Proceedings of The Institute of Acoustics

AIRCRAFT NOISE MONITORING IN LONDON

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INTRODUCTION

Heathrow Airport is by far the busiest airport in Europe with about 275,000 movements per year. Unfortunately, its location being about 20 Km from the centre of London and close to the western suburbs, as well as on the east-west alignment of the two main runways, also means that it is one of the world's worst airports regarding the number of people affected by aircraft noise.

In order to reduce the effects of noise, aircraft departing from Heathrow follow noise preferred routes designed to avoid the built-up areas as much as possible and observe noise abatement procedures to ensure that they do not exceed specified noise limits of 110 PNdB by day and 102 PNdB at night. These limits are enforced by the British Airports Authority which now has 13 automatic recording stations situated close to the airport edges and nearest to the built-up areas covering all departure routes. Infringments of these limits are notified to the airlines concerned but landing aircraft are not covered by any similar limits. This means that for about 70% of the time, aircraft which land across London in a westerly direction are not monitored by the B.A.A. or covered by any noise control measures.

The local authorities responsible for planning, housing, education and administration within the west of London were very interested in seeking more information on the overall levels of aircraft noise. This was in order to provide factual information for aircraft noise control policies. Therefore, in 1979 the Greater London Council in co-operation with eight of the London boroughs set up an independent aircraft noise monitoring system in west London.

The principal objectives of the system are:

1 To provide independent information on noise exposure and both departing and landing craft over the whole area of London significantly affected by aircraft noise.

2 To provide factual data for planning purposes relating to the location of new noise-sensitive developments such as schools or housing.

3 To provide a basis for determining the optimum degree of sound insulation required or considered desirable for both new and existing developments.

4 To provide a basis for informed comment on various issues related to aircraft noise.

SYSTEM DESIGN

It was realised from the outset that a computerised system capable of

handling a large database would be required in order to provide sufficient space for storage and retrieval of aircraft noise data. It was necessary to seek a limit on the amount of data collected for each movement, realising that the peak level by itself would be insufficient, while full spectral information on each movement would be too much. Limited equipment resources meant that initially only six sites could be in use at any one time though these would still cover around 100,000 aircraft movements per year. It was necessary therefore, to compromise on data volume in order to obtain maximum benefit from the recording system. Thus a threshold system was used where half-second samples of the peak envelope in dB(A) were recorded above a pre-set level. This required about 18 megabytes of storage per year giving rise to a manageable set of data in the form of a tape or mass storage file.

Additional information was also required in order to perform effective retrievals. Site information was needed describing the location and height of the microphone, the map reference of the site, distance from the runway etc. There was also a need for a runway data file containing information on runway usage and arrival/departure patterns throughout the day. An information file described problems associated with the equipment and with operational procedures at the airport and lastly there was a weather file describing wind, temperature and precipitation parameters throughout the periods of recording. The database software was prepared at the same time as instrumentation, that is prior to the start of the monitoring programme.

It was therefore necessary to use instrumentation that could record data in a computer compatible format. Due to restrictions on capital expenditure at that time, an existing data logging system normally used to monitor continuous levels of traffic noise, was modified to record noise levels above a threshold level. Audio cassettes were used by this system and it was estimated that these would record for two to five days.

This rate of cassette changing could not be carried out within the resource restrictions of the project and it was necessary to obtain the help of London Borough staff for changing and calibrating cassettes and forwarding to County Hall for computer processing.

SYSTEM OPERATION

The noise level is detected using a Bruel and Kjaer 4921 outdoor microphone powered by a 2610 amplifier. The d.c. voltage output, giving a linear representation of a 60dB dynamic range, is fed to a Microdata M200 data logger. This is an incremental logger capable of recording a eight bit phase encoded binary signal at half second intervals. The threshold detector is located in an associated interface along with counter cards for determining the time of day at the point of triggering. The procedure for cassette changing was simplified as far as possible since many of the Borough staff involved were inexperienced with such instrumentation.

Following installation of the equipment there was no need for any settings of the logger or amplifier to be disturbed as calibration was effected by means

of an independent switch that operates the electrostatic actuator of the microphone. The main operational problems experienced were not due to equipment usage but more related to cassette collection. The large number of aircraft movements at the permanent sites meant that the capacity of the cassettes was often reached in less than two days, resulting in periods of missing data. Data loss due to instrumentation failure was infrequent, but was mainly caused by moisture penetration of cables and mechanical problems with the data recorders. This loss of data in the early stages of the project has largely been rectified by a programme of regular maintenance.

Data Processing

On reaching County Hall the cassettes are read by a special translator on the Prime 750 computer. Each eight bit number is converted back to a noise level or to a timing signal. During this stage of the processing valid aircraft events are differentiated from spurious events such as wind noise and from calibration signals. Initially a valid event was defined as one which exceeded the threshold for more that 6 seconds. However, it was soon discovered that one aircraft flyover could be split into two or three apparant separate events due to level fluctuations around the threshold during the flyover. This was particularly noticeable where the peak level was less than 10dB above the threshold.

