Assessment of the aircraft noise immission at airports on the basis of splitting up the aircraft-mix into two groups

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Introduction and retrospect

A new calculation model for aircraft noise immission was introduced at the "DAGA 2001". It was based on a group of aircraft types each having an average maximum noise level that differs less than +/-1 dB from the statistical mean level of the whole group [1]. These were types of aircraft of the manufacturers Airbus and Boeing, which are used for short and medium distance flights and are fitted with comparable engines regarding engine power and bypass ratio. The examined reference group of aircraft was then and still is representing between 30 and 70% of the whole traffic at all international airports.

The noise measuring points regarded in the surroundings of the airports of Hamburg and München were located very differently and it was ensured that all measured data were unambiguously dedicated to only one flight corridor at each point. For the outgoing flights the measuring points were located either before any turning corridors had begun splitting the whole traffic, or they were assigned to a certain outgoing corridor. The central line of such corridor and its width had been based on the flight tracks analysis of the air traffic control. The 11 chosen measuring stations for starting aircraft proved distances of 400 to 1300 m from the flight path and flew with a slope angle between 16 and 88° above the horizon.

For landing aircraft only data of those measuring stations were analysed, at which it was sure that all aircraft were flying on the ILS landing track already. At these 7 measuring stations for landing aircraft the distances varied between 130 to 530 m with slope angles between 15 and 89°.

The reasons why this study was conducted at that time was to examine the legitimacy to assume an average climb rate for starting jet-engined aircraft traffic as well as to examine the possibility to indicate the difference between the maximum noise level and the immitted sound energy of a single noise event during the straight-on flight by only using the average minimum distance between sound source and point of immission.

With this possibility the aid of a theoretically determined average speed became dispensable for the calculation of the effective duration of aircraft noise events.

Basics and procedure

Following the positive results of this first examination, the attempt could now be made to derive a calculation model for aircraft noise immissions, which takes into account the total present aircraft mix or rather an expected one.

The goal for practical application of the new and second examination was to derive prognostic calculations for determining the extent of an affected area in relation to different aircraft mixes, to differently set limit values and to alternative out-going flight corridors.

The calculations should thus determine the total immission within a tolerance of +/-1 dB on the basis of statistically secured measurement results.

In order to compare the results with those of the first examination, the same measuring points around München airport were chosen. The coordinates of the measuring station within the southern starting corridor were recalculated according to [2] because this corridor had been slightly shifted eastwards in the meantime.

A total of 146.775 measured values of starting aircraft and 133.303 measured values of landing ones were analysed for the new study, covering the whole air traffic between January and November 2003 at Munich Airport.

Within the first step it seemed to be helpful to extend the reference group examined in 2001 by aircraft types of similar or smaller sound performance compared with the reference group.

If the new aircraft types of Airbus (A319) and Boeing (Boeing 737/600, /700 und /800) are added to the reference group, deviations of 0,52 dB for starts and. 0,56 dB for landings from the mean values of the first examination occur for the mean maximum level. The engines of these in the meantime developed aircraft types show only slight modifications compared with previous types.

For the assessed LAX values deviations of 0,96 dB for starts and 0,55 dB for landings occured.

All values keep within the frame of tolerance.

As a second step, the mean values for all aircraft types run during the examination period of 2003 at München airport including the influence of propeller driven traffic were evaluated at all measuring stations. As a result, it was found that 10,9 % of starting and 6,4 % of landing machines exceeded the tolerance level. Included were aircraft types that did not provide a statistically reliable result to be assigned to the louder group because of the small number of measured values. Therefore, the possibility cannot be eliminated, that also these aircraft would provide mean values meeting the tolerance conditions if only there would be a higher number of measured events.

The resulting extended reference group of 89,1 % of the starting and 93,6 % of the landing aircraft deviated, both downwards, by 1,2 dB for starting and by 2,0 dB for landing aircraft, from the mean maximum levels across all measuring stations of the reference group 2001.

