NOISE MONITORING AT A REGIONAL AIRPORT

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1. INTRODUCTION

Humberside Airport is located in quiet countryside about eleven miles south of Hull and midway between Grimsby and Scunthorpe - the three largest towns in Humberside. It is run by Humberside International Airport Limited under the ownership of Humberside County Council, and currently handles some 150,000 passengers per year.

In 1988 an application was submitted to Glanford Borough Council to extend the main runway from 1554 metres to 2225 metres so that inclusive tour charter flights by medium-haul aircraft such as the Boeing 737 could be accommodated at economic payloads. At the time of the planning application, and in addition to helicopter traffic, the Airport was used by turbo- and business-prop aircraft such as the Fokker F27 and Cessna 421 respectively and, less frequently, by business-jets such as the BAe 125. The proposal to extend the main runway for use by larger jet aircraft was therefore accompanied by expressions of concern from the local community and district planning authority regarding additional noise. It was anticipated however, that these would generally be Chapter 3 aircraft with turbo-fan engines which are considerably quieter than older technology Chapter 2 aircraft which had occasionally visited the Airport. In consequence the Application included noise information in the form of aircraft footprints and noise exposure contours. Comparison of the pre- and post-extension scenarios showed an expected increase of between 3 and 7 NNI for the most affected properties up to a maximum of 45 NNI; this was not considered to be of major significance.

In 1989 planning permission was granted, but in response to the concerns regarding increased noise disturbance certain conditions were imposed. These included provision of a noise monitoring system and implementation of a noise insulation scheme.

This paper examines the development of a noise monitoring system for Humberside Airport, describing the instrumentation used and presenting data collected during the initial monitoring period.

2. AIRPORT NOISE MONITORING SYSTEMS

Modern airport noise monitoring systems usually consist of a number of noise monitoring terminals (NMT) linked to a host computer for remote operation.

By necessity the collection of long-term noise information means that any measuring equipment must be capable of outdoor operation in all weather conditions with minimum supervision and maintenance. Therefore each NMT is typically comprised of a weatherproof microphone unit fitted with a dehumidifier, a rain/wind shield, a bird roosting deterrent and a calibrator. The microphone provides input for a noise level analyser capable of self calibration, statistical analysis, event recognition and storage of at least several days worth of data. The analyser is usually housed within a weatherproof cabinet which is attached to a pole on which the microphone is mounted at sufficient height to minimise adverse reflections and deter vandalism. Power is provided direct from an AC supply or by battery.

The positions of the NMT's are determined by the major landing and departure routes, the community boundaries and the total number of terminals available. They generally straddle the nominal approach and departure routes in a "gateway" formation at distances along the flight path typical of the community boundary. In this way measurements can be used to check operational limits and deviations from minimum noise routes designed to avoid the most populated areas.

Information thus obtained can serve the following purposes[1]:

- Indicate official interest by the airport and district planning authorities and instil public confidence that airport related noise is being monitored to protect the local community.

- Enable the detection of unusual flight events, allowing the airport authority to assess and impose a voluntary code of noise control.

- Create a valid statistical database over an extended period of time for use by the airport authority in, for example planning, noise impact, public relations and educational issues.

3. NOISE MONITORING AT HUMBERSIDE AIRPORT

Due to its rural location Humberside airport has no minimum noise routes. Also, in view of the small amount of additional noise expected from use of the extended runway, provision of a gateway formation was considered excessive to the requirements of the district planning authority: namely that the scheme should monitor all significant noise events from the full usage of runway 03/21 and noise exposure in the surrounding communities. Additionally, periodical summaries of noise data and access to information on specific noise incidents following receipt of a complaint were also required.

