NPL REPORT CMAM 16

REPORT

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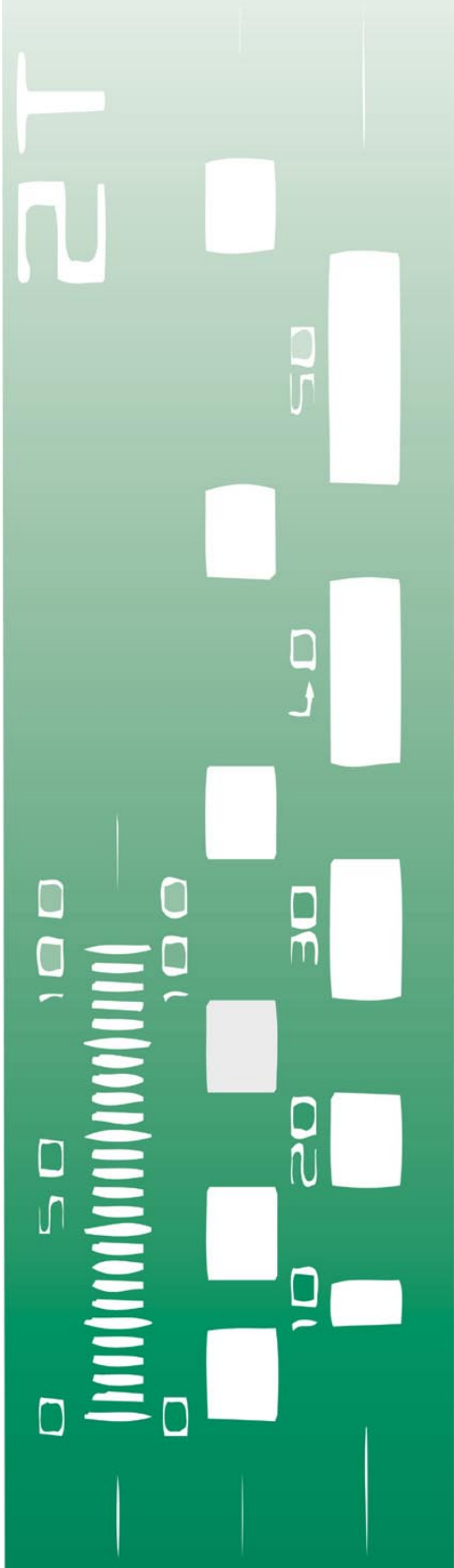

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ABSTRACT

The UK Department of Environment (DETR) requested the National Physical Laboratory (NPL) together with the Institute of Sound and Vibration Research (ISVR), to review noise standards used for assessing the health impact of environmental noise. The aim of this work was to advise the DETR of the extent to which it is justifiable to use existing knowledge on potential health effects to define future noise standards and targets. The literature confirms that there are a number of potential effects of noise on health, although the evidence in support of actual health effects other than those based on reported bother or annoyance and on some indicators of sleep disturbance is quite weak. Although the scientific evidence suggests thresholds below which it is unlikely that there is an impact on health, we cannot interpret these as definitive at this time. Existing standards and regulations usually take the results of primary research into account to some extent, but social, political and historic factors are at least as important. The 1995 WHO guideline criteria are interpreted as a precautionary approach to setting criteria.

It is concluded that given the present state of knowledge, it would be unwise to base future environmental noise standards and regulations on what are at present hypothesised non-auditory health effects until future research can make the present confused situation clearer. An increased emphasis on non-auditory health effects, as opposed to annoyance, as the outcome variable may lead to greater transparency in the development of standards, although there is considerable doubt as to the magnitude of these effects. To ensure that non-auditory health effects are included in future standards, research is required. This must be carefully designed, not only in terms of its planning and execution, but also in terms of setting precisely defined and achievable objectives.

ISSN 1369-6785

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EXECUTIVE SUMMARY

1. The UK Department of Environment (DETR) have recognised that in considering future policy on environmental noise, the idea of standards with a close link to health effects should be explored together with a consideration of the implications. It is within this framework that DETR placed a contract with the National Physical Laboratory (NPL), in collaboration with the Institute of Sound and Vibration Research (ISVR), to review noise standards used for assessing the health impact of environmental noise. The aim of this work was to advise the DETR of the extent to which it is justifiable to use existing knowledge on potential health effects to define future noise standards and targets. This report describes the study and its findings.

2. The main objectives of this work were to (1) consider existing information on health effects in order to establish noise levels at which there may be particular effects on the population, and from this, (2) advise on the feasibility of establishing effects-based standards which could be used to inform the setting of objectives and targets.

3. The work itself was conducted in two phases: the phase 1 review of the effects of environmental noise, current standards and noise criteria/limits and the interpretation of 1995 WHO Community Noise Guidelines document; and the phase 2 feasibility study.

4. The results are reported in five main sections: an examination of the scientific evidence for health effects due to noise, an investigation of the practical noise criteria used to assess environmental noise, a guide to the interpretation of the WHO guidelines, conclusions on whether effect based assessment methods can be established and issues for DETR to consider in setting out the way ahead.

5. The concept of noise and health is examined in general terms in section 3. There are a number of definitions and defined requirements for (good) health but it is concluded that descriptors that can be used to assess the impact of noise on health and can provide a framework on which to base a method to balance costs and benefits are the most useful to the decision maker.

6. The literature confirms that there are a number of potential effects of noise on health, although the evidence in support of actual health effects other than those based on reported bother or annoyance and on some indicators of sleep disturbance is quite weak. In fact the available literature on this topic is contradictory. In general, it is only the most poorly designed and executed studies which show significant effects. There are serious methodological difficulties involved in being able to carry out definitive research. This also means that significant effects amongst the most susceptible members of the population remain scientifically plausible, even if unproven.

7. On examining existing information on dose-response relationships based on scientific evidence, we can make some conclusions from the primary research. However it is found that since the evidence in support of potential health effects other than annoyance is weak, we cannot at present define meaningful exposure-response relationships for other effects. Non-acoustic factors are also important in determining a response and serve to add variability to the data. Although the scientific evidence suggests thresholds below

which it is unlikely that there is an impact on health, we cannot interpret these as definitive at this time.

8. The general link between an effect and its impact on health is even more complex, and depends on many aspects including how one effect can modify another, the role of other modifiers and confounding variables, the number of effects, cumulative noise exposures, the susceptibility of individuals and the risk factors associated with multi-origin health conditions.

9. Section 4 looks at the actual practical setting of existing criteria and targets as opposed to criteria based solely on primary scientific research evidence. Practical noise targets are a compromise between the desirable and the affordable. The desirable relates to the thresholds suggested by the scientific evidence below which no effect is expected. The affordable involves weighing the costs and benefits in monetary and social costs. Practical noise limits are usually based above these lower desirable thresholds.

10. On reviewing environmental noise regulations and standards in the UK and in other EU countries, we find that existing standards and regulations usually take the results of primary research into account to some extent, but social, political and historic factors are at least as important. It is very important to be clear about the role played by these factors in the aetiology of current standards and regulations.

11. In view of the uncertainties involved in setting standards, there are moves within Europe to adopt a precautionary approach when setting future noise standards and regulations to protect against possible health effects. An example of this is the 1995 WHO guideline document which is reviewed in section 5. While this precautionary approach may be justified by the scientific plausibility of these effects, it is necessary to place these possible effects in proper perspective. An over-precautionary approach to setting future noise standards and regulations might lead to unacceptable impacts in other areas.

12. In section 7 it is concluded that *given the present state of knowledge, it would be unwise to base future environmental noise standards and regulations on what are at present hypothesised non-auditory health effects until future research can make the present confused situation clearer.*

13. There could be greater transparency in the way in which future standards and regulations are developed so that the public can become more aware of both the strengths and limitations of these standards. An increased emphasis on non-auditory health effects, as opposed to annoyance, as the outcome variable may lead to this greater transparency, although there is considerable doubt at the time of writing as to the magnitude of these effects due to environmental noise. Non-auditory health effects cannot be included in the development of future standards without further research. On the other hand, further research will be unlikely to yield definitive results unless it is very carefully designed, not only in terms of its planning and execution, but also in terms of setting precisely defined and achievable objectives.

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1 INTRODUCTION

Research carried out for the Wilson Report published in 1963 established that there were a wide range of environmental noise problems in this country and that there was considerable potential for these problems to increase without determined action (WILSON 63). Despite a great deal of subsequent research and development, a considerable investment in noise control technology, a wide-ranging technical debate nationally and internationally, and many new standards and regulations, quite a few of these problems are still outstanding (BERRY 97). The most recent national noise survey carried out in 1990 showed that average noise levels outside houses had hardly changed since an earlier survey carried out 18 years earlier in 1972 (SARGENT 93). At the same time noise complaints to local government, airports, industry and others continue to increase. The problem of noise has not been solved.

Noise control is not simply a matter of setting targets and then taking action as required because there are often severe technical, economic and social constraints on what can be achieved in practice. While the costs of noise control are usually more or less tangible, the benefits must be carefully weighed against these costs, and this is hard to do when the most widely used indicator of noise effects is simply “annoyance”. It is clear that a general change-over to some more concrete indicator of effects such as effects on health, might enable future noise targets to be defined with greater transparency. Monetary evaluations of noise effects would also be attractive but there is little evidence that any progress can be made in this area, at least in the short to medium term.

The 1996 Green Paper "Future Noise Policy" (EC 97) shows that the European Commission is moving towards noise control action as a response to increasing concerns of possible health effects. The EC is working towards a Directive to harmonise noise assessment methodology, to establish target values, and to oblige member states to take action to reach such targets. Noise guidelines based on a liberal interpretation of health effects, reported and edited on behalf of WHO by Berglund and Lindvall (BERGLUND 95), appear to have been influential in the development of the Green Paper. However all such guidelines are open to different interpretations. Other recent documents, such as the review published by the Health Council of the Netherlands, also examine the issues of noise and health. The topic of noise and health was discussed in depth at a workshop on Non-auditory Health Effects of Noise held in Leicester in May 1997. A large number of future research requirements and topics were identified, illustrating continuing scientific uncertainty in this general area (IEH 97).

In view of these developments, the idea of standards which are closely linked to possible health effects requires critical investigation. The National Physical Laboratory (NPL), together with the Institute of Sound and Vibration Research (ISVR) began a project in January 1998 for the UK Department of the Environment, Transport and the Regions (DETR) to review noise standards used for assessing the health impact of environmental noise. The objectives of the project were set out to:

- consider existing information to establish noise levels at which there may be particular effects on the population, and from this,

- advise on the feasibility of establishing effects-based standards which could be used to inform the setting of objectives and targets.

Put as simply as possible, the DETR want to know how, or even whether it is possible, to derive robust health effect based noise standards. Do health effects actually exist at typical levels of environmental noise and if so, can they can be reliably quantified? What other factors should be considered in establishing practical effect-based assessment methods?

The starting point is a summary of current knowledge of health effect based noise assessment methods, based on previous reviews. In the time available, it has only been possible to extract the key information required to address the defined objectives. This study then goes beyond previous reviews by examining the feasibility of establishing effect based standards. Both the available scientific evidence and the practicality of existing regulatory noise limits are found to be relevant.

Section 2 sets out the work strategy and explains how the work was done. Section 3 examines the scientific evidence underlying the relationship between noise and health. It considers the concept of health, the potential and actual impacts of noise on health, and the levels suggested by research below which these effects are unlikely to be observed. This section also looks at the uncertainties associated with relating the separate effects to an overall impact on health.

Section 4 looks at practical noise criteria and how these differ from those based on scientific evidence alone. It briefly reviews the environmental noise regulations and standards used in the UK and other EU countries and comments on the extent to which these are based on scientific data alone, or on other factors.

Section 5 offers guidance for the interpretation of the WHO guideline criteria. It is important that the WHO guidelines are properly understood in the context in which they were written. Section 6 summarises the key findings of the study. Section 7 considers the way ahead.

References to published literature are listed at the end of the report. The list is arranged alphabetically, with details given in the text in brackets using the first named author and year of publication. Throughout this report the term 'standard' is used to describe an assessment method, whereas it can also mean a British, European, or International standard.

2 WORK STRATEGY

Phase 1- Review
The review phase was split into three stages;

- a review of literature on **the known effects of environmental noise**,

Existing reviews of the effects of environmental noise were consulted in some depth. Close examination of the Health Council of the Netherlands study (NETHERLANDS 94) showed much commonality with the objectives of this study. The Health Council of the Netherlands were tasked to consider:

" What health effects are to be expected from exposure to noise at different sound levels ?" and *" What health-based exposure limits can be derived from these data ?"*

In view of the significant amount of work which had already been done, this review took the Health Council of the Netherlands report as the starting point. Further reviews carried out since 1994 were then consulted. The key reviews are summarised in table 1 below;

Table 1: Key review papers

Reference	Summary information
BERGLUND 95	Berglund and Lindvall examined the effects of noise in the community for the WHO. They link potential health effects to noise immission in the environment rather than to noise emission from specific sources.
JOB 95	Job outlines a model of the potential psychological factors and their possible causal roles in the production of noise related health effects.
JOB 96	Job extends the 1995 work to explore the potential causal link between noise exposure in a residential setting and detrimental health effects.
SHAW 96	Shaw looks at the effects of various levels of noise exposure on human activities and health. He considers criteria and guidelines based on social studies.
THOMPSON 96	Thompson updates her earlier reviews of noise and health by looking at the potential modifiers to the relationship between noise and health indicators and views these as intervening factors in the causal chain which either reinforce or diminish the original stress response.
BERGLUND 96	Berglund reviews the concept of health, health effects of community noise and environmental health control in the context of aircraft noise. She looks at dose-response relationships, vulnerable groups and threshold levels. The work appears to be very largely based on BERGLUND 95.
MORRELL 97	Morrell examines evidence for health effects due to aircraft noise.
NETHERLANDS 97	This report proposes a system of environmental noise exposure metrics for risk assessment of and policy decision-making on the

	adverse effects of environmental noise on health and the well-being of residential communities. One chapter is dedicated to the effects of environmental noise exposure.
LUDLOW 97	This paper outlines the uncertainties which make the interpretation of epidemiological studies into noise and health effects difficult. It looks briefly at the evidence for health effects of noise and proposes alternative research approaches to examine causative mechanisms between noise and health.
IEH 97	This report is based on review papers prepared for a workshop on non-auditory effects of noise. One paper by Stansfeld reviews environmental noise and health. Summary reviews on noise exposure and specific effects are also given. The available evidence is critically reviewed and recommendations made for future research.

- a review of **current standards and noise criteria or limits** in operation in the UK and other EU countries,

This stage had two main aims; to summarise the standards and limits used to control environmental noise in different countries, and to understand where possible the origin and justification for any resulting numerical noise limits or targets.

The starting points for this stage of the study were two key publications. In 1994 Dieter Gottlob of the German Federal Ministry of the Environment presented the results of an extensive review of community noise regulations (GOTTLOB 95). In 1995 work was completed at NPL on a review of national practices on the assessment of industrial noise (PORTER 95). For this project, updated information was sought from national experts across Europe. Three main areas in the measurement and assessment of environmental noise were followed up:

1. the legislative or regulatory framework,
2. any noise limits where specified to include indicators used (noise units),
3. relevant research findings or other information against which the national standards criteria or limits had been developed.

The information was requested in tabular form where possible. Copies of the written request for information, including an example table, are reproduced in Appendix I. The results are presented in section 4.2.

- a review or **"guide to interpretation" of the 1995 WHO Community Noise Guidelines** document.

Phase 2 - Feasibility study

This phase considered whether effects-based standards can realistically be set in the UK context. The findings are based on;

⇒ The extent to which there is general agreement (or not) on the existence of an effect due to noise

⇒ The extent to which there is general agreement (or not) on underlying noise-exposure relationships and how reliably these can be used to set threshold indicators for effects.

⇒ The uncertainties associated with assessing separate effects and aggregating them into an overall impact on health

⇒ The role of other factors apart from noise exposure level in setting meaningful, practical, and attainable noise criteria.

3 NOISE AND HEALTH - THE SCIENTIFIC EVIDENCE

3.1 DEFINING IMPACTS ON HEALTH

"Life is not just being alive, but being well" (MARTIAL AD 40- AD 103: Epigrammata)

Good health is very important to overall quality of life. But what is good health? The World Health Organisation has defined health as follows:

> "*a state of complete physical and mental and social well-being and not merely the absence of disease or infirmity"* (WHO 68)

and explained the requirements of a good healthy environment:

> *"Good health and well being require a clean and harmonious environment in which physical, physiological, social and aesthetic factors are all given their due importance. The environment should be regarded as a resource for improving living conditions and increasing well being"* (WHO 90)

The WHO definition of health does not define what is meant by 'well being'. But how do we measure the well being of an individual or population? Morrell measures health quality statistically as follows;

> *"People are healthy until they are deemed not to be so. The relative health can be determined by comparative population measures of mortality, morbidity and impairment"* (MORELL 97),

Many people might consider the concept of good health to be more dependent on individual expectations than this. The Dutch Health Council proposed yet another definition of good health which could be applied to set 'norms' in relation to both individual and public health and which was not solely based on purely objective measures:

> *"Health is a dynamic condition of the organism which functions properly and mentally according to the individual's age, sex and general conditions of the population to which the individual belongs, and the current state of science and technology and the related objectives of health care and public health, the beliefs and the cultural patterns of society"*
> (NETHERLANDS 97)

It is clear that definitions of good health vary. Any individual's state of health can vary up or down a scale defined by expectations and cultural needs. Expectations and needs vary and depend on the situation, circumstances and belief systems within the society within which they are formed. Relative health impacts can be only be determined by comparing objective measures against expectations and needs for any particular situation.

