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Field trials of proposed procedure for the assessment of low frequency noise complaints

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SUMMARY

This report describes field trials carried out to test the workability and usefulness of a procedure for assessing low frequency noise. The procedure includes guidance notes and a pro-forma report with step by step instructions. It does not provide a prescriptive indicator of nuisance but rather gives a set procedure to help Environmental Health practitioners to form their own opinion. The assessment is based on whether the measured levels of LFN exceed a reference curve, and whether there is correlation between the complainant's comments and measured noise.

A series of six trials of genuine 'live' LFN complaints was conducted by volunteers from Environmental Health departments. In two out of six cases an environmental noise was identified and its source located. In the remaining four cases no environmental noise was found and the officers concluded that there was no remedial action they could take. Their experience in applying the procedure was generally very positive: the participating officers found the procedure easy to use and that working to a set procedure increased their confidence and the complainant's acceptance of the results. They also considered that the procedure achieved a good balance, giving a set procedure but allowing them the flexibility to form their own conclusions. The EHOs were generally able to draw firm conclusions and reach 'closure' if there was nothing they could do to help.

The proportion of cases for which no precise cause can be found is typical of LFN cases around the world. It points to the need for an improved understanding of the phenomenon, as well as for alternative sources of help for complainants.

A number of mostly minor modifications have been made to the procedure which it is recommended should be made available for a trial period as soon as possible.

1. INTRODUCTION

The report follows on from previous reports by Defra into low frequency noise (LFN). The overall aim given by Defra is to recommend a method for assessing low frequency noise suitable for use by Environmental Health Officers (EHOs¹) in the UK. In [Le03] a comprehensive review of the low frequency noise problem was given. In [Mo05a] a set of assessment criteria was proposed. In this report a series of field trials is described in which these criteria were formulated as a written procedure which was then applied to real LFN cases by EHOs in the UK.

The objectives of the field trials were to:

- test whether the procedure could be applied by Environmental Health officers (EHOs)
- determine how successful it was in resolving cases
- refine the guidance documents as appropriate.

¹ Taken to include Environmental Health Officers and Environmental Health Technicians etc.

2. FIELD TRIALS

Cases were solicited by letter and email requests to environmental health departments. A total of 62 local authorities were contacted. Of these, seven responded to offer appropriate 'live' cases. Five of these eventually proceeded to take part in the trials, one of which investigated two cases. The selection criteria used were that the cases were 'real', i.e. resulted from a formal complaint, and that there were no ethical issues involved (one case was not pursued because it was felt it would be unreasonable to ask the complainant to take part).

The following format was adopted for the trials:

- **Written procedure:** - a draft written procedure together with guidelines in how to apply it was produced; this incorporated the criteria given in [Mo05a], and included a pro-forma report to be completed in the field.
- **Training:** - EHOs took part in a training session at the University of Salford.
- **Field work:** - EHOs applied the procedure to their cases as if it was a normal case (telephone support was available from the University of Salford during this period).
- **Report:** - EHOs completed the pro-forma report and returned a copy to the University.
- **Debrief:** - EHOs attended a final debriefing session at the University of Salford.

The draft procedure and guidance document as used by the participating EHOs has not been reproduced in this report in order to avoid it being confused with the final, modified draft. However, it was similar to the final draft, a list of modifications being given in section 4.

3. REVIEW OF EXPERIENCE FROM FIELD TRIALS

3.1. Summary of field trials results

Altogether six cases were investigated. Results are summarised in Table 1. In one case an environmental LFN was clearly identified, as a result of which the source was subsequently located. In one case a LFN was identified and was judged to be ‘marginal’. Although a ‘marginal’ judgement often indicates that the investigator is unsure of their opinion, this did not appear to be so in this case. The reason for the marginal judgement was that, although the LFN was below the criterion curve, the premises suspected of causing it was on a low production schedule at the time of the test. The investigator therefore suspected that it could become a problem when on full production and was prepared to leave the case open for that reason. There was also some uncertainty in how to apply the correction for fluctuations which has subsequently been removed.

	Description indicates possible LFN	Criterion curve exceeded	Complainant's comments correlate with measured sound levels
Case 1	Y	Y	Almost
Case 2	Y	Marginal	Reasonably
Case 3	Y	N	N
Case 4	N	N	N
Case 5	Sometimes	N	N
Case 6	Y	N	N

In four cases the investigators concluded that there was no environmental sound causing levels above the reference curve, and that the complainants log sheets did not correlate with increased noise levels. In three of these cases, although unable to explain the cause of the disturbance, the investigators concluded that there was no action that they could take that would improve the situation and closed the case. In one instance the EHO did not close the case feeling that the results were insufficiently conclusive and has agreed to revisit the site at a later date. However, this EHO was clear that the procedure had been beneficial on both sides, increasing their confidence and the complainant's acceptance of the findings.

