



## Land-use planning at airports in Germany

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### ABSTRACT

In 2001 the International Civil Aviation Organization (ICAO) initiated the Balanced Approach to Aircraft Noise Management. It consists of four essential elements to reduce aircraft noise. One is land-use planning and management. In Germany, this already starts with planning of an airport in order to find a suitable site. This planning process deals with aircraft operational aspects as well as economical and environmental ones. After the airport has been built, noise protection areas are to be established according to the German Act for Protection against Aircraft Noise. The noise protection area is subdivided into two daytime and one nighttime protection zone. The act obliges the airport operator to pay for constructional soundproofing measures in existing residential buildings located in daytime protection zone 1 and in the nighttime protection zone. Moreover, expenses for installation of ventilation systems in rooms predominantly used for sleeping are to be reimbursed by the airport operator for buildings in the nighttime protection zone. Furthermore, several local regulations which comprise building restrictions in the vicinity of the airport exist which primarily have the aim to prevent or reduce noise conflicts. The land-use planning at German airports will be described and evaluated.

Keywords: Airport, Noise, Insulation

### 1. INTRODUCTION

Germany is a densely populated country with a high traffic volume. Therefore, large parts of the population are affected by noise which adversely affects their health and quality of life. At two-year intervals, the German Federal Environment Agency commissions representative surveys to determine the noise annoyance of the population in Germany. According to the survey carried out in 2012, about 54 % of those interviewed complained of being disturbed or annoyed by road traffic in the vicinity of their homes (1). Rail traffic was the second most common noise source generated by transport. But it is not just ground-based transport that is the cause of considerable noise exposure. Many people are also affected by aircraft noise. Slightly more than a fifth of the population are disturbed by aircraft noise. For the reduction of aircraft noise the ICAO Balanced Approach to Aircraft Noise Management (2) is of great importance. It consists of four essential elements to mitigate aircraft noise. These are the reduction of noise at the source, land-use planning and management, noise abatement operational procedures and operating restrictions. All these measures are applied at airports in Germany in order to improve the noise situation.

### 2. LAND-USE PLANNING IN GERMANY

#### 2.1 Airports and military airfields

The Land-use planning in Germany deals with building and settlement restrictions including the

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reimbursement for constructional soundproofing measures in residential buildings in the vicinity of airports and airfields. The type of land-use planning depends on the degree of aircraft noise exposure. For airports and airfields with flight operations that cause a rather high noise exposure the Act for Protection against Aircraft Noise is applied (3). It requires the establishment of noise protection areas at commercial airports as well as military airfields with the operation of jet or heavy transport aircraft. The noise protection area is subdivided into two daytime protection zones and one nighttime protection zone. The act 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 which are displayed in tables 1 and 2.

Table 1 – Overview of the limit values for existing airports or airfields according to the Act for Protection against Aircraft Noise

type of airport/airfield	daytime protection zone 1	daytime protection zone 2	nighttime protection zone	
	$L_{Aeq, day}$	$L_{Aeq, day}$	$L_{Aeq, night}$	$n \times L_{Amax}$
civil airport	65 dB(A)	60 dB(A)	55 dB(A)	6 x 72 dB(A)
military airfield	68 dB(A)	63 dB(A)	55 dB(A)	6 x 72 dB(A)

Table 2 – Overview of the limit values for new or significantly expanded airports or airfields according to the Act for Protection against Aircraft Noise

type of airport/airfield	daytime protection zone 1	daytime protection zone 2	nighttime protection zone			
			until 31.12.2010		from 01.01.2011	
	$L_{Aeq, day}$	$L_{Aeq, day}$	$L_{Aeq, night}$	$n \times L_{Amax}$	$L_{Aeq, night}$	$n \times L_{Amax}$
civil airport	60 dB(A)	55 dB(A)	53 dB(A)	6 x 72 dB(A)	50 dB(A)	6 x 68 dB(A)
military airfield	63 dB(A)	58 dB(A)	53 dB(A)	6 x 72 dB(A)	50 dB(A)	6 x 68 dB(A)

In the whole noise protection area the construction of noise-sensitive buildings (e.g. hospitals, schools) is generally prohibited. In the daytime protection zone 1 as well as in the nighttime zone the construction of new dwellings is also not allowed. For existing residential buildings located in these zones the Act for the Protection against Aircraft Noise contains provisions that oblige the airport operator to cover the costs for constructional soundproofing measures at these buildings. 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 nighttime protection zone. Expenses incurred for constructional soundproofing measures including the ventilation systems are reimbursed to a maximum amount of 150 Euros per square meter of living space. The noise insulation requirements are specified in a statutory decree (4).

