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HUMBERSIDE AIRPORT - THE DEVELOPMENT OF A NOISE MONITORING SYSTEM

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1. INTRODUCTION

Humberside Airport is situated on the east coast of England, some ten miles south of the Humber Estuary. It is surrounded by land used primarily for agriculture with one nearby village, Kirmington, and a number of small villages and farmsteads in the vicinity of its flight paths.

A recently completed runway extension, increasing the main runway length by 43%, has provided a regional facility for medium-haul jet aircraft such as the Boeing 737 and 757 to operate economically for the first time.

Prior to the runway being extended the District Environmental Health Department had carried out noise surveys around the Airport for many years. This previous interest meant that noise issues were carefully considered and on granting planning permission for the development, the Planning Authority required that a number of nearby dwellings were insulated against potential aircraft noise, a noise monitoring system was installed and night-time aircraft movements were restricted to certain types of aircraft only.

The initial design and development of the resultant noise monitoring system has been described in an earlier paper[1], but with nearly 2 years since its installation, the instrumentation and its operation has been fully tested and further developed. This paper examines the development of the System since its installation, including the way in which the Airport and Planning authorities inter-relate over the issue of noise.

2. THE NOISE MONITORING SYSTEM

The noise monitoring system subsequently employed at Humberside Airport is illustrated in Figure 1. It consists of two permanent noise monitoring terminals (NMT's) linked directly to a host computer and a mobile NMT which can be connected to a portable computer for downloading data in the field.

All three monitoring terminals are Cirrus Research CRL 243 units which simultaneously, recognise and record noise "events" caused by aircraft movements, measure standard environmental noise parameters such as L_{Aeq} and L_{A90} and store about one weeks worth of "time history" data in the form of 1s short Leq elements.

The permanent NMT's are located at the end of the lighting arrays for each runway, approximately 0.9 km from each threshold, and monitor continuously, recording all significant noise events from aircraft using the Airport. The mobile terminal can be moved between sites to record aircraft noise within the local community and has been used to monitor noise at the source of complaints.

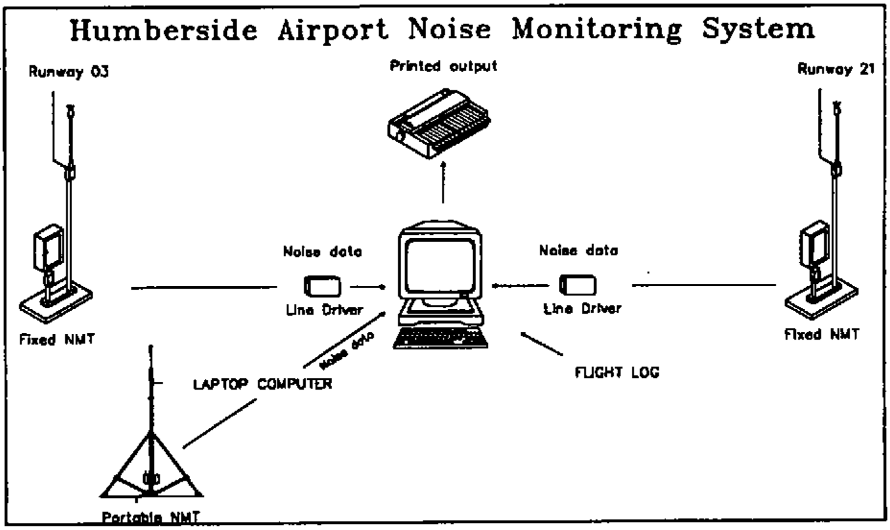

Figure 1: Humberside Airport Noise Monitoring System

Operation of the permanent NMT's essentially consists of downloading stored data, calibration and checking system parameters for faults and alarms - all done using the host computer. Operation of the mobile NMT is similar but initialisation of a survey and data download are usually performed in the field.

