NPL REPORT CMAM 68

REPORT

Aircraft Noise at School and Children's Cognitive Performance and Stress Responses (The West London Schools Study)

Aircraft Noise Measurements and Personal Dosimetry

Mark Jiggins & Bernard F Berry

September 2000

NPL National Physical Laboratory

AIRCRAFT NOISE AT SCHOOL AND CHILDREN'S COGNITIVE PERFORMANCE AND STRESS RESPONSES (THE WEST LONDON SCHOOLS STUDY)

AIRCRAFT NOISE MEASUREMENTS AND PERSONAL DOSIMETRY

Mark Jiggins and Bernard F Berry
Centre for Mechanical and Acoustical Metrology
National Physical Laboratory
Teddington
Middlesex

ABSTRACT

This report details the methodology and results obtained for noise measurements undertaken by NPL for the Department of Psychiatry, St Bartholomew's and the Royal London School of Medicine and Dentistry, Queen Mary and Westfield College (QMW) at Mile End London.

The work involved:-

- Selection of schools to take part in the project based on exposure to chronic aircraft noise according to the summer 1997 noise contours, exposure to other external noise sources and whether the school was well insulated against external noise.
- Provision of individual home chronic aircraft noise exposure data according to the summer 1997 noise contours for those children included in the project.
- Measurement of the acute noise exposure of the school during the cognitive testing of the children by QMW.
- Trial of the use of personal dosimetry with school children to assess their noise exposure during time in class.

The results have been used by Queen Mary and Westfield College to assess the effect that chronic exposure to aircraft noise has on children's cognitive performance and stress responses.

NPL Report CMAM 68
Sept 2000

ISSN 1369-6785

National Physical Laboratory
Teddington, Middlesex, United Kingdom, TW11 0LW

Approved on behalf of the Managing Director, NPL,
by Dr G R Torr, Director, Head, Mechanical and Acoustical Metrology

Contents

List of Figures and Tables

List of Appendices & Annexes

1 Introduction

This report details the noise measurements and geographical data manipulation undertaken as part of 'The West London Schools Study - Aircraft Noise at School and Children's Cognitive Performance and Stress Responses'. This work was performed by the National Physical Laboratory (NPL) for the Department of Psychiatry, St Bartholomew's and the Royal London School of Medicine and Dentistry, Queen Mary and Westfield College (QMW).

The overall aim of the project is to assess the effect that chronic exposure to aircraft noise has on children's cognitive performance and stress responses. It has been argued by Berry & Flindell[1] and others that insufficient attention is given to accurate determination of physical exposure in health effect studies hence particular care was taken in this study to ensure that exposure levels were correctly and appropriately monitored. The chronic exposure of the school to noise was assessed using the aircraft noise contours whilst noise monitoring was performed at the school during appraisal of the children's cognitive performance to assess any acute noise exposure. It should be noted that no school is directly referred to by name in this report.

The work performed by NPL for the project was split into a number of components:-

- Selection of schools to take part in the project based on exposure to chronic aircraft noise according to the summer 1997 noise contours, exposure to other external noise sources and whether the school was well insulated against external noise.
- Provision of individual home chronic aircraft noise exposure data according to the summer 1997 noise contours for those children included in the project.
- Measurement of the acute noise exposure of the school during the cognitive testing of the children by QMW.
- Trial of the use of personal dosimetry with school children to assess their noise exposure during time in class.

2 Selection of schools and provision of home noise exposure

To be able to compare schools exposed to high aircraft noise with those exposed to low aircraft noise, exposure values expressed as $L_{Aeq,16hr}$ were obtained for each school using the summer 1997 noise contours published by the Department of the Environment, Transport and the Regions (DETR). Annex 1 describes the methodology used to derive exposure values for each school. Schools were selected as high noise if the exposure was above 63dB $L_{Aeq,16hr}$ and low noise if the exposure was below 57dB $L_{Aeq,16hr}$. Schools were matched by QMW for other non-noise factors to provide categories of schools for study. In each category there were a number of schools to choose from, with the final choice of school aided by data on proximity to other sources of external environmental noise (based on map distances to major roads etc.) and information from the Local Authorities (LA's) as to the state of sound insulation of the schools. Where the school did not have extensive sound insulation and was not exposed to significant external sources other than aircraft, the school was considered for the study.

Initial survey work was performed by the LA's to assess some of the schools' sound insulation and exposure levels where this information was not already available or where more detail was needed. Annex 2 shows the form used during this fieldwork.

20 schools were chosen to take part in the study, 10 with high exposure and 10 with low exposure to noise from aircraft. Table A2 in Annex 1 shows details of the number of schools in the categories of aircraft noise exposure. Annex 1 also fully describes the process used to derive the home noise exposure values for the children who took part in the study.

3 Field measurements

3.1 Requirements & methodology

In each school that participated in the study (exposed to either high or low noise) cognitive testing of the children in one class was performed over a whole morning from around 09:00 to 12:00hrs. During this testing internal and external noise levels were monitored continuously.

Noise data gathered from this exercise provided:-

- Average, minimum and maximum external aircraft SEL's.
- Average, minimum and maximum external SEL's of other sources.
- Hourly values of L_{Amax}, L_{Aeq}, L_{A10}, L_{A90} inside and outside the school.
- An indication of the outdoor to indoor level difference for aircraft noise events.
- Total individual external source levels, cumulative duration and number of events.
- Details of the significant sources of external environmental noise.
- A brief description of the type of building and location.

From the data on the outdoor to indoor level difference it was possible to estimate average SEL's inside the classroom, indicating how the $L_{Aeq,16hour}$ noise contour value relates to the long term indoor noise exposure. See section 3.3.

All indoor/outdoor noise monitoring was performed using a laptop PC based system, Symphonie from the manufacturer 01dB. The arrangement of the equipment is shown in Figure 1. Symphonie allows the use of two channels of acquisition which are completely synchronised, with real time one-third octaves for each channel and digital audio recording of trigger events captured to hard disk. The system was powered by batteries which were charged from the mains supply whilst in use. This gave immunity from any potential data loss due to power line problems. Software modules dBTrig and dBTrait were used for acquisition and post process analysis respectively.

Data was acquired as 'A' weighted and one-third octave spectral parameters from both indoor and outdoor microphones simultaneously at 100 millisecond intervals. Any aircraft noise events occurring during the monitoring were captured as digital audio recordings: these could be replayed during analysis to confirm that noise events were aircraft. Triggering of the audio recording was automated and based on a statistical parameter $L_{99.9,10seconds}$ calculated during acquisition. This parameter is the noise level exceeded for 99.9 percent of the time during a rolling time period of 10 seconds and was found to follow trends in the minimum measured values for the time period. When this statistical parameter exceeded a threshold value then an audio recording was triggered. One second of pre-trigger was used, with the recording stopped after the level dropped back below the threshold. The exact triggering arrangement was tailored at each school to optimise capture of the events with unique values set for the threshold. In some instances a shorter $L_{99.9,5seconds}$ was used, for others a fixed length audio recording was used. Threshold values of between 45 and 55 dB(A) were found to be useful. The audio recordings were 2 channel, indoors and outdoors, but limited to 10kHz bandwidth in order to keep storage requirements to a reasonable minimum. The threshold set for the audio recording was also used to code the stored time history to indicate an aircraft noise event may have occurred.

During data acquisition, signals from either microphone could be monitored using headphones, simplifying the tailoring of the trigger settings. Note was made of the layout of the school, the prevailing weather conditions and the flight path of any aircraft flying nearby for each school visited. Digital photographs were also used extensively to record details of the internal and external microphone locations.

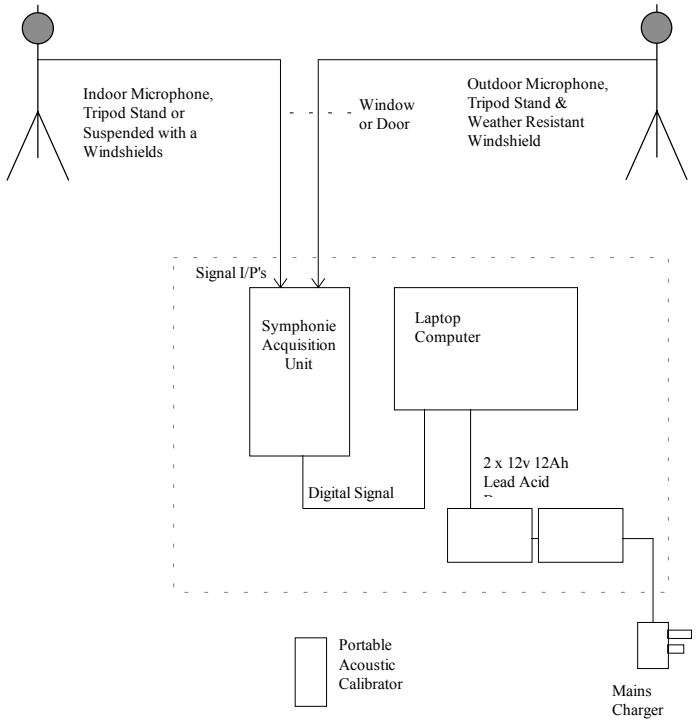


Figure 1 The PC based Symphonie system used for all indoor/outdoor noise monitoring.

The exact positions of the indoor and outdoor microphones were chosen to give representative results in each case with an attempt to get free field locations where possible. What became obvious very early on was that the use of a traditional microphone stand inside a classroom was not always practical. Typically classrooms have desks arranged close together therefore any equipment sited in an acoustically desirable location becomes an obstacle to the normal use of the classroom. In most cases the microphone was suspended from the ceiling by the cable as this proved a practical solution to the problems of floor mounting equipment. The indoor location was chosen to be away from any windows, any doors or the walls of the room. When stand mounted the height was 1.2 to 1.5m above the floor, when suspended the height was approximately 2m above the floor. Appendix 1 shows pictures of the interior of some classrooms and the microphone locations used.

The outdoor microphone position also proved to be problematic. In schools where there was an open space adjacent to the classroom, exposed to similar levels of aircraft noise, this was used for the outdoor microphone. Where such conditions were not met, attempts were made to avoid putting the microphone in any areas accessed by the children by placing the microphone on the roof of the building or on any adjacent raised areas. In one school where this was not possible, metal crowd control barriers were used to fence off an area surrounding the microphone stand. Appendix 2 shows some of the external locations used. In all cases the microphone was mounted on a stand 1.2 to 1.5m high.

Where possible the case housing the Symphonie system was placed at the back or to one side of the classroom, the aim being to avoid the system being a distraction to the children. All cabling

from the two microphones to the system case were routed carefully to avoid creating any tripping hazards. The cable from the outdoor microphone was usually routed through gaps around any doors or windows but in all cases it was the intention, where possible, to leave doors and windows closed if that would normally have been the case.

Both channels of the measurement system were calibrated prior to use using a 01dB CAL01 portable acoustic calibrator. The CAL01 was last calibrated on 10th September 1999 by NPL. Synchronisation of the internal clock of the system to a Rugby radio clock receiver was also performed before each measurement.

3.2 Explanation of Heathrow Airport runway operations

Heathrow Airport has two main runways, 'north' and 'south', both of which run east-west. During the daytime (0700 to 2300) the airport normally operates on what is known as 'Westerly Operations' where aircraft depart to the west and arrive from the east. When wind speeds are higher and blowing from the east then the airport operates on 'Easterly Operations'.

