

**Annex 1: Meeting  
Report**



# Report on the first planning meeting on night noise guidelines

Bonn, Germany, 7- 8 June 2004

European Centre for Environment and Health  
(Bonn Office)  
World Health Organization Regional Office for Europe

## ABSTRACT

This meeting was the first of the WHO program, co-financed by the European-Commission, on night time noise guidelines. The project partners, experts and national government officers met to define the work plan and discuss organizational issues. They also allocated responsibilities, looked at the timetable, team coordination, the logistics and finance. The next step will be the production of background papers on the different identified themes and the second meeting is planned for March 2005.

### Keywords

NOISE  
GUIDELINES  
ENVIRONMENTAL HEALTH  
SLEEP  
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EUROPE

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## CONTENTS

|  |    |
|--|----|
| Background .....   | 2  |
| Introduction .....   | 2  |
| Summary of the meeting .....   | 3  |
| Presentations .....  | 3  |
| Partners' presentations .....  | 4  |
| Invited Member of Member States and European Commission<br>presentations ..... | 9  |
| General discussion and working groups.....                                     | 12 |
| Other points discussed – expertise required from experts outside the group .   | 14 |
| Conclusions and follow up work .....   | 15 |
| Sequence of tasks and time table.....  | 15 |
| Annex 1.....   | 16 |
| Annex 2.....   | 18 |
| Annex 3.....   | 25 |

## **Background**

The project on night time noise guidelines (NNGL)" of the World Health Organization Regional Office for Europe (European Centre for Environmental and Health, Bonn Office) (ECEH), is carried out in partnership with the European Commission (EC) Directorate General Health and Consumer Protection (DG Sanco) and several Member States. Its purpose is to develop guidelines for night time noise exposure. This project will review the evidence of night time noise effects on health, and estimate the magnitude of the associated health risks.

The project will provide expertise and scientific advice to Member States, and propose guideline values for night noise both for short and long-term exposure. It will support the development of future legislation in the area of night noise exposure control and surveillance. The project will follow the WHO methodology for the development of guidelines.

## **Introduction**

Partners of the project, experts and national government officers agreed the methodology to be followed to reach guideline values; the work plans, schedule, responsibilities, and team coordination and the health effects and various end points of night time noise exposure. They also discussed the question of additional contractual partners, and the metrics and exposure assessment.

Five of the project partners, Professor Andre Kahn, Professor Sona Nevsimalova, Dr Andras Muntag, Dr Marie Louise Bistrup and Dr Danny Houtjuis were excused for other professional arrangements.

## **Summary of the meeting**

The meeting was introduced by WHO: Mr Bonnefoy presented the background, the goals of the night noise guidelines project, described the budget, the envisaged role of the partners and possible ways of filling the gaps of expertise in the group; Ms Rodrigues presented the meeting objectives and agenda and Dr Krzyzanowski presented the experience gained by WHO when developing the air quality guidelines and how this experience can help on the development of the night noise guidelines. Mr Bonnefoy gave some examples during the meeting on the experience gained during the development of the drinking water guidelines.

The participants were invited to present the results of their work for the guidelines at the Vilnius housing and health symposium that will take place in October 2004. This symposium could be a good opportunity to have the partners discussing the work progress.

After these general presentations the floor was given to the project partners, followed by comments and questions. The invited representatives for the European Commission were also invited to express their opinion on the project and to give their feedback on how it can help them when developing legislation.

Two working groups were set up to describe the sequence of work and identify who would be responsible for each work package.

## **Presentations**

Dr Michal Krzyzanowski presented the process followed when designing the WHO air quality guidelines and made suggestions for the development of the night noise guidelines. His presentation concentrated on the review of the evidence in order to avoid external criticism. He proposed a scheme for the review for night time noise and for deriving guidelines (figure 1).

The development of the air quality guidelines underwent several steps of analysis and review of scientific data in the field of air pollution toxicology and epidemiology. In-depth reviews of the effects of each pollutant were prepared, followed by a discussion based on this review, and then finally the guideline values were established. A scientific advisory committee was established for reviewing the literature and the background documents.

Dr Krzyzanowski suggested that the first step for developing the night noise guidelines should be to carry a comprehensive literature review according to the approach and method described in the WHO publication "Evaluation and use of epidemiological evidence for environmental health risk assessment". These reviews should be the background for group discussion and the basis of the guidelines document.

