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STUDY OF THE APPLICATION OF THE REVISED BS4142:1990 'METHOD FOR RATING INDUSTRIAL NOISE AFFECTING MIXED RESIDENTIAL AND INDUSTRIAL AREAS'

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INTRODUCTION

Development, implementation, review and revision of all standards is a continuous cycle as the companion paper to this one has highlighted (1). BS4142 is no different from other standards in this evolution process. This paper sets out to examine the most recent part of this cycle, the implementation of the revised BS4142:1990.

Many changes were made to BS4142 during its recent revision but with little new data on noise complaints the assessment procedure was not significantly changed (2). Gaps in knowledge were revealed about people's response to noises, in particular noises having different frequency spectra and temporal characteristics (3). The Report of the Noise Review Working Party 1990 (4) recommended that there should be a more extensive revision of BS4142 than has been possible, and the view was expressed that research on responses to various types of industrial noise should be undertaken.

A three year programme of research has been started at the National Physical Laboratory (NPL) sponsored by the Building Research Establishment (BRE) on behalf of the Department of the Environment to examine the objective and subjective assessment of industrial noise. It is intended that this programme should begin to address the needs for research identified above. The aim of this work is to investigate the performance of objective assessment methods for rating industrial noise, firstly by collecting data from the users of the standard and secondly through laboratory experiments on the judged annoyance of various types of industrial noise. This paper is concerned with the first of these objectives, a systematic evaluation of the application of the newly revised standard by means of a data sheet study.

The main aims of the study are set out here, followed by a brief account of how data was gathered. The response to the study and initial results are then discussed together with the preliminary conclusions.

It should be pointed out this is an interim report only and the results in this paper are up to date at the time of writing but may be modified with additional data at the conference.

STUDY OF THE APPLICATION OF THE REVISED BS4142:1990

AIMS OF DATA SHEET STUDY

The aims of the data sheet study were:-

(1) To determine how well the assessment by the BS4142:1990 rating method compares with the actual investigated noise complaints.
(2) To show where there are weaknesses in the standard and where the investigating officer is having problems applying the measurement and rating procedure.
(3) The measurement of residual noise uses L_{A90}. Various concerns have been voiced on the comparison of L_{Aeq} with L_{A90}. It was hoped that the data sheet would provide us with data to be used when considering this point.
(4) We are fully aware that BS4142 is often used beyond its stated scope. It was hoped that the study would help gather information on its various applications.
(5) The final aim was to assist in the identification of sites for possible recording of material to be used in later subjective listening tests.

PREPARATION OF DATASHEETS

The data sheets were designed to closely follow section 9 of the standard 'Information to be reported' (5) so that little extra time or resources would be required to complete the data sheets. Each data sheet is divided into five sections:

general information
description of noise source
description of complaints
measurements
assessment

Extra questions were included in addition to the requirements of section 9 in order to gain further valuable information. These included questions relating to the opinion of the investigating officer on how the BS4142:1991 rating procedure compares with the actual investigated noise complaints and their opinion on whether the complaint was considered justifiable. A space was provided at the end of most sections for additional comments.

Before the data sheet was printed in full, a small pilot study was conducted. Firstly at the end of October 1990, the data sheets were sent to various members of BSI Committee EPC1/3 for comment, and amendments were made. Ten local authorities were then chosen from information given in a previous NPL study (6) and the data sheets were sent for comments on layout, ease of

use, etc. in January 1991. Two months later the data sheet was approved by the Central Survey Unit. The main distribution started in April 1991.

RECRUITING VOLUNTEERS

The project was publicised in order to attract interest from those people who could assist in the collection of data. The sources of the one hundred and forty five volunteers who offered to participate are shown below:-

Source (and reference)		Numbers EHO's	Numbers Other
Letter in Institute of Acoustics Bulletin	(7)	25	18
Letter in Environmental Health News	(8)	48	5
BSI Seminar April 1991		10	14
IOA/Noise Council Seminar May 1991		7	4
Follow up letter in IOA Bulletin	(9)	1	2
Other		8	3
Total		99	46

RESPONSE

Although the response to requests for volunteers was considerable, at this stage the number of returned data sheets is lower than had been anticipated.

