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.

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-off, 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

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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