During Westerly Operations the airport alternates between the northern and southern runways with the changeover made at around 1500hrs. The pattern changes each week, so for a whole week of Westerly Operations aircraft will arrive by the southern runway then at 1500hrs change to the northern runway. The following week the pattern changes to arrivals on the northern runway switching to the southern runway at 1500hrs. Aircraft do not necessarily follow this alternation pattern when departing during Westerly Operations but best endeavours are made: generally departures are by the southern runway when arrivals are by the northern and visa versa.

During Easterly Operations all departing aircraft use the southern runway and all arriving aircraft use the northern runway: no alternation pattern is used.

3.2 Data analysis

Once the field work was completed, all of the data was reviewed and manual coding of the aircraft events on both the indoor and outdoor channels performed. This ensured that the coding extended to fully cover the event and to double check that the capture event was an aircraft. At some locations noise events were attributable to other sources such as trains; where present the events were coded separately to provide results for that source. This coding process also allowed elimination of any short term extraneous sources of noise from the final analysis of the event data.

The charts in figures 2 and 3 show data for the same time period from the outdoor and indoor microphones for school BP. The largest noise event in this case was Concorde. Identifying and coding the data as aircraft events on the internal microphone channel was often not possible due to masking noise from inside the classroom. As seen in the chart of figure 3 internal aircraft events are frequently not as obvious as they are in the data from the external microphone.

When assessing the outdoor to indoor level difference it is important for the aircraft noise to dominate the acoustical environment both outside and inside the classroom. This was only possible with those schools exposed to high levels of aircraft noise. After performing a review of the data it was considered necessary to repeat some short term tests of the level difference out of normal school hours at eight of the ten high noise schools. This avoided the inevitable extraneous noise generated during school hours which made the previous data less reliable in this respect. These repeat tests were generally performed between 15:45hrs and 16:30hrs, taking advantage of the noisiest runway operation for each particular school where possible.

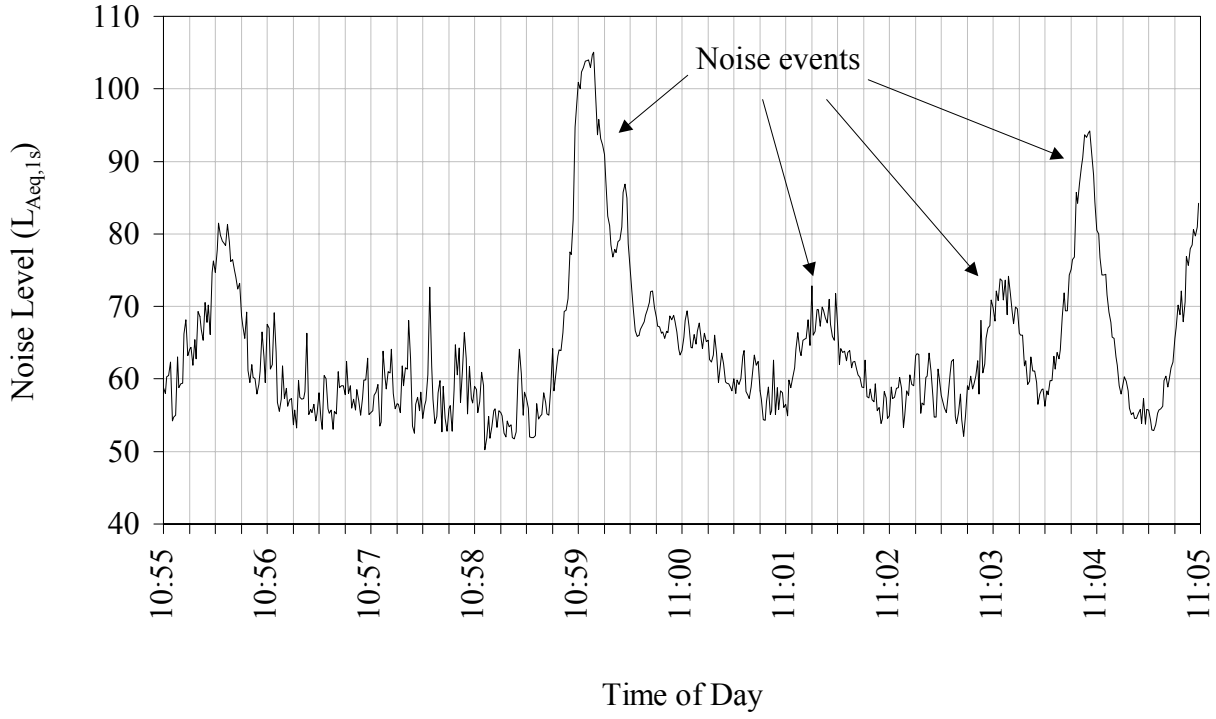


Figure 2 Chart showing an example of aircraft noise events measured outside a school.

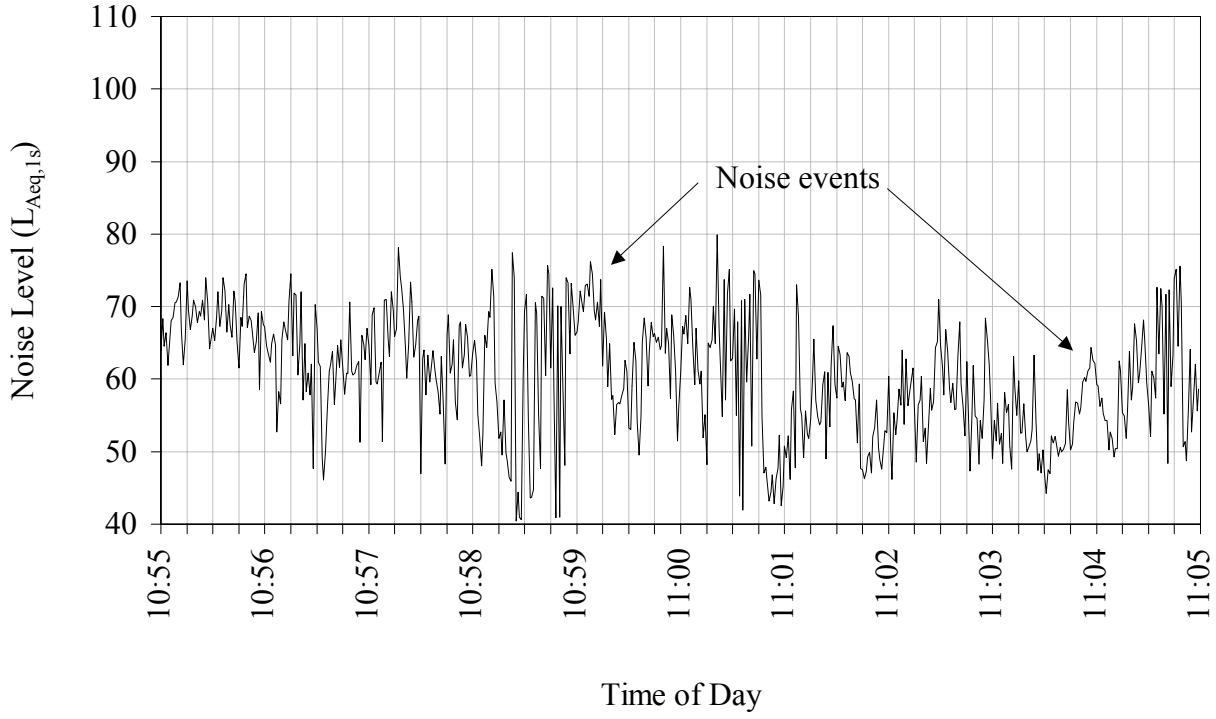


Figure 3 Chart showing an example of aircraft noise events measured inside a school.

3.3 Results

The 01dB software was used to produce various results from the coded acquired data, these are shown as a separate data sheet for each school in sections 3.3.1 to 3.3.20. For each sheet there is information such as the style and layout of the school and classroom, where the school is located in relation to the airport, what flight pattern the airport was using during the measurements and what noise sources were dominant. The data sheets include results from the measurements as:-

External and internal hourly noise levels – these are overall values of the parameters shown including all sources of noise in the indoor and outdoor environments.

Source contributions; outdoors – for each source the data was coded to attribute the corresponding noise levels to the source, the table shows the total overall noise level, the number of instances and the total cumulative duration for each source of noise at the outdoor microphone location.

Outdoor to indoor level difference – where available this shows the average difference between the aircraft SEL noise levels outdoors minus the corresponding indoor values for data from the main study and repeat measurements. For those schools exposed to low levels of aircraft noise there were not sufficient data available to indicate this relationship.

Aircraft event SEL's (Main Study) – Results from the main study giving average, maximum and minimum values of aircraft SEL's measurements outdoors. Calculated indoor average, maximum and minimum values of aircraft SEL's are shown where the indoor to outdoor level difference was available, calculated from the outdoor SEL values minus the level difference with windows closed.

Aircraft event SEL's (Level Difference) – Results from the extra measurements performed at some of the high noise schools; where available this gives average, maximum and minimum values of aircraft SEL's outdoors. These measurements were of a much shorter duration than those in the main study (the total duration is shown in the table).

Table 1 shows calculations using the level difference to relate outdoor noise contour values to indoor values, with windows closed and open, in the high noise schools. For those schools where measurement data was not available for the level difference with windows open the cell in the table is shown dashed. In some schools (high and low noise) windows not open.

There will always be small differences in the sound field within unoccupied rooms when compared to occupied but this was not felt to have affected the level difference results significantly. The frequency content of the aircraft events will, to some extent, affect the measured 'A' weighted internal noise levels at any particular school. Generally, sound insulation values for buildings are poorer at low frequencies, therefore if the aircraft events have more low frequency content but otherwise similar 'A' weighted external noise levels then internal levels would be higher. This may be true of aircraft departures when compared to arrivals but there was insufficient data available in this study to comment on this. Location of the source with respect to the classroom and position of windows/doors etc will also affect the level difference obtained: aircraft taking a slightly different route but otherwise similar in level could produce different results.

Some factors that may effect how noise contour values relate to exposure at the school is time of day and also term time compared with the total calendar period covered by the contours. For

some of the summer the schools close for a long break: this may affect total exposure, for instance, if patterns of flight during this period contributed more to the total exposure than outside this period. The contours are also expressed as an $L_{Aeq,16hr}$ from 0700 to 2300hrs whereas children are at school from around 0900 to 1530hrs. As aircraft flight patterns change throughout the day, due to wind direction, runway alternation etc., exposure values will change, which when averaged over the full 16 hours may give different results than the exposure values for the 6.5 hours the children are at school.

From the results in Table 1 it is clear that there is a wider range of internal noise exposure levels compared with using external contour values alone. This is due mainly to the large differences in the sound insulation performance of the different schools. Where windows are opened for ventilation internal exposure values are higher still, therefore the total range of internal noise exposure across all high noise schools is even greater.

