FOCUSSED NOISE MONITORING 2013

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1 INTRODUCTION

Following on from noise measurement and attitude surveys over the preceding 50 years, Defra (Department for the Environment, Food and Rural Affairs) commissioned a team lead by URS to undertake a Focussed Noise Monitoring programme in 2013. During this survey, measurements were conducted over eight days at 77 properties in England. Addresses were selected to revisit those used for previous surveys, some back to the 1960s, providing an unprecedented opportunity to investigate trends on noise levels over periods of up to 50 years. Residents at all properties were also asked to complete a short self-completion questionnaire to provide further information on attitudes to noise. This paper presents an overview of the project, the measurement results and findings of more detailed analysis and comparisons of data with that from various previous surveys.

2 PROJECT OVERVIEW

2.1 Previous Surveys

A number of previous noise surveys across the UK and within specific areas have been undertaken over the last 50 years. The key studies are summarised below:

- National Noise Incidence Study 1990 (NNIS 1990)[1]
  In 1990 the then Department of the Environment commissioned a study of environmental noise levels in England and Wales based on 24 hour measurements outside 1000 dwellings. The study generated objective estimates of the noise exposure of the population.

- National Noise Incidence Study 2000/2001 (NNIS 2000)[2]
  During 2000 a similar study to NNIS 1990 was commissioned by Defra and produced new estimates of the pattern of population exposure. NNIS 2000 was based on 24 hour measurements obtained outside 1160 dwellings over the UK, of which 1020 were in England and Wales. The majority of these sites were chosen to match the NNIS 1990.

- National Noise Attitude Surveys 1990, 2000 and 2012[3,4,5]
  In 1990, the then Department of the Environment commissioned a National Noise Attitude Survey to environmental, neighbour and neighbourhood noise (NNAS 1990). During 2000 a second attitude survey (NNAS 2000) commissioned by Defra was undertaken involving over 5000 face-to-face interviews across the UK. A third attitude survey covering the whole UK was again undertaken by Defra in 2012 (NNAS 2012).

- London Noise Survey (1962) (LNS)[6]
  A survey of noise levels throughout central London was undertaken by the Building Research Station (BRS) in the 1960s.This survey included measurements at locations selected on a grid throughout central London. Due to the available instrumentation in the

1960s, measurements were taken on a sampled basis, with a short sample taken each hour. The data from this survey allows measured L_{A10} and L_{A90} noise indicators to be estimated from graphs shown in the project reports.

In addition to these key surveys, data have also been drawn from previous noise surveys undertaken in Westminster and Camden where these provide further insight into changes in noise levels.

2.2 Purpose of the Focussed Noise Monitoring 2013 Survey

Defra commissioned URS (supported by the University of Salford and CJG Environmental Management) to undertake a national noise measurement survey called "Focussed Noise Monitoring 2013" (FNM 2013). The FNM 2013 involved eight days of uninterrupted sound monitoring at each of 77 addresses across England. As the previous surveys discussed above had gathered data over a single 24 hour weekday period, the extended monitoring duration used in this project has provided a new opportunity to analyse data over weekday and weekend periods from a large number of sites.

The measurements were undertaken at addresses that had previously been included in various noise measurement and noise attitude surveys (or at acoustically equivalent sites). The measurement protocol followed best practice from the National Noise Incidence Study 2000 (NNIS 2000) but was modified to cover the extended eight day period. The FNM 2013 was primarily designed to increase understanding of changes in the acoustic environment at specific locations rather than to update the nationally representative data from previous surveys.

The FNM 2013 was designed to provide:

- a snap-shot view of the noise levels at selected sites throughout England;
- information to enable any changes to the acoustic environment over time to be observed;
- data on diurnal and weekly patterns in the acoustic environment at the selected sites;
- additional information concerning sound sources not mapped as part of Directive 2002/49/EC - the Environmental Noise Directive (END); and
- a supplement to the results of the strategic noise mapping by providing more detailed evidence on background noise levels, and other noise indicators, at the selected addresses.

