Aircraft noise report 2015

Luftfahrt bewegt.

Air transport allows people to quickly reach almost every corner of the globe, while also connecting companies and their products to the global economy. However, this demand for mobility is at odds with the desire of people who live near airports for rest and protection.

In this report, the German Aviation Association (BDL) summarises the key facts and information in this regard, and explains the strategies and measures that lead to a reduction in noise emissions.

Content

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Aircraft noise report 2015

Development of passenger numbers at German airports from 1991 to 2014	+168 %
Development of flight movements at German airports from 1991 to 2014	+57 %
Reduction of noise emissions by aircraft since the mid-1950s	–80 %
Reduction in the number of people affected by aircraft noise in Germany from 2006 to 2014	–65 %
Planned investments of German airlines in 230 new, quieter aircraft over the next ten years	€ 32 bn
Expenses by the aviation industry on noise control at German airports to date	€ 925 m

BDL
Bundesverband der Deutschen Luftverkehrswirtschaft

Aircraft noise: key indicators 2015

An increase in passenger numbers does not necessarily lead to increased aircraft noise. After all, the development of passenger numbers in Germany no longer means a parallel development in terms of flight movements. New technologies mean that modern aircraft are becoming ever quieter and their noise emissions are significantly below the permissible limits.

Efficient organisation of air transport reduces aircraft noise

In the field of air transport, increasing passenger numbers do not automatically mean an equally sharp increase in flight movements. Significantly more passengers and freight are now transported at German airports compared to 20 years ago, but the flight movements have not increased at the same rate. There were 77 million passengers in Germany in 1991. By 2014, that number had almost tripled to 208 million passengers – an increase of 168 per cent. Flight movements have increased during this period by just 57 per cent.

Breaking the link between movements and passenger growth

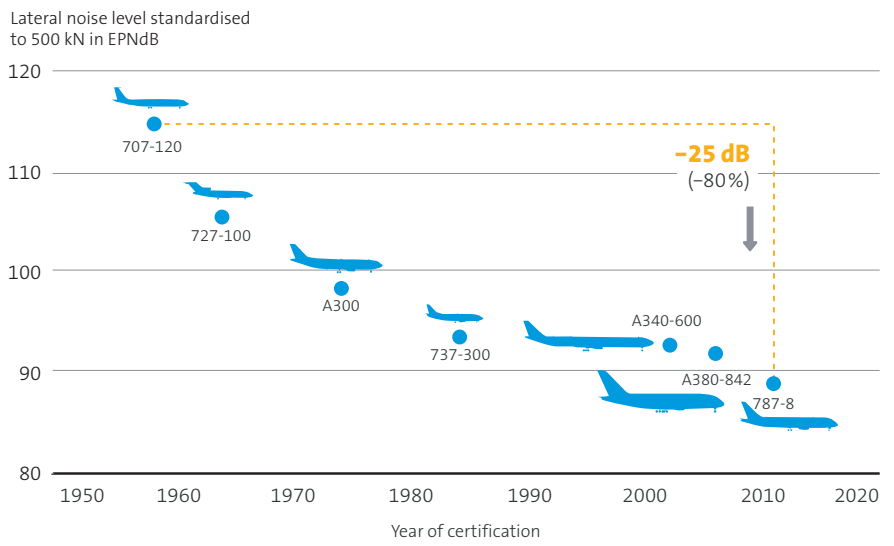
Source: German Airports Association (ADV)

This is because an aircraft can now seat around 70 per cent more passengers than 20 years ago. On the one hand, airlines are increasingly using larger aircraft that can transport more passengers at a time. On the other hand, airlines around the world have been able to continually improve their passenger load factors. On average, eight out of every ten seats on an aircraft will now be occupied during a flight.

Noise development to the present day: down by 80 %

The most effective way of preventing noise is to invest in new aircraft technologies and to continually modernise existing aircraft. Major advances have been made in this area over the past few decades, with latest-generation aircraft 25 decibels, or around 80 per cent, quieter than 60 years ago.

Development of aircraft noise emissions



**EPNdB: Effective Perceived Noise in Decibels*

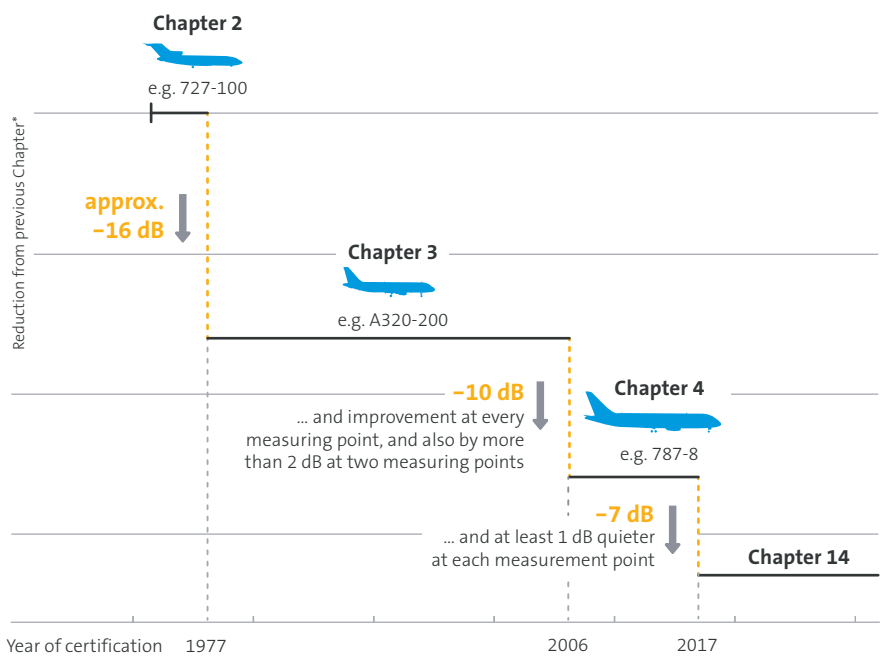
Source: CFD-Software E+F GmbH Berlin

Aircraft fall significantly below required noise levels

Noise levels are defined in Annex 16 to the Convention on International Civil Aviation (Chicago Convention) as a result of the international nature of aviation. The permissible levels depend on an aircraft's maximum take-off mass and number of engines, and are therefore different for each model. Noise standards known as Chapter 2, 3, 4 and 14 specify the requirements to be met by the various aircraft models and the deadlines for compliance. Since 2006, aircraft have been certified based on the standard in Chapter 4. These include the Airbus A350 and the Boeing 787 – the newest aircraft currently in use. In order for Chapter 4 aircraft to be approved, they must be at least 10 decibels quieter than the previous generation, i.e. Chapter 3 aircraft.

