Environmental Research and Consultancy Department

ERCD REPORT 1209

Proposed methodology for estimating the cost of sleep disturbance from aircraft noise

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Summary

This report builds on significant work undertaken in the past decade by the WHO and the UK Government Interdepartmental Group on Costs and Benefits to propose a methodology for estimating the monetary cost due to sleep disturbance from aircraft noise. The impacts evaluated include the loss of productivity resulting from sleep disturbance, and the health impacts resulting from the increased risk of hypertension that can lead to acute myocardial infarction (heart attack), hypertensive strokes or dementia.

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Glossary of Terms

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AMI	Acute Myocardial Infarction, the medical term for a heart attack.
CAA	UK Civil Aviation Authority.
dB	Decibel units describing sound level or changes of sound level.
dBA	Levels on a decibel scale of noise measured using a frequency dependent weighting, which approximates the characteristics of human hearing. These are referred to as A-weighted sound levels.
DALY	Disability Adjusted Life Years.
DfT	Department for Transport.
DW	Disability Weighting.
ERCD	Environmental Research and Consultancy Department of the CAA.
%HSD	Percentage Highly Sleep Disturbed.
HSD	Number Highly Sleep Disturbed.
IGCB(N)	UK Government Interdepartmental Group on Costs and Benefits of environmental noise.
$L_{6.5, hour}$	An equivalent sound level of aircraft noise, measured over 6.5 hours from 2330 to 0600.
L_{day}	An equivalent sound level of aircraft noise, measured over 12 hours from 0700 to 1900.
L_{eq}	Equivalent sound level of aircraft noise, often called equivalent continuous sound level. L_{eq} is most often measured on the A-weighted scale, giving the abbreviation L_{Aeq}.
$L_{eq, 16hour}$	An equivalent sound level of aircraft noise, measured over 16 hours from 0700 to 2300.
L_{eve}	An equivalent sound level of aircraft noise, measured over 4 hours from 1900 to 2300.
L_{night}	An equivalent sound level of aircraft noise, measured over 8 hours from 2300 to 0700.
OR	Odds Ratio.
QALY	Quality Adjusted Life Years.
webTAG	The Department for Transport's Transport Analysis Guidance for modelling and appraisal of major transport schemes.
WHO	World Health Organisation.
YLD	Years of life with disability.
YLL	Years of life lost.

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1   Introduction

1.1   Background

1.1.1   This report has been commissioned by the Department for Transport as part of its first stage consultation on replacing the existing night flight regime at the designated London airports. This work is intended to feed into the Government's commitment to understanding the impacts of any proposed interventions in the private, public or third sectors, which includes estimating the full range of costs and benefits associated with such proposals.

1.1.2   The Department for Transport's appraisal framework for monetising the impacts of transport noise, webTAG, only addresses daytime noise and the annoyance it causes, and then only for road and rail sources. In the absence of a robust methodology for monetising the effects of daytime annoyance caused by aircraft noise, the DfT recommend aircraft noise annoyance is monetised using the methodology set out in webTAG for road and rail noise.

1.1.3   The effects of aircraft noise at night are somewhat different to daytime, thus the webTAG methodology is inappropriate for assessing the costs of changes to the night noise regime. The Department therefore asked the CAA to develop a methodology for the monetisation of the adverse effects of aircraft noise at night.

1.1.4   Work on quantifying and monetising the adverse effects of noise on people has progressed rapidly in the past decade as highlighted in a comprehensive literature review of the impacts of noise at night (Ref 1). This progress is best illustrated by the publication of the WHO Europe/EU Commission report on "Estimation of burden of disease from environmental noise" (Ref 2). This includes annoyance and sleep disturbance from aircraft noise, but also acute health impacts. Methodologies for establishing the monetary cost of acute health impacts are relatively well developed, since they are often used to demonstrate that health treatments are cost effective. These methodologies have been expanded to include noise related impacts that affect quality of life, but without acute health effects, e.g. daytime annoyance and night-time sleep disturbance. Whilst the WHO Burden of disease from environmental noise methodology focused on all environmental noise sources and day and night effects, the WHO methodology was applied in order to monetise the effects of night-time aircraft noise at London Heathrow airport in a study published by CE Delft in 2011 (Ref 3).

1.1.5   The proposed methodology set out in this report is based on the literature review of night-time noise impacts, the CE Delft report and the UK Government Interdepartmental Group on Costs and Benefits from Environmental Noise, IGCB(N) (Ref 4). It is considered to be consistent with the views of the IGCB(N).