School Code	Outdoor $L_{Aeq,16hr}$	Indoor $L_{Aeq,16hr}$ (windows closed)	Indoor $L_{Aeq,16hr}$ (windows open)
BF	66 - 69	46 – 49 (47.5)	51 – 54 (52.5)
CW	66	46 (46.0)	(2) -
SJ	66 - 69	44 – 47 (45.5)	52 – 55 (53.5)
CJ	63 - 66	44 – 47 (45.5)	49 – 52 (50.5)
WP	63 - 66	36 – 39 (37.5)	53 – 56 (54.5)
PS	69	37 (37.0)	(1) 37 (37.0)
BP	66 - 69	35 – 38 (36.5)	(2) -
HH	66 - 69	32 – 35 (33.5)	(2) -
GR	66 - 69	31 – 34 (32.5)	(2) -
OJ	63 - 66	24 – 27 (25.5)	(2) -

(1 - Fire exit door open only. 2 – No data available)

Table 1 Table of measured outdoor and calculated indoor noise contour values for the high noise schools (rounded to whole decibels). The values in brackets are an average of the shown range. The schools are ranked by the average indoor calculated $L_{Aeq,16hr}$ with windows closed.

Indoors the significance of an aircraft event will to some extent depend on how noisy it is compared to other sounds in the room. At some high noise schools the sound insulation was such that even when directly overflown aircraft did not dominate the internal environment. At other schools, particularly those where windows were opened for ventilation, aircraft were much more significant. At some schools there were other environmental noise sources that contributed to the internal noise environment. Rail noise events were found at schools CW, FJ and most significantly at school SG where rail events were common and the dominant external noise source. For most schools road traffic formed the underlying component of the background noise environment but did not dominate at any location.

When new schools are built the proposed design must meet constructional standards published by the Department for Education and Employment, these specify Design Note 17[2] as the standard for environmental design. This recommends that for normal teaching classrooms, such as those in this study, background noise levels should not normally be above 40dB $L_{Aeq,1hr}$. Where external noises are intermittent, such as for aircraft, then the level from this source should not exceed 55dB L_{01}. The time period is not specified but stated as the period the room is in use e.g. a lesson. It is presumed the testing is to be performed in an unoccupied room. (There are no

current European wide criterion but the subject will be the topic of investigation by International INCE[3]).

Reliable values for L_{A01} were not available for the main study due to the classrooms being occupied. During the repeat visits emphasis was placed on acquiring data to provide outdoor to indoor level differences hence reliable L_{A01} values were again unavailable. An estimate of the values of internal L_{A01} could be obtained from the outdoor L_{A01} minus the level difference but this method is not statistically sound.

In order to provide some form of comparison it is suggested that the predicted $L_{Aeq,16hr}$ values be compared against the 40dB $L_{Aeq,1hr}$. criterion. Although the time periods are different (problems identified above) it is likely that for some of the time $L_{Aeq,1hr}$ values will be higher than the contour values and for some of the time lower therefore this comparison is not without merit. This comparison would therefore reclassify schools BF, CW, SJ, CJ and WP as high noise whereas PS, BP, HH, GR and OJ could be reclassified as low noise.

Table 2 shows the original classification of the schools into either high or low noise exposure along with the categories the school would fall into based solely on the acute external exposure during the measurements. For some high noise schools the exposure was considered low during the cognitive testing but high on the repeat level difference visits. All low noise schools had low exposure to noise. Variation in flight patterns due to weather conditions and runway alternation will result in significant day to day exposure differences for each school.

School Code	Contour	First Visit	Revisit
BF	H	L	H
BP	H	H	-
CJ	H	H	H
CW	H	L	H
GR	H	L	H
HH	H	H	-
OJ	H	L	H
PS	H	H	-
SJ	H	L	H
WP	H	H	H
BJ	L	L	-
FJ	L	L	-
GJ	L	L	-
GP	L	L	-
HJ	L	L	-
JE	L	L	-
LJ	L	L	-
NG	L	L	-
RF	L	L	-
SG	L	$L_{(Trains)}$	-

Table 2 Table showing the schools and their exposure categories according to the noise contours along with the categories of external exposure found during the noise measurements.

Table 3 shows a summary of the aircraft source L_{Aeq} levels from the datasheets shown in Sections 3.3.1 to 3.3.20 with additional data presented on source L_{Aeq} levels from the repeat measurements. The last column shows worst case predicted levels based on the level difference with windows open, where applicable.

School Code		Measurement Duration (hh:mm:ss)	Source Duration (hh:mm:ss)	Number of Events	Source L_{Aeq} Outdoors	Calculated Indoor L_{Aeq} (worst case)
WP	1	02:59:51	00:21:49	41	74.2	64.3
	2	00:23:41	00:04:24	11	72.4	62.5
CJ	1	02:55:27	01:14:35	105	77.9	64.0
	2	00:23:53	00:08:59	15	71.6	57.7
SJ	1	02:35:33	00:46:16	72	55.8	41.6
	2	00:33:19	00:08:07	11	75.2	61.0
CW	1	02:59:53	01:00:11	79	57.1	37.6
	2	00:31:09	00:16:42	20	74.0	54.5
BF	1	03:00:00	00:16:40	46	63.3	48.8
	2	00:23:07	00:06:46	11	67.3	52.8
PS	1	02:58:05	01:25:34	128	84.1	52.4
	2	-	-	-	-	-
BP	1	02:56:03	01:29:30	124	80.0	49.1
	2	-	-	-	-	-
GR	1	02:26:42	01:02:45	85	61.7	26.4
	2	00:10:31	00:04:02	7	77.9	42.6
HH	1	03:00:00	01:24:05	121	72.7	38.7
	2	-	-	-	-	-
OJ	1	02:59:57	01:03:36	82	59.6	20.7
	2	00:15:31	00:06:41	12	72.5	33.6

(1 – Data from first visit. 2 – Data from revisit.)

Table 3 Table of aircraft source L_{Aeq} values from the main study and revisit measurements for each school. Schools are ranked according to internal exposure.

3.3.1 Data set obtained for school: BF

Local Authority: Hounslow ***Noise Category:*** High
Noise contour value: 66 - 69

Short description of the building and it's location:

The classroom was part of the main building and adjacent to a corridor on one side. Door/windows to outside along most of the wall to the opposite side of the room from the corridor. Windows were single glazed metal framed. The classroom was a single storey with a large glass roof light covering 50% of the ceiling area. Ventilation was only achieved by opening the door to the corridor or the door/windows to the outside. The outside area was a grassed courtyard running the length of three adjacent classrooms approximately 60m by 20m. The external microphone was positioned in this courtyard area, the indoor microphone was suspended from the ceiling approximately 2m above the floor. The school was located south of the eastern end of the southern runway. The airport was on Westerly Operations using the southern runway for arrivals during the main study visit and on Easterly Operations with the southern runway used for departures during the extra level difference measurements.

Description of the main sources of external environmental noise during the main study:

Distant traffic noise formed the basis of the noise environment during the main study, aircraft were on arrivals but were not a particularly significant source of noise. Ground based aircraft noise from the airport was also audible. During the revisit aircraft were on departures with levels dominated by aircraft noise. The weather was overcast but clearing, dry with little wind.

Two helicopter noise events were also found at this school with an average, maximum and minimum SEL's of 79.8, 82.9, 76.6 dB(A) respectively.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
16/11/99 09:00:00	57.0	50.1	74.6	52.7	58.7	66.2	36.8	88.7	44.2	68.6
16/11/99 10:00:00	60.0	49.7	91.3	53.1	59.8	63.2	35.9	90.8	42.4	66.3
16/11/99 11:00:00	55.0	48.7	66.4	52.0	57.2	62.9	35.9	86.0	43.2	66.3

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	63.3	46	00:16:40:500
Helicopter	64.9	2	00:01:17:500
Not coded	56.3	47	02:42:02:000
Overall	57.8		03:00:00:000

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	20.1
Open	14.5

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	72.2	50.1
Maximum	90.6	70.5
Minimum	57.6	37.5

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	82.1
Maximum	86.7
Minimum	78.1
Duration	00:23:07

3.3.2 Data set obtained for school: BJ

Local Authority: Hillingdon

Noise Category: Low
Noise contour value: < 57

Short description of the building and it's location:

The classroom was part of the single storey main building. Two adjoining classroom shared a common exit to the corridor on one side whilst the opposite side of both rooms were glazed with single glazed metal frame windows. The two classrooms were partially separated by a wall running part of the way between them, leaving a large opening which resulted in cross-talk between the rooms. Outside the classroom was an open field which was used for the external microphone, the internal microphone was suspended from the ceiling approximately 2m above the floor. Ventilation was achieved by opening windows/doors. The school was located approximately 7-8km to the north east of the airport . The airport was on Westerly Operations using the southern runway for arrivals during the main study visit.

Description of the main sources of external environmental noise during the main study:

Distant traffic along with wind in trees were the main components of the external noise environment. When aircraft noise was present, in many cases it was audible only as a distant rumble with little effect on noise levels; some aircraft events were noisier with Concorde the most dominant aircraft event during the measurements. The weather was cloudy and raining with a moderate to strong wind. There was some wind noise on the microphone which at times effected the measured external noise levels.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
05/11/99 09:00:00	54.8	50.9	71.0	52.9	56.2	61.9	36.6	95.8	42.6	63.1
05/11/99 10:00:00	60.5	50.7	81.6	53.9	58.0	74.8	39.1	97.2	47.5	78.7
05/11/99 11:00:00	56.5	51.7	65.2	54.3	58.0	68.3	37.9	88.3	45.6	71.2

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	68.1	13	00:07:37:000
Not coded	55.6	14	02:39:12:100
Overall	58.1		02:46:49:100

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	-
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	74.9	-
Maximum	94.2	-
Minimum	68.6	-

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.3 Data set obtained for school: BP

Local Authority: Hounslow

Noise Category: High
Noise contour value: 66 - 69

Short description of the building and it's location:

This classroom was separated from a corridor by a washroom/cloakroom, two large windows in one wall were double glazed with a 100mm gap, double doors were fitted on the fire escape to outside. There was also a large glass roof light in the ceiling (glazing construction unknown). The adjacent classroom was accessible by a corrugated metal room separator which had poor sound insulation resulting in cross-talk between the rooms. There were no signs of forced air ventilation and the windows were all sealed. The outdoor microphone was located on the large grass field outside the fire exit with the internal microphone suspended from the ceiling approximately 2m above the floor. The school was located directly east of the airport, roughly half way between the southern and northern runways. The airport was on Easterly Operations using the southern runway for departures during the main study.

Description of the main sources of external environmental noise during the main study:

Aircraft noise dominated the external environment with distant traffic providing the underlying levels when aircraft were not audible. Concorde was the most dominant aircraft event during the measurements. The weather was cloudy, not raining but with wet ground and very little wind.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
22/10/99 09:00:00	74.6	47.3	98.7	50.2	75.4	64.2	31.6	91.4	42.4	65.3
22/10/99 10:00:00	79.4	46.7	108.4	49.6	75.0	62.9	28.0	92.3	41.4	65.2
22/10/99 11:00:00	75.4	45.6	98.0	50.0	74.9	70.1	37.5	95.0	47.7	69.8

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	80.0	124	01:29:30:800
Not coded	56.0	125	01:26:32:800
Overall	77.0		02:56:03:600

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	30.9
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	89.7	58.8
Maximum	113.9	83.0
Minimum	60.7	29.8

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.4 Data set obtained for school: CJ

Local Authority: Hounslow ***Noise Category:*** High
Noise contour value: 63 - 66

Short description of the building and it's location:

The classroom was one of four portacabin units located at the rear of the school on the edge of the playing field. The building was of timber construction with aluminium framed single glazed windows along two opposing sides. No ventilation was provided other than opening windows/doors. The internal microphone was suspended from the ceiling at approximately 1.8m height; the external microphone was positioned on the roof of the classroom due to the playing field being used at break times. The periphery of the field was surrounded on all three sides by large commercial buildings, one of which had a large air handling unit. The school was located directly east of the airport, roughly half way between the southern and northern runways. The airport was on Easterly Operations using the southern runway for departures during the main study and again during the repeat visit for the extra level difference measurements.

