

---

## Reviewing the current guidance in England for the valuation of noise impacts

Hilary NOTLEY<sup>1</sup>; Alisha IYER<sup>1</sup>; Emma POWELL<sup>1</sup>

<sup>1</sup>Defra, UK

### ABSTRACT

In England, the current guidance for valuing impacts associated with environmental noise is published by the Department for Environment Food and Rural Affairs (Defra) and the Interdepartmental Group on Costs and Benefits Noise Subject Group, (IGCB(N)).

The development of the World Health Organization (WHO) Environmental Noise Guidelines followed a rigorous methodology and their recommendations are based on systematic reviews published separately. The systematic reviews considered evidence published between 2000 and 2014 – 2016 (health outcome dependent). There have been several high quality studies published since those considered by the WHO that may further develop the understanding of the link between noise exposure and health.

This paper describes the steps that the IGCB(N) are taking to determine whether they should update their current recommendations. The paper describes the commissioned reviews of evidence relating to health effects and efforts to assess a number of potential effects that are outside of the scope of the WHO, such as the benefits of quiet areas/tranquility and the impact on productivity. The paper further describes how the valuation of any effects will be considered.

Keywords: Noise, Health, Valuation

### 1. INTRODUCTION

In England, the current guidance for valuing impacts associated with environmental noise is published by the Department for Environment Food and Rural Affairs (Defra)<sup>1</sup> on behalf of the Interdepartmental Group on Costs and Benefits Noise Subject Group, (IGCB(N)) (1).

The IGCB is a Defra-led group of government analysts and policy officials that provides analysis and advice relating to the quantification and valuation of local environmental impacts. It aims to do this through the development of methodology, evidence reviews and subsequent recommendations.

The Noise subject group, IGCB(N), described its current methodology for valuing health impacts associated with environmental noise in two documents in 2010 and 2014 (2,3). The relevant health outcomes are annoyance, sleep disturbance, hypertension (via stroke and dementia) and acute myocardial infarction. Other factors considered are the benefits of quiet areas and impacts of noise on productivity. Together, these recommendations outline the current guidance to the UK Government for incorporating noise impacts in cost benefit analysis. These recommendations have subsequently been incorporated into the DfT transport analysis guidance (WebTAG) and the HMT Green Book (4,5) on appraisal and evaluation.

On 10th October 2018, the World Health Organization (WHO) Regional Office for Europe published its Environmental Noise Guidelines for the European Region (6), ‘the WHO Guidelines’. The guidelines provide recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. The development of the guidelines followed a rigorous methodology; their recommendations are based on systematic reviews of evidence published separately (7).

The publication of the WHO Guidelines has generated interest from stakeholders. Ministers have welcomed the WHO’s focus on this important issue and in line with the government’s commitment to

---

<sup>1</sup> noise@defra.gov.uk

ensure noise is managed effectively, the IGCB(N) was convened to consider any necessary updates to relevant government guidance.

This paper describes the process that the IGCB(N) is following to determine whether it might update the current recommendations. The paper describes the commissioned reviews of evidence relating to health effects and efforts to assess a number of potential effects that are outside of the scope of the WHO, such as the benefits of quiet areas/tranquility and the impact on productivity. The paper further describes how the valuation of any effects could be considered.

Noise policy is a devolved matter in the UK. The IGCB(N) membership consists of representatives from the Devolved Administrations (Wales, Scotland and Northern Ireland), as well as representatives from departments across central Government.

