Proceedings of the Institute of Acoustics

PPG 24 - PLANNING AND NOISE

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1. INTRODUCTION

The Government's Planning Policy Guidance: PLANNING AND NOISE, PPG 24 [1] was issued in September 1994. It contains technical advice on noise assessment, and difficulties have been reported in the application of the PPG criteria. The then Department of the Environment therefore awarded a research contract to review the technical application of PPG24 and to identify any requirements for additional guidance. (It is not intended to make any changes to policies and principles contained in the PPG.) The contract was awarded in March 1996 to the author, and this paper summarises the work undertaken, and the findings.

The objectives of the work were to study the application of PPG 24; to identify any requirements for additional guidance; to make recommendations as to needs and priorities for additional guidance to assist in the application of PPG24; and to provide an indication of possible methods that could be developed and then adopted in the guidance. The issue of further actual guidance is of course a matter for Government and is outside the scope of this paper which contains solely the views of the author and not necessarily those of the Government.

2. THE EXISTING GUIDANCE

The guidance given in PPG 24 can be summarised as follows. The first priority is separation of noise sources and noise receivers. Mitigation is the second priority, where separation is not possible. Local authorities must take the content of Planning Policy Guidance notes into account in preparing their development plans. Plans should contain policies to separate noise sensitive development from existing noise sources and noise-emitting development from noise-sensitive areas. Policies to protect tranquil areas may be appropriate. In consideration of applications for residential development near transport-related noise sources Noise Exposure Categories should be used. Development control should ensure that development does not cause an unacceptable degree of disturbance. Noise-sensitive development should not normally be permitted in areas which are—or are expected to become—subject to unacceptably high levels

of noise. Where separation of land uses is impossible, noise should be controlled or mitigated through the use of planning conditions or planning obligations. The effect of noise on designated areas and the countryside should be considered. Further guidance is provided to elaborate upon the policy guidance, and to provide, in some cases, numerical and other technical means of determining whether the policy criteria are met. The principle numerical guidance relates to the determination of Noise Exposure Categories (NECs). In Category A, noise need not be considered as a determining factor in granting planning permission, although the noise level at the high end of the category should not be regarded as a desirable level. In Category B, noise should be taken into account when determining planning applications, and, where appropriate, conditions imposed to ensure an adequate level of protection against noise. In Category C, planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise. In Category D, planning permission should normally be refused. Recommended boundaries for the NECs are given in terms of L_{Aeq} for day and night according to type of noise source, (see table 1 below).

For residential development exposed to noise dominated by an industrial source the recommended method of determining noise acceptability is to use the guidance in BS4142 [2]. However, this standard offers no test of acceptability *per se*. PPG 24 indicates that likelihood of complaints, which is to some extent predictable using BS 4142, should be the basis of acceptability.

For the assessment of noise from non-industrial and non-transportation sources, no guidance is given on the quantification of acceptability.

2. THE STUDY

All planning authorities in England, of which there are just under four hundred, were consulted. A wide range of other organisations were also consulted and five workshops were held. Approximately 40% of the local authorities replied. Of these, seven have policies exactly based on the PPG24 Noise Exposure Categories. Fourteen local authorities have taken or expressed an intention to take PPG24 into account in review of their plans. Several authorities are acting together to provide guidelines for use in their areas. Twenty six authorities reported no policies on noise, no planning appeals or inquiries giving rise to unresolved noise issues, and had no difficulties or other views on PPG24.

A study was made of planning appeals decided by inspectors or by the Secretary of State for the Environment in which reference was made to PPG 24. A total of twenty reports and decision letters were considered.

The consultation responses and the workshops discussions raised a large number of points. These can be summarised as: shortage of resources; uncertainties over measurement and prediction of noise levels; lack of consideration of amenity as a concept; needs for further guidance on noisy development both involving commercial/industrial and a wide range of other sources; lack of advice about preventing creeping ambient; difficulties with Noise Exposure Categories; interaction with other orders, regulations and guidance and many other miscellaneous points.

3. NEEDS FOR ADDITIONAL GUIDANCE

Needs for additional guidance were identified in the following areas.

- There is a need for further guidance on a number of aspects of Noise Exposure Categories, including methods of establishing site noise levels whether by measurement or prediction, and to define whether an open site should be assumed or whether the built environment should be taken into account.
- There is a need to define the levels of noise protection which are required if residential development is permitted in categories B and C.
- There is a need to clarify whether references to "industrial" development also include "commercial" development.
- A wide range of circumstances were identified in which there is a need for further guidance, including cases of low background noise level, aerodromes with low movement numbers and ground noise at airports.
- The need for a number of corrections was identified.
- There is a need to clarify the status of model conditions in the light of Circular 11/95 and to provide further guidance on conditions which implement the PPG's advice about the need for 'adequate' and 'commensurate' protection.
- There is a need to consider how to take account of changing guidance from the World Health Organisation.