2.3 Site Selection

The aim of the site selection in FNM 2013 was to achieve a minimum of 75 successful noise measurements, with a good geographic distribution over the country and covering a range of addresses used in the London Noise Survey, NNIS 1990, NNIS 2000, NNAS 2012 and others.

A clustered sample of potential measurement addresses was developed to achieve the following distribution:

- seven addresses used during both NNIS 1990 and NNIS 2000 and three used during NNAS 2012 in each of the areas around Exeter, Colchester, Newcastle, Manchester, and Nottingham (50 addresses in total)
- In London, five addresses from the 1962 London Noise Survey, five in the Camden area monitored during a previous survey, six NNIS and two NNAS sites from the Kingston-upon-Thames area and five NNIS and two NNAS sites in the Enfield area (25 addresses in total)

A further 75 addresses were also produced as a "reserve" list meeting the same criteria, hence giving a total of 150 addresses from which the measurements should be achieved. To improve the chance of recruiting a suitable measurement location, up to four acoustically equivalent sites were identified around each of these addresses, with measurements being undertaken at no more than

one acoustically equivalent site from each group. The selection of potentially acoustically equivalent sites was undertaken as a desktop exercise, however the final decision on site suitability was always taken on site by experienced staff setting out monitoring equipment with a checklist for guidance on selection of such sites.

A mail shot comprising initial contact letters, a response form and a list of frequently asked questions about the project was sent out to over 700 addresses. The mail shot resulted in permission to access properties at 62 of the potential measurement locations.

2.4 Instrumentation and Laboratory Calibration

Each site measurement included the following parameters: L_{Aeq}, L_{A10}, L_{A50}, L_{A90}, and 1/3-octave L_{eq} values over 1-hour time frames, logged contiguously throughout the eight day duration. Each Sound Level Meter (SLM) also recorded a full time history of $L_{Aeq,100ms}$ and/or $L_{pA,100ms}$ noise levels which can be used to calculate A-weighted parameters over any time frame of interest. Short samples of audio were captured to aid identification of noise sources.

Measurements were undertaken using Class 1 SLMs with all meters and calibrators having undergone UKAS accredited calibration. In addition, a detailed calibration of all sound level meters was undertaken by the University of Salford prior to the start of the measurements.

Additional comparisons between SLM types were undertaken using samples of recorded audio from previous noise monitoring projects. This process was undertaken for at least one SLM of each type used for the project with a view to identifying any significant differences in the measured sound level indices produced when an equivalent input signal is applied. Measured values were compared across the SLM types for the following indicators: $L_{Aeq,10min}$, $L_{A5,10min}$, $L_{A10,10min}$, $L_{A50,10min}$, $L_{A90,10min}$, and 1/3 octave band $L_{eq,10min}$ from 25Hz to 20kHz.

L_{Aeq} and statistical noise values recorded by each SLM type had a variation of no more than 0.2 dB between all meters. The measured 1/3-octave band spectra for each configuration showed very little variation between the SLM types over most of the frequency range. At very high and very low frequencies, there was a slightly greater variation, but no identified differences were considered to have a significant effect on the measurements taken within the project.

2.5 Site Methodology

For each site, continuous monitoring was undertaken for an uninterrupted period of at least eight days, commencing between the hours of 10:00 Monday and 14:00 Thursday. Where this period included a bank-holiday, the measurement was extended by an additional day to ensure sufficient data were collected on typical weekdays. Where possible, measurements were not made during local school holiday periods (including Easter, half-term breaks and other school closure days).

A mid-period site visit was made to each monitoring location. This offered an opportunity to collect additional subjective information on the sound climate, noise sources, weather conditions etc. as well as check on instrument performance and battery levels.

Measurements were standardised to a microphone position 1 m from the front facade of the identified property and 1.2 m above the height of the floor containing the entrance door. At all times, SLMs were set to the appropriate time zone (Greenwich Mean Time or British Summer Time).

