

# The Noise in Air Transportation

Andrzej Barski

Czesław Kolanek

*International School of Logistics and Transport in Wrocław, Poland*

*Międzynarodowa Wyższa Szkoła Logistyki i Transportu we Wrocławiu, Polska*

The transportation activities realization in transportation system needs taking into consideration its environmental aspects. The rules of the environmental management, which have been functioned in society consciousness, accept the beginning of actions for identification of main environmental risks in form of so-called: significant environmental aspects. The recon character of the study cause the identification of various environmental aspects of air transportation and a comprehensive analysis of noise emission of air units powered by combustion engine is presented.

## 1. THE ECOLOGICAL ASPECTS OF AIRPORT OPERATIONS

Aviation, like any other type of transportation, requires an appropriate land-based infrastructure, which is indispensable for its existence and for the realization of its mission. The basic element of this infrastructure are landing strips or other areas adjusted the take-offs and landings of aircrafts and other flying vehicles. Considering the issues connected with the ecological aspects of aviation activities it is best to view the problem from the perspective of airports, as they face most of the problems involved here due to their character and concentration of aircraft activities and operations. Therefore, in practice, it does not matter whether an environmental problem concerns a military or a civilian airport.

The issues discussed in this article, being associated with broadly comprehended ecology, will mainly concern the land-based infrastructure aviation activity rather than the aircrafts, which themselves are merely the noise generating element, which constitutes a fundamental problem for the external environment.

## 2. THE ROLE AND MISSION OF AIRPORTS

Airports are the base for aviation operations (aircraft take-offs and landings) and perform a vital role in passenger air transportation. They are the origin, stopover and destination point in both passenger and cargo air traffic. On the one hand they must meet all the requirements connected with passenger service and cargo handling, and on the other hand – the ones connected with servicing aircrafts (take-offs and landings as well as airfield plane service).

Air transportation activities are thereby accompanied by environmental problems of various types, such as:

- noise emission,
- atmospheric gas pollution due to the combustion engine exploitation,
- generating solid and liquid wastes (exploitation materials, fuels, chemicals for the airport technical maintenance, for defrosting aircrafts and for their anti-freezing protection during the flight) connected with the proper functioning of the system,
- air crash results,
- terrorist attack vulnerability,
- land use restrictions in airport areas.

Airports perform a key role in air communication as they connect distant sites allowing for quick transportation of passengers as well as quick shipment of goods.

The air traffic in Poland is regulated by the Aviation Act of 3 July 2002, which in accordance with the European Union requirements abolished most of the restrictions for free air navigation over Poland for foreign carriers. Over a very short time this caused a dynamic increase in passenger air traffic, which ranked Poland among the highest positions in the world (3, 4). This, in turn, gave rise to an immediate need for a rapid development of the land infrastructure of all Polish airports as well as construction of new ones (especially on the eastern edge of the country).

As a result of such a dynamic air transportation development airport authorities face with the necessity of solving many problems as well as addressing the environmental issues involved. Airport external surroundings are one of the key issues here.

### 3. AVIATION LAW AND ECOLOGY

The Aviation Act of 3 July 2002 determines in a direct or indirect way (by reference to other legal regulations) the requirements imposed on the airports and aircrafts regarding environmental protection. Failing to comply with the requirements eliminates the possibility to conduct aviation operations or at least introduces major restrictions in them.

Section IV Airports, landing strips and aviation land-based facilities, Chapter 1 Foundation and registration of airports, art. 55, par. 1 *An airport can be founded on reception of the Civil Aviation Office President's permission on application of the party concerned.*

*Par.3 The applicant is obliged to enclose in the application mentioned in par. 1 (among other things):...*

*2) the copy of the decision certificate for Conditions for Construction and Land Management,*

*10) the decision of the state sanitary inspector about hygiene and health requirements for the airport being founded and the decision of the*

*provincial environment inspector about the airport influence upon the environment.*

Therefore, the act implies explicitly the duties imposed on the airport founder regarding environmental protection. The Civil Aviation Office being a state regulatory body has the power to refuse to issue a permit for conducting aviation operations considering their nuisance and threats to the environment.