Some of the detailed issues associated with these needs for additional guidance are discussed below.

3.1 Noise Exposure Categories

It became quite clear in the study that the PPG's advice about Noise Exposure Categories is being widely interpreted, by local authorities, developers, planning

inspectors and others in two conflicting ways. In some cases, sites are assessed as open sites without taking account of noise mitigating features such as noise screens or of the built form on the finally developed site. Developers have come forward with schemes in which, by a variety of means, they achieve noise levels at façades which place the development in a lower category than would be the case for an open site. There have been cases put by developers that they need only evaluate the noise level at ground level (e.g. 1.2 to 1.5m above ground), when clearly at higher levels, such as first floor and above, the effect of noise barriers may be substantially less. At the other extreme, local authorities have insisted that sites should be categorised as open sites, without allowing for noise barrier features, even going to the trouble of calculating the effect of an already existing noise barrier in order to remove the effect.

One of the tasks of development plans is to allocate land, and in allocating land for future housing development, when there can be a long delay between considering land for housing and development actually being completed, it is difficult to determine NECs if it is necessary to take account of the built form on the site, when only the broadest indication of the likely form that development might take may be available. By contrast, paragraph 8 advises that NECs are introduced to help local planning authorities in their consideration of applications for residential development near transport-related noise sources, in which case determination of NEC categories could, if necessary, take full account of all features to be built on the site.

Some assistance in resolving the apparent conflict is available if care is taken to read the specific technical guidance on NECs within the context of the overall guidance provided by the PPG. Paragraphs 2 and 12 of the PPG make it quite clear that the principal policy is to separate noise-sensitive development from noisy areas. Only when this is not possible is mitigation recommended (paragraph 2, last sentence). Mitigation is defined in paragraph 13, and includes protection of noise-sensitive buildings (e.g. by improving sound insulation in these buildings and/or screening them by purpose-built barriers), screening by natural barriers, other buildings, or non-critical rooms in a building. In paragraph 17, advice is given on conditions. "Where it is proposed to grant permission for noise-sensitive development in areas of high ambient noise, planning conditions should be imposed to ensure that the effects of noise are mitigated as far as possible. For example intervening buildings or structures (such as garages) may be designed to serve as noise barriers. In some cases sound insulation measures may be considered appropriate. (Such measures will mainly apply to windows: additional guidance is given in Annex 6.). However, it should be remembered that the sound level within a residential building is not the only consideration: most residents will also expect a reasonable degree of peaceful enjoyment of their gardens and adjacent amenity areas."

Annex 1 advises that "When assessing a proposal for residential development near a source of noise, local authorities should determine into which of the four noise exposure categories (NECs) the proposed site falls, taking account of both day and night-time levels. Local planning authorities should then have regard to the advice in the appropriate NEC." The advice in NECs B and C refers to conditions being imposed when permission is given.

In summary, the position is: determine the *site* NEC, *then* consider conditions, and conditions include measures such as barriers which would actually reduce façade noise levels. There is no suggestion that having imposed the conditions, the resulting mitigation entails re-categorization to a less strict category.

If it were otherwise (and noise mitigation caused recategorization), logical absurdities would ensue. For example, if an open site exists, and noise levels on the site place it is category B, and a developer subsequently prepares a planning application assuming planning conditions requiring noise barriers along the road frontage which have the effect of reducing noise on the site by at least the amount by which the noise exceeded the threshold of category B, then the consequence of transferring the site from NEC B to NEC A would be to change the advice to "Noise need not be considered as a determining factor in granting planning permission". There would then be no need for a planning condition to ensure that the mitigation measures on which the transfer from category B to category A depended were included in the scheme.

If "open site" assessment is the rule, however, how do you define "open site"? Suppose the natural terrain of a site gave noise protection, for example because a road passing the site were in a cutting, such that the site was in category A, and a developer regrades the site, lowering the ground level and the noise barrier effect of the top of the cutting is reduced, which is the open site—the original ground topography, or the regraded topography? To take out of a NEC computation the effect of a cutting, which in most cases ground levels are not subjected to significant regrading, would be going too far.

The real test to determine whether or not topographical features on the site have the effect of changing the NEC category is whether the NEC is dependent on planning conditions. If façade noise levels, or noise levels in gardens, are low enough to shift a development from one NEC to another only as a result of including features in the development the presence of which has to be ensured by means of planning conditions, then the NEC category does not change.

Extending this logic leads to a potential difficulty if the development itself introduces a significant source of noise such as a road. Applying a consistent approach, its effect should not be taken into account in determining the NEC for the development, but

mitigation against its effects should be considered as a matter for planning conditions or planning obligations.