3.2. General feedback from participants

Feedback from the Environmental Health Officers taking part in the trial was very positive. Overall they felt the procedure was easy to follow and strengthened their position with the complainant:

“The procedure... raised our credibility and the complainant's acceptance of the findings”

A major part of the discussion was focussed on whether the procedure should be more or less prescriptive. It emerged clearly that there were two balancing arguments. On the one hand investigators did not want to be ‘tram-lined’ into forming particular conclusions. EHOs were all used to forming their own judgements in their work and indeed considered it an essential part of their job – “*We are paid to think*”. On the other hand, the prescriptive nature of the procedure was felt to be a strength, the more rigid the framework the easier it was to satisfy the complainant that everything possible had been done.

When asked if the procedure should be made less prescriptive there was a firm consensus that this would weaken it and make it more difficult to form a definite ‘closure’ on the case. When asked if it should be made more prescriptive the body of opinion was also against. This was supported by the fact that in almost every case the EHO had been able to draw a firm conclusion without being strongly directed in the procedure. Consequently, it was concluded that the correct balance had been achieved between a prescriptive and a flexible procedure. The only modification proposed was to include a ‘Concluding Remarks’ box at the end of the report pro-forma, although this was left blank so as to avoid leading comments.

The EHOs who had found no low frequency environmental noise present all commented that the lack of alternative, more appropriate course of action for the complainants was difficult. There was a strong feeling that officers need somewhere to send people affected in this way:

“However, complainants who perceive noise, which can not be detected within the scope of this document, generally will not seek advice or help from other agencies and tend to continue to complain about the perceived noise either directly or indirectly through local Councillors. It would be useful to have advice or refer to an agency complainants who are affected in this manner which does not have the stigma of referring to the doctors or the information that the tinnitus society give.”

Consequently, we would strongly support initiatives to develop alternative courses of action, perhaps along the lines of ‘relief strategies’.

3.3. Completion of report pro-formas

The investigators all completed the report pro-formas thoroughly and areas that were unclear were effectively discussed and rectified in the debriefing session. Seeing how the forms had been completed enabled the researchers to identify areas of uncertainty and where misinterpretation had occurred. Apart from the treatment of fluctuations (see later) only minor changes were identified as necessary. Very little in the way of telephone queries were received during the trials which was taken to indicate that the instructions were, in the main, clear.

3.4. Feedback from complainants

A number of the officers taking part in the trial claimed that the complainant felt significantly reassured once they saw that a detailed procedure was being followed. One described a complainant who had been a rather difficult case for them being “*completely satisfied*” once they had seen the level of analysis that had taken place.

'We asked if the complainant wants us to come back ... but he said no... This was because he was satisfied we'd done everything we could.'

3.5. Fluctuations

The original guidance included the following section aimed at distinguishing between fluctuating and steady sounds in line with the findings of [Mo05a].

If the noise is steady then a 5dB relaxation may be applied to all third octave bands. A noise is considered steady if either of the conditions a. or b. below is met:

- a. $L_{10}-L_{90} < 5\text{dB}$
- b. *the rate of change of sound pressure level (Fast time weighting) is less than 10dB per second**

where the parameters are evaluated in the third octave band which exceeds the reference curve values by the greatest margin.

** For a meter capable of storing short term L_{eq} the rate of change is $(L_2 - L_1)/t_s$ where L_1 and L_2 are subsequent values of the level and t_s is the time for each sample (should be less than 0.1s). For simpler instruments it should be possible to estimate the rate of change from the depth and speed of fluctuations judged by eye. For example, if there are 2 fluctuations per second with a difference of 6dB from peak to trough then the total change in a second is 24dB (two up, two down, each 6dB). The rate of change would therefore be at least 24dB if the level changes smoothly, and more than this if it changes irregularly or suddenly.*

These criteria were applied in the two cases in which an environmental LFN was positively identified. In both cases the sound was audible to the investigator and was judged subjectively to be fluctuating. However, when the criteria were applied the sound was found to be classed as steady. This was probably due to the procedure being applied incorrectly.

The two investigators who used this procedure both felt that it detracted from the otherwise simple procedures. It was also felt that the relaxation for steady sounds would only apply in a minority of cases, and that any potential benefit of this section was outweighed by the risk of it being applied wrongly (as seemed to have happened in these cases). Consideration was given as to whether the identification of steady and fluctuating sounds could be carried out more easily, but it was decided that it was already in the simplest form possible. Consequently it was decided to remove this section and replace it with a short note to the effect that fluctuating sounds tend to be more disturbing than steady sounds. A reference to [Mo05a] was included for a more detailed treatment of fluctuations.

3.6. Calibration of sound level meters

The procedure includes a cautionary note about calibration of sound level meters at low frequency:

LFN is often at the extreme of the usable frequency range of the instrumentation, and so special care is required to ensure the reliability of the results. If the meter has a UKAS calibration certificate this usually means that it underwent the 'verification' procedure for sound level meters according to BS7580 Part 1 (1997) on the date of the certificate. In the verification test the lowest frequency for a full acoustic check is 125Hz: third octaves down to 31.5Hz are checked electrically but not acoustically. This is sufficient for the majority of sound measurements, and is also probably satisfactory for LFN in most cases. However, there is no guarantee of accuracy without an acoustic check at the frequency being measured, which in the case of LFN is often around 40Hz, and could

extend down to 10Hz. An acoustic check at lower frequencies than is normally carried out during verification is therefore advisable if possible. This could be achieved for example using a calibrator such as a multi-frequency calibrator which itself has a traceable calibration at low frequency, or by making a special request to a calibration laboratory.