Description of the main sources of external environmental noise during the main study:

Traffic noise and the air handling unit formed the underlying background noise level but this was dominated by aircraft noise events when present. The weather was dry and with a light breeze.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
19/10/99 09:00:00	75.9	54.4	105.2	56.9	71.6	68.8	37.0	90.4	45.5	72.5
19/10/99 10:00:00	75.4	55.1	105.6	57.9	72.7	70.1	37.8	90.0	45.6	72.7
19/10/99 11:00:00	71.1	54.2	93.2	57.7	74.5	69.2	39.4	89.9	48.2	72.9

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	77.9	105	01:14:35:000
Not coded	66.6	106	01:40:52:200
Overall	74.6		02:55:27:200

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	19.0
Open	13.9

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	86.8	67.8
Maximum	110.7	91.7
Minimum	79.3	60.3

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	85.8
Maximum	92.2
Minimum	81.9
Duration	00:23:53

3.3.5 Data set obtained for school: CW

Local Authority: Hounslow ***Noise Category:*** High
Noise contour value: 66

Short description of the building and it's location:

This school had classrooms arranged down one side of a long corridor, the other side of each room had single glazed metal frame windows along the whole wall almost to ceiling level. There were single glazed windows onto the corridor; above the corridor roof level there were some smaller high level single glazed windows. No ventilation was provided other than opening windows/doors. Outside the classroom windows was a large tarmac playground area, this was used at break times therefore the external microphone was located on top of a small flat section of the school roof. The internal microphone was suspended from the ceiling at approximately 2m above the floor. The school was located 5 to 6km directly east of the end of the southern runway. During the main study the airport was on Westerly Operations with arrivals on the northern runway, for the extra level difference measurements the school was directly overflown by aircraft as the airport was on Westerly operations with arrivals on the southern runway.

Description of the main sources of external environmental noise during the main study:

The school was exposed to road, rail and aircraft noise: road traffic formed the underlying background noise with event levels due to trains and aircraft. During the main study the aircraft events were not significant whereas during the level difference visit they dominated. Weather conditions were overcast but dry with little wind.

Fifteen rail noise events were found at this school with an average, maximum and minimum SEL's of 73.1, 77.0, 67.9 dB(A) respectively.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
24/11/99 09:00:00	55.8	46.5	77.4	50.1	58.4	62.8	34.5	90.4	42.4	65.3
24/11/99 10:00:00	69.6	46.5	92.9	50.3	73.0	69.2	36.2	91.1	45.1	72.3
24/11/99 11:00:00	56.1	45.6	71.7	49.6	59.2	68.4	37.0	90.1	45.5	72.0

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	57.1	79	01:00:11:300
Train	58.9	15	00:07:08:000
Not coded	67.0	89	01:52:34:100
Overall	65.2		02:59:53:400

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	19.5
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	72.5	53.0
Maximum	84.5	65.0
Minimum	67.1	47.6

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	90.2
Maximum	96.3
Minimum	87.4
Duration	00:31:09

3.3.6 Data set obtained for school: FJ

Local Authority: Hounslow ***Noise Category:*** Low
Noise contour value: < 57

Short description of the building and it's location:

The classroom was located on the first floor of a two storey building, all rooms were arranged along a corridor one side. The other side of the classroom to the corridor had large single glazed metal frame windows along the whole wall extending to ceiling height; these faced a road. The corridor had single glazed wooden framed windows facing the direction of the airport. Above corridor roof level and on the same side as the corridor the classroom had a row of small single glazed windows. No ventilation was provided other than opening windows/doors. The interior microphone was suspended from the ceiling at approximately 2m above the floor, the external microphone was positioned on top of a single storey flat roof extension on the side of the school facing towards the airport. The school was approximately 3km south south east of the end of the southern runway. During the main study the airport was on Westerly Operations with arrivals on the northern runway.

Description of the main sources of external environmental noise during the main study:

The local traffic was the dominant source of background noise, aircraft were audible externally as a distant rumble which caused noise levels to rise. Weather conditions were wet but with rain clearing quickly to sunny intervals; there was little wind.

Two rail noise events were found at this school with an average, maximum and minimum SEL's of 73.4, 74.9, 71.9 dB(A) respectively.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
25/11/99 09:00:00	58.2	50.5	73.5	54.8	60.3	66.7	37.1	84.6	43.5	69.7
25/11/99 10:00:00	69.9	50.2	90.3	54.4	74.1	65.7	31.6	89.5	37.1	69.1
25/11/99 11:00:00	63.4	48.9	88.1	53.0	64.7	66.1	35.5	90.3	42.7	68.8

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	66.1	21	00:21:49:200
Train	60.4	2	00:00:40:200
Not coded	66.4	24	02:29:33:400
Overall	66.3		02:52:02:800

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	-
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	78.2	-
Maximum	96.0	-
Minimum	72.1	-

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.7 Data set obtained for school: GJ

Local Authority: Slough

Noise Category: Low
Noise contour value: < 57

Short description of the building and it's location:

The school was a two storey building with the classroom on the first floor. All rooms were off a corridor to one side and had large single glazed windows to ceiling height on the other, these overlooked a road. No ventilation was provided other than opening windows/doors. The outdoor microphone was located on a flat roof single storey extension out from the corridor side of the school, the indoor microphone was stand mounted at 1.2-1.5m height from the floor. The school was located approximately 10 to 11km north west of the western end of the north runway. The airport was on Westerly Operations with arrivals on the southern runway.

Description of the main sources of external environmental noise during the main study:

Aircraft noise events tended to be either a low rumble or were more dominant when compared to the background noise from the roads in the area. Weather conditions were overcast but dry with light wind.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
02/11/99 09:00:00	49.8	43.0	67.0	45.4	52.2	63.7	33.8	91.6	40.0	66.0
02/11/99 10:00:00	54.3	43.8	80.1	46.4	57.4	63.0	36.0	88.9	42.2	65.8
02/11/99 11:00:00	56.0	43.7	78.9	46.9	57.4	69.1	35.6	90.3	43.9	72.5

Source contributions; outdoors:

	Source Leq	**Count**	**Cumulative Duration**
Plane	58.2	46	00:44:13:700
Not coded	50.1	46	01:55:06:100
Overall	54.1		02:39:19:800

Outdoor to indoor level difference:

Windows/Doors	**SEL Level Difference**
Closed	-
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	**Indoors (Calculated)**
Average	73.1	-
Maximum	84.3	-
Minimum	66.5	-

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.8 Data set obtained for school: GP

Local Authority: Hillingdon

Noise Category: Low
Noise contour value: < 57

Short description of the building and it's location:

The classroom was on the first floor of a two storey school. Windows to the outside were single glazed and overlooked the playground. On the other side of the classroom there was a corridor which had external windows looking onto a courtyard. There were small high level single glazed windows in the classroom above corridor roof level. No ventilation was provided other than opening windows/doors. The school was located approximately 6 to 7km north north east of the eastern end of the north runway. The external microphone was located on the roof of the classroom, the internal microphone was suspended approximately 2m above the floor. The airport was on Westerly Operations with arrivals on the northern runway.

Description of the main sources of external environmental noise during the main study:

Traffic was the main source of external noise with occasional aircraft audible in the distance. The weather was overcast, wet and drizzly with light wind.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
22/11/99 09:00:00	53.3	48.3	67.4	50.7	54.3	61.3	30.4	85.0	38.9	64.3
22/11/99 10:00:00	63.5	48.0	80.9	50.7	68.3	62.5	31.5	86.9	40.5	64.2
22/11/99 11:00:00	51.7	47.0	65.9	49.7	53.2	69.2	41.2	91.4	45.4	71.4

Source contributions; outdoors:

	Source Leq	**Count**	**Cumulative Duration**
Plane	59.1	4	00:02:57:100
Not coded	59.4	5	02:57:02:900
Overall	59.4		03:00:00:000

Outdoor to indoor level difference:

Windows/Doors	**SEL Level Difference**
Closed	-
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	**Indoors (Calculated)**
Average	74.0	-
Maximum	78.9	-
Minimum	68.6	-

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.9 Data set obtained for school: GR

Local Authority: Hounslow ***Noise Category:*** High
Noise contour value: 66 - 69

Short description of the building and it's location:

This was a modern school with double glazed windows and secondary glazed atrium style skylights in the roof. The design was circular with each classroom being a segment. The classrooms were all open to one another via a shared corridor and also dividing walls with large gaps at ceiling height. No ventilation was provided other than by circulation around the open plan design or by opening windows/doors. The school was located 4 to 5km due east of the eastern end of the southern runway. The external microphone was placed on the edge of the pitched roof of the classroom; the internal microphone was suspended at approximately 2m height above the floor. The school had no nearby busy roads and the classroom was at the rear of the school nearest the flight path. The airport was on Westerly Operations arriving on the northern runway until 11:00hrs when it switched to Easterly Operations.

Description of the main sources of external environmental noise during the main study:

Aircraft were visible at a distance arriving and departing with the view obscured by large buildings for part of the flight path. Aircraft dominated the external noise environment when present, otherwise the main component was distant road traffic. The weather was dry but overcast with a light wind: the wind picked up over the course of the measurements and the cloud cleared.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
09/11/99 09:00:00	52.6	43.4	70.0	47.1	55.5	63.1	38.3	88.2	48.9	66.2
09/11/99 10:00:00	58.6	43.2	89.9	45.9	56.0	68.4	38.7	90.2	46.4	72.2
09/11/99 11:00:00	61.7	41.9	82.2	46.7	65.1	69.0	42.4	89.3	52.7	72.5

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	61.7	85	01:02:45:200
Not coded	55.7	85	01:23:57:000
Overall	59.3		02:26:42:200

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	35.3
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	74.6	39.3
Maximum	87.0	51.7
Minimum	65.4	30.1

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	93.6
Maximum	95.7
Minimum	90.7
Duration	00:10:31

3.3.10 Data set obtained for school: HH

Local Authority: Hounslow ***Noise Category:*** High
Noise contour value: 66 - 69

Short description of the building and it's location:

The school had classrooms positioned around central courtyard areas. Around the perimeter of the courtyard was a corridor, with classrooms arranged around the corridor. The other side of the classroom of interest had windows along the whole wall looking out on to the playground. These windows were provided with secondary glazing with a large gap. Forced air ventilation was provided but the secondary glazing was also able to be opened. There were some poorly fitting interconnecting doors between the classrooms allowing some cross-talk. The school was located 3 to 4km due east of the eastern end of the south runway. The courtyard areas were inaccessible to children therefore one was used for the outdoor microphone, the indoor microphone was suspended from the ceiling approximately 2.2m above the floor. The airport was on Westerly operations with arrivals on the southern runway.