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. Further details such as the extent of the outside living area that requires protection and the compensation for impairment in this area are laid down in a statutory decree (5). The compensation has to be paid by the airport operator.

The calculation of the noise protection area is carried out on the basis of a prediction on the 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 described in the “Instructions on the Acquisition of Data on Flight Operations, AzD” (6, 7).

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” (6, 7). 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 maneuvering 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 which divides the three-dimensional flight path of an aircraft into a series of segments. Each of these segments provides a contribution to the total noise exposure. Therefore, the AzB uses a modern method for the determination of the noise protection area which is described in a complex calculation algorithm. To ensure a correct transformation of this algorithm to computer software an extensive quality assurance has been conducted. Furthermore, there exists a standardized interface for data import and export.

The regulations on data acquisition and the calculation procedure as well the quality assurance enable an efficient enforcement of the Act on Protection against Aircraft Noise. Noise protection areas are established by a statutory decree of the Federal state (Bundesland), in which the airport is located. At present, noise protection areas have been designated for a total of 26 civil airports and ten military airfields.

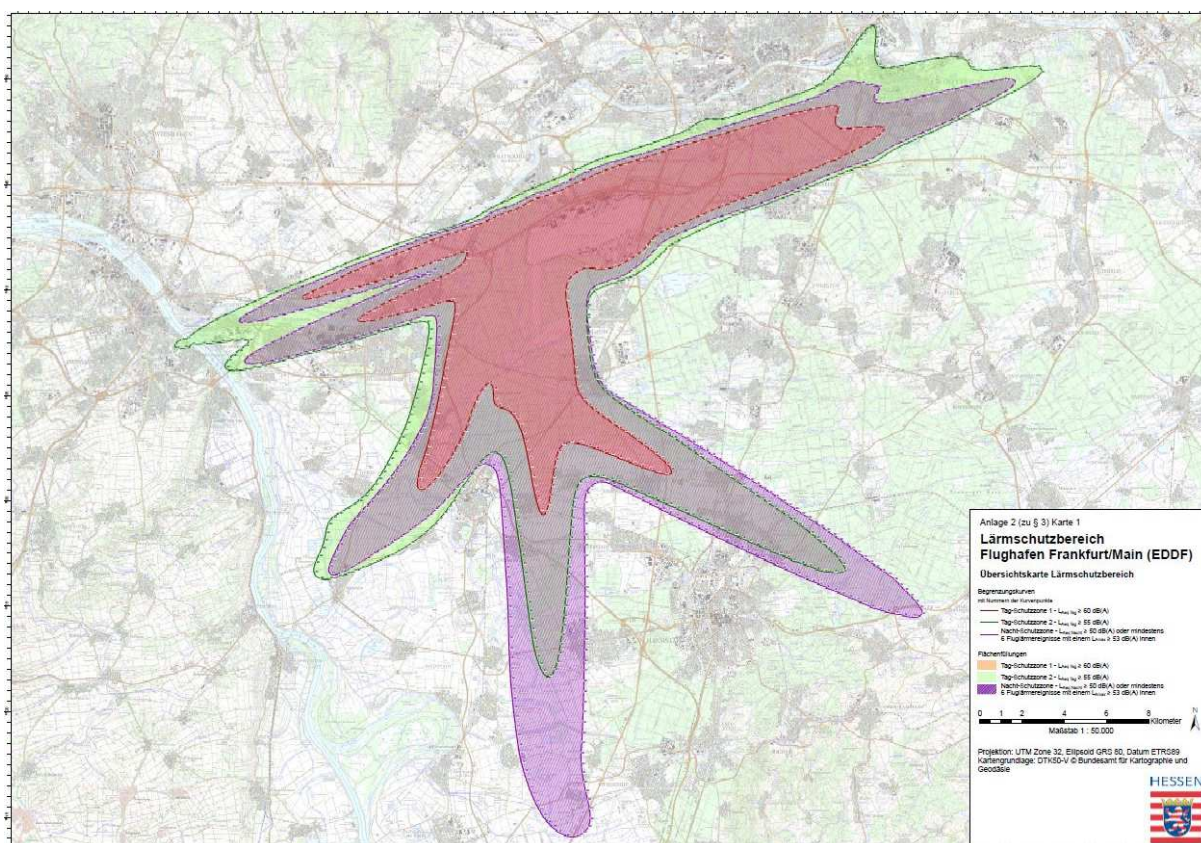


Figure 1: Noise protection Area of Frankfurt/Main Airport; Daytime noise protection zone 1=orange, Daytime noise protection zone 2=green; Nighttime noise protection zone = purple (8)