In the field of noise and health, policy makers are often faced with considerable uncertainty. First, there is uncertainty as to the direct magnitude of any objectively measurable effects on

health. Second, there is even confusion in the literature about the way these effects are defined. This makes the task of balancing the costs of noise control action against the likely outcome in terms of health effects problematical.

The main emphasis of current noise standards and regulations is annoyance. This is probably because the most immediate consequence of unwanted environmental noise exposure is complaints. Many airports in particular have a long standing history of persistent noise complaints from a significant minority of noise exposed residents. Individuals are perfectly competent to decide whether they are 'annoyed' or not, or whether they believe their sleep has been disturbed. For this reason, annoyance has formed a natural and immediate topic for research over many years. In the sense that annoyance and perceived sleep disturbance can interfere with perceived 'quality of life', then these effects are already included in the broadest definitions of health effects.

On the other hand, annoyance and perceived sleep disturbance are in any sense of the term, much less 'serious' health effects than cardiovascular or mental disorders would be, if they occurred. The problem here is that individuals generally have no way of knowing whether noise has had any effect on their general health or not, as this can only be determined by observations of increased morbidity in the general population. To the extent that proven effects on cardiovascular or mental health would be likely to be perceived as much more 'serious' impacts on general health than mere annoyance or perceived sleep disturbance, then any greater emphasis on these topics for the future must be encouraged. A statement that x or y percent of the population would be likely to suffer from some life threatening disease as a result of stress caused by environmental noise would form a much more transparent basis for any future policy decisions than current generalities about the relative likelihood of annoyance underlying many existing standards and regulations.

It is important to understand that individuals cannot make reliable judgements about the precise causes of any 'serious' adverse health effects that might otherwise be attributable to excessive noise because, if such effects exist, they appear to be quite weak and might only be contributory to other causal factors. It is effectively impossible to resolve the complex mix of separate potential risk factors and their combination in any individual case. For this reason, it is necessary to talk about increased or decreased risk rather than precise cause, and only large scale studies looking at the progressing health status of groups of individuals under changing environmental conditions can discover the truth about these matters. Even in the case of sleep disturbance, which might otherwise seem to be an obvious and easily reported effect, it turns out that individuals are generally not very good at being able to report precisely what happened on a previous night. While this is not surprising in the sense that people cannot be expected to recall what happened when they were mostly asleep, it is not helpful in being able to obtain definitive measures of the relative magnitudes and importances of these effects. People's perceptions of the relative magnitudes of these effects might be just as important as their actual magnitudes. Given the present state of scientific knowledge, and subject to future research, the possible adverse health effects of environmental noise might best be considered as an issue of public perception rather more than as an issue involving a direct and proven health risk.

In essence, to judge an impact on health, policy makers will need to know;

- potential effects and their relative dependencies on different types of exposure.

- levels of exposure at which these effects become significant

- different ways in which the most significant effects can be linked, combined or prioritised when judging an overall impact on health

3.2 POTENTIAL EFFECTS OF NOISE ON HEALTH

Shaw (SHAW 96) emphasises the importance of a thorough understanding of all effects of noise on people to assist in bringing community noise exposure under control in the most consistent and effective way. These effects include; psycho-social effects such as annoyance and other subjective assessments of general well-being and quality of life; effects on mental health; effects on sleep which can be both psychological and physical effects; effects on physical health such as hearing loss; and stress-related health effects which can be psychological, behavioural, somatic and physical. Possible indicators of these different effects cover a very broad range.

Annoyance

Annoyance has been defined as *"a feeling of displeasure evoked by a noise"* (WHO 80) and *"any feeling of resentment, displeasure, discomfort and irritation occurring when a noise intrudes into someone's thoughts and moods or interferes with activity"*. It is the most common and most researched effect of noise on people and can often be related to the potentially disruptive effects of intrusive noise on a broad range of activities, although people can be annoyed by noise simply because they feel it to be inappropriate to the situation in which it is heard. It can only be measured by a subjective report, although techniques have been investigated based on observing behaviour assumed to be related to annoyance. Noise annoyance is simple in concept, but since it can only be defined subjectively, comparative studies are often defeated to some extent by the problems of comparing annoyance scales using different verbal or numeric descriptors. The extent of noise annoyance, however described or reported, is clearly influenced by numerous non-acoustic factors such as personal, attitudinal, and situational factors in addition to the amount of noise per se.

Noise annoyance is usually attributed to a specific source of noise, yet the underlying causal mechanisms are not always clear (PORTER 1997). Research studies can often be surprisingly vague in terms of whether specific or general effects are being described. For example, reported annoyance to a specific noise source can often considerably exceed aggregate or total annoyance to the overall noise environment. Many researchers have concentrated on the role of specific interferences with speech, communication, sleep, concentration, or task performance in mediating reported annoyance, but the underlying relationships found vary from one study to another. Figure 1 shows one of many possible interpretations of the various underlying relationships between noise and reported annoyance showing both direct and indirect routes from stimulus to effect.

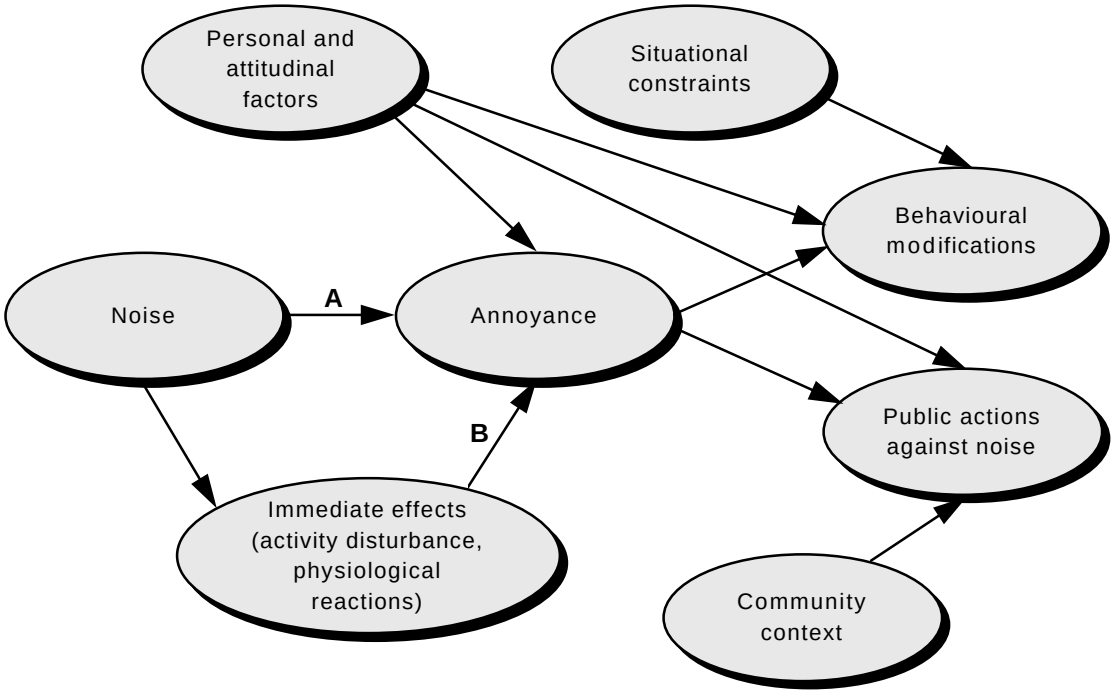

Figure 1: Noise annoyance in a community setting (from NELSON 87)

Speech interference

Human society depends on communication by speech, which is subject to masking by noise. The precise degree of interference with speech communication can be measured either subjectively by using rating scales, or objectively by measuring the percentage of words or sentences correctly understood (true speech intelligibility measures). Physical measures of so-called speech intelligibility such as the Speech Transmission Index and the Articulation Index are only proxies for direct measurement using subjective reports or proper behavioural tests, and can give erroneous results.

Environmental noise, especially varying and intermittent noise, can interfere with many activities involving speech. The extent to which any particular degree of speech interference can be overcome or contribute to stress in different situations is not well understood.

Performance - concentration and task interference

Noise can contribute to increased arousal; can require changes of mental strategy; can impair social performance; can distract attention from relevant social cues; can mask wanted signals in tasks involving auditory cues; and can contribute to what has been described as unwanted aversive changes in affective state. Interference of this type can contribute to the creation of less desirable living environments and might therefore lead to increased annoyance and stress or to a decreased state of well-being or general health.

Mental Health

A variety of mental health effects due to noise have been suggested by research. Indicators which have been studied in the past include mental hospital admission rates, headaches, susceptibility to minor accidents, and increased reliance on sedative and sleeping pills.

Hearing loss

Noise can contribute to both temporary and permanent hearing loss, although current evidence suggests that the risks at the typical exposure levels associated with environmental noise are very low. Noise induced hearing loss often occurs at higher frequencies first, at around 4000 Hz. Hearing damage can then extend to lower frequencies and become relatively more severe after increasing exposure at higher levels. Temporary hearing loss after short term exposure may be associated with permanent hearing loss even though the physiological mechanisms may be quite different. Noise induced hearing loss can directly contribute to increased stress and annoyance, particularly in respect of speech communication and tasks requiring auditory cues. There are of course many other potential or contributory causes of hearing loss in any particular case including illness, ototoxic drugs, hereditary factors and inflammation of the middle ear.

Noise induced stress related effects

As the Dutch Health Council recognised (NETHERLANDS 97), individual reactions to a stressor can be of a psychological, behavioural or somatic nature. It is not clear precisely what is meant by the concept of stress in this situation. Not all effects of noise exposure are necessarily negative. It is clear that a certain amount of noise can contribute to beneficial arousal, and that individuals differ in the their ability to adapt. Increased arousal can assist with task motivation and thereby improve performance, depending on the individual concerned. On the other hand, excessive stress is by definition 'excessive' and there are a number of possible stress-related adverse effects of excessive environmental noise reported in the literature. Psychological effects concern feelings of fear, depression, frustration, irritation, anger, helplessness, sorrow and disappointment. Examples of behavioural reactions to a stressor are social isolation, aggression, and resort to excessive use of alcohol, tobacco, drugs or food. Psychological and behavioural stress could have direct or indirect effects on physiological processes in the body. In the absence of any more definitive results, many studies have implicitly assumed that noise could be considered as an unspecified stressor leading to over-stimulation of the central nervous and endocrine systems. Potential indicators of health impact due to stress-related effects and appearing in the literature include changes in blood pressure, abnormalities in the electrocardiogram, rates of diagnosing clinical hypertension, occurrence rates of ischaemic heart disease and other cardiovascular disorders, biochemical effects, changes in the immune system, and effects on the unborn child such as birthweight effects and incidence rates for various congenital defects.

Sleep disturbance

Sleep patterns vary considerably between different individuals and sleep disturbance can arise from a large number of different causes. Disturbance can be measured subjectively using morning after questionnaires, or objectively, using a wide range of physiological indicators. The problem with objective measurements using instruments is that they can be intrusive, particularly when used in the laboratory, and there is often a significant difference between results obtained in sleep laboratories and in own-home experiments. Laboratory studies can be extremely well controlled, particularly in terms of the stimuli used, but on the other hand, it may take some considerable time for subjects to get used to the laboratory. Field studies are difficult in terms of instrumentation, and might not be at all well controlled in terms of the pattern of stimuli that actually occur on instrumented nights. An additional problem is that the clinical or social significance of any particular increment of sleep disturbance associated with additional noise events is not at all clear.

3.3 ACTUAL EFFECTS ON NOISE ON HEALTH

A considerable amount of research has been carried out to attempt to relate noise dose to the various potential or hypothesised effects. Much of this work has merely looked for statistical associations between indicators of noise exposure and indicators of noise effect, but of course, statistical association on its own does not in any sense 'prove' cause and effect. The main problem here is that, if there are any real effects of environmental noise on health (other than 'simple' effects such as annoyance, sleep disturbance, and interference with speech and task performance), then they are likely to be quite complex and associated with more than one 'causal' factor. For example, since it is well known that different individuals respond differently to various kinds of stress, then there are likely to be a whole range of individual differences in terms of health effects of noise, very few of which can ever hope to be properly controlled in any feasible research study design. Potential confounding factors and co-related variables include genetic pre-dispositions to particular health effects, individual diet and lifestyle, adopted coping strategies (the extent to which individuals might have adapted their lifestyle to accommodate otherwise unacceptable environmental stress), and various possible self-selection biases. It is possible that, on average, people who are long term resident in higher environmental noise areas might be somehow different from people who are long term resident in quieter areas as a result of having different priorities when making employment and housing choices over many years. Cross-sectional epidemiological studies cannot be expected to be able to unravel all these possible relationships, some of which might even be hypothesised to operate in different directions depending on the other circumstances present. Longitudinal studies are in theory capable of controlling for individual differences to a much greater extent, but outcomes will still depend on how patterns of noise exposure change over several years in relation to other social, economic and political changes that might occur.

On the other hand, just because research has not definitely 'proved' any causal linkage between environmental noise and long term adverse health effects, this does not mean that such linkages do not exist. It remains inherently plausible that excessive noise might contribute to long term adverse health effects, and because of this the whole area is increasingly becoming a matter of public concern.

Table 2 summarises the findings of two previous review articles, in terms of the perceived strength of available evidence in support of particular noise and health linkages. Of course, each of these findings merely represent the consensus view of the different panels of experts available at the time and are subject to modification and change as new research results become available in the future. The main findings of the primary research have shown that the following conclusions can be made about the actual existence of effects of noise on health:

- Environmental noise exposure definitely leads to reported noise annoyance in representative populations.
- Reported noise annoyance increases with noise exposure.
- Reported noise annoyance varies in different situations and in different contexts.

- Environmental noise causes other effects such as speech interference, performance interference and sleep disturbance. These effects vary depending on situation and context.
- Although speech interference can be explained by direct background noise masking, the extent to which any particular degree of speech interference can be overcome or contributes to stress in different situations is less clear.
- Sleep disturbance caused by noise is a real phenomenon, but there is considerable evidence that residents can habituate to noise and there is some doubt as to the real long term consequences of any particular degree of noise induced disturbance. It is unclear how much sleep loss is actually required before being considered a health effect but excessive interference with sleep does seem to compromise positive mental well-being.
- There is some weak evidence that environmental noise exposure may contribute to non-auditory health effects such as cardio-vascular disease.
- The evidence for real effects contributing to increased morbidity such as cardiovascular effects is not convincing at this time, although it seems scientifically plausible that a minority of the population exposed at the highest noise levels might be susceptible to some increased risk.
- Much of the evidence in support of these non-auditory health effects is based on extrapolation from laboratory studies of occupational exposure at much higher noise levels. Such extrapolation is not necessarily valid.
- There is less convincing evidence of non-auditory health effects based on direct field studies of environmental noise exposure. It is possible that such effects exist but might be very difficult to detect statistically. There are serious methodological difficulties involved in being able to carry out definitive research.
- The available literature on this topic is contradictory. In general, it is only the most poorly designed and executed results which show significant effects. Significant effects amongst the most susceptible members of the population could remain scientifically plausible, even if they are as yet unproven.

Table 2: Strength of evidence for a particular effect as judged in earlier reviews

Effect	Strength of evidence
Annoyance	Sufficient[*1] Sufficient[*2] Sufficient[*5]
Psychiatric disorders	Inconclusive[*1] Limited[*2] Inconclusive[*3] Inconclusive[*5] Weak[*6] Suggestive but inconsistent[*7]
Performance	Limited[*2] Task dependent[*5]
performance by school children	Sufficient[*1] Sufficient[*2]
Sleep	
changes to sleep pattern	Sufficient[*2] Sufficient[*7]
onset/latency	Sufficient[*1]
waking during the night	Sufficient[*1] Sufficient[*2]
waking prematurely in the morning	Sufficient[*1] Sufficient[*3]
changes to sleep stages	Sufficient[*2]
sleep loss	Sufficient[*7]
subjective reports of sleep quality	Sufficient[*1] Sufficient[*2] Sufficient[*3]
mood next day	Sufficient[*1] Sufficient[*2]
sleepiness and performance next day	Inconclusive[*1] Limited[*2]
heart rate	Sufficient[*2]
hormones	Limited[*2]
immune system	Inadequate[*2]
Hearing loss	Sufficient[*2] Sufficient[*5]
Stress related health effects	
hypertension	Inconclusive[*1] Sufficient[*2] Inconclusive[*3]
ischaemic heart disease	Sufficient[*1] Sufficient[*2]
forms of cardiovascular disease	Inconclusive[*3] Inconclusive[*5] Limited[*6]
biochemical effects	Limited[*2]
immune effects	Limited[*2] Inconclusive[*6]
birthweight	Inconclusive[*1] Limited[*2] Inconclusive[*3] Inconclusive[*7]
congenital	Lack[*2] Inadequate[*5]

Key: source and classifications:

[*1] (IEH 97),
sufficient : sufficient evidence for a causal association between noise exposure and the health end point
inconclusive: evidence for a causal link between noise exposure and the health end point is inconclusive

[*2] (NETHERLANDS 97)
Sufficient: a relationship has been observed between noise exposure and a specific health effect, chance, bias and confounding factors can be ruled out with reasonable confidence
Limited: an association has been observed between noise exposure and a specific health effect, chance, bias and confounding factors cannot be ruled out with reasonable confidence
Inadequate: the available studies are of insufficient quality, lack the consistency or statistical power to permit a conclusion regarding the presence of absence of a causal relationship.
Lack: several adequate studies are mutually consistent in not showing a positive association between exposure and health effect

[*3](MORREL 97) [*4] (BERGLUND 96) [*5](SHAW 96) [*6](THOMPSON 97) [*7](JOB 96)
Classifications inferred from text

3.4 AT WHAT NOISE THRESHOLD LEVEL CAN NOISE AFFECT HEALTH ?

How strong is the research evidence that noise effects follow any particular relationship with the degree of noise exposure? Both field and laboratory data has been used to derive a number of standard dose-effect curves showing very little response at around 40 LDN up to around 100% highly annoyed at around 90 LDN. Figure 2 shows the Schultz curve and its later update relating percent highly annoyed to day-night average sound level (FIDELL, 91). Similar curves have been developed for other effects such as activity and sleep disturbance (see MIEDEMA 98 and PORTER 97). These curves are not summarised in this report. There are of course numerous methodological problems present when attempting to combine the results of a number of different primary studies into an overall meta-analysis and the precise shape of the curves should not therefore be taken too literally.

