ISSUES RAISED IN REVIEW OF BS6472

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1. INTRODUCTION

In theory British standards are reviewed quinquennially. However, reviews are often triggered only when significant new information becomes available or when a revision is made to a related standard. In the case of BS6472 'Guide to Evaluation of human exposure in buildings (1Hz to 80Hz)' the review of the 1992 edition commenced in 1999 by the relevant British Standards Institution (BSI) committee was initiated when revisions to ISO2631 were proposed. The committee was aware of a perception amongst users, fed back largely anecdotally, that the standard was difficult to use and that the recommended assessment procedure delivered unexpected results. Some practitioners felt that the analysis of vibration measured in buildings using the weightings and table of VDVs related to probability of adverse comment proposed in Appendix A under-rated the likelihood that the motion would be perceived adversely.

The panel convened to undertake the work decided upon three main areas of effort:

i) to review the technical advice to check its accuracy and thence to formulate any necessary corrections or revisions;

ii) to review the logical development and clarity of the text in order to find ways to improve the presentation of the guidance; and

iii) to review any relevant research evidence that might have been over-looked or had become available since the publication of the 1992 edition, which might support technical revision.

At the start of the review the panel was asked to consider the separation of the guidance on shock (principally vibration from blasting) presently covered in Appendix B into a new Part 2. The possible need for explicit references to companion and related standards such as BS5228 and BS6841 emerged. Other matters proposed at the outset included a need for a more formal definition of terms and the inclusion of guidance on the assessment of parallel effects such as ground borne noise and a description of the threshold of perception of whole body vibration.

2. ORIGIN OF THE STANDARD

An obvious starting point for the review was to re-visit the research evidence that had provided the foundation for the technical content of the 1992 edition of the standard. The panel was reminded that the preference for vibration dose value (VDV) as a descriptor of whole body vibration, the weightings reflecting the distinction between the sensitivities of the human body to motion along its spinal and lateral axes, and the suggested numerical relationships between VDV and probability of adverse comment, all had their origins in research into thresholds of perception. The strategic decision as to whether a thorough technical revision was justified could be made on the basis of availability or otherwise of significant new evidence from research in this area post dating the publication of the 1992 edition.

The panel concluded that there was no significant new research evidence and that the aim of the review should therefore be focussed on editorial changes to the existing text to improve its clarity. These would include the addition of further advice on the assessment of parallel effects and on distinguishing between existing cases of vibration in buildings and planning for new development. It is felt that users might more readily understand the guidance if they have some insight into the complexity of defining perception thresholds and information on the research underpinning the standard will also be added.

Although the use of VDV as the preferred descriptor of whole body vibration has been a cause for much adverse comment from users, the panel has resolved that the research evidence convincingly demonstrates it to be the best of the practical alternatives. The revised standard will assert more emphatically than the present edition that the preferred method for measurement will be to record the unweighted acceleration time history of the motion under investigation, which would then be post-processed to obtain VDV from the weighted, band limited signal. The use of other methods will not be ruled out.

The Association of Noise Consultants (ANC) is represented on the panel and had just started its own review of BS6472 aimed at publishing guidelines for practitioners on its use. An interesting debate led to the conclusion that British standards are not intended to be textbooks. This conclusion limits the extent to which the narrative in the standard might be expanded but confirms the legitimacy and value of parallel guidance on its use and application. The ANC's input has been valuable and will be reinforced with the contribution of results from an experiment co-ordinated with the BSI committee to investigate inter-laboratory variation between different measurement techniques and analyses of a common suite of signals under controlled source conditions.

Meanwhile, the panel is frustrated that no dose/response data are available for vibration affecting people in real life conditions in buildings and has resolved to lobby for funding to be made available for research. In the long term the thorough technical revision of the standard and upgrading of numerical guidance for assessment of exposures from advisory to mandatory can only be undertaken on the basis of a broader corpus of information than is currently available. The panel regrets that it has been unable to secure any encouragement from funding bodies that grants will be made available in the foreseeable future. One of the reasons offered by the relevant government department is that there is no evidence that the public is significantly concerned about whole body vibration. This is a proposition to which practitioners from local authorities and consultancies might like to respond.

3. REVIEW OF THE TECHNICAL ADVICE

An initial review of the technical content of the 1992 edition of the standard concluded that it contains no serious mistakes and that any errors are sins of omission rather than of commission.

Amongst the omissions is a significant one, clear to a dedicated critical reader but probably un-noticed by the average user. The difference in the mean threshold of perception for whole body vibration along the spinal (z) as opposed to lateral (front to back (x) or side to side (y)) axes of the body is well known. The logic for different weightings to be applied to linear broadband measurements of motion is clear. Although direction is provided in paragraph 3.2 of the existing edition it is not clear to all readers, however, that the standard anticipates that the principal axis of motion (relative to the human subject, not the building they occupy) under investigation should be identified and the assessment then made for the uniaxial signal. It is then even less clear that the table (Table 7 in Appendix A) suggesting probabilities of adverse comment against bands of dose values refers only to z-axis motion, because the offset between the base curves for x/y and z-axis motion is not explicitly mentioned. Some users have identified the omission for themselves and correctly multiply their x/y values by 1.4 before comparing them with the values in the table, but not all. Of course, the un-acknowledged offset reinforces the implicit message that vector values should not be summed.

These issues will be addressed and clear advice given in the revised standard. The elimination of the base curves and clearer presentation of weightings, both explicitly by reference to BS6841 and by the inclusion of tables of factors akin to the familiar A-weighting factors used in frequency domain analysis of noise, will reinforce the advice.