A matter which requires clarification is whether the onus should be upon the planning authority to carry out the noise assessment of a planning application, or whether the authority can legitimately place the burden on the applicant.

3.1.1 Low background noise levels. There is repeated reference in the consultations to problems of areas with low background noise levels. Where this affects the applicability of BS4142, the comments are clearly valid and the 1997 revision to BS 4142 provides some clarification. Some of the comments are made in the context of the use of Noise Exposure Categories, which are based on absolute environmental standards and the concept of their representing large increases in noise in areas of low background is illogical since with new housing development there is no pre-existing occupier to experience the increase, unless, contrary to PPG24's advice, NECs are used in reverse. The argument against using NECs in reverse is not stated very strongly in the PPG, and indeed could be reinforced by adding the point that in areas of very low background noise, using NECs to gauge the impact of a new noise-emitting development could conceal a significant increase in noise for the pre-existing residents.

3.1.2 Use of NECs in reverse. The consultation responses indicated a significant demand for something akin to the use of NECs in reverse, or more clearly stated absolute standards or specific guidance on noise limits such as that given in MPG 11 [3]. PPG24 appears to acknowledge the place of absolute standards for noise-emitting development, in its reference to BS 8233:1987 [4] in Annex 3 paragraph 19, and to the WHO guidelines [5] in Annex 2. However, a forensic reading of the documents could suggest that BS 8233 relates to standards for new buildings, and reference to WHO is made only in the context of NECs, which only apply to new buildings. Annex 5 Section 1, indicates the appropriateness of an absolute limit for noise from a new source, without giving explicit guidance on the selection of the numerical value of the limit.

3.1.3 Creeping ambient and absolute limits. The repeated concern expressed about the loss of the advice formerly given in Circular 10/73 [6] on prevention of the "creeping ambient" is allied to the subject of absolute limits, since a creeping ambient becomes a problem when the ambient creeps above some point of unacceptability.

Given the fact that sources such as recommendations from the World Health Organisation obviously have status quite independently of PPG24, and their recommendations are not restricted to new noise-sensitive development near existing sources, from transportation or otherwise, the introduction of absolute standards into planning arguments is inevitable, and PPG24 ought perhaps to grasp the nettle.

3.2 Non-industrial noise emitting development.
The largest policy area in which guidance is lacking relates to noise-emitting development other than industrial noise, or industrial and commercial noise if paragraph 11 of the PPG is not interpreted strictly. The list of types of noise source faced by planning authorities is long and contains some surprising items. The prospects of being able to give detailed guidance on all of them are not good, but a possible approach to solving the problem progressively emerged in the course of the study, and is referred to below.

4. POSSIBLE METHODS THAT COULD BE ADOPTED IN FURTHER GUIDANCE

With a view to fulfilling the needs for additional guidance identified, the following text passages give an outline of the type of advice that would deal with the issues raised.

4.1 Interpretation of NEC advice
There are two conventions in the presentation of environmental noise data, one of which takes account of the effect of the presence of building façades, the other does not (the results being known as "free-field"). The values in the table below are free-field noise levels as would, for example be measured on a flat, open site at the position of the proposed dwellings, well away from any existing buildings. Many sites are neither flat nor open, and the question of whether or not site features, which cause noise levels to differ from those on an open site, should be taken into account must be considered in the following manner.

Predictions of noise should take account of the layout of the site ignoring any features whose presence in the completed development could be ensured only by planning condition or planning obligation. The effect of noise barriers, earth bunds, buildings which will exist on the site following completion and the nature of the ground surface should be taken into account only if they would exist in the absence of planning conditions or obligations. The purpose of the NEC system is to detect the need for such planning conditions or obligations and therefore their effect does not play a part in deciding the NEC into which an application site falls. Noise generated by parts of the development itself, such as access roads, should not affect the NEC categorization of the site, but should be taken into account in considering necessary mitigation measures.

The noise levels which are relevant to the determination of the Noise Exposure Category of a site affected by noise from roads or railways should be determined using the calculation procedures, where they are valid, required by the relevant Noise Insulation Regulations. Measurements are appropriate where those procedures provide for them. The results should be adjusted for consistency with the units and time periods used. For noise from roads to which the procedures of the Department of Transport

publication 'Calculation of Road Traffic Noise' (CRTN) [7] are applicable, hourly traffic flow figures should be determined (taking those which would produce the highest noise levels based on predictions of traffic flows for 15 years after the proposed dwellings would be first occupied) and the hourly L_{A10} values calculated in accordance with Section I, paragraph 31.2 using Chart 2. The hourly values between 2300 and 0700, and between 0700 and 2300 should be averaged arithmetically and rounded to the nearest whole number of decibels (0.5 being rounded up). In circumstances where CRTN provides for measurement instead of prediction, hourly values may be measured according to Section III, and adjusted for the projected traffic flow figures. In such cases L_{Aeq} values may be measured directly; in other cases, L_{Aeq} levels should be obtained from calculated L_{A10} levels by the subtraction of 3 dB from the final result.

