Calculation of Aircraft Noise Contours in Germany

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National interim computation method for environmental noise

There are three main methodologies for calculating aircraft noise exposures in Germany. In 2005 the EC Environmental Noise Directive (2002/49/EC) has been transposed into national law. The act requires the development of noise mapping and action plans for major airports and other dominant noise sources. For this purpose a national interim computation method for aircraft noise is used which is laid down in a document called VBUF [1]. This calculation procedure is based on a Closest Point of Approach (CPA) model and meets the requirements stated in Annexes I and II of the Directive. It provides information on the actual aircraft noise situation of nine airports.

Calculation of noise protection areas

In 2007 a new Act for Protection against Aircraft Noise came into force in Germany [2]. It requires the establishment of noise protection areas at 35 civil airports and 17 military airfields. The noise protection area is subdivided into two daytime protection zones and one night-time protection zone. The act oblige the airport operator to pay the costs for constructional soundproofing measures in existing residential buildings located in daytime protection zone 1 and in the night-time protection zone. Moreover, the expenses for the installation of ventilation systems in rooms that are predominantly used for sleeping are to be reimbursed by the airport operator for buildings in the night-time protection zone. In the case of construction of new or the expansion of existing airports, these regulations are supplemented by compensation arrangements for deterioration of the quality of outdoor living space (terraces, balconies etc.) in daytime protection zone 1. The law contains different limit values for the individual zones. A distinction is made between existing and new or significant expanded airports. Furthermore, there exists different limit values for airports and military airfields.

The aircraft noise exposure has to be determined on the basis of detailed forecast data on future flight operations as well as on the description of the flight routes in the surrounding of the airport. This information is gathered with standardized data sheets which are fully described in the "Instructions on the Acquisition of Data on Flight Operations" (AzD) [3, 4].

The use of a runway system depends in particular on wind direction. For this reason the distribution of aircraft movements on the different runway directions varies over the years. In order to consider this effect the act contains an innovative approach which is called sigma rule. It takes into account the variations of runway use in the previous ten years. On the basis of statistical data on the runway use over this time period adjustments for the required noise indices are calculated.

Moreover, the AzD contains detailed regulations on quality control of the input data. For instance, the flight routes given in the Aeronautical Information Publication (AIP) have to be compared with plots from the Flight Track and Noise Monitoring System FANOMOS. This radar-based system shows the actual flown tracks in the vicinity of the airport. On the basis of this information ground tracks with realistic corridors width are described in the data acquisition system.

The calculation of the noise protection area is carried out on the basis of the data acquisition system. The algorithm is laid down in the "Instructions on the Calculation of Noise Protection Areas" (AzB) [3, 4]. It enables the calculation of equivalent continuous sound levels for day and night as well as of the number above threshold (NAT) criterion. The calculation comprises aircraft noise emission data, the number of aircraft movements during the six months of the forecast year as well as the flight routes. In addition, taxiing on the manoeuvring area of the airport and the operation of auxiliary power units (APUs) of the aircraft are also taken into consideration. The aircraft noise calculation is based on a segmentation approach because it corresponds with the current state of knowledge. The segmentation procedure divides the three-dimensional flight path of an aircraft into a series of straight segments. From each of these segments the aircraft contributes to the total sound exposure.

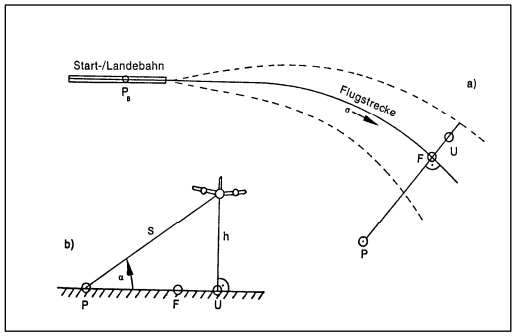
Calculation of aircraft noise exposure at airfields

The air traffic of an airport differs from that of a civil airfield with mainly general aviation traffic in many ways. These airfields are characterized by a smaller area, a different aircraft mix and a considerably lower traffic volume. Additionally, the aircraft movements are often concentrated at weekends. For these reasons the application of the complex AzB algorithm is inappropriate. For the determination the aircraft noise exposure at airfields a special calculation algorithm has been developed. It is published in the German standard DIN 45684-1 [5]. It is also a segmentation-based model but requires less quantity of input data. In contrast to the AzB the operation of aircraft at certain times (e.g. at weekends) is taken into consideration. The calculation procedure according DIN 45684-1 therefore produces realistic noise contours at civil airfields.

Comparison of national interim method with the new aircraft noise calculation procedure

The European Commission strives for common methods for determination on environmental noise. For this purpose a comparison of the national interim computation method for environmental noise with the new calculation procedure for the determination of noise protection areas would be helpful. Whereas the national interim method is based on a CPA model the new AzB uses a segmentation procedure. The principles of these methods are illustrated in Figure 1 and its effects is shown in Figure 2.

