UDC 629.7: 534.2

O Zaporozhets, Professor (National Aviation University,Ukraine)
A.Jagniatinskis, PhD (Gediminas Technical University, Lithuania)
B.Fiks, PhD (Gediminas Technical University, Lithuania)
M.Smiesek, Professor (Politechnika Rzeszowska, Poland)
A.Chyla, PhD (SVANTEK, Poland)
M.Bukała (SVANTEK, Poland)

Noise monitoring for improvement of operational performances of the aircraft in vicinity of airports

Aircraft noise levels are subject of aircraft certification, the aircraft with incorrect levels of noise are illegal to be produced and operated. Permanent or/and temporary noise monitoring to be undertaken usually in local community on assumption that aircraft noise will exceed what is considered 'acceptable' or legally permissible level of noise, and in this connection it is necessary to refer to the legislative control on aircraft noise. The number and location of the terminals in noise monitoring system is important depending upon the specific role they are to play inside this system.

The aircraft noise is usually the single or somewhere one of the most important local impact factor arising from airport operations which, unless managed effectively, has the potential to constrain the ability of airports to grow in response to demand and hence limit the social and economic benefits that future growth could bring [1]. People living around the airports are driven to complain when some nuisance factor (or stressor) in the environment gives rise to annoyance and/or sleep disturbance when this stressor reaches a threshold of tolerance. Polish Environmental Protection Law (EPL) [2] treats noise as an environmental pollution, hence this Act adopts the same general principles, obligations and forms of proceedings in relation to noise, as to other areas of environmental protection. The EPL also introduces to the legal system of environmental protection a new institution of the so-called noise areas – the areas where the noise level is exceeded to the extent that it requires corrective action via the recovery programs.

According to art. 179 of the EPL, airports are included in list of objects, whose operation may cause a negative acoustic impact on environment in significant areas, and the manager of such airport is obliged to draw up acoustic maps of the area every 5 years, during which the operation of the airport may exceed permissible noise levels for the environment. As required by EPL to control the impact of aircraft noise on population an area of limited usage (noise zone or *obszar ograniczonego użytkowania* in Polish – OOU) is created around any airport in Poland. This area arises when, from an ecological review or from an environmental impact assessment, required by the provisions of the Polish Act of 3 October 2008 on access to information about the environment and its protection, public participation in environmental protection and environmental impact assessments, or post-implementation analysis shows that despite the use of available technical, technological and organizational solutions, environmental quality standards outside the airport area can not be met.

Noise monitoring for assessment of noise reduction efficiency in and around the airports

To evaluate the effect of the protection measures implemented, a comprehensive set of surveys to evaluate the short- and long-term effects should be undertaken. A number of the previous studies indicate that when changes in noise exposure are achieved by source-related measures (quieter aircraft and/or low noise flight procedures implemented, air traffic reduced, etc.), the responses could be higher than those predicted from the exposure-response relationships established from a more stable condition. In studies where the changes include noise screens or insulation efforts, the change may be smaller than predicted. For example, inside dwellings of the "experimental" group that received the noise reduction intervention, an average equivalent noise reduction of 7 dBA was calculated inside the dwellings. But some of intervention studies show that people are often satisfied with an intervention regardless of the result of the intervention (Hawthorne effect). For example, one study show the positive effect equal to average equivalent noise reduction of 5 dBA from informing a population about simply a noise monitoring program realised carefully around the airport. A review of different theoretical approaches explaining such differences can be found elsewhere.

The measurements of aircraft noise and the analysis of the results are necessary in order to protect correctly the local community living in the airport surrounding areas. Permanent or/and temporary noise monitoring to be undertaken usually in their local community on the assumption that aircraft noise will exceed what is considered 'acceptable' or legally permissible, and in this connection it is necessary to refer to the legislative controls on aircraft noise. The results show that for airports with low intensity of flights the long term equivalent sound level is heavily changing in relation with the long term maximum sound level, but for high intensity flight traffic this interrelation is quite stable. In the vicinity of airports with low flight intensity the maximum sound level as a noise impact metric is more sensitive than the equivalent level. In general case the purposes of monitoring are described elsewhere as:

1) to assess the current status of the resource to be managed or to help determine the priorities for management,

2) to determine if the desired management strategies were followed and produced the desired consequences,

3) to provide a greater understanding of the system being managed, and

4) to show that population involvement in noise management helps to reach the goals of the noise management program, etc.