When the System was being developed it was intended that Humberside County Council, the Airport's owners, would act as acoustic consultant and carry out the monitoring on its behalf, but once installed, financial restrictions dictated that this function be kept in-house. Therefore, because of the relationship with air traffic movements and a historic association with noise complaints, operation was assigned to Air Traffic Control. This led to a slight conflict of interests, however, in that airport priorities are different from those of an acoustician: whilst acoustically it would be ideal to collect as much data as possible, noise monitoring tends to be regarded by the Airport as an imposed burden. Consequently, lack of staff resources and expert understanding means that operation is confined to the minimum required for compliance with the planning conditions and, although the majority of data is collected, there are significant gaps and no further analysis generally takes place.

Collection of permanent NMT data is initiated from the host computer at the operator's request. Initially this was carried out erratically with periods of up to one month between downloads. In theory this should pose no problem, due to the large storage capacity of the instruments, but on several occasions, system resets occurred during nearby electrical storms resulting in the loss of significant amounts of data. The effect of this problem has now been minimised by regularly downloading data every week or on receipt of a complaint.

Another problem that occurs at the monitoring terminals is associated with wind noise. Both permanent NMT sites are located in open countryside and are occasionally exposed to strong winds. During such periods the microphones record high noise levels which cause many spurious noise events to be triggered. This is illustrated in Figure 2 which shows event generation at the south NMT on a day where wind speeds varied between 7 and 14 m/s, with gusts of up to 21 m/s. This caused 405 events over 80 dB(A) to be triggered with only 24 attributable to aircraft.

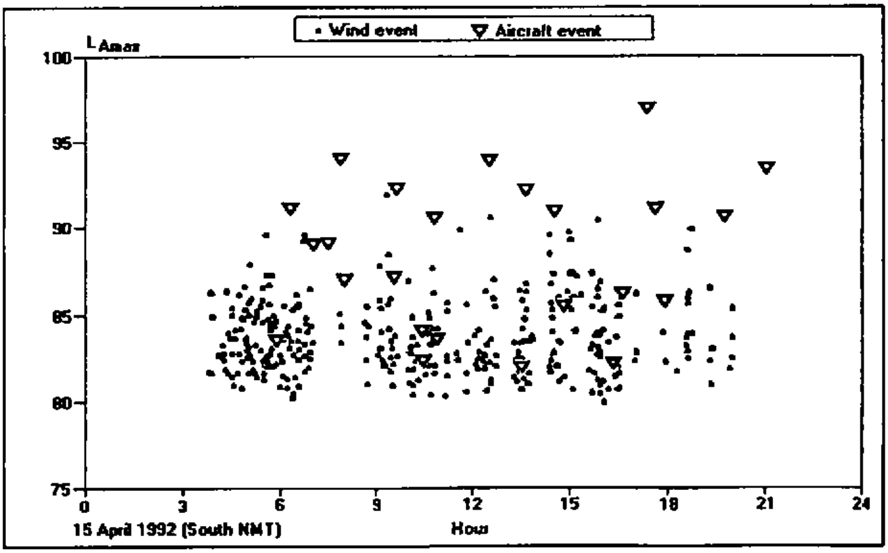

Figure 2: Event generation on a windy day

Similarly wind also has a dramatic effect on environmental noise parameters as can be seen in Figure 3 which covers the above period. Here the average daily background noise level and L_{Aeq} have increased by 14 and 15 dB(A) respectively due to wind noise.