At the time of writing, 40 case studies have been returned for analysis. This represents only a 17% return rate from the total number of volunteers although 38% of respondents have sent more than one data sheet. Three planning cases are included. All the information was entered into a computer database for analysis.

In response to our request for cooperation, in addition to the returned data sheets, several letters and telephone calls were also received with comments on the standard.

INITIAL RESULTS

Description of Noise Sources

Although on first examination there appeared to be a large variety of noise sources, several categories could be identified to account for a large proportion of the cases: 30% of the cases were fans, 15% resulted from compressor units, generators and air

conditioning units, 15% of the cases involved refrigeration plant (including fans and trailers), 7% were due to activities from paint spray booths.

Information relating to the nature of the noise source showed that about one third of the noise sources were described as continuous with slightly more given as intermittent in nature.

Over eighty percent of the cases related to noises which were described subjectively as exhibiting specific characteristics, with over half the noises described as tonal, a quarter as impulsive and a quarter defined as irregular enough to attract attention. It should be noted that these categories were not mutually exclusive.

Around half of the sources were operational during the early morning with two thirds of these operating both at weekends and on weekdays. Also half of the noises reported as present during the daytime period were present both on weekdays and at weekends. Two thirds of all the specific noise sources did not operate during the night time period but those that did operate at night almost invariably caused complaint. Only two cases related to sources that operated at night time only.

Description of Complaints

In three quarters of the data sheets, the number of complaints per case investigated was less than 10. 30% of all cases related to single complaints. Where the complaint frequency was rated, the frequency was described as 'occasional' for 30% and 'fairly often' for 60% of the cases. The intensity of the complaints was assessed as approaching severe (3 and 4 on a four-point scale) in two thirds of the cases.

Measurements

Two thirds of all the reported measurements were taken at a distance of between 10 and 50 m away from the specific noise source with many of these in the gardens of the nearest residential building or complainant's house. Two sets of measurements were taken outside the first floor facade and two sets were taken inside the complainant's bedroom. The different types of instrumentation are shown in table 1.

Measurement Values

Figure 1 shows the Rating Levels for the cases where this value was given. The figure shows that most of the cases had a Rating Level which fell into the range between 56 and 60 dB(A). On

closer examination of the noise levels, it could be observed that where the complaints were assessed as likely and the investigating officer agreed with the BS4142:1990 prediction, 20 out of 22 cases had a Rating Level of 49 dB(A) or more for day time measurements. For nighttime, this level was 45 dB(A) or more for all of the cases where complaints were assessed as likely.

These Rating Levels will be interesting to compare with the action levels (absolute noise levels) proposed in the revision of Circular 10/73 'Planning and Noise' (10). The Rating Level values however contain character and duration corrections. It should be pointed out that since little data was obtained on complaints that were rated as unlikely, a minimum value for a noise action level for planning was difficult to determine from these results.

Figure 2 shows a comparison of the values of L_{A90} and L_{Aeq} for the residual noise in the cases where both values were given. This showed that the L_{Aeq} values covered a slightly wider range of levels than for L_{A90}. However, it should be pointed out that this information does not provide data relating to variability over time. In two of these cases, the difference between the values was greater than 10 dB(A). The first of these cases involved measurements taken over a 300 seconds period near to the side of the road with a variable flow of traffic. The other case resulted from measurements taken over 1 hour near to the entrance of a site with HGV's entering and leaving.

An examination of the types of sources which contributed to the residual noise showed that over three quarters were reported as resulting from road traffic noise and a third was due to local industry and plant.