A standard pro-forma, an update on that used for the NNIS 2000, was developed for the collection of site specific information during the site visits. Key items in the pro-forma included: instrument details and set up; start and end calibration results; date and time of start and end of measurements; GPS co-ordinates; subjective description of the acoustic environment; details of potential and actual sound sources; sketch plan of the site, including location of major noise

sources and photographs; local land usage (residential / commercial / industrial etc.); weather conditions; road surface condition; and any other comments considered relevant by site staff.

At each site, the resident/occupier of the property was asked to complete a short questionnaire, based on that completed by residents of properties during the NNIS 2000 but modified to account for the eight day measurement duration. Some of these questions were also in the site proforma and hence allowed a comparison between responses given by residents and the opinion of engineers setting out/collecting the monitoring equipment.

2.6 Data analysis

Checking was carried out on the results from each site, including confirmation that all measurement data and subjective observations required had been recorded. Calibration levels were checked and data were reviewed by an experienced acoustician. This included use of the audio recordings to assist in identifying sound sources and/or the causes of unusual noise levels. Where any data problems were identified (such as unacceptable calibration drift), the measurements were repeated.

Various noise indicators were derived from the raw measurement data for each site. In particular, the one-hour measurement data were used to calculate the following indicators:

- L_{day}, $L_{evening}$, $L_{Aeq,16hr}$, L_{night}, $L_{Aeq,24hr}$, and L_{den} for each day of measurement at each site.
- Each of the above noise indicators were also calculated separately from average 24-hour time histories for each of Monday-Thursday, Friday, Saturday and Sunday.

Where data were averaged across several days (for example Monday to Thursday) the arithmetic average was used and the standard deviation was also reported. Night time data for each day was deemed to start at 23:00 of that day and run until 07:00 the following morning.

3 RESULTS

3.1 Sample results

A large amount of data were analysed as part of this project, and the following sections of this report present an selection of example results and analysis .

3.1.1 Example individual site data – London Noise Survey

Of particular interest from the data included in the LNS cluster is a site within the City of Westminster on a mostly residential square. At this site, data from four noise surveys over a 50 year period were available. In addition to the surveys from 1962 and 2013, additional data from measurements at equivalent sites on this square were also available from surveys undertaken in 2003 and 2008. Figures 1 to 3 below show the variation in L_{Aeq}, L_{A10} and L_{A90} noise levels respectively over these surveys.

When viewing these charts, it should be noted that the LNS L_{A90} and L_{A10} data have been read from a hard copy of graphs from the LNS report datasheets and this may have introduced an error estimated to be approximately ±1 dB. It should also be noted that no L_{Aeq} noise levels were available for the LNS. During the LNS survey, the reported L_{A90} and L_{A10} values are based on short sample measurements within each one hour period, and are not true hourly noise levels as for the FNM 2013 survey. For the FNM 2013, the average Monday-Thursday time history has been used; this averaging process leads to smoother curves for the FNM 2013 than the 24 hour surveys.

These figures show a reduction in daytime L_{A10} and L_{A90} from 1962 and 2013. All indicators show very little change between 2003 and 2013 with little change in the night L_{A90} over all four surveys.