All curves follow the same generic shape regardless of the particular effect being considered. Due to the scatter of individual data points above and below the curves, the precise shape is often determined more by the method of statistical analysis used than by the actual data. In principle however, noise effects are, or can be assumed to be, low or negligible at low noise levels. At increasing noise levels the effects start to increase slowly at first and then more rapidly. Finally the upper end of the effects scale flattens out at 100%. It is meaningless to consider further increases in the effects of noise above this point where 100% of the population are affected or where individuals are 100% affected. This is shown in figure 3. Whether the shape of the generic S-curve really follows from the available data (given the general statistical uncertainty in this area), or whether it is merely a plausible theoretical construct that happens to fit the data as well (or as badly) as any other theoretical construct is a matter for conjecture.

On the assumption that the lower asymptotes of the curves represent threshold noise exposure values below which effects are infrequent or unlikely, it is possible to derive the guideline values set out in Table 3. For effects other than percent highly annoyed, activity interference and sleep disturbance, the precise shape of the corresponding S-curves is extremely uncertain, even if these hypothetical effects really exist, particularly at the sort of levels typical of environmental or residential exposure. Even for the percentage highly annoyed, it is well known that residents can register strong objections to certain types of noise such as that generated by inconsiderate neighbours even where the noise levels are quite low in absolute terms.

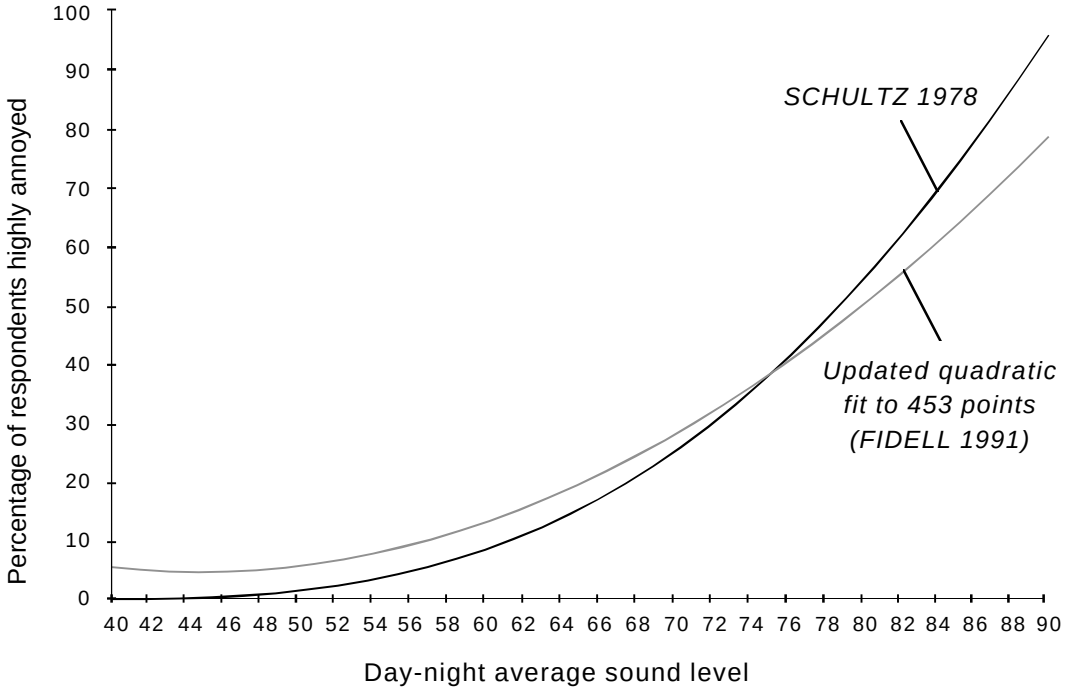

Figure 2: Percentage highly annoyed versus noise level (from FIDELL 91)

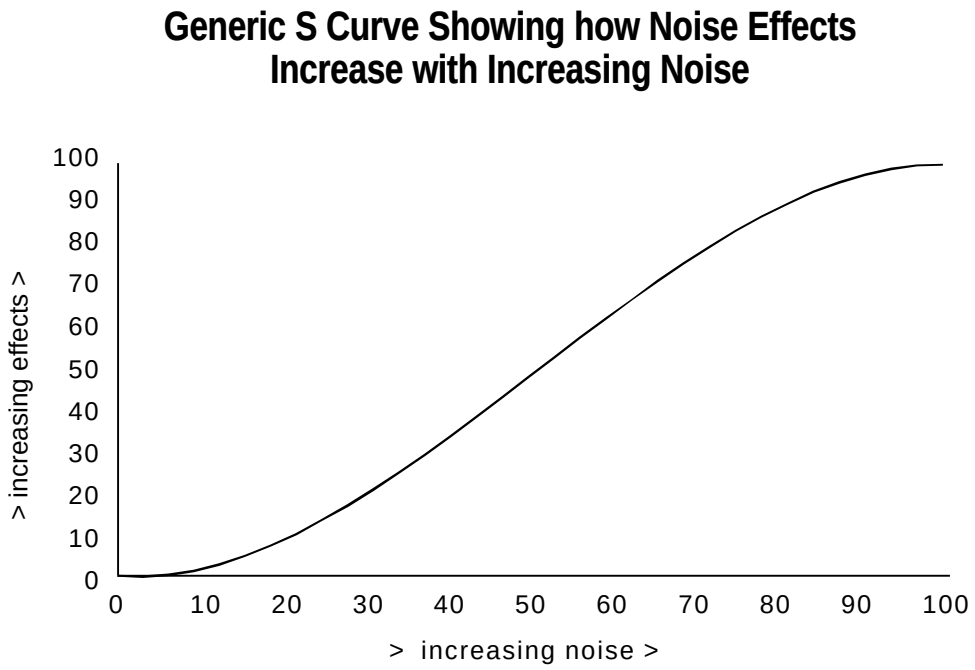

Figure 3: Generic curve for noise effects versus noise level

Table 3: Guideline threshold noise exposure values below which reviews report that an effect is unlikely to be observed

Effect	Guideline threshold value (dB(A))
Annoyance	40 ($L_{Aeq,24h}$: transportation noise) [*1] 42 (L_{dn}: outdoors) [*2] 55 (dB $L_{Aeq:}$ outdoors, few seriously annoyed below this value)
speech communication	45-55 (dB L_{Aeq} :for elderly or impaired)[*4] 55-65 (dB L_{aeq}) [*4]
Sleep	30 (dB L_{amax} - for continuous noise to avoid serious effects) [*4] 45 (dB L_{amax} - for low background and non-continuous noise) [*4]
waking during the night	60 (SEL indoors) [*1] 60 (SEL indoors) [*2] 60 (dB L_{Amax})[*4]
changes to sleep stages	35 (SEL indoors) [*2] 40-45 (dB L_{amax}) [*4]
subjective reports of sleep quality	40 ($L_{Aeq, night}$) [*1] 40 ($L_{Aeq, night}$:outdoors)[*2]
mood next day	60 ($L_{Aeq, night}$) [*1] 60 ($L_{Aeq, night}$:outdoors)[*2]
heart rate	40 (SEL indoors) [*2] 45 (dB L_{Amax})[*4]
Stress related health effects	
general cardiovascular effects	65-75 (dB L_{Aeq})[*4]
hypertension	70 ($L_{Aeq,, 06-22h}$:outdoors for road and aircraft traffic noise in living environment) [*2]
ischaemic heart disease	70 ($L_{Aeq,}$:outdoors) [*1] 70 ($L_{Aeq,, 06-22h}$:outdoors for road and aircraft traffic noise in living environment) [*2]
Hearing loss	70 ($L_{Aeq,}$:indoors for living and recreational environment) [*1] 65-75 (dB L_{Aeq}: "negligible" risk for hearing loss for 8 hour exposure and 40 years age group) [*4]
Performance	55-65 (dB L_{Aeq}: for deteriorated reading acquisition in school children, people learning languages and the elderly) [*4]
performance by school children	65 ($L_{Aeq, school}$:outdoors)[*1] 70 ($L_{Aeq, school}$:outdoors)[*2]

Key:

*1 (IEH 97), guideline value is the value above which an observable effect might be expected

*2 (NETHERLANDS 97), guideline value is the value of the lowest exposure at which on average an effect has been observed in epidemiological studies

*3 (MORREL 97)

*4 (BERGLUND 96), value is based on (BERGLUND 95) and indicates the value above which an effect is observed

3.5 LINKING THE ACTUAL EFFECTS OF NOISE TO AN OVERALL IMPACT ON HEALTH

Where reliable exposure response curves exist, and there are of course some doubts on this score in relation to certain effects, we might then assume a direct relationship between the effect of interest and the associated community impact as follows:

exposure $\Rightarrow$ effect$\Rightarrow$ impact

The actual situation is rather more complex. Exposure can lead to more than one effect, and community impacts depend on multiple effects as follows:

exposure $\Rightarrow$ effect $\Downarrow$

exposure $\Rightarrow$ effect $\Rightarrow$ impact

exposure $\Rightarrow$ effect $\Uparrow$

There is no agreed method to combine everything into an overall response, even if this were meaningful when taken out of the context of the many and varied social and economic factors that often have much greater health impacts. Most reviewers avoid this problem completely by considering each effect separately, but this is not by any means a satisfactory solution. Recently, Job has set out a preliminary linked model reproduced as Figure 4 (JOB 96). It is debatable whether this really is a comprehensive model or merely a graphical representation of the various inter-relationships that need to be taken into account, but at least it shows that researchers are beginning to tackle some of these essentially quite difficult problems.

Thompson has supported Job's approach by suggesting that effect modifiers could be viewed, not as confounders, but as intervening factors in the causal chain either re-inforcing or diminishing the original stress response (THOMPSON 96). She recommends that future research should tease out those factors which are 'necessary' in the causal chain and which offer evidence that noise exposure precedes the given physiological changes. It is our view that future research which is not specifically addressed to carefully developed and biologically plausible causative hypotheses is unlikely to be able to unravel any of these complex relationships to any useful extent whatsoever. Far too many studies in this general area have merely assumed that some relationship between noise exposure and the health effect under investigation 'exists' and that mere statistical association will be sufficient for

the findings of the study to be useful when deciding policy, but there is no evidence that studies of this type can be of any assistance at all.

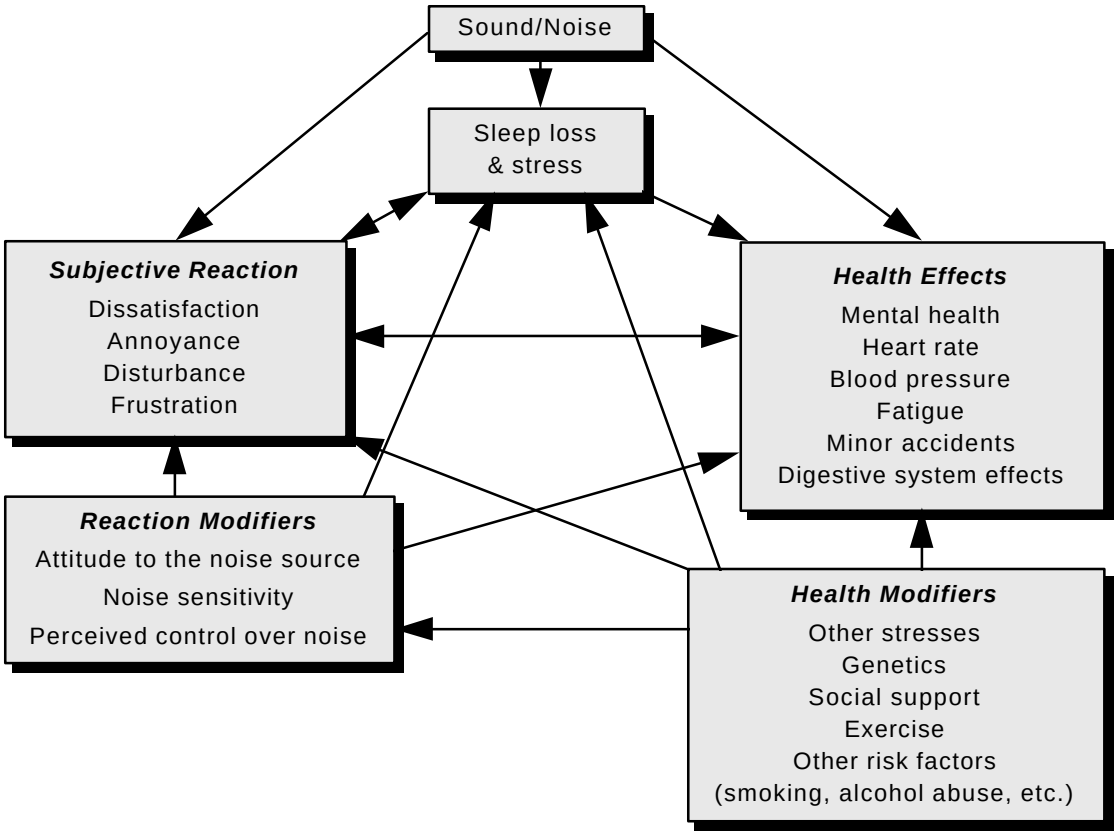

Figure 4: A model of the causal connections between noise, community reaction, modifiers and health effects (from JOB 95)

Table 4 : Vulnerable, susceptible or sensitive groups for each effect (as discussed in the literature)

Effect	Susceptible or sensitive groups
Annoyance	self-reported noise-sensitive individuals[*1] noise sensitive people, people with fear of certain sources, those feeling they have no control over the situation have an increased risk of severe annoyance[*2] those who indicate fear of aircraft crashes, those concerned with health effects of noise, those who report interference with activities, self-reported noise sensitive individuals[*3]
general well-being	people annoyed by noise in the work place show an increased post-work irritability which might affect their well-being[*2] Those with a negative attitude towards noise may be more likely to suffer health effects[*5]
speech communication	elderly and hearing impaired
Sleep	ill people, older people, people with sleeping difficulties[*2] elderly people, shift workers, those with physical or mental disorders people with sleeping difficulties[*4] Shift workers[*5]
waking during the night	sensitive groups e.g. anxious/depressed[*1] older people
Stress related health effects	
general cardiovascular effects	family history of cardio-vascular disease[*5]
hypertension	family history of hypertension[*1] people highly annoyed by low levels of road traffic noise[*2] people with noise-induced sleep disturbance[*2]
ischaemic heart disease	men exposed to high levels of traffic noise and occupational noise[*2] people with noise-induced sleep disturbance[*2]
Hearing loss	effects on the unborn and young children[*2]
Performance	
performance by school children	pupils with learning difficulties, hearing impairment, English as a second language. [*1]

Key:

[*1] (IEH 97)

[*2] (NETHERLANDS 97)

[*3] (MORREL 97)

[*4] (BERGLUND 96),

[*5] (JOB 96)

Understanding the role of effect modifiers in contributing to outcome variables is important when attempting to assess likely health outcomes after long term exposure to any particular noise environment. Two areas in Job's model relate to reaction modifiers including those relating to individual or group sensitivity (vulnerable or susceptible persons). Various reviewers have suggested ways of identifying vulnerable groups as listed in table 4, but some of the entries reported here do not stand up to close examination. It would be surprising if 'self-reported noise sensitive individuals' did not report higher noise annoyance in noise attitude surveys, but this does not necessarily mean that those same individuals are actually any more significantly affected by the noise. In the absence of any biologically plausible theory as to how noise might actually contribute to hypertension, there is no a priori reason why the class of people with a 'family history of hypertension' should actually be any more sensitive to noise induced hypertension than anyone else. It is equally plausible that people with a family history of hypertension or self-reported noise sensitive individuals might somehow be predisposed towards avoiding higher noise levels that others accept and thereby suffer less health effects as a consequence.