*Art.56, par. 1 The Office President refuses permission to found an airport if the documents submitted indicate that the airport being planned does not comply with the requirements ...*

*3) the permit issued would involve a considerable threat to the environment...*

*par. 2 A permit to found an airport can include a provision that the applicant has to comply with additional requirements determined in this permit and connected with the airport exploitation and environmental protection...*

It continues:

*Art.59, par. 1 One can commence exploitation of an airport after the airport has been entered into the register of airports. Airport registration is done on application of the airport founder after the verification by the President of the Civil Aviation Office or a person authorised that the airport complies with the requirements specified by the building code... and that the founder complies with the requirements specified in art. 55.*

The above mentioned articles from the Aviation Act indicate that land-based aviation activity is subject to the same legal regulations as any other business activity. Noise protection issues, however, are especially emphasized here. The legal restrictions in this field refer to both airports and aircrafts, which is reflected in the following articles of the Aviation Law:

#### Chapter 2 Airport exploitation

*Art.66, par.1 Aircrafts, with reservation of art. 93, par 1, may take off and land at the airports entered in the register of airports and whose names have been published in the Journal of the Civil Aviation Office.*

*Art. 71a, par. 1 The President of the Civil Aviation Office can, by means of administrative decision, impose restrictions or prohibitions on*

aviation operations by supersonic jet aircrafts of the maximum ramp weight not lower than 34,000 kg or those with, according to the aircraft type certificate, seating capacity of more than 19 passengers excluding the seats reserved strictly for the cabin crew members, which is intended to reduce noise emission at airports where the average annual number of aviation operations has been lower than 50,000 over the last 3 years.

Par. 2 The restrictions and prohibitions mentioned in par. 1 refer to aircrafts which are marginally compatible i.e. of the accumulated noise margin amounting to not more than 5 EPNdB (the actually perceptible noise in decibels). The accumulated noise margin is to be understood as the sum of the difference between the permissible noise level and the noise level determined in the certificate of the aircraft airworthiness according to the measurements done in 3 points of reference. The permissible noise level and the points of reference are specified in Chapter 3 in the 2<sup>nd</sup> part of Volume 1 of Annex 16 to the Chicago Convention on International Civil Aviation of 7 December 1944.

Par. 4 The principle of the balanced approach is to be understood as a selection of methods and means designed to reduce the noise level at an airport and its surroundings, which consists in:

*limiting the noise emitted by aircrafts (reducing the noise at its source);*

*appropriate planning and land management – in accordance with the statutory entry of 27 March 2003 on land development and planning (The Office Journal No 80, item 717, with further alterations);*

*appropriate air traffic management in order to limit the nuisance connected with the noise at the airport and in its surroundings;*

*imposing limitations and prohibitions on aviation operations at a specific airport.*

The Aviation Law, however, accepts situations when the restrictions and prohibitions can be temporarily waived by the Office President. Situations like these can comprise those of emergency character such as all rescue flights or the ones connected with aircraft repair and services. The above waiver is included in art. 71d of the Aviation Act 'The Office President can give permission to perform aviation operations in

*emergency situations despite earlier restrictions and/or prohibitions'.*

Art. 72 par. 2 concerning the removal of an airport from the register of airports 'An airport can be removed from the register ... in the case of a flagrant breach of the legal regulations'.

In the subsequent part of the Act there are entries limiting air navigation due to environmental protection issues (art. 119, par. 3 and 5), and they concern aircrafts – as the source of the noise. The articles quoted above refer directly to the airports although the aircrafts are also the source of the noise. The reason for such entries is the direct impact of aviation operations in their initial and terminal phases (the take-off and landing) on the nearest airport surroundings.

Art. 124 of the Act imposes a prohibition on flights of power-propelled aircrafts over national parks and natural reserves below the altitudes specified by the state air traffic management body.

#### 4. THE BASIC ECOLOGICAL ASPECTS OF AIRPORT ACTIVITY

In Poland the total number of airports and landing strips as well as areas adjusted for take-offs and landings is 330. 113 are the airports and landing strips (military and civil ones).

12 of them are civil airports – passenger communication airports. The airports in this group which are located on the edge of urban agglomerations but within administrative city borders are Warszawa Okęcie, Poznań Ławica, Wrocław Strachowice, Łódź Lublinek and Bydgoszcz. The location of the Poznań military airport of Krzesiny is similar. Such locations pose a major problem for the airports and their surroundings (both proximal and distal ones) which are located below aircraft descent trajectories.