This was felt necessary because most of the third octave bands to be used in assessment of LFN fall outside the usual range of the instrument and so its calibration is essentially unknown.

It was decided to carry out a check on the instruments used by the participants as this would give some indication as to the likelihood of calibration errors in typical meters as used by local authorities. The instruments were taken to the calibration laboratory at University of Salford² and given a full acoustic check in the third octave bands down to 20Hz. The values obtained, given as a deviation from the required reference value, are shown in table 1.

Hz	20	25	31.5	40	50	63	80	100	125	500	1000
Meter 1	-0.3	-0.2	-0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Meter 2	-0.4	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Meter 3	-0.6	-0.1	-0.1	0.0	-0.1	0.0	0.1	0.0	0.1	0.0	0.0
Meter 4	-0.5	-0.3	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0

Results show that the meters used were all reliable to within 0.6dB. Although this is only a small sample, it does give some confidence in the performance of typical meters as used by Local Authorities.

² At the time of the tests the Laboratory for Calibration of Sound Level Meters at the University of Salford was in the final stages of obtaining UKAS accreditation. Hence, all calibrations obtained are traceable to national standards, but not strictly UKAS accredited.

4. MODIFIED GUIDANCE DOCUMENT

As a consequence of these field trials a number of changes were made to the guidance document. The only substantial change was that the section on fluctuating sounds was removed and replaced with a reference to [Mo05a].

The following minor modifications and improvements were also made:

Introduction section

- include a clearer explanation as to why the criteria should not be used for planning purposes
- add references
- give an idea of the proportion of cases in which an environmental noise is typically found
- change 'external noise' to 'environmental noise'

Measurement section

- include guidelines for when a sound level meter extending down only to 20Hz third octave band is adequate
- allow flexibility in the 5 minute averaging period
- include more spaces for domestic equipment to be analysed

Interview section

- add gender and age of complainant
- when asked for 'occupation' prompt for more detail if job title isn't very informative
- when asking about exposure to the problem add a question about what activities it stops the complainant from undertaking
- when asking about noise avoidance be more explicit about the types of noise avoidance that might have taken place – i.e. provide prompts
- ask if the noise is heard in other locations and when earplugs worn
- a clearer exposition of what constitutes a consistent description of LFN to be given in the guidance
- add a final box 'Concluding Remarks'

The final modified (final draft) guidance document is given in reference [Mo05b].

5. CONCLUDING REMARKS

The objectives of the field trials were to determine if the procedure was (a) workable, and (b) useful, and if so (c) to refine it as appropriate.

In terms of workability, all EHOs were able to apply it with relative ease to their cases. The only area of difficulty (evaluation of fluctuations) has subsequently been removed. There was a firm consensus that the correct balance had been struck in prescribing clear-cut steps whilst allowing officers the flexibility to exercise their own informed judgements. Investigators were generally able to draw firm conclusions about their cases.

Concerning the usefulness of the procedure, there was a strong consensus from the field trials that it would be beneficial both for investigating officers and also for complainants. We therefore conclude that the procedure is both workable and likely to be useful. The appropriate refinements have been included in the final draft [Mo05b].

In four out of the six field trials the EHO could find no environmental noise consistent with the complaint (which is a fairly typical ratio). Such cases frequently remain open for extended periods, although if no environmental noise can be found there is no real possibility of remedial action by the EHO. The results of the field trials indicate that the procedure could provide a useful tool to help close such cases. From the EHOs perspective this is positive because they will not need to spend time and resources when there is no action they can take to improve the situation. We would argue that this is also positive from the complainant's point of view, because if no environmental noise can be identified there is nothing to be gained from further EHO involvement. However, this line of argument will only be fully effective when there are realistic alternative options available. Consequently, we would recommend (as was also recommended in [Le03] and [Mo05a] as well as other places) that further research be conducted into understanding the causes of the complaints, as well into ways of relieving the symptoms, such as 'relief strategies'.

In view of the positive experience from these trials we would recommend that the guidance be made available as soon as practicable. Initially, a trial basis is recommended, to be reviewed after, say, one or two years. This is because the results of the procedure could have an effect on a number of parties (developers for example) who have not so far had any chance to comment.

REFERENCES

- [Le03] Leventhall G. A review of published research on low frequency noise and its effects. Report for Defra, London 2003.
- [Mo05a] Moorhouse A T, Waddington D C, Adams M D. Proposed criteria for the assessment of low frequency noise disturbance. Report for Defra, London 2005.
- [Mo05b] Moorhouse A T, Waddington D C, Adams M D. Procedure for the assessment of low frequency noise. Report for Defra, London 2005.