Although today in most cases the main concern is the negative impact of aircraft noise, the highest goal is to show that measuring and monitoring the aircraft noise can be used for positive purposes. For example to show in routine mode what an aircraft exceeded the permissible level at a point of noise control, to show even why it was exceeded (flight procedure mistake happened or an aircraft type is quite noisy to be operated in particular conditions), any flight safety issues may be raised with monitoring system usage and at the same moment providing confidence to aviation as a whole. A very new challenge should be expected: how to deliver respite from

aircraft noise at the airport that is valued by the community, which is consistent with efficient operations?

The number and location of the monitors is important depending upon the specific role they are to play. Quite usual elements of current aircraft noise monitoring systems are the air traffic data connection for flight events detection (correlation with noise events) and the latest point – gathering the complaints from residents living around. A number of technologies is available currently to provide all these necessary functions independently from airports and air traffic providers and in cost-efficient manner, in such way being available for any airport (or community), which is interesting in efficient noise management.

The typical monitoring system (Fig. 1) consists of four main parts: data sources, data collecting and storing mechanism, data correlation and calculation tool and reporting module.

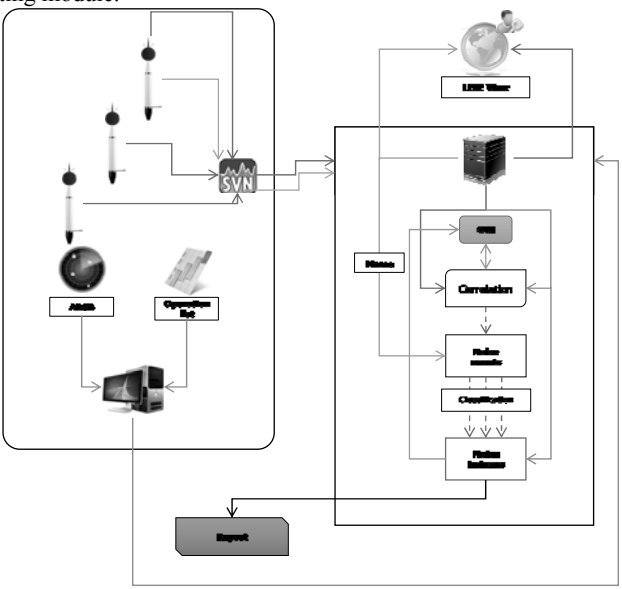

Figure 1 Architecture of an exemplary noise monitoring system

Aircraft noise monitoring system characterization due to aircraft acoustic performances

The noise monitoring systems, which are installed at many airports around the world, range from simple systems measuring the noise levels of individual flights to complex systems, which accumulate and analyze noise data and monitor the flight tracks of aircraft, weather information, complaints of the neighboring population, and so on. It must supply factual analysis of aircraft operations and their consequences for environment and information useful to a surrounding community of the activities taken for environmental noise control. The data and analysis

available from the system may improve planning efforts for noise control, such as in aircraft operation, or the best location for residential zones around the airport.

There are many national rules and guidelines that govern the installation of monitoring systems around international airports. During the last two decades around ten airports per year have provided new or improved installations. Initial systems were very simple in design and operation compared with more recent ones.