#### 5. THE SOURCES OF AVIATION NOISE

Considering its generation sources and places of its occurrence, aviation noise is divided into internal noise (within aircraft cabins) and external noises (outside aircrafts) [2]. The external noise is significant in airport activity. The classification, occurrence and the impact of the external noise are presented in fig. 1.

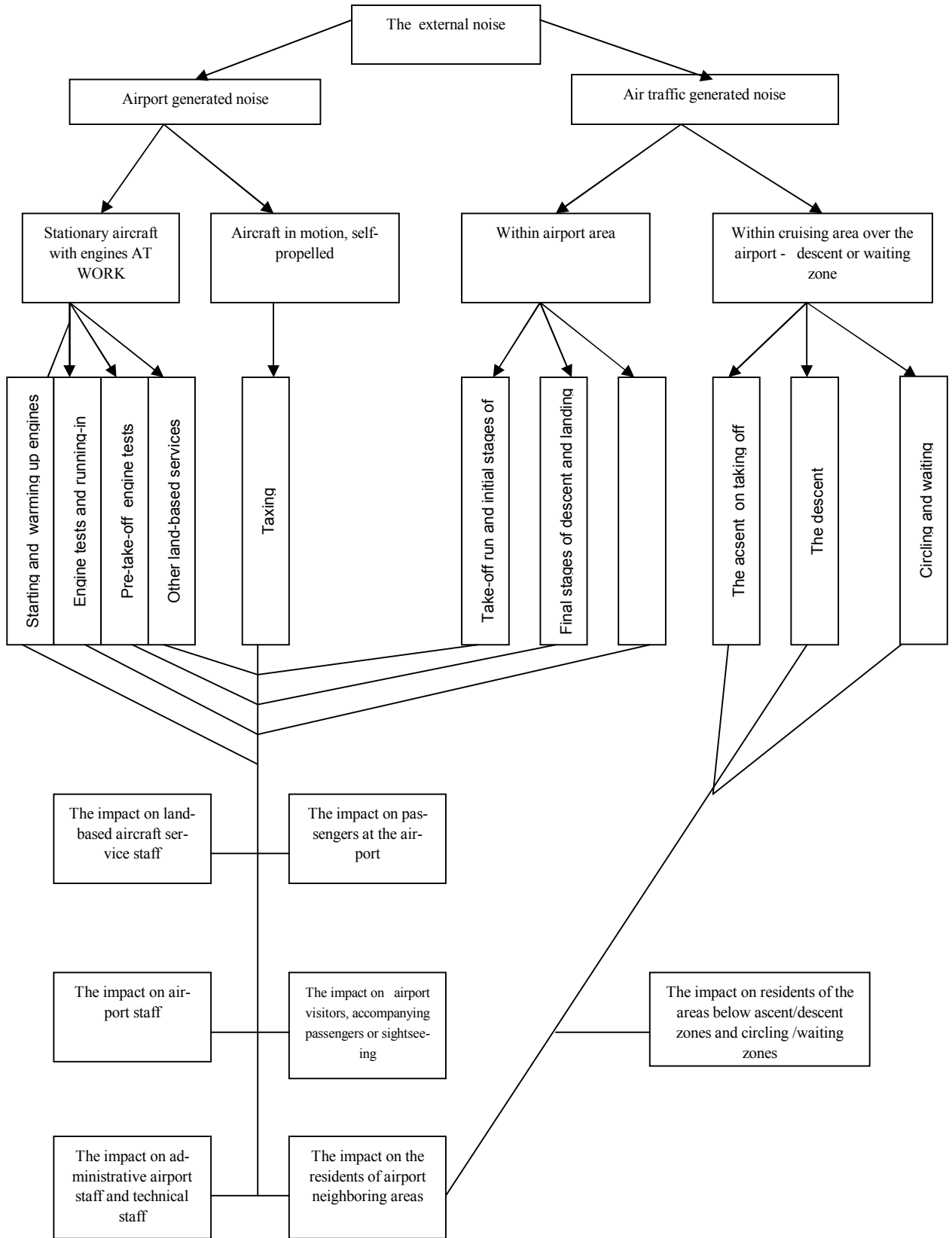


Figure 1. Classification of external aviation noise.  
 Source: M. Leško, M. Pasek: Airports. Selected Issues in Ecological Engineering.  
 Published by Silesian University of Technology, Gliwice 1997.