The following graphic shows how the internationally defined noise levels have been continually tightened since the 1970s.

Tightening of international noise levels



** Calculated from the total of the individual measurements (approach, lateral, flyover) measured in EPNdB*

Source: The UN's International Civil Aviation Organisation (ICAO)

Many aircraft not only meet these limits, but fall significantly below them. An Airbus A319-100, a Chapter 3 aircraft, is up to 19.4 decibels quieter than the limit for its Chapter. And some aircraft models fall well below the noise levels for Chapter 4. These include the Boeing 747-8, which is 15.6 decibels below the level, and the Airbus A380, which is 16.7 decibels below.

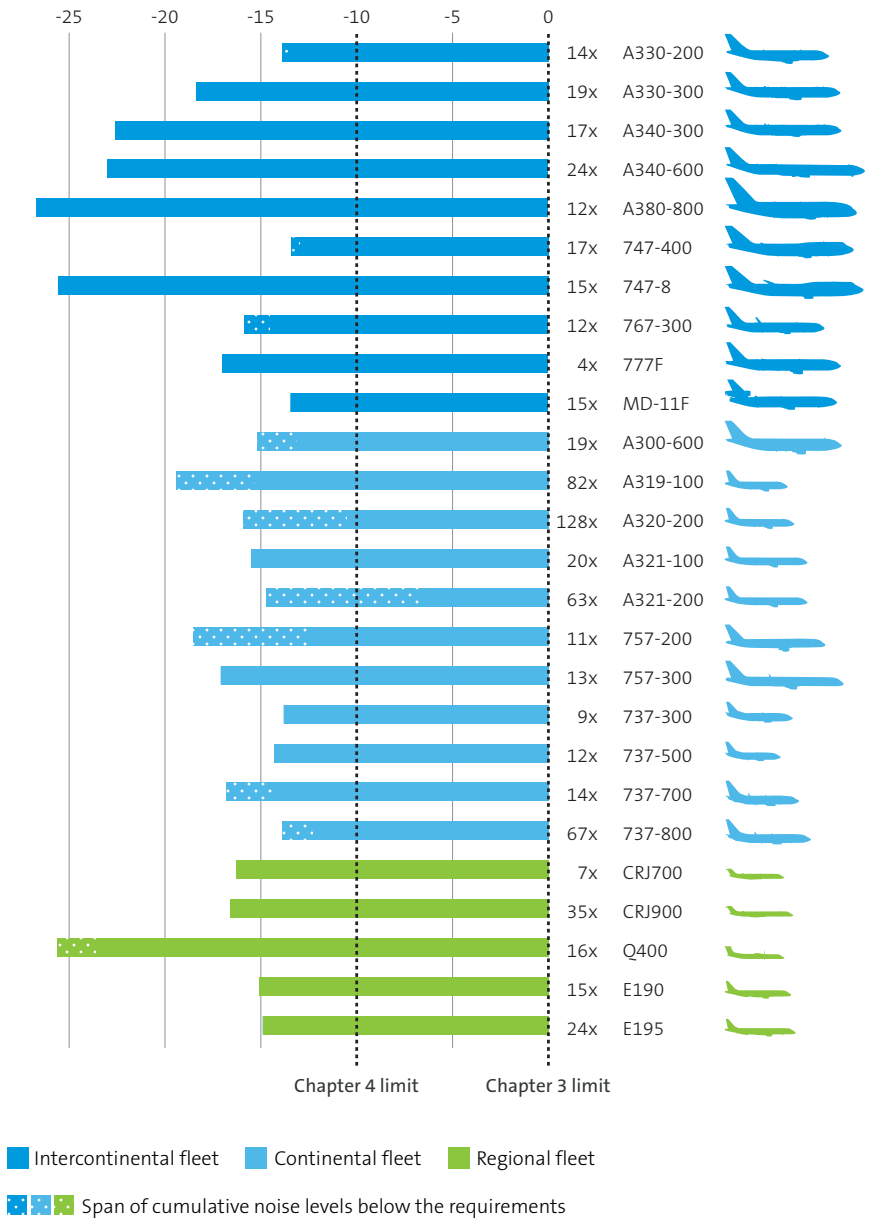
German airlines taking older aircraft out of service

New aircraft are considerably quieter compared to their predecessors. German airlines are already operating a large number of state-of-the-art aircraft, and have already ordered 230 aircraft at a value of over €32 billion for the coming years. Noise management is just one reason behind the airlines' efforts to upgrade their fleets. Another incentive: not only are modern aircraft quieter, they also use significantly less fuel.

The new machines are generally being used to replace older, louder aircraft. Since 2012, for example, one of the world's most advanced freight aircraft, the Boeing 777F, has operated out of Cologne Bonn Airport, replacing the Boeing MD-11. Measurements show that this replacement achieves significant noise abatement for the public. At certain measurement points, the new model is over 5 decibels quieter.

