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AIRCRAFT NOISE: ASSESSMENT AND MITIGATION

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The article provides an overview and analysis of the impact of aircraft noise on the environment. There is analyzed the classification of methods to reduce noise at all stages (from planning). Particular attention is paid to the development and review of the application of measures to reduce aircraft noise.

Keywords: aviation; noise; aircraft noise; noise pollution; mitigation of aircraft noise; methods of aviation noise reduction; technologies of noise mitigation.

Досліджено та проаналізовано вплив авіаційного шуму на навколишнє природне середовище. Наведено класифікацію методів зниження шуму на всіх етапах (від планування). Особливу увагу приділено огляду розробок та застосуванню системи заходів зниження авіаційного шуму.

Ключові слова: авіація; шум; авіаційний шум; шумове забруднення; зниження авіаційного шуму; методи зниження шуму; технології зниження шуму.

Introduction

Environmental problems are one of fundamental constraints on the increase of air transport in the 21st century. The environmental impacts of aviation include contributions to climate change, noise and air pollution. Together with various social and economic problems, such environmental issues have the potential to constrain the operation and growth of airports and therefore the overall operational capacity of the air traffic management (ATM) system. Constraints on airport capacity affect the capacity of the air navigation system as a whole. Many international airports are operating at their maximum, and some have already reached their operating limits including those resulting from environmental impact. This situation is expected to become more widespread as traffic continues to increase. Already aircraft noise is a limiting factor for the capacity of regional and international airports throughout the world.

Aircraft noise produced during take-ff, over and landing operations can cause community annoyance. Annoyance is broadly defined as the physical or psychological discomfort caused by noise and its interference with different activities. Aircraft noise is considered to be annoying when it interferes with daily activities, for example, day-to-day communication, recreation, sleep, cognitive performance, and class-room learning activities, etc.

At very high levels noise can lead to hearing damage. Apart from hearing impairment, it is also known that aircraft noise may be a risk factor for respiratory, digestive, mental instability, depression and nervousness.

Because of the great number of people announced and the degree of physical and psychological discomfort, aircraft noise today may be one of the greatest pollution problems.

Problem statement

Aircraft Noise is noise associated with the operation and growth of airports that impact upon local communities, in particular the nature and extent of noise exposure arising from aircraft operations. It is the single most significant contemporary environmental constraint, and is likely to become more severe in the future.

The noise produced by aircraft during operations in the areas around airports represents a serious social, ecological, technical and economic problem. Substantial levels of noise emission can bring about worsening of people's health, lowering of their quality of life and lessening of their productivity at work, through speech interference for example. In the areas around airports aircraft noise has adverse influences on ground, maintenance and flight operations personnel, on passengers and on the local resident population. In abating aircraft noise, it is necessary to consider several criteria: ecological, technical, economic and social.

At present, only 2 % of the population is exposed to aircraft noise in comparison with, for example, 45% exposed to noise of road traffic and 30 % to industrial noise. Nevertheless ICAO analysis has suggested that there will be a 42 % increase in the number of people affected by aircraft noise in Europe by the year 2020 [2].

Analysis of publications and researches

The capacity of an airport is a function of many different factors and ability of airport infrastructure, including airfield layout (number of runways, the extent of taxiway, apron development), the terminals and landsite facilities, air traffic control procedures, ground handling operations, meteorological conditions. An individual airport capacity depends on the time between an aircraft landing and it

leaving the airport, ability to accept aircraft with concrete time of a delay, of the airport air traffic control system and its runway approach facilities [4]. In 2001 ICAO developed a balanced approach to noise management at airports. The balanced approach includes four elements: reduction at source, land-use planning and management, operational procedures for noise abatement and aircraft operational restrictions. The balanced approach has been applied to European airports by means of EU Directive 2002/30/EC concerning rules and procedures for introducing noise related practices at airports. The noise mitigation measures should take into account specific features of the particular airport and the maximum achievable efficiency of suggested methods.