The diagram presented identifies primarily the influence on people (passengers, airport staff and airport neighbouring area residents) excluding the local fauna.

The spectral characteristic and the external noise level are among others dependent on:

- propulsion type,
- the number, parameters and technical properties of the propulsion motors,
- the number and properties of the propellers, their axis distance from the ground,
- the distance from the ground of the exhaust nozzle, and its parameters,
- power unit engine set-up,
- engine casing and fittings in in the power unit,
- the type of land management in the aircraft surroundings,
- atmospheric conditions (temperature, pressure and humidity) and wind velocity and direction.

Figure 2 shows on the example of the aeroplane Jak-40 the emission of noise during take-off and landing presenting its sound level and its radius.

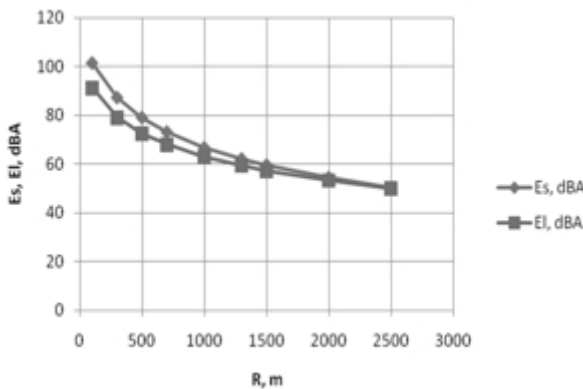


Figure 2. Noise emission at take-off (Es) and landing (El) of Jak-40 aeroplane in the function of emission radius (R).

Source: Personal elaboration, based on: Kulik N.C., ed.: *The Encyclopedia of Safety in Aviation* 'Technika' Kiev 2008.

Figure 3 presents an example of a descent trajectory of a jet aircraft determining its impact on the airport area.

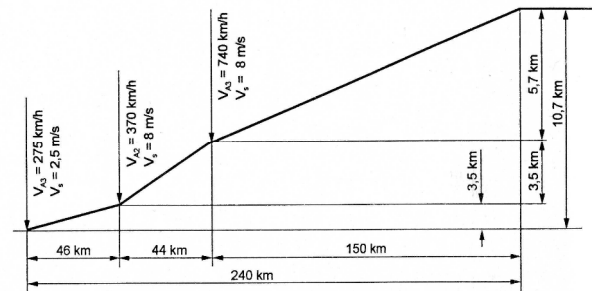


Fig. 3 An example of a jet aircraft descent trajectory; VA – horizontal velocity, Vs - vertical velocity.

Source: Leško M., Pasek M.: *Airports. Selected issues in Ecological Engineering.* Published by Silesian University of Technology, Gliwice 1997.

The distribution, intensity and range of the external noise on the ground is of vital importance here. Figure 4 presents the effects of the simulation of their values for various aircraft types and different propagation conditions.

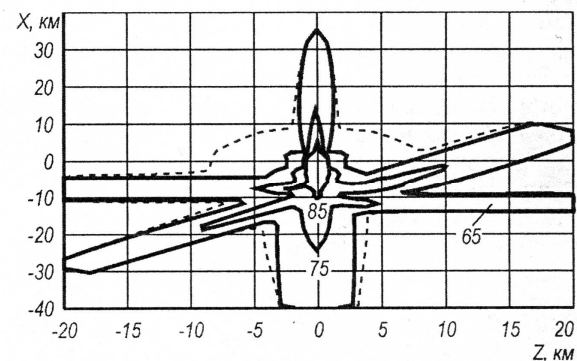


Fig. 4 Range and distribution of external noise intensity on different simulation models.

Source: Kulik N.C., ed. *The Encyclopedia of Safety in Aviation* 'Technika' Kiev 2008.

The information of such noise distribution allows for the exclusion or partial exclusion of certain areas around the airport from land development.