What would be most relevant here would be independently observable variables that might actually modify the strength of the effect being addressed. For example, people with a previous history of ischaemic heart disease or hypertension might be more or less susceptible to future episodes of cardiac ischaemia in the presence of noise than they would otherwise have been. This then becomes a testable hypothesis and is potentially useful in terms of planning future research. To merely ask people how annoyed they are and then relate this to self-reported noise sensitivity is essentially tautologous and not particularly useful for anything other than strictly academic purposes. Other examples might be to compare exposure response relationships between people with high fat and low fat diets, or between people who are measurably more or less reactive to sudden impulsive noise.

Ludlow and Flindell have pointed out that identifying susceptible individuals by means of some independent measure in advance could significantly increase the statistical power of any future research studies in this area (LUDLOW 97). The basic problem which must be overcome for any worthwhile progress to be made is the strong possibility that true effects, if they exist, will be completely swamped by the general statistical uncertainty caused by a combination of the effects being weak, of their affecting only a minority of the population, and of the large number of potential confounding and co-related variables involved. Prior identification of susceptible individuals could go a long way to overcoming some of these limitations. The traditional approach has been to merely consider particular groups as being somehow 'vulnerable' such as old people and young children, even though there is no real evidence in support. It is unlikely that this traditional approach will be at all helpful.

There are further difficulties caused by combinations of noise exposure from more than one noise source. This particularly arises in the case of road traffic noise, which is often present at the same time as other sources. Differences in individual noise exposure attributable to different occupations and life-style are unlikely to be very well represented by measurements of environmental noise taken outside houses. There have been a number of attempts to develop models of combined noise, most recently reviewed by Gjestland (GJESTLAND, 97). There is no consensus at the present time at least in part because no researcher has yet developed a model which can be successfully generalised across to other situations.

Finally, Berglund and others (BERGLUND 95) have suggested that certain essentially mild or trivial noise effects found after short term exposure in laboratory type studies might translate to more significant or serious effects after long term exposure. While this is a plausible suggestion, there is no particular reason to be believe it to be true and there is a great danger of it being used to justify what might otherwise be an unjustifiably precautionary approach. The problem here is perhaps best explained by example. It is well known that short term exposure to relatively high noise levels in laboratory situations can contribute to a number of physiological responses, such as transient elevations in blood pressure, heart rate and certain biochemical indicators. The translation hypothesis then goes on to associate these transient physiological changes with more permanent changes such as hypertension and altered endocrine function, and the case for a precautionary approach is thereby 'proved'. This argument is specious as there are many indications that these same transient physiological responses can be beneficial, particularly when associated with exercise.

In conclusion, it must be recognised that the human organism is extremely complex and it is therefore not surprising that that there are great difficulties in expressing cause-effect relationships in simple terms, particularly when it is remembered that the effects of noise are all indirect in the sense that they represent the way that the body reacts or responds to noise stimuli. There are no direct effects of community and environmental noise on the tissues of the body because the levels of energy involved are far too small.

4 PRACTICAL NOISE CRITERIA

4.1 BALANCING THE DESIRABLE AND AFFORDABLE

In general, practical noise targets or criteria are a compromise between the desirable and affordable. It is desirable for the noise environment to be as quiet as possible, but human activity itself generates sound. In setting targets we need to consider how much noise should be regarded as an acceptable by product of normal living.

The most recent draft revision of ISO 1996 part 0 recognises three and only three possible outcomes of any noise assessment ranging from acceptable to unacceptable;

Outcome class A: zero or negative noise impact where no action is required.
Outcome class B: intermediate noise impact in the range between zero and unacceptable outcome.
Outcome class C: completely unacceptable noise impact.

The division between these outcome classes can be illustrated by considering the effect consequences of increasing noise level. Let us return to our generic S curve that represents increasing noise effects against increasing noise levels (figure 5). We will consider a single effect for now so that our explanation is not confused with trying to ‘total’ all the effects.

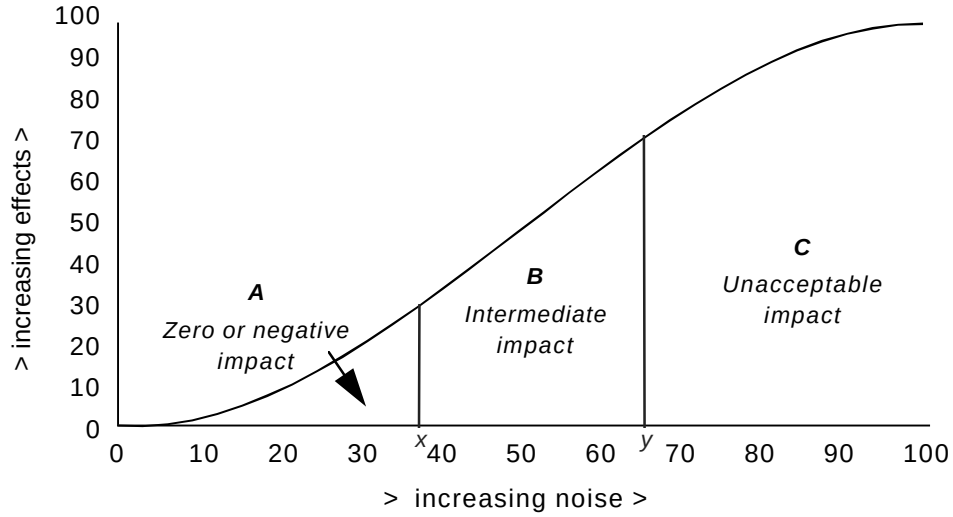

Figure 5: Generic curve for noise effects versus noise exposure showing three assessment outcomes

The generic curve follows the same general shape irrespective of the particular effect being considered. At low noise levels (outcome class A) there are generally low or negligible noise effects, either in terms of the strength of the effect or in terms of the percentage of the population affected. At increasing noise levels the strength of the effect or the percentage of the population affected also increases (outcome class B). However, these effects are not such as to be over-riding in any assessment. At some increasing noise level, the magnitude of effects may become unacceptable (outcome class C) in which case noise control action becomes imperative regardless of any costs or inconvenience incurred.

Where existing noise limits are based on scientific evidence, they are necessarily indicative of a threshold X dividing outcome classes A and B, since the definition of a threshold of unacceptability (threshold Y, dividing outcome classes B and C) is essentially a matter of social, economic and political interpretation. Of course, the avoidance of all noise impact (noise levels below threshold X) would be a commendable aim, but this is rarely achievable without unacceptable costs or inconvenience in other areas. There is a tendency within parts of the scientific community at the present time to mis-represent scientific data which actually indicates the position of threshold X on the noise level scale as indicating the position of threshold Y, and this is a mistake.

4.2 EXISTING METHODS USED TO ASSESS ENVIRONMENTAL NOISE

As part of the review work the noise criteria adopted in the UK and some of other EU countries have been examined. Full details are reported in Appendix II by country and noise source.

The short timescale allowed for this project imposed some limitations on the amount of information which it was possible to collect and on the level of comparative analysis which it was possible to undertake.. It is recommended that additional resources should be directed towards the full analysis and completion of this review, to be carried out as a separate study. A comprehensive programme of verification and wider dissemination of the information collected could be of considerable value. It should include updated tables as given in the Porter and Gottlob papers (PORTER 95, GOTTLOB 95). For this work, a few brief conclusions are made below in the context of this project.

- Exposure limits vary for different receptor locations and types of source

- Most adopted limits appear to refer to annoyance. The threshold values given are in general larger than those based on the scientific evidence alone.

- The limits are generally based on measurements, although prediction is used mainly in addition to measurements.

- The basis of the limits and procedures can be broken down into several groups:

    1. Those based on the results of primary research (e.g. The Swiss limits for general abatement of noise from road, rail and industrial noise).

    2. Those directed by social, economic, and political considerations (e.g. the general noise limits in Italy).

    3. Those that use as a base the limits set in other countries (e.g. airport noise in Italy)

    4. Those that are perhaps almost arbitrary in terms of their derivation or depend on historical origins (e.g. qualification for noise insulation from railway noise in the UK).

- Some research is planned but there is an indication that member states are awaiting the outcome of EU activities on formulating an “EU Noise Policy” in planning future research.

These findings confirm that noise targets, criteria or limits are not usually based on assumed health effects (other than annoyance or sleep disturbance). Existing standards and regulations usually take the results of primary research into account to some extent, but social, economic, and political considerations are often at least as important as suggested in the last section. Furthermore, this review has revealed that the aetiology of many existing

noise limits seems to be somewhat obscure, and might be considered somewhat arbitrary in the light of present knowledge.

Schultz in 1972 also noticed some of these distinctions in reviewing the literature on various noise rating methods (SCHULTZ 72). He noted two approaches; one largely based on what he defined as hindsight and the practical experience of the acoustical consultant, and the other mainly based on laboratory or field studies undertaken with the express purpose of discovering some relation between subjective response and objective physical measures. He suggested that the experience of the consultant lent itself to the development of 'state of the art' solutions consistent with time-scales and budgets. In turn these led to rules of thumb and consistent schemes for assessing a particular problem. Interestingly he concludes that the difference between the two approaches lies with the difficulty of tracing the lineage (or heredity) of a method or limit and hence establishing its pedigree.

The historical development of some standards has encouraged the development of entrenched positions by different institutions. People tend to argue about precise numeric values of noise exposure but this often misses the point of the whole exercise. Environmental noise control decisions are invariably about compromise where the most important issues are general concepts and broad objectives. It is very important to be clear about the role played by the social, political and historic factors in the aetiology of current standards and regulations in the future development of new standards and regulations. Social and political interpretations can change, even if the underlying noise exposure response relationships remain constant. In addition, the underlying noise exposure response relationships might also change as public expectations develop.

5 GUIDE TO THE INTERPRETATION OF THE WHO GUIDELINES

5.1 INTRODUCTION

As part of this project, DETR requested an interpretation of the recent WHO guidelines, included in this section. In 1980, the World Health Organisation published an Environmental Health Criteria report dealing with noise (WHO 80). This document introduced what have since become generally known as the '*WHO noise limits*'. These WHO noise limits have been widely used in setting standards and criteria in a number of areas, although they have no official status. On the front cover of the report itself, it is clearly stated that; '*This report contains the collective views of an international group of experts and does not necessarily represent the decisions or the stated policy of either the World Health Organisation or the United Nations Environment Programme*'.

More recently, Berglund and Lindvall published an updated Community Noise document (BERGLUND 95) for the World Health Organisation setting out revised noise limit guidelines. Certain criteria have been revised in the light of accumulated scientific knowledge since the publication of the original Environmental Health Criteria document in 1980. It is clearly acknowledged in the Foreword to the new document; '*Thus, although the document is the amalgamated result of the work of a large number of persons, the complex and extended work process makes it necessary to declare that the editors are solely responsible for the present text of the document*'. The guideline values contained therein have not been adopted by the WHO or by any other official body, although this does

not of course have any effect on their underlying scientific validity as determined from the available research data.

The first draft of the 1980 Environmental Health Criteria document was prepared by a study group of international experts that met in Geneva in late 1973. The WHO secretariat prepared a second draft taking into account comments received from national focal points for the WHO Environmental Health Criteria programme. The draft produced by the secretariat was reviewed and revised by a WHO Task Group which met in Brussels in early 1977. A much smaller group of experts then assisted the Secretariat to publish the document in its final form in 1980. Every effort was made to review all pertinent data and information available up to 1978, although a note at the front of the document acknowledges the possibility of errors and omissions and requests notification to the Secretariat if any errors are found.

The first draft of the updated 1995 document was initially prepared by Berglund and Lindvall on behalf of the WHO and the Nordic Noise Group of the Nordic Council of Ministers, as based on reviews of community noise effects published since the 1980 document. This draft was reviewed by a WHO Task Force of invited international experts at a meeting held in Dusseldorf in late 1992. A series of revised guideline values were agreed upon in consensus at the Dusseldorf meeting and have been included in the updated 1995 document as a separate chapter (Chapter 11). Berglund and Lindvall then prepared an external review draft for wider comments incorporating some additional contributions from members of the Dusseldorf Task Force. This draft was widely circulated in 1993. Many comments from different experts around the world were submitted to the editors. The final published document was compiled by Berglund and Lindvall with some assistance from the WHO secretariat. The editors alone decided how to deal with particular points where conflicting comments had been received. This means that parts at least of the updated document include an element of personal interpretation by the editors.

5.2 GUIDELINE VALUES

The main premise underlying the two WHO-inspired noise guideline documents (1980 and 1995) is that excessive exposure to community and environmental noise damages health. It is well known that excessive noise exposure in an industrial context can damage hearing, but the true effects of community and environmental noise in a residential context are more controversial. The various WHO guideline values for the range of noise effects are given in table 5. These are included in our earlier table 3 to some extent as BERGLUND 96.

It is immediately apparent when comparing the 1980 and 1995 guideline values that there is a lack of consistency in the definitions of the different effects of noise considered, and the units in which the guideline values are specified. For example, the 1980 guidelines for steady background noise levels to support 100% speech intelligibility were given as 45 L_{Aeq}, whereas the equivalent guideline values for 1995 were given as 35 dBA. The true levels of speech interference will not have changed, and although it might appear that the criterion value to avoid speech interference has been tightened by 10 dB in 15 years, in fact, both the way that the effects are measured and the way that the noise exposure is measured have changed and this makes it difficult to compare the two sets of guideline values.

Table 5: The WHO guideline values

Effect to be avoided	Effect criterion	1980	1995
speech interference	100% intelligibility	45 L_{Aeq}	35 dBA
	reasonable intelligibility		45 dBA
	loud speech understood		55 dBA
noise induced hearing loss	negligible risk	75 $L_{Aeq,8hrs}$	75 $L_{Aeq,8hrs}$
	increasing risk	140 dB	130-150 dB(peak)
sleep disturbance	electrophysiological effects	35 L_{Aeq}	30 L_{Aeq}
			45 L_{Amax}
cardiovascular disease		more research needed	more research needed
performance effects	cognitive tasks		no specific criteria
	startle effects		no specific criteria
	reading skills in children		no specific criteria
thresholds of reported annoyance	moderate annoyance		50 L_{Aeq}
	serious annoyance	50 L_{Aeq}	55 L_{Aeq}
social behaviour	reduced helping behaviour		80 dBA

Two critical areas are sleep disturbance and reported annoyance. The 1980 guideline value to avoid '*interference with the restorative process of sleep*' by continuous noise was specified as 35 L_{Aeq} as measured in the bedroom. The 1995 guideline value for continuous noise '*if negative effects on sleep are to be avoided*' is specified as 30 L_{Aeq}, some 5 dB lower than in 1980. An additional L_{Amax} guideline of 45 dBA is specified in the 1995 document to avoid sleep disturbance caused by separate noise events. These changes represent a more conservative approach by the editors of the updated 1995 document rather than any fundamental changes in human sensitivity to noise whilst asleep.

For reported annoyance, the 1980 guideline value was '*that daytime noise levels of less than 50 dBA Leq cause little or no serious annoyance in the community*'. '*Taking into account other factors such as transport needs, ..., daytime noise limits in the region of 55 dBA Leq might be considered as a general environmental health goal for outdoor noise levels in residential areas*'. The 1995 document states that '*the threshold of annoyance for steady-state, continuous noise is around 50 dB* L_{Aeq}*. Few people are seriously annoyed during the day time at noise levels below around 55 dB* L_{Aeq}'. For reported annoyance, close comparison of the precise specifications given in the 1980 and 1995 documents suggests that the guideline values have actually been relaxed. In 1980, 55 L_{Aeq} was

suggested as a general environmental health goal, whereas in 1995, 55 L_{Aeq} is being suggested as the threshold value below which few people are seriously annoyed.

5.3 INTERPRETATION

The most important factor to be borne in mind when interpreting the guideline values given in either of the 1980 or 1995 WHO-inspired noise criteria documents is that neither set actually has any official status. The fact that the guideline values in each case are based on a consensus reached by an invited group of international experts in the field lends them credibility, but, in such a complex field, it is inevitable that individual experts will disagree to some extent. For this reason, any attempt at formal ratification of the guideline values by any form of international voting would probably be doomed to failure. On the other hand, both documents represent a considerable amount of careful and detailed analysis of the available literature and are extremely valuable for that reason alone.

If the basic validity of the guideline values given in the WHO-inspired documents is accepted, and ignoring the minor differences between the 1980 and 1995 versions and any minor controversies raised by differences between individual expert opinions, the next step is to consider how the guidelines might be interpreted in future noise regulations and standards. This is basically quite straightforward, in that apart from the 1980 suggested '*general environmental health goal*' of 55 L_{Aeq} for daytime outdoor noise levels, virtually all of the guideline values are specified at the lower threshold below which the occurrence rates of any particular effect can be assumed to be negligible. It can be concluded that the guidelines do provide useful guidance as to the lower threshold levels below which residual noise impacts can probably be considered as negligible (threshold X on the curve given in figure 5). They can therefore be considered as ‘desirable’ and ideal targets.

While in an ideal world it may be desirable for none of these effects to occur, in practice a certain amount of noise is inevitable in any modern industrialised society. Perhaps the main weakness of both WHO-inspired documents is that they fail to consider the practicality of actually being able to achieve any of the stated guideline values.