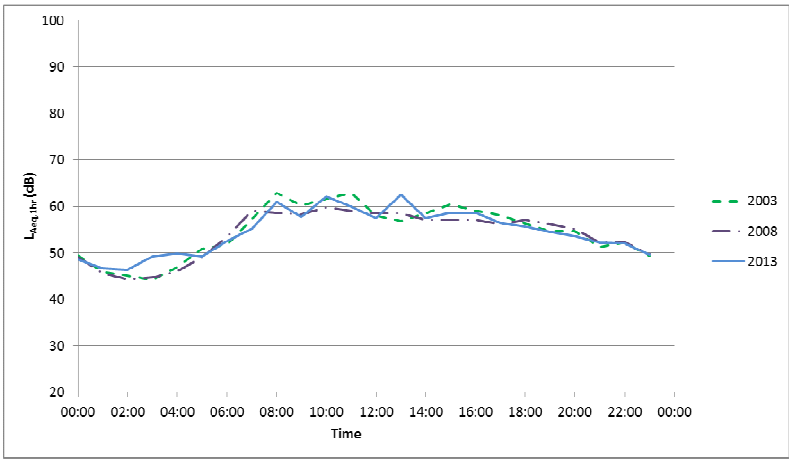

Figure 1. Site FL3F $L_{Aeq,1hr}$ time history 2003 to 2013

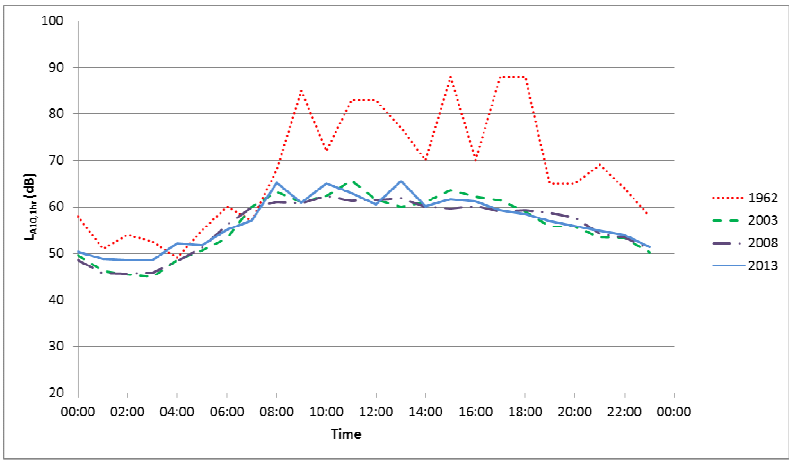

Figure 2. Site FL3F $L_{A10,1hr}$ time history 1962 to 2013

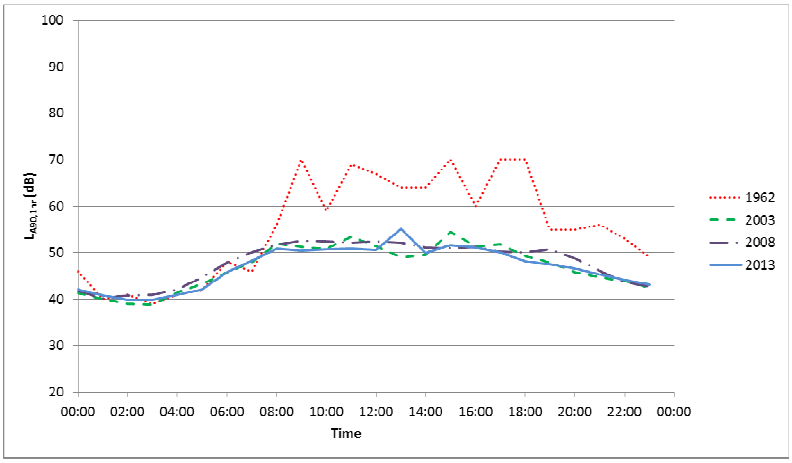

Figure 3. Site FL3F $L_{A90,1hr}$ time history 1962 to 2013

3.1.2 Overall results comparing NNIS 2000 to FNM 2013

An analysis was undertaken of changes in measured noise levels at the 15 sites where the precise same address was visited both for NNIS 2000 and FNM 2013. Figure 5 presents a summary of the changes between 2000 and 2013, averaged over the 48 such sites.