3.1 Noise Events

It was agreed with the planning authority that the requirement to monitor all significant noise events could be met by 2 permanent NMT's located at either end of the main runway directly under the approach and departure paths. Distances of 3-5 km from the end of a runway are typical for gateway formations, but solitary NMT's located at these distances may not consistently record departing aircraft due to flight path variations away from the microphone. Single NMT's therefore need to be located close enough to the runway to avoid these deviations - ideally within 2 km. At Humberside Airport several factors had to be considered when selecting permanent NMT sites at these distances, namely:

- Planning permission would be required for any permanent NMT sites falling outside the original planning permission area - this area extended approximately 900 metres south of the proposed runway to the Lincolnshire boundary which would have meant involving another planning authority. In so doing further conditions on its use could have been imposed.

- Each permanent NMT site must be readily accessible to allow for periodic maintenance - the relevant areas are rural and exclusively agricultural so access is limited to farm tracks and bridleways.

- Power and data communication facilities must be readily available to permanent sites - there are none close enough to exploit outside the planning application area.
- The NMT must not obstruct any part of the fight path.
- The sites should not interfere with any agricultural activities and vice versa.
- The sites should be secure.

Accordingly, the only practical location for the permanent NMT's was on land acquired for the approach lighting, approximately 0.9 km from the threshold of each runway. In this way the sites would be accessible and power and data-links could be supplied as part of the lighting installation. However, in view of the short distances involved, the terminals would be monitoring during the initial, full-power phase, of take-off and difficulty in differentiating between old and new technology aircraft was anticipated. The feasibility of using these sites was therefore investigated and subsequently confirmed by measuring (at Manchester International Airport) typical noise levels of aircraft expected to use the new runway at equivalent distances.

3.2 Community Noise
Direct measurement of noise exposure in the community serves to quantify aircraft noise in areas of maximum concern, thus satisfying public opinion and promoting good public relations. This is to be achieved through the use of a mobile NMT on similar lines to the method employed at Leeds/Bradford Airport.

3.3 Choice of Noise Monitoring Terminal
In order to meet the requirements of the district planning authority the noise monitoring terminals needed to be able to recognise and record information on noise caused by aircraft and make measurements of standard environmental noise parameters such as LAeq and LAn; with the Department of Transport announcement to replace NNI with LAeq,16hr(0700-2300 local) it was desirable to measure this index. Air Traffic Control were also keen to have a "real time" display of noise levels in the main take-off direction. No further specification regarding measurement data was given. This then left the choice of terminal wide open, as most terminals available at that time allowed the specified measurements to be made.

The supply and installation of the System was put out to tender with the final choice of terminal being the Cirrus Research CRL 243. Three were purchased - two permanent installations, linked by direct cable to the host computer, and one portable unit.

The CRL 243 was proposed primarily because, in the absence of a direct specification, it provides the most flexibility in the choice of acoustic parameters that can be measured. It meets the requirements of IEC 651 and 804 to type 1 and is very rugged, to stand whatever the British weather can throw at it.

The terminals effectively compute three types of acoustic measurement, all of which are based on a fundamental measurement of Short Leq taken every 62.5 ms.

The first of these measurements uses the Short Leq elements to monitor the noise envelope[2] and from this detect when an aircraft is causing the noise. Once an aircraft has been detected the terminal computes various acoustic parameters such as SEL and Lmax and can include weather measurements from suitable sensors if present. This could be used, for example, to identify when flight path violations have occurred as a result of weather conditions.

The second type of measurement uses the same Short Leq elements to firstly calculate the (S)low sound level response to a high degree of accuracy. The resultant sound level samples are then processed to produce group environmental noise measurements which include statistical levels and LAeq measurements. The period of these groups can be configured by the operator which enables the requirement of a 16 hour LAeq to be met. The CRL 243 has three separate environmental measurement stores which can run simultaneously. At Humberside Airport these are set to measure every hour, every 24 hours and over the 16 hour period mentioned above.

The final type of measurement is the most flexible available from the whole system. The 62.5 ms Short Leq elements are processed to give a 1 sec Leq measurement which is stored in the system. Enough storage exists in the terminal to have a complete time history of noise over 7 days. The store is managed in a circular fashion so that the previous 7 days worth of data is always present. Extracted data is then available at any time for the common post processing techniques available to Short Leq[3]. In this way time histories of aircraft fly-overs can be examined and older indices such as NNI can be calculated.