Aircraft fleet of the BDL airlines

Cumulative noise level below Chapter 3 and Chapter 4 requirements (all values in EPNdB)



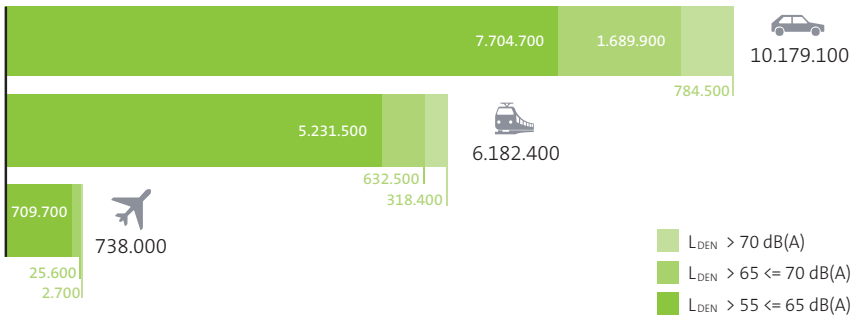
Source: airberlin group, Condor, DHL/EAT, Germanwings, Lufthansa, Lufthansa Cargo, Lufthansa CityLine, TUIfly; data from: 31.12.2014

Noise mapping: fewer people affected by aircraft noise

In accordance with the EU Environmental Noise Directive, traffic noise was recorded for the first time in Europe in 2007. The latest figures for Germany are from 2012, and show that 8,500 fewer people are affected by aircraft noise than in 2007, despite the fact that two more airports were taken into account for the noise mapping.

According to an evaluation by the German Federal Environment Agency, 10.2 million people in Germany are affected by road-traffic noise and 6.2 million people by rail-traffic noise, with an average sound level of over 55 dB(A). A much smaller group of people is affected by aircraft noise – just 738,000 people to be precise.

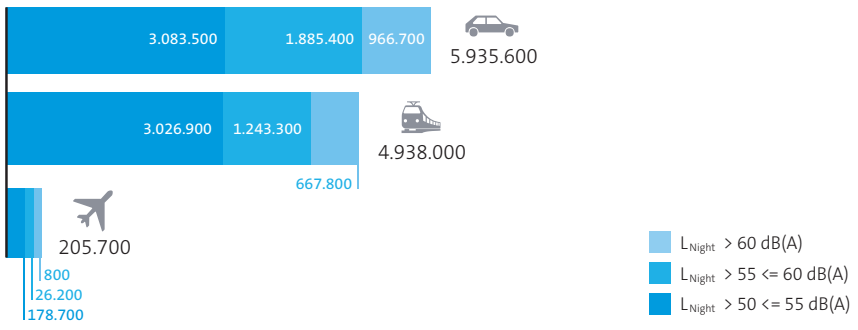
People affected by traffic noise in Germany



Source: German Federal Environment Agency (UBA) 2015

The differences are even greater at night: Between 10 p.m. and 6 a.m., 29 times more people are disturbed by road-traffic noise and 24 times more people by rail-traffic noise than those disturbed by aircraft noise.

People affected by traffic noise in Germany (night-time)



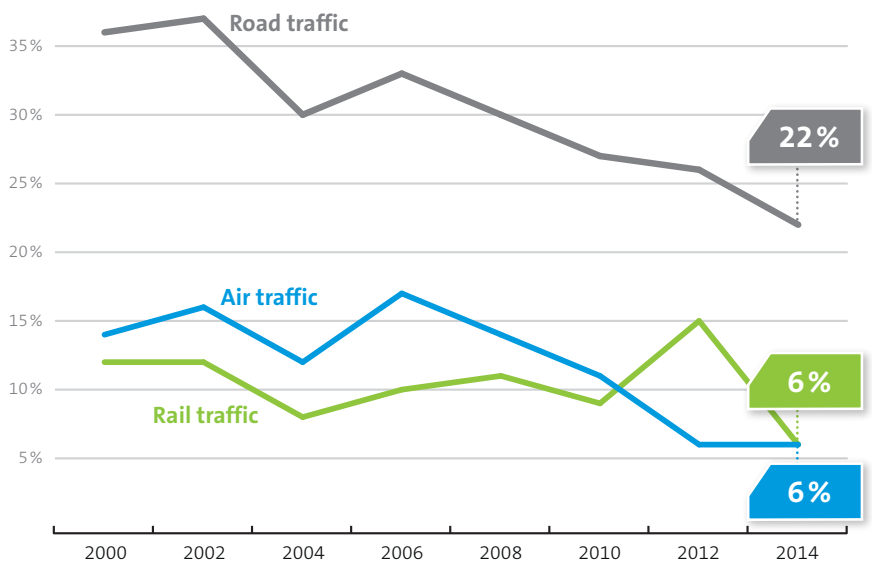
Source: German Federal Environment Agency (UBA) 2015

Fewer and fewer people feel disturbed by aircraft noise

The numerous approaches to avoiding aircraft noise and therefore improving life for those affected are proving effective. This is confirmed in the regular representative survey carried out by the Federal Ministry for the Environment every two years, called "Umweltbewusstsein in Deutschland" [Environmental Awareness in Germany]. As part of this survey, the Ministry aims to find out information such as the extent to which Germans feel that they are disturbed by different sources of noise. The evaluation shows that the proportion of people who feel moderately, severely or very severely affected by aircraft noise has decreased by 65 per cent between 2006 and 2014. This is a huge success in light of the fact that the number of flight movements has continued to increase and that the public is more aware of the issue of aircraft noise as a result of new development and expansion projects.

This survey demonstrated that the proportion of the population that feels disturbed by aircraft noise has fallen from 17 per cent in 2006 to 6 per cent in 2014. At the same time, 6 per cent of Germans feel affected by rail-traffic noise, 22 per cent by road-traffic noise and 15 per cent by residential noise. 79 per cent of people stated that they do not feel at all disturbed by aircraft noise.

People disturbed by traffic noise in Germany*



These figures relate to people who feel very severely (extremely), severely or moderately affected by noise.