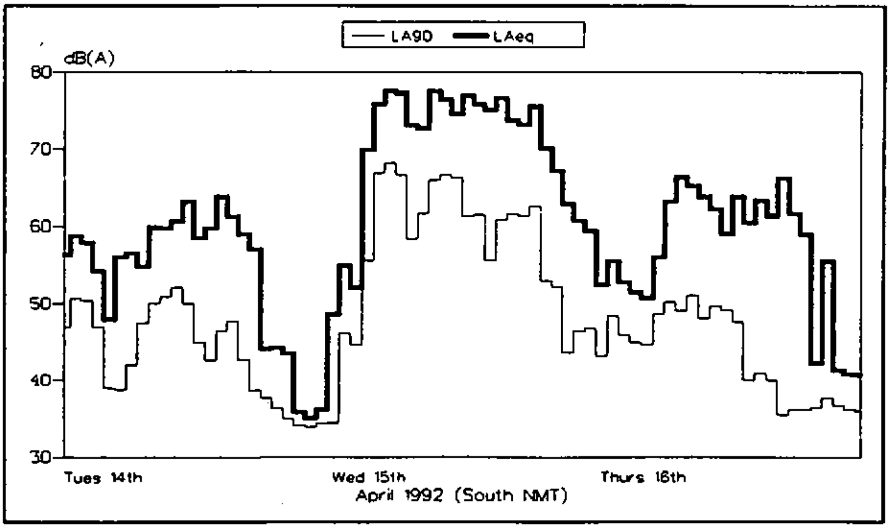

Figure 3: Wind effects on environmental noise levels

3. THE DISTRICT PLANNING AUTHORITY

On making noise monitoring a condition of the planning consent for the runway extension, the District Planning Authority, Glanford Borough Council, required that they receive a quarterly summary of the following monitored data:

- Utilisation of the main runways
- A summary and listing of noise events recorded at each NMT with a maximum noise level of at least 90 dB(A) during daytime hours (0600-2200 local) and 80 dB(A) during night-time hours (2200-0600 local).

- Time histories of aircraft movements of particular interest such as a newly encountered aircraft or a manoeuvre causing a complaint.

- A graphical representation or listing of daily 24 hour L_{Aeq}, L_{A90}, and L_{A1} during each month with a summary of monthly average 16 hour L_{Aeq}(0700-2300 local), 24 hour L_{Aeq} and L_{A90}.

Also, on receipt of a complaint, access to specific event data was required on demand. In such circumstances the Planning Authority can determine, firstly, whether the offending aircraft was operating from the Airport (military aircraft regularly fly in its vicinity), secondly, whether it was typical of other similar aircraft and, thirdly, whether it was in contravention of night-flying restrictions.

Restrictions on night-time operations were included in the planning consent to prevent noisy Chapter 2 type aircraft such as the Boeing 737-200 from using the Airport between 2200 and 0600 hours local time. Due to the rural location and the need to attract business, however, it was accepted that quieter aircraft should be allowed to fly during these hours. Thus only Chapter 3 aircraft falling into the night noise classification NN/C adopted at Heathrow, Gatwick and Stanstead are allowed to operate in addition to other aircraft which can show compliance with NN/C criteria: namely, a 95 PndB ICAO take-off footprint not exceeding 5.2 km^2 in area.

In this respect the Planning Authority has already used data from the monitoring system to regulate night flying. For example, a number of complaints were received regarding the departure of an MD-83 aircraft at around 1 am local time. Observation of noise traces from the permanent NMT's showed that this aircraft was approximately 10 dB(A) more noisy than a B737-300 or B757 on departure and that its noise took approximately half as long again to decay. On checking with the appropriate NN/C schedule it was apparent that an MD-83 could only meet the criteria with certain engines and a reduced payload but the Airport confirmed that the engines and typical payloads were correct. These departures were not, therefore, in contravention of night flying criteria, however, in view of the borderline circumstances, it was recommended that this particular departure be re-scheduled to depart earlier in the evening during the following summer season - a request that has since been complied with.

In the event of more persistent noise complaints from the same person or general area the mobile NMT has been used to monitor at source. The most prolific complainant, located close to the flight path some 3 km from the end of the new runway, regularly writes to the Planning Authority and Airport with a list of offending aircraft so the monitor has been placed in his garden on a number of occasions. The surveys have yielded weekday daytime L_{Aeq}, L_{A1} and L_{A90} values of approximately 45, 53 and 37 dB(A) respectively with corresponding night-time values of 37, 45 and 32 dB(A) - none of which give cause for alarm. In addition, time histories corresponding to Airport movements (Figure 4) show that maximum noise levels from typical jet aircraft departures are unlikely to exceed 70 dB(A) at this property, whilst levels in excess of 120 dB(A) have been recorded for military aircraft.