## 6. THE ACTIVITIES AIMING TO REDUCE THE IMPACT OF AVIATION NOISE

The location selected for building an airport should be in the distance of at least 50km from the nearest urban agglomeration, which should prevent the problems of noise impact on nearest

surroundings. In practice, however, big agglomerations themselves tend to move increasingly closer to airports. Consequently, local residents' protests about excessive noise are becoming more and more common. Here, aviation noise will always exceed permissible norms. The major problem and nuisance connected with it is due to the fact that here it is hardly ever accompanied by any other noises – generated by other sources. Therefore, it is much easier for us to get accustomed to city noise, where noises from cars, trams, pneumatic drills etc. all merge together into one, and are often of incessant character, rather than aviation noise, which itself is merely a fraction of urban noise. In areas 'free of noise' which are located at a distance from airports aviation noise occurs temporarily over a very short time. It cannot be eliminated completely but you can design airports (the ones under construction) or secure them (the already existing ones) in such a way that the noise impact could be optimally limited. This concerns both the land-based infrastructure and the angle of descent as well as descent trajectory.

In order to eliminate such situations where airports are approached by housing estates, state administrative bodies create the so-called limited use zones aiming at preventing the type of land development or generally land management which air traffic and the noise it generates are especially harmful to. Naturally, all airports are subject to this – the ones under construction and the already operating ones. For those airports which are located within or on the edge of a city agglomeration such zones are especially inconvenient, which is due to the necessity of payment of damages, land buyout, financing housing soundproof insulation etc. – briefly speaking incurring great additional costs.

For such airports as Warszawa Okęcie, Poznań Krzesiny or Łódź Lublinek the costs resulting from the creation of limited use zones will be a serious burden to their activity. It is therefore understandable that the authorities of these airports go to great lengths in order to delay their creation or limit their scope. This process, however, is inevitable. What should be considered in the first place are the activities aiming at limiting the noise impact on the airport surroundings. And this is the second aspect of limited use zones. The first one is the necessity to incur costs, the second one is the necessity to address the environmental problems.

Creating limited use zones gives also rise to protestes on the part of the owners of land plots situated within the zones. The land plot prices fall, their designation alters etc. In Warsaw, for one, the Province Governor' Office has received nearly 4.5 thousand protestes against the creation of limited use zone. On the Warsaw example one can imagine the range of such areas. The zone in Warsaw has 51 km<sup>2</sup>, over half of which is situated in the area of Warsaw quarters of Ursynów and Włochy.

Depending on the noise intensity (the anticipated level ranges from 65dB during the day to 45 dB during the night) the area has been divided into three zones. In the limited use area the Province Governor introduces the following restrictions:

- it will be impossible, therefore, to allot new plots of land here for building hospitals, social welfare homes, schools and kindergartens,
- the regulations also impose strict technical requirements as regards the buildings – they must be appropriately noiseproof insulated,
- the area situated closest to the airport should not be a residential one – relocating the current residents is naturally out of the question, but the zone itself is suitable for trading and services exclusively.

Alike Warsaw, Wrocław faces similar problems. The range of the zone here is much smaller (as a result of the air traffic intensity) but its nuisance is of similar character. On the side of the community of Kały Wrocławskie, a big housing estate of detached and terraced houses has been built (Smolec and Krzeptów). I do not think we can call this fact incidental.

It is widely known that the permission to build the estate was granted by the local authorities (Kały Wrocławskie) in conflict with many legal entities' interests. Today the problem is not so much noticeable yet but once the airport extends as planned, the vast majority of this area will find itself within the limited use zone.

The examples given indicate the need for such airport management activities that will contribute to the reduction of noise related nuisance as well as to the protection of the environment. The majority of Polish airports are not equipped with noise monitoring appliances. This is only because of the rapid air traffic increase over the last years and the

prospect of the creation of limited use zones that it is imperative to address the problem of the aviation noise impact and effects.

All European airports (in Poland only exceptions) are equipped with aviation noise monitoring systems. They operate on two fixed noise measuring stations (at the beginning and at the end of the runway) and one mobile station (located in a selected place depending on the situation or local residents' protests). The correlation between the measurements at the stations and the surveillance radar readings indicates the source of the noise, descent trajectory (planned and the actual one), noise volume, height etc. The system allows the assessment of the propriety of the operations performed by the pilot, their compliance with the planned route, height etc. In practice the penalties imposed for a breach of norms and regulations here eliminate behaviors and actions which, e.g. for economical reasons, cause a change in the route (shortening it, too rapid descent etc.).