For noise from railways where the Department of Transport publication 'Calculation of Railway Noise' (CRN) [8] is applicable, $L_{Aeq\ 0700\text{-}2300}$ $L_{Aeq\ 2300\text{-}0700}$ may be calculated directly using Stage 5 and substituting appropriate figures for numbers of trains in the period 2300-0700 in Q_{NIGHT} and in the period 0700-2300 in Q_{DAY}. The constants 43.3 and 48.1 should be changed to 44.6 for night and 47.6 for day. The rail traffic assumed should be that which would produce the highest noise levels within 15 years after occupation of the proposed dwellings.

On a flat, open site, the effect of height is largely limited to the effect of soft ground cover. On complex sites, perhaps affected by elevated transportation systems, or the effect of cuttings, noise levels may vary considerably with height. For aircraft noise, the effect of height is not normally relevant. The noise levels used for determining NECs should be determined for, or corrected (using the methods given in the CRTN or CRN) to, the height of the highest noise sensitive window in any building façade which could be built on the site.

For aircraft noise, noise contours prepared according to the method adopted by the Department of Transport should be used both as regards the technique used to predict the contours and the treatment of assumptions regarding runway usage. These should be based on air traffic forecasts such that would give the highest noise levels within 15 years after the proposed dwellings would be first occupied.

If part of a site falls in one category and part in another, the relevant parts of the site should be assigned Noise Exposure Categories individually.

In cases where noise from more than one transportation source affects a site under consideration care must be taken in combining the contributions of each source to the overall noise level.

The NEC boundaries, the derivation of which is explained in Annex 2, are largely based on (or traceable to) the effects of noise indoors and indoor noise levels are little affected by reflections from façades or the ground surface. For this reason, when combining noise levels from aircraft with noise from roads and railways, the effect of ground reflection which is included in aircraft noise contours (and deemed to be 2 dB) should be subtracted from the aircraft noise level before decibel (logarithmic) addition of the sources. If the combined level is 3 dB or more greater than the noise level of any individual source, the "mixed sources" category limits should be used. Otherwise the road, rail or air traffic category limits for the source with the highest noise levels should be used. Although there are circumstances where different transportation noise sources may exist on opposite sides of a site, so that one building façade may not be affected by both together, the consequences of this possibility should be ignored.

If a proposed development site contains buildings to be demolished or significantly altered, the change in topography is not dependent on a planning condition or obligation, and a measurement method is used, care should be taken to correct the results for the proposed change in the layout and topography of the site, using correction methods in either CRTN or CRN as appropriate. No corrections for the presence of buildings should be made in the case of aircraft noise.

Where a dwelling falls exactly on the boundary between two categories, it should be placed in the higher of the two categories.

The NEC system is not primarily intended for dealing with industrial noise. Where a site is affected by noise from an industrial or commercial source, an assessment according to BS 4142:1997 should first be carried out. If the conclusion according to paragraph 8.2 of BS 4142:1997 is that complaints are likely, the proposed development should be placed in category D. If the conclusion is that the noise is of marginal significance, the proposed development should be placed in category C. In all other cases, the $L_{Aeq\ 0700\text{-}2300}$ and $L_{Aeq\ 2300\text{-}0700}$ values of the industrial noise (after adding a character correction as described in paragraph 7.2 of BS 4142) should be calculated and combined by decibel (logarithmic) addition with noise from transportation sources and allocated a NEC using the criteria for "mixed sources", unless one of the transportation noise sources is dominant in which case the development should be assessed against the NEC criteria for that source. A noise source is dominant if its noise level, before combination with the noise of other sources, is not less than 2 dB below the combined noise level of all sources.

In considering the effect of planning conditions to make development acceptable in categories B or C, care should be taken, when carrying out a BS 4142 assessment, to allow for the lowering of background noise which may be a consequence of the

inclusion of noise barriers to protect a housing scheme, and which may consequently increase the likelihood of complaints about an industrial/commercial noise source.

4.2 Possible widening of the NEC principle
Consideration should be given to the possibility of using NECs for other non transportation noise sources if the local authority's assessment was that noise complaints would be likely in a particular area, for example an area around a well-established recreational facility.

4.3 Railway vibration
New guidance is required on the subject of NECs and vibration and ground-borne noise from railways.