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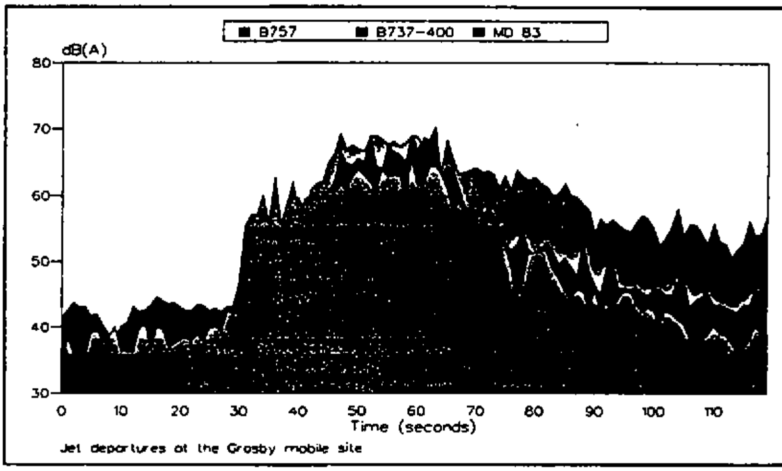

Figure 4: Time histories for typical jet departures at a mobile monitoring site

4. SYSTEM DEVELOPMENTS

When originally installed the control software for the permanent monitors only enabled the operator to be in contact with one NMT at a time. Although not a problem in terms of data acquisition, it necessarily restricted the "real-time" display to one NMT, thus compromising its usefulness during days on which both main runways were in use. New control software has since been introduced which now allows simultaneous contact with both NMTs and provides a visual display from both ends of the runway superimposed on a map of the airport. An example of this display is shown in Figure 5. The appearance of this new feature has stimulated the interest of Management to such an extent that it is now planned to put it on public display.

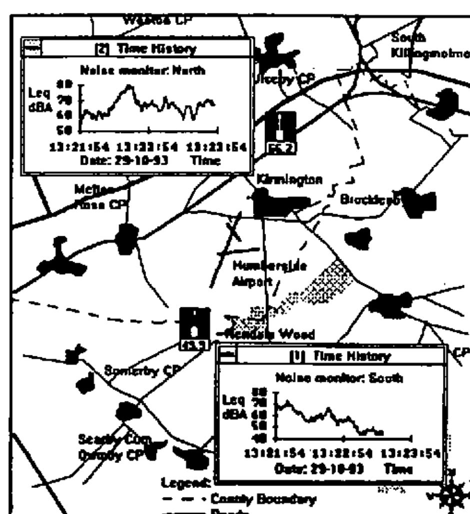

Figure 5: RASP Software

Another development which has been installed at the airport involves improvements to the way in which noise events are detected. Figure 1 and Figure 2 clearly show one of the problems presented to the instrument manufacturer when attempting to extract particular noise events from local and environmental noise. Two major factors exist:

i) Wind noise and local noise (traffic and in the case of Humberside, agricultural noise) can cause "false events".
ii) The local background level can vary considerably, as running 24 hours a day in ALL weather conditions.

A great deal of effort has been put into improving event detection to resolve the above problems and make the system easier to use.

Real/False Event Differentiation

The existing event detection worked on a simple threshold basis. The noise level had to pass a first threshold (TH1) and then remain above a second threshold (TH2) for a minimum time duration (MD). If the level remains below the second threshold (TH2) during the guard time (GD) then the event ends. This guard time is designed to allow for reverse thrust after an aircraft lands (Figure 5).