We know from the most recent national survey of noise exposure carried out in England and Wales (SARGENT 93) that around 56% of the population are exposed to daytime noise levels exceeding 55 L_{Aeq} and that around 65% are exposed to night-time noise levels exceeding 45 L_{Aeq} (as measured outside the house in each case). The value of 45 L_{Aeq} night-time outdoors is equivalent to the 1995 WHO guideline value of 30 L_{Aeq} night-time indoors allowing 15 dB attenuation from outdoors to indoors for a partially open window (for free-air ventilation to the bedroom). The percentages exposed above the WHO guideline values could not be significantly reduced without drastic action to virtually eliminate road traffic noise and other forms of transportation noise (including public transport) from the vicinity of houses. The social and economic consequences of such action would be likely to be far greater than any environmental advantages of reducing the proportion of the population annoyed by noise. In addition, there is no evidence that anything other than a small minority of the population exposed at such noise levels find them to be particularly onerous in the context of their daily lives.

In view of the uncertainties involved in setting standards, the WHO guidelines might be considered as a highly precautionary approach if used when setting future noise standards and regulations to protect against possible health effects. While this precautionary approach may be justified by the scientific plausibility of these effects, it is necessary to place these possible effects in proper perspective. An over-precautionary approach to setting future noise standards and regulations at too low levels might lead to unacceptable impacts in other areas

5.4 SUMMARY

In essence, the WHO guidelines represent a consensus view of international expert opinion on the lowest threshold noise levels below which the occurrence rates of particular effects can be assumed to be negligible. Exceedances of the WHO guideline values do not necessarily imply significant noise impact and indeed, it may be that significant impacts do not occur until much higher degrees of noise exposure are reached. One difficulty here is the true importance of the different noise effects considered when placed in an overall context relating to quality of life, and the extent to which noise control might have excessive consequences in other areas of human experience.

As such, it would be unwise to use the WHO guidelines as targets for any form of strategic assessment, since, given the prevalence of existing noise exposure at higher noise levels, there might be little opportunity for and little real need for any across the board major improvements. On the other hand, the most constructive use for the WHO guidelines will be to set thresholds above which greater attention should be paid to the various possibilities for noise control action when planning new developments. It is important to make clear at this point that exceedances do not necessarily imply an over-riding need for noise control, merely that the relative advantages and disadvantages of noise control action should be weighed in the balance. It is all a question of balance, and mere exceedance of the WHO guidelines just starts to tip the scales.

6 CAN EFFECT-BASED ASSESSMENT METHODS BE ESTABLISHED ?

The aim of this work was to advise DETR whether it is possible to derive robust health effect based noise standards. We have looked at the issues and conclude ***that it is not possible at this time to establish health effect based assessment methods.*** This is because:

- We need a clearer understanding of the definition and framework within which we can judge the overall impact on health in order to develop standards that are useful to the decision maker and general public.

- Although there is evidence to support the existence of a cause-effect relationship for annoyance, and some evidence for activity interferences such as sleep disturbance and speech interference, we do not have convincing evidence whether other measurable effects exist at all at typical levels of exposure to community noise. In addition we do not know what proportion of the population might be affected and to what extent.

- Although there have been numerous scientific studies on the health effects of noise, we cannot at present define robust exposure-response relationships for all the potential effects. Existing dose-response relationships are confounded by a number of variables which serve to scatter the data points around these cause-effect curves. These include non acoustical exposure variables which can have major effects on attitudes and opinions.

- The scientific evidence suggests threshold levels below which no effects are expected. Again, since these are based on fragmentary and unconvincing evidence, the levels suggested cannot be taken as definitive at this time.

- There are uncertainties in assessing the overall impact of noise on health. These relate to the treatment of more than one effect, the role of modifiers, the cumulative exposure of different time periods, the handling of vulnerable or susceptible groups, and the role of other risk factors in assessing conditions of multi-factorial origin. These need to be better understood before effect-based assessment methods can be established.

- Practical noise criteria are a balance between the desirable and affordable. The desirable relates to the thresholds suggested by the scientific evidence below which no effect is expected. The affordable involves weighing the costs and benefits in monetary and social costs. Effect-based noise assessment methods and criteria must therefore take into account this compromise which may be different in different situations.

- Existing standards and regulations usually take the results of primary research into account to some extent, but social, economic and political considerations are often at least as important. Many existing noise limits also depend on unknown historical factors. It is very important to be clear about the role played by these social, economic, political and historic factors in the aetiology of current standards and regulations in the future development of new effect-based standards. It must also be taken into account that social and political interpretations can change, even if the underlying noise exposure response relationships remain constant. In addition, the underlying noise exposure response relationships might also change as public expectations develop.

7 THE WAY AHEAD

It is clear that the existing standards framework for environmental noise regulations in the UK is fragmentary and can lead to confusion. Some of these standards are based on the results of primary research, others are based almost totally on social, economic, and political considerations, and yet others appear to have been almost arbitrary in terms of their derivation. This has encouraged the development of entrenched positions by different institutions. People tend to argue about precise numeric values of noise exposure whereas perhaps what they should be doing is balancing concepts and broad objectives.

This work has concluded that we cannot at present establish health effect based assessment methods. DETR should take into account the following in developing such standards and improving the current situation:

1. The UK delegation to the ISO working group charged with revising the main international standard in this area, ISO 1996, is presently developing an improved framework approach. This approach recognises the diversity of different situations in which noise assessment might be applied as well as the need to balance noise exposure against other considerations which might be different in different situations. It concentrates on the three different outcomes for an assessment as described in this work. It is described in (FLINDELL 97). The work is currently supported by DETR and could contribute to the positive development of future standards in this area.

2. There could be greater transparency in the way in which future standards and regulations are developed so that the public can become more aware of both the strengths and limitations of these standards. In particular, the current emphasis on reported “bother” or “annoyance” as the main adverse outcome effect of environmental noise exposure leads to debate. This is because it is difficult to weigh or balance noise 'annoyance' against other benefits and impacts of any proposed development. An increased emphasis on non-auditory health effects as the outcome variable of choice might lead to greater transparency in this respect, although there is considerable doubt at the time of writing as to the magnitude of these effects.

3. To ensure that non-auditory health effects are included in the development of future standards and regulations, more research is required. This must be carefully designed, not only in terms of its planning and execution, but also in terms of setting precisely defined and achievable objectives. A number of suggestions for research are given in the IEH workshop report (IEH 97) which need prioritising in the light of the comments given in this report. A view towards which we incline is that is it more important to make small but scientifically defensible steps along the way towards a complete understanding than to try to understand the overall problem in one hit and probably fail (LUDLOW 96).

4. The major uncertainty is not just what proportion of the population might be affected and to what extent, but whether measurable effects exist at all at typical levels of exposure to community noise. There is certainly a possibility that at least a susceptible minority of the population might be affected, particularly at the higher levels of environmental noise. Consideration should be given to developing methods to identify

such groups and then using such groups for future research studies to facilitate the identification of health effects which otherwise may be difficult to observe in the general population. The goal of noise control policies could then be to offer a reasonable level of protection to susceptible groups which will automatically protect the 'normal' population.

5. If these effects could ever be reliably quantified, then it would be essential to take them into account, and, they would have direct meaning in terms of balancing costs and benefits. But DETR must be aware of the role of other factors in deriving effect-based standards such as the social, economic, political and historic factors. There is a role for setting limits as targets such as the WHO limits based on scientific evidence, but to be of any use they must be practical and attainable, as otherwise they are nothing more than committee exercises.

6. Work is required in developing an agreed method to consider the whole situation i.e. how to treat more than one effect, cumulative noise exposure, and risk factors or modifiers in order to assess the overall impact on health. This is not a simple problem but the solution should aim towards providing a framework for the practitioner or decision maker to consistently and effectively assess the impact and could even help to inform effective noise control decisions.

7. The importance of many of these issues have been recognised by DETR and DoH in their recent initiative to investigate the non-auditory effects of noise. It would be prudent to, when selecting and monitoring any projects resulting from this initiative, give consideration to their links with the development of future standards.

8. Given the present state of knowledge, it has been concluded that it would be unwise to base future standards and regulations on what are at present hypothesised non-auditory health effects until future research can make the present confused situation clearer. An alternative stance could be adopted based on the precautionary principle, i.e. if in doubt err on the side of caution. However, it has to be recognised that any too liberal application of this principle might lead to unacceptable impacts in other areas.

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9 ACKNOWLEDGMENTS

This study was funded by the UK DETR. The support of the DETR is gratefully acknowledged. NPL would also like to thank all those who provided valuable information on regulations and standards in their own Member States. The contribution of Mark Jiggins of NPL to the compilation of the Appendices is gratefully acknowledged.

We would also like to thank a number of international experts who were consulted at the early stages of this project. These were Dr Stephen Stansfeld, Dr Shirley Thompson, Dr Soames Job, Dr Stephen Morrell, Dr Peter Lercher and Mr Larry Finegold.

Appendix I: Letters and tables used for reviewing environmental noise regulations used in the UK and other countries.

Our Ref: ANC15A01
Your Ref:

Direct Line 0181-943 6705
Direct Fax 0181 943 6217
Date

Dear

ENVIRONMENTAL NOISE STANDARDS PROJECT- REQUEST FOR INFORMATION

The UK government is considering how best to develop noise standards in relation to known and hypothesized health effects. NPL together with the Institute of Sound and Vibration (ISVR) have been awarded a contract to carry out a review. As part of this review we would very much appreciate your help.

Why you ?

From our existing knowledge, we understand that you are a key worker in this area in your country. We realise that helping us might take a little time, but in return, we will circulate the results of our review to all participants so that you are made aware of the situation in other countries. If however you are unable to assist us, for whatever reason, it would be very helpful if you could let us know, and if possible provide the name and email address of someone who might help and then pass the information on.

What we would like to find out

Current noise standards and noise limits vary in different countries across Europe. We are aware of the standards and noise limits which apply in the UK, their legislative framework and on what basis they were developed. However, we need your help in obtaining the same information for your country. We are interested in three main aspects as follows:

- the legislative or regulatory framework
- the noise limits where specified (and units)
- a brief history of research findings or any other basis against which the standards and/or noise limits were developed

We have been reliant on recent reviews by NPL (Porter 95) and by D Gottlob (Gottlob 95). We enclose copies of these reviews for your information. Of course, there may have been changes since the publication of these reviews and we would like to find out if they are still current, or indeed, if they were entirely accurate in the first place. So where the current situation in your country is adequately represented by these reviews, ***then please tell us***. If there are differences, ***then please send details***. If your country is not covered in either review, then please just provide the information outlined in the next section.

Irrespective of the actual noise limits prescribed in particular standards or legislative controls, there can be large differences in the methods and philosophy against which they

have been derived. Undoubtedly, some of the noise standards and limits have been based solely on socio-political interpretation of established noise effects research findings. Others however have been based solely on what is considered practicable in terms of what can realistically be achieved. We are very interested in what particular approach underlies the noise standards and limits in your country. Where you believe that a particular piece of research has had an important influence, then ***please give us details.***

To make the collation of this information easier, we have prepared a framework table, a copy of which is attached. We eventually hope to compile all the information into a large table in order to show similarities and differences at a glance. The table is also enclosed electronically and should load easily onto your pc. We would be most grateful if you could insert information into the framework table either electronically or by hand. A different table is required for each type of noise source (road traffic, railway, aircraft, industrial, domestic etc) and each matter dealt with. We have enclosed an example table for your information. If adequate details for a particular section are given in either of the review articles, then just say so in the table. Also if you do not want to write out the full references and if they are included in either of the reviews, then just indicate the number given to the reference in the relevant review article.

If time is limited, then just send us whatever information you have which you feel is the most important for us to take into consideration in our review. We can always get back to you later with further requests, if necessary**. *Please send copies of any reports or other references*** which you feel might help us in this task.

What to do next ?

1. Having read through this letter, please decide whether you can assist. If you cannot, please pass this letter on to someone who may be able and let us know what you have done.

2. Please comment on the validity of information in the review articles enclosed with this letter.

3. Please complete the framework table, using a different table for each noise source and each matter dealt with. Remember, brief details are better than none at all !

4. Please return all the information and any supplementary reports, papers and references to:

Nicole D Porter
Centre for Mechanical and Acoustical Metrology
National Physical Laboratory
Teddington, Middlesex, TW11 0LW
United Kingdom
or alternatively you could fax us on: +44 181 943 6217

or use email: nicole.porter@npl.co.uk (you could attach the file)

by the end of February 1998

Then sit back and await your free copy of our NPL report detailing the situation in other countries !

I would like to thank you in advance for taking the time to help us. We look forward to passing our findings onto you in due course.

Yours sincerely

NICOLE D PORTER

Senior Research Scientist

Encs: Copy of pro-forma table (on paper and on disk)

Example table

Paper by Gottlob

Report by Porter

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country:

Specific noise source:

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with:

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

EXAMPLE
ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **United Kingdom**
Specific noise source: **Railway Noise**
Matters dealt with: **Entitlement to noise insulation grants (new works)**

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information how they interrelate)	Noise insulation grants for new railway works are assessed under the Noise Insulation Regulations 1995 (SI no. XXXX) made under Section xx of the Control of Pollution Act 1974. The details of noise insulation provided is specified under xxxx Regulations 19yy (SI no. xxxx). Entitlement is assessed by reference to 'Calculation of Railway Noise' Dept. of Transport,1996 which provides a method to calculate the noise levels.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	The statutory limits for entitlement to a noise insulation grant are: daytime 68 $L_{Aeq,\ 18hr}$ night-time 63 $L_{Aeq,\ 6hr}$ Noise limits apply at 1m from the facade of qualifying internal rooms
Is the assessment of noise against the limits based on measurement, prediction or both ?	Predictions
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	The basis for the noise limits was agreed by the Mitchell Committee (reported in Railway noise and the insulation of dwellings, DoT, 1991). The Department of Transport then made changes x and y for reasons a and b to the final version. The aim was to treat railway noise and road traffic noise the same in terms of the degree of community annoyance at which a noise insulation grant scheme could be expected. The committee considered: 1. results of surveys of railway noise annoyance (refs x, y and z) 2. comparisons between road and rail noise annoyance (refs x, y and z) 3. sleep disturbance studies (refs x, y and z)
Is further research planned or considered necessary ?	None identified at present

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

Appendix II: Findings from the review of environmental noise regulations and standards in the UK and EU countries.

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **United Kingdom**
Specific noise source: **Aircraft**
Matters dealt with: **Regulations for the management of aircraft noise**

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	All UK registered aircraft must comply with noise certification requirements laid down in the in the Air Navigation (Noise Certification) Order 1990 made under the Civil Aviation Act 1982, and BCAR Section N. The relevant noise certification requirements are set out in various chapters of ICAO Annex 16 (1962). EC Directive 89/629 specifies no further additions of ICAO Annex 16 Chapter 2 aircraft to the registers of Members States, EC Directive 92/14 specifies that existing ICAO Annex 16 Chapter 2 aircraft should be phased out by 2002. The Civil Aviation Act 1982 provides immunity from civil actions related to noise, provided operations comply with the relevant Air Traffic Navigation Order. To avoid conflict with this immunity, the Environmental Protection Act 1990 specifically excludes *'noise by aircraft other than model aircraft'*. The Civil Aviation Act 1982 also provides for the Secretary of State to designate airports for the purposes of regulating aircraft noise by setting limits and directions to airport managers. The Airports Act 1986 allows noise and track monitoring equipment to be specified by the Secretary of State at designated airports.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	The are no aircraft noise limit values in the UK. Noise contour maps in $L_{Aeq,16hr}$ are published annually at designated airports and are becoming commonplace at others. Various $L_{Aeq,16hr}$ contour boundaries have been used in the past to define noise insulation schemes to update historic schemes based on the 50 NNI contour.
Is the assessment of noise against the limits based on measurement, prediction or both ?	Noise contours are always generated by a method calculation.
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings and/or practical considerations	The changeover from NNI to $L_{Aeq,16hr}$ in 1990 was based on the results of the 1984 Aircraft Noise Index Study (CAA DORA Report 8402 1985), which generally supported trends towards the use of L_{Aeq} based indices. NNI was originally adopted as a result of the Wilson Report of 1963, based on the results of a 1961 aircraft noise study.
Is further research planned or considered necessary ?	The management of aircraft noise at night has become increasingly controversial in recent years and further research is being planned.

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **United Kingdom**
Specific noise source: **Road Traffic**
Matters dealt with: **Regulations for the management of road traffic noise.**

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	All UK registered vehicles must comply with vehicle noise approval requirements according to EC Directive 84/424/EEC. The Noise Insulation Regulations 1973, 1975 and 1988 made under the Land Compensation Act 1973) provide for the noise insulation of house where road traffic noise from a new or significantly altered road exceeds 68 $L_{A10,18hr}$, predicted or measured 1m from an eligible facade.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	There are no road traffic noise limit values in the UK. Predictions of future road traffic noise levels are required as part of the environmental appraisal of all new road schemes, but the results are merely a factor to be taken into account when deciding on the optimum scheme. Where feasible, it is becoming customary to provide noise barriers, speed reductions, or absorbent road surfaces to reduce the number of properties where the 68 $L_{A10,18hr}$ noise insulation criterion is exceeded.
Is the assessment of noise against the limits based on measurement, prediction or both ?	Noise levels are preferably determined by a calculation method, although measurements are permitted.
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings and/or practical considerations	The use of the $L_{A10,18hr}$ noise index for road traffic noise environmental appraisal is based on historic road traffic noise studies. The derivation of the 68 $L_{A10,18hr}$ criterion for entitlement to noise insulation is not traceable.
Is further research planned or considered necessary ?	The is increasing concern that the $L_{A10,18hr}$ noise index does not fully reflect public reactions under all circumstances in which it is applied and a number of research projects have been carried out recently, or are underway, to address this point.