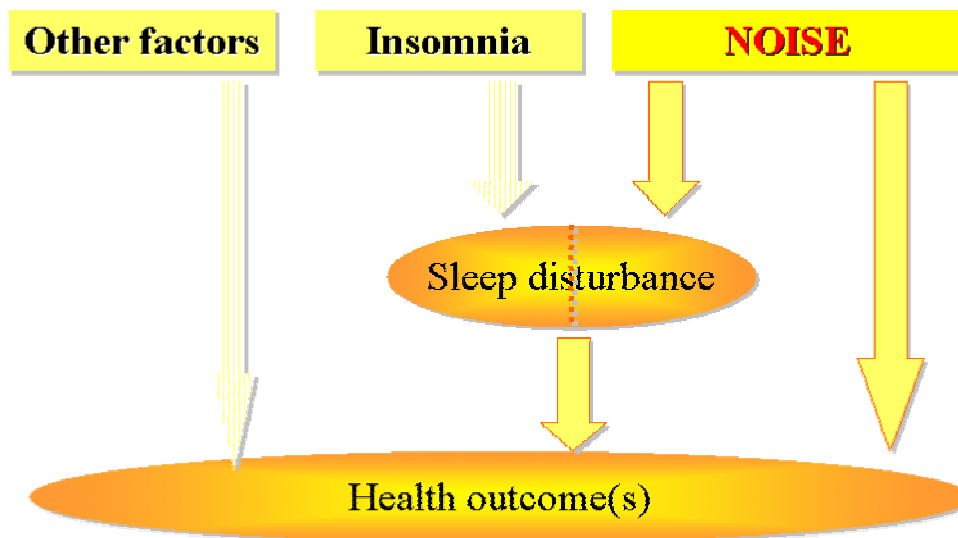


Figure 1 – A possible review of the noise epidemiological evidence on health

### ***Partners' presentations***

#### *Dr Gaetano Licitra – Characterization of the different noise levels, sources, metrics*

European Union Member States are starting to produce noise maps for their main cities. There is still no clear information on the percentage of population covered by the Directive 2002/49/CE in every Member State. It is difficult to outline the extent of the problem of night noise disturbance.

Another difficulty is that noise maps will neither cover neighbourhood noise nor leisure activities, so we may not get a full picture of the problem. Neighbourhood noise is very important because it is often the source of large number of noise events during the night. There is no accurate assessment of the impact of neighbourhood noise in many countries, mainly because it is highly dependent on the normal local behaviour of the population.

Dr Licitra suggested that the members of the NNGL group should be informed of the trends and predictions on the noise levels as well as the action plans carried by some countries for noise reduction. European projects such as CALM or STAIRRS, SOURDINE, IMAGINE, HARMONOISE could provide important input. Cooperation should take place with different stakeholders such as the European Environment Agency, research institutions, European Commission Working Groups and DG Environment.

#### *Dr. Stylianos Kephelopoulos – Human exposure*

Dr Kephelopoulos raised the importance of analysing the problem with “human beings” at its centre, and examining the interaction between the different stressors. A concept of total human exposure assessment, similarly to that used in indoor air quality, should be used. When looking at the effects of noise, the effects of other pollutants present at the time of exposure, should also be considered with time activity patterns. There is also uncertainty resulting from the fact that all measures are performed outdoors..

A three-step approach can be considered:

- i) Define personal exposure (dose per person)

- ii) assess the risk and
- iii) evaluate the health effects resulting from the possible combinations.

Knowledge is constantly changing .The guidelines should be able to adapt well to changes in time and developments in science. This is achievable with a consistent framework.

*Professor Peter Lercher - exposure assessment; sensitive groups*

Professor Lercher acknowledged four major challenges for the assessment and future developments of regulation in the noise field:

- i) the problem of sources combination assessment: what we know about today is mostly individual noise source,
- ii) mono-sensory assessments are made even if other sensory qualities are present.
- iii) the fact that data only exists for “steady” conditions and
- iv) the generalization across context. Examples from two very different settings were given (Vienna and Alpine Valley) for dose-effect relationships for annoyance. There are significant differences between the two of them.

There was discussion about the metrics and about which indicators serve better for night-time assessment. Should average level indicators to be used? Some examples were shown of differences in the assessment when using several metrics.

Many factors influence the way in which noise is perceived, pre-dispositions such as noise sensitivity, family history of hypertension, vegetative lability. Some diseases can also make a difference, such as depression and cardiovascular disease. Circumstances are relevant too, such as whether there are combined exposures, whether the noise is low frequency, and the differences between background and peak levels. Among the groups that are susceptible of being predisposed to sleep problems are elderly, pregnant and peri-menopausal women; people with primary insomnia, and co-morbid mental/physical mental diseases; and circumstances such as the environment (temperature, EMF’s, etc.) and stress. This complexity will have to be considered when developing simple figures.

*Professor Alain Muzet - Identification of relevant adverse health effects*

Professor Muzet has classified the possible adverse health effects into three categories: major sleep disturbances which are equivalent to insomnia and include awakenings, moderate sleep disturbances, and other disturbances.

Moderate sleep disturbances include acute responses like sleep stage changes and arousals. The long term effects of these responses are not completely known. What should be the approach to evaluate this impact? What can the guidelines say on this?

A third group of responses occurring during sleep includes all the psychological functions, heart beat rates, body movements, etc. These responses are increasing during sleep, do not habituate to noise, and can lead to damage (evidence exists in laboratory studies).

In summary, Pr Muzet suggested to look at the following effects:

**Major sleep disturbances:**

1. Lengthening the time to fall asleep;
2. Awakenings from sleep;
3. Too early wake-up time.

**Moderate sleep disturbances:**

1. Arousals;
2. Sleep stage changes;
3. Reduction in time spent in specific sleep stages:
  - Slow wave sleep
  - REM sleep
4. Sleep quality.

**Other disturbances occurring during sleep:**

1. Body movements;
2. Autonomic responses;
  - Change in heart rate;
  - Vasoconstriction;
  - Short-lasting increase in blood pressure;
  - Change in respiratory rate.
3. Hormonal responses.

