Interpreting Airport Noise Contours

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Aircraft noise is a major environmental issue in areas surrounding airports. The noise exposure forecasting (NEF) method has been adopted in Canada and other countries for land use planning around airports. Specific noise contours have been implemented as rigid guidelines for development near airports, leading to questions about the interpretation and validity of these conceptual noise contours for particular locations. A comprehensive survey was conducted to investigate people's attitudes toward noise in an area close to the Macdonald-Cartier International Airport in Ottawa, Canada, which has particular geographical conditions. The results revealed that responses related to the degree of annoyance, disturbance, and complaint were lower than results from similar surveys carried out elsewhere. The survey findings showed that noise contours should be considered carefully in areas where geographical characteristics are not the same as those employed in the NEF method. Comments on some field-specific geographical factors are provided to improve land use planning based on NEF contours.

The primary responsibility for integrating noise aspects into the urban planning process rests with local governments. At this level of government, land use compatibility planning has been adopted to guide noise-sensitive land uses away from the noisier areas and encourage nonsensitive land uses.

The analysis and development of compatible land use near airports in Canada is based on the noise exposure forecasting (NEF) method (*1*); in the United States it is based on the day-night average sound level (DNL) method. Both methods are supported by the integrated noise model (INM) (*2*), which has been adopted by Transport Canada and the FAA. NEF and DNL noise levels correlate well with each other (DNL = NEF + 35). Forecasting of aviation noise depends on the number of aircraft movements, fleet composition, runway utilization, flight paths in and out of runways, air speed, and engine power during approach and landing procedures as well as atmospheric pressure and temperature distributions and wind directions and velocities.

Important elements that may attenuate the exposure of individuals to aircraft noise around airports, such as topography of the area; existence of buildings, vegetation, and other types of sound barriers; and shielding near the airport are not considered in the INM. The variation in the level of individual exposure and human reaction to noise may also involve several factors such as type of dwelling, construction material, and socioeconomic standards.

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PROBLEM STATEMENT

Despite all efforts to improve the NEF method to calculate aircraft noise impacts around airports, it is still difficult to relate forecasted noise with the prediction of people's reaction to noise (*3*). As emphasized by Ashford (*4*), "it is not surprising, therefore, that forecasting the impact of aircraft noise on nearby neighborhoods is an inexact process that must be applied with considerable attention to its subjective aspects."

The concern with noise forecasting is that it is expressed by noise contours representing specific NEF or DNL values. These contours have become rigid boundaries in terms of zoning decisions for land use near airports limiting areas deemed to be noncompatible with some human activities (*5*). Mistakes in zoning decisions caused by mislocation of the noise contours may have appeared in areas with atypical geographical characteristics that are not similar to the standard field conditions adopted in the NEF/DNL method.

The purpose of this paper is to summarize research (*6*) to gauge people's perceptions toward aircraft noise under atypical field geographical conditions in noisy areas defined by NEF contours and to compare its outcome with previous noise attitude surveys.

NOISE CONTOUR LINES

The NEF method produces noise contours that are an estimation of the total noise exposure for a particular airport resulting from aircraft movements over a specific period of time, usually a planning peak day. The noise contours are defined in printouts usually plotted on a 8.5 × 11 in. paper and then transferred mechanically to a map of the region. In general, the scale of printouts varies from 1:100,000 to 1:200,000; regional maps are drawn on charts at scales of 1:25,000 to 1:50,000.

NEF contour maps yield a helpful delineation for visualization of noise fields. However, these NEF lines may not be precise. Errors may happen in the noise contours proportionally to the precision of the assumptions used for the input data. Furthermore, because of scale reductions, the exactness of transferring contour lines from the computer printouts to regional maps and then to the terrain cannot be maintained. For example, 1 mm of a noise contour line on a computer printout may represent up to 200 m in the field.

Land use planning based on noise exposure contours has caused many complaints. These complaints have happened because as soon as noise contours are sanctioned as a rigid boundary for land use, regardless of factual local evidence, the resulting noise contours are taken as "unquestionable." At present, there is no methodology for modifying noise contours to reflect local conditions.

COMMUNITY REACTIONS TO AIRCRAFT NOISE

People's reaction to noise depends on the way in which individuals experience the undesirable effects of noise. Many advances have

been made in noise measurement and forecasting, but there still is a lack of knowledge in the area of people's reaction to noise, especially under atypical field conditions. Some attitude surveys have been done to measure reaction and annoyance to aircraft noise. Three major studies developed in the United States and Canada, by Schultz (*7*), Kryter (*8*), and Hall et al. (*9*), are of importance.

