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THE EU NOISE INDICATORS THE DGXI WORKING GROUP POSITION PAPER

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1. Background

The European Commission's Green Paper on Future Noise Policy published in November 1996 (1) identified a requirement for a new '*framework based on shared responsibility involving target setting, monitoring of progress and measures to improve the accuracy and standardisation of data to help improve the coherency of different actions*'. Among other actions, the Green Paper proposed '*a directive for the harmonisation of methods of assessment of noise exposure and the mutual exchange of information. The proposal could include recommendations on noise mapping and the provision of information on noise exposure to the public. In a second stage consideration could be given to the establishment of target values and the obligation to take action to reach the targets*'.

Having regard to the Green Paper, the European Parliament (EP) noted the need for an ambitious European noise reduction policy '*in view of the fact that noise has a serious effect on health and detracts from the quality of people's lives*' (2). The EP urged the Commission '*to promote the establishment of common methods for measuring and evaluating noise and common exposure indices, relating to both daytime and night-time*' (clause 3), these measures to be laid down in a framework directive on the reduction of ambient noise (clause 1).

A formal conference was organised in Den Haag in May 1997 at which there was widespread support for many of the Commission's ideas. The Den Haag conference recommended that the recommendations of the Health Council of the Netherlands committee on a uniform noise exposure metric should be taken into account. The Health Council committee report (3) was published in October 1997 and recommended 2 separate noise indicators: the EEL (Environmental Exposure Level) to assess annoyance during the 24 hour daily cycle and the ENEL (Environmental Night Exposure Level), intended to be associated with sleep disturbance. The Health Council committee adopted the principle that measurements or calculations of physical noise levels expressed in L_{Aeq} should be adjusted for time of day, type of source and any other '*special noise characteristics*' such that '*irrespective of the type of noise source, situations in residential areas with the same EEL lead to approximately the same level of general annoyance in a community. Similarly, in situations with the same ENEL, communities would experience approximately the same level of noise-induced sleep disturbance*'. The Health Council committee concluded that '*the available data are insufficient to complete the full specification of EEL and ENEL*', and therefore recommended that further research into comparative dose/effect curves would be required in order to define the various adjustments more precisely.

In order to take matters forward, the Commission organised an ad hoc committee of experts from the Member States in Bruxelles in January 1998. This committee agreed on a kick-off conference to be held in May 1998 in Copenhagen at which the terms of reference of five new working groups could be discussed and confirmed. A general strike in Denmark in May meant that the Copenhagen conference had to be postponed to September 1998. The terms of reference were therefore agreed at a meeting of the Commission with the chairs and co-chairs of the working groups in Bruxelles in June 1998. There is a comprehensive description of the Copenhagen conference in Acoustics Bulletin for September-October 1998 (4).

The invited chairs and co-chairs of each WG were as follows;

	Title	Chair	Co-chair
WG1	Indicators	Martin van den Berg Netherlands	Ian Flindell United Kingdom
WG2	Dose-Effect	Jacques Lambert France	Birgitta Berglund Sweden
WG3	Computation and Measurement	Dieter Gottlob Germany	Jorgen Kragh Denmark
WG4	Noise Maps	Catherine Bouland Belgium	John Hinton United Kingdom
WG5	Abatement	Sirkka Paikkala Finland	Werner Talasch Austria

The members of each working group were selected by the Commission from nominations made by Member States. The Commission tried to balance the membership across the Member States and around half the nominees were not selected. One objective of the September 1998 Copenhagen conference was to provide opportunities for wider consultation in the parallel working group sessions held for this purpose.

Additional WGs on Costs and Benefits and on Research were announced at a steering committee of Member States experts held in Bruxelles in March 1999. The Costs and Benefits WG is chaired by Tom Worsley from the United Kingdom and the Research WG includes the chairs or co-chairs of every WG except WG1.

2 WG1 Indicators

2.1 Terms of reference

The terms of reference for WG1 were set out as follows; '*This WG will recommend (physical) indicators to be used in the European Union to describe noise from all outdoor sources for assessment, mapping, planning and control purposes and will propose methods of implementation*'. The indicators were to be used for the assessment of annoyance, sleep disturbance, complaints and speech interference in residential and other noise-sensitive situations. A number of issues were to be taken into account as follows;

- the indicators must take into account current understanding of the relationship between the degree of noise exposure and the resulting effects
- the indicators should contribute to increased public understanding and therefore should be as simple as possible while avoiding confusion
- the indicators should properly represent as many as possible of those features of the acoustic environment which are relevant to any assessment being carried out; this includes the specification of the point where the indicator refers to, and the beginning and end of relevant time periods (day/evening/night or workday/weekend, etc.)
- the levels of accuracy required
- where possible, the indicators should avoid conflict with existing indicators already in use by MS.