Another way of reducing the aviation noise nuisance on the ground (the airport surroundings) is the installation of acoustic screens, building earth embankments or afforestation of the areas adjacent to the airport.

The highest exceedance of noise emission norms occurs in the following flight phases: the descent, landing, taxiing, engine operation on the tarmac, and the take-off. In all these phases the emission of noise and its impact can be considerably brought down.

When we compare the currently exploited planes with those from 30 – 40 years ago we can notice a considerable improvement in their parameters relevant to the environment – lower use of fuel, lower level of noise emission... These elements, however, can by no means be reduced to 'zero'. Even today there are aircrafts still in operation which fail to comply with the obtaining noise emission norms. These, being mostly cargo aircrafts which used to serve military purposes before, currently have specific legal entries in the aviation law limiting their possibility to perform operations. Depending on the importance and type of the aviation operation performed (emergency rescue flights, business flights), the Aviation Office President grants permission for single limited flights (e.g. ban on night flights...). One of the elements of the reduction of the nuisance involved in airport

operation is limiting the number of operations during the night hours. In practice (with the exception of summer charter flights) airports start operating at 6:00 am and finish at 10:00 – 11:00 pm.

Eliminating the environmental effects should be one of the main aspects of airport design and exploitation. The aircraft generated noise should be predominantly confined within the airport limits.

In airport planning and design special attention should be given to the question of optimal energy use in airport buildings and facilities (the air terminal cubic capacity volume). Along with the use of innovative energy recycling systems, the installation of modern systems based on renewable energy sources has also become worth considering here. Besides geothermal energy option, one can mention, for instance, cooling systems based on rain water use.

An example of such pro-ecological thinking and approach is the building of the modern Berlin – Brandenburg airport (Airport BBI). Not only can we observe the application of the above mentioned solutions here but also the entire pro-ecological realization of the construction project with the environmental supervision ensuring that the impact on the natural environment is minimized. The use of little noise generating trucks or the application of 'silent' asphalt here do contribute to the positive environmental effects. Additionally, efforts have been made to help the protected species in the airport surroundings. There are also large scale substitution and compensatory investments as for example the renaturalization of the 2,000 hectare area south of the city.

This is self-explanatory that the presented above project is costly and it is little probable that it could be fully realized a Polish airports. Nevertheless, the growing ecological awareness and the importance it gains in various aviation activity aspects can bring about initiatives that will be beneficial both for the environment and for effective airport management. The time has come to put the idle slogan 'Ecology is important for us' into practice. We need to know that high project realization costs will be compensated by low exploitation costs in the following years of the airport operation. In this case, therefore, the pro-ecological activities involved also make sense in the economical aspect.

## 7. THE SUMMARY

The elimination of the impact on the natural environment should be one of the main aspects in airport planning and exploitation. The noise generated by aircrafts should be confined within the airport boundaries.

Modern airports are equipped with aviation noise monitoring systems which operate on two fixed noise measuring stations (at the beginning and at the end of the runway) and one mobile station. Such system allows for the verification of the operations performed by the pilot, their compliance with the planned route, height etc. The penalties for the exceedance of the norms here eliminate effectively actions and behaviours violating the noise reduction principles.

## BIBLIOGRAPHY

- [1] Kulik N.C., ed. The Encyclopedia of Safety in Aviation. 'Technika' Kiev 2008
- [2] Leško M., Pasek M. Airports. Selected Issues in Ecological Engineering. Published by Silesian University of Technology Gliwice 1997
- [3] Ruciński A., ed. Airports in the Presence of 'Open Sky' Policy. The Foundation for the Development of Gdańsk University Gdańsk 2008
- [4] The Aviation Act. Act Journal No 130, item 1112 of 16 August 2002
- [5] Banaszek K., Air Traffic Management and Global Climate Protection. Polish Air Navigation Services Agency. Aviation in the Presence of Global climate Protection – Conference materials; Warsaw 06.10.2008
- [6] Glover B.M., Aviation and the Environment – Active Engagement. Boeing: The Strategy for the Environment; Aviation in the Presence of Global Climate Protection conference materials; Warsaw 06.10.2008