1.2   Methodology Overview

1.2.1   It has long been recognised that noise exposure at night results in sleep disturbance, which leads to tiredness through sleep disruption and next day effects resulting in reduced work output or quality. More recently, it is now considered that noise exposure can lead to long-term health effects, such as hypertension, acute myocardial infarctions (heart attacks) and strokes and dementia and that these effects can be monetised (Figure 1). Some of these are considered to include changes in mortality. Whilst there is evidence of aircraft noise causing cognitive impairment in children the science is not considered mature enough to monetise those effects at this time.

Figure 1 Effects of night time noise exposure
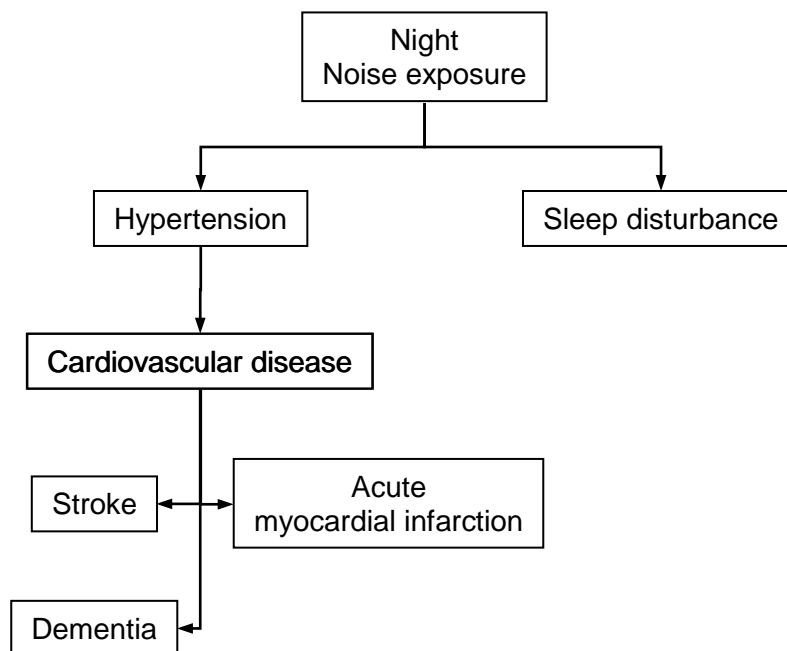
1.2.2   The following sections set out a framework for monetising the sleep disturbance and long-term health effects from noise exposure at night.

1.3   DALYs and QALYs

1.3.1   The WHO considers that disease can have two effects on human life. It can cause premature loss of life and secondly it can result in portions of life spent with a disability. For the latter case, the WHO has defined Disability Weighting (DW) in order to reflect the severity of living with a disability. This allows years of lost life and years living with a disability to be aggregated in a single value of Disability Adjusted Life Year (DALY). The DALY is therefore expressed as:

$$DALY = YLL + YLD \quad (1)$$

where:

YLL = Years of life lost
YLD = Years of life with disability

YLL is estimated as:

$$\text{YLL} = \text{impacted population} \times \text{mortality rate} \times \text{average loss of life per death} \quad (2)$$

YLD is estimated as:

$$\text{YLD} = (\text{impacted population}) \times \text{DW} \times \text{L} \quad (3)$$

where

DW is the disability weighting
L is the number of years assessed

1.3.2   DALY is normally calculated over a single year prior to monetising so that any monetary discount rates can be applied. Equation 2 remains valid since this is an estimate of morbidity within in a single year. However, in equation 3, L is therefore equal to one.

1.3.3   The concept is not new - it has been used in the medical field for many years in order to determine cost-effective treatment and prioritise health care needs. The monetary value is then estimated by placing a value on a single DALY.

1.3.4   In the UK it is standard practice in the area of life and health to use the concept of Quality Adjusted Life Year (QALY). Despite having a slightly different meaning to DALY, the IGCB(N) considers that WHO recommended DW values are valid for use in quantifying QALY (Ref 4). The IGCB(N) report also recommends that the UK value of a QALY is set £60,000, this value being a central estimate.

1.4   Assessment Period

1.4.1   In 2000 a working group of the European Commission defined four standard metrics that might be used for the assessment of environmental noise, L_{day}, L_{eve}, L_{night}, and L_{den}. All represent average annual day conditions in contrast to the historic summer average noise metric used in the UK for assessing aircraft noise. L_{day} represents the period 0700-1900, L_{eve} 1900-2300 and L_{night} 2300-0700. L_{den} is a composite metric of the 24 hour components with weightings or penalties added to the evening and night components. These indicators subsequently appeared in Directive 2002/49/EC (Ref 5) on the assessment and management of environmental noise.