The terminals operate entirely independently of the system operator, indeed they need only be contacted once per week to download information (which is the case for the mobile NMT), although in general operation one or other of the permanent sites is connected all the time to provide a "real-time" display.

The CRL 243 provides sufficient storage for 10,000 noise events and 10,000 environmental measurements. This means that, with the current low volume of traffic at Humberside Airport (registering approximately 30 events per day), each terminal can hold over 300 days worth of event information.

The mobile NMT is directly compatible with the fixed units and can produce the same measurements which may be downloaded to a portable computer in the field. It can be powered directly from the mains or from batteries which will support unattended operation for at least 7 days. Using this equipment the Airport initially plans to monitor at six sites in its vicinity for at least one week, twice per year. The validity of any complaints can also be assessed at source. In this way noise exposure at the most affected properties can be monitored, providing a valuable public relations service and key acoustic information.

4. EXAMPLE DATA FROM THE INITIAL MONITORING PERIOD

Installation of the permanent noise monitoring system was completed in January 1992 and the initial data has been examined in some detail to assess its capabilities; the full programme of mobile noise monitoring, however, has not yet started.

Figure 1 illustrates how noise event information is stored in the system and how it can be correlated with the airport movement log. This is particularly relevant when the district environmental health authority receive a complaint regarding a particular aircraft movement and, under the conditions of the planning consent, request specific information. The events shown in Figure 1 correspond with a regular MD 83 arrival; the departures, at around midnight local time, have prompted a number of complaints.

Correct setting of the event recognition parameters in the permanent terminals requires some fine tuning in order to record all events which may be of some interest; both sites are, unfortunately, exposed to strong winds which can cause noise levels of between 80 and 90 dB(A) over extended durations thus causing events to be triggered. With this in mind, aircraft data has been analysed and is summarised in Table 1.

The noise event features of the CRL 243 allow time histories of individual noise events to be downloaded from the Short Leq store upon request. This enables features of the event to be examined which may not be obvious from corresponding numeric data, for instance whether reverse thrust occurred during landing. Figure 2 shows a comparison of typical time histories for aircraft departing from the new runway; it is interesting to note the similarity between the F27 and B757 traces and the decay patterns for the DC9 and Concorde.

Much environmental data has already been collected at the permanent terminals from which Table 2 summarises monthly average LAeq values over relevant time periods. The results show that, for this airport, there is little difference between 12, 16 and 24 hour LAeq when averaged over a month. Considerable daily variation can exist, however, depending on the frequency of noisy events. This variability is further enhanced at the southern end of the runway due to lower background noise levels as shown in Figure 3.

5. CONCLUSIONS

By extending its main runway, Humberside Airport has taken a significant step towards a prosperous future in the international travel market but residents from the local community are concerned that their quality of life will be diminished as a result. Consequently the district planning authority has paid due attention to these concerns and taken appropriate steps to ensure that mitigation and monitoring of the impact is undertaken by the Airport Authority.

The resultant noise monitoring system has been installed with these aims in mind whilst allowing for practical restrictions imposed by the Airport's size and status. In the short term it is hoped that the presence of such a system will help to reassure members of the public that their concerns have been noted and are being acted upon. It is also envisaged, however, that data collected by the system will eventually be used to justify further expansion and development.

5. ACKNOWLEDGEMENTS

The cooperation of Humberside International Airport Limited in allowing its data to be used for this paper is greatly appreciated by the authors.

5. REFERENCES

[1] Nelson P. "Transportation Noise Reference Book" Butterworths 1987.

[2] Stollery C.P. "Aircraft event detection algorithms implemented in a simple microprocessor" Proc. Internoise, Sydney, Australia. DEC 1991.

[3] Wallis A. & Luquet P. "Noise control applications of Short Leq" Proc. Internoise, Munich, Germany. AUG 1985.