Assessment

Table 2 gives the assessment of the BS4142:1990 rating method together with whether the investigating officer considered the complaint to be justifiable and whether the source operators had been contacted directly. This shows that the majority of the BS4142:1990 predictions related to complaints that were rated as likely. In 85% of the cases, the EHO considered the complaint to be justified and only in 30% of the cases had the complainant not contacted the source operator directly. Where the complaint was not considered justifiable, the assessment predicted that complaints were unlikely except for one case where the difference between the Rating Level and Background Noise Level was 5 dB(A) and another case involving multiple noise sources.

Figure 3 gives an indication of how well, in the opinion of the investigating officer, the BS4142:1990 rating method compares to

the actual investigated noise complaints. This shows that where an opinion has been expressed, 78% indicate that the assessment method corresponded fairly well.

From the forty cases, in the opinion of the investigating officer, five suggested that the rating method was underpredicting the number of complaints, whereas two suggested that it overpredicted. The overpredicted assessments arose from the officer's subjective impression of the noise levels. For the underpredicted cases, opinions were expressed on the reasons for the apparent inaccuracy of the standard's predictions, as follows.

The first case related to shooting noise, which strictly speaking lies outside the scope of the standard. The officer concluded that the subjective annoyance of its impulsive nature was underrated.

The next case related to noise from the impacts resulting from waste being transferred from skips to lorries. The BS4142:1990 prediction of the likelihood of complaints was considered to be underpredicting this type of noise.

A further case of reported underprediction by the standard related to noise which was tonal, intermittent and new. The view was held that the combination of these characteristics added considerably to the overall annoyance effect and the rating method underpredicted its total effect of the noise on nearby residents.

The fourth case involved a planning assessment for a car wash with the drying phase deemed as the most annoying to the community. It was commented that with noise of this particular character and intermittent durations of operation, the assessment method did not correspond very well with the predicted likelihood of complaints.

Finally, reference was made to structure borne vibration which was manifesting itself inside the dwelling as a low frequency hum. This in the view of the officer was not addressed properly in the standard.

Additional Comments Relating to the Implementation of the Standard

From the comments on the data sheets and with supplementary comments from written and verbal correspondence, additional points were highlighted relating to the implementation of BS4142:1990. The following gives a few examples of how the investigating officer has dealt with particular situations.

In several cases, direct reference was made to problems the investigating officer was having in rating a noise as tonal. With no objective measurement procedure within the standard, subjective assessment was relied upon. However, even in the cases where this was supplemented by spectral analysis, it was sometimes unclear whether the noise was indeed tonal or otherwise. In all the cases the rating was performed with a character correction thereby relying primarily on the subjective impression of the noise.

Difficulties were identified with the assessment of multiple noise sources. These arose when trying to measure the background noise and having to make a decision as to whether the noises should be considered separately with each noise contributing to the residual noise of the other. In some cases, the shutdown of one piece of equipment revealed an additional offending source. With these cases, a decision had to be made as to whether the industrial plant as a whole or a particular noise source alone should be rated. Most of the time, each individual noise source was examined separately thereby including other sources in the residual noise level. Creeping and diminishing background were also identified as factors which were not properly addressed within the standard and was highlighted in a recent paper (11).

Although only two cases involved measurements inside a bedroom, comments were made as to whether the standard should apply inside the dwelling. This was emphasised in one case where measurements inside the house showed that easily measurable nodes and anti-nodes were set up from a low frequency hum. It was the opinion of several users of the standard that limits set inside the dwelling would be more representative. In all these cases, subjective rating seemed to determine the measurement positions and method of assessment.

In many cases the investigating officer has carried out the assessment to determine nuisance. The objective method was used to back up subjective opinion before action was taken with respect to nuisance under COPA (12) although according to the scope of the standard, this is outside its application. However with the absence of any other method, BS4142 is often used. In some cases, the industrial activities have not been assessed for nuisance with respect to noise alone but with other forms of pollution eg odour and dust.