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **United Kingdom**
Specific noise source: **Railway Traffic**
Matters dealt with: **Regulations for the management of railway noise**

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information how they interrelate)	There are no railway type approval noise requirements in the UK. The Noise Insulation (Railway and Other Guided Transport Systems) Regulations 1995 (made under the Land Compensation Act 19730 provides for the noise insulation of houses where railway noise from a new or significantly altered railway exceeds 68 $L_{Aeq,18hr}$ (0600-2400 day) or 63 $L_{Aeq,6hr}$ (2400-0600 night), predicted or measured at 1m from an eligible facade.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	There are no railway noise limits in the UK. Prediction of future railway noise levels are required as part of the environmental appraisal of all new railway schemes, but the results are merely a factor to be taken into account when deciding on the optimum scheme.
Is the assessment of noise against the limits based on measurement, prediction or both ?	Noise levels are preferably determined by a calculation method, although measurements are permitted.
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings and/or practical considerations	The use of the L_{Aeq} noise index is based on the results of historic railway noise studies, together with an appraisal of international trends towards a wider adoption of L_{Aeq} type noise indices. The 18hour L_{Aeq} is used for daytime noise to maintain consistency with the existing road traffic noise insulation regulations. The 68 $L_{Aeq,18hr}$ and 63 $L_{Aeq,6hr}$ criteria were selected for assumed consistency with the existing road traffic noise insulation regulations, as based on a review of published road traffic and railway noise research.
Is further research planned or considered necessary ?	None identified at present. Existing railway noise from well-established routes is not generally considered to be a major problem and very few residents have been significantly affected by new railway noise in recent years.

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **United Kingdom**
Specific noise source: **Industrial Noise**
Matters dealt with: **Regulations for the management of industrial noise.**

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	The Environmental Protection Act 1990 allows for industrial noise to be assessed as a statutory nuisance if the circumstances so dictate. Industrial noise can also be assessed as a private nuisance under common law. There is no noise limit value to help in deciding whether industrial noise is a nuisance or not.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	There are not industrial noise limits in the UK. BS4142:1997 provides a technical means of assessing whether or not 'complaints are likely'. The result of an assessment carried out to BS4142 would normally be relevant to the deliberations of any court considering whether or not a nuisance exists.
Is the assessment of noise against the limits based on measurement, prediction or both ?	Noise levels are determined by measurement, but calculations are permitted where they can be justified.
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings and/or practical considerations	The derivation of the method of assessment in BS4142 is technically obscure. It appears to be based on an early USA report by Rosenblith and Stevens dating from 1955, with various modifications introduced by different British Standards Committees over the years.
Is further research planned or considered necessary ?	Various research programmes have been carried out in recent years in support of the technical improvements to BS4142, further work appears to be justified.

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **United Kingdom**
Specific noise source: **Aircraft**
Matters dealt with: **Planning permission for new dwellings exposed to existing aircraft noise**

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	Town and Country Planning Act 1990. Planning Policy Guidance Note PPG24 : Planning and Noise. PPG24 provides general guidance and advice on the aspects to consider when dealing with planning applications for new development where dwellings may be subject to noise. The noise exposure categories in PPG24 are used for new dwellings near existing noise sources.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	Noise exposure categories (NECs) are used to determine the degree to which noise is a factor in the planning process, based on $L_{Aeq,t}$:- 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. B Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate protection against noise. 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. D Planning permission should normally be refused. A B C D 0700 - 2300 <57 57 - 66 66 - 72 >72 2300 - 0700 <48 48 - 57 57 - 66 >66
Is the assessment of noise against the limits based on measurement, prediction or both ?	Both: measurements allow noise contour maps to be made, and position allows prediction of noise at buildings
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings and/or practical considerations	Builds on the principles of Planning Circular 10/73 and the recommendations made by the Noise Review Working Party 1990. The boundary of NEC A and B for daytime levels is based on considerable research using local surveys and measurements which show that 57dB(A) L_{Aeq} (previously 35 NNI) relates to the onset of annoyance. Night time levels are taken from WHO Health Criteria 12 "based on limited data available, a level of less than 35dB(A) is recommended to preserve the restorative process of sleep". This is corrected from internal to external free field noise levels by adding 10dB(A) for the attenuation of an open window and corrected by a further 2dB(A) for reflections from the ground. 48dB(A) is the nearest aircraft L_{Aeq} contour level.

	The boundary of NEC B and C for daytime levels is based on the trigger level for official grant schemes of 66dB(A) $L_{Aeq,16h}$ (previously 50 NNI) at Heathrow, Gatwick and Stansted airports. Night time levels are based on the trigger level for official grant schemes at Stansted of the 57dB(A) L_{Aeq} noise contour value. The daytime boundary of NEC C and D is based on a well established level proposed in Planning Circular 10/73 of 60 NNI, equivalent to 72dB(A) $L_{Aeq,16h}$ with a 2dB(A) allowance for ground reflection included. Night time levels are based on the WHO limit of 35dB(A) with an allowance for the typical attenuation of the standard noise insulation package and corrected to free field. A further reduction of 1dB(A) ensures levels are below 35dB(A) indoors giving a corresponding nearest noise contour of 66dB(A) L_{eq}.
Is further research planned or considered necessary ?	L_{Aeq16h} maps being produced to replace NNI ones

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **United Kingdom**
Specific noise source: **Road Traffic**
Matters dealt with: **Planning permission for new dwellings exposed to existing road traffic noise**

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	Town and Country Planning Act 1990. Planning Policy Guidance Note PPG24 : Planning and Noise. PPG24 provides general guidance and advice on the aspects to consider when dealing with planning applications for new development where dwellings may be subject to noise. The noise exposure categories in PPG24 are used for new dwellings near existing noise sources.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	Noise exposure categories (NECs) are used to determine the degree to which noise is a factor in the planning process, based on $L_{Aeq,t}$:- 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. B Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate protection against noise. 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. D Planning permission should normally be refused. A B C D 0700 - 2300 <55 55 - 63 63 - 72 >72 2300 - 0700 <45 45 - 57 57 - 66 >66
Is the assessment of noise against the limits based on measurement, prediction or both ?	Both
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings and/or practical considerations	Builds on the principles of Planning Circular 10/73 and the recommendations made by the Noise Review Working Party 1990. The boundary of NEC A and B for daytime levels is taken from WHO Health Criteria 12 "general daytime outdoor noise levels of less than 55dB(A) L_{eq} are desirable to prevent significant community annoyance". Night time levels are again taken from WHO Health Criteria 12 "based on limited data available, a level of less than 35dB(A) is recommended to preserve the restorative process of sleep". This is corrected from internal to external free field noise levels by adding 10dB(A) for the attenuation of an open window.

(Continued)

Country: **United Kingdom**
Specific noise source: **Road Traffic**
Matters dealt with: **Planning permission for new dwellings exposed to existing road traffic noise**

	The boundary of NEC B and C for daytime levels is based on the trigger level for official grant schemes of 68dB(A) $L_{A10,18h}$ corrected to free field and to $L_{Aeq,16h}$ by subtracting 5dB(A). Night time levels are again based on the WHO 35dB(A) criteria allowing for the attenuation through a closed window giving 57dB(A) $L_{Aeq,8h}$ free field. The boundary of NEC C and D is based on a study by the building research establishment that has shown noise insulation packages supplied under the Noise Insulation Regulations are inadequate beyond an external free field level of 72dB(A) $L_{Aeq,t}$. Night time levels are based on the WHO limit of 35dB(A) with an allowance for the typical attenuation of the standard noise insulation package and corrected to free field. A further reduction of 1dB(A) ensures levels are below 35dB(A) indoors.
Is further research planned or considered necessary ?	None specifically noted.

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **United Kingdom**
Specific noise source: **Railway Noise**
Matters dealt with: **Planning permission for new dwellings exposed to existing railway noise**

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	Town and Country Planning Act 1990. Planning Policy Guidance Note PPG24 : Planning and Noise. PPG24 provides general guidance and advice on the aspects to consider when dealing with planning applications for new development where dwellings may be subject to noise. The noise exposure categories in PPG24 are used for new dwellings near existing noise sources.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	Noise exposure categories (NECs) are used to determine the degree to which noise is a factor in the planning process, based on $L_{Aeq,t}$:- 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. B Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate protection against noise. 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. D Planning permission should normally be refused. A B C D 0700 - 2300 <55 55 - 66 66 - 74 >74 2300 - 0700 <45 45 - 59 59 - 66 >66
Is the assessment of noise against the limits based on measurement, prediction or both ?	Both.
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings and/or practical considerations	Builds on the principles of Planning Circular 10/73 and the recommendations made by the Noise Review Working Party 1990. The boundary of NEC A and B for daytime levels is taken from WHO Health Criteria 12 "general daytime outdoor noise levels of less than 55dB(A) L_{eq} are desirable to prevent significant community annoyance". Night time levels are again taken from WHO Health Criteria 12 "based on limited data available, a level of less than 35dB(A) is recommended to preserve the restorative process of sleep". This is corrected from internal to external free field noise levels by adding 10dB(A) for the attenuation of an open window.

(Continued)

Country: **United Kingdom**
Specific noise source: **Railway Noise**
Matters dealt with: **Planning permission for new dwellings exposed to existing railway noise**

	The boundary of NEC B and C for daytime levels is based on the trigger level for official grant schemes of 68dB(A) $L_{Aeq,18h}$ corrected to free field and to $L_{Aeq,16h}$ by subtracting 2dB(A). Night time levels are based on the trigger level for official grant schemes of 63dB(A) $L_{Aeq,6h}$ converted to 59dB(A) $L_{Aeq,8h}$ free field. The boundary of NEC C and D is based on a study by the building research establishment that has shown noise insulation packages supplied under the Noise Insulation Regulations are inadequate beyond an external free field level of 72dB(A) $L_{Aeq,t}$ but with a further allowance of 2dB(A) due to evidence that railway noise is less disturbing than road noise. Night time levels are based on the same WHO limit of 35dB(A) with an allowance for the typical attenuation of the standard noise insulation package and corrected to free field. A further reduction of 1dB(A) ensures levels are below 35dB(A) indoors.
Is further research planned or considered necessary ?	

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **United Kingdom**
Specific noise source: **Mixed Sources Including Industrial Noise**
Matters dealt with: **Planning permission for new dwellings exposed to existing mixed sources including industrial noise**

THE LEGISLATIVE OR REGULATORY FRAMEWORK

Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	Town and Country Planning Act 1990. Planning Policy Guidance Note PPG24 : Planning and Noise. PPG24 provides general guidance and advice on the aspects to consider when dealing with planning applications for new development where dwellings may be subject to noise. The noise exposure categories in PPG24 are used for new dwellings near existing noise sources.

NOISE LIMITS (where stated)

What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	Noise exposure categories (NECs) are used to determine the degree to which noise is a factor in the planning process, based on $L_{Aeq,t}$:- 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. B Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate protection against noise. 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. D Planning permission should normally be refused. A B C D 0700 - 2300 <55 55 - 63 63 - 72 >72 2300 - 0700 <45 45 - 57 57 - 66 >66
Is the assessment of noise against the limits based on measurement, prediction or both ?	Both.

DERIVATION OF NOISE LIMITS

Please give summary details on the basis of these noise limits e.g. on which research findings and/or practical considerations	Builds on the principles of Planning Circular 10/73 and the recommendations made by the Noise Review Working Party 1990. The boundary of NEC A and B for daytime levels is taken from WHO Health Criteria 12 "general daytime outdoor noise levels of less than 55dB(A) L_{eq} are desirable to prevent significant community annoyance". Night time levels are again taken from WHO Health Criteria 12 "based on limited data available, a level of less than 35dB(A) is recommended to preserve the restorative process of sleep". This is corrected from internal to external free field noise levels by adding 10dB(A) for the attenuation of an open window.

(Continued)

Country: **United Kingdom**
Specific noise source: **Mixed Sources Including Industrial Noise**
Matters dealt with: **Planning permission for new dwellings exposed to existing mixed sources including industrial noise**

	The boundary of NEC B and C for daytime levels is based on the trigger level for official grant schemes of 68dB(A) $L_{A10,18h}$ corrected to free field and to $L_{Aeq,16h}$ by subtracting 5dB(A). Night time levels are based on the same 35dB(A) limit as above but corrected from internal to external free field noise levels by adding 22dB(A) for the attenuation of a closed window The boundary of NEC C and D for daytime levels is based on a study by the building research establishment that has shown noise insulation packages supplied under the Noise Insulation Regulations are inadequate at and beyond an external free field level of 73dB(A) $L_{Aeq,t}$. Night time levels are based on the same WHO limit of 35dB(A) with an allowance for the typical attenuation of the standard noise insulation package and corrected to free field. A further reduction of 1dB(A) ensures levels are below 35dB(A) indoors.
Is further research planned or considered necessary ?	

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **United Kingdom**
Specific noise source: **Construction Sites**
Matters dealt with: **Regulations for the management of construction site noise**

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	The Control of Pollution Act 1974 gives Local Authorities the power to control noise from construction and open sites, or for prior consent for the works to be agreed with the developer. In general best practical means are employed with reference made to BS5228:1997 'Noise and vibration control on construction and open sites' as the approved code of practice.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	There are no over-riding construction noise limits in the UK, but individual Local Authorities can impose conditions defining agreed site boundary noise limits to which developers can then be constrained under the Control of Pollution Act 1974. These limits will vary depending on the circumstances of each case. The information provided in BS5228 enables the $L_{Aeq,t}$ to be calculated due to all aspects of site activity at any receiver position, this could include stationary plant and haul road noise. Consideration is given of working hours and noise levels but fixed limits are not specified. Specific advice:- *"the evening limit may have to be as much as 10dB(A) below the daytime limit"...."The periods when people are getting to sleep and just before they awake appear to be particularly sensitive. Site noise expressed as $L_{Aeq(1h)}$ at the facade of noise-sensitive premises may need to be as low as 40dB(A) to 45dB(A) to avoid sleep disturbance". . . ."In certain circumstances it may be appropriate to apply a weighting, or character correction, of 5dB(A) to the source of intermittent, tonal or impulsive noise"* Mitigation methods are also provided.
Is the assessment of noise against the limits based on measurement, prediction or both ?	Initial assessment would usually be done by prediction, but measurements will normally be used to determine compliance with locally agreed conditions.
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings and/or practical considerations	Construction Industry Research and Information Association (CIRIA): Report 64, "Noise from Construction and Demolition Sites - measured levels and their prediction" forms the basis of BS5228.
Is further research planned or considered necessary ?	

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **United Kingdom**
Specific noise source: **Noise at Work**
Matters dealt with: **Regulations for the management of noise exposure at work**

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	Health & Safety: Noise at Work Regulations 1989 The Regulations impose a general duty on the employer to reduce the risk of damage to hearing to the lowest level reasonably practical. Where any employee is exposed to noise levels above the first or peak action levels the exposure to noise shall be reduced as far as is reasonably practical (not by personal hearing protection). In any event the noise exposure shall be kept below the second action level.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	First action level: $L_{EP,d}$ ($L_{Aeq,8hr}$) daily personal noise exposure of 85dB(A); Second action level: $L_{EP,d}$ ($L_{Aeq,8hr}$) daily personal noise exposure of 90dB(A); Peak action level: a peak sound pressure of 200 pascals. Specified at the position the worker would normally be exposed to the noise.
Is the assessment of noise against the limits based on measurement, prediction or both ?	Measurement ensures compliance with the regulation but prediction can be used when planning a work environment.
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings and/or practical considerations	The limits were imposed by EC Directive, adopted in the UK regulations under the Health & Safety at Work Act 1974. The EC limits were based on international research which identified an increasing risk of NIHL with increasing long term exposure.
Is further research planned or considered necessary ?	

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: GREECE

Specific noise source: Industry and any other kind of mechanical installations

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Maximum noise limit

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	Presidential Decree 1180 / 1981
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	Depending on the character of the area, the noise limits are the following: -industrial zones : 70dB(A) -areas in which industrial character prevails : 65dB(A) -areas equaly industrial and residential : 55dB(A) -areas in which residential character prevails : 50dB(A). If the installation is «in touch» with a house, the noise limit inside the house is 45dB(A). The above levels are simple SPL. In practice, they represent the mean maximum of a series of measurements, from which the background noise level (mean minimum) is «substracted». There are no special night limits.
Is the assessment of noise against the limits based on measurement, prediction or both ?	Measurement
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	This Pres. Dec. is under reconcideration. It is highly probable to wait for the results of the work of the Commission of E.U. on the formulation of a common Directive on Noise.