## 2. IDENTIFICATION OF SCOPE

The broad methodology currently applied by the IGCB(N) is the impact pathway approach which involves following the pollutant (the noise emissions) from its source (such as a vehicle) to a receptor. The impact on the receptor from this exposure is then classified into one of four broad groups of endpoints and evaluated. The broad groups of endpoints in the current guidance are health, amenity, productivity and environmental outcomes:

- Health – Noise is associated with a range of effects on health, including both morbidity and mortality. The health effects currently valued are heart attacks (AMI), strokes and dementia (from hypertension).
- Amenity - In the current guidance amenity reflects public well-being, including direct annoyance. It also includes positive benefits such as from quiet areas. However, in one of the current IGCB(N) reports, it is defined as including “the conscious negative reaction of those exposed to the noise” in relation primarily to annoyance, but also to sleep disturbance. The IGCB(N) felt that this definition may no longer be appropriate. There is evidence that suggests that some of the health impacts, in particular those associated with sleep disturbance, may be considered to be ‘unconscious’. Therefore, the IGCB(N) agreed to redefine these endpoints. For the purposes of this review, annoyance and sleep disturbance will come under the ‘health’ endpoint. This is in line with the WHO’s broad definition of health as a “state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. Quiet areas will be subsumed into the environmental endpoint and the ‘amenity’ term is no longer required.
- Productivity - Through distraction, fatigue and interrupting communication, noise can have a negative impact on productivity. At the time of the previous publication, it was not possible to assess and value these impacts.
- Environmental - Noise can have a notable impact on the natural environment, for example noise may alter bird breeding patterns, disturb wildlife and damage sensitive ecosystems.

The current approach was decided by the IGCB(N) in 2010 and a similar impact pathway approach is used in other areas, e.g. air quality (IGCB(A)). The IGCB(N) agreed to continue with this broad approach, albeit with some re-categorisation as detailed above. It should be noted that the endpoints were redefined purely for ease of carrying out this review and solely within the context of this review. Accordingly, the revised endpoints are:

- Health;
- Productivity; and
- Environmental.

### 2.1 Noise Sources

Once it had been agreed to continue within the existing framework, the first task undertaken by the IGCB(N) was to identify noise sources within the scope of the work. Defra has overall lead responsibility for policy on (non-occupational) noise management in England. At a national level, noise is managed through the implementation of the Noise Policy Statement for England (NPSE) (8). Its vision is to “promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development”. The NPSE recognises that it is not possible to have a single objective noise-based measure that is applicable to all sources of noise in all situations. This is because effect levels are likely to be different for different noise sources and at different times.

The aims of the NPSE are:

“Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.”

The intention is that the NPSE should apply to all types of noise apart from noise in the workplace (occupational noise). For the purposes of the NPSE:

- Environmental noise - includes noise from transportation sources, such as road, rail and aviation;
- Neighbour noise - includes noise from inside and outside people’s homes. It includes noise from and between neighbours’ premises (including gardens) that tends to affect people in the immediate vicinity – for example, noise from high volumes on televisions, music equipment, pets, household products and noise from people activity such as doors slamming or shouting; and
- Neighbourhood noise - includes noise from within the community that can affect a larger number of people – for example, from entertainment premises (e.g. pubs, clubs, music venues), outdoor concerts, industrial, business or trade premises, construction sites, equipment or machinery being used in the street and wind farms.

The definition of ‘noise’ is commonly expanded to include (environmental) vibration. The IGCB(N) used the NPSE as the starting point for defining which noise sources were within the scope of the review. Discussions were held to identify those sources for which there were likely to be some literature on studies relevant to the IGCB(N). Thus, the following noise sources were determined to be in scope:

- Road
- Rail
- Aircraft
- Windfarms
- Industry
- Noise from building services equipment including ground and air source heat pumps
- Neighbour noise
- Neighbourhood noise (including leisure noise, not from personal listening devices)

## 2.2 Health Endpoint

The second task undertaken by the IGCB(N) was to identify the health outcomes within the scope of work. The starting point was the WHO Guidelines. The WHO systematic reviews considered evidence published between 2000 and 2014-2016 (dependent on health outcome). Table 1 details the exact dates considered by the WHO systematic reviews by health outcome.

