies and field surveys have been conducted to measure annoyance and to account for a number of the variables, which are dependent on each person's individual circumstances and preferences. Laboratory studies of individual response to noise have helped isolate a number of the factors contributing to annoyance, such as the intensity level and spectral characteristics of the noise, duration, the presence of impulses, pitch, information content, and the degree of interference with activity.

Social surveys of community response to noise have allowed the development of general dose-response relationships that can be used to estimate the proportion of people who will be highly annoyed by a given noise level. Results of these studies have been the foundation for land use criteria established around the world.

The results of the social surveys have proven to be fairly uniform and consistent, but not without scatter. The most useful metric for assessing people's responses to noise impacts is the percentage of the exposed population expected to be "highly annoyed." A wide variety of responses have been used to determine intrusiveness of noise and disturbances of speech, sleep, audio/video entertainment, and outdoor living. The concept of "percent highly annoyed" has provided the most consistent response of a community to a particular noise environment. In annoyance surveys, people are asked to rate their annoyance about noise on a numerical scale.

For example on a five point scale, the descriptors are usually "not annoyed", "slightly annoyed", "moderately annoyed," "very annoyed" and "extremely annoyed." Schultz developed a relationship between the percentage of people choosing the top two descriptors ("very annoyed" and "extremely annoyed", which are combined within the term "highly annoyed") and residential noise exposure. In his synthesis of several different social surveys that employed different response scales, Schultz defined "highly annoyed" respondents as those respondents whose self-described annoyance fell within the upper 28% of the response scale. Schultz's definition of "percent highly annoyed" (%HA) became the touchstone of Federal policy on environmental noise.

A number of non-acoustic factors have been identified that may influence the annoyance response of an individual. Newman and Beattie divided these factors into emotional and physical variables:

Emotional Variables:

- Feelings about the necessity or preventability of the noise.
- Judgment of the importance and value of the activity that is producing the noise.
- Activity at the time an individual hears the noise.
- Attitude about the environment.
- General sensitivity to noise.
- Belief about the effect of noise on health.
- Feeling of fear associated with the noise.

Physical Variables:

- Type of neighborhood.

- Time of day.
- Season.
- Predictability of noise.
- Control over the noise source.
- Length of time an individual is exposed to a noise.

Daily average sound levels are typically used for the evaluation of community noise effects (i.e., long-term annoyance), particularly aircraft noise effects. In general, scientific studies and social surveys have found a correlation between the percentages of groups of people highly annoyed and the level of average noise exposure measured in DNL [2], [4] . The classic analysis that relied on this correlation is Schultz's original 1978 study, whose results are shown in Figure 1. This figure is commonly referred to as the Schultz curve. It represents the synthesis of a large number of social surveys that relates the long-term community response to various types of noise sources (161 data points in all), measured using the Day-Night Average Sound Level (DNL) metric. An updated study of the original Schultz study that was based on the analysis of over 450 data points collected through 1989 essentially reaffirmed this relationship . Figure 2 shows an updated form of the curve fit in comparison with the original Schultz curve. The updated fit, which does not differ substantially from the original, is the current preferred form in the U.S. In general, correlation coefficients of 0.85 to 0.95 are found between the percentages of groups of people highly annoyed and the level of average noise exposure. However, the correlation coefficients for the annoyance of individuals are relatively low, on the order of 0.5 or less. This is not surprising, considering the varying personal factors that influence the manner in which individuals react to noise.

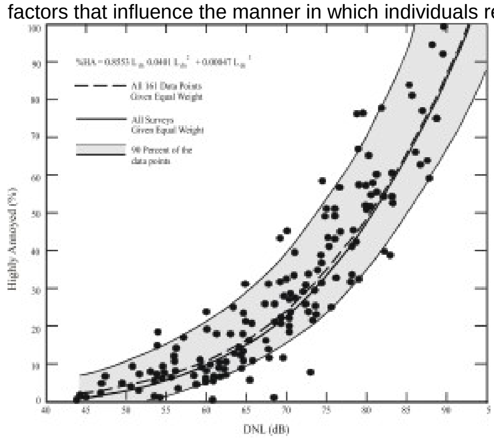

Figure 1. Community Surveys of Noise Annoyance

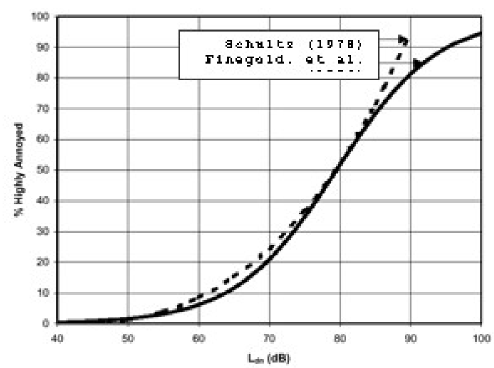

Figure 2. Response of Communities to Noise; Comparison of Original (Schultz, 1978) and Current (Finegold, et al. 1994) Curve Fits

The original Schultz curve and the subsequent updates assumed that the relationship between percent highly annoyed and DNL was independent of the noise source. This was an important element, in that it allowed Schultz to obtain some consensus among the various social surveys from the 1960s and 1970s that were synthesized in the analysis. In essence, the Schultz curve assumes that the effects of long-term annoyance on the general population are the same, regardless of whether the noise source is road, rail, or aircraft.

In the years after the classical Schultz analysis, additional social surveys have been conducted to better understand the annoyance effects of various transportation sources. Miedema & Vos present synthesis curves for the relationship between DNL and percentage “Annoyed” and percentage “Highly Annoyed” for three transportation noise sources. Separate, non-identical curves were found for aircraft, road traffic, and railway noise. Table 1 illustrates that, for a DNL of 65 dB, the percent of the people forecasted to be Highly Annoyed is 28% for air traffic, 18% for road traffic, and 11% for railroad traffic. For an outdoor DNL of 55 dB, the percentage highly annoyed would be close to 12% if the noise is generated by aircraft operations, but only 7% and 4% respectively if the noise is generated by road or rail traffic.

Comparing the levels on Miedema’s curve to those on the updated Schultz curve indicates that the percentage of people highly annoyed by aircraft noise may be higher than previously thought when the noise is solely generated by aircraft activity.

Table 1. Miedema's Annoyance Curves – Percent Highly Annoyed for Different Transportation Noise Sources

DNL	Percent Highly Annoyed (%HA)			
	Miedema			Schultz
	Air	Road	Rail	Combined
55	12	7	4	3
60	19	12	7	6
65	28	18	11	12
70	37	29	16	22
75	48	40	22	36

(Source: Miedema, JASA 1998)

As noted by the World Health Organization (WHO), even though aircraft noise seems to produce a stronger annoyance response than road traffic, caution should be exercised when interpreting synthesized data from different studies. WHO noted that five major parameters should be randomly distributed for the analyses to be valid: personal, demographic, and lifestyle factors, as well as the duration of noise exposure and the population experience with noise. The Federal Interagency Committee on Noise (FICON) found that the updated “Schultz Curve” remains the best available source of empirical dosage effect information to predict community response to transportation noise without any segregation by transportation source; a position still held by the Federal agencies on the Federal Interagency Committee on Aircraft Noise (FICAN). But, FICON also recommended further research to investigate the differences in perceptions of aircraft noise, ground transportation noise (highways and railroads), and general background noise.