1.4.2   Following on from this, the first round mapping of environmental noise was conducted across the EU in 2007 representing the exposure year 2006. Member States had to report information to the Commission in terms of L_{den} and L_{night}. This has resulted in a step change in available data on population noise exposure within Europe. As a result researchers are actively adopting these noise metrics in their health effects-based research.

1.4.3   At the London designated airports, night restrictions apply during both the night period (2300-0700) and the night quota period (2330-0600), with the most stringent restrictions applying to the latter period. Directive 2002/30/EC (Ref 6) makes it clear that the requirement is to assess the costs and benefits of proposed changes to operating restrictions. It is not an assessment of the total costs and benefits of night flights.

1.4.4　It is therefore proposed that the assessment period should relate to the policy being assessed, i.e. where it related to the 6.5 hour night quota period, this should be the assessment period. If the policy relates to the 8 hour night period, then the effects should be assessed over the 8 hour period. The annual average 8 hour night period noise exposure is defined L_{night}, however, there is no established noise exposure notation for 6.5 hour night quota period, therefore, for the purposes of this report, it will be referred to as $L_{6.5, hour}$.

1.5　Findings from the literature review

1.5.1　The literature review identified three effects resulting from noise exposure at night:

   a) Sleep disturbance
   b) Cardiovascular effects
   c) Cognitive impairment in children

1.5.2　Sleep disturbance primarily covers the loss of productivity due to next day sleepiness. Cardiovascular effects cover hypertension, ischemic heart disease (which includes myocardial infarction as well as other outcomes) and are considered to have direct health impacts. Cognitive impairment in children is considered to manifest itself as a loss in long-term productivity. The IGCB(N) second report suggests that a reduction in cognitive development could be seen to have a detrimental effect on the UK labour force and hence on the productivity of the economy. However, it considers that additional research is needed in order to develop a workable methodology for monetising the effects of cognitive impairment in children. Thus this effect is not considered.

1.5.3　Section 2, below, presents a proposed methodology for monetising the effects of sleep disturbance, whilst section 3 presents a proposed methodology for monetising cardiovascular disease. Section 4 describes how the methodology would be applied to assess the effect of a new policy measure.

2　Sleep disturbance

2.1　Summary of evidence

2.1.1　The literature review and the findings of the IGCB(N) are that night time noise exposure leads to direct sleep disturbance, i.e. awakenings and also biological changes, i.e. changes in sleep stages. This results in reduced quality of life and next day effects such as reduced performance.

2.2　Dose-response relationship

2.2.1　The WHO Europe Burden of Disease report (Ref 2) recommends the use of the Miedema relationship for estimating the number of people said to be Highly Sleep Disturbed (HSD), based on studies of self-reported sleep disturbance:

$$\%HSD = 18.147 - 0.956 \times L_{night} + 0.01482 \times L_{night}^2 \quad (4)$$

where L_{night} is the equivalent continuous noise level for an annual average 8 hour period 2300-0700 local.

2.2.2   The dose response function could be applied to each postcode or every individual
location, however, this would be very onerous as L_{night} is not normally calculated to
such precision. Conventionally noise exposure is defined in contour bands, e.g. 50-
54.9 dB, 55-59.9 dB etc. The dose response function may be applied to these bands
by assuming that on average the population within a band is exposed to the average
noise level for the band. This is a reasonable approximation as within relatively
narrow noise bands the population will generally approximate to a homogeneous
distribution. webTAG considers noise exposure in 1 dB increments for valuing
daytime noise and, whilst it is unlikely to add any meaningful precision, it is proposed
that the analysis is undertaken in 1 dB bands simply to be consistent with webTAG.

2.2.3   The Miedema noise response function for HSD is based on the 8 hour L_{night} from
2300-0700. Arguments can be put forward that the dose-response function for a $L_{6.5, hour}$ will be different. Sleep patterns are lighter at the start and end of the night so there
is evidence that the risk of being sleep disturbed during the 6.5 hour night quota
period will be lower than for the 8 hour night period for a given noise event. There is
also a contrary argument that disturbance during the night quota period could have a
more significant effect on sleep as result of it occurring during deeper periods of
sleep. On balance, and in the absence of data to contrary it is considered there is no
evidence to alter the dose-response function and thus $L_{6.5, hour}$ can be substituted in
equation 1 for L_{night}.