Source: Federal Ministry for the Environment (BMU), Umweltbewusstsein in Deutschland 2000 bis 2014 [Environmental Awareness in Germany 2000 to 2014]

International aircraft noise strategy and European targets

The International Civil Aviation Organisation ICAO has published guidelines for a balanced way of dealing with aircraft noise – known as the Balanced Approach. In addition, the EU has formulated specific targets for aviation noise reduction by 2050.

The Balanced Approach

In the Balanced Approach, the ICAO has defined four key elements that can be used to achieve an effective reduction in aircraft noise without jeopardising safety standards, which have to take precedence over environmental protection.

The ICAO has determined, on an international level, that the first three measures are of a higher priority than the fourth measure:

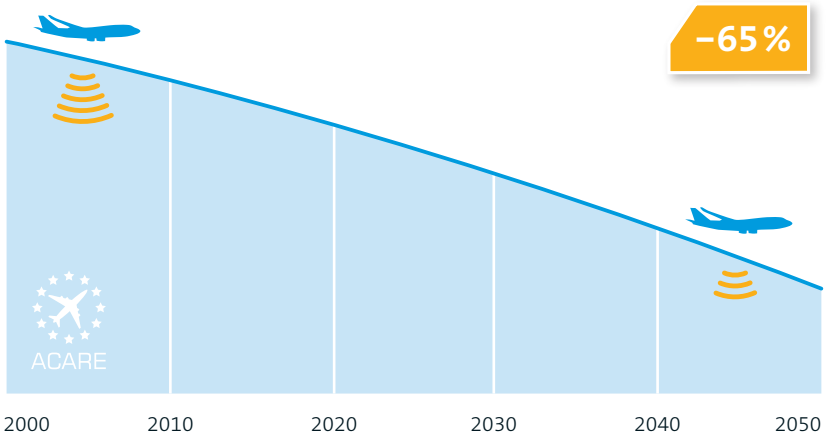
1. **Noise reduction at source,** i.e. at the aircraft. This includes the use of quieter aircraft and the implementation of noise-reducing measures on the engines, wings and landing gear of existing aircraft fleet.
2. **Local measures in the vicinity of the airport.** These include a land-use plan tailored to the noise protection zones, passive noise control and noise-based take-off and landing charges.
3. **Noise abatement operating procedures in the air and on the ground.** The range of innovative flight procedures being trialled at various airports include the continuous descent approach as well as satellite-supported approach procedures. Measures that help to cut engine use on the ground also reduce noise.
4. **Noise-based operating restrictions.** These should only be implemented as a last resort, if the other three measures combined have not brought about an acceptable reduction in the aircraft noise pollution levels.

European target for aircraft noise: a 65 % reduction

Together with its Member States and Europe's aviation industry, the European Union is pursuing an ambitious target. Based on the state of the art from 2000, the developments in aircraft technology are expected to bring about a 65 per cent reduction in noise by 2050, which is equivalent to 15 decibels. This target was issued by the Advisory Council for Aviation Research and Innovation in Europe (ACARE) in its strategy document "Flightpath 2050". The research agenda defined by ACARE will set the direction for the promotion of aeronautical research at both European and international levels.

One of the key European research projects that will help in achieving this target is the "Clean Sky" project. This initiative was set up in 2008 as a public-private partnership between the European Commission and European airlines.

Flightpath 2050: target for less aircraft noise



Source: Advisory Council for Aviation Research and Innovation in Europe (ACARE)

The aviation industry is making a major contribution to aircraft noise reduction, most notably with its innovations in the field of engine technology. For example, Airbus will be supplying the "New Engine Option(neo)" version of its A320 to the first customers from the end of 2015, with the A330neo following from the end of 2017. Extensive use of the new, quieter models plus additional technologies that are still being tested will enable manufacturers to meet the ACARE specifications.

Noise reduction at source

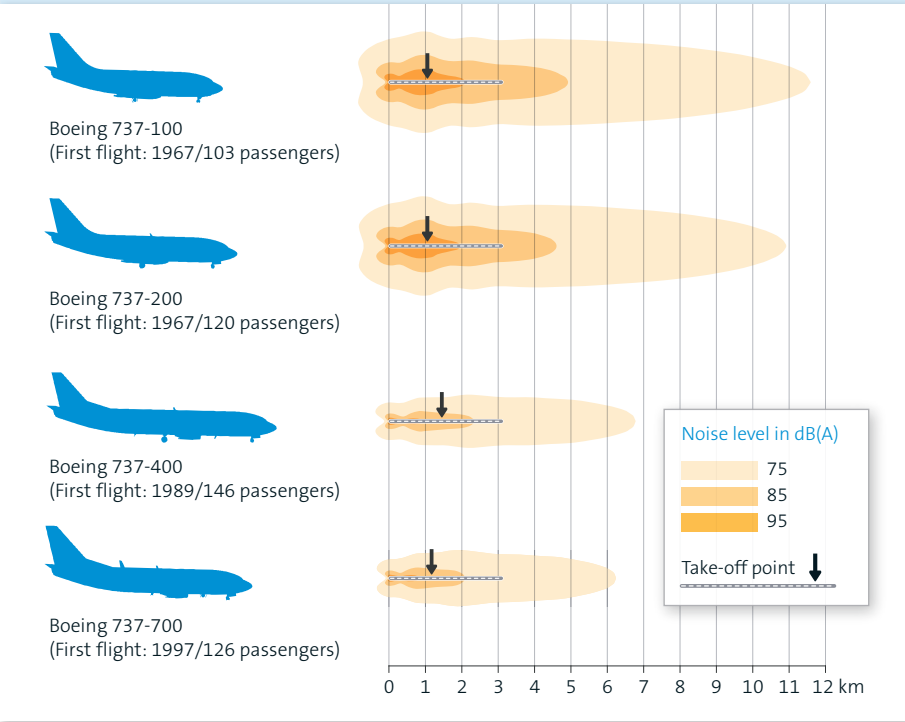
The most important method of noise reduction is the replacement of old, and therefore loud, aircraft with newer, quieter ones. An additional option is the upgrading of existing aircraft.