*Dr Ivanka Gale*

Dr Gale's presentation concentrated in the legal situation concerning environmental laws in the Slovenia. Slovenia became independent in 1991 and since 1996 they have been adapting their legislation to the European Union. At present they have to consider the implementation of harmonized noise exposure indicators, target limit values, dose/effect relationships, modern noise assessment methods and noise mapping.

*Dr Staffan Hygge – Effects of noise exposure on different cognitive tasks across age groups*

Dr Hygge suggested that separating the different types of memory according to Tulving's memory theory, allows a better assessment of the impact of noise on cognitive functions. Tulving separates the procedural memory, perceptual representational system, semantic memory, primary memory (working memory) and episodic memory. Dr Hygge showed results on semantic memory with quietness, road noise and other people talking. Noise has a strong influence on this type of memory. For day-time noise the ages of 13/14 years are important because that seems to be when changes happen in cognitive development. Most studies on effects on children are for day time noise, Dr Hygge has proposed looking at the night time noise levels from the Munich and RANCH studies, provided the project can identify special funding for this.

*Dr Snezana Jovanovic – Sleep disturbances and accidents*

Dr Jovanovic proposed carrying out a literature review on sleep and accidents. She will look at insomnia and analyze daytime fatigue, sleepiness and drowsiness as triggers of accidents. Home, road, work, and school accidents will be covered.

*Professor Stephen Stansfeld - Sleep and Psychiatric disorder*

Pr Stansfeld focused showed data for insomnia and psychiatric disorders. Thirty three per cent of insomnia in community samples is related to a primary psychiatric disorder and seventy five per cent of sleep clinic patients have a primary or secondary psychiatric disorder.

An association between sleep and psychiatric disorders is pertinent because:

- i) Structural/biochemical abnormalities in psychiatric disorders also influence sleep regulation
- ii) Sleep disturbance is one of the primary symptom of psychiatric disorder
- iii) Psychiatric drugs can disturb sleep
- iv) Primary sleep disturbances often have associated psychiatric symptoms

Sleep disturbance is an important and common problem in psychiatric disorders. It is an aspect of psychiatric disorder that needs treatment. Investigating this area will be very useful for assessing the impact of noise on mental health.

*Dr Michał Skalski – health effects of insomnia*

Transient insomnia expresses itself by sleep deprivation and data exists that facilitate the evaluation of the health impacts. Chronic insomnia is different and very little data exists. Sleep disturbance leads to chronic insomnia that, in turn, can lead to some psychiatric disorders.

Transient insomnia has as consequences an increase in daytime sleepiness, impairments of psychomotor function and fatigue.

Chronic insomnia is different from sleep deprivation, it doesn't provoke daytime sleepiness and impairments of psychomotor function but it provokes hyper arousal (autonomic nervous system such as hormone secretion from the hypothalamic-pituitary-adrenal axis – HPA) and leads to psychiatric disorders (depression, anxiety, drug and alcohol abuse).

The risk of accidents and depression are strongly linked with insomnia. The use of this clinical knowledge will be crucial for evaluating the long-term noise effects on sleep.

Insomnia also affects children's cognitive development as they show worse results in learning. The quality of life for insomniacs is decreased and their accident rate is by 4.5 times that of "normal sleepers".

*Dr Wolfgang Babisch – Relevant adverse health effects*

Dr Babisch advised the group to try to keep decision-makers in mind.. Decision-makers want to know on one hand what is safe and on the other hand they do not want to jeopardize economic development and people's mobility on the other. There are obvious conflicts between quietness and mobility for example.

He presented valuable information on availability of studies, existence of evidence, and scenarii with different metrics and he introduced the few new studies on noise and health. This overview of the existing literature helped guide the group's technical work.

As an example, table 1 provides an overview of the state of the art on the availability of data for the most important effects.

| <b>Availability of data</b> |            |              |
|-----------------------------|------------|--------------|
| <b>Effect</b>               | <b>Day</b> | <b>Night</b> |
| Annoyance / Disturbance     | Yes        | Yes          |
| Cardiovascular effects      | Yes        | Infer*       |
| Stress hormones             | No         | Yes          |
| Electrophysiological sleep  | N.R.       | Yes          |
| Performance at work         | Yes        | No           |

Table 1 – Availability of data for the different effects and noise exposure during day and night time exposure (Babisch 2004)

\* - Not enough data is available for night time noise and inferences can be made from studies that considered only daytime measurements of 24h measurements.

For biochemical changes the existing evidence, according to expert's judgments, is "limited", for hypertension and ischaemic heart diseases "limited / sufficient" (using the International Agency for Research on Cancer definitions of „no – insufficient – limited – sufficient" evidence) for night time noise.

*Professor Jacques Beaumont, Professor Joao de Quinhones Levy - Noise and health indicators - Evaluating exposure*

In the European Union (EU) there are a lot of people exposed to noise, but there is a lack of knowledge about the characteristics of urban noise and the current assessment of noise in the urban context is poor. The key question is therefore how to evaluate this important exposure.

A "good" noise indicator should reflect the energy (Lden), the emergences - temporal and tonal (Lmax,SEL...), the nature of the sources (human activities / mechanical activities). It should be usable depending on time, and geographic scales, classification of the noise situations, acoustical and perceive characteristics and urban morphology.