Several of the case studies related to the assessment of noise near residences for elderly people. Although they probably do not have such acute hearing as younger people, they are in most cases more likely to be sensitive to noise due to the amount of

time spent in residence and their requirements for a relatively higher quality of life. This brought to light queries on how to rate noise near sensitive populations and queries were raised on whether the rating method should allow for these situations.

Concerns were raised relating to the comparison of L_{Aeq} with L_{A90}, particularly with fluctuating noise sources. It was pointed out that even without the specific noise source operating, the difference between the L_{Aeq} and L_{A90} can be in the order of 10dB giving an assessment of 'complaints likely'. It was commented that this was not what the standard had intended.

PRELIMINARY CONCLUSIONS

From the data sheets returned from the users of BS4142:1990, it has been shown that the BS4142 rating method on the whole seems to give a good indication of the likelihood of complaints although problem areas and ambiguities have been identified which need attention or clarification. These include the treatment of background noise with multiple noise sources, rating of tonal, impulsive and short duration noise, indoor measurements, population sensitivity and the comparison of L_{Aeq} with L_{A90}.

The study has shown that a large proportion of BS4142 assessments relate to noise problems involving tonal character. It has also shown that although the range of Rating Levels was fairly widespread, the results could be used to support values for the proposed action levels for planning.

Examination of the case studies has confirmed that some aspects of the standard are open to the individual interpretation of the investigating officer and personal judgment is required. This is shown when the standard is used outside the written scope, for example for indoor measurements, planning assessments and nuisance assessment. In the absence of specified objective procedures eg tonality identification, the individual must rely on his/her own subjective evaluation of the problem.

One conclusion that can be drawn from this work is essentially similar to that of Fleming (13). Noise problems are often assessed and solved by a combination of lateral thinking, discussion and through experience. BS4142 can be refined in the light of new experience and hence using information from this type of study but one should not expect it to answer all our noise problems or to lay down definitive rules. BS4142 is primarily an objective measurement procedure assessing a subjective effect and therefore can only be a tool for use with noise complaint investigations.

The work done so far has gone along way to meeting the original aims of the study. In addition to further analysis of existing data, more data is still required in order to increase the number of case studies and thereby create a more accurate national picture of how the standard is being implemented and so assist in its evolution.

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STUDY OF THE APPLICATION OF THE REVISED BS4142:1990

Table 1: Table to Show The Instrumentation Used for Measurement.

EQUIPMENT TYPE	NUMBER OF CASES	NUMBER OF RESPONDENTS
Brüel & Kjær 2231	15	9
Brüel & Kjær 2230	1	1
Brüel & Kjær 4427	2	1
Brüel & Kjær undefined	1	1
CEL 162(E)	3	2
CEL 262	1	1
CEL 393 (A & B)	9	4
CEL undefined	1	1
Cirrus 236	1	1
Other (undefined)	5	5

Table 2: The Assessment of the Industrial Noise.

	Number of Occurrences	Percentage of Those Responding to Question
Assessment of Likelihood of Complaints:		
no complaints	1	3%
unlikely	1	3%
marginal	2	5%
marginal to significant	1	3%
likely	32	84%
Does EHO Consider Complaint Justifiable?		
yes	29	85%
no	5	15%
Has Complainant Contacted Source Operator Directly?		
yes	23	70%
no	10	30%