€32 billion for quieter aircraft

New aircraft are considerably quieter compared to their predecessors. German airlines are already operating a large number of state-of-the-art aircraft, and also aim to procure 230 new aircraft at a value of over €32 billion for the coming years. But companies can only invest if they are generating profits. Airlines with low profit margins, and additionally burdened with taxes levied unilaterally by national legislators, are not able to invest as much as they would need into new aircraft.

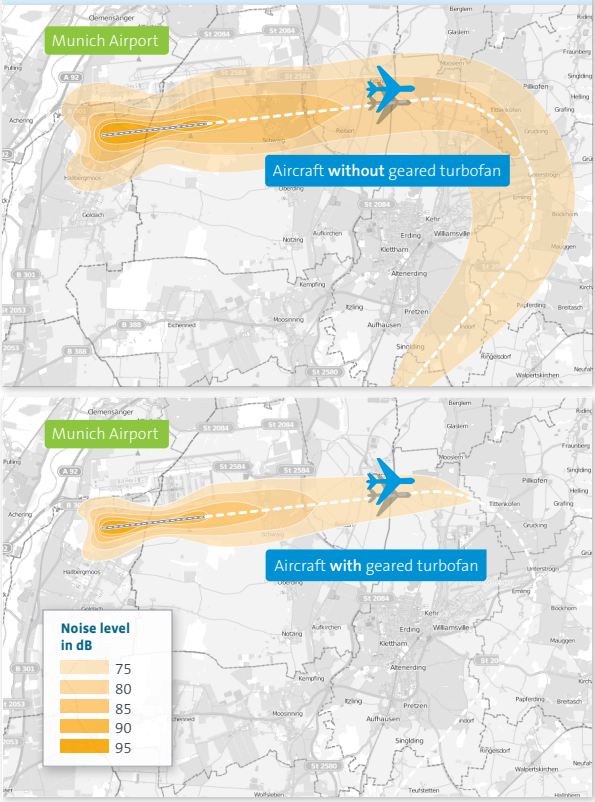
The efforts of aircraft and engine manufacturers have been crucial to the fact that aircraft have become around 80 per cent quieter over the past 60 years. The following graphic shows this noise reduction using the example of the Boeing 737, the best-selling passenger aircraft in the world.

Boeing 737 series: development of noise emissions



Source: Harris Miller & Hanson Inc.

Geared turbofan reduces noise



Source: based on information from MTU Aero Engines; maps: OpenStreetMap.org

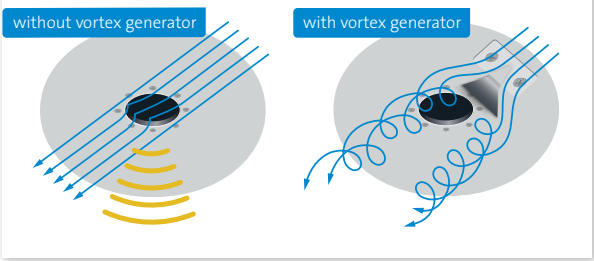
Noise reduction with modern engines

An additional technological advance has been made by engine manufacturers MTU Aero Engines and Pratt & Whitney, in the form of the so-called geared turbofan. Unlike conventional engines, the geared turbofan generates high-frequency sounds, some of which lie outside the human audible range, and which are attenuated more by the air than lower-frequency sounds. This brings about a significant reduction in aircraft noise, which in turn leads to a reduction in the noise footprint, i.e. the area affected by noise in the vicinity of the airport, by around 70 per cent during take-off. Aircraft manufacturers Airbus, Bombardier and Embraer are fitting these engines in their new regional and short-haul and medium-haul aircraft.

Noise reduction with vortex generators

In the Airbus A320, two annoying sounds were caused by the airflow across the tank pressure equalisation vents underneath the wings, an effect that was rather like blowing over the rim of a glass bottle. Vortex generators are a solution to this problem. These devices generate longitudinal vortices that change the flow of air over the vents so that the annoying sounds can no longer occur. Measurements taken at Frankfurt Airport show that the incorporation of vortex generators has lead to a reduction of up to four decibels in the overall sound level during landing approach, at a distance of between ten and 17 kilometres. According to Airbus, the effect is even more impressive at greater distances.

Principle of the vortex generator



Local measures in the vicinity of the airport

As well as reducing noise at the source, passive noise control can be used to reduce noise disruption for local residents, while an intelligent settlement policy also prevents new cases of people being affected by noise. The implementation of noise-dependent fees provides an incentive for the use of quieter aircraft.

€560 million for passive noise control

The term "passive noise control" relates to structural measures that reduce noise at the place of impact. Funding for passive noise control is provided by airports or rather airlines from the airport fees. The aviation industry is the only transportation system that bears the costs of noise control itself. Over recent decades, the aviation industry has spent around €560 million for passive noise control measures, and further investments of hundreds of millions of euros will again need to be made over the coming years due to the additional implementation of the stricter Aircraft Noise Abatement Act, which has been in force since 2007.

Noise-protection hangar

In principle, protection against aircraft noise on the ground takes place in two areas: on the airport site itself and as passive noise control at the buildings in the statutory protection zones of the surrounding area. Engine testing is a major source of noise emissions from airport sites. Some airports have built noise protection facilities in order to curb this noise. These systems screen the noise of engine testing so that it never reaches the neighbouring areas at full volume.