A pertinent indicator should consider:

- Perception: being representative of key noise characteristics from the perception point of view;
- Forecasting: suiting real or forecast noise situations;
- Measurability: a standardized measurement method has to be drawn up;
- Computation: to forecast a noise situation, a computation tool must be available;
- Communication: allowing efficient communication between decision makers, infrastructure managers and the public-

*Dr H.M.E. Miedema*

Dr Miedema identified six points that he considers crucial during the development of guidelines:

1. Which noise sources are we dealing with?  
Will only transportation sources be considered? Construction and demolition noise are increasingly a source of complaints all over Europe.
2. Which health effects are we going to consider?
3. Classification of the evidence (how to use indirect evidence);
4. Identification of sensitive groups;
5. Noise metrics (number of events, sound insulation);
6. Causal chain and subcortical effects (cortex mediated or non-cortex mediated).

## ***Invited Member of Member States and European Commission presentations***

A representative of the European Commission (Directorate General of the Environment) and representatives of environment and health Ministries from France, the Netherlands, Germany and Switzerland were invited to present the work on noise on their countries and to express their opinion on how the guidelines could support their legislative work.

### ***EC - DG Environment***

The directive 2002/49/EC for environmental noise proposes 2 indicators Lden (day-evening-night level) and Lnight (night level) as indicators for monitoring noise. These two indicators will be used in the strategic noise maps and be the basis for the development of noise reduction and prevention plans in major urban areas as well as around major transport infrastructures. These common indicators will also enable strategic noise maps to be used at national and EU level to show respectively the number of people annoyed (via Lden) and sleep-disturbed (via Lnight). The first maps have to be produced in 2007. Hence, night-time noise guidelines should, as a priority, consider at least these two EU indicators.

Nevertheless, the directive mentions for special cases the use of appropriate supplementary noise indicators. The article 5 of the directive stipulates "Member States may use supplementary noise indicators for special cases such as those listed in annex I(3)". Maybe this will be the case for the night time guidelines but its use has to be well justified. The annex I(3) of the directive mentions the LAmax and a number of events as adequate supplementary indicators for night time noise peaks, notably from passing trains and aircraft. Given the trends in the growth of night-time volumes of traffic and relative noise exposure around major airports, highways and high speed train lines, these indicators should also be taken into account.

Mr Delcampe suggested that the NNGL group interacts and exchanges information with the Commission working group on health and socio economics aspects and considers the work developed in the position papers which can be downloaded from <http://www.europa.eu.int/comm/environment/noise/home.htm> , where the reports of the various noise working groups set up by the Commission are available.. In particular he recommended linking with the position paper on EU noise indicators and the one on relationships between transportation noise and annoyance.

### ***France***

L'AFSSE, Agence Française de Sécurité Sanitaire Environnemental has recently produced a report on the health effects of noise ("Les effets sanitaires du bruit – rapport d'étape") in French, not yet published. This report would be useful for developing the guidelines.

Mr Grénetier raised the problem of metrics; in his opinion the measurement of an average level is not suitable for assessing night effects. We would like to have more information on short and long term exposure. The current WHO guidelines on noise don't respond very well to the demands for legislation. For example the number of events is missing.

Important aspects to be considered for a noise indicator should, according to the French representative, include:

- Number of noise events;
- The time they occur during the night;
- Duration of events;

Mr Grenetier advises the group to consider a synthetic indicator that takes into account all these parameters.

### ***The Netherlands***

A Dutch committee from the Ministry of Environment produced a document that covers all aspects of night noise exposure for advice to the Dutch Health Council (ready in June 2004). This document introduces the L<sub>night</sub> in the Netherlands, presents the health effects from noise and how they relate to other effects and proposes measures to reduce these effects. It will be public by the end of summer 2004. This document was considered important for the work of the NNGL group, but it is only available in Dutch. Mr Van Den Berg will explore the possibility of translating it into English.

The working group on health and socio-economic aspects established by DG Environment has produced a position paper on L<sub>night</sub> that is now open for comments from the Member States. This document could be an important input for the work of the NNGL group.

Dr Van Den Berg presented data on evidence of noise health effects from laboratory and field studies and some differences between countries on sleeping hours and levels recommended in national legislation.

### ***Germany***

The representative of the German ministry of environment would like WHO, and the guidelines document in particular, to provide advice and guidance on the following points:

- i) Description of night time noise exposure in terms of the sources of noise and the particular characteristics of the noise sources;
- ii) Assessment of the different effects of night noise on sleep;
- iii) Development of criteria for a “reasonable” protection of night time sleep.

Dr Brüggemann recommended that WHO doesn't restrict itself solely to the prevalence and incidence of noise-induced illnesses. It should examine the full spectrum of effects produced by night time noise, including the impact on sleep that occurs before the possible onset of health risks, as well as other noise-induced disturbances.

It is generally acknowledged that uninterrupted sleep is of particular importance for a person's health and well-being and for their sustained working capacity. Nonetheless, it is difficult to avoid the impression that the degree of impact that noise has on health frequently tends to be underestimated by the public and by politicians. The creation of the WHO guidelines should contribute to a more intensive discussion and a more realistic perception of the situation.

