Abstracts of the International Conference
ACOUSTIC CLIMATE INSIDE AND OUTSIDE BUILDINGS
held in conjunction with the workshop

"Aircraft Noise Reduction by Flow Control and Active / Adaptive Techniques"

eISBN 978-609-457-704-8
23–26 September, 2014, Vilnius, Lithuania Abstract Number: *acoustic.09*

http://www.acoustic.vgtu.lt/

CRITERIA FOR AIRCRAFT NOISE CONTROL AROUND AIRPORTS AND THEIR ROLE IN REACHING THE STRATEGIC GOALS IN ENVIRONMENTAL PROTECTION FROM AVIATION IMPACT

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Abstract. The extent of the noise problem is large. In the European Union countries about 40% of the population are exposed to road traffic noise with an equivalent sound pressure level exceeding 55 dB(A) daytime and 20% are exposed to levels exceeding 65 dB(A). Environmental noise means that emitted from sources such as road traffic, trains, and aircraft. The main health risks of noise identified by WHO [1] are:

- Pain and hearing fatigue; Hearing impairment including tinnitus; Annoyance;
- Interferences with social behaviour (aggressiveness, protest & helplessness);
- Interference with speech communication; Sleep disturbance;
- Cardiovascular effects; Hormonal responses & their possible effects on metabolism & immune system;
- Performance at work and school.

The protection of the residents is understood as a dynamic process, meaning that the evaluation criteria must be repeatedly tested and – if necessary – adapted to new scientific findings. In addition, to increase the quality of life, it is recommended ever to apply the best noise reduction measurements provided by technical development. Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life;
- where possible, contribute to the improvement of health and quality of life.

Possible indicators of these different effects cover a very broad range. There are three types of noise indicators: those that express noise cumulatively as a function of total energy experienced over a set period of time, those that express the noise levels experienced during a discreet aircraft operation, and those that are a hybrid of the other two. Based on extensive and detailed reviews the presentation suggests evaluation limits for aircraft noise for the prediction of noise effects and for the protection of residents living in the vicinity of the airports. The protection concept provides graded assessment values [1]: Critical Limits indicate noise loads that shall be tolerated only exceptionally during a limited time. Protection Guides are central assessment values for taking actions to reduce noise emission. Threshold values inform about measurable physiological and psychological reactions due to noise exposures where long term adverse health effects are not expected. As protection of the residents is understood as a dynamic process, these criteria must be repeatedly tested and adapted to new scientific findings. The WHO guidelines [2] are general recommendations, which are impossible to achieve now. Taking all exposure to transportation noise together about half of the European Union citizens are estimated to live in zones which do not ensure acoustical comfort to residents. The noise pollution problem is severe in cities of developing countries and caused mainly by traffic.

Data collected alongside densely travelled roads were found to have equivalent sound pressure levels for 24 hours of 75 to 80 dBA. Exposure periods of residents in the vicinity of airports are 24 hours a day and for this exposure period the US EPA has extrapolated an equivalent noise level of 75 dBA that is regarded as a limit below which hearing damage is not expected. Reports on occupational noise indicate that levels of more than 80 dBA are associated with a higher risk for hypertension and of more than 90 dBA with other cardiovascular findings. Concerning transportation noise equivalent noise levels exceeding 70 dBA are suspected to contribute to the genesis of hypertension and levels between 65 and 70 dBA to ischaemic heart diseases. The protection goals given above refer to the average person. Their establishment is expected to improve the situation for everybody, but there are persons and situations where additional measures are required.

Because the responses regarding annoyance and sleep disturbance of people in different countries might be different due to differences in cultural expectations about the acceptability of transportation noise exposure, differences in climate and the adequacy of housing sound insulation techniques, the use of the annoyance and sleep disturbance curves for local situations should be applied with great care. Fig. 1 shows data of the percentage of high noise annoyance by aircraft noise (%HA)

obtained in RDF Study in comparison to results from 11 similar studies [3]. The figure with exposure-response data of the 11 studies is part of a review of 28 studies on aircraft noise annoyance. The %HA estimate for the RDF study is well above the curve presented in the EU Position Paper on noise annoyance ("EU-curve" in Fig. 1).

Nevertheless the RDF data do not indicate any extreme conditions in the Rhine-Main areas in terms of noise annoyance. The EU-curve, however, refers to data collected from 1965–1992; the mean age in the generalized curve is 14 years (in 2006). The fact that air traffic has changed considerably since then may be one of the main reasons for a shift in the percentage of annoyed persons in reference to the generalized curve. The extent of noise annoyance, however described or reported, is clearly influenced by numerous non-acoustic factors such as personal, attitudinal, and situational factors in addition to the amount of noise per se. Many researchers have concentrated on the role of specific interferences with speech, communication, sleep, concentration, or task performance in mediating reported annoyance, but the underlying relationships found vary from one study to another. A question should be asked: Are the RDF data the final for today results of noise impact assessment or we need to expect their changes in near future? Latest results for annoyance assessment of the wind turbine noise (Fig. 2) provide the conditions that changes must be taken in mind if any possible measures will not be used to stabilize a situation. Any possible interpretations of the various underlying relationships between noise and reported annoyance may show both direct and indirect routes from stimulus to effect.