Source: Flughafen Hamburg GmbH; maps: OpenStreetMap.org

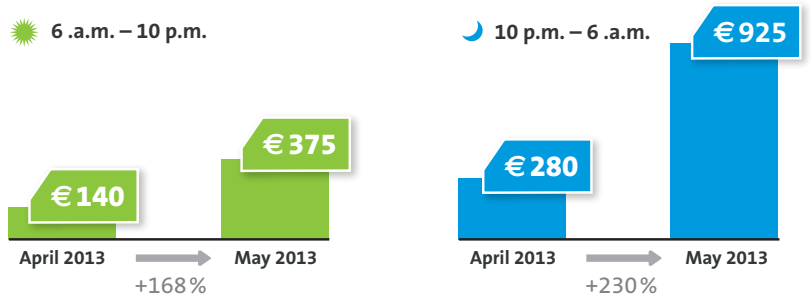
Responsible residential settlement policy

As aircraft are becoming ever quieter, they cause correspondingly less noise pollution in the area surrounding an airport. But many neighbouring local authorities are extending their residential areas further towards the airports, so the number of people affected by aircraft noise is in fact increasing in such regions. A large number of exceptions to the statutory restrictions make it possible for residential areas around airports to grow in size. For example, houses can continue to be built in areas for which development plans or restructuring had already been agreed when a residential restriction zone came into force. Consequently, the building development grows towards the source of noise, which is rather counter-productive in terms of noise protection. Regional residential housing policy needs to be changed, which means that those responsible in the regions and communities should act.

Noise-based airport charges

Over recent years, German airports have increased their noise-based charges, in particular for louder aircraft, with the aim of creating an additional incentive for the use of quieter models. Cologne Bonn Airport, for example, has more than doubled its noise surcharge for louder aircraft; at night, this surcharge is as much as three and a half times the standard amount. The noise-dependent fees account for up to a third of the entire airport charges in Cologne Bonn.

Noise-based charges for MD-11 aircraft



Source: Cologne Bonn Airport

Airlines that use quieter aircraft will reap the financial rewards. If an airline lands at Cologne Bonn Airport six times a week and uses the older freight aircraft MD-11 instead of the significantly quieter Boeing 777F, it will end up paying almost a million euros in additional charges over the course of three years.

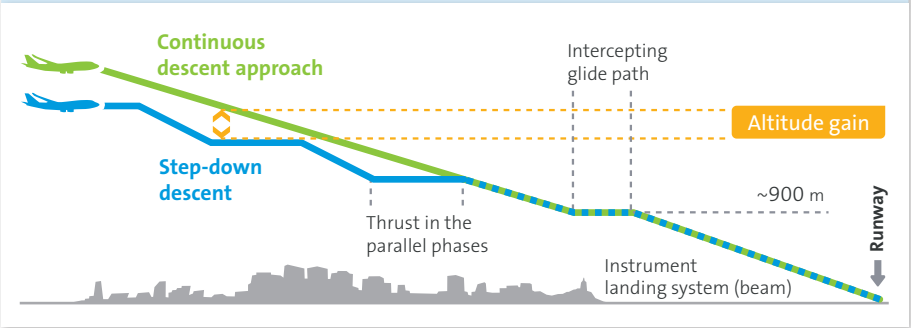
Noise abatement operating procedures in the air and on the ground

Both noise-reducing flight-operation procedures and low-noise ground operations can be used to reduce noise emissions in the areas surrounding airports.

Continuous descent approach reduces noise

In addition to the angle of approach, the thrust power is another decisive factor in the amount of noise that reaches the ground when an aircraft is landing. Continuous descent approach aims to reduce thrust to a minimum and to allow the aircraft to land in a sort of glide. This can reduce aircraft noise by up to five decibels over an area 55 km to 18 km from the runway.

Continuous descent approach reduces aircraft noise

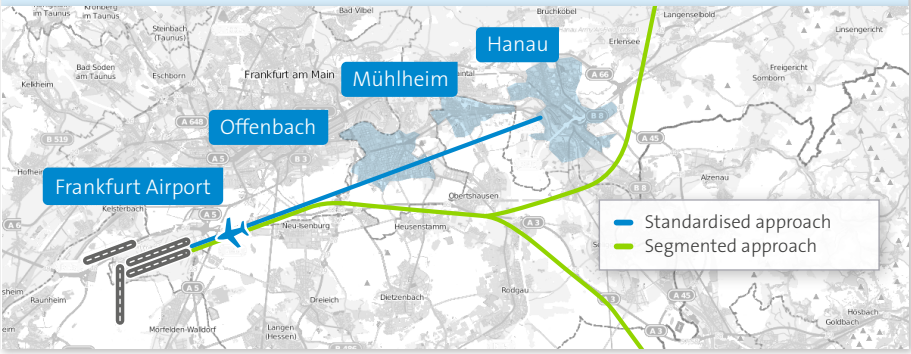


Source: German air traffic control

Bypassing populated areas

The use of satellite-supported flight procedures provides another way of ensuring more relief from aircraft noise for certain regions in the future. Curved approaches can be used, whereby more densely populated regions can be bypassed in a targeted manner.

Satellite navigation reduces aircraft noise



Source: forum flughafen & region – Gemeinnützige Umwelthaus GmbH; maps: OpenStreetMap.org

Electrical power and conditioned air from the airport

Aircraft noise is primarily generated during take-off and landing, but also at airport sites. When an aircraft is in its parking position, for example, its on-board auxiliary power unit needs to be running in order to illuminate the cabin or power the air-conditioning system. This will cause noise. Therefore, airports are trying to reduce noise emissions by supplying power to parked aircraft, which renders the noisy operation of the auxiliary power unit superfluous. Where an aircraft is connected to the terminal via a passenger boarding bridge, airports provide power to the stationary aircraft via cables at the end of the bridge. Ground power can also be supplied to the remote positions of the apron. For example, Stuttgart Airport has around 50 electric vehicles that can be used to connect all those aircraft that do not park directly at the terminal to the ground power supply.

Source: Fraport AG

As well as power, aircraft can also be supplied with conditioned air from the airport. Hamburg and Frankfurt airports provide airlines with conditioned air directly into the cabin, for example. There are also plans to introduce an environmentally friendly fresh-air supply at Munich airport in the future. By 2016, a total of 72 passenger boarding bridges will be fitted with a specially developed air-conditioning system, known as the Pre-Conditioned Air (PCA) system, which supplies the aircraft with fresh air. This measure in turn ensures that there is even less need to use the auxiliary power unit.