Table 1 – Period considered by WHO Systematic Reviews

Health Outcome	End Date of Review
Annoyance	Dec 2014
Effects on Sleep	1 Dec 2015
Cardiovascular and Metabolic Effects	Aug 2015
Cognition	Jun 2015
Adverse Birth Outcomes	Dec 2016
Quality of Life, Well-Being and Mental Health	Oct 2015

There have been several high quality studies published since those considered by the WHO that may further develop the understanding of the link between noise exposure and health. Some studies consider not only the health outcomes above considered by the WHO, but also additional health outcomes. The IGCB(N) discussed including these additional health outcomes and concluded that to ensure all the relevant evidence were considered, the scope of the review should be wider than that covered by the WHO. It is acknowledged that the evidence for some of these health outcomes may be insufficient to progress to a valuation methodology, but it was felt important that they at least be considered. The IGCB(N) agreed to consider not only the supporting evidence base of the WHO, but also other subsequent high-quality evidence carried out in the UK and abroad.

Thus, the following health endpoints were determined to be in scope:

- Annoyance
- Sleep Disturbance
- Cardiovascular (Ischaemic Heart Disease, Hypertension)
- Metabolic Disease (Stroke, Diabetes, Obesity)
- Cognitive Effects in Children
- Mental Health (excluding annoyance, but including well-being and quality of life)
- Reproductive Outcomes (Birth weight, etc)
- Cancers (non-Hodgkin’s Lymphoma)
- Cognitive degeneration (dementia, Parkinson’s)

Consideration of hypertension requires an additional explanation. The current IGCB(N) recommends using a two-step approach to value hypertension-related impacts. Step 1 is to quantify the likely number of additional cases of hypertension due to noise. Step 2 is to monetise these additional cases of hypertension by quantifying and valuing the consequential impact on dementia and stroke. This approach was taken because there was no agreed disability weight for hypertension at the time. However, the recent guidance document developed for the European Commission stated that not all exposure-response functions derived as part of the WHO review are valid for use in a health impact assessment. Hypertension is not considered as a health outcome, but rather as a risk factor and as such is sufficiently covered by coronary heart disease (9). It was agreed by the IGCB(N) to consider whether the current approach should be amended to align with this newer approach, to ensure that double-counting does not occur.

### 2.3 Productivity and Environmental Endpoints

Future tasks for the IGCB(N) include defining the scope for these two endpoints. This is anticipated to commence in July 2019.

## 3. REVIEW OF EVIDENCE

### 3.1 Health Endpoint

#### 3.1.1 Process

It was decided to seek evidence for every combination of noise source and health outcome (as detailed for road traffic noise in Figure 1).

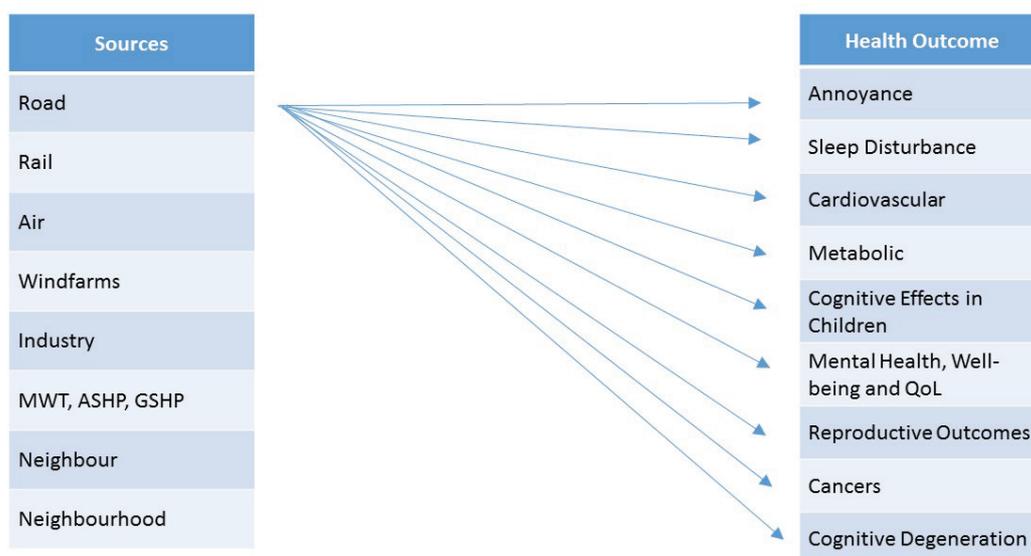


Figure 1 – Road Traffic Noise and Health Outcomes to be considered

There are three scenarios for each source-outcome combination.