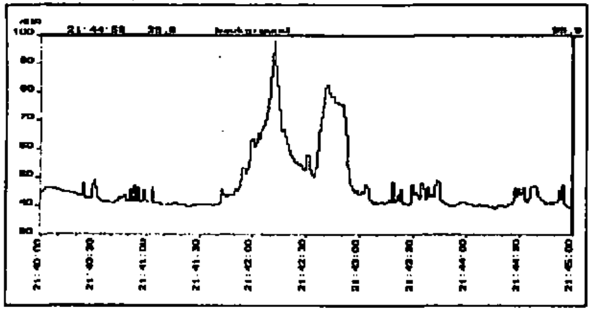
TABLE 1: Summary of aircraft noise event data

Aircraft type	Average Lmax,s dB(A)		Average SEL dB(A)		Average duration above 80 dB(A) seconds	
	Arrival	Departure	Arrival	Departure	Arrival	Departure
Turbo-prop eg F27	89	86	94	90	6	5
Executive-prop eg C421	85	87	88	90	4	4
Executive-jet eg BAe125	91	88	93	93	5	8
B737-200	96	101	101	109	9	28
B737-400	95	92	99	98	8	10
B757	95	89	100	96	9	10
MD83	93	100	97	106	7	15
Concorde	116	118	120	124	18	24
Helicopter eg SK76	86	--	92	--	7	--

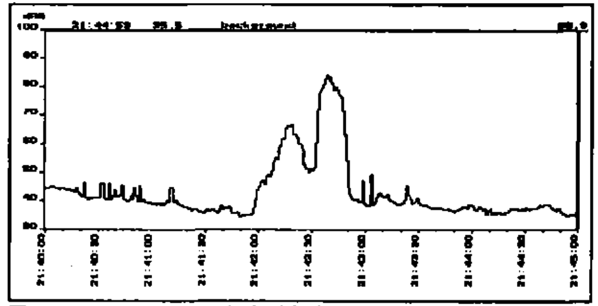
TABLE 2: Comparison of average monthly LAeq measured over different periods.

	Runway 21 NMT (North)				Runway 03 NMT (South)			
	LAeq,12hr (0600-1800) GMT Ave, SD (range)	LAeq,16hr (0700-2300) Local Ave, SD (range)	LAeq,8hr (2300-0700) Local Ave, SD (range)	LAeq,24hr Ave, SD (range)	LAeq,12hr (0600-1800) GMT Ave, SD (range)	LAeq,16hr (0700-2300) Local Ave, SD (range)	LAeq,8hr (2300-0700) Local Ave, SD (range)	LAeq,24hr Ave, SD (range)
Feb 1992	61, 1.9 (57-64)	62, 1.2 (60-63)	55, 2.5 (52-60)	60, 1.1 (58-62)	no data	no data	no data	no data
March 1992	61, 3.2 (53-67)	61, 2.9 (54-66)	55, 5.4 (41-67)	60, 2.8 (54-64)	60, 4.7 (54-68)	60, 4.5 (53-69)	52, 8.6 (36-73)	59, 5.3 (51-70)
April 1992	63, 3.0 (58-71)	62, 2.6 (59-70)	53, 4.4 (43-66)	61, 2.6 (57-69)	61, 5.1 (54-76)	60, 5.0 (54-75)	48, 7.9 (38-71)	59, 5.2 (52-74)
May 1992	58, 1.8 (55-61)	59, 1.5 (57-61)	53, 6.4 (45-64)	58, 1.9 (55-62)	60, 4.2 (54-73)	59, 4.0 (55-72)	49, 8.4 (38-72)	58, 4.3 (53-72)
June 1992	61, 2.0 (58-64)	62, 2.3 (58-65)	54, 6.8 (44-63)	60, 2.4 (56-64)	60, 3.2 (56-65)	60, 2.7 (56-65)	48, 4.4 (41-55)	59, 2.6 (55-63)
Total	61, 3.0	61, 2.7	54, 5.3	60, 2.6	61, 4.8	60, 4.8	50, 8.5	59, 5.1

FIGURE 1: Example of how aircraft noise can be identified using data from the monitoring system



Time history recorded at a permanent NMT showing an MD83 arrival (note the reverse thrust).



