NOISE AND FLIGHT PATH MONITORING AT AUSTRALIAN AIRPORTS

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Abstract

The noise from aircraft operations can be a source of dissatisfaction for residents of communities surrounding airports. To provide information which may assist in reducing that dissatisfaction, Airservices Australia operates a noise and flight path monitoring system at several of Australia's major civil airports. The system is networked for operation from a single control centre in Canberra. In the surrounds of each airport is a number of noise monitoring terminals, continuously monitoring the noise to which they are exposed. The system also records flight track and aircraft operational information from the airport radar systems, and correlates the noise with the flight track data. The detailed numerical and pictorial analyses of the data which can be produced are invaluable in the environmental management of aircraft operations in the vicinity of the monitored airports. They also assist community understanding of the issues. The paper describes the system, the way it operates, the data it produces and the applications to which the data is put.

Introduction

Although there have been very substantial reductions in the noise levels produced by jet transport aircraft, this has been accompanied by substantial increases in the average size of the aircraft and their engines, and in the quantity of air traffic. As a consequence, noise from aircraft operations can still be a source of dissatisfaction for residents of communities surrounding airports. The political pressure which groups from such communities can apply may lead to restrictions on aircraft operations such as curfews, limitations on the aircraft types which may be used and great difficulties with selecting and obtaining approval for airport or runway expansion.

A good deal of the concern can be dispelled if factual information is readily available on the types of aircraft which have operated, where and when those aircraft have operated, the heights of the aircraft, and the noise levels they produced. Such data can be obtained through the use of a Noise and Flight Path Monitoring System (NFPMS), set up to collect the data automatically.

Airservices Australia has established an NFPMS at Australia's major airports, as shown in Figure 1, including Adelaide, Brisbane, Cairns, Canberra, Coolangatta, Melbourne/Essendon, Perth and Sydney. Covering several time zones and several thousand kilometres, the Australian NFPMS is the world's largest, most geographically-spread system of its type. The complete system is operated and controlled from Airservices Australia's Head Office in Canberra. It is noteworthy that the NFPMS was designed and developed in Australia, including not only the software, but also the noise measurement hardware. The purpose of this paper is to describe the principal elements of the NFPMS and the information that the system can provide.

Figure 1: Airports with Noise and Flight Path Monitoring

System Configuration

The NFPMS includes all the hardware and software necessary for:

a) the measurement of aircraft noise and background noise at selected locations around the airport;
b) the recording of aircraft flight tracks via an interface to the airport radar;
c) the correlation of measured noise events with aircraft movements on the flight tracks;
d) the identification of the aircraft correlating with noise events;
e) the storage of data;
f) operation and management of a database of operational and permanent information for the production of displays and reports of measured results.

At its heart, the system includes a central computer from which the system is controlled and in which incoming data is stored. Because many complaints and queries about aircraft operations and aircraft noise relate to seasonal effects on aircraft operating patterns (eg "why are the aircraft flying over my house this year when they have never been over here before?"), the database is very large, so that several years of accumulated data are available on line for comparison and historical reference purposes.

From the central computer, the system has connections and interfaces to the sources of data required by the system. These are:

(a) noise monitoring terminals in the surrounds each of the airports;
(b) The Australian Advanced Air Traffic System (TAAATS), which provides aircraft positional data from the airport radars, and flight plan data identifying each aircraft and the particular operation it is flying; and
(c) the Airport Terminal Information Service (ATIS) which provides airport- and time-specific weather and runways-in-use data.

Data Sources

Noise Monitoring Terminals

Around each airport, there is a number of Noise Monitoring Terminals (NMTs) situated at locations in residential areas, and connected to a communications processor at the airport by telephone or data line. Most NMTs are permanently sited, but there are also portable units for shorter-term measurements at additional locations as required.

An NMT consists of a microphone at the top of a 6-metre mast, a precision sound level meter to measure the noise being received by the microphone, hardware and software for the initial data processing of the measured noise, and the data transfer equipment necessary to send the noise data to the central computer and to receive control signals sent from the central computer to the NMT. The NMT also monitors its own performance and reports its status to the central computer. In addition, there is power supply equipment including a connection to a source of mains power, back-up batteries and battery charging equipment.

The NMTs measure and record all the noise to which they are exposed, not just the noise from aircraft, over the range from 30 dBA to 130 dBA. The data provided by the NMTs includes the A-weighted S-response sound level at one-second intervals, the time history of "noise events", and the time average noise level (L_{Aeq}) and a range of percentage-exceedance (Ln) noise levels over each hour, day and night-time (2300 to 0600) period.