This was corrected in the software by measuring the separation time between detected valid events and then, depending on the period of this separation, deciding whether they should be joined as one event. On checking this procedure with simultaneously run level recorder charts it was determined that a much higher recognition rate was achieved.

Data from all aircraft noise events are then sent forward to form a file from each cassette. These files are then merged together monthly to form a tape which would be passed to the mainframe computer for further processing and adding to the noise databank. A monthly report is produced for each site describing the aircraft movements, separating landings from take-offs during various parts of the day and giving statistical data on the distribution and average peak levels for the periods concerned.

Telemetry

After about three years use, this system of instrumentation was developed in order to cope with the large volumes of data arriving from the two permanent sites. A micro-processor controlled data-logger the Microdata Prolog 1680, with $\frac{1}{4}$ inch cartridge tapes was selected as the most compatible solution. This gave better data resolution and far improved recording reliability with the facility for remote control of all logging operations. It was also possible to telemeter data direct to the computer using the telephone lines and modem systems.

The Prolog uses the same signal from the noise amplifier as the M200 logger but records the data on tape quite differently. An internal clock generates the time of day at the point of exceeding the trigger level and the noise data values are sampled at the same half second rate. However, this

information is then written to the tape cartridge in the form of ASCII characters. This sequence of operations is controlled by a user-written program stored in the processor memory. At the busiest sites the tape would take about two weeks to fill while at other sites it could last from 4-6 weeks. In order to eliminate the tape collection stage of the system, it was decided to take advantage of the Prolog's remote control facilities and send data to the computer via telephone links. It was estimated that one day's recording at a permanent site would take about 15 minutes to replay and if this could be carried out at night, there would be minimal loss of useful data.

This was a simple concept but many practical difficulties were encountered. Approval from British Telecom took about one year, but in the meantime the progress in testing the micro-processor revealed faults in the tape system which the manufacturers needed to correct. Telephones on two sites at Hounslow Civic Centre and the Beavers Lane Army Barracks took many months to install, as the GLC did not own the premises. To further this delay, the installation could not be carried out until after the British Telecom approval had been given. Changes to the remote control interface were required by British Telecom and this meant re-writing part of the software. However, in spite of the problems the value of the system is now being realised, quicker response to equipment failures, greater data reliability and far less involvement of staff time are some of the initial benefits.

At the present these systems are located at the two permanent sites, and the portable sites are being converted to a similar system but with no telephone, as the sites are only likely to be in operation for three to four months.

SYSTEM DEVELOPMENT

Future development of the monitoring system instrumentation has been planned to include the use of the latest data logging system from Microdata, the Solog. This is virtually identical to the Prolog in terms of function and control except that computer memory is used to store the data, thus avoiding any mechanical problems associated with the tape mechanism.

Recent advances in the use of cellnet radio for telecommunications links means that it will no longer be necessary to install a site telephone line and that all site systems could be the same. Figure 1 shows the development of the site systems and the routes for data processing.

DATA RETRIEVAL AND APPLICATIONS

During the early stages of the operation of the system, a data retrieval program was developed which enabled the master file to be interrogated and produce various statistical parameters. Initially the master file is reduced to a managable size by extracting four parameters for each event, that is the peak, the duration, the Lax and duration at 10 dB below the peak. The reduced master file is then interrogated by the retrieval program and a set of tables are produced for each set of retrieval parameter conditions.

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Searching is carried out by restricting the values of site information, date, time, runway data, information and weather parameters, in order to produce a selected data set from which statistical calculations can be performed. At the present time, summaries of average peak levels, Leq and NNI can be produced for various time periods.

Information from the databank has been used by the Council at the Public Inquiry into the fifth terminal at Heathrow where an assessment of aircraft noise impact on schools was produced. Similarly data has been used at the Planning Inquiry into Hayes Road, Harlington and other authorities such as Hounslow and Surrey County Council have used the databank for retrieval and comparison of NNI measured values with NNI published values. Current work in this area is involved with assessing the trends of aircraft noise values over the past four summers and a series of reports are being produced on individual sites.

Aircraft Noise Complaints

In order to put the data to use in making policy decisions, it was necessary to find which aspects of aircraft noise people found most annoying. Sources of complaints about aircraft noise were found to show little response from the public, but the further investigation showed confusion as to where complaints should be directed.

For this reason, a clearing house for complaints was set up in June 1984 by the Greater London Council. Any complaint about aircraft noise can be referred to the 'Aircraft Noiseline' at any time. The call will be acknowledged, logged and recorded in a database system. The complaint is then referred to the appropriate authority along with any others of a similar nature. During the first four months of the service about 800 complaints have been received. Further information on the analysis of these complaints will be published shortly, but they are expected to show a high proportion of disturbance during the early morning and at night, thus identifying periods that need more detailed monitoring and further investigation.