It was anticipated by the commission that WG1 would need to make its recommendations as early as possible since much of the work of the other WGs would be dependant on it. In areas subject to scientific uncertainty, WG1 was required to make interim recommendations with a note of future research requirements set down for WG Research to consider later. WG1 was required to produce a draft position paper in December 1998, with the final position paper published in February 1999.

The membership of WG1 was as follows:

Chair	
M van den Berg	Netherlands
Co-chair	
I Flindell	United Kingdom
V Irmer	Germany
H Lang	Austria
M Lindqvist	Sweden
K Pesonen	Finland
M Stani	Austria
M Vallet	France
G Vindevogel	Belgium
T ten Wolde	DGXI European Commission

There were six meetings of the entire WG held between June 1998 and Feb 1999 and the chair and co-chair met on three other occasions. A draft position paper was produced in December 1998 and the WG1 executive summary with agreed recommendations was finalised at the last meeting of the WG held in Wien in February 1999. The three page executive summary was presented at the steering committee held in Bruxelles in March 1999. At the end of March 1999, the full position paper supporting the executive summary recommendations was still in existence only as a working draft.

2.2 Problems and issues

Existing noise assessment methodology in use across Europe is complex, disparate and confusing. Member states vary in the extent to which they have noise assessment methodologies already in place and they also vary in the degree of priority placed on noise control as compared to other demands on resources. There is an unnecessary multiplication of instruments and computation methods and in many cases there is quite limited public understanding. These problems all serve to make strategic assessment either difficult or impossible and as such, this means that the majority of decisions are taken on a strictly local level. On the other hand, there are a large number of issues where a more strategical approach might be expected to lead to better decisions regarding the application of scarce resources to future noise control.

Despite strenuous efforts applied to noise control at source, there is no convincing evidence of corresponding reductions in noise levels at receiver points within the community. This could be because increases in traffic have often outweighed reductions in noise levels generated at source. The Commission has taken the view that the balance needs to be shifted away from the noise sources and onto the noise receivers, so as to concentrate public attention onto this important aspect of environmental quality. By publishing noise maps using clearly defined harmonised indicators this will allow comparisons between MS which may then generate increased political momentum for noise control. Subsequent maps published in later years will show progress (or regression) against noise control action plans. In many ways, maps showing progress or otherwise will probably be more useful over the longer term than simply comparing aggregate noise exposure between member states. Anecdotal evidence suggests that there are clear cultural differences in noise sensitivity between different parts of the EU, and it is not at all clear how these either could be, or need to be, taken into account.

For MS who already have existing noise assessment methodologies in place, then why bother to change to any new system of harmonised EU noise indicators? There are many possible reasons for changing, but the main reason should perhaps be the ability to focus on strategic decision making. There might be little point in developing harmonised EU noise indicators for use in local noise problems which are often best dealt with by negotiation between the parties concerned. Harmonisation can support the rationalisation of some of the older and less scientifically valid indicators in use today. A key question in all of this is essentially one of costs and benefits, how much will noise control action cost and what will be the benefits?

The wider adoption of a more strategic approach will create difficulties. In the UK we have a tradition based on attempting to reach the best available compromise between the parties to any local dispute. This implies different solutions in different situations and is not intrinsically strategic in character. The system of local planning inquiries in the UK has no mechanism for considering a wider strategic view. PPG 24 (5), for example, gives guidance on the suitability of noisy areas for noise sensitive development and not the other way around. Existing guidance and regulations deal with each noise source separately and there is often a great deal of local discretion allowed. The majority of noise complaints to local government officers concern domestic or neighbour noise, which is effectively outside the scope of any type of harmonised physical noise indicator for the foreseeable future. Finally, local authorities often have little or no control over many of the major noise sources in their areas anyway. While the main objections to any changes in the noise indicators used might turn out to be largely administrative, there are potentially huge unknowns regarding the possible long term consequences of any new approaches that could be introduced by the EC.