The inclusion of more background information on the imprecision of thresholds of perception will help to explain the imprecision in the advice on assessment. The revising panel notes that the precision in the specification in Table 7 of night time thresholds is unjustified and perhaps misleading.

4. REVIEW OF THE LOGICAL DEVELOPMENT AND CLARITY OF THE TEXT

The review panel has recognised that pulling apart the source/transmission path/receiver components implicit in the guidance and re-editing them to present a more logical development could probably improve the clarity of the text. Thus the revised edition will treat the characteristics of the source and hence the probable best approach to measurement, the characteristics of the building in which the motion is perceived and hence the measurement itself, and then the characteristics of the receiver and hence the meaning of assessment, as a logical progression.

New elements to the guidance will be introduced. A careful definition of different types of source will lead to more direct advice on appropriate measurement techniques. Aspects which are perhaps too briefly covered in the present edition such as the appropriate sampling time, extrapolation of results in the time domain and periods of assessment will be more expansively treated.

A new component to the advice on measurement will be the introduction of a quick preliminary test to establish roughly the building – or at least, the floor – response. Guidance will be offered on how to sample vibration levels across a floor having established its likely modal behaviour. The use of the standard as a planning tool has been recognised as a special case and advice will be presented on the prediction of vibration levels in a proposed building either from modelling or from measurement of ground vibration in the free field and extrapolation by the application of transfer functions. In the spirit of the overall principle that a British standard should not become a textbook, the level of the advice offered will be sufficient to guide experienced users in the right direction but will not substitute for proper study of the subject from established sources.

It has seemed to the review panel that some of the problems reported by users of the present edition of the standard are not so much the result of inadequate specification as of inexperience. An example is the use of the base and multiplied curves as rating rather than as weighting. The elimination of the curves and inclusion more explicitly of instructions on weighting will make the intention more clear. A further area in which the guidance could be clearer lies in the advice on measurement positions. Thought is going into the proposition that the standard should adopt the idea of a measurement reference position from which a human subject's experience of whole body vibration might be estimated by applying transfer functions. Advice on measurement sample averaging times would be desirable but is difficult to formulate and leads are being sought from other national and international standards.

Advice will be provided for the first time on evaluating, or at least on acknowledging, the influence of parallel effects on a subject's perception of vibration. Tangible vibration may be accompanied by the shaking of houseplants, rattling of crockery and not least, by low frequency ground and structure-borne noise. Qualitative advice will be provided along with more objective guidance on evaluating noise. The practice of evaluating ground borne noise by A-weighted descriptors will be discouraged and instead a regime involving evaluation in third-octaves will be recommended.

A draft of a new Part 2 to the standard in which shock, particularly from blasting, will be addressed separately has been produced for discussion. It is likely that this will be developed into a freestanding second part to the revised standard.

The panel has recognised the help to investigators, and therefore to those they set out to advise, of the checklist provided in BS4142 of facts and quantities to be reported. It is proposed that a similar checklist will be provided in BS6472. This will enhance the usefulness of the standard in perhaps its most important role, that of establishing a level playing field for all investigators so that their results can be directly compared and thus, in time, a database of experience built up from which some of the research gaps identified earlier might be plugged.

5. REVIEW OF ANY RELEVANT NEW RESEARCH EVIDENCE

Having established that no major new research into perception or into dose/response relationships had been reported since the 1992 edition was completed the panel determined that no technical amendments could be made. However, it emerged in discussions that there was an outstanding question as to whether at the relatively low magnitudes of vibration usually involved in real life complaint investigations, the BS6841 w_g weighting which is implicitly adopted (through the linear approximation represented by the base curve) for the evaluation of z-axis motion was the best option. There is research evidence to support the proposition that the w_b weighting would be more representative of perception at those magnitudes.

A desk study has been carried out by members of the panel who have looked at existing data that can be re-analysed to show corresponding differently weighted results. It has emerged that the frequency content of some common day to day environmental vibrations, of which passing trains are probably the best known and most ubiquitous source, is such that the change from w_g to w_b weighting would approximately double the magnitudes of measured z-axis event VDVs. The change of weighting curve would to an extent answer the often levelled perception that the assessment procedure laid recommended in the 1992 edition leads to under-estimation of probability of adverse comment.

The panel does not have the resources to examine the effect of changing the z-axis weighting on dose/response correlation. It can only observe that there is some evidence to support such a change in the available research data, much of it related to laboratory experiments aimed at investigating perception thresholds, and that a consequence of so doing would be to approximately double numerically the event VDVs for a number of types of commonly encountered vibration event.

At the time of writing the panel has not reached a final decision on whether to institute the change in the next edition of the standard.

6. CONCLUSION

A panel set up under the auspices of the relevant BSI standing committee has reviewed the 1992 edition of BS6472. In the light of critical comments from users it has looked at the standard with a view to identifying actual mistakes and errors, areas where advice could usefully by augmented and re-organised to make the guidance more clear and easier to use, and at the scope for technical revision.

The panel hopes that by filling in errors of omission and by re-ordering the text it can improve the readability of the standard. Expanded advice on measurement and additional advice on matters such as prediction and on evaluating parallel effects should sharpen the standard as a tool for practical investigations. One significant technical revision might involve the replacement of the presently recommended z-axis weighting with an alternative. A final decision on the last has yet to be made.

The process of reviewing and revising a technical British standard is necessarily a long one. The unpaid panel members all give their time freely and much literature reviewing as well as critical appraisal of existing research evidence and drafting of subsidiary position papers is required. The aim is to produce a concise, accurate summation of the state of the art knowledge in the subject area. This is not a process that can be hurried to meet ideal publishing deadlines.

The author will not venture a publication date for the next edition of BS6472. It would be nice to think that it will be BS6472:2003, but that is most certainly not a promise!