SUMMARY

The aircraft noise monitoring system has been operational now for about five years. The instrumentation has been logically developed to take advantage of changing technology and following a number of ammendments, software has been successfully developed to store about 800,000 aircraft movements. It has been found that there is little difference between daytime and nightime average peak noise levels and in the Hounslow area, little difference in noise between landing and departing aircraft. This is particularly significant for west London where much of the area is exposed to landing aircraft. The data from the system has proved valuable in a number of inquiries and other investigations and will continue to be used for policy-making decisions and planning purposes. The system has also given comparisons between noise levels of individual aircraft, although this is not its primary purpose as there is greater interest in the average exposure of the community to aircraft noise.

As described in the report, further development of the system is planned

which will give greater data reliability and involve far less staff time in the collection and analysis of data. The system represents one of the largest sources of aircraft noise level data available anywhere and its value is continuing to be realised in many different aspects of local authority work.

Acknowledgement

This paper is presented with the permission of the Head of Scientific Services and views expressed are those of the author and not necessarily those of the Council.

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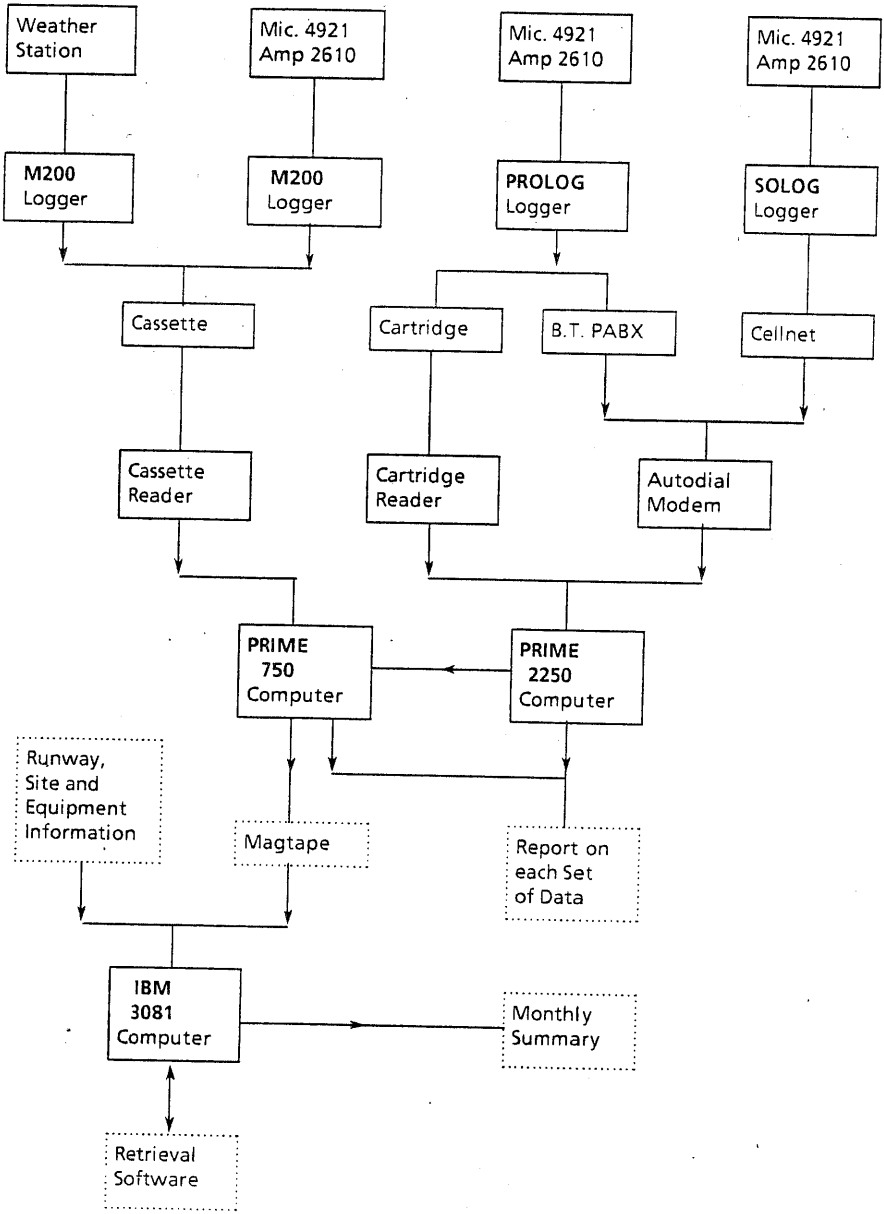
Figure 1.



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