- Source-outcome combinations IN BOTH current IGCB(N) and WHO (e.g. road traffic noise and annoyance) - The WHO systematic review was considered to be sufficient as a starting point. However, as mentioned earlier, it is acknowledged that high quality studies may have been published since the cut-off point of the systematic reviews. Therefore, it was decided to commission evidence reviews to identify relevant studies published after each specific systematic review cut-off date. The evidence review was to follow the methodology of the WHO reviews as closely as possible. The outcome of the review is to form a view on whether any identified new evidence suggests that a material change to the exposure-response relationships proposed in the WHO systematic review might be considered by the IGCB(N).
- Source-outcome combination NOT in current IGCB(N), but IS in WHO (e.g. windfarm noise and annoyance) - The WHO systematic review was considered to be sufficient as a starting point and the same process as in the previous bullet point followed. The outcome of the review is to form a view firstly on whether the scope of the current IGCB(N) recommendations might be extended to include this new source-outcome combination and secondly, on whether any identified new evidence suggests that a material change to the exposure-response relationships proposed in the WHO systematic review might be considered.
- Source-outcome combination NOT in current IGCB(N) or in WHO (e.g. neighbour noise and annoyance) - Relevant evidence from 2000 onwards is to be identified, again following the process of the WHO reviews as closely as possible. The outcome of the review is to form a view on whether the scope of the current IGCB(N) recommendations might be extended to include this new source-outcome combination.

Some noise sources have long-established links to health outcomes, e.g. transport noise with annoyance. Other sources are less-well researched. The level of robustness of evidence for each of these potential relationships varies greatly both in terms of the body of research (repeatability of results) and the quality of the research (e.g. carried out on sufficient sample sizes and with recognised approaches). The aim of the evidence reviews are to confirm for each source-outcome combination whether sufficient robust evidence exists to suggest a relationship may be defined and whether that evidence is relevant to the UK. A view then needs to be taken on whether that relationship should be included in any future IGCB(N) recommendations.

It is accepted that a viable and realistic outcome from the evidence reviews may be that for many of the source-outcome combinations, the evidence reviews may suggest that:

- There is SUFFICIENT robust evidence to suggest that a relationship does NOT exist;
- There is INSUFFICIENT robust evidence to suggest that a relationship DOES exist; or
- The evidence may suggest that a link might exist, but that there is currently insufficient robust evidence to define a relationship.

These are considered acceptable outcomes and may provide the IGCB(N) with a clear and evidenced reason to NOT consider the source-outcome combination any further in the process.

### **3.1.2 Progress**

To date evidence reviews have been commissioned considering the eight scoped noise sources (road, rail, air, wind turbines, building services, industry, neighbour and neighbourhood) and the nine scoped health outcomes (annoyance, sleep disturbance, cardiovascular (ischaemic heart disease and hypertension), metabolic (stroke, obesity, diabetes, blood pressure), mental health (incl quality of life and well-being), cognitive effects, cancers, neurodegenerative diseases (Parkinson's, dementia) and reproductive outcomes (pre-term, birth weight, infertility)). Results are not yet available at the time of submission of this paper, but discussions with the researchers suggests that many more papers than expected were identified in the initial searches, thus showing that the exercise is well-worth undertaking.

Initial indications of the results suggest that there will be insufficient evidence to determine exposure-response functions for some of the newly included noise sources (e.g. building services, neighbour, neighbourhood noise). This is not entirely unexpected. The heterogeneity of neighbour and neighbourhood noise sources makes it extremely complex to define the noise sources in a repeatable manner. It may be that these generic sources need breaking down further into more specific sources, e.g. instead of neighbour noise, it may be possible to consider voices, impact noise, barking dogs and so on separately. However, finding sufficient sample sizes of these individual sources might then prove difficult and there would be challenges around the control of any such study as the sources are not as constant or predictable as say those from a major road.