OTTAWA SURVEY

Background

The purpose of the field investigation at Macdonald-Cartier International Airport (MCIA) in Ottawa was to better understand the influence on the community response to aircraft noise of important local geographical characteristics, such as topographic, vegetation, and climatic conditions, which differ from the standard adopted in the NEF method. This field work allowed a comparison of the residents' annoyance response to aircraft noise, with the results of previous noise attitude surveys carried out elsewhere.

Description of Survey Area

The survey area was selected to present as many different field characteristics as possible from the standard in the NEF method. Another factor for selection was that of low noise complaints. Transport Canada (*6*) records showed that in 1983 and 1984, of 115 formal complaints, there was just 1 from the chosen area.

The survey area is situated in the Rideau River Valley, some 30 m below the altitude of Runway 07. The area contains 194 single-family homes, most which have man-made noise barriers such as multiple glazing and insulated walls. The area is covered by natural noise barriers composed of big trees and dense vegetation.

Data Requirements

The noise exposure levels in the survey area were set using noise contours derived from the NEF method. They were based on a typical peak day at MCIA with 870 movements (landings plus takeoffs), which included local and itinerant aircraft. The survey area was divided by four NEF contours: 40, 35, 30, and 25 NEF to produce three NEF areas: 25–30 NEF, 30–35 NEF, and 35–40 NEF. People's reactions to noise were collected through face-to-face interviews using questionnaires.

Survey Method

In the survey, no more than one person was interviewed at the door of each dwelling. The survey took place at different times during weekdays and weekends in order to reach a random sample of residents. The sample size was 140 interviews.

Analysis of Results

In the first set of questions, respondents reported that the general living conditions were good and that most of them like living there. Most thought that the noise situation had remained the same. A few residents (5 percent) said that they had experienced worsening living conditions because of air and road traffic.

The second set of questions showed that most residents did not perceive their neighborhood as noisy even though the areas are crossed by roads and are situated under the flight approach path. However, they did identify aircraft and road traffic as a noise heard more regularly.

The third set of questions addressed the extent of annoyance and activity disturbance caused by noise. Degrees of annoyance aggregated into NEF areas indicated that just a small percentage (fewer than 10 percent) of the residents had been extremely annoyed by aircraft noise (Figure 1). The results also showed that conversation (for an average of 40 percent of the respondents) was disturbed more than were listening to and watching television (about 20 percent of the respondents) (Figures 2 and 3). The activity that was least interfered with was sleeping (fewer than 10 percent of the respondents).

Comparisons with Previous Attitude Noise Surveys

The first comparison, shown in Figure 1, indicates the percentage of people highly annoyed in Ottawa versus that of other researchers' findings. This figure suggests that residents interviewed in Ottawa are not as annoyed as those in earlier surveys elsewhere. The Ottawa curve takes an almost identical shape, exponential, as the curves from earlier surveys, but it occurs approximately 10 NEFs below Schultz's curve.

The second comparison, shown in Figures 2 and 3, indicates the percentage of people in Ottawa who reported being disturbed often in conversation, sleep, and listening to radio or television versus results from previous noise attitude surveys. In this case, Ottawa residents appeared to be less disturbed by aircraft noise than people interviewed in surveys elsewhere.

Important Findings

The magnitude of people's annoyance toward aircraft noise in all three NEF areas nearby MCIA is lower than the degree of annoyance and activity disturbances noticed for the same noise levels from earlier noise survey results. The most plausible explanation for the low degree of annoyance found in Ottawa is that the NEF method takes into account only acoustical emissions produced by aircraft under standard field conditions. (Even though the latest

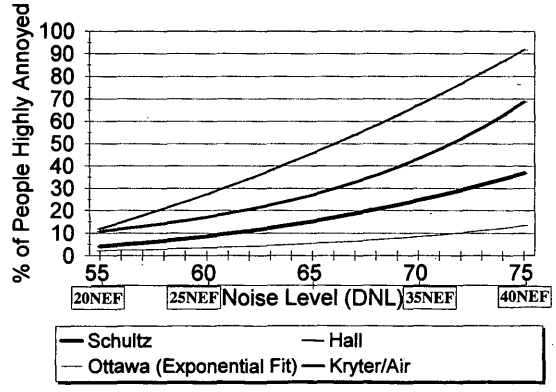

FIGURE 1 Noise annoyance curves.