4.4 The L_{Amax} test
Clarification of Note 1: "Several" means more than twice in any one hour period. "Regularly" means that it is predictable that events will occur according to a timetable or programme, e.g. trains in a timetable or delivery lorries which follow a predictable pattern, or of night time heavy vehicle flows on a road are high enough for several heavy vehicles to pass the site in one hour and give rise to individual noise events in excess of 82 dB $L_{Amax,S}$.

For aircraft noise and railway noise, an SEL value of 90 dB(A) may be used as the test instead of 82 dB $L_{Amax,S}$, since these quantities may be obtained by standard prediction methods. New guidance is required to enable $L_{Amax,S}$ or SEL to be calculated for road vehicles.

4.5 Annex 3
Annex 3 should be split into two sections, one dealing with development affected by existing noise sources, the other dealing with noise emitting development.

Advice on the planning of new roads is required, i.e. by referring to the Design Manual for Roads and Bridges in a wider context than vibration.

Advice on the interaction between the content of PPG 24 and the requirements for Environmental Statements is required.

4.6 Noise-emitting development
The conclusions reached using BS4142:1997 may be used as a test of the acceptability of the degree of disturbance referred to in paragraph 10. A likelihood of complaints is an unacceptable degree of disturbance. In considering cases of marginal significance, regard should be had to general standards for noise levels inside dwellings set out in paragraph 8.1 of BS 8233:1987 using values for the time period *T* consistent with those

used in the BS 4142 assessment and including a character correction as described in paragraph 7.2 of BS 4142. If these are not exceeded, then marginal significance may be acceptable.

Where there is no foreseeable likelihood of subsequent noise-emitting development in the same area such that the overall noise level from industrial and commercial sources would be increased, permission should not be granted where the conclusion according to BS 4142 is that complaints are likely. In cases where there are several specific noise sources, or are likely to be in the future, regard should be had primarily to the likelihood of complaints using the formal procedures of BS 4142, and also to the absolute noise level. It is undesirable that the overall free-field L_{Aeq} level should be increased as a result of new industrial or commercial development to a total external level of more than 55 dB 0700-2300 or 45 dB 2300-0700, or in cases where transportation noise sources give rise to external L_{Aeq} levels of at least one of those levels to a total external level which represents an increase of more than 3 dB using worst-case assumptions for a 15 year period following first use of the development.

In the case of development which is neither conventional transportation nor industrial or commercial, such as recreational and sporting activities or small aviation developments, the noise climate which would be likely to result should be predicted or estimated using a combination of field measurements (where possible) and established acoustical calculation methods. The change in the three descriptors most widely used for characterizing noise climate, namely L_{A90}, L_{Aeq} and a suitable method of representing typical maximum noise levels (e.g. the decibel average of a representative number of L_{Amax} levels) should be measured or calculated with and without the development. Changes in any of the descriptors of 3 dB or more are an indication that the development would potentially have a noise effect which should be carefully considered. The most valid way of considering numerical noise levels is to use them for the purposes of comparison with known cases of comparable nature in which information on the extent of disturbance to people is available, either in the form of published technical reports of noise and social surveys, or the experience of local authorities with similar developments. Where noise measurements are made for this purpose, some guidance is available in BS 7445 [9].

Local authorities should keep and make generally available all data which they obtain on noise levels and known public response to the noise sources concerned.

5. REFERENCES

[1] PLANNING POLICY GUIDANCE: PLANNING AND NOISE, PPG 24, Department of the Environment, H.M.S.O. London, April 1993
[2] METHOD FOR RATING INDUSTRIAL NOISE AFFECTING MIXED RESIDENTIAL AND INDUSTRIAL AREAS, BS 4142:1997, British Standards Institution, London, 1997
[3] MINERALS PLANNING GUIDANCE: THE CONTROL OF NOISE AT SURFACE MINERAL WORKINGS, MPG 11, Department of the Environment, H.M.S.O. London, April, 1993.
[4] British Standard Code of Practice for SOUND INSULATION AND NOISE REDUCTION IN BUILDINGS, BS 8233:1987 British Standards Institution, London, 1987
[5] ENVIRONMENTAL HEALTH CRITERIA 12 – NOISE. World Health Organisation, Geneva, 1980.
[6] PLANNING AND NOISE, Department of the Environment Circular 10/73, H.M.S.O. London 1973
[7] CALCULATION OF ROAD TRAFFIC NOISE, Department of Transport, H.M.S.O. London, 1988
[8] CALCULATION OF RAILWAY NOISE, Department of Transport. H.M.S.O. London 1995
[9] DESCRIPTION AND MEASUREMENT OF ENVIRONMENTAL NOISE, Part 1. Guide to quantities and procedures, BS 7445: Part1: 1991, (≡ISO 1996-1:1982), British Standards Institution, London, 1991

noise source		noise exposure category A	B	C	D
road traffic	(07.00-23.00)	<55	55-63	63-72	>72
	(23.00-07.00)	<45	45-57	57-66	>66
rail traffic	(07.00-23.00)	<55	55-66	66-74	>74
	(23.00-07.00)	<45	45-59	59-66	>66
air traffic	(07.00-23.00)	<57	57-66	66-72	>72
	(23.00-07.00)	<48	48-57	57-66	>66
mixed sources	(07.00-23.00)	<55	55-63	63-72	>72
	(23.00-07.00)	<45	45-57	57-66	>66