The same event recorded with the mobile NMT at a property 650m from the landing threshold (note that the reverse thrust is now predominant).

DATE	START TIME (GMT)	Lmax dBA	SEL dBA	Leq dBA	Leq.n dBA	NxT s	DUR s	TH1 dBA	TH2 dBA	MD s	ST s
Runway 03 NMT											
12/06/92	19:15.17	83.5	84.6	79.8	86.2	1	3	80.0	80.0	3	3
12/06/92	19:30.02	86.0	93.1	83.0	97.0	3	8	80.0	80.0	3	3
12/06/92	19:36.26	83.1	89.5	80.9	85.1	1	3	80.0	80.0	3	3
12/06/92	19:43.33	87.8	94.7	85.6	99.2	4	6	80.0	80.0	3	3
12/06/92	19:54.41	93.5	98.2	89.7	97.0	2	7	80.0	80.0	3	3
12/06/92	20:01.49	88.3	93.6	85.3	98.2	1	7	80.0	80.0	3	3
12/06/92	21:11.59	88.9	93.2	86.1	92.8	2	5	80.0	80.0	3	3
12/06/92	21:42.10	96.2	99.8	91.3	101.4	9	7	80.0	80.0	3	3
12/06/92	21:42.41	81.5	85.2	80.4	90.2	1	3	80.0	80.0	3	3
Mobile NMT											
12/06/92	21:42.16	93.2	90.9	91.0	81.4	4	6	80.0	80.0	3	3
12/06/92	22:34.54	84.4	93.3	82.4	94.8	8	13	80.0	80.0	3	3

Recorded noise events (the MD83 arrival is underlined).

Date	Log No	Time	Mvt	A/D	Airport	Reg No	Type	Pass	Captain
120692	155947	18:37	C	A	HEATHROW	GBAMA	BE20	5	MAUDE
120692	155948	17:30	P/C	D	HUMBERSIDE	GBADE	C150	2	WATSON
120692	155949	18:46	P/C	A	HUMBERSIDE	GBADE	C150	2	WATSON
120692	155950	18:51	P/C	D	HUMBERSIDE	GBCTF	PA28	4	PATIK
120692	155951	19:27	P/C	A	HUMBERSIDE	GBCTF	PA28	4	PATIK
120692	155952	19:56	S	A	TEES-SIDE	GBEMR	F027	17	HILTON
120692	155953	19:50	P/R	A	HIBALDSTOW	GSTAT	C206	1	
120692	155954	20:03	P/R	A	WILLY HOWE	GBBBC	C150	2	HILLICRAMP
120692	155955	19:10	ACC	D	HUMBERSIDE	GBLUP	B365	2	HEATHERALL
120692	155956	19:19	ACC	A	HUMBERSIDE	GBLUP	B365	2	HEATHERALL
120692	155957	19:19	ACC	D	HUMBERSIDE	GBLUP	B365	2	HEATHERALL
120692	155958	19:20	ACC	A	HUMBERSIDE	GBLUP	B365	2	HEATHERALL
120692	155959	19:20	ACC	D	HUMBERSIDE	GBLUP	B365	2	HEATHERALL
120692	155960	19:21	ACC	A	HUMBERSIDE	GBLUP	B365	2	HEATHERALL
120692	155961	19:21	ACC	D	HUMBERSIDE	GBLUP	B365	2	HEATHERALL
120692	155962	20:03	ACC	A	HUMBERSIDE	GBLUP	B365	2	HEATHERALL
120692	155963	20:28	P/R	A	LEEDS/BRAD	GBCOL	C172	1	
120692	155964	20:18	P	D	CLEETON	GBLUP	B365	2	HEATHERALL
120692	155965	20:28	P/R	D	HIBALDSTOW	GSTAT	C206	0	
120692	155966	20:50	S	A	AMSTERDAM	GBLFJ	F027	41	VAISEY
120692	155967	21:11	O	A	CLEETON	GBLUP	B365	4	SHEPHERD
120692	155968	21:12	S	D	TEES-SIDE	GBLFJ	F027	13	VAISEY
120692	155969	21:18	ACC	D	HUMBERSIDE	GBLUP	B365	2	HEATHERALL
120692	155970	21:24	ACC	A	HUMBERSIDE	GBLUP	B365	2	HEATHERALL
120692	155971	21:29	C	D	HEATHROW	GBAMA	BE20	5	
120692	155972	21:44	C	A	TENERIFE	ECFTB	MD83	133	DUQUE
120692	155973	22:56	C	D	TENERIFE	ECFEB	MD83	159	DUQUE