The difference values LAX – Lmax of the aircraftmix occurring during the examined period at München airport have not been higher than the values calculated in 2001. Therefore, the average single event LAX value of the extended reference group, which is the basis for calculating the pro-rata Leq value of this group within the total immission, can only be smaller compared with the average value of the reference group of 2001.
Consequently, the calculation of the higher average sound performance of the remaining louder fraction of the aircraftmix is safe.
This higher sound performance is a result of comparing for every single day of the measurement period the measured Leq value of the extended reference group with the measured total Leq value of aircraft noise immission of that day. The measured Leq value arises in both cases from the logarithmical summation of the measured single event levels.

Based on the difference between the Leq value of the extended reference group, the total Leq value and the known percentage of the louder aircraft within the total mix of the regarded day, the pro-rata Leq value of the remaining, louder part of the aircraftmix can be calculated separately for every single day.
Logarithmically sumarized over the total period of 11 months in 2003 and across all measuring stations results with this procedure an average plus in sound performance for the average loud mix for starting aircraft of 8 dB and of 6 dB for landing ones.

Results

In [1] the sound performance of the examined aircraft types referred to the octave levels for the aircraft classes 18 and 19 given in [2]. Deviations of –7 dB for starting and –4 dB for landing aircraft were published in [1] for the reference group. Consequently, the mean value of the louder part of the aircraft mix during the period of examination of eleven months comes out with 1 dB above the sound performance of starting aircraft class 18. Compared to the sound performance of aircraft class 22 of [2] this corresponds to a level 4 dB below this class. As for landing aircraft, the louder part of the aircraft mix results 2 dB above the sound performance of landing aircraft class 19. This corresponds with the sound performance of aircraft class 23 given in [2].

The results of this study are based on the aircraft mix within the first 11 months in 2003 at München airport. This mix might be different at other airports and can also change at München airport in the long run. Nevertheless, general deductions, which are valid for all airports can be made based on the derived values.
As a first precondition for that, suitable measuring sites have to be selected around the airport to be examined. It has to be ensured that all measurement data are unambiguously assignable to one certain flight corridor.
At these measuring points, the mean maximum levels of all aircraft types need to be assessed over a fair period of time. Out of these the aircraft types of the reference group are to be summed up to a mean maximum level for the total reference group. All aircraft types which statistically exceed this mean value of the reference group, sumarized over all measuring stations, by more than 1 dB will be recorded by the software of the respective continuously measuring aircraft noise monitoring system at the spot.

If the percentage of these louder aircraft within the total mix of landing aircraft is under 4 %, its influence on the total aircraft noise immission can be neglected. In this case, the Leq level of the total mix can be used for the calculation of the total immission by subtracting 4 dB from the values resulting for class 19 in [2]. If the percentage of the louder aircraft movements lies between 4 and 14 %, a subtraction of only 3 dB from the class 19 values would be appropriate for the total mix, if it lies between 14 and 26 % 2 dB and between 26 and 42 % 1 dB have to be subtracted, respectively.
If the percentage of the louder aircraft types of starting aircraft lies below 2 %, the influence on the total immission can be neglected so that a subtraction of 7 dB off the values for class 18 in [2] can be used for the calculation of the total noise immission. If it lies between 2 and 8 % a subtraction of only 6 dB provides to a total noise immission to be expected with an accuracy of 1 dB, between 8 and 15% a subtraction of 5 dB and between 15 and 23% a subtraction of 4 dB would lead to a total noise immission to be expected with an accuracy of +1 dB.

The examined case of München airport reveals for the total immission of the aircraft mix of 2003 for an average sound performance corresponding to class 18 AzB –5 dB for starts, and an average sound performance corresponding to class 19 AzB –3 dB for landings. All evaluated data recording starting aircraft already consider an accomplished power reduction. Thus, the recommended difference values for starting aircraft always refer to the octave levels given in [2] for class 18, before power reduction.

Literature:

[1] T. Meyer, E. Renz, M. Bosse Berechnungsmodell für Fluglärmimmissionen auf der Grundlage umfangreicher statistisch gesicherter Meßdatensätze, DAGA 2001, published in DAGA-report 2002

[2] AzB Anleitung zur Berechnung von Lärmschutzbereichen nach dem Gesetz zum Schutz gegen Fluglärm, Edition 1984