The noise data is transmitted from the NMT to the central computer either continuously over a full time data connection, or at pre-determined times of day by means of a dial-up system.

The number of NMTs around each airport is dependent on the runway layout at the airport, the situation of the airport in relation to noise-sensitive locations, and the number of such locations to be monitored. The number of permanent NMTs at the various airports ranges from 11 at Sydney down to one at Canberra. The number and siting of NMTs is decided in consultation with the local Airport Noise Abatement Committee, which usually includes representatives of community groups, government at all levels (local, State and Federal) and the aircraft and airport owners and operators.

In addition to the permanently-located NMTs, the NFPMS also incorporates portable NMTs which can be readily deployed at additional sites when required. The portable NMTs have the same capabilities as the permanent NMTs, and are fully compatible with the rest of the system. Communication between the portable NMTs and the central computer is via mobile phone. The portables allow the assessment of the noise levels at a much greater number of locations than would be feasible or economic using permanently-installed NMTs. They may also be used to assess or demonstrate the effects of the introduction of a noise abatement procedure tailored to suit a particular area.

In selection of a site at which an NMT will be located, there are several criteria which need to be satisfied. These are:

(a) the site should be in an area which is predominantly residential, and preferably not more than about ten kilometres from the near end of the closest runway;
(b) the site should be near regularly-used flight tracks, to minimise the chances of mis-identification of ambient noise sources as aircraft;
(c) the site must be in a relatively quiet location so that aircraft noise is generally detectable above the background noise. This means not in close proximity to noise sources such as main roads, railway lines, factories, and air conditioning systems. Depending on the local climate, the close proximity of metal roofs may also need to be avoided because of the noise generated during heavy rain;
(d) there must be a direct line-of-sight from the microphone to the aircraft, and no close proximity to large buildings or steep terrain which could cause echoing or shielding of noise;
(e) access to electric power and telephone lines;
(f) ready access for maintenance; and
(g) security from malicious damage.

The usefulness of the noise data measured by the system is dependent on being able to demonstrate its accuracy and reliability. As the NMTs are operating in a relatively harsh outdoor environment, exposed to all the variations and extremes of the weather, and deposition of dust, salt and industrial fallout, it is necessary to keep a regular watch on their performance. This includes

automatic checking and reporting of the level sensitivity of the microphone twice per day, using an in-built electrostatic actuator, with appropriate error messages if the sensitivity moves outside pre-defined tolerances. A preventive maintenance program is operated, in which the measurement characteristics of the complete NMT are checked regularly, and the microphone replaced at yearly intervals with a freshly laboratory-calibrated unit.

Flight track and flight plan data

The system receives flight track and flight plan data on aircraft using each airport via real-time connections to Airservices Australia's TAAATS system. The flight track data collected includes the aircraft's xy position, its altitude, and the time of each radar return. This information is used to construct continuous tracks, height profiles and speed profiles. The associated flight plan data collected includes aircraft callsign, aircraft type, origin for arriving aircraft or destination for departing aircraft, runway used, and Standard Instrument Departure route (SID) or Standard Arrival Route (STAR).

Radar data is routinely collected and stored by the system for all aircraft within a 50 km radius of the airport, and over the altitude range from ground level to 10,000 feet above ground level.

The system is also supplied with weather data for each airport, to assist in analysis of operations and in providing explanatory material to complainants.

System Operation

The system collects noise and flight path data continuously, 24 hours per day, seven days per week. Timing is of critical importance to the system's operation, and all parts of the system need to work in synchronism with each other and with the external data sources to which the system is connected.

As the NMTs are measuring all the noise to which they are exposed, not just the aircraft noise, there is a need to distinguish aircraft noise from the noise of other sources. This process uses the concept of the "noise event". A noise event occurs each time that the noise level exceeds a preset threshold for more than a preset duration. The noise level and time duration thresholds defining a noise event are determined by experience with the conditions at a particular site. The selection of thresholds is a compromise between ensuring that as many aircraft as possible are measured and identified, and avoiding overloading the system's capacities with large numbers of extraneous, non-aircraft, noise events.

The noise data measured and stored for each noise event includes the maximum noise level during the event (L_{ASmax}), the second-by-second time history of the noise event, the Sound Exposure Level (SEL), and the time average level (L_{Aeq}). In addition, the event data also includes the time at which the event starts and finishes, and the time at which the maximum sound level during the event occurs.