Description of the main sources of external environmental noise during the main study:

Aircraft noise dominated the external noise environment when present, traffic on local roads created the underlying background noise level. The forced air ventilation system created a small amount of noise that, when running, may have raised the minimum levels measured on both internal and external microphones. The weather conditions were dry, sunny with little cloud, wet ground and cool.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
18/11/99 09:00:00	69.4	40.6	87.5	44.1	74.3	59.9	36.7	86.6	41.8	62.4
18/11/99 10:00:00	69.8	39.6	93.8	44.2	74.1	63.0	34.2	89.7	41.2	66.6
18/11/99 11:00:00	69.0	39.8	87.7	44.7	73.4	66.2	35.8	85.0	42.4	69.0

Source contributions; outdoors:

	Source Leq	**Count**	**Cumulative Duration**
Plane	72.7	121	01:24:05:700
Not coded	50.1	121	01:35:54:300
Overall	69.4		03:00:00:000

Outdoor to indoor level difference:

Windows/Doors	**SEL Level Difference**
Closed	34.0
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	**Indoors (Calculated)**
Average	88.2	54.2
Maximum	94.5	60.5
Minimum	83.3	49.3

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.11 Data set obtained for school: HJ

Local Authority: Hillingdon

Noise Category: Low
Noise contour value: < 57

Short description of the building and it's location:

This school was a reasonably modern single storey building. The classroom had single glazed aluminium framed windows along one wall to the outside and internal corridors along the two other sides. There was forced air ventilation; the windows did not open. The external microphone was located on the roof as all external ground level areas were accessible by children during break time; the internal microphone was suspended from the ceiling approximately 1.8m above the floor. The school is approximately 14 to 15km north of the airport which was on Westerly Operations with arrivals on the southern runway during measurements.

Description of the main sources of external environmental noise during the main study:

Local traffic and some wind in nearby trees were the main components of the background noise at this location. There were a couple of audible aircraft events but noise levels from this source were not significant and were not coded. Weather conditions were clear and dry with a light to moderate wind.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
17/11/99 09:00:00	50.7	45.4	70.2	48.1	52.3	68.3	31.3	94.7	41.2	70.5
17/11/99 10:00:00	70.0	45.0	96.3	48.0	73.4	63.5	35.1	91.4	43.7	64.2
17/11/99 11:00:00	63.4	45.2	88.2	47.9	61.0	70.1	33.4	95.5	43.8	73.2

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	0	0	00:00:00:000
Not coded	66.4	1	02:49:03:000
Overall	66.4		02:49:03:000

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	-
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	-	-
Maximum	-	-
Minimum	-	-

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.12 Data set obtained for school: JE

Local Authority: Slough

Noise Category: Low
Noise contour value: < 57

Short description of the building and it's location:

The classroom was on the first floor of a two storey school with all windows double glazed. There was a corridor on the opposite side to the windows with further windows overlooking a flat roof on which the external microphone was located. The internal microphone was suspended from the ceiling approximately 1.8m above the floor. Opening windows was the only form of ventilation. The school was approximately 9 to 10km west north west of the western end of the north runway. The airport was on Westerly Operations with arrivals on the southern runway.

Description of the main sources of external environmental noise during the main study:

The background noise consisted of local traffic, some construction noises from a site nearby but aircraft only audible as a distant rumble. Concorde was one of the few significant aircraft noise events. Wind noise on the microphone was also a significant source of noise. Weather conditions were dry and clear with a moderate to fresh wind.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
18/10/99 09:00:00	54.9	33.3	90.1	49.5	56.5	61.5	32.7	89.4	38.9	64.9
18/10/99 10:00:00	56.8	47.1	75.9	50.1	59.7	62.6	29.2	85.0	38.0	65.7
18/10/99 11:00:00	56.3	46.3	77.7	49.6	59.3	64.7	30.0	87.7	39.0	68.8

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	62.6	4	00:03:56:700
Not coded	55.7	5	02:49:51:100
Overall	56.1		02:53:47:800

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	-
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	76.7	-
Maximum	84.6	-
Minimum	70.0	-

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.13 Data set obtained for school: LJ

Local Authority: Slough

Noise Category: Low
Noise contour value: < 57

Short description of the building and it's location:

The school was of modern single storey construction with the classroom of interest having single glazed aluminium framed windows looking onto a playground on one side. Two classrooms and a study area formed an open plan arrangement. Opening windows was the only form of ventilation. The external microphone was located in the playground whilst the internal one was stand mounted at the front of the classroom. The school was approximately 9 to 10km west north west of the western end of the north runway. The airport was on Easterly Operations

Description of the main sources of external environmental noise during the main study:

Local traffic was the main source of external background noise with some noise from wind in nearby trees also; only two aircraft events were audible. A road not far from the school was being resurfaced during the measurements, the noise from this operation contributed to the external noise environment. The weather was wet, with rain and light winds.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
21/10/99 09:00:00	58.5	49.6	76.7	52.1	62.5	64.5	31.4	86.3	43.0	67.9
21/10/99 10:00:00	52.3	46.8	66.3	49.3	54.4	65.4	36.0	86.0	46.9	68.2
21/10/99 11:00:00	52.2	46.1	79.2	48.9	53.5	69.4	36.0	88.4	48.2	72.4

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	58.7	2	00:01:11:400
Not coded	55.4	3	02:58:48:600
Overall	55.4		03:00:00:000

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	-
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	74.2	-
Maximum	75.3	-
Minimum	73.1	-

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.14 Data set obtained for school: NG

Local Authority: Hounslow

Noise Category: Low
Noise contour value: < 57

Short description of the building and it's location:

The school was a single storey building with mostly flat roofs. The classroom had single glazed metal frame windows covering most of the wall area on one side of the classroom. The windows overlooked the play area and out to a nearby local road. Ventilation was provided by opening the windows. The internal microphone was suspended from the ceiling approximately 2m above the floor whereas the external microphone was located outside the classroom windows away from the building on a grassed area. The school was less than 1km from the M4 motorway and approximately 4km east north east of the eastern end of the north runway. The airport was on Westerly Operation with arrivals on the southern runway.

Description of the main sources of external environmental noise during the main study:

Distant and local traffic were the main components of background noise; two aircraft events were audible but were not a significant source. The weather was overcast but dry with little wind.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
08/11/99 09:00:00	58.4	45.6	78.2	51.3	61.5	59.1	31.1	85.6	38.1	60.9
08/11/99 10:00:00	58.0	43.8	82.4	49.6	60.3	63.0	30.8	83.9	37.3	65.5
08/11/99 11:00:00	68.0	43.8	95.5	50.7	71.9	60.4	31.3	85.4	41.0	63.5

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	60.7	2	00:00:35:000
Not coded	64.1	3	02:59:25:000
Overall	64.1		03:00:00:000

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	-
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	73.2	-
Maximum	74.0	-
Minimum	72.4	-

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.15 Data set obtained for school: OJ

Local Authority: Hounslow ***Noise Category:*** High
Noise contour value: 63 - 66

Short description of the building and it's location:

This school was a relatively modern single storey flat roof design with classrooms provided with forced air ventilation and no opening windows. All doors to the exterior had double doors with lobbies and the majority of the windows were double glazed with a large 300mm air gap. The classroom of interest was separated from the corridor by a corrugated partition. The internal microphone was suspended from the ceiling approximately 1.8m above the floor. The external microphone was located on the roof as external areas were all accessible by children during break times. The school was approximately 4 to 5km due east of the eastern end of the southern runway. The airport was on Westerly Operations arriving on the north runway during the main study visit and arriving on the southern runway during the repeat visit for the extra level difference measurements.

Description of the main sources of external environmental noise during the main study:

Distant traffic and aircraft were the main components of the external noise at this school, however the external microphone location may also have been exposed to a small amount of noise from the school's air handling unit, possible affecting the minimum values measured. Weather conditions were overcast, cool and dry with little wind.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
23/11/99 09:00:00	58.8	54.1	84.6	55.8	60.5	63.7	33.5	91.3	39.6	65.4
23/11/99 10:00:00	71.4	54.4	90.0	56.4	76.0	59.8	32.7	86.8	38.1	60.1
23/11/99 11:00:00	62.1	53.7	84.3	55.7	61.1	64.6	34.6	88.8	40.2	67.9

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	59.6	82	01:03:36:800
Not coded	68.9	83	01:56:21:100
Overall	67.3		02:59:57:900

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	38.9
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	76.0	37.1
Maximum	80.0	41.1
Minimum	71.8	32.9

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	85.8
Maximum	89.9
Minimum	71.3
Duration	00:15:31

3.3.16 Data set obtained for school: PS

Local Authority: Slough ***Noise Category:*** High
Noise contour value: 69

Short description of the building and it's location:

A modern single storey annex to the main school with particular attention paid to sound insulation in the main and annex buildings. The classroom of interest was one of two in this annex having double glazed sealed windows that did not open and forced air ventilation, although with only a single door fire exit. The external microphone was located on a grassed area to the rear of the annex whilst the internal microphone was suspended from the ceiling approximately 2m above the floor. The school was approximately 1.5km west of the western end of the north runway. The airport was on Westerly Operations with arrivals on the southern and departures on the northern runways.

Description of the main sources of external environmental noise during the main study:

Aircraft noise dominated the external environment with some lorry events from a nearby freight yard. The M25 motorway was ½km away and so this will probably have provided the minimum measured noise levels. Weather conditions were dry and fine with no wind.

Seven lorry noise events were found at this school with an average, maximum and minimum SEL's of 76.3, 77.2, 75.2 dB(A) respectively.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
04/11/99 09:00:00	74.2	49.4	96.9	53.9	77.0	61.6	37.8	86.0	41.6	64.3
04/11/99 10:00:00	84.5	49.6	114.2	53.0	77.6	63.7	34.8	85.9	41.5	66.0
04/11/99 11:00:00	77.5	52.1	100.1	55.3	78.0	69.1	35.6	91.2	44.3	71.8

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	84.1	128	01:25:34:800
Lorry	64.5	7	00:01:47:400
Not coded	58.6	135	01:30:43:000
Overall	80.9		02:58:05:200

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	31.9
Open (door only)	31.7

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	92.3	60.4
Maximum	119.6	87.7
Minimum	78.1	46.2

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.17 Data set obtained for school: RF

Local Authority: Hillingdon

Noise Category: Low
Noise contour value: < 57

Short description of the building and it's location:

A reasonably modern construction single storey school building. The classroom of interest had single glazed metal frame windows forming the whole of two opposing walls, one looked out onto the school car park, the other onto a small courtyard. The classroom was open plan with a corridor that ran through the room from one side to the other. The external microphone was located on the roof and the internal microphone suspended from the ceiling approximately 2m above the floor. Ventilation was by opening windows. The school was located 4 to 5km north north east of the western end of the northern runway. The airport was on Westerly Operations with arrivals on the northern runway.