(1)



(2)

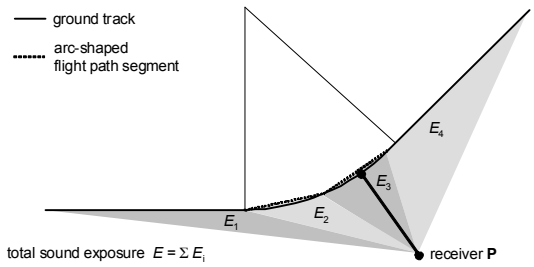


Figure 1: Comparison of CPA model (1) with the new AzB calculation (2) [3]

The segmentation approach has major advantages against the CPA model. Especially in the case of curved flight paths. The CPA model results in an overestimation of noise exposure of the external area of the curve and an underestimation of the internal area. The segmentation procedure avoids this effect and enables so a significantly better calculation of the aircraft noise exposure.

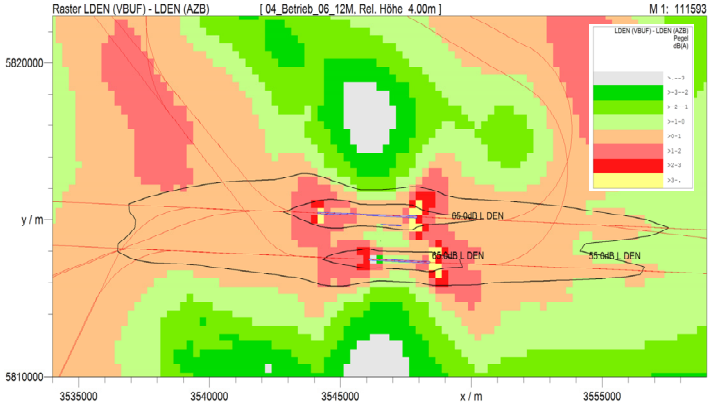


Figure 2: Effects of CPA model compared with the new AzB calculation

Furthermore, there are several other essential differences between the national interim computation method for environmental noise (VBUF), the new AzB and the German standard DIN 45684-1. These differences are summarised in Table 1.

Considered items	VBUF	AzB	DIN 45684-1
CPA model	X		
Segmentation model		X	X
Airport data	X	X	X
Aircraft movement data	X	X	X
Civil air traffic	X	X	X
Military air traffic	X	X	
Reverse thrust		X	
APU operation		X	
Variations of runway use in the past years		X	
Taxiing aircraft		X	
Flight routes with corridors	X	X	X
Quality control of input data		X	
L_{den} criteria	X		
L_{eq} criteria		X	X
NAT criterion		X	
Directivity of aircraft noise emission	X	X	X
Topography		X	X
Cartographic representation of noise contours	X	X	X
Archiving of essential documents		X	

Table 1: Comparison of aircraft noise calculation procedures in Germany

The comparison of the calculation procedures for the determination of aircraft noise exposure indicates that the new AzB method is much more sophisticated that the interim model. It contains several substantial improvements. The AzB represents current best practice and is a candidate for a harmonized European aircraft noise calculation model in the future.

References

[1] Bekanntmachung der Vorläufigen Berechnungsverfahren für den Umgebungslärm nach § 5 Abs. 1 der Verordnung über die Lärmkartierung (34. BImSchV), Vorläufige Berechnungsmethode für den Umgebungslärm an Schienenwegen (VBUSch), Vorläufige Berechnungsmethode für den Umgebungslärm an Straßen (VBUS), Vorläufige Berechnungsmethode für den Umgebungslärm an Flugplätzen (VBUF), Vorläufige Berechnungsmethode für den Umgebungslärm durch Industrie und Gewerbe (VBUI); (Interim Computation Method for Environmental Noise) of 22.05.2006, Bundesanzeiger of 17.06.2006

[2] Bekanntmachung der Neufassung des Gesetzes zum Schutz gegen Fluglärm (Act on Protection against Aircraft Noise) of 31.10.2007 (Federal Law Gazette (BGBl. I) p. 2550)

[3] Erste Verordnung zur Durchführung des Gesetzes zum Schutz gegen Fluglärm (Verordnung über die Datenerfassung und das Berechnungsverfahren für die Festsetzung von Lärmschutzbereichen – 1. FlugLSV)“ (First Decree on the Implementation of the Act on Protection against Aircraft Noise [Decree on the Acquisition of Data and the Calculation Procedure for the Establishment of Noise Protection Areas] of 27.12.2008 (BGBl. I p. 2980)

[4] Bekanntmachung der Anleitung zur Datenerfassung über den Flugbetrieb (AzD) und der Anleitung zur Berechnung von Lärmschutzbereichen (AzB) (Instructions on the Acquisition of Data on Flight Operations and the Calculation of Noise Protection Areas) of 19.11.2008, Bundesanzeiger of 23.12.2008

[5] DIN 45684–1: Acoustics – Determination of Aircraft Noise Exposure at Airfields – Part 1: Calculation Method, September 2006