TABLE 1 **RECOMMENDED NOISE EXPOSURE CATEGORIES, $L_{Aeq,T}$, dB**

Proceedings of the Institute of Acoustics

SAFETY VALVE NOISE; LIMITS, REDUCTION AND CONTROL

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1. FIRST A LITTLE PHILOSOPHY

1. As a Contractor's Engineer, one wants to have a model or other method of solution in place before one meets a cause for it's use.
2. Surely to have "no available model" shows absence of prior thought.
3. Some models will show lack of thought ,
eg1 A model inconsistent with the known facts or common sense,
eg2 No data to substantiate the maths,
eg3 Predictions inconsistent with the data.
4. A simple or basic model is better than no model at all, because, as information is gathered, the extra descriptions and data can be used to improve or change the model.

2. WHAT IS A SAFETY VALVE? HOW OFTEN, LONG, AND LOUD IS IT'S NOISE?

The safety valve is a device to avoid a dangerous build up of pressure within a system that it is designed to protect. The device may release the process fluid directly to the atmosphere via a short stub pipe, or release the process fluid via a pipe to a flare, or some other equipment. These will be called "open vent" and "closed" systems respectively. Such a safety valve is actuated by upstream pressure and is characterised by a "pop" action upon opening. Thus one should not expect a gentle release of gas proportional to valve lift. A safety valve is normally used with compressible fluids, and is distinguished from a relief valve which is primarily used with incompressible fluids (See the introduction to Ref 1 API 520). The safety valve is generally known as a PSV.

PSV noise can be expected to be in the region of 150 - 170 dB PWL. I will guess a figure of "once in a hundred years" for the operational frequency of a single PSV, and thus on a plant with a hundred PSVs a noise from a PSV might be heard once a year.

While the system is depressurising the PSV will make noise. The noise changes and decays with time as the pressure decreases. The noise is greatest while the pressure drop across the valve induces sonic velocities in the valve. The higher the pressure ratio the higher the noise. The PSV may "chatter" due to flow instability while the gas flow continues, and it may not re-seat when the pressure is low enough for this to happen.

We shall define these emergency releases of gas as transient noise sources, but it may take hours for the total inventory to be released to the atmosphere or to the flare.

3. WHAT CRITERIA MIGHT BE USED IN THE EVALUATION OF SAFETY VALVE NOISE?

Three noise related criteria are suggested for PSVs,
1. Noise received at the local community,
2. Acoustic fatigue of the components and associated pipe-work,

3. Noise received by a worker who is 'close' to an actuated PSV,
This paper is related to only the third of these.

Noise is radiated from the downstream piping and equipment as well as the wall of the PSV, but with open vent systems the majority of the noise exits via the open vent at the end of a stub pipe. PSVs with stub pipes to atmosphere might occur with Steam, Air, or Nitrogen, but rarely with Hydrocarbons.

Plant Owners' noise limits, for the avoidance of hearing damage risk, from such transient sources can be expected to be in the region of 100 to 125 dB(A) Sound Level. The 115 dB(A) limit in API EA7301 can be considered typical (See pages 16,17 of Ref 2).
The level is to be measured/ predicted at the worker location (or where he is expected to be, i.e. at Ground level, and on Platforms, Ladders, and Stairs).

4. WHAT REGULATIONS AND STANDARDS APPLY TO PSV'S AND THEIR NOISE?

Not all countries and standards organisations require that the safety valve be treated as a source of sound which has to be limited.
As an example of what might later be seen as an enlightened standards organisation, we might look at NORSOK and it's view that noise from PSVs should not be considered during design. (see Section 6.5.2 of Ref 3) [The noise limits shall not apply to design emergency conditions e.g. near safety --- valves, firepumps or outdoor areas during full emergency flaring, etc.]

References 4 to 11 are offered for review. The question to be answered (Designers and PSV vendors please note) is:
Does this SI etc. apply to my system and it's PSVs?