Description of the main sources of external environmental noise during the main study:

Background noise levels came mainly from distant traffic and wind in trees. There were two audible aircraft events one of which was Concorde. Weather conditions were bright with a little cloud and moderate winds. There was some influence on the outdoor microphone due to wind noise.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
19/11/99 09:00:00	55.1	50.6	76.4	52.7	56.4	67.5	35.0	90.6	43.2	70.3
19/11/99 10:00:00	57.4	50.7	71.3	53.0	60.1	67.3	30.7	92.6	39.4	69.6
19/11/99 11:00:00	55.6	50.2	80.1	52.4	57.2	71.4	36.6	96.8	45.1	74.7

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	62.4	2	00:01:59:100
Not coded	56.0	3	02:43:52:100
Overall	56.2		02:45:51:200

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	-
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	78.5	-
Maximum	82.6	-
Minimum	74.3	-

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.18 Data set obtained for school: SG

Local Authority: Hounslow ***Noise Category:*** Low
Noise contour value: < 57

Short description of the building and it's location:

This school was an older style two storey building with high ceilings and large single glazed windows. The classroom was on the ground floor with a corridor to one side and windows overlooking the playground on the other. Beyond the playground was a railway line with a construction site on the far side. Ventilation was by opening windows. The indoor microphone was suspended from the ceiling approximately 2.5m above the floor; the outdoor microphone was located in the playground. The school was approximately 10 to 11km east of the eastern end of the north runway. The airport was on Easterly Operations.

Description of the main sources of external environmental noise during the main study:

The underlying background noise was composed mainly of distant traffic, although background levels were significantly influenced during the visit by noise from the construction site. Aircraft noise was not a significant source at this school whereas rail noise dominated when present. Helicopters movements were also found. Weather conditions were dry and overcast with a light wind.

Twenty five train noise events were found at this school with an average, maximum and minimum SEL's of 86.9, 95.8, 79.9dB(A) respectively. Two helicopter noise events were found with an average, maximum and minimum SEL's of 86.0, 86.5, 85.0 9dB(A) respectively.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
11/11/99 09:00:00	63.4	53.5	85.1	56.5	62.3	65.0	37.8	89.9	45.7	67.8
11/11/99 10:00:00	80.8	53.2	107.8	56.5	80.5	66.7	35.8	92.5	44.1	68.9
11/11/99 11:00:00	66.9	54.0	89.7	57.2	66.7	69.2	37.8	90.4	47.9	72.7

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	66.4	5	00:01:39:300
Train	75.9	25	00:08:18:400
Helicopter	72.7	2	00:00:42:000
Not coded	76.4	33	02:49:03:300
Overall	76.3		02:59:43:000

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	-
Open	-

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	79.0	-
Maximum	81.2	-
Minimum	74.7	-

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	-
Maximum	-
Minimum	-
Duration	-

3.3.19 Data set obtained for school: SJ

Local Authority: Hounslow

Noise Category: High
Noise contour value: 66 - 69

Short description of the building and it's location:

The classroom was one of four portacabins sited in the school playing field. The building was of all wooden construction, flat roofed with single glazed wooden framed windows. Ventilation was achieved by opening the door or windows. The indoor microphone was suspended from the ceiling approximately 1.8m above the floor; the outdoor microphone was located in the playing field away from the buildings. The school was approximately 3 to 4km due east from the eastern end of the north runway. During the main study the airport was on Westerly Operations with arrivals on the southern runway, for the extra level difference measurements the school was overflown by some departing aircraft as the airport was on Easterly operations.

Description of the main sources of external environmental noise during the main study:

Distant traffic noise was the main underlying noise source with levels raised marginally by regular aircraft events. The weather was dry and overcast with a light wind.

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
01/11/99 09:00:00	54.2	48.7	66.5	51.1	56.5	69.0	37.8	92.4	46.6	71.7
01/11/99 10:00:00	54.2	47.0	69.5	50.1	56.7	67.2	36.6	89.1	43.6	67.8
01/11/99 11:00:00	54.1	48.0	71.7	50.7	56.3	60.5	37.2	87.5	42.5	62.9

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	55.8	72	00:46:16:400
Not coded	53.3	72	01:49:16:600
Overall	54.2		02:35:33:000

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	22.1
Open	14.2

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	71.1	49.0
Maximum	75.6	53.5
Minimum	64.0	41.9

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	87.0
Maximum	99.5
Minimum	77.7
Duration	00:33:19

3.3.20 Data set obtained for school: WP

Local Authority: Hounslow

Noise Category: High
Noise contour value: 63 - 66

Short description of the building and it's location:

The classroom was one of five portacabins located in the playground of the school and was of wooden construction, flat roofed with aluminium framed single glazed windows down two sides. Ventilation was only possible by opening windows/doors. The outdoor microphone was located on the roof of the classroom with the internal microphone suspended from the ceiling approximately 1.8m above the floor. The school was located 4 to 5km east of the eastern end of the north runway. The airport was on Easterly Operations during the main study, for the extra level difference measurements the airport was on Westerly Operations with arrivals on the northern runway, therefore the school was overflown by arriving aircraft.

Description of the main sources of external environmental noise during the main study:

Road traffic on the road running past the front of the school was the most common component of the external noise environment, aircraft do dominate noise levels when present. Weather conditions were wet with light rain which cleared towards the end of the visit.

One helicopter noise event was found at this school with an SEL of 87.3 dB(A).

External and internal hourly noise levels:

	Outdoors					Indoors				
Period Start	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**	**Leq**	**Lmin**	**Lmax**	**L90**	**L10**
10/11/99 09:00:00	66.8	52.0	92.8	57.3	68.9	67.8	32.3	94.5	43.5	70.0
10/11/99 10:00:00	69.9	52.3	90.9	57.5	73.0	64.8	33.8	88.4	44.5	67.1
10/11/99 11:00:00	68.6	52.2	92.6	57.0	69.1	68.1	35.2	88.1	44.8	71.5

Source contributions; outdoors:

	Source Leq	Count	Cumulative Duration
Plane	74.2	41	00:21:49:100
Helicopter	75.5	1	00:00:15:100
Not coded	66.6	43	02:37:47:600
Overall	68.6		02:59:51:800

Outdoor to indoor level difference:

Windows/Doors	SEL Level Difference
Closed	26.9
Open	9.9

Aircraft event SEL's (Main Study):

	Outdoors (Actual)	Indoors (Calculated)
Average	85.9	59.0
Maximum	99.0	72.1
Minimum	80.6	53.7

Aircraft event SEL's (Level Difference):

	Outdoors (Actual)
Average	85.8
Maximum	89.1
Minimum	82.5
Duration	00:23:41

4 Trial of personal dosimetry

4.1 Requirements & methodology

The use of personal dosimetry is widespread in assessing exposure to noise at work, less so for personal exposure during non-work related periods. In order to assess the usefulness of this technique and the instrumentation available a trial was performed during some of the visits to the schools. The Head teacher was asked to select two pupils, one male and one female, who were likely to act responsibly if asked to wear a dosimeter. These children were in the same year as those taking part in the main study but were exposed to noise from a typical class day rather than the less usual activities during the cognitive testing. The dosimeters were worn during the same period as the noise monitoring performed for the main study giving parallel data from the instruments.

The instruments used were a pair of CEL 460 logging dosimeters set up to acquire one second values of L_{Aeq} & L_{AMax} for the whole duration. The dosimeters were calibrated before and after use to ensure proper operation of the microphone system. The body of the device was clipped to the child's belt with the microphone attached to clothing at shoulder level. Each child was asked not to let their classmates shout into the microphone, to try and forget they are wearing it and most importantly told that it would not be recording what they said, only measuring noise levels. The class teacher was made aware in all cases that the children were wearing the devices. Small manufacturer supplied windshields were taped on to the microphones to afford some protection against knocks.

4.2 Results

Table 3 shows the results obtained from the dosimeters as hourly $L_{Aeq's}$ and a total $L_{Aeq,3hr}$ value for each subject. From these results it is clear the noisiest period was between 10am and 11am for each school covering the time when the children were at morning break. The data indicates that although children were in both high and low exposed schools this didn't result in higher or lower total exposure to noise.

School	School	A			B			A	B
Code	Exposure	*9 - 10*	*10 - 11*	*11 - 12*	*9 - 10*	*10 - 11*	*11 - 12*	*3hr*	*3hr*
BF	***High***	75.0	87.8	77.5	70.0	86.6	74.1	83.6	82.2
CW	***High***	74.7	83.7	76.5	73.9	81.6	75.9	80.2	78.4
HH	***High***	69.6	88.7	76.8	70.8	90.4	75.3	84.3	86.1
OJ	***High***	67.7	83.4	75.9	76.3	88.8	83.8	79.8	85.7
FJ	***Low***	78.3	86.6	83.8	76.6	85.5	86.4	84.1	84.3
GP	***Low***	75.5	88.4	66.9	69.2	89.9	66.3	84.0	85.4
HJ	***Low***	74.4	84.2	78.0	76.0	85.2	80.4	80.8	82.1
RF	***Low***	75.8	87.2	78.5	74.1	87.9	75.5	83.3	83.6

Table 4 Table of $L_{Aeq,1hr}$ personal dosimetry values for subject A and B at each school during the periods 0900 to 1200hrs along with their total $L_{Aeq,3hr}$ exposure.

The chart in figure 4 shows a more detailed time history of $L_{Aeq,10second}$ noise levels for subject A at the school HH. During the morning break period noise levels exceeded 95dB(A) at times whilst in normal lesson time levels were generally less, varying between around 50 to 80dB(A).

The general pattern of noise exposure shown in Figure 4 was found to be similar for all subjects, with highest levels measured during the break times and lower levels during the lesson times.

If the hourly results for the dosimetry are compared to those from the main study the results suggest that noise levels in a classroom sitting a normal lesson are higher than those for the class performing the cognitive testing. It should be noted that the hour from 10am to 11am cannot be directly compared as some of the time the dosimeter measured levels in the playground and for the same period the data from the main study had no children in the classroom. This comparison assumes that there is some direct relationship between levels measured with a dosimeter and those measured at a standard microphone location, though in this study it was not possible to comment on the exact relationship between the microphones locations as different rooms were used. However, it is highly likely that there is a direct relationship though dosimeter levels could well be higher than those from a standard microphone location assuming the children themselves are a major noise source and the dosimeter microphone is located closer to them. The higher results obtained could either be due to the dosimeter being closer to the source or that the activities and consequent classroom noise levels were higher than those in the room where the cognitive testing took place.

Figures 5 and 6 show charts of the noise level inside and outside the classroom at the same school as the subject data is shown in figure 4. The chart in figure 6 has a small rise in minimum levels between 10:30 and 11:00hrs which corresponds with the morning break period and has associated high noise levels recorded by the dosimeter shown on the chart of figure 4. The high level short duration noise events in figure 6 are aircraft; the noise level of these events does not appear to be significant compared to the levels the child was exposed to in the playground for the same period.