According to a special ICAO CAEP Work Program, an airport noise monitoring effort should [7]:

(a) compile data on methods used to describe aircraft noise exposure and applications of the data (Fig. 2a);

(b) determine the contribution (general and/or specific by type, route, airlines, etc.) of aircraft to the overall noise exposure (Fig. 2b);

(c) collect data on the characteristics of airports with noise and/or flight path monitoring systems;

(d) collect details of airport noise monitoring systems such as capabilities, data stored, technical support;

(e) compare calculated and monitored noise levels for a suitable sample of airports;

(f) compare measured noise levels with certificated noise levels for a range of aircraft types and operating conditions;

(g) examine changes in measured noise exposure over a representative time period (Fig. 3);

(h) update advisory documents on methodologies and applications of noise contouring and monitoring, supplemented, for environmental noise management, by the elements of expert and decision-making systems.

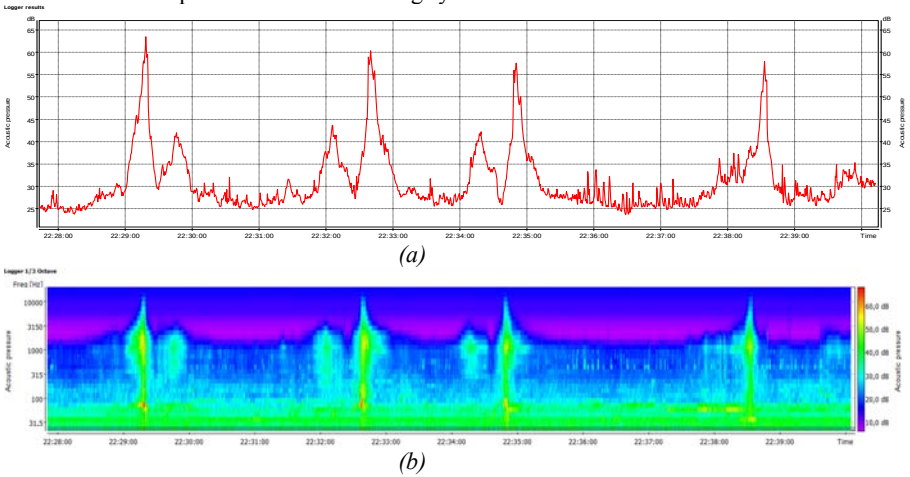

Figure 2. Time history of the registered noise level of aviation noise (a) along with the identification of acoustic events (b)

This collection of information:

(i) enables determination of the contribution of aircraft to overall noise exposure (Fig. 2);
(ii) enables detection of occurrences of excessive noise levels from aircraft operations;
(iii) enables assessment of the effects of operational and administrative procedures for noise control and compliance with these procedures and/or assess alternative flight procedures for noise control (the tool of objective assessment of efficiency of the proposed operational and administrative procedures for noise control in the vicinity of the airport);
(iv) assists in the planning of airspace usage issues;
(v) increases public confidence that airport related noise is being monitored to protect the public interest (Fig. 3);
(vi) enables validation of noise forecasts and forecasting techniques and their methodologies over an extended period of time (collection of data for noise contouring, system noise exposure forecasting and contouring with compiled data);
(vii) assists relevant authorities in land-use planning for developments and noise impact on areas in the vicinity of an airport;
(viii) enables assessment of a Quota Count system (special mitigation procedure which defines an appropriate number of flights of the aircraft of specific types during a specific period of the day without violation of noise limits), among other possible noise mitigation measures; and
(ix) indicates official concern for airport noise by its jurisdiction and its governing bodies and enables provision of reports to, and responses to questions from, Government and other Members of Parliament, industry organizations, airport owners, community groups and individuals.

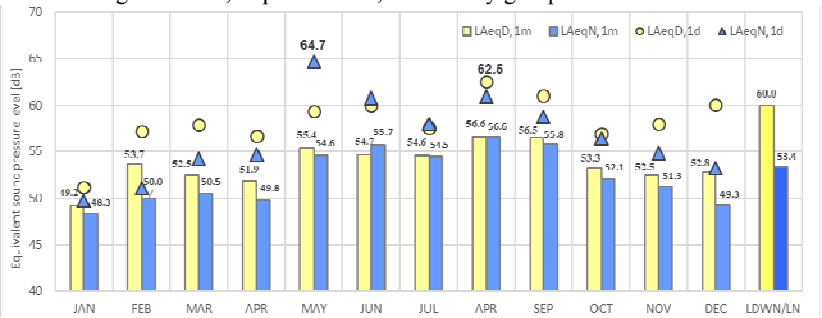

Figure 3. Equivalent sound level from the period of one day, one month and year for day and night measured at one measurement point

Such a collection of information is basic for assessment of aircraft acoustic performances in real operation in airport under consideration – it is very important for airport capacity assessment from operational and environmental points of view.