An important issue for WG1 turned out to be the particular proposals for harmonised noise indicators proposed by the Health Council of the Netherlands. WG1 could have taken the view that most of its work had already been done and indeed, given the short timescale and the very limited resources available, this was very attractive. On the other hand, WG1 recognised that the current EC initiative on future noise policy represented a rare opportunity to make a worthwhile and lasting contribution to the cause of noise control, and that it was important that as many as possible of the various issues arising should be fully debated from first principles. WG1 considered that it alone would have to accept the responsibility for any recommendations made and that while as much use as possible should be made of previous work, it was necessary for the WG to reach a consensus for itself. The main advantage of the Dutch EEL and ENEL proposals is that any and all noise of any kind can be represented by only two single number indicators (for overall noise and night-time noise). This simplification provides obvious benefits, but the main disadvantage is that the necessary subjective adjustments for acoustic features, time of day, and type of noise have not been agreed and could lead to undesirable consequences when one type of noise is traded for another. In many cases, where acoustic features are at issue, it is often the feature itself which is the problem and not the noise level per se. (6). In other cases, non-acoustic features can be as or more important than noise levels however adjusted (7).

Finally, it is important to note that effective noise management is almost invariably focused on individual noise sources, not on the overall ambient noise climate. Perhaps the most difficult problem with any combined single number noise indicator is that, where there is more than one noise source present, the significance of each separate contribution is concealed. The strategic approach to noise assessment depends on establishing priorities for alternative noise control policies and this can only really be done when the likely effects of each possible action can be clearly shown. The underlying philosophy of the Health Council of the Netherlands proposals is based on the concept of observed differences between steady-state dose-effect curves for different types of noise source and different exposure situations. On the other hand, effective noise management is nearly always about considering the likely costs and benefits of change, a topic about which there has been very little quantitative research.

3. WG1 position paper executive summary (recommendations)

It was agreed that the objective of the European Environmental Noise Indicators is to indicate outdoor noise for use in noise maps and for strategic planning and assessment. Indicating sound levels at source, personal noise exposure, or noise indoors were all considered to be outside the scope of the indicators. Two fields of application were identified as follows;

- the harmonisation of national methods of noise assessment where this is both feasible and worthwhile - these indicators are described in a section called general,
- the strategic comparison of noise exposure between and within Member States - these indicators are described in a section called strategic mapping and planning.

The distinction between the two fields of application was made because the general system of indicators could necessarily result in up to twelve or more separate indicators of different aspects of the acoustical environment at each defined receiver position. For strategic comparisons it was felt to be more appropriate to recommend a means of aggregation that would result in many fewer indicators but also in some loss of information which may or may not be important for local assessment depending on the particular circumstances of the case.

The recommended indicators were considered to be primarily addressed to the control of annoyance and sleep disturbance. This does not of course mean that they can directly control either of these effects, but instead, it means that, all other things being equal, changes in the indicator values would normally be expected to lead to corresponding changes in these identified effects. Since other noise-related health effects generally arise, if at all, at much higher levels of noise exposure than those which can cause annoyance and sleep disturbance, then it was felt that noise control actions leading to reductions in annoyance and sleep disturbance would automatically provide corresponding benefits in these other areas. No additional indicators were therefore required to represent these effects. The topic of noise complaints was considered to be outside the scope of the indicators, although this is not specifically mentioned in the agreed executive summary.

The recommendations for **general application** were as follows;

1. *the European Environmental Noise Indicators* shall be based on the average A-weighted sound pressure level L_{Aeq} in decibels
2. the indicator shall be expressed separately for each specific outdoor noise source present (the specific noise sources for this purpose would normally be one or more of road, railway, aircraft, industrial noise or other man made sources).
3. the basis for the indicators shall be expressed separately for 12 hour day, 4 hour evening, and 8 hour night periods. The beginning and end times for each of these periods shall be defined by each Member State in the light of local circumstances. The default value is 07.00-19.00 hrs, 19.00-23.00 hrs and 23.00-07.00 hrs local time.
4. the indicator shall be representative of the calendar year adopted for assessment. An additional representation for Sundays is a recommended option.
5. the indicators shall be determined for conditions representative of noise exposure outside dwellings, where the effects of reflections at the surface itself at the receiver point shall be excluded; thus the incident sound level is determined. For the precise estimation of noise abatement measures like screens or isolation, the height of the assessment point will have to be selected to take into account the noise sensitive receiver point.
6. the indicators are intended for general purposes; from time to time there may be additional factors which should be taken into account in any assessment (see section called additional factors below).

The recommendations for **strategic mapping and planning purposes** were as follows:

1. for the assessment of the overall noise impact, the day, evening and night levels are to be combined into one level with a weighting of 5 dB for the evening and 10 dB in the night: this is the L_{EU}.
2. for the assessment of night time noise impact, the $L_{EU,N}$ is to be used.
3. the strategic indicators shall be determined at a height of 4 meters.