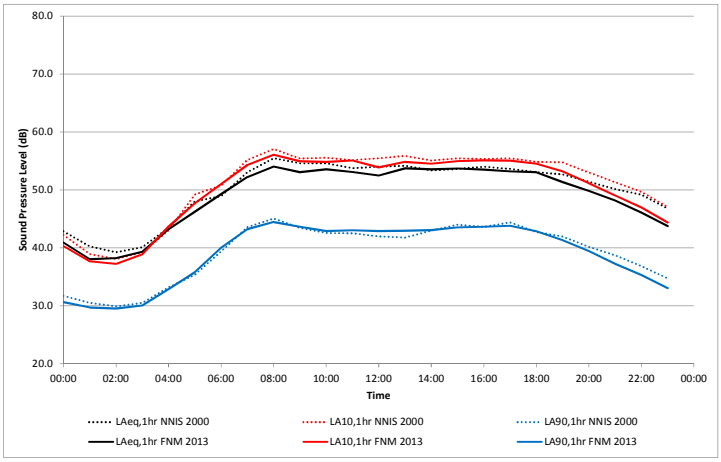

Figure 5. Comparison of sites all NNIS sites (NNIS 2000 & FNM 2013)

A slight overall reduction in $L_{Aeq,1hr}$ and $L_{A10,1hr}$ is seen across most periods of the day, and a slight reduction in night time $L_{A90,1hr}$ is also identifiable. The reduction in noise levels during the evening is more pronounced, either starting earlier, or reducing at a greater rate. Given the 1-hour resolution of these comparisons, it is not possible to identify which of these two effects (or both) is taking place.

3.1.3 Site proformas – sound source findings

Staff used the site pro-forma to identify sound sources which were audible during site visits. At two thirds of the sites road traffic noise was listed as the dominant source.

At 94% of sites noise from local road traffic was noted. Aircraft were audible at 53% of sites, and train noise at 7%, Construction activities were heard at 14% of sites, roadworks at 6% and industry at 1% of sites. Birds were audible at 81% of sites and dogs at 39%. Noise from people in the street was audible at 71% of the sites and from noise from within a neighbour's property at 20%.

3.1.4 Eight day analysis

An analysis comparing Monday to Thursday long term (L_{day}, L_{night}, $L_{evening}$) noise levels with Friday, Saturday and Sunday show some notable trends in noise level. However, the only statistically significant differences are for Sunday daytime, where noise levels are significantly lower than those during the week with a 95% confidence interval.

Comparison of 24-hour time histories for $L_{Aeq,1hr}$, $L_{A10,1hr}$ and $L_{A90,1hr}$ indicators respectively for different days of the week shows a common set of differences, these are:

- Night time levels are generally higher on Friday and Saturday nights than for weeknights (including Sunday night into Monday morning).
- Morning rush hour peaks evident in Monday to Friday mornings with a notably later increase in noise levels on Saturday and Sunday mornings.
- Afternoon L_{Aeq} and L_{A10} noise levels similar for all days of the week.
- Daytime and evening L_{A90} generally lower on weekends than for weekdays.

3.1.5 Self-completion questionnaires

An response rate of 68% was achieved for the self-completion questionnaires.

Both the questionnaire and site pro-forma included a question asking the respondent (resident / site engineer) to rate the sound environment on a scale of 1 to 7 using the following four scales:

- unpleasant to pleasant;
- chaotic to calm;
- eventful to uneventful; and
- monotonous to exciting.

Analysis showed no significant correlation between the responses from residents and site staff to these questions. However the results do indicate residents are generally more likely than site staff to use the values of the scale closest to “pleasant”, “calm”, “uneventful” and “monotonous”.

3.2 LNS Analysis

Five sites in the survey were chosen from sites used in the 1962 LNS. The precise locations of the measurements used for the LNS were not practical for long-term unattended noise measurements. FNM 2013 sites were chosen to be as representative as possible of the locations used during the LNS, whilst standardising the measurement position to 1 m from a building façade.

Figure 4 below shows a comparison between LNS survey and FNM 2013 data. This is the average across these five sites and can be used to identify trends for this cluster of sites.