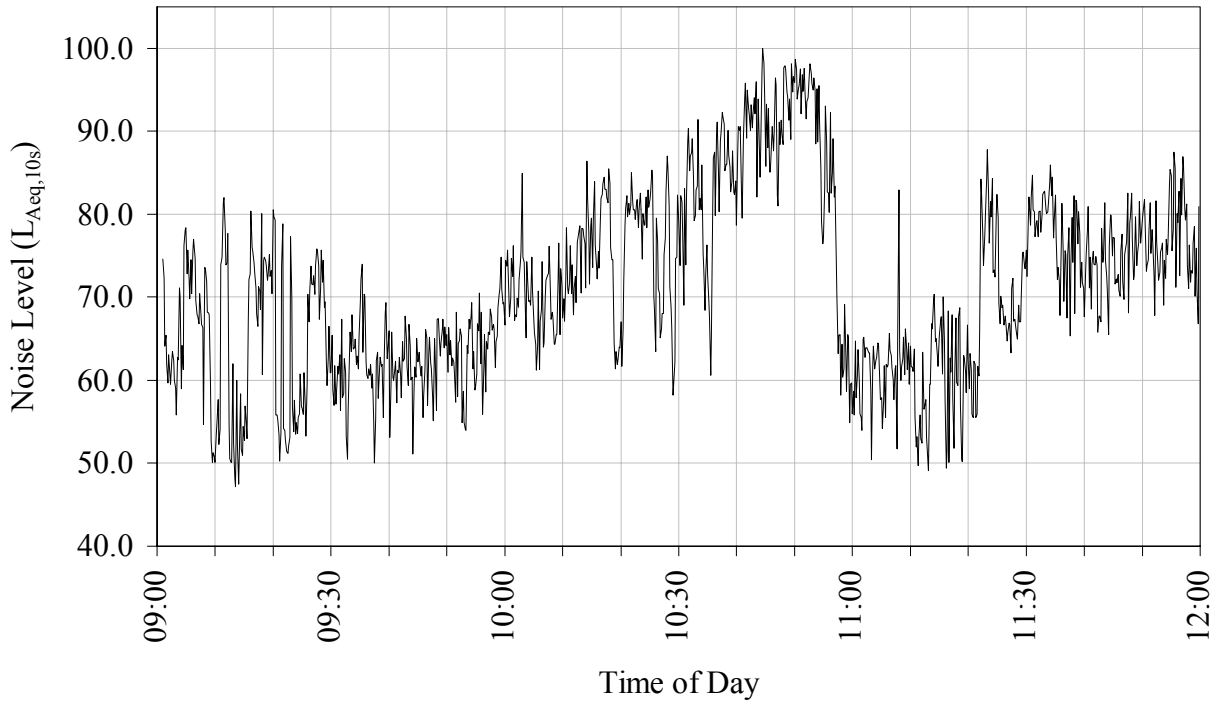


Figure 4 Chart showing $L_{Aeq,10s}$ personal exposure levels for subject A at school HH.

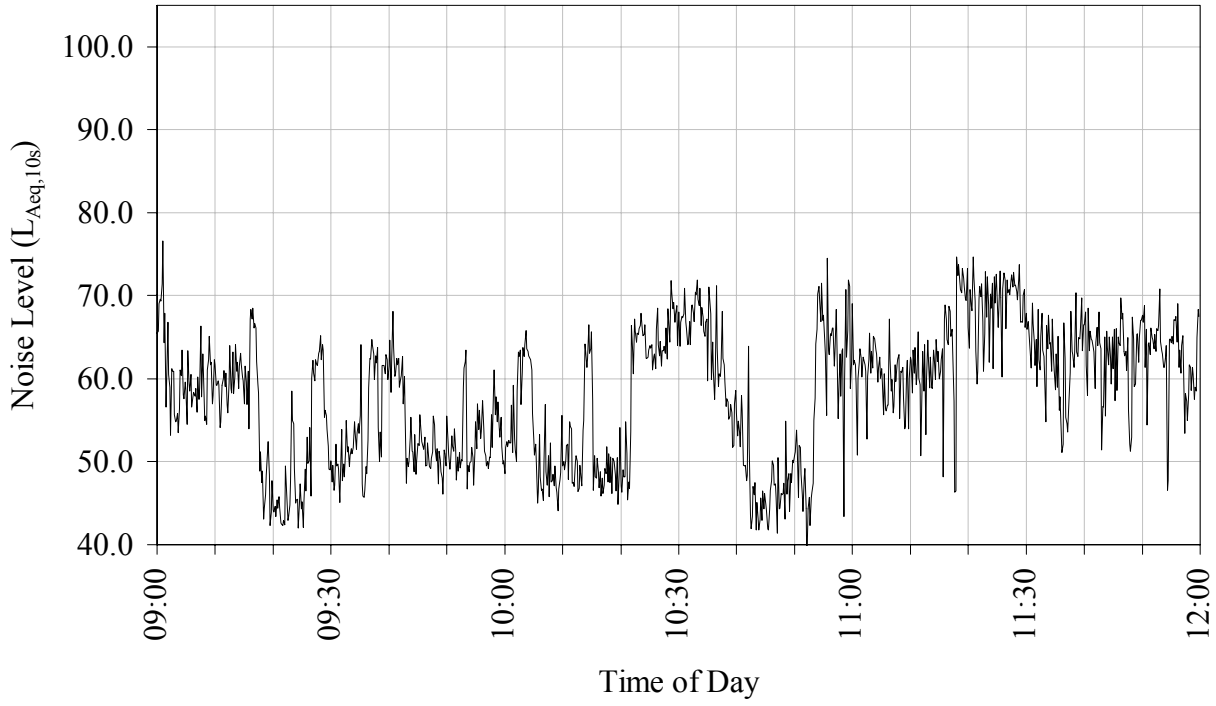


Figure 5 Chart showing $L_{Aeq,10s}$ noise levels inside the classroom at school HH. (note: this is a different classroom to that of the subject of Figure 4)

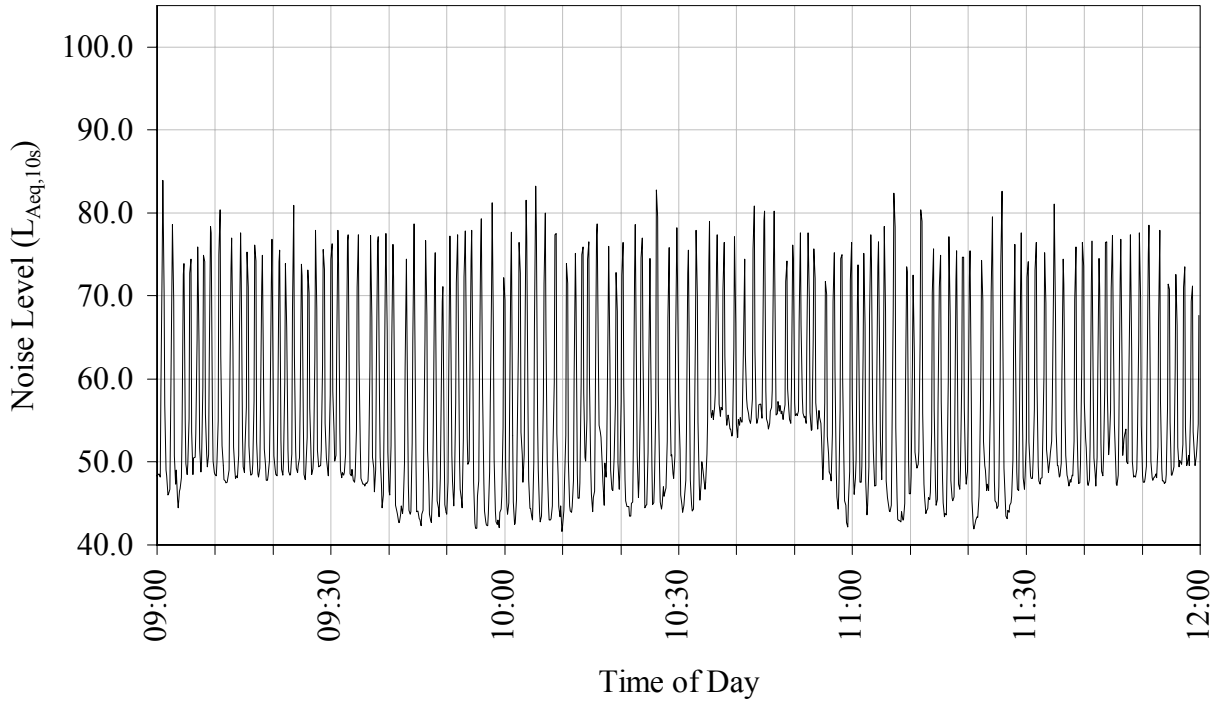


Figure 6 Chart showing $L_{Aeq,10s}$ noise levels outside the school HH.

5 Conclusions and Recommendations

5.1 Conclusions

Selection of schools to take part in the project was performed with 20 schools used for cognitive testing. Summer 1997 aircraft noise contour values were provided for each school as well as home exposures for each pupil taking part.

Measurements were made of the acute noise exposure of the 20 schools during the cognitive testing of the children. A two channel measurement system was used to monitor the indoor and outdoor environments yielding the following results:

- Average, minimum and maximum external aircraft SEL's.
- Average, minimum and maximum external SEL's of other sources.
- Hourly values of L_{Amax}, L_{Aeq}, L_{A10}, L_{A90} inside and outside the school.
- An indication of the outdoor to indoor level difference for aircraft noise events.
- Total individual external source levels, cumulative duration and number of events.
- Details of the significant sources of external environmental noise.
- A brief description of the type of building and location.

Calculation of internal noise contour values based on the outdoor to indoor level difference proved instructive, enabling ranking of the schools by internal exposure. Although measurements were made of the acute exposure during cognitive testing this should not necessarily be used to infer levels of chronic exposure. The changing patterns of runway use mean this relationship is complex and the calculated internal exposure based on the external contour values is the best estimate of the long term exposure of the children to aircraft noise in the classroom.

Internal noise levels in the classroom were often dominated by noise from within the classroom in all but the most highly exposed schools and in this respect of particular note was the poor sound insulation of portacabin style school buildings, especially with open windows. In those schools where good levels of sound insulation were found provision was often made for ventilation by means other than opening windows, this ensures the benefit of the good sound insulation is available all year.

The data obtained confirms that the schools classified as high noise were actually exposed to high levels of aircraft noise. For those schools exposed to high noise levels it would be reasonable to expect there to be an effect on learning and the cognitive performance of the children. At the most simplistic level interference with speech is possible at some schools which will clearly impact upon teaching efficiency for some lesson types.

A trial was undertaken of the use of dosimetry for measuring the personal noise exposure of children when at school. This demonstrated that personal dosimetry of children was a practical possibility; the devices were robust due to their intended use in industrial workplace environments, the keypad was locked to prevent tampering and with those particular units detailed noise level data was obtained for small time intervals of one second. No problems were perceived in getting the children to wear the units and fitting was straightforward.

The results of the dosimetry sub-sample do not indicate differing personal exposure to noise for children attending high or low noise exposed schools.

The results obtained suggest that dosimetry could play an important role in future assessment of true personal exposure to environmental noise sources when used in conjunction with the more usual microphone locations. This technique allows the assessment of exposure as the subject moves into differing noise environments, in this case for example, when the children were outside.

5.2 Recommendations

When undertaking noise measurements in and around schools special consideration must be given to the unique problems that may be encountered, such as ensuring that microphone positions are representative whilst keeping equipment out of the way of normal classroom activities. In this respect ceiling mounting of the internal microphone and roof locations for the external microphone were found to offer the best compromises.