Initial indications of the results also suggest that there will be insufficient evidence to determine exposure-response functions for some of the health outcomes (e.g. reproductive outcomes). Again, this is not entirely unexpected as the WHO also concluded that additional high quality studies were required to explore potential links between many of the noise sources and reproductive outcomes (9) and it would be unrealistic to expect that enough of these have been published between 2017 and 2019. However, this does not mean that the effects do not exist, just that there is insufficient quality evidence at present to conclude one way or the other.

Interestingly, for some of the noise source-health outcome combinations, the initial indications of the results suggest that enough quality evidence is now available to consider carrying out new meta-analyses and to potentially define more robust or different exposure-response functions. The IGCB(N) will need to consider whether this is a route they wish to take after considering the final conclusions of the reviews carefully.

However, and as a caveat, it should be borne in mind that the results are not yet finalised, and so the above discussion is subject to change.

### 3.2 Productivity Endpoint

At the time of drafting this paper, the scoping for this endpoint had not been completed. However, as a minimum, an update to the previous review of noise related sleep disturbance impacts on productivity is expected to be undertaken. It is accepted that the methodology for reviewing the evidence relating to productivity is perhaps less developed and/or standardised than that for the evidence reviews of noise-health effects.

### 3.3 Environmental Endpoint

One factor considered in the previous IGCB(N) review was the beneficial effects of access to quiet areas. To be beneficial it is generally agreed that an area needs to be not only relatively quiet compared to the surrounding area, but also tranquil. However, a tranquil space need not necessarily be quiet, e.g. in the vicinity of a waterfall or waves on a beach. More recently, these concepts have been included in the topic known as ‘soundscape’. One area for consideration by the IGCB(N) is therefore that of a positive soundscape, including quiet, tranquility, the absence (or masking) of noise, and restorative benefits.

Another area which the IGCB(N) may choose to consider is that of environmental noise exposure and ecosystem impacts.

Again, it is accepted that the methodology for reviewing the evidence relating to both these points is perhaps less developed and/or standardised than that for the evidence reviews of noise-health effects.

### 3.4 Other Work Packages

There are some additional areas that the IGCB(N) may wish to explore.

- Change Effect - The WHO systematic review for annoyance suggests some changes to the exposure response relationships from those previously used (11). Particularly for air transport, this has generated some debate. One argument centres on “change effect”. The question is whether there is an increased sensitivity to noise and if so, is this irrespective of a change to the local environment. The quantification of effects often occurs during consideration of a change and it may be possible that this has influenced the results in some way. It seems quite feasible that the initial reported annoyance from those experiencing a change in noise exposure from say  $55\text{dB}L_{\text{Aeq},16\text{hr}}$  to  $58\text{dB}L_{\text{Aeq},16\text{hr}}$  is elevated compared to those experiencing a constant exposure of  $58\text{dB}L_{\text{Aeq},16\text{hr}}$ . The question is whether there is sufficient evidence for determining whether this “change effect” reduces over time, by how much and whether it ever aligns with the steady-state relationship.
- Non-Acoustic Interventions - One common used method to mitigate noise impact is that of respite – ensuring the noise is not present e.g. at certain times of the day or during the week. However, current  $L_{\text{Aeq},t}$  based noise metrics are insensitive to respite, whereas community response is very sensitive.

## 4. Valuation of Effects

The effects of noise on health are currently valued using a quality-adjusted life year (QALY) framework. This is based on a value assigned to a life year lived in perfect health and a set of adjustment factors, known as utility weights, that adjust the perfect health value for different

conditions in relation to their severity or impact on an individual's quality of life. This approach is used in other Defra areas, e.g. air quality, and is recommended in HMT's Green Book. It is a two-dimensional measure of both the impact on length of life (longevity) and health-related quality of life. The current monetary willingness-to-pay (WTP) value for a QALY is £60,000 (sterling – 2014 prices).