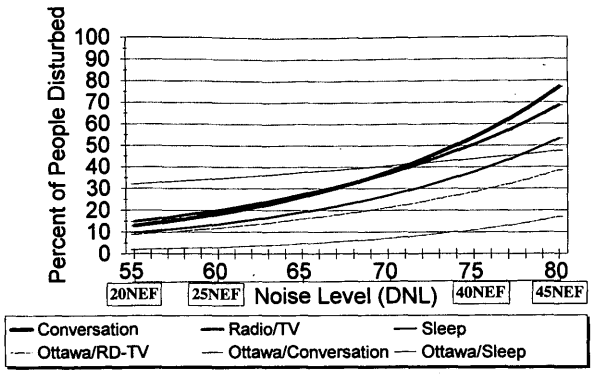

FIGURE 2 Activity disturbance.

INM Version 4.11 considers local topography, it is limited to calculating slant range distances.) That means NEF contours are relative to the runway configuration on flat terrain, with no barriers or shielding surface. However, the survey area at Ottawa is nonstandard.

Cold climatic conditions did affect the type of windows and insulation materials used in the buildings, which can reduce noise from outdoors. This climatic condition also influences time spent in outdoor activities, reducing exposure to noise since cold weather clearly forces residents to keep windows closed for most of the year and modifies their lifestyles. Therefore, the effects of a cold climate should be considered when adopting the NEF method as a basis to support land use planning around airports. Kryter has suggested that 5 dBA in the DNL method should be added to the noise exposure level expressed by a noise contour in order to have a similar effect between "warm" and "cold" cities (*10*).

Another local field characteristic that may explain the low degree of annoyance is related to the topography of the area. A study carried out by the Airport Land Use Commission of the county of Santa Clara, California (*11*), demonstrated that after it installed an accurate noise monitoring system on terrain that dropped off laterally from the airport runway in a ratio of 1 percent into a shallow flood plain, previous computer-based noise contours overestimated the noise by about 10 dBA using the DNL method. The survey area in Ottawa is located at the extension of Runway 07, which is in a depression, 30 m (100 ft) below Runway 07, with almost the same ratio (approximately 1 percent). The noise attenuation in this area is probably reinforced by the presence of many mature trees.

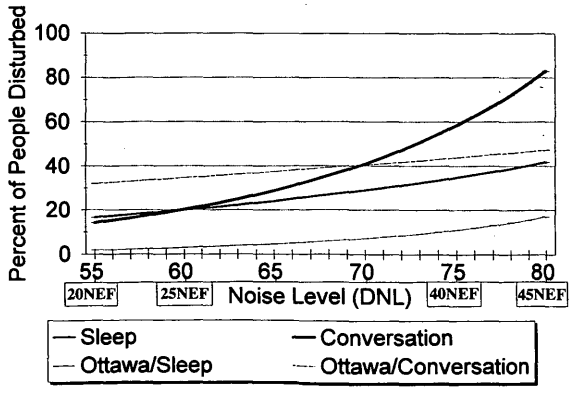

FIGURE 3 Activity disturbance.

CONCLUSIONS AND RECOMMENDATIONS

Land use planning guidelines are used to plan urban development in harmony with airport operations. Since noise is a big factor in land use planning near airports, noise exposure forecasts are used. As a general planning approach, the NEF method is a useful tool for identifying areas close to the airport under heavy impact of noise.

The adoption of specific noise contours as a strict limit for development in land use has been criticized by developers because of restrictions placed on large portions of land and by airport neighbors because of the loudness in the areas where they live. These criticisms often arise because of the misallocation of the noise contours, which leads to inaccurate levels of noise exposure. Such inaccuracy usually originates from the weakness of the NEF method in failing to account for important variations in community noise impact due to local field geographical conditions that are atypical. As a result the regulation and planning of land use around airports, based solely on noise contours, have been challenged.

Recently, Transport Canada and the Ministry of Municipal Affairs (*12*) agreed that a site's specific natural topography, ground condition, or presence of reflective or shielding surfaces may provide enough attenuation of ground-based aircraft noise to reduce NEF values. However, it does not bring any change or revised methodology to improve the applicability of the NEF method at a specific location.

Land use planning around airports can be improved by paying particular attention to specific geographical characteristics. However, the NEF method should be modified by field adjustment factors. Therefore, it is recommended that research be carried out to determine these field factors. The study of people's perception to aircraft noise should also be carried out over a long period to identify and quantify any important change over time.

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