STUDY OF THE APPLICATION OF THE REVISED BS4142:1990

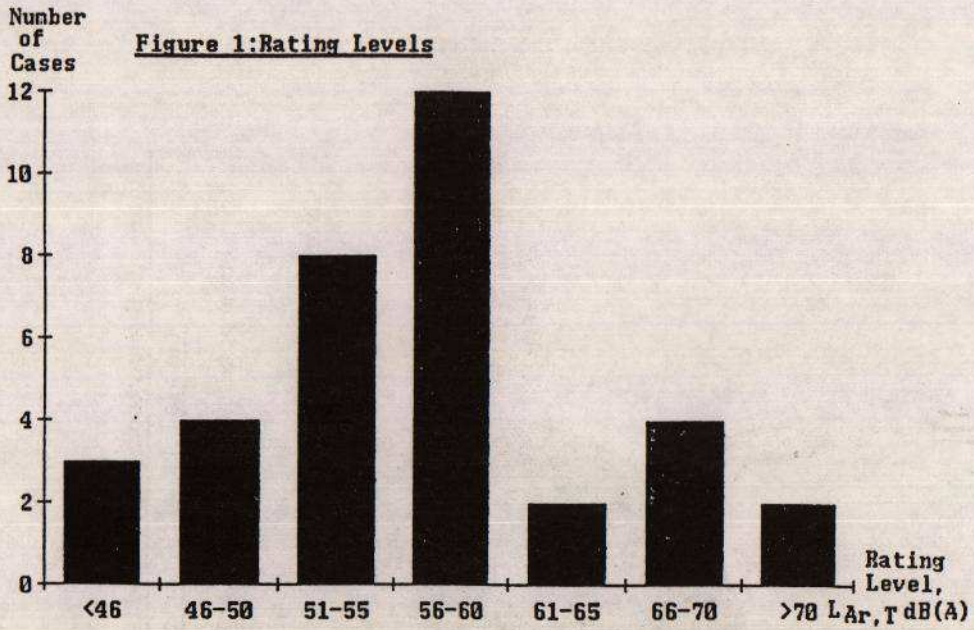

Figure 1:Rating Levels

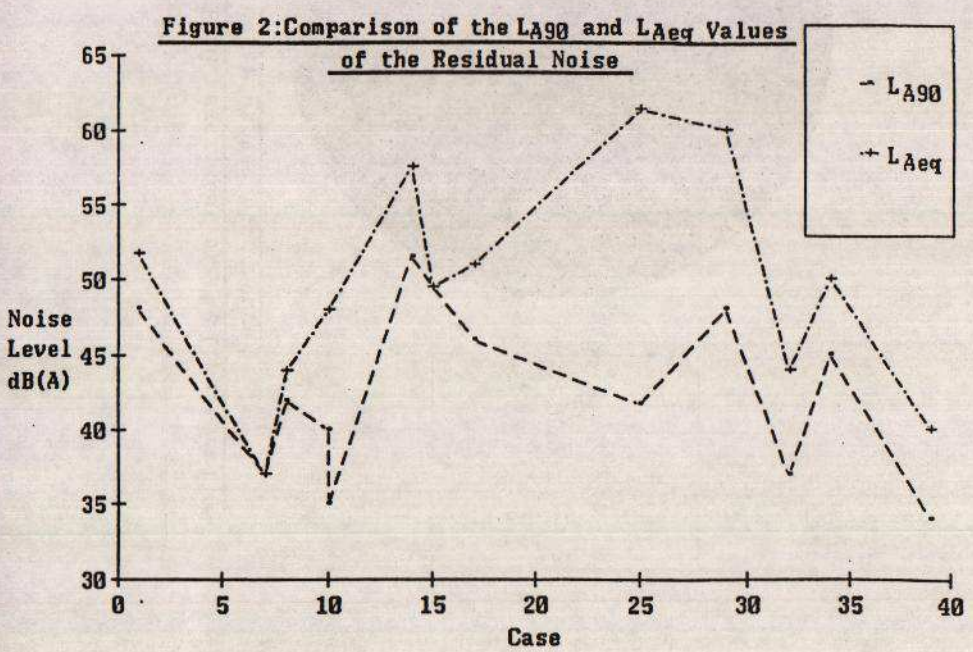

Figure 2:Comparison of the L_{A90} and L_{Aeq} Values of the Residual Noise

Figure 3: Comparison of the BS4142:1990 assessment of the likelihood of complaints with the actual reported occurrence