There are real differences of opinion in the relevant scientific disciplines with regard to the assessment of various sleep disturbances caused by noise. It is therefore little wonder that the informative value of existing studies on the effects of night time noise is judged very differently, not only by the various disciplines, but also by individual scientists.

It does appear, however, that a broad consensus has now emerged, according to which the description of night time noise cannot be based on an average value alone. The noise

indices used, however, continue to differ in various aspects. He would therefore very much welcome any moves contained in the guidelines toward greater standardization in this regard as well.

Currently, various legislation being considered in Germany deals with the subject of environmental noise control. Protection against night time noise is an important element in all of these. In terms of air traffic noise, an amendment to the Air Traffic Noise Act is currently being prepared. This will for the first time include limit values for protection against night time air traffic noise. If these values are exceeded, victims will be entitled to the installation of sound insulating windows and ventilation. Issues of night time noise control also feature prominently in the forthcoming implementation of the EU Environmental Noise Directive.

Political and administrative bodies do not, however, deny the financial burden created by noise reduction measures and demand that clear priorities are set. The task is therefore to develop scientific criteria for such an exercise and justifications for the necessary noise abatement measures.

In view of these points, and for the focused future development of noise abatement policy in its entirety, there is a particular need for advice on the following subjects, which should be examined in depth as part of the current project and feature clearly in the guidelines :

- i) (Quantified) effects of different doses of noise in terms of sleep disturbance
- ii) Assessment of the different types of effects that night noise has on sleep, not only with regard to the acute effects, but also taking account of possible long-term consequences
- iii) Development of recommendations for the protection of night time sleep, if possible in the form of control standards.

The primary aim of the project should therefore be to help achieve a consensus regarding the scientific assessment of existing study findings, including the epidemiological evidence of the results. It is time to reach a more unified perspective on this point. The results of WHO's work and its recommendations will then be of the utmost interest for legislators in industrial nations and will potentially have a considerable impact.

### **Switzerland**

The representative of the Swiss Agency for the Environment, Forests and Landscape gave a general overview of the limits for aircraft noise at during night, presented the daytime and night time exposure limits for Switzerland, and discussed the importance of night noise guidelines for policy making.

In Switzerland the night is defined from 22:00 to 06:00 and there is a flight ban from 0:00 to 05:00. The establishment of Swiss limit values of daytime and night time exposure involve identifying three levels of noise: planning level, Impact threshold and alarm value. For the day time they are respectively (for a sensitive level II) 57, 60 and 65 dB; for the night time (23:00 to 06:00) they are 47, 50 and 60. For aeroplanes they calculated a matrix considering L<sub>max</sub>, L<sub>aeq</sub> and number of over flights.

Switzerland has a special interest in participating in the project because:

- i) The project's scope corresponds with their regular evaluations of the latest studies;

- ii) It will allow international harmonization of methods for setting limit values and for noise abatement;
- iii) It will help harmonization with the European Union environmental policy. Although Switzerland is not an official Member of the EU, it sits in the heart of Europe and always harmonizes its environmental legislation with the EU.).

## **General discussion and working groups**

After the presentations the group agreed to separate in smaller groups according to expertise and fields of knowledge. Two working groups were created, each with the task of identifying the working papers needed and who should be responsible for each of them. The groups also discussed the topics where not enough expertise exists in the NNGL group for completing the work. The first group concentrated in epidemiology and medicine and the second on physics and physiology (with a big component on exposure assessment and metrics).

### ***Working Group I – Epidemiology and medicine***

The following themes were identified for background papers:

1. Methodology for deriving guidelines– Dr Martin Van den Berg
2. Overview of existing epidemiological evidence for cardiovascular effects – Dr Wolfgang Babisch
3. Cognitive development of children and night time noise – Dr Staffan Hygge
4. Accidents – Dr Svena Jovanovic
5. Sleepiness / drowsiness – Dr Ivanka Gale
6. Depression/anxiety
  - a. Night noise and mental health – Dr Stephen Stansfeld
  - b. Sleep disturbance and mental health – Dr Michal Skalski
7. Animal studies / biological plausibility – Dr Ising (subject to his agreement)
8. Risk groups (children, pregnant women, elderly, stressed people, ...) – review of the literature - Dr Willy Passchier-Vermeer (subject to his agreement)
9. Stress hormones - Dr Christian Maschke (subject to his agreement)

The group did not reach an agreement on the importance of producing a new meta-analysis for cardio vascular effects. This project on new studies, mainly in autonomic responses, had been set up after the existing meta-analysis. The opinion of Dr Danny Houthuijs would be sought on this matter.

Habituation will be covered in each of the papers.

### ***Working Group II –Physics and physiology***

Dr Henk Miedema was the moderator of this group. He asked each of the participants about their understanding of the process and about their willingness to contribute to it.

Professor Muzet presented the health effects that should be considered. He raised the point that the evidence on acute effects is mainly on the general population, consequently the groups that can be at a greater risk are not covered. We should also consider the subjective

feelings and the biological measures of acute effects. The data on biological responses is adequate but it comes mainly from laboratory studies that don't include subjective feelings.

There are significant differences between field and laboratory studies that have to be taken into consideration. There is also a shortage of studies on the long term effects (e.g. reduction of sleep time, fatigue, drowsiness, increased accidents, ...). From the literature, threshold values for awakenings can be derived, but it is difficult to have clear figures for the other responses.