Also an airport monitoring system can assist:

(i) in answering noise complaints about aircraft operations from the general public and their enquiries;

(ii) detecting unusual flight events (measurement and verification of noise levels by aircrafts, air companies);

(iii) educating pilots, airlines, airport proprietors, the public (detection of operations which have not complied with flight corridor requirements;

(iv) obtaining statistical data using an objective resources (aircraft types, operating times, usage of flight tracks and routes, of runways, complaints, etc.);

(v) applying research tools to assist the airport in performing certain tasks as required and mandated (planning of airspace usage around the airport, detection of operations which have not complied with flight corridor requirements, determination of the contribution of aircraft to overall noise exposure);

~~(i)~~(vi) assessing compliance with mandatory noise levels, established by a governmental entity, etc (measurement and verification of noise levels and flight procedures by aircraft types, air companies, detection of occurrences of excessive noise levels from aircraft operations, etc).

Summary and conclusions

The benefits of operating a noise and flight path monitoring system are substantial. However, these benefits may not be fully realised and the operating agency's credibility may be reduced if insufficient resources are provided to oversee the system's operation and ensure its accuracy. Points to note include the following:

a) The noise and flight path monitoring system generates vast quantities of data, and a methodical process of summarizing and reporting the data is vital. This may take the form of standardized report formats, produced at pre-determined intervals.

b) It is essential to check the accuracy of the data carefully before it is issued publicly. This relates particularly to the noise data, where the system may be performing extensive mathematical calculations on data which has been gathered automatically from unattended instrumentation. With the logarithmic processing which is basic to sound level calculations, it does not require many incorrect inputs to severely distort a summarised average.

c) It is essential to keep records of system outages, particularly in regard to flight track information, to avoid the circumstance where a complainant may be told there was no aircraft operation at the time and place corresponding to that complained about, when in fact there was an operation, but it was not recorded due to a system outage.

d) There is a need to run a preventative maintenance and calibration program, as described in the section on Noise Monitoring Terminals, and this will be an ongoing cost. If the system is used to detect violations of noise limits and/or of flight corridor boundaries, for the purpose of prosecution of offenders, then the records of

maintenance and calibration data may become evidentiary material in legal proceedings.

e) The process of installation of a noise and flight path monitoring system may be seen as a service to the community in helping to deal with the adverse affects of aircraft operations. However, while the system will provide for a more informed discussion, it is not in itself a solution to those adverse affects.

References

1. Economic Benefits from Air Transport in Poland. Poland country report. Oxford Economics 2011. Oxford, OX1 1HB, UK . – 25 p.

2. Prawo ochrony środowiska. Dz. U. z 2013 r. poz. 1232 oraz z 2014 r. poz. 40, 47.

3. ICAO Annex 16 to the Convention on International Civil Aviation, Vol. 1, Environmental Protection, Aircraft Noise, 2011

4. Polish Aviation Law (http://prawo.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20170000959)

5. O Zaporozhets, A.Jagniatinskis, B.Fiks, M.Smiesek, A.Chyla, M.Bukała. Monitoring as an instrument for aircraft noise nuisance reduction //Proc. The 7th World Congress “Aviation in the XXI-st Century”, September 19-21, 2016, Kyiv. 5.4.39-5.4.41.

6. On Board a Sustainable Future. ICAO Environmental Report 2016. www.icao.int.

7. Zaporozhets, V.Tokarev, K.Attenborough. AIRCRAFT NOISE: assessment, prediction and control. CRC Press Reference (ISBN 9781138073029), March 31, 2017 – 420 p.