

EFFECTS OF NOCTURNAL AIRCRAFT NOISE ACOUSTICAL SETUP AND RESULTS OF THE LABORATORY AND FIELD STUDIES

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Introduction The DLR-Institute of Aerospace Medicine has been investigating the influence of nocturnal aircraft noise on sleep, subjective well-being and performance since 1999. Therefore the data of 192 healthy volunteers in total (128 volunteers in laboratory studies of 13 consecutive nights and 64 volunteers in field studies of 9 consecutive nights near the Cologne/Bonn Airport) were analysed. The Cologne/Bonn Airport is all-night open, predominantly for prevalent cargo flights during the night.

Methods For event correlated research of noise effects on human sleep there are different requirements for an acoustic equipment in laboratory or in field studies, depending on the acoustical situation at the selected location. Under laboratory conditions when the sleep rooms are shielded against outside noise, the acoustical situation during the night is controlled by the investigator. Thus, noise with varying different noise structure of starting and landing airplanes was played back at regular intervals between 4 and 128 times per night with maximum sound pressure levels between 50 and 80 dB(A). The different aircraft noises had been recorded by calibrated class-one sound level meters (48 kHz sampling rate) in apartments and at different window tilting angles near a busy airport. The play-back to the eight dormitory rooms of the laboratory occurred by means of an acoustic workstation which allowed a clock controlled automatic replay of the sounds in the night and therewith a “double-blind” study design. The correct noise level at the sleeper’s ear was ensured by providing pink noise of known maximum level in each dormitory room and its comparison with the simultaneously measured third-octave analysis.

In the field study, however, the acoustical conditions in the night are uncontrolled because the sleeping rooms usually are not acoustically secluded against noise from outside. Thus, in order to get a comprehensive assessment of the acoustical situation it is necessary to record the inside and outside sound pressure level simultaneously throughout the whole night. The internal sound pressure level was measured as close as possible to the sleeper’s ear by two sound level meters. One meter recorded actual sound files when the internal sound pressure level of the background was exceeded by more than 5 dB(A). The second internal sound level meter was triggered by the one measuring the outside sound level, and thus, internal noise levels were recorded in accordance to external noise events. By these procedures, internal and external sound events were simultaneously recorded when an out-side noise event exceeded the external background by more than 5 dB(A). This type of double-recording allows the correct identification of each noise arising within the night, and the comparison of the difference in noise level and frequency distribution provides important information of the damping characteristics of the sleeping room’s windows and walls.

Results The level and frequency of played-back aircraft noise events under laboratory conditions and the different aircraft noises, noise maximum levels and their psychoacoustic measurement categories will be presented.

Further on in comparison to the laboratory studies also the measured frequency of occurrences of aircraft noise events during the field studies near the Cologne/Bonn Airport and the according parameters (see above) will be shown. The psychoacoustic properties of representative examples of these noise events will be presented.

Considerable differences between the laboratory and the field condition were observed. In the laboratory, aircraft noise events were applied at regular intervals (between 4 and 128 per night). Depending on the air traffic volume, the direction of starts and landings and the location of the investigated home, the aviation related occurrences of noise was between 0 and 80 events per night. Aircraft noise was often clustered to particular time intervals during the night. In addition to aircraft noise, other sources of external and internal noise were recorded. The damping characteristic (comparison of outside and inside noise) depended on the position of the window (whether open, degree of tilting, closed) and varied between 11 and 30 dB(A).

Discussion When investigating the effects of aircraft noise on sleep, it is necessary to provide event correlated data of acoustic signals and sleep disturbances. Then these data can be judged with respect to the acoustic situation inside a bedroom and outside the house.

Keywords: aircraft noise, annoyance, sound level, sound level meter, damping quality, psychoacoustics