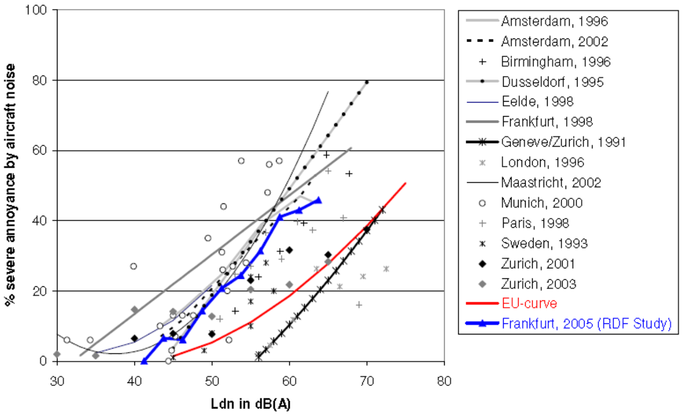

Fig. 1. Severe annoyance by aircraft noise. Results from different international studies [3]

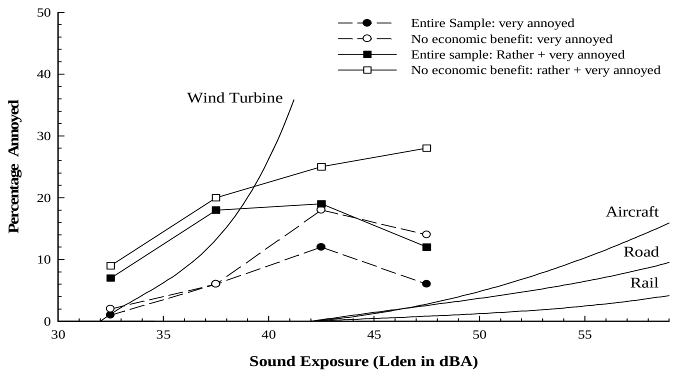

Fig. 2. Annoyance plotted as a function of noise level for four theoretical models and four sets of data obtained from van der Berg [4]. For the data, closed symbols are for the entire sample, while open symbols are for those who identified that they had no economic interest. Circles represent the percentage of "very annoyed" responses whilst squares represent the sum of "very annoyed" and "rather annoyed" responses.

Protecting residents is a dynamic process that must be followed up. The evaluation limits must be repeatedly tested in view of new scientific findings and adapted, if necessary. The recently issued WHO Night Noise Guidelines [5] expanded the Community guidelines on the issue of sleep disturbance, and concluded that although biological effects kick in as low as 30 dB L_{night}, 40 dB L_{night} should be an adequate health protection value, but proposed also an "interim target" of 55 dB L_{night}. The Night Noise guidelines give clear advice that from the health point of view the calculations of night time burden should start at 40 dB L_{night} and that action planning should at least contain actions to bring down the level to below 55 dB L_{night}. Converting the L_{max} variable to L_{night} resulted in a relationship between L_{night} and the number of noise events in which a doubling of the number of events resulted in an approximately 10 dBA increase in L_{night}. This is an intuitively reasonable result as 10 dBA is equivalent to a doubling of loudness in human perception of noise and a far more realistic one than the 3 dBA inherent in L_{eq}-based metrics. All of the countries reporting limits have limits in place for L_{night} and that, for residential areas, these are at or below the WHO Interim Target level, 55 dBA.

Among acoustic measures describing air traffic noise (L_{max}, N_{AT70}, L_{eq}), the L_{eq} shows the closest connection to annoyance and disturbance judgements (Fig. 3). There is only a marginal difference between estimation measures of long term aircraft noise exposure when investigating the relationship between noise level and annoyance. Scrutiny of Fig. 4 reveals that annoyance reactions to noise vary substantially and do not appear to be correlated with noise level. Other factors associated with the listener have been found to correlate with annoyance, and need to be accounted for when attempting to predict noise annoyance. It can be concluded that the high variability between individuals and groups makes it difficult to model the relationship between noise and annoyance. Regrettably, plots such as the Fig. 3 above are still used to determine noise standards.

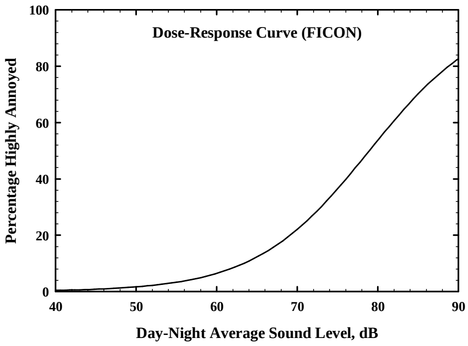

Fig. 3. A theoretical curve formulated to model the relationship between noise level and annoyance to aviation noise

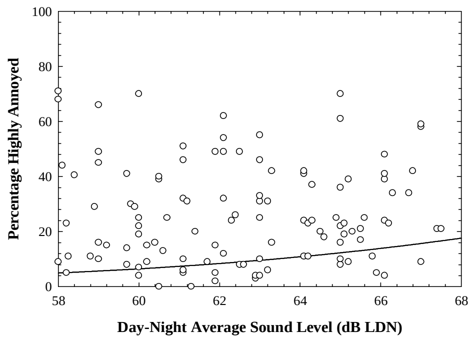

Fig. 4. Percentage highly annoyed at aircraft noise plotted as a function of noise level. The solid curve is a portion of that presented in Fig. 3, while the scattered points represent real measurements [6]

Keywords: noise criteria, noise annoyance, sleep disturbance, noise reduction targets and goals.

References

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