Further research is needed to compare results from static microphones with those from dosimeters worn by children when measuring in the same room. This type of investigation should be attended or watched to find out if the dosimeter wearer attracts attention as this might affect measured levels.

If personal dosimetry is to be used for assessment of exposure to environmental sources then the facility to record a detailed profile of the time history of noise levels is considered essential.

The initial results of this study have been presented at Internoise 2000 as a paper entitled "Aircraft noise at school and child performance and health: initial results from the West London Schools Study" by QMW. A full report will be submitted by QMW to the Department of Health on completion of the project. A publication for peer review is required.

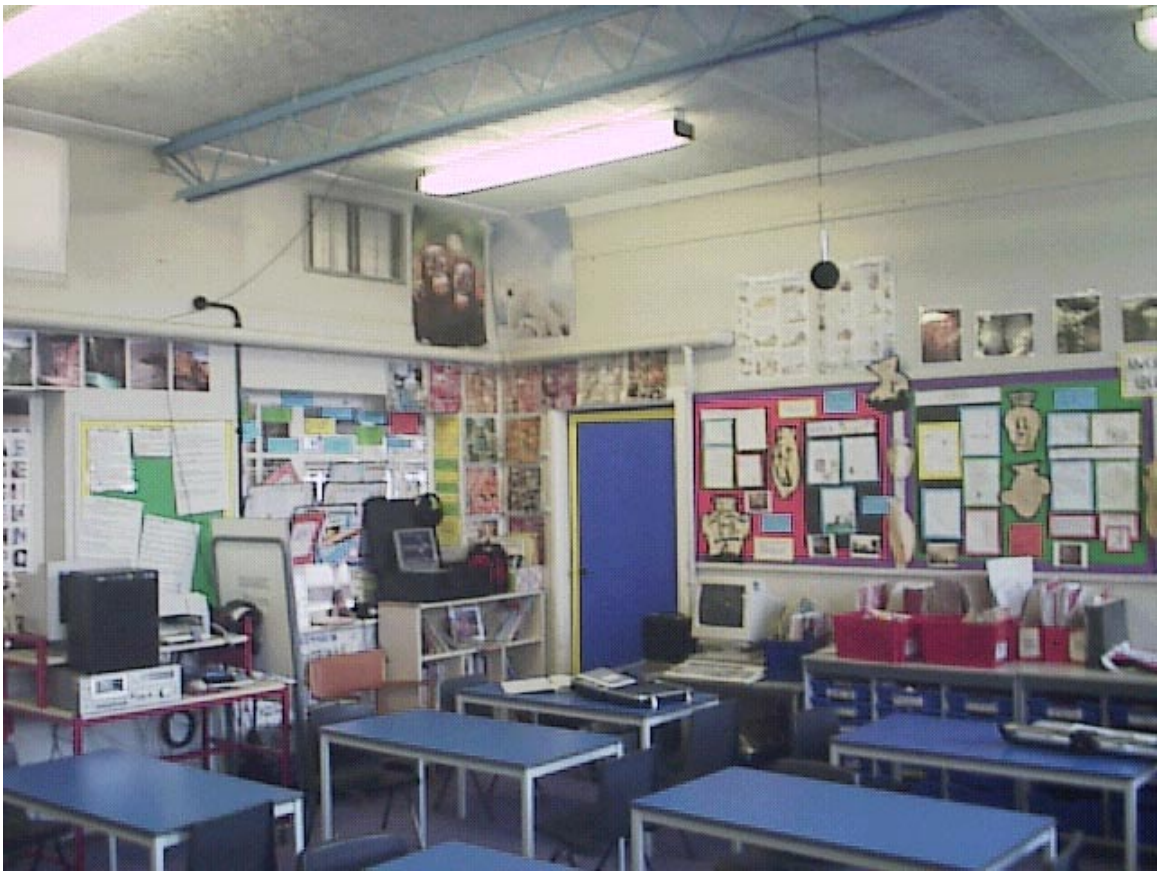
6 References

1. Berry B F & Flindell I H: Noise effects research: the importance of estimating noise exposure properly. *Proceedings of Noise Effects 98*, Sydney, Australia, November 1998, p627 - 630.

2. Department for Education and Employment: Building Bulletin 87, Guidelines for Environmental Design in Schools (Revision of Design Note 17), HMSO, 1997.

3. International INCE Technical Initiatives: Technical Initiative #4, noise and reverberation control for schoolrooms. General Assembly vote, Fort Lauderdale (December 1999).

Appendix 1 Photographs of some indoor microphone locations.



Appendix 2 Photographs of some outdoor microphone locations.

Annex 1 Geographical information methods used in the West London Schools Study

This annex details the methods used to obtain long term $L_{Aeq,16hr}$ aircraft noise exposure values for a) each of the schools considered for the study and b) the children's home locations for those that actually took part. The Summer 1997 noise contours were used as these were the most recent available at the start of the project and used for both stages a) and b) for consistency.

Generating an association between the schools and the contours was straightforward as the Local Authorities (LA's) responsible for each area were able to supply location points for each school in digital format. Noise contours were also available from DETR in digital format as a DXF file. ESRI Arcview v3.2 was used to manipulate the data and provide the matching of noise contour value to school locations. Table A1 shows the contour values and number of schools originally considered for the study; Table A2 is similar but relates to those that actually took part.

$L_{Aeq,16hr}$	Count
<57	115
57 - 60	20
60 - 63	10
63	1
63 - 66	8
66	2
66 - 69	7
69	1

Table A1 Contour values and numbers of schools considered for the study.

$L_{Aeq,16hr}$	Count
<57	10
63 - 66	3
66	1
66 - 69	5
69	1

Table A2 Contour values and numbers of schools that actually took part in the study.

Associating noise contour values to the home locations was more complex due to the amount of data requiring processing. During the field work stage each school supplied the home address postcode for each child. Ordnance Survey Address Point data was supplied by each LA which relates every address in their area to its location on the map: in total over 330,000 addresses were supplied. An individual post code can represent a number of properties, therefore the location co-ordinate eastings and northings were averaged to give an approximate centre of the area covered by each unit post code. This data manipulation was performed using Microsoft Access to create a data set which related post codes to location, reducing the data set to around 20,000 records. Final matching of post code data was achieved in 98% of cases with the remaining 2% living outside the LA's areas, these were manually amended to be categorised as <57dB(A) $L_{Aeq,16hr}$.

Table A3 shows the contour values and corresponding numbers of children in each exposure category for those that took part in the study. Figures A1 and A2 respectively show the locations of the schools and pupils in relation to the summer 1997 noise contours.

$L_{Aeq,16hr}$	Count
<57	216
57 - 60	19
60 - 63	44
63 - 66	74
66 - 69	53
69 - 72	31
>72	10

Table A3 Contour values and numbers of children that took part in the study

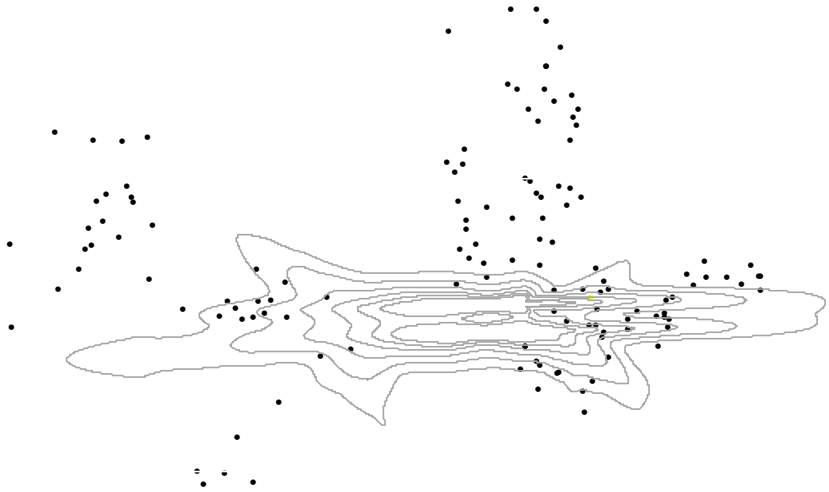


Figure A1 $L_{Aeq,16hr}$ noise contours and school locations considered for the project

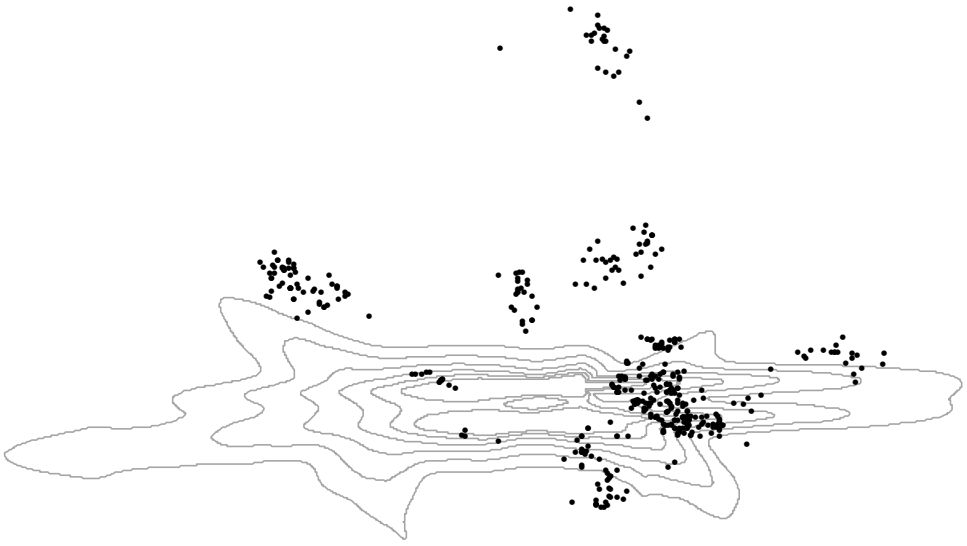


Figure A2 $L_{Aeq,16hr}$ noise contours and pupil locations of those that took part in the project

Annex 2 Local Authority Survey forms

Name of school.....

Date of visit .....

Name of Inspecting Officer.....

Classroom Construction:

Not all classrooms may have exactly the same construction and sound insulating features, please indicate an approximate proportion in each question (where appropriate).

Window construction	Single glazed		
	Double glazed (sealed units)		
	Double glazed (secondary glazing)		Width of Gap(s) .....
	Triple glazed (sealed plus secondary)		Width of Gap(s) .....

Are windows opened for ventilation (YES/NO) .....

If yes, is this commonly the case and for what proportion of the time (YES/NO) .....

.....

If no, how is the classroom ventilated?.....

.....

Relative size of windows .....

.....

Details of any proposals to change the sound insulation before Dec 1999? .....

.....

Please rate the aircraft noise events (please give proportions where this differs between rooms significantly):

Just Audible	
Clearly Audible	
Noisy	
Very Dominant	

Measurements are to be done indoors with the windows closed. Measure the maximum 'A' weighted sound pressure level of 4 aircraft noise events (consecutive if possible) using 'Fast' time weighting on the sound level meter. Locate the microphone at least 1.5 meters away from windows, preferable central to the room and 1.2 meters above the floor. Either hand held or tripod measurements are suitable. For equipment without a maximum hold function a visual indication of the maximum level will suffice.

Event 1.....Event 2 .....Event 3 .....Event 4 .....