The information received from the radar includes not only the aircraft positional information but also the time that each radar return was received. The computer performs a process of correlation of noise event information and radar track information. When the time of a noise event coincides with the time that an aircraft's track was in the vicinity of the NMT, the noise event is attributed to the aircraft. Since it is possible that another noise source, such as a truck, may have produced a noise co-incident with the presence of an aircraft, it is not possible to be completely certain that the noise event was generated by an aircraft. However, with appropriate site selection and set-up parameters, such mis-correlations are minimised.

The separation of aircraft noise from other noise allows processes such as calculation of the statistics of the noise levels produced by a given aircraft type performing a particular operation. It also provides data for calculation of the average noise levels due to aircraft alone, and for estimation of what contribution aircraft noise is making to the overall urban noise levels.

System Applications

Data display and analysis

On a map of each airport and its surrounds, the system displays (in real time or from stored data) the noise levels measured by each of the NMTs, and the flight tracks of the aircraft. The base maps are detailed to individual property level. There is provision for adding or removing layers containing other geographic data such as zoning or population data if required.

Data stored on the system can be queried in a variety of ways to suit the purposes required. The user can request the system to display the tracks flown by any required selection of aircraft operations, together with the noise levels which those operations produced at the NMTs. For instance, the selection could be an individual aircraft operation, or jet aircraft operations as a whole, or aircraft of a particular type, or operations by a particular airline, or on a particular route, or over a particular period.

For preparation of aircraft noise exposure contours, the actual flight tracks of aircraft, as received from the radar, and the types and numbers of aircraft using those tracks, can be extracted from NFPMS for use in noise modelling.

For tasks such as checking compliance with noise abatement procedures, the system includes the capability to analyse the positions of aircraft tracks, by defining software windows and corridors through which aircraft are expected to pass, and highlighting and listing those tracks which deviate from the defined areas or altitudes. Conversely, aircraft exclusion zones can be defined, and the tracks of aircraft which have entered the defined zone can be highlighted. The analyses can be selective, for example by selecting the type of aircraft, or the route being flown.

The results of the analyses described above are the basis of regular reports to Government, airline and airport operators, the airport noise abatement committees and the general public, or as one-off special investigations.

Complaint handling

The applications of the NFPMS to the investigation of complaints and enquiries related to aircraft operations from the general public are readily apparent. Once the complainant has provided his/her location and the time of the aircraft operation which has caused the disturbance, the operator can use the system to find records of all relevant aircraft operations, with details of aircraft callsign, operator, aircraft type and route, together with any noise events the operation has produced at the NMTs and the weather information around the time of the disturbance. The system can calculate the distance of closest approach of the aircraft to the complainant's address and the altitude of the aircraft at that point. The operator can then display this information on hardcopy maps which can be sent to the complainant or enquirer.

Benefits of Noise and Flight Path Monitoring

The benefits provided by the NFPMS include:

(a) better information for planning:
- (i) objective assessment of the effects of alternative operational and administrative procedures for noise control;
- (ii) automatic compilation of a database of airport usage statistics, including runway and flight path utilisation, operating times, aircraft types, traffic categories and curfew compliance;
- (iii) assistance in planning of airspace usage;
- (iv) measurement and verification of noise levels by aircraft types;
- (v) compilation of data for use in noise exposure forecasting and contouring;
- (vi) validation of noise exposure contour modelling methods; and
- (vii) assistance to authorities in land use planning for developments in the vicinity of airports.

(b) increased service to the community:
- (i) assistance in the investigation of noise complaints and enquiries from the public;
- (ii) assessment of compliance with noise abatement procedures;
- (iii) determination of the contribution of aircraft to overall noise exposure; and
- (iv) detection of operations which have not complied with flight corridor requirements.

Availability of NFPMS Data

For each NFPMS-equipped airport, an overall summary of noise and flight path data for operations at that airport is produced quarterly. These quarterly reports are those produced for review and consideration by the airport noise abatement committees. The reports are freely available to the general public on Airservices Australia's website, at

www.airservicesaustralia.com.

Airservices Australia intention for the not-too-distant future is that interested members of the public will be able to log in to the NFPMS via the internet, and perform their own queries relating to aircraft noise and flight paths directly from the NFPMS database, without the need to work through an intermediary operator.