Additional factors

In practice, human responses may be influenced by additional factors to noise level expressed as one of the recommended European Environmental Noise Indicators alone:

1. the type of noise source can influence the response. This will usually be important where comparisons are made between noise from different sources.
2. the variation in noise level over the time period indicated can influence the response. Noise sources which operate for less than 20% of the day or for less than 20% of the days in a year or where there are less than 1 event per hour over the averaging period for the indicator may require special attention.

3. where there is significant tonal or impulsive content this can increase the annoyance response, and special efforts should be made for the elimination of these features where practicable. Where these features are present this should be separately noted;
4. where there are other acoustic features such as low frequency noise present the annoyance response can be significantly affected. In this case the use of the linear or C-weighted L_{eq} is recommended.

All such additional factors that may need to be taken into account shall be separately noted or otherwise indicated. The working group notes that there are various methods available for applying adjustments to the basic indicator of physical noise to take some of these additional factors into account. Although for strategic mapping and planning purposes it is necessary to harmonise to a larger extent, for more local use other considerations may prevail. Where adjustments are applied additional to or different from the basic *European Environmental Noise Indicators,* then these should be clearly indicated.

4. Commentary on the recommendations

The working group accepted that the use of the A frequency weighting is extremely widespread and could find no justification for any change for general applications. As noted under additional factors where there are acoustic features present such as tones, impulses or low frequency noise, then this may need to be separately noted and in the case of low frequency noise the linear or C frequency weightings could also be useful. More detailed frequency spectrum information could of course be relevant for the design of physical noise control measures, but this was considered outside the scope of these indicators. The increased complexity of alternative frequency weighting schemes such as those devised by Stevens and Zwicker was not considered to be justified, bearing in mind the variable results obtained with these and similar schemes.

Similarly, the working group accepted the widespread use of the so-called equal-energy averaging principle implicit in the use of L_{Aeq}. Using the L_{Aeq} average to represent time varying sound accords with basic physical principles and is therefore the most convenient for measurement. Alternative statistical descriptors do not behave as predictably. The working group concluded that there was no good evidence to justify any change, although it was recognised that additional factors may need to be separately noted where events are infrequent. A long term average might not properly represent the short term disturbance at the time that the event occurs. It is important to note that even in situations where there are infrequent events, any change in the maximum noise levels (L_{Amax} or SEL) of those events would also result in corresponding changes in the overall L_{Aeq} contribution attributable to that source.

The working group recommended separate indicators for each specific outdoor noise source present for two reasons, first, that there is no consensus on any method of aggregation that will yield so-called combined noise levels that correlate with overall response, and secondly, that effective noise management is almost invariably focused on the separate noise sources present anyway.

The working group recommended separate indicators for the day and night periods because of an increasing consensus that possible sleep disturbance effects should be separately taken into account. Moving on from this, the working group further identified the potential importance of the evening period for relaxation at home and recommended that this also should be separately indicated. In many urban situations it can be difficult to achieve significant reductions in ambient noise during the normal working day, but most people would agree that special attention should be given to the night-time period where this is feasible. The working group additionally recommended separate attention for the evening period as well because this would provide an opportunity for regulators to consider noise control action separately for this time period. The possibility of identifying different noise level targets for the different recommended time periods was not of course a matter for WG1. The working group did not consider that any anticipated difficulties in collecting information for the three time periods should deter the Commission from including these recommendations in future directives because none of these indicators would come into force for several years and there would be plenty of time for new arrangements to be made in the future.

The working group considered that it could be left to Member States to define the start and end times for each period although the number of hours should be fixed to facilitate strategic comparisons. The recommendation for Sunday representation was based on the same reasoning.

One of the more controversial recommendations was that the indicators should be representative of a calendar year. The wording does not precisely specify a yearly average noise level, although it was intended that the indicators should represent long term averages. The main difficulty with yearly averages is that they would nearly always have to be computed from much shorter measurement samples taking the likely variation in noise levels due to meteorological variability into account. The working group considered that it was right that the indicators should reflect long term average noise exposure, and that the matter of how these indicators should be determined would be a matter for WG3 - Computation and Measurement. Of course, this could mean that Member States that have existing regulations based on mild downwind meteorological conditions or on maximum short term average noise levels may have particular difficulties in implementation which would need to be resolved.

The working group recommended that the indicators should be defined in terms of outdoor incident sound levels. This means that any effects of reflections from surfaces near to the receiver point should be excluded. This definition avoids the uncertain frequency effects of these reflections, but may also create difficulties for measurements in heavily built up areas. This will be a matter for WG3. For general use, the measurement height above ground should be representative of the sensitive receiver height, for example; if upstairs rooms are being assessed, then the measurement height should be representative of the window heights of those rooms. The working group could find no compelling reasons for continuing with the traditional standard height of 1.2 to 1.5 m, and for strategic purposes, recommended the increasingly common noise mapping standard of 4 m above the ground. It should be noted that noise assessment at greater heights will show lower benefits from noise barriers than is customarily assumed.