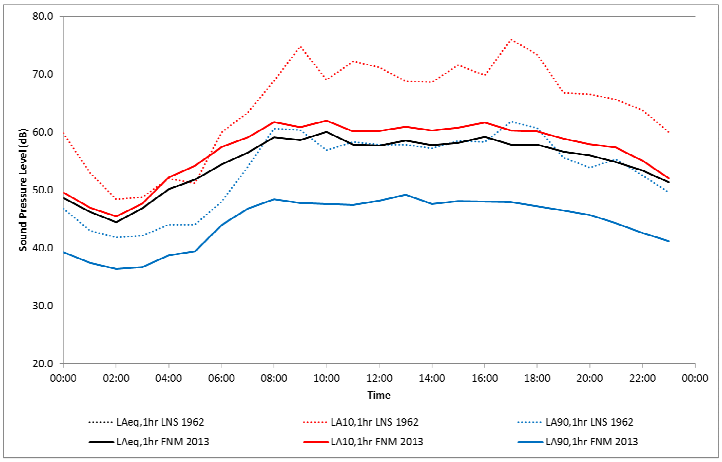

Figure 4. Comparison of sites in London (London Noise Survey 1962 & FNM 2013)

Despite the limitations of the data available from the 1962 survey, these are interesting results. Both L_{A10} and L_{A90} are significantly lower in the FNM 2013 survey than those from the LNS during most hours of the day.

A more detailed analysis was undertaken to consider the following aspects that could have contributed to the differences in measured noise levels from 1962 to 2013:

- The two minute per hour sampling approach used to derive noise measurements in 1962.
- Changes in the actual noise climate, dominant noise source, road layouts, etc.
- Changes in noise policy and the relationship between these measurements and research previously undertaken by Defra into the effects of historic noise policy interventions.

The key findings of this analysis are:

- The two minute sampling approach results in a significant random variation in noise levels when compared to a measured $L_{A10,1hr}$ or $L_{A90,1hr}$ values. This could have a significant effect on any individual 1-hour measurement period. On average, the difference between the two minute sampled and hourly noise levels is very small, indicating that this is unlikely to provide an explanation for any of the changes in noise level identified between the surveys .

- Subjective descriptions of the local sound climate and site details from the LNS data set showed a high degree of similarity to the 2013 FNM survey. At two locations changes in the noise sources and/or the precise measurement positions were noted that could be partly responsible for the difference in measured levels. However differences in precise location were considered unlikely to provide explanations of the full magnitude of the differences between measured noise levels at the majority of sites.
- Consideration was also given to research into historic noise policy interventions[7], and it was noted that the changes seen in measured noise levels matched those predicted for road traffic noise levels in this previous Defra research.

3.3 Conclusion

FNM 2013 has delivered detailed noise measurements and other data at 77 properties in eight areas of England which have previously been the subject of noise measurements or noise attitude studies. Unlike previous 24 hour surveys the FNM 2013 measurements ran for eight days, allowing analysis of data for whole weeks, including weekends and providing a valuable resource for future study. Noise attitude data from building occupiers was also gathered.

This is a small sample and not designed to be statistically representative of England as a whole, however the data provide a detailed resource for the understanding of the 2013 noise climate at those locations allowing comparisons of noise levels and attitudes to previous and future surveys.

The final report and subsequent analysis includes hourly datasets and data for longer period noise indicators (e.g. L_{day}, L_{night}, $L_{evening}$, L_{den} etc) for each site. Comparison to previous measurements for some sites showed larger variations than for the geographical clusters due to averaging effects. A comparison between NNIS 2000 and FNM 2013 shows a slight overall reduction in L_{Aeq} and L_{A10} across most periods of the day, and a slight reduction in night time L_{A90}.

Detailed analysis of sites where data exists covering a 50 year period from the 1962 London Noise Survey to the 2013 FNM showed significant decreases in L_{A10} and L_{A90} noise levels over this time (no data for L_{Aeq} noise levels were available from the 1962 survey). These changes were further analysed and it was found that the sampled measurement procedure used in 1962 and differences in precise measurement locations may provide an explanation for a small proportion of these differences, but could not explain the full magnitude. Consideration of research into historic noise policy interventions showed that this research predicted changes in noise level consistent with those seen at this small number of sites.

Any views expressed in this paper are those of the authors and not necessarily those of any government department.

4 REFERENCES

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