Task statement

The potential to reduce noise at source is limited and land use measures are difficult to implement in density populated zones. Operational procedures which depend on pilot behavior may lead to a reduction in the level of flight safety. The growth of air traffic is faster than developments in new technologies and methods of noise reduction.

Analysis and application of effective noise abatement measures

The abatement of aircraft noise involves limiting the noise at the source, noise control along the sound transmission path, low-noise take-off and approach flight procedures, optimal distribution of aircraft between the arrival and departure routes and land-use planning. Methods of noise abatement can be realized at all stages of the "life cycle" of aircraft — from designing to aircraft phase-out [1].

Increasing stringency of the noise certification limits for subsonic airplanes, noise-based operational restrictions, reduction of noise at source, land use planning and low-noise operational procedures are all elements of the ICAO program on noise reduction. International organizations (for example, ICAO, ECAC) and the aviation industry work together to formulate and implement environmental regulations [2].

Aircraft noise management includes noise exposure simulation, environmental regulations, land use planning, noise monitoring and air traffic control. This approach to the noise problem includes the following steps:

– reduction of aircraft noise at source by means of new technologies to mitigate noise impacts (propulsion system noise reduction using higher bypass ratios and turbo machinery noise reduction);

– special operational measures (for example, throttling-back the engine on take-off, low power low drag approaches, continuous decent approaches and delayed flap and landing gear extension);

– rational distribution of aircraft in zone of airport (preferred runway operation and flight tracks/corridors and use of aircraft of less noisy types particularly at night and fewer night flights);

– restricted building in high noise level zones around airports and the introduction of noise mitigation measures;

– noise monitoring systems in vicinity of the airport and effective policing of them.

The essential elements of air traffic noise management are: airport noise prediction and forecasting, noise exposure simulation, elaboration of noise reducing strategies, noise certification of aircraft, accounting for noise propagation under various operational conditions, local environmental adjustments at the airport and the monitoring of aircraft noise.

Airport noise forecasting needs information about the traffic pattern, the structure of the aircraft fleet, aircraft noise characteristics, aircraft weight and flight path, the number of aircraft operating on the flight path, their schedule and operational measures, the atmospheric parameters, sound propagation in atmosphere and the ground surfaces and topography in the vicinity of airport.

At a regional level tools for noise control can include noise limits for over-flying aircraft within region, noise emission limits, restrictions the number of inhabitants within certain noise contours and an environmental audit.

In the vicinity of an airport, the noise control tools can include zoning and land-use with respect to aircraft noise, limitations on the number of night movements, noise charges, noise minimization operations through optimization of airplane movements, layout of parking areas, construction of acoustic screens for reducing aircraft noise impact, construction of engine test places and actions to take care of ecological aspects around the airport [3].

Noise abatement tools for the airline can include the process of aircraft fleet formation and training the flight crew on low-noise operational procedures.

Normative documents are made by the International Organization on Standardization (ISO), the International Electro technical Commission (IEC), ICAO, the World health organization and other organizations [2]. The approaches to noise normalization can be categorized as sanitary or technical. Sanitary noise normalization establishes the limitations on noise under conditions of insignificant harmful influence on man. Technical noise normalization establishes the maximum noise levels in regard to technically achievable methods of noise reduction for given acoustic sources. The sanitary norms determine the necessary noise attenuation and the technical norms specify the attainable noise levels of the equipment [5].

The classification of noise abatement methods

Noise abatement measures	Procedure	Aircraft and equipment operation						
		Taxing	Take-off	Landing	Roll-on	Training flight	Run-up	Ground equipment
Aircraft noise emissions	Standard and recommended practices of ICAO, Annex 16, volume 1, National standards		●	●				
Aircraft noise transmission and emissions	National emission standards, noise monitoring	●	●	●	●		●	●
Planning of airport	Change of direction runway, length of runway	●	●	●	●	●		
	Building of high speed taxiway	●		●		●	●	●
	Reconstruction of terminal building							
	Use of noise mufflers or screens for isolation of zones run-up of engines	●					●	●
Land-use planing	Alienation of land-use in the vicinity of the airport	●	●	●	●	●	●	●
	Purposeful airport development	●	●	●	●	●	●	●
	Zoning territory in the vicinity of the airport	●	●	●	●	●	●	●
	Observance of national building norms and sound insolating of dwelling	●	●	●	●	●	●	●
Development of noise abatement programs	Landing charge with noise factor calculation	●	●	●	●	●		
	Research of population complaints on noise	●	●	●	●	●	●	●
	Inculcation of automation noise monitoring systems	●	●	●	●	●	●	●