Below are the names of four documents which include noise limits that seem appropriate in the UK for any review of PSV noise.
API Medical Research Report EA7301.
This document dates from 1973. It describes the situation under discussion today. It set a limit of 115 dB(A) to steady sound, and 140 dB(peak) to impulsive noise. These were based on the US. OSHA 1970 Act.
Department of Employment Code of Practice. (Ref 12)
This document from 1972 sets an upper SPL limit of 135 dB(fast), or with an impulse noise an instantaneous SPL of 150 dB, for the unprotected ear.
86/188/ECC. (Ref 13)
This directive states that if a maximum value of the unweighted instantaneous sound pressure level is greater than 200 Pa "suitable and adequate" ear protectors , which can be reasonably expected to keep the risk to hearing to below the risk arising from exposure to 200 Pa, must be used
It is on this Directive that the UK's Noise at work regulations are based.
The Noise at work regulations. (Ref 14)
In this instrument there is reference to a peak action level of 200 Pa and they state that in cases of (likely) exposure above this level "suitable" ear protection shall be worn so as to keep the risk of hearing damage to below that caused by exposure to the peak action level.

We should note that in neither 86/188/ECC nor The noise at work regulations is the 200 Pa limit an absolute one. Above this pressure one can use "ear protection".
We might, however, reflect on the 200 Pa limit and the questions,
Is this a peak or rms. level?

What dB(A) level shall we assign to this 200 Pa?
What dB(Lin) level shall we assign to this 200 Pa?
Does it matter?
What we have to do is make a prediction of the expected sound and have a series of design options ready as we approach or exceed the limit.

5. HOW DO WE CALCULATE THE PSV NOISE AT KNOWN WORKER POSITIONS?

Standard methods of calculation for valve noise at a distance are available. Two methods for calculation of the noise are suggested: Sections 4.3.5 and 5.4.4.3 of API 521 (Ref 15), which appears to be based on the method described by Franken (See chapter 24 of Ref 16); and the new IEC/BSEN standard for control valve noise prediction (See Ref 17). It is reasonable to suppose that the noise at the manned positions close to the PSV will be a function of:

- valve and pipe radiation (themselves functions of frequency)
- vent radiation which is directly to atmosphere (a function of frequency)
- the distance to the nearest " worker position"
- any directivity associated with the ratio of, wave length of sound to vent diameter.

(the gas may be cold or hot and possibly about mach 0.5)

We will consider the case of an open vent rather than a closed system as it represents the most onerous case.

A simple method was developed to predict the sound level at an angle and distance from the pipe vent.
Assumptions were;
1. The API 521 calculation provided a dB(Lin) value that could be approximated to the same value in dB(A)
2. Directivity factors for the stub pipe's vent could be found and used.
3. A peak frequency of noise could be selected so as to act as a guide to the directivity factor.
4. Reduction of noise with increase of distance would follow the inverse square law.

A simplified set of directivity curves was used for the initial trial calculations with this method. They provided the increase or decrease of sound with angle and were based on data in ISVR Course notes (See Chapter 9 of Ref 18) which was itself based on BBN data from 1952 and VDI 3733 data of 1983. This directivity data is not given in VDI 3733 of July 1996.

Initially, there was a lot a work involved in gathering the data on the positions of the platforms ladders and stairs, and the positions of the closest PSV vents, but now, with the help of Foster Wheeler / Intergraph 3D PDS. it is a much quicker process.

6. "SO YOU KNOW IT'S NOISY, NOW WHAT?"

As contractors we expect to purchase equipment that complies with relevant laws, codes, standards etc. We expect vendors of equipment to comply with such stipulations, to have carried out sufficient research so that they can calculate the expected noise, warn of any foreseen dangers, and reduce the noise as much as reasonably practicable.

Recently, in furtherance of the work described above, an additional activity was undertaken. This was to seek the views of the PSV vendors on the current limits, and methods of noise reduction and control

A letter of enquiry was sent out to a number of PSV vendors. An edited copy is provided in the Appendix to this paper. The letter covered:

- Limit to PSV noise
- Philosophy for PSV noise released directly to atmosphere
- Noise Reduction
  The possibility of a quiet (<115 dB(A) at 1.5 m) PSV
  or PSV and silencer element
- Noise Control
- Current method of noise calculation and test basis of noise data
- Responsibility for noise prediction
- A proposal to provide to PSV vendors design information related to the position of the PSV vents and manned positions, so that the vendor could use it to advantage in their proposed solutions.
- Five possible methods were mooted.

Of the ten companies contacted we received two written replies.

7. CONCLUSION

1. The discharge from a PSV is noisy.
2. The limits are various, may be impossible to achieve, and pose the question,
How do we demonstrate by calculation that the limits have been complied with?
3. Some organisations absolve PSVs from compliance with noise restrictions in emergency conditions.
4. It would appear that some PSV vendors have yet to "grasp the nettle" and provide noise data for their ranges of safety valves.
5. Contractors may have understood their obligations but find it difficult to provide accurate information on the SL or SPL to be measured at a selected worker position.