Aircraft Movement Log, the only data not supplied by the noise monitoring terminals.

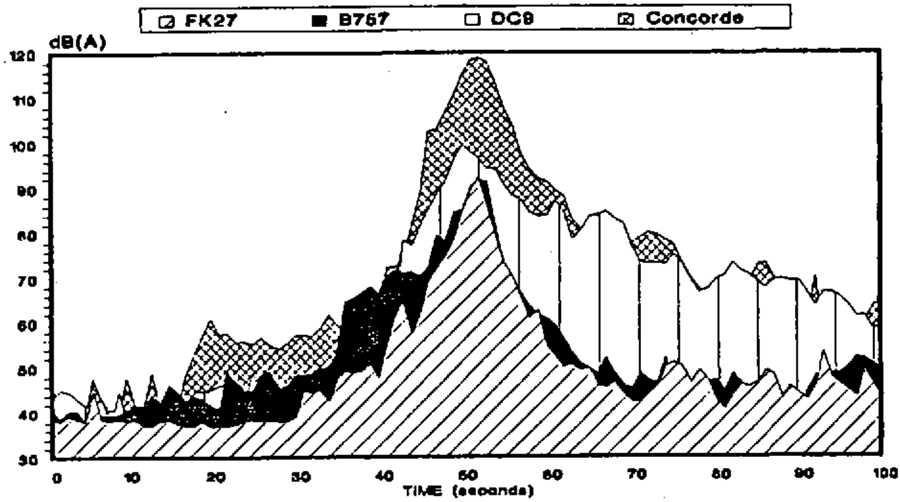


FIGURE 2: Aircraft departures (South NMT)

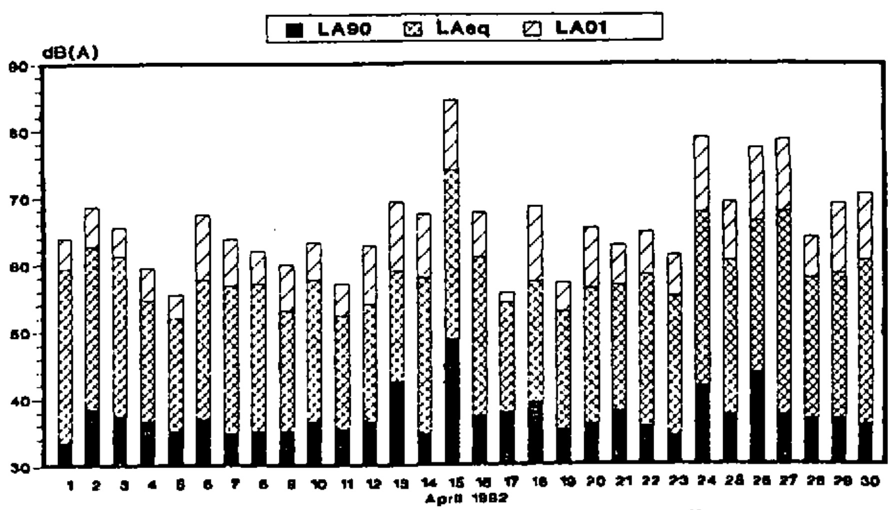


FIGURE 3: Daily average noise levels (South NMT)