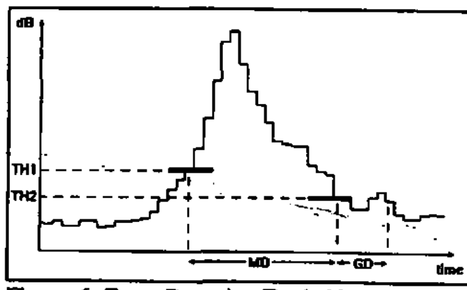

Figure 6: Event Detection Tresholds

This method of detection works well as long as wind and local noise (cars, tractors, etc) are not a problem. However, the latest development in event templates involves checking the rate of rise and rate of fall of the noise level. These are calculated from the slopes of the lines joining the maximum level during the event to the points where they cross the thresholds.

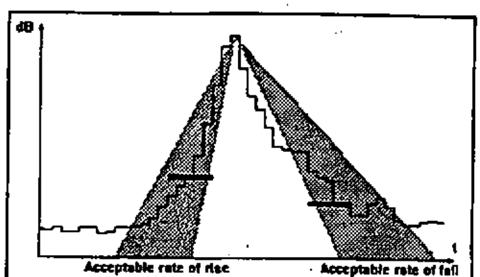

Figure 7: Event rise and fall times

For aircraft recognition, the rate of rise and rate of fall (or at least an acceptable range) is known - based on the distance from the airport and the type of aircraft flying.

Now, for example, passing cars would be removed as the rates of rise and fall are too great whilst trains and tractors are removed because the rates of rise and fall are too low.

Varying Background Levels

The remaining shortfall of the above methods involves the fact that local background levels can change under the following conditions:

- Day/night
- Wind
- Rainfall
- Portable systems, installed at varying locations

With existing systems, the thresholds have to be set based on acoustic knowledge of the local environment. This is fine as long as that environment does not change from day to day, hour by hour, or, in the case of the mobile NMT, place to place.

The plot of L_{A90} against time in Figure 2 shows clearly that if thresholds were set at 80 dB(A) a large number of false events would be detected, as actually happened. The problem of incorrect threshold setting also manifests itself with the mobile NMT when they are set too high to recognise quieter aircraft events, for example, the aircraft traces shown in Figure 3 were obtained from the short L_{eq} store and did not actually trigger corresponding events.

The solution to this, although not yet installed at Humberside, is to offer an automatic system of setting thresholds based on current background levels. To this end the terminal continually monitors the statistical background noise level and then uses the threshold and rate of rise/fall method on all noise events exceeding the background by a predefined amount.

The Airports' decision to handle all data acquisition and analysis "in house" is in common with many other small airports. The result is that these systems tend to be used by somebody with very little spare time to handle the huge amounts of data that can be produced (and is always "required" by the airport). It takes time to download the data and even more time to evaluate it and create reports.

Developments since the installation at Humberside are designed to allow the system to run automatically, letting the computer do all the work. Data can be downloaded automatically at preset times, analysis carried out and reports generated. All the operator has to do is remove the paper from the printer and check that no problems were reported.

The reports are kept to a minimum, summarising the data where possible. Of course detailed information is available but most of the time, a simple summary of the amount of noise created by an airport is all that is required.

Should Humberside decide to fully automate their monitoring system there would no longer be any necessity to compromise data collection and analysis through lack of resources. However, as a smaller developing airport, who cannot afford extra resources to operate the manual system, it is unlikely that additional money would be made available for automation.

5. SUMMARY

The noise monitoring system as Humberside Airport was installed as part of major runway extension project in response to requirements of the district planning authority which has always shown a keen interest in aircraft noise.

The System is operated internally by airport staff and data is freely passed over to the planning authority for their information, and in the event of a complaint. Such data has shown pre-extension predictions to be largely correct and has been used to rebut complaints, both in terms of hard fact and good public relations.

The original System has been enhanced with developments to aid in its ability to detect aircraft noise and improve its visual display. In addition, further improvements are available to the Airport should it want them.

6. ACKNOWLEDGEMENTS

The authors wish to thank the Airport for its cooperation in the production of this paper.

7. REFERENCES

[1] Horton C.A & Stollery C.P. "Noise Monitoring at a Regional Airport" Proc. IOA Vol 14 part 4 (1992).