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: GREECE

Specific noise source: Traffic

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Maximum noise limits

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	Ministerial Decision 17252 / 1992 It concerns max permissible noise levels in **new** roads. It applies at the stage of elaboration of the Enviromental Impact Assessment Study of the new road.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	The expected max noise levels of the new road can be expressed either in Leq(8:00-20:00) or in L_{10}(06:00-24:00). The corresponding levels are 67dB(A) and 70dB(A) respectively.
Is the assessment of noise against the limits based on measurement, prediction or both ?	For the scope of the Env. Im. Ass. Study, the assessment is based on predictions. The prediction methodology is mostly based on CRTN (U.K. DoT). After the constraction of the road, the above levels are verified by measurements.
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: GREECE

Specific noise source: Vehicles (cars and motorcycles)

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Registration of new vehicles

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	Our legislation is completely harmonised with all the relevant E.U. Directives on this matter. For the vehicles in use, the checks are made according to the «stationary method» and the noise level emmited by the vehicle is compared with the level written in its permit.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: GREECE

Specific noise source: Aircraft

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with:

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	Our legislation is harmonised with all the relevant E.U. Directives on this matter.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: GREECE

Specific noise source: Discoteques and other public places with music

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Maximun noise limit

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	Ministerial Decision A5 / 3010 / 1985
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	a. For discos, max. permissible noise levels outside the premise are from 30dB(A) to 45dB(A) according to the caracter of the area. b. For discos, if house «in touch» minimum required isolation 65dB(A). c. For open-air discos, minimum distance from houses 300m and a. above. d. For all discos, max. permissible level inside 100dB(A). e. For «other», max. permissible level inside 80dB(A). f. For open-air «other», as a. above.
Is the assessment of noise against the limits based on measurement, prediction or both ?	Measurement
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: GREECE

Specific noise source: Constraction machinery

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Registration of new machines

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactment's, standards etc. (where possible giving information about how they interrelate)	Our legislation is completely harmonised with all the relevant E.U. Directives on this matter.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Italy

Specific noise source: Airport Noise

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Land use planning

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	Decree of the Ministry of Environment 31.10.1997 "Metodologia di misura del rumore aeroportuale" (Methodolgy for the measurement of the aircraft noise around airports), published on the Gazzetta Ufficiale n. 267 15.11.1997. The decree has been issued to implement the framework law on environmental noise pollution n. 447 dated 26.10.1995 and published on the Gazzetta Ufficiale n. 254 30.10.1995.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	The statutory limits for land use planning are: $L_{VA} \leq 65$ dB(A) for zone A where no limits are established for the land use $65 < L_{VA} \leq 75$ dB(A) for zone B prohibited for residental use $L_{VA} \geq 75$ dB(A) for zone C where only airport activities are allowed See attached sheet for the definition of L_{VA}
Is the assessment of noise against the limits based on measurement, prediction or both ?	Prediction can be used in addition to measurement
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	Relevant noise legislations in other countries have been considered together with practical considerations
Is further research planned or considered necessary ?	None identified at present

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

Annex A of the Decree of the Ministry of Environment 31.10.1997

Summary of the definition of the L_{VA} index (assessment of the airport noise)

$$L_{VA} = 10\log\left[\frac{1}{N}\sum_{j=1}^{N} 10^{L_{VAj}/10}\right] \text{ dB(A)}$$

where:
N=21 days, namely 3 weeks chosen in order to include one week in every of the following 3 periods: 1st October-31st January; 1st February-31st May; 1st June-30rd September and each week is selected to have the maximum number of aircraft operations.

$$L_{VAj} = 10\log\left[\frac{17}{24}\cdot 10^{L_{VAd}/10} + \frac{7}{24}\cdot 10^{L_{VAn}/10}\right] \text{ dB(A) is the 24 hour value of the index}$$

L_{VAd} is the value corresponding to the day-time period (6-23 hours) and L_{VAn} is the value corresponding to the night-time period (23-6 hours) calculated as follows:

$$L_{VAd} = 10\log\left[\frac{1}{61200}\sum_{i=1}^{N_d} 10^{SEL_i/10}\right] \text{ dB(A) where } N_d \text{ is the number of the aircraft operations in the day-time period}$$

and SEL_i correspond to the i-th aircraft operation;

$$L_{VAn} = 10\log\left[\frac{1}{25200}\sum_{i=1}^{N_n} 10^{SEL_i/10}\right] + 10 \text{ dB(A) where } N_n \text{ is the number of the aircraft operations in the night-time}$$

period and SEL_i correspond to the i-th aircraft operation.

$$SEL_i = 10\log\left[\frac{1}{T_0}\int_{t_1}^{t_2}\frac{p_{Ai}^2(t)}{p_0^2}dt\right] \text{ dB(A) where } T_0=1 \text{ s and } t_2\text{-}t_1 \text{ is the period where the } L_{AFast} \text{ is above the treshold}$$

$L_{AFastmax}$ -10 dB(A).

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Italy

Specific noise source: Airport noise

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Noise control and abatement measures

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	Decree of the President of the Republic 11.12.1997 "Regolamento recante norme per la riduzione dell'inquinamento acustico prodotto dagli aeromobili civili" (Measures for the control and reduction of the noise produced by civil aircrafts), published on the Gazzetta Ufficiale n. 20 26.1.1998. The decree has been issued to implement the framework law on environmental noise pollution n. 447 dated 26.10.1995 and published on the Gazzetta Ufficiale n. 254 30.10.1995.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	Definition of the fines for the violation of the noise abatement procedures by aircrafts (from ITL 500000 up to 20000000). Design of the noise abatement plan for each airport. Ban of the national and international flights during the night-period (23-6 hours) with the exception of the intercontinental airports, that is Rome-Fiumicino and Milano-Malpensa.
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	None identified at present

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Italy

Specific noise source: All sound sources, excepting means of transport

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Noise limits

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	Decree of the Prime Minister 14.11.1997 "Determinazione dei valori limite delle sorgenti sonore" (Noise limits for sound sources), published on the Gazzetta Ufficiale n. 280 1.12.1997. The decree has been issued to implement the framework law on environmental noise pollution n. 447 dated 26.10.1995 and published on the Gazzetta Ufficiale n. 254 30.10.1995.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	L_{Aeq} for the day period (6-22 hours) and for the night period (22-6 hours) is used as descriptor for the following limits (for the values see attached sheet): emission limits; immission limits; warning values; quality targets.
Is the assessment of noise against the limits based on measurement, prediction or both ?	Excepting quality targets, only measurements are accepted
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	Adaptation among several aspects such as health protection, socio-economical impacts, practical consideration on the applicability of the procedures.
Is further research planned or considered necessary ?	None identified at present

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

All the limits and values are referred to the land use divided into six categories as defined in the table A attached to the Decree.

Type	Land use zone
I	Noise sensitive premises (schools, hospitals, recreational areas, etc.)
II	Residentia areas (low density of population and light traffic flow, limited commercial acitivity
III	Mixed areas (medium density of population and and normal traffic flow, offices and commercial activities)
IV	Intense activity areas (high density of population and heavy traffic flow, offices and commercial activities, limited small industrial activity)
V	Industrial areas and low density of residential buildings
VI	Industrial areas only

Emission limits (for fixed or moving sound sources not regulated by either standards or legislation) measured at the noisiest receiver position

Category of land use	Reference period	
	Day-time (6-22 h)	Night-time (22-6)
I	45	35
II	50	40
III	55	45
IV	60	50
V	65	55
VI	65	65

Immission limits (adding the contribution of all the noise sources at the receiver position, including the noise produced by means of transport outside their property area)

Category of land use	Reference period	
	Day-time (6-22 h)	Night-time (22-6)
I	50	40
II	55	45
III	60	50
IV	65	55
V	70	60
VI	70	70

In addition to the above absolute limits for indoor noise the differential criterion has to be met, that is:

Day-time L_{Aeq} ambient noise - L_{Aeq} residual noise ≤ 5 dB

Night-time L_{Aeq} ambient noise - L_{Aeq} residual noise ≤ 3 dB

to be applied when the L_{Aeq} ambient noise measured at window opened (specific source outside the building) is ≥ 50 dB(A) at day-time and ≥ 40 dB(A) at night-time or the L_{Aeq} ambient noise measured at window closed (specific source inside the building) is ≥ 35 dB(A) at day-time and ≥ 25 dB(A) at night-time.

Warning values, in terms of long term L_{Aeq} (integer multiple of the reference period), equal to the immission limits when referred to the reference period and equal to the immission limits +10 dB (day period) or +5 dB (night period) if referred to one hour.

Quality targets

Category of land use	Reference period	
	Day-time (6-22 h)	Night-time (22-6)
I	47	37
II	52	42
III	57	47
IV	62	52
V	67	57
VI	70	70

All the above limits and values will be effective when the Municipalities will issue the noise zoning of their own territory. In the mean time the limits established by the DPCM 1/3/1991 are still in force.

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country:

Specific noise source: Italy

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Maximum noise limit

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	Decree of the Ministry of Environment 11.12.1996 "Applicazione del criterio differenziale per gli impianti a ciclo produttivo continuo" (Application of the differential criterion to the no-stop operating plants), published on the Gazzetta Ufficiale n. 52 4.3.1997. The decree has been issued to implement the framework law on environmental noise pollution n. 447 dated 26.10.1995 and published on the Gazzetta Ufficiale n. 254 30.10.1995.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	Day-time (6-22) Ambient noise L_{Aeq} - residual noise $L_{Aeq} \leq 5$ dB(A) Night-time (22-6) Ambient noise L_{Aeq} - residual noise $L_{Aeq} \leq 3$ dB(A) where ambient noise=residual noise + specific source noise To apply only indoors and in non industrial areas, when the immission limits are exceeded.
Is the assessment of noise against the limits based on measurement, prediction or both ?	Measurement only.
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	Further researches are necessary to develop measurement procedures for the residual noise.

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Italy

Specific noise source: Recreational noise

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Maximum noise limits

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	Decree of the Prime Minister 18.9.1997 "Determinazione dei requisiti delle sorgenti sonore nei luoghi di intrattenimento danzante" (Requirements of the sound sources in the entertainment places both indoors and outdoors), published on the Gazzetta Ufficiale n. 233 6.10.1997. The decree has been issued to implement the framework law on environmental noise pollution n. 447 dated 26.10.1995 and published on the Gazzetta Ufficiale n. 254 30.10.1995.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	$L_{ASlow\ max} \leq 103$ dB(A) and $L_{Aeq} \leq 95$ dB(A) for the entire operating period of the electroacoustic system during the daily opening hours, measured in the noisest position in the area reserved to the public.
Is the assessment of noise against the limits based on measurement, prediction or both ?	Measurement only
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	Further researches are necessary and at present the Decree is under a large revision due to difficulties in the application.

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Norway

Specific noise source: motor sports

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with:

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	Norway uses Swedish regulations
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	Lamax free field (not corrected for façade) residences weekdays 0700-1800 60 dBA nights (1800-2200) plus weekends: 55 dBA hospitals, recreational areas, etc weekdays 0700-1800 55 dBA nights and weekends 50 dBA
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Norway

Specific noise source: industry

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with:

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	Regulations given by Dep of the Environment TA-506
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	Noise index: LAEQ for specified period. LAmax not to exceed LAEQ by more than 10 dBA Limits are given for these periods: 0600-1800 1800-2200 2200-0600 residences and schools 50 dBA 45 dBA 40 dBA rec.homes, hospitals etc 40 35 35 Sundays and holidays the evening limits apply all day 0600-2200 If tonal components and impulse noise limits are corrected by 5 dBA
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Norway

Specific noise source: shooting ranges

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with:

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	There are regulations depending on the activity Class 1: less than 20.000 shots pr year Class 2: between 20.000-50.000 shots Class 3: more than 50.000 shots pr year Noise limits apply in the period 0700-2200
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	Noise index: Noise level pr shot dBA impulse Class1 residences 65 dBA, recreation homes 60 dBA if less than 3 houses affected 70 dBA and 65 dBA respectively class 2: residences 65 dBA, rec.homes, hospitals etc 60 dBA class 3: residences 60 dBA, rec.homes etc 55 dBA increase limits by 5 dB if less than 3 houses affected
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country:Norway

Specific noise source: road traffic

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with:

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	Regulations issued by the dept of the Environment T-8/79 currently being revised
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	Noise index: LAEQ 24 hour and Lamax at night (2200-0600) Outside façade: Residences: LAEQ 55-60 Lmax 70-80 Health institutions 50-55 65-75 Schools, kindergarten 50-55 Indoor (windows closed) residences 30-35 45-55 health inst 25-35 40-50 schools etc 30-35 offices etc 40-45
Is the assessment of noise against the limits based on measurement, prediction or both ?	Both predictions and measurements
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	The regulations are being revised

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **Portugal**
Specific noise source: **Noise to the exterior of buildings**
(complete a separate sheet for each source covered by existing or proposed standards/limits)
Matters dealt with: **Noise generated by industrial, commercial and service buildings**
(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	*Decreto-Lei* no. 251/87 of 24th June (*Regulamento Geral sobre o Ruído*), modified and updated by *Decreto-Lei* no. 292/89 of 2nd September. The *Regulamento Geral sobre o Ruído* (General Regulations on Noise) was the first legal document in Portugal which gathered and completed a set of sparse existing laws on noise. The law mentions that measurements must be made according to the applicable Portuguese Standards (*Normas Portuguesas* or *NP*). The most important is *NP*-1730, which was recently reviewed and is now a simple translation into Portuguese of ISO 1996.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	The difference between L_{eq} of noise originated by industrial, commercial and service buildings, after undergoing appropriate corrections, and L_{95} (assumed to represent background noise) may not exceed 10 dB(A) in any given reference period (Art. 14th). According to *NP*-3225/1 (Vocabulary and definitions), there are three reference periods, namely: • daytime period: 0700-2000 hours; • intermediate period: 2000-2400 hours; • night time period: 0000-0700 hours.
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	Unknown. Possibly based on data provided by the *Laboratório Nacional de Engenharia Civil* (*LNEC*), under the direction of Professor Pedro Martins da Silva.
Is further research planned or considered necessary ?	The Ministry of the Environment has monitored the situation over the past few years and the Government has been pressured to tighten the above limits, as well as to avoid the use of L_{95} in the law.

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **Portugal**

Specific noise source: **Noise in the interior of buildings**

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: **Activities that require concentration and quiet**

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	*Decreto-Lei* no. 251/87 of 24th June (*Regulamento Geral sobre o Ruído*), modified and updated by *Decreto-Lei* no. 292/89 of 2nd September. The *Regulamento Geral sobre o Ruído* (General Regulations on Noise) was the first legal document in Portugal which gathered and completed a set of sparse existing laws on noise. The law mentions that measurements must be made according to the applicable Portuguese Standards (*Normas Portuguesas* or *NP*). The most important is *NP*-1730, which was recently reviewed and is now a simple translation into Portuguese of ISO 1996.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	The value of L_{50} in places that require concentration and quiet may not exceed 60 dB(A) (Art. 15th).
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	Unknown. Possibly based on data provided by the *Laboratório Nacional de Engenharia Civil* (*LNEC*), under the direction of Professor Pedro Martins da Silva.
Is further research planned or considered necessary ?	Not identified at present.

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **Portugal**

Specific noise source: **Noise generated at industrial, commercial and service facilities**

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: **Exposure of workers to noise**

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	*Decreto-Lei* no. 72/92 of 28th April, regulated by *Decreto Regulamentar* no. 9/92 of 28th April. These legal documents transcribe into Portuguese law the Directive no. 86/188/EEC of the Council, of 12th May 1986, relative to the protection of workers against the risks of exposure to noise at work. The publication of *Decreto-Lei* no. 72/92 of 28th April, regulated by *Decreto Regulamentar* no. 9/92 of 28th April, revoked Art. 16th, 17th and 18th of *Decreto-Lei* no. 251/87 of 24th June (*Regulamento Geral sobre o Ruido*), modified and updated by *Decreto-Lei* no. 292/89 of 2nd September
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	The limits are identical to the ones gives in the Directive no. 86/188/EEC of the Council, of 12th May 1986.
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	
Is further research planned or considered necessary ?	Not identified at present.

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **Portugal**
Specific noise source: **Environmental noise**
(complete a separate sheet for each source covered by existing or proposed standards/limits)
Matters dealt with: **Location of new residential buildings, schools and hospitals**
(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	*Decreto-Lei* no. 251/87 of 24th June (*Regulamento Geral sobre o Ruído*), modified and updated by *Decreto-Lei* no. 292/89 of 2nd September. The *Regulamento Geral sobre o Ruído* (General Regulations on Noise) was the first legal document in Portugal which gathered and completed a set of sparse existing laws on noise. The law mentions that measurements must be made according to the applicable Portuguese Standards (*Normas Portuguesas* or *NP*). The most important is *NP*-1730, which was recently reviewed and is now a simple translation into Portuguese of ISO 1996.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	New residential buildings, schools and hospitals may not be located in so-called "noisy" or "very noisy" areas (Art. 5th). The definitions are given in the *Decreto-Lei* no. 251/87 of 24th June (Table 1) are as follows: • "little noisy" places: $L_{50} \leq 65$ dB(A), between 0700 and 2200 hours and $L_{50} \leq 55$ dB(A), between 2200 and 0700 hours; • "noisy" places: places which are not considered above and whose $L_{50} \leq 75$ dB(A), between 0700 and 2200 hours and $L_{50} \leq 65$ dB(A), between 2200 and 0700 hours; • "very noisy" places: places which are not considered in the definition of "little noisy" and "noisy" places.
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	Unknown. Possibly based on data provided by the *Laboratório Nacional de Engenharia Civil* (*LNEC*), under the direction of Professor Pedro Martins da Silva.
Is further research planned or considered necessary ?	The Ministry of the Environment has monitored the situation over the past few years and the Government has been pressured to tighten the above limits.

