

Spectral 3-dimensional sound directivity models for fixed wing aircraft

Acoustic measurements on aircrafts in flight have been analyzed in order to derive the coefficients of a mathematical model describing the spectral 3-dimensional directivity pattern of the sound radiated by departing aircrafts. On the basis of the fitted models, the directivity characteristics of various aircrafts are analyzed and compared to existing models. Depending on aircraft types, comparison with new international aircraft noise guidance showed that Empa-results were up to 3 decibels louder.

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Although the noise impact of a single aircraft was significantly reduced in the last decades by means of new technologies and regulations, the problems of aircraft noise have increased for most airports. In or-

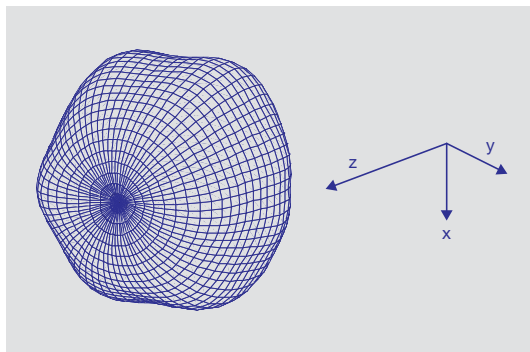


Fig. 1: Graphic representation of the fitted 3-dimensional, A-weighted directivity pattern for the Airbus A320 relative to the flight direction z .

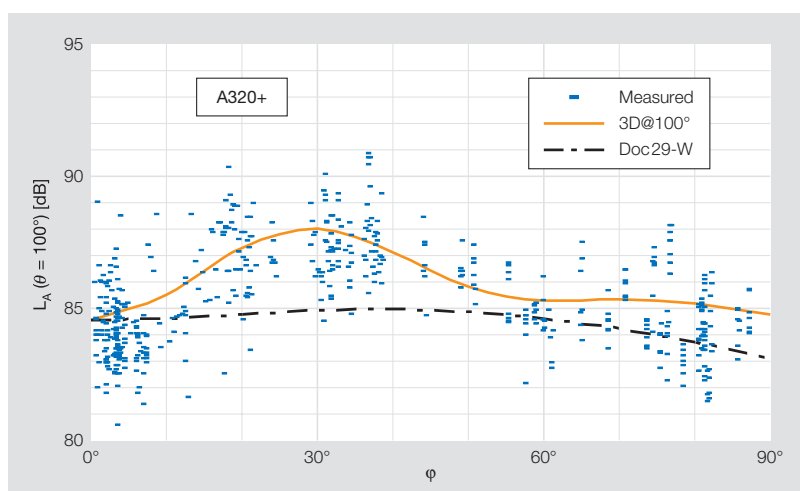


Fig. 2: Clusters of measured sound levels and the estimated lateral directivity for the longitudinal angle of 100 degree (3D@100°). For comparison, the "installation effect for wing mounted engines" according to ECAC Doc29 is also shown.

der to control and evaluate the effects of air traffic, quantitative information on noise impact has to be available. Due to the large ground area affected, aircraft noise is usually assessed by means of noise calculation programs, and considering the far-reaching commercial and political consequences, the reliability of noise calculations is of utmost importance. Empa has developed and maintained an advanced aircraft noise simulation program for two decades and has applied it to major civil and military airports.

In the absence of suitable data and due to huge computational efforts, most aircraft noise simulation programs use simplified models to describe the acoustic noise source. In these models the sound directivity is usually considered to be rotationally symmetric with respect of the direction of flight. However, recent publications suggest that the sound power emitted by fixed wing aircraft shows a lateral directivity as well.

In order to investigate the lateral directivity of fixed wing aircrafts, part of the data were re-analyzed which had been used previously for the rotationally symmetric model Empa-Flula2. The problem to be solved was to fit the proper coefficients to the full 3-dimensional model despite the fact that available data did not cover all emission angles. On the basis of the fitted models the directivity characteristics of various aircrafts were analyzed. This analysis revealed that for some aircrafts the lateral directivity significantly deviates from a rotational symmetric directivity and is even more pronounced than the engine installation correction proposed in new international documents like ECAC Doc29 (3rd edition) or SAE 5662. Taking into account these new findings, the calculated noise loads in areas to both sides of departure routes may increase by 1 to 2 decibels compared with results from conventional calculation programs.

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References:

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