Professor Peter Lercher mentioned the temporal variations of noise levels during the night and spatial country differences. How do the existing studies deal with these variations? There are variations between Member States in time pattern; Not only the number of events should be considered but also the time they occur during the night - if there are studies. Differences on sleep habits should be considered: what is the significance of the different definitions of night-time in the different countries? Which index has been used in the studies examining the differences and to ensure the protection of quiet areas and sensitive areas (rural or urban)?

Long-term health damage is a too vague a concept according to Dr Hans Bögli. The "damage" should be accurately defined. What are the causes? To harmonize the evidence a score system could be designed to rate the damage, how important is the damage? This exercise would allow comparing the risks and deciding upon the priorities, as it would bring different effects on a single scale.

The risk groups are important, but they should not be the focus of the guidelines. Having this as main point might sidetrack the work from the scope of the guidelines, it is better to focus on the majority of the population and to consider the special cases in a separate chapter.

Professor Jacques Beaumont focused his presentation on noise metrics, distribution of energy during the night, the importance of measuring peak levels and in the existence of sensitive areas and sensitive periods. Lden is very good for a steady level, but during the night the energy level occurs very often during a short period of time and has a big impact. Methods exist to calculate these levels, but the impact assessment seems to be missing.

France (INRETS) has a lot of studies in airports (e.g. night time Roissy), not very recent, using LAeq, the calculations of peak levels would be possible. The use of indicators that describe the short high energy events that occur during the night need to be discussed: how can we use them for evaluating the effects?

The most important role of the guidelines should be preventing people being exposed to noise levels that provoke awakenings and adverse effects, according to Mr Nicolas Grenetier. France uses LAeq, 8 hours and this is not representative of the situation, they would like to have additional characteristics on peak levels included in their metrics. Effects as awakenings are important and should not be dropped.

Dr Gaetano Licitra suggested the use of the DPSEEA schema as a frame for producing the guidelines. There is a need for a better metrics, the current legislation only covers noise outdoor and is not well connected with the health effects (indoor levels are more important for describing night time). It's not particularly difficult, but an agreement must be reached.

Dr Stelios Kephapoulos discussed again the problem of uncertainty in exposure assessment, the sensitivity accuracy in input data, sensitivity to the choice of calculation points and the conversion of this uncertainty in exposure to uncertainty in effects; in the expert's opinion, the answer to this problem can be outlining a framework, to help to deal with uncertainty in assessing the risk. It will also avoid the document becoming quickly obsolete and ensure that the information it contains will be digestible.. A coherent framework can guide the Member States how to make use of the guideline values.

Dr Henk Miedema would like to contribute on the effect side, instantaneous and 24 hours effects with specific attention to mechanisms and possible health effects.

The results of the discussion were to have two bigger themes and two groups producing the background papers:

1. **Noise exposure description** – Pr Lercher, Dr Licitra, Pr Beaumont, Dr Kephapoulos, Pr Levy
2. **Instantaneous and 24 hour-effects with specific attention to mechanisms** – Dr Miedema, Pr Muzet

## **Other points discussed – expertise required from experts outside the group**

Some points identified as very important and crucial to be considered in the guidelines are not in the field of competence of the project partners. The group suggested they will require input from outside experts. The secretariat will produce an outline of the background papers' table of contents and distribute it for discussion.

### ***Neighbourhood noise***

A discussion took place on including neighbourhood noise in the guidelines. The project proposal defines the sources as transportation but it could include this source as well.

Even if neighbourhood noise is a very particular noise source and guidelines values will not consider it, this is one of the main sources of people's complaints. The group decided by consensus that even if it will not have guidelines values for it, attention should be paid to this source reflecting the different sources of neighbourhood noise (ventilation, indoor noises, neighbours, etc), the characteristics of housing and how this noise could be mitigated, etc.

The group gave some names for possible authors; the secretariat will contact them and identify the author.

### ***Animal studies***

Even though noise effects have a strong component of perception and are strongly related to psychological factors, the studies developed in laboratories with animals could be reviewed in the guidelines.

## Conclusions and follow up work

In the plenary session on the last day of the meeting, the group established and agreed on the follow up actions, timetable and key milestones. The main conclusion was that the process would start with the production by the project partners and other experts, of background papers on the different themes identified during this workshop.

These background documents will not be size limited, and should contain as much information as possible on their specific topic. The assigned experts will have the freedom of covering a large range of data, risk assessment, dose-effect relationships and studies. These will be the foundation of the guidelines document therefore no limitations are necessary at this stage. The crucial point is to ensure that the existing knowledge is covered.

Regarding the work already existing in Member States, Dr Van de Berg will explore the possibility of having the "Dutch report" on noise translated to English as well as Mr Grenetier for the French one. If the complete reports cannot be translated, efforts will be made to have the summary available in English.

The production of a meta-analysis will depend on having an expert opinion. Dr Danny Houthuijs will be consulted regarding the importance of having a specific meta-analysis for night noise or/and focusing on children.

### *Sequence of tasks and time table*

The secretariat will distribute the meeting report for comments on the group. Partners should feed back on their attributed background documents. Secretariat will produce the terms of reference for external background papers – **End of June 2004**

The partners should start writing the papers feed backing with the group if necessary. By the **15<sup>th</sup> October** the secretariat will produce a progress report.