Noise-based operating restrictions

As a key business hub, Germany needs the operating hours at its airports to meet the existing demand, including at night. But airports are also faced with the challenge of protecting local residents' requirements for quiet nights. In accordance with the ICAO's Balanced Approach, restrictions in operating hours should be the last resort in protecting against aircraft noise.

Restrictive operating hours at German airports

Unlike in the rest of the world, operating restrictions in Germany are now the rule rather than the exception, with most airports being subject to tight restrictions ranging to an outright ban on night flights. Flights during the core night period (from 12 a.m. to 5 a.m.) are therefore not permitted in many places, with additional restrictions on flights in the shoulder periods and daytime hours.

Operating hours of selected airports

Scheduled flight movements not permitted at least in the "core night" (12 a.m. to 5 a.m.)

Passenger flights not permitted at night, express freight permitted

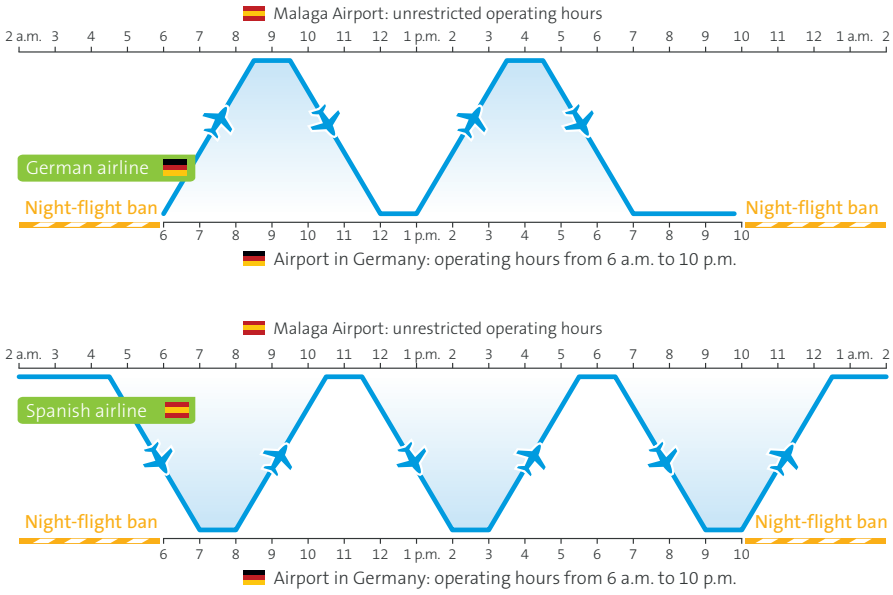
Scheduled flight movements permitted at night – possibly with restrictions
There may be a ban on particularly loud aircraft, for example, or a restriction of the number of flight movements.

The situation is different for foreign airports that compete with German locations for transfer passengers and freight transport, and these strict rules do not apply at the major hub airports outside of Germany. This is particularly true of airports in Turkey or in the Gulf Region, both of which compete with Germany in the field of intercontinental air transport. For the German airlines, which naturally have a majority of flights taking off from airports in Germany, this represents a huge disadvantage in terms of the utilisation times of their aircraft.

Competitive disadvantage for German airlines

Aircraft are extremely expensive. In order to make the investment worthwhile, the aircraft need to be in the air for as long as possible, and need to transport passengers and freight. Airlines therefore try to make sure that their aircraft are on the ground for as short a time as possible. Aircraft operating from an airport where there is no ban on night flights can make more flights on a given day, and can therefore be significantly more productive.

Operating hours as a competitive factor

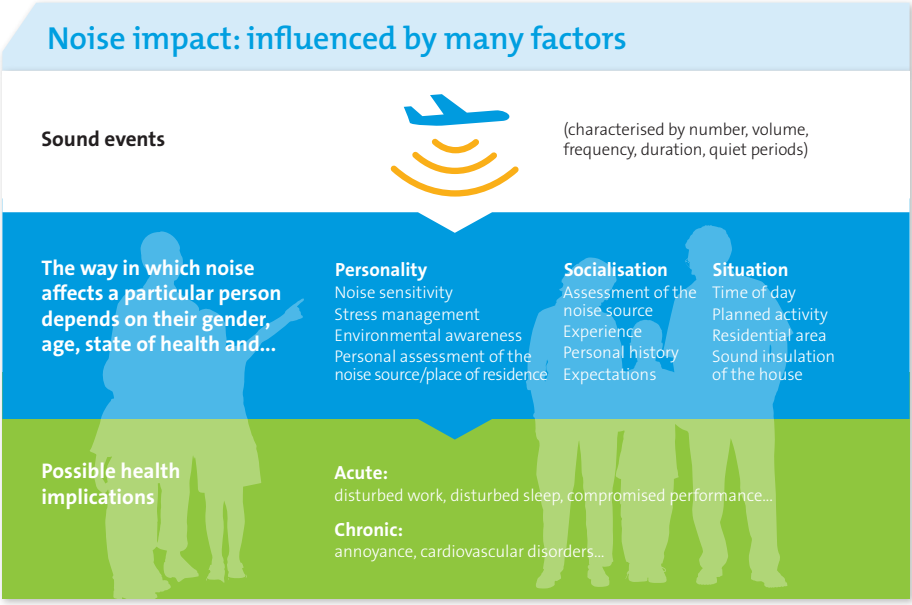


But the situation is different at airports where there is a ban on flights between 10 p.m. and 6 a.m. A German airline that is based at an airport with a night-flight ban, for example, and operates its aircraft from this airport, will only be able to fly to a destination such as Malaga in Spain twice a day. Foreign airlines that have based their aircraft at an airport outside of Germany which also operates at night will be able to use its aircraft for longer, and will therefore receive the financial benefits. For example, an aircraft that takes off from Malaga for the first time at 4.30 a.m. and returns there at 12.30 a.m. will be able to make three return trips to Germany every day. This is known as the homebase effect, and also means that airlines that base their aircraft at foreign airports which are open during the night can operate in a significantly more productive way and have a clear competitive advantage over their German competitors.