8. REFERENCES

1. API RP 520. Sizing, selection and installation of pressure relieving devices in refineries.
Pt 1. Sizing and selection (March 1993)
Pt 2. Installation (December 1994)
2. Guidelines on noise. Medical Research Report EA 7301. API 1973
3. Design principles: Working environment. Norsok Standard S-DP-002 Rev 1,
Dec. 1994 (PO Box 547, N-4001 Stavanger, Norway. Fax (47) 51562105.)
4. Health and safety at work etc. act 1974 HMSO
5. The offshore installations (construction and survey) regulations. SI No 289, 1974
6. The construction (design and management) regulations. SI No 3140, 1994
7. The supply of machinery (safety) regulations. SI No 3073, 1992
8 The supply of machinery (safety) (amendment)regulations. SI No 2063, 1994*
9. Offshore electricity and noise regulations. SI No 1993, 1997
10. Offshore Installations: guidance on design, construction and certification.
Fourth edition. 1990. Section 52 and Appendix A52. Department of Energy. HMSO
11. Draft noise at work (offshore) regulations 199- . A Health and Safety Commission consultative document. HSE Books, 1996.

12. Code of practice for reducing the noise exposure of employed persons to noise.
Department of Employment. 1972 HMSO
13. 86/188/EEC Council Directive of 12 May 1986 on the protection of workers from the risks related to the exposure to noise at work.

14. The noise at work regulations. SI No. 1790, 1989.

15. API RP 521. Guide for pressure relieving and depressuring systems (March 1997)
16. Noise Reduction. L L Beranek (Ed) McGraw-Hill (Pub. 1960)
17. IEC 534-8-3: 1995 Industrial process control valves
Part 8 Noise Considerations
Section 3 Control valve aerodynamic noise prediction method
This standard has the dual number BSEN 60534-8-3 1996
18. Noise control for engineers in processing industries. Course notes 1990.
Institute of Sound and Vibration Research. University of Southampton.

APPENDIX TO
SAFETY VALVE NOISE; LIMITS, REDUCTION AND CONTROL

February 1996

Dear Sir,
LIMITS AND CONTROL OF NOISE FROM THE RELEASE OF SAFETY VALVES DIRECTLY TO ATMOSPHERE

1. Philosophy for Safety Valve Noise

Currently, we have occasion to consider what philosophy we should adopt on future projects in regard to the noise from safety valves which release directly to atmosphere, i.e. those that are not connected to a flare or other system. This letter, and your reply, will help define our future philosophy.

2. Limits to Safety Valve Noise

Limits to noise from "emergency vents" are often set at about 115 to 125 dB(A) at the ear of the nearest personnel. See, for example, the 115 dB(A) of API EA7301 (1973). Here 'emergency' relates to foreseeable design situations such as safety valve operation and emergency depressurisation.

3. Request for Comment

We seek your comments on the possibility of purchase of, say:-

1. a Safety Valve which does not exceed 115 dB(A), both at 1.5 m from the pipe vent and at positions 1 m from the valve body and 1 m from the down-stream pipe;

2. a Safety Valve with associated silencer element, which does not exceed the limits given above.

We also seek your comments on other possibilities for reduction or control of Safety Valve noise at the nearest personnel. Here we have in mind by way of example,

a. quieter valve designs;
b. quieter valve systems;
c. common silencers to a group of Safety Valves,

d. high level discharge, i.e. tall vent-pipes on individual valves or groups of valves, to take advantage of increased distance and directivity;
e. injection of water to cool the process fluid, say air or steam;
f. water curtains to act as a barrier to sound;
g. permanently installed sound barriers near to the Safety Valves or the personnel positions.

The foregoing should in no circumstance be taken as recommended solutions by FWEL.

4. Responsibility for Calculation and Test

We seek your comments on the suggestion that a Safety Valve vendor should be responsible for both the calculation to verify the noise from the Safety valve and the test procedure and measurement of the sound pressure level and sound power level. The same responsibility would remain with the vendor where a Safety Valve and an associated silencer element were bought from the Safety Valve vendor.

At this juncture, we also request that you send to us notes and information on:-
1. your current calculation method and its justification;
2. the test basis of your current range of noise data for Safety Valves.

5. Noise at Platforms, Stairways, and Ladders

The difficulty and cost of noise control may be reduced if advantage is taken of the distance and directivity between a Safety Valve vent and the nearest platform, stairway, or ladder (P,S,L).

We invite your comments on the proposal to provide vendors with details of both Safety Valve vent positions and P,S,L positions in order that they may take appropriate advantage of the distance and directivity effects of their proposed solutions.

6. General Nature of this Enquiry

Please treat this enquiry as a discussion document, which may be seen as " for the general good", and thus need not be regarded as strictly confidential.

Yours faithfully,

MDGR.