The government policy on the control, abatement and mitigation of aircraft noise involves a balance between the needs of an efficient aviation industry and the need to minimize the impact of noise around airports. An important improvement in aircraft certification noise levels has been achieved over past 25 years.

It is important to distinguish between the notions of emission and emission with regard to noise abatement. Emission is the noise influence on a receiver in a noise source action zone. Emission describes the radiation of noise from the source. Permissible emission is related to standardized emissions after taking into account the noise propagation from source to receiver.

Although noise abatement procedures may have quantifiable environmental benefits, effective implementation may be difficult: procedures must be developed, tested, and evaluated for benefits and ATC impacts; approved and accepted by the airport and the ANSP (Air Navigation Service Provider); and adopted by the airlines and other airport users. The criteria specify minimum altitudes for thrust reduction and flap retraction, but otherwise give operators considerable latitude to develop their own profile designs. For any noise abatement operating procedure to be adopted, it needs to be demonstrated that with appropriate crew training, it does not compromise safety and that ATC can accommodate the procedure with minimal or no impact to airport capacity or controller workload.

The noise abatement operational procedures described above can make a measurable contribution to reducing noise levels in the vicinity of airports. The magnitude and scope of the reductions, as well as the specific procedures to

be used to achieve them should be determined through a comprehensive noise study. The study should also include an analysis of emissions impacts and fuel burn, as these variables may be affected by procedure changes both in the air and on the ground. The aircraft operators and ANSP should be parties to the study to ensure the safety and feasibility of the procedures and to take advantage of their technical expertise. The environmental benefits of some operational procedures are straightforward and easy to visualize: preferential runways or flight tracks move aircraft away from more noise sensitive locales. Conversely, the benefits assessments for NADP's and CDA procedures are extremely complex and may require detailed modelling in order to be well understood. It is imperative that accurate aircraft operating data and specific operator flight procedures are applied as input to the noise and emissions models and that impacts on airport and airspace capacity be analyzed. It is worth repeating that some noise abatement operational procedures may increase emissions or derogate airport capacity while providing significant noise relief.

Appropriate consideration of all potential environmental impacts is essential, particularly as priorities change and procedures evolve or come up for review.

Conclusions

Aircraft noise is one of the most pressing problems of nowadays. With the intensive growth of civil aviation, every day aircraft noise annoys more and more population of the whole world. It was analyzed the scale of the problem and current state of the global task.

It was proved decades of years ago, that noise and especially aircraft noise cause extreme changes in central nervous system.

With the aim to mitigate influence of aircraft noise into environment, the system noise abatement measures have to be applied. In other case, in 20–25 years population will face with the problem radically.

REFERENCES

1. *Zaporozhets* O. Aircraft noise. Assessment, prediction and control / O. Zaporozhets, V. Tokarev, K. Attenborough. — London : Spon Press, 2011. — 414 p.

2. http://www.icao.int/ — official site of International Civil Aviation Organization.

3. *Kazhan K*. Methods to reduce aircraft noise in the vicinity of the airport under given operating conditions / K. Kazhan. — K. : Vyshcha sh., 2007. — 44 p.

4. *Zaporozhets O*. Noise reduction in operating of passenger aircraft / O. Zaporozhets, V. Tokarev, V. Straholes. — K. : Tehnika, 1990. — 125 p.

5. *Kvitka V*. Civil aviation and environmental protection / V. Kvitka, B. Melnikov, V. Tokarev. — K. : Vyshcha shk., 1984. — 136 p.

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