Noise impact

There are a variety of factors behind whether and why a person may become ill as a result of noise. Noise-impact research can provide new findings in this field.

Studies clearly show that people who live near to an airport may feel considerably disturbed by aircraft noise. On the one hand, the extent of the disturbance depends on the volume and frequency of the noise; the louder the noise and the more frequently it occurs, the more likely that it will be perceived as unpleasant noise. On the other hand, a person's individual noise sensitivity and the particular situation also play a role. Traffic noise during the day is usually perceived as less of a problem than noise of the same volume during the evening or night, which is when people have more need for rest, or are trying to sleep. People's working and living situation also play a role in their perception of noise. So it may be the case that someone who works at and lives near the airport will perceive the noise as less disturbing than someone who just lives near the airport.



Source: our own illustration based on Guski and Bartels

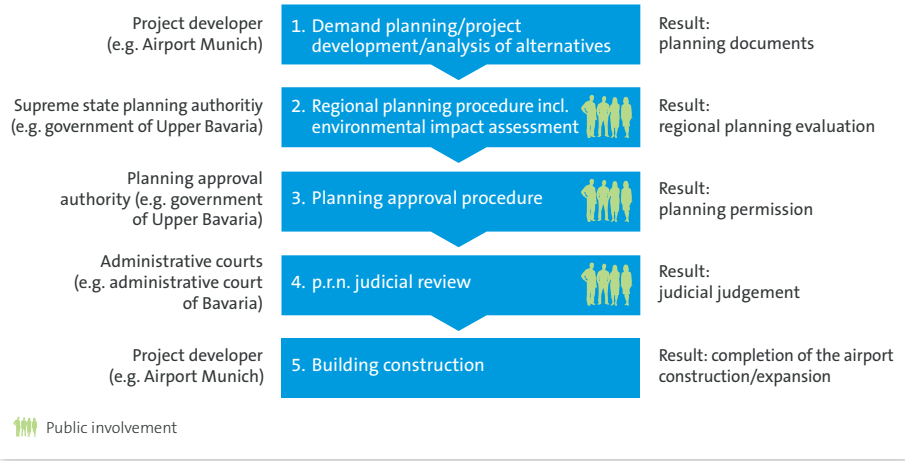
Professional noise-impact research creates the basis for an understanding of the connection between personal, social and situational factors. Additional findings are expected from the NORAH study (Noise Related Annoyance, Cognition and Health), in particular. This study is investigating how aircraft, rail-traffic and road-traffic noise impacts health and quality of life of people who live near airports.

Public involvement

The issue of aircraft noise attracts some strong opinions. Many people who live near to airports want to be included in the debate, and now they can be – either directly or via municipal representatives in the aircraft noise commissions.

Recent protests against major infrastructure projects have shown that there are people who feel that they have been sidelined in the planning stages for major projects. But there is now intensive public involvement in the complex planning and approval procedures, which can often take years to complete. In the German Airports Association (ADV)'s "Guidelines for good public involvement", airports have declared their commitment to timely, open and transparent public involvement.

Process of an airport construction/expansion project



The planning of flight procedures follows clear rules

The planning of flight procedures is carried out by German air traffic control. Flight procedures cover instructions both on the direction of flight and on the altitude and speed. The most important criterion when specifying flight procedures is the safety of air transport, with noise protection, environmental aspects and the timely operation of air transport services also playing key roles. The German Federal Environment Agency and the aircraft noise commission, which includes representatives from the cities and communities affected by aircraft noise, are both involved in the specification of flight procedures. The German aviation industry is supporting even closer involvement of the public in the work of the aircraft noise commissions.

Glossary

Equivalent continuous sound level

The equivalent continuous sound level L_{Aeq} is a parameter used to evaluate noise emissions. In Germany, it is calculated for purposes such as the definition of protection zones for a noise-protection area at an airport. The L_{Aeq} constitutes an average value, and takes into account the duration and intensity of all noises that occur within a certain time frame. In the German Aircraft Noise Act, a distinction is made between the daytime L_{Aeq} (6 a.m. to 10 p.m.) and the night-time L_{Aeq} (10 p.m. to 6 a.m.). The unit for this measurement is dB(A).

Effective Perceived Noise Level (EPNL) – unit of measurement EPNdB

The Effective Perceived Noise Level (EPNL) is a measurement used in the noise certification of aircraft. It was introduced by the UN's International Civil Aviation Organization (ICAO) and takes into account the special characteristics of aircraft noise, with the particularly prominent frequencies produced by engines having a greater weighting. The unit of measurement is "Effective Perceived Noise in Decibels", which is shortened to EPNdB. It is not possible to convert between dB(A) and EPNdB, as the two noise-level types have fundamentally different physical compositions.

Night noise index

The night noise index L_{Night} indicates the average noise level between the hours of 10 p.m. and 6 a.m.

Sound pressure level

The intensity of a sound event is given as a sound pressure level in decibels (dB). The lowest sound pressure that can be perceived by the human ear is 0 dB – known as the auditory threshold. A sound event starts to be experienced as painful from around 120 dB. The logarithmic scale of the decibel unit makes it possible to represent the entire human audible range, and means that an increase of 10dB in the sound pressure level is perceived by the human ear as twice as loud.

Day-evening-night index

The day-evening-night index L_{DEN} indicates the noise level over an entire day, with different weightings given to the individual time periods:

The time between 6 a.m. and 6 p.m. is considered daytime, between 6 p.m. and 10 p.m. is considered evening, and between 10 p.m. and 6 a.m. is considered night-time. Noise in the evening and at night is weighted more heavily than noise during the day.

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Das Fluglärm Portal

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