The papers should be ready for internal review by **December 2004 / January 2005**. This review should be finalized by **March 2005**.

The second partners' meeting is planned for **March 2005**. This meeting will have as main result a decision on how the working papers should be summarized, and plan the process of writing the guidelines.

By **December 2005** a first draft of the guidelines will be ready and the third meeting will happen in **January 2006**, this will be a partner consensus meeting, and the process of external review by peers and all stakeholders will be initiated.

**In March 2006 the fourth partners'** meeting will be held and agreement will be reached on the final version of the document for presenting in **June 2006** to Member States.

Small meetings with partners working in similar subjects could be held between the identified periods.

## Annex 1

### LIST OF THEMES AND RESPONSIBLES

| Themes   | Responsible                                       |
|--|---|
| <b>1. Setting the scene</b><br>Sources, metrics, sensitive areas, number of people exposed, trends, number of events, ,variations during the night, overview of legislation....  | Lercher, Licitra, Beaumont, , Levy                |
| <b>2. Uncertainty in exposure</b>  | Kephalopoulos                                     |
| <b>3. Instantaneous effects</b><br>Major sleep disturbances, moderate sleep disturbances, other  | Muzet, Miedema,                                   |
| <b>4. Cardiovascular effects, Hypertension</b>   | Babisch   |
| <b>5. Immune system (hormones excretion, decreased glucose assimilation, ...)</b>  | Maschke (Depending on the expert's agreement)     |
| <b>6. Other health outcomes ,</b>  |   |
| a) Physical (fatigue, drowsiness, sleepiness, ...)   | Gale  |
| b) Cognitive impairment (deterioration of performance, attention and motivation and diminishment of mental concentration and intellectual capacity and, increases the chances of accidents at work and during driving,...) | Hygge   |
| c) Accidents (this point needs special attention although covered in a) and b)   | Jovanovic   |
| d) Mental health   | Stansfeld, Skalski                                |
| e) Sleep pathologies   | Nevsimalova (Depending on the expert's agreement) |
| <b>7. Animal studies</b>   | Ising (Depending on the expert's agreement)       |
| <b>8. Scoring the evidence</b>   | Boegli  |

**9. Guidelines derivation, methodology aspects**

Van den berg

**10. Risk groups**

Bistrup, Kahn  
(Depending on expert's  
agreement)  
Passchier Veermer

**10. Meta-analysis?**

**The expert will be asked on the relevance of this point**

D. Houthuijs (if of  
interest)

**11. Neighbourhood noise (night)**

Colin Grimwood  
(Depending on expert's  
agreement)

## WORKING DOCUMENTS

### **Theme 1. Proposed elements of a 1<sup>st</sup> background paper on night noise exposure assessment**

#### Group members

*Jacques Beaumont* - Transport and Environment Laboratory, French National Institute for Transport and Safety Research

*Stelios Kephelopoulos* – EC Joint Research Centre, Institute for Health & Consumer protection, Physical and Chemical Exposure Unit

*Peter Lercher\** – Innsbruck Medical University, Institute of Hygiene and Social Medicine

*João de Quinhones Levy* - Instituto Superior Técnico, University of Lisbon

*Gaetano Licitra* – ARPAT, Dipartimento provinciale di Pisa

\* *Rapporteur*

1. Rationale for tight regulation of night noise exposure
  - 1.1 Increase in night noise exposure?
  - 1.2 Spread of night noise to previous quiet and/or sensitive areas?
  - 1.3 Recent results of sleep research
  - 1.4 Increase of the pool of susceptibles?
  - 1.5 The open doors of the END
2. Noise metrics for characterization of night time noise exposure
  - 2.1 Directive 2002/49/EC
  - 2.2 Other metrics
  - 2.3 Qualities needed for best description of night noise exposure with regard to human health effects
  - 2.4 Noise metrics used in short-term health effect studies
  - 2.5 Noise metrics used in long-term health effect studies
3. The structure, distribution and measurement of night noise exposure across Europe
  - 3.1 Types of night noise exposure
    - 3.1.1 Continuous noise exposure
    - 3.1.2 Intermittent noise exposure
    - 3.1.3 Other forms of noise exposure
    - 3.1.4 Types of night noise used in short-term human health effect studies
    - 3.1.5 Types of night noise used in long-term human health effect studies
    - 3.1.6 The uncertainty in estimating the various exposure types
  - 3.2 Difference between most and least exposed façade
    - 3.2.1 Measurement approaches
    - 3.2.2 The quiet backyard ?
    - 3.2.3 Uncertainty involved in estimating different façade exposures
  - 3.3 Indoor versus outdoor night noise exposure

- 3.3.1 Measurement of indoor night exposure
- 3.3.2 Comparisons across Europe
- 3.3.3 The uncertainty in estimating the actual night exposure at the ear of the sleeper
  
- 3.4 Night noise in special areas
  - 3.4.1 Sensitive areas
    - 3.4.1.1 Definition of sensitive areas
  - 3.4.2 Noise characterization in sensitive areas
    - 3.4.2.1 Quiet areas
    - 3.4.2.2 Definition of quiet areas
  