The working group recognised that human responses, both individual and collective are often influenced by many factors additional to physical noise levels alone, however expressed. There are many schemes in use around the world for applying subjective adjustments to physical noise levels to account for some of these factors, but there is no great consensus on how these different schemes of adjustment should work. In addition, subjectively adjusted noise levels can be more difficult to work with when designing noise control measures. Recognising these difficulties, the working group felt that no specific scheme of subjective adjustments could be recommended at this time, but that all those additional factors which might be relevant to any assessment should nevertheless be noted in some way. For example, a noise map of industrial noise with tonal or impulsive content should use the general or strategic indicators without subjective adjustment, but should also indicate separately that there is tonal or impulsive content present which may require separate noise control attention irrespective of the absolute noise levels present.

The working group recognised that the general indicators could require a relatively large number of noise maps or separate tables of statistics. Each separate map would provide information useful for the design and assessment of specific noise control options applicable to the local situation, but the totality of the overall presentation could nevertheless present a confusing picture to the public and might lead to difficulties when strategic comparisons are attempted. Therefore, the working group also recommended a reduced set of strategic indicators based on L_{den} for overall noise and $L_{Aeq,night}$ for night-time noise. These indicators were given the special symbols L_{EU} and $L_{EU,N}$ to allow them to be given precise and unambiguous definitions which will appear in the full position paper. The selection of an L_{den} type measure for the overall L_{EU} indicator may have some controversial elements, in particular the choice of 5 dB and 10 dB weightings for the evening and night-time periods. The working group recognised that while there is good evidence for different and probably increased sensitivity to noise in these periods (as compared to the daytime) there is no scientific evidence in support of any particular values for these weightings. However, wherever L_{den} type measures are in use, there is almost a de facto standard for the weightings to be 5 dB and 10 dB and the working group could find no good reasons for change. The use of the 5 dB and 10 dB weightings provides some protection against increases in evening and night-time noise levels that might otherwise not register on any unweighted 24 hour measure, given the fact that existing hourly

noise levels often fall away during the evening and night-time periods in many cities. It should be noted that these weightings were specifically denoted as weightings and not as subjective adjustments, since they were not intended to be prescriptive of precise amounts by which noise sensitivity is presumed to increase during the evening and night-time periods and indeed, there is no presumption that EU target values, if adopted, would need to follow the same principles.

The working group made no recommendations for combining the separate values of L_{EU} and $L_{EU,N}$ for each specific noise source present into any overall measure of ambient noise. The working group particularly drew attention to the fact that the total noise level, however combined, will not always give a proper representation of the likely effects considered in aggregate. This recommendation was based on the fact that there is no consensus on methods for dealing with combined noise sources, other than separately.

Finally, the working group, noting the increasing attention being paid to the preservation of quiet areas, acknowledged the need to visualise and control quiet areas especially near cities. For this purpose the same indicators could be used as the ones already described. It is recognised that both calculation and measurement of the recommended indicators could be subject to greater uncertainty at the lower levels, but this again was left as a matter for WG3. The working group acknowledged that other statistical measures such as the L_{90} and L_{95} are in current use in several Member States for the indication of background noise levels and there is nothing in the working group's recommendations which would necessarily require any changes in this particular respect.

5. Concluding remarks

It is important to consider what should happen next. The working group's recommendations were presented to the steering committee of Member State's experts in March 1999 which will then submit written comments to the Commission who will then decide how to go forward. Initial responses were largely positive. It is likely that there will be a further meeting of the steering committee in September or October 1999 to consider the Commission's response. In the meantime, the Commission tabled a very preliminary first draft of the proposed directive on the 'Assessment and reduction of environmental noise exposure' at the March 1999 steering committee. This draft goes considerably further than the WG1 recommendations in that it mandates the use of the strategic indicators, L_{EU} and $L_{EU,N}$, for a much wider range of applications than envisaged by WG1. It also introduces the concept of noise quality classes intended to represent defined percentages of 'highly annoyed people' for use in noise maps and statistical tables. These classes differentiate between the three major transport sources by allowing a 5 or 10 dB bonus for railway noise and a 5 dB penalty for air noise as compared to road traffic. It will be interesting to see how the Member State's experts react to these proposals, which appear to adopt rather more from the original Health Council of the Netherlands proposals than was accepted by WG1.

6. References

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2. **European Parliament** Resolution 'Noise Policy' A40183/97, 1997.
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