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: **Portugal**
Specific noise source: **Noisy activities**
(complete a separate sheet for each source covered by existing or proposed standards/limits)
Matters dealt with: **Noise generated by shows, entertainment and any noisy activities**
(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	*Decreto-Lei* no. 251/87 of 24th June (*Regulamento Geral sobre o Ruído*), modified and updated by *Decreto-Lei* no. 292/89 of 2nd September. The *Regulamento Geral sobre o Ruído* (General Regulations on Noise) was the first legal document in Portugal which gathered and completed a set of sparse existing laws on noise. The law mentions that measurements must be made according to the applicable Portuguese Standards (*Normas Portuguesas* or *NP*). The most important is *NP*-1730, which was recently reviewed and is now a simple translation into Portuguese of ISO 1996.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	The difference between L_{eq} of noise originated by shows, entertainment and any noisy activities, public or private, after undergoing appropriate corrections, and L_{95} (assumed to represent background noise) may not exceed 10 dB(A) in any given reference period (Art. 20th). According to *NP*-3225/1 (Vocabulary), there are three reference periods, namely: • daytime period: 0700-2000 hours, • intermediate period: 2000-2400 hours, • night time period: 0000-0700 hours.
Is the assessment of noise against the limits based on measurement, prediction or both ?	
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	Unknown. Possibly based on data provided by the *Laboratório Nacional de Engenharia Civil* (*LNEC*), under the direction of Professor Pedro Martins da Silva.
Is further research planned or considered necessary ?	The Ministry of the Environment has monitored the situation over the past few years and the Government has been pressured to tighten the above limits, as well as to avoid the use of L_{95} in the law.

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Spain

Specific noise source: Railway Noise

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Target noise limits for new works

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	Royal Decree of evaluation of Environmental Impact (Real Decreto Legislativo 1302/1986, de 28 de Junio, de evaluación de impacto ambiental) applicable to new long distance lines, including High Speed Train lines.
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	$L_{eq\ 24\ h}$ 65 dBA in residential areas and in areas where wildlife is to be protected. Could also be $L_{eq\ day}$ 65 dBA, $L_{eq\ night}$ 55 dBA
Is the assessment of noise against the limits based on measurement, prediction or both ?	Prediction
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	Limits that will be set in application of the future Law of Protection against Acoustic Pollution, that will be approved at the beginning of 1999, concerning all sources of acoustic pollution
Is further research planned or considered necessary ?	Not for the moment

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Spain

Specific noise source: Aircraft noise

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Entitlement to noise insulation grants

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	Royal Decree of evaluation of Environmental Impact (Real Decreto Legislativo 1302/1986, de 28 de Junio, de evaluación de impacto ambiental) applicable to residential buildings influenced by the noise impact of the enlargement of the Madrid Airport, and the previsions of flights for the years 2000 and 2010
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	Grants applicable to residential buildings (built before April 1996) placed within the isophones $L_{eq\,(7\text{-}23\ hours)}$ 65 dBA, $L_{eq\,(23\text{-}7)}$ 55 dBA. Grants for noise insulation reinforcement of roofs and façades to obtain $L_{eq\ day}$ 40 dBA and $L_{eq\ night}$ 30 dBA, in bedrooms
Is the assessment of noise against the limits based on measurement, prediction or both ?	Prediction of external levels by means of INM Measurement of existing insulation
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	Measurement campaigns
Is further research planned or considered necessary ?	Considered necessary

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Spain

Specific noise source: Industrial and recreative activities

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Maximum noise limits outdoors

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	1) Decree 171/1985 of 11th of June of the Basque Autonomous Community 2) Ordinance of 17th February 1990 of the Province of Alava 3) Decree 99/1985 of 17th October of the Asturias Autonomous Community 4) Decree 70/1987 of 30th April 1987 of the Balearic Autonomous Community 5) Decree 2/1991 of 8th January 1991 of the Extremadura Autonomous Community
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	1) For all types of industries, recreational activities and installations in buildings, maximum levels transmitted to the vicinity: • L_{eq}, 1 minute, 40 dBA from 8 to 22 hours, L_{max}, 45 dBA • L_{eq}, 1 minute, 30 dBA from 22 to 8 hours, L_{max}, 35 dBA 2) Outdoor levels in urban areas, L_{max}, 50 dBA, 8 to 22 hours, 40 dBA, 22 to 8 Id. in hospital areas, 45 dBA, 8 to 22 hours; 35 dBA, 22 to 8 hours Id. in industrial areas, 75 dBA, 8 to 22 hours, 75 dBA, 22 to 8 hours 3) Outdoor noise levels of 55 dBA, 7 to 22 hours, 45 dBA, 22 to 7 (units not specified) 4) Outdoor L_{max} levels in industrial and touristic areas, 65 dBA during the day, 60 dBA during the night; non industrial nor touristic areas, 55 dBA during the day, 45 dBA during the night 5) Outdoor levels in hospital areas, L_{eq} of 35 dBA; outdoor levels in residential/commercial areas, L_{eq} of 60 dBA from 8 to 22 hours, 45 dBA from 22 to 8 hours; outdoor levels in industrial areas, L_{eq} of 70 dBA from 8 to 22 hours, 55 dBA from 22 to 8 hours
Is the assessment of noise against the limits based on measurement, prediction or both ?	Measurement
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	Considered to be in line with limits in other countries
Is further research planned or considered necessary ?	Yes

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Spain

Specific noise source: Industrial and recreative activities

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: Maximum noise limits outdoors

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	Ordinances of municipalities for outdoor noise levels: 1) Madrid, 31st October 1985 2) Barcelona, 18th February 1983 3) Zaragoza
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	1) Hospital areas: L_{max} in dBA, 45, 8 to 21 hours; 35, 21 to 8 hours Residential areas: L_{max} in dBA, 55, 8 to 22; 45, 22 to 8 hours Commercial areas: L_{max} in dBA, 65, 8 to 22; 55, 22 to 8 hours Industrial areas: L_{max} in dBA, 70, 8 to 22; 55, 22 to 8 hours 2) Hospital areas: L_{max} in dBA, 55, 8 to 22 hours; 45, 22 to 8 hours Residential areas: L_{max} in dBA, 55, 8 to 22; 45, 22 to 8 hours Commercial areas: L_{max} in dBA, 55, 8 to 22; 45, 22 to 8 hours Industrial areas: L_{max} in dBA, 65, 8 to 22; 60, 22 to 8 hours 3) Industries inside residential areas: $L_{eq\,60\,s}$ in dBA, 55 Industrial areas: L_{max} in dBA, 80
Is the assessment of noise against the limits based on measurement, prediction or both ?	Measurement
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	Considered to be in line with limits in other countries and towns. Probably, they will be revised in the near future.
Is further research planned or considered necessary ?	Yes

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Switzerland

Specific noise source: Road traffic noise, rail traffic noise, industrial noise

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: General noise abatement (incl. land use planning, limiting values)

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK

Please list all relevant laws, enactments, standards etc

(where possible giving information about how they interrelate)

The legislative framework for noise abatement is based on the following legal texts: (in hierarchical order)

- Article 24^{septies} of the Swiss constitution
- The federal law relating to the protection of the environment (1983)
- The ordinance on noise abatement (1986)

NOISE LIMITS (where stated)

What noise limits are used ?

Please give details of these in terms of

- how and where they are specified
- metric used
- day and night limits

The ordinance on noise abatement contains detailed regulations for the applications of the law. Among others, there can be found limiting values for various noise sources, for each of which are defined three different limiting values at increasing levels:

- *planning values* : taking effect as a preventive measure, (if these values would be exceeded, neither new installations can be built nor building areas can be developed).
- *impact thresholds*: for assessing harmful effects or nuisances, (existing installation that exceed these values must be improved and buildings with noise-sensitive rooms are not allowed to be built).
- *alarm levels*: that when exceeded indicate the urgency to improve the installation, (installations that exceed these values must be improved of first priority).

The above values are defined for four *sensitivity zones* which allow for increasing noise pollution:

Zone I: Areas with an increased need for protection against noise, e.g. resort areas.

Zone II: Areas where no disturbing activity is allowed, e.g. residential areas.

Zone III: Areas with moderate noise emission, e.g. mixed zones such as residential and business areas as well as agricultural regions.

Zone IV: Areas with heavily disturbing activity, e.g. industrial areas.

Limiting values are given under appendix 3, 4 and 6 of the ordinance on noise abatement

	Planning values		impact thresholds		alarm levels	
Zone	day	night	day	night	day	night
I	50	40	55	45	65	60
II	55	45	60	50	70	65
III	60	50	65	55	70	65
IV	65	55	70	60	75	70

All values are rating levels ($L_r = L_{Aeq} + K$), whereas L_{Aeq} is the energy equivalent continuous A-weighted sound pressure level.

	Evaluation periods are : - Road and rail traffic noise: day 6-22, night 22-6. - Industrial noise: day 7-19, night 19-7 The adjustment K is different for each noise source. Moreover, K is a sum of sub-adjustments that take into consideration the following parameters: - Road traffic noise: (K=K1) traffic flow K1 = -5 .. 0 dB - rail traffic noise: (K=K1+K2) traffic flow K1 = -15 .. -5 dB shunt traffic K2 = 0 .. 8 dB - Industrial noise: (K=K1+K2+K3) type of installation K1 = 0 .. 10 dB tonality K2 = 0 .. 6 dB impulsiveness K3 = 0 .. 6 dB Note: There is the obligation to improve already constructed installations (valid for any installation, e.g. industry, roads, railways, airports, etc). Moreover, noise abatement in Switzerland aims not only to improve noise affected areas but also to avoid future noise problems. We have therefore integrated our noise abatement strategy into the area planning in order to prevent construction within black-spot areas. As a result, installations, whose emissions would exceed planning values are not allowed to be build
Is the assessment of noise against the limits based on measurement, prediction or both ?	both
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	Limits are based on scientific socio-psychological studies that evaluated the noise level where a proportion of about 25% of the population is considerably annoyed by the noise. These studies were conducted for the impact threshold (day) in sensitivity zone II. Planning values are then 5 dB lower and alarm levels are 5 to 15 dB higher. Values for zone I are 5 dB lower and for zone III and IV are 5 and 10 dB higher, respectively. (Exception, alarm levels for zone II & III are equal) Planning values and impact thresholds for the night are 10 dB lower than day levels. For alarm values this reduction is only 5 dB. These studies were conducted for each noise source.
Is further research planned or considered necessary ?	The following research projects are active or are planned for the near future: - Economical reasonableness and appropriateness of noise reduction measures - Vibrations - Distribution of noise emissions of lorries - Noise-absorbing road surfaces for low-speed traffic - Low noise railway engines

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Switzerland

Specific noise source: Aircraft-noise of civil airfields and regional airports

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: General noise abatement (incl. land use planning, limiting values)

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK

Please list all relevant laws, enactments, standards etc

(where possible giving information about how they interrelate)

The legislative framework for noise abatement is based on the following legal texts: (in hierarchical order)

- Article 24^septies of the Swiss constitution
- The federal law relating to the protection of the environment (1983)
- The ordinance on noise abatement (1986)

NOISE LIMITS (where stated)

What noise limits are used ?

Please give details of these in terms of

- how and where they are specified
- metric used
- day and night limits

General remarks are the same as under road-, rail traffic and industrial noise.

Limiting values are given under appendix 5 of the ordinance on noise abatement.

(There are about 50 airfields and regional airports in Switzerland.)

Only day values are specified, as there are no flights allowed during the night.

Zone	Planning values	impact thresholds	alarm levels
I	50	55	65
II	55	60	70
III	60	65	70
IV	65	70	75

All values are rating levels ($L_r = L_{Aeq} + K$). Evaluation period is one hours. The adjustment K is depending on the number of flights and is in the range of 0 to 10 dB.

In addition to the above rating levels, the following maximal sound pressure level (A-weighted) must be met for those airfields and regional airports used only by helicopters.

The maximal levels L_{max} in dB(A) are:

Zone	Planning values	impact thresholds	alarm levels
I	70	75	85
II	75	80	90
III	80	85	90
IV	85	90	95

Is the assessment of noise against the limits based on measurement, prediction or both ?

both

DERIVATION OF NOISE LIMITS

Please give summary details on the basis of these noise limits
e.g. on which research findings *[1] and/or practical

Limits are based on scientific socio-psychological studies that evaluated the noise level where a proportion of about 25% of the population is considerably annoyed by the noise.

These studies were conducted for the impact threshold (day) in sensitivity zone II

considerations	Planning values are 5 dB lower and alarm levels are 5 to 10 dB higher. Values for zone I are 5 dB lower and for zone III and IV are 5 and 10 dB higher, respectively. (Exception, alarm levels for zone II & III are equal)
Is further research planned or considered necessary ?	The following research project is running now: - Immission values for the three national airports (Geneve, Basel, Zurich)

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Switzerland

Specific noise source: Noise of civil shooting ranges

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: General noise abatement (incl. land use planning, limiting values)

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK	
Please list all relevant laws, enactments, standards etc (where possible giving information about how they interrelate)	The legislative framework for noise abatement is based on the following legal texts: (in hierarchical order) - Article 24^{septies} of the Swiss constitution - The federal law relating to the protection of the environment (1983) - The ordinance on noise abatement (1986)
NOISE LIMITS (where stated)	
What noise limits are used ? Please give details of these in terms of • how and where they are specified • metric used • day and night limits	*General remarks are the same as under road-, rail traffic and industrial noise.* Limiting values are given under appendix 7 of the ordinance on noise abatement. There are about 3000 civil shooting ranges in Switzerland (almost one for each community). Shooting takes place over a distance of 300 meter, mostly with military rifles. Only day values are specified, there is no shooting allowed during the night. Zone / Planning values / impact thresholds / alarm levels I 50 55 65 II 55 60 75 III 60 65 75 IV 65 70 80 All values are rating levels ($L_r = L_{Aeq} + K$), whereas L_{Aeq} is the energetic sum of each shot measured with the setting FAST. The adjustment K dependa on the number of shooting days and the average number of shots within a period of three years. K is generally in the range of -5 ..20 dB
Is the assessment of noise against the limits based on measurement, prediction or both ?	both
DERIVATION OF NOISE LIMITS	
Please give summary details on the basis of these noise limits e.g. on which research findings *[1] and/or practical considerations	Limits are based on scientific socio-psychological studies that evaluated the noise level where a proportion of about 25% of the population is considerably annoyed by the noise. These studies were conducted for the impact threshold in sensitivity zone II Planning values are 5 dB lower and alarm levels are 10 to 15 dB higher. Values for zone I are 5 dB lower and for zone III and IV are 5 and 10 dB higher, respectively. (Exception, alarm levels for zone II & III are equal)

Is further research planned or considered necessary ?	The following research project are active or planned for the near future: - Implementation of a computer program for calculating immission values of civil shooting ranges. - Immission values for low calibre shooting - Immission values for military training areas

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other

ENVIRONMENTAL NOISE STANDARDS AND LIMITS - EUROPE

Country: Switzerland

Specific noise source: Aircraft-noise of military airports

(complete a separate sheet for each source covered by existing or proposed standards/limits)

Matters dealt with: General noise abatement (incl. land use planning, limiting values)

(complete a separate sheet for each matter dealt with, such as land use planning, entitlement to compensation, maximum noise limit etc .)

THE LEGISLATIVE OR REGULATORY FRAMEWORK

Please list all relevant laws, enactments, standards etc

(where possible giving information about how they interrelate)

The legislative framework for noise abatement is based on the following legal texts: (in hierarchical order)

- Article 24^{septies} of the Swiss constitution
- The federal law relating to the protection of the environment (1983)
- The ordinance on noise abatement (1986)

NOISE LIMITS (where stated)

What noise limits are used ?

Please give details of these in terms of

- how and where they are specified
- metric used
- day and night limits

General remarks are the same as under road-, rail traffic and industrial noise.

Limiting values are given under appendix 8 of the ordinance on noise abatement.

Only day values are specified, as there are no flights allowed during the night.

Zone	Planning values	impact thresholds	alarm levels
I	50	55	65
II	60	65	70
III	60	65	70
IV	65	70	75

All values are rating levels ($L_r = L_{Aeq} + K$). Evaluation period is one hours. The adjustment K is depending on the number of flights and is in the range of -8 to 0 dB.

For civil aircrafts using military airports the immission values for civil airfields and regional airports must be met additionally.

Is the assessment of noise against the limits based on measurement, prediction or both ?

both

DERIVATION OF NOISE LIMITS

Please give summary details on the basis of these noise limits
e.g. on which research findings *[1] and/or practical considerations

Limits are based on scientific socio-psychological studies that evaluated the noise level where a proportion of about 25% of the population is considerably annoyed by the noise.
These studies were conducted for the impact threshold (day) in sensitivity zone II
Planning values are 5 dB lower and alarm levels are 5 to 10 dB higher.
Values for zone III are equal. They are 5 dB lower for zone I and 5 dB higher for zone IV.

Is further research planned or considered necessary ?	none

*[1]: i.e. studies of annoyance/ sleep disturbance/ activity interference /speech interference/ hearing loss/ other