Disability-adjusted-life-years (DALYs) are a measure of life-years adjusted for loss of quality of life and loss of life expectancy for people living with a health condition or its consequences. Appraisal of an intervention is concerned with estimating the difference that it makes – hence the intervention's impacts could be described in terms of QALYs gained or DALYs prevented. However, in practice, DALYs differ in some subtler ways and are used less often in the UK. However, the WHO's Burden of Disease from Environmental Noise uses the DALY. The currently IGCB(N) methodology uses a disability weight to estimate the health impact of an outcome in DALYs. This is then valued in line with the prevailing guidance on valuing life and health. The recommended monetary value of a QALY is the recommended Department of Health DALY, and therefore consistent across the two approaches.

The IGCB(N) may also consider two additional work packages on valuation:

- Estimation of costs to the NHS and social care due to the health impacts of noise pollution – this is an area considered by the Public Health England (12) for Air Quality and it may prove possible to investigate whether it can be adapted for noise; and
- Costs to local government (and other relevant bodies), for example in investigating complaints – in 2012, Defra commissioned a report to estimate the cost of complaints about noise nuisance (13). These were the estimated costs to both the individual making the complaint about an alleged statutory noise nuisance in England (in hours) as well as the cost to a Local Authority in investigating and enforcing the complaint (in hours and monetised). The IGCB(N) has commissioned an update to this report.

## 5. Summary and Conclusions

The IGCB(N) has already agreed to undertake an ambitious programme of work. This programme of work covers 4 main work areas – health effects from noise, productivity impacts attributable to noise exposure, environmental impacts (and benefits) of noise (and positive soundscapes) and the valuation of those effects and impacts. Whilst the scoping remains incomplete for some areas, in others great progress has already been made in rapidly convening the IGCB(N) and commissioning three work packages – two covering reviews of eight noise sources and nine potential health effects and one updating an existing report on the cost of complaints about noise to both the complainant and the investigating authority.

Work will continue over the coming months to complete the scoping and commission the remaining work packages. The IGCB(N) will then consider all the evidence and determine what updates, if any, are advisable to the current guidance. Any revised guidance will be published by the IGCB(N) in due course.

## ACKNOWLEDGEMENTS

The author would like to thank the members of the Defra Noise and Statutory Nuisance Team and economists without whom this assessment would not be possible. The author would also like to acknowledge the input of the IGCB(N).

## References

1. Interdepartmental Group on Costs and Benefits Noise Subject Group, (IGCB(N)): <http://webarchive.nationalarchives.gov.uk/20130402224016/http://archive.defra.gov.uk/evidence/economics/igcb/index.htm>
2. Defra. [Environmental Noise: Valuing Impacts on: Sleep Disturbance, Annoyance, Hypertension, Productivity and Quiet](#). 2014.
3. The Interdepartmental Group on Costs and Benefits Noise Subject Group (IGCB(N)). [Noise & Health – Valuing the Human Health Impacts of Environmental Noise Exposure](#). 2010.
4. Department for Transport, Transport Analysis Guidance (webTAG): <http://www.gov.uk/guidance/transport-analysis-guidance-webtag>
5. HM Treasury, The Green Book – Appraisal and Evaluation in Central Government: <https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in->

[central-government](#)

6. WHO Regional Office for Europe. [Environmental Noise Guidelines for the European Region](#). 2018.
7. Int. J. Environ. Res. and Public Health. [Special Issue “WHO Noise and Health Evidence Reviews”](#). 2017.
8. Defra. [Noise Policy Statement for England](#). 2010.
9. RIVM. Study on Methodology to perform Environmental Noise and Health Assessment. 2018.
10. Int. J. Environ. Res. and Public Health. [WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Adverse Birth Outcomes](#). 2017.
11. Int. J. Environ. Res. and Public Health. [WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Annoyance](#). 2017.
12. PHE. [Estimation of costs to the NHS and social care due to the health impacts of air pollution](#). 2018.
13. Defra. [Estimating the Cost of Complaints about Noise Nuisance](#). 2012.