Every ten years existing noise protection areas will be examined whether there has been any substantial change in the noise impact or whether any significant change can be expected within the next ten years. For this purpose the values of equivalent continuous sound level at the curve points of the existing daytime protection zone 1 and the nighttime protection zone will be compared with new calculated zones. The new zones are determined on the basis of flight operations which will be conducted in the forthcoming in ten years. If this investigation leads to the result that there is a difference between the curves points of at least 2 dB(A) then the noise protection area will be re-established. An earlier re-establishment of this area is necessary if an alteration in the airport facilities or flight operations will lead to a significant change in aircraft noise exposure.

In addition to the regulations of the Act for Protection against Aircraft Noise, there are several provisions at regional level to control the development of settlements in the vicinity of airports. These provisions are usually a part of the state development plans of the Federal states (Bundesländer). They are the legal basis for the establishment of aircraft noise contours which are often greater than the noise protection areas. Within these contours, land-use is restricted in order to prevent future noise conflicts.

Moreover, there exist additional soundproofing programs at most German airports. These programs have often been developed in the context of planning approval procedures for the expansion of airports, or they are carried out as a voluntary service by the airport operator. The programs differ in particular in the size of the zones and the underlying criteria. For instance, such a soundproofing program was set up at Leipzig/Halle airport. This airport is characterized by a heavy night flying activity. In order to protect the residents from aircraft night noise a special criteria was developed by the German Aerospace Center (DLR) (9). It describes an exposure-response relationship between the maximum sound pressure level of an aircraft noise event and the probability to wake up. The criteria led to a night protection zone of about 256 km<sup>2</sup>. Within this zone bedrooms have to be equipped with soundproofed windows and ventilation systems at the expense of the airport operator.

## **2.2 Civil airfields**

The air traffic of an airport differs from that of a civil airfield in many ways. At these airfields mainly general aviation traffic is carried out. Additionally, they are often characterized by a concentration of aircraft movements at weekends. For these reasons other measures for land-use planning are applied in Germany. These comprise the limit value of the aircraft noise contour as well as the calculation procedure. Concerning the determination of the aircraft noise exposure a special calculation algorithm has been developed which is published in the German standard DIN 45684-1 (10). It has in common with the AzB that both calculation procedures are based on a segmentation approach but it requires less input data. Therefore, it fits well for this field of application and provides realistic aircraft noise contours.

## **3. EVALUATION OF LAND-USE PLANNING MEASURES**

Land-use planning at German airports and airfields pursues a problem-oriented approach. The required information for the determination of aircraft noise contours as well as the extent of building and settlement restrictions depend on the noise exposure. The Act for Protection against Aircraft Noise is the legal basis for the reimbursement of expenses for constructional soundproofing measures in existing residential buildings located in highly noise exposed areas. As a consequence numerous residential buildings in the surrounding of civil airports or military airfields were equipped with soundproofed windows. At the same time, the act significantly restricts the construction of dwellings or noise-sensitive institutions (e.g. hospitals) in the close vicinity of the airports. In addition to these restrictions, there are provisions at regional level to control the development of settlements. These regulations prevent potential noise conflicts and maintain free spaces in the surroundings of airports. Furthermore, there exist regulations on land-use planning at civil airfields with mainly general aviation traffic. The procedure for the calculation of the aircraft noise exposure at airfields is less complex and the land-use restrictions are suitable for this case.

## **4. CONCLUSIONS**

Numerous national and international studies have shown that noise can disturb communication and relaxation and can be a considerable source of annoyance. The risk of illness also grows with increasing noise exposure. A clear reduction in the negative effects of noise can only be achieved by a noise reduction strategy which uses all possible measures. For an effective protection of the population from aircraft noise a coordinated application of a variety of individual tools is necessary. They reach from reducing noise at source to noise abatement flight procedures as well as flight operating restrictions to planning measures. Land-use planning is an important element of this comprehensive strategy.

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