- 3.5 Overall uncertainty in noise exposure assessment
  - 3.5.1 Sensitivity to accuracy in input data
  - 3.5.2 Sensitivity to choice of calculation points
  - 3.5.3 Sensitivity to choice of noise metrics
  
- 3.6 Transfer of uncertainty in exposure assessment to uncertainty of effect assessment
  - 3.6.1 Uncertainty due to inaccuracy in measurement data
  - 3.6.2 Uncertainty due to inaccuracy in calculation points
  - 3.6.3 Uncertainty due to the use of inaccurate noise metrics
  
- 4. The protection of the night against noise across Europe
  - 4.1 The behaviour of populations during night time
  
  - 4.2 Existing guidelines
    - 4.2.1 Description of the variations
    - 4.2.2 The limits of current legislation
  
  - 4.3 Current legislation
    - 4.3.1 Description of the variations across countries
    - 4.3.2 The limits of current legislation
  
  - 4.4 The need for harmonization of protection of nights against noise exposure across Europe
  
- 5. Proposal for accurate night noise exposure assessment
  - 5.1 In short-term studies
  - 5.2 In long-term studies
  - 5.3 In noise mapping, SEA and EHIA
  - 5.4 In sensitive areas
  - 5.5 In quiet areas
  
- 6. References
  
- 7. Appendix

## **Theme 2. - “Short-term effects of noise on sleep with specific attention to mechanisms and possible health impact”.**

### **Group members**

H. Miedema and A. Muzet

This paper should include three particular aspects:

- On the light of short-term effects, what could be the expected long-term effect of the sleep structure modifications?
  
- Existence of groups at risk and possible potentialization between noise exposure and general sensitivity to environmental factors.
  
- Can we explain the differences between “laboratory” and “field” results?

### **Theme 3. 'Cardiovascular effects, Hypertension' - Dr Wolfgang Babisch**

The background paper for this theme will include a review of the relevant epidemiological literature on the relationship between transportation noise and cardiovascular endpoints, including the prevalence or incidence of angina pectoris, ECG ischaemia, myocardial infarction and hypertension. Particular emphasis will be given to dose-effect relationships, effect modifiers, noise metrics, gender differences and day/night differences.

A distinction will be made between objective exposure (sound level) and subjective exposure (annoyance..

Issues of evidence will be considered in the background paper using the criteria given in the WHO document "Evaluation and use of epidemiological evidence for environmental health risk assessment", which was distributed. The noise studies will be discussed with respect to the possible bias. The background paper will refer to reviews that have already been published. Existing reviews will be updated according to new study results.

Since it was decided in the NNGL group meeting not (only) to rely on existing or new meta-analyses to derive dose-effect curves. An attempt will be made to suggest/select a few reliable studies that can be used as a reference for quantitative risk assessments.

The background paper will include results from epidemiological studies on mean blood pressure readings in children. The focus here is not on risk groups, which is covered by theme 9, but on the presence or absence of an association as such.

## Theme 5.b. Cognitive impairment – Dr Staffan Hygge

The author will summarize what is reported on children and adults and a number of cognitive functions and will organize the material in the following way:

|          | Day time noise | Night time noise |
|----------|----------------|------------------|
| Children |                |                  |
| Adults   |                |                  |

### Cognitive measures that probably will have a heading of their own

Psychomotor performance  
Attention – primary memory  
Semantic memory – reading – language development  
Episodic memory  
Problem solving

Motivation  
Accidents

If enough material is available **vulnerable groups** such as children – elderly, the sick and pregnant women.

In a parallel way the author will look at how **sleep deprivation** as an independent variable affects cognitive functions

## Theme 5.d. Night Noise and Mental Health

Stephen Stansfeld & Michael Stalski

### **Table of Contents**

Introduction

Transportation Noise and Mental health

Road Traffic Noise

Acute effects

Chronic effects

Aircraft Noise

Acute effects

Chronic effects

Neighbourhood noise and mental health

Mechanisms for causal links between noise and mental health

Habituation to noise and mental health

Risk groups for mental health effects of noise

Population groups at risk for mental health effects from noise

Noise Sensitivity

Sleep disturbance and mental health

(To be completed by Michael Stalski)

Conclusion

## Theme 5.e. Sleep pathologies - Professor Sona Nevsimalova

### Subjective criteria of sleep pathologies:

- sleep log
- sleepiness scales (Epworth or another type)

### Objective criteria of sleep pathologies:

#### 1. Screening method – Actigraphy

At least 7 days of monitoring is necessary

#### 2. Gold nocturnal standard – Nocturnal Polysomnography

*Parameters to be scored in Nocturnal Polysomnography:*

- Time in bed
- Total sleep time
- Sleep latency (NREM sleep and REM sleep)
- Sleep efficacy
- Sleep architecture (% 1NREM, 2NREM, 3NREM, 4NREM and REM sleep)
- Cycles NREM-REM (No and continuity)
- Stage shifts (Nos)
- Pathological events: periodic leg movements (PLMI)
  - apnea and/or hypopnea (AHI, saturation)
  - others

#### 3. Excessive daytime sleepiness

- MSLT (multiple sleep latency test) and/or
- MWT (multiple wakefulness test)

#### 4. Computerized neuropsychological tests – e.g. Vigil

- attention is examined:
- reaction time and
- number of incorrect reactions

## **Annex 3**

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