2.2.4   Miedema states that the dose-response function is valid over the range 45-70 L_{night}. It
is not normal practice to produce $L_{6.5, hour}$ or L_{night} contours down to 45 dBA, previous
consultations having assessed night quota period noise contours in steps of 3 dB
from 48 to 66 dBA L_{eq}. In practice, few, if any populations are exposed to night noise
above 66 dBA L_{eq}, the main issue, therefore, is the choice of the lower threshold.

2.2.5   The WHO Europe Night Noise Guidelines for Europe (Ref 7) suggest that sleep
disturbance effects are tending to occur at lower exposure levels, consequently, it
appears appropriate to extend the analysis down to 45 dBA and up to the highest
exposure level found (expected to be no greater than 70 dBA. The %HSD can then
be calculated for each mid-point $L_{6.5, hour}$ exposure level using equation 1.

2.2.6   The total number of people estimated as HSD is then calculated using:

$$\text{Total HSD} = \sum_{45.5}^{69.5} \%\text{HSD} \times \text{Population} \qquad (5)$$

2.2.7   Because of the potentially significant effect that the lower threshold may have on the
overall results, it is proposed to report costs down to both a 45 and a 48 dBA $L_{6.5, hour}$
lower threshold.

2.3   Disability weighting

2.3.1   The WHO Night Noise Guidelines for Europe note that the DW for primary insomnia is
0.1. For sleep disturbance due to environmental noise they conclude that DW lies in
the range 0.04-0.1 with a recommended value of 0.07. The IGCB(N) recommends
use of the WHO value. It is proposed that the three values, 0.04, 0.07 and 0.1 be
used to provide low, central and high estimates of the years of life with disability due
to sleep disturbance.

2.4 Monetary estimate

2.4.1 The scientific literature is clear that noise induced sleep disturbance does not result in premature death, therefore for sleep disturbance the term YLL is zero. The number of years of life lost due to disability from sleep disturbance per year of exposure is therefore given by:

$$YLD_{low} = \text{Total HSD} \times 0.04 \qquad (6a)$$

$$YLD_{central} = \text{Total HSD} \times 0.07 \qquad (6b)$$

$$YLD_{high} = \text{Total HSD} \times 0.1 \qquad (6c)$$

2.5 Uncertainty

2.5.1 The disability weightings identified in paragraph 2.3.1 represent a range of 2.5:1. Varying the noise threshold from 48 dBA $L_{6.5, hour}$ to 45 dBA $L_{6.5, hour}$ typically increases the population exposure by a factor of almost 2. Taking both together, monetary estimates of sleep disturbances will vary over a range of 5:1.

3 Cardiovascular disease

3.1 Summary of evidence

3.1.1 The WHO defines cardiovascular disease as encompassing hypertension and ischaemic heart disease, the latter of which also includes acute myocardial infarction (AMI). Whilst the precise pathway for noise-related cardiovascular disease is not known and possibly may never be known beyond doubt, it is generally considered that long-term noise exposure results in stress, leading to hypertension and ultimately cardiovascular disease.

3.1.2 Whilst the time of day of the exposure to noise may be a critical factor in acute health outcomes, the common availability of 24 hour exposure metrics has typically lead to a noise dose over 24 hour being assessed against specific health outcomes. A significant confounding factor here is that for most people noise exposure will vary considerably between the working day, and the evening and night periods (and weekends) which will generally be at a person's place of residence. The literature review highlighted that no studies have been undertaken that assessed only night-time exposure; studies have either been assessed against daytime noise exposure or 24 hour exposure. Because of the length of time it takes for the health outcomes to appear, it would not be feasible to design an experiment to separate out time of day effects such as has been done with sleep disturbance.

3.1.3 Despite this, the WHO Night Noise Guidelines for Europe (Ref 7) conclude that there is no reason to suggest that daytime cardiovascular effects are not present at night at least to the same degree. In the absence of night-time specific research, it therefore recommends application of daytime/24 hour research findings on a precautionary basis. It recommends using a threshold of 50 dB L_{night} for protection against cardiovascular disease, i.e. no effects are found below this level. Whilst not stated, it is plausible that exposure at the place of residence, during the evening and night-time is more relevant to acute health outcomes, and that L_{day} and L_{den} are simply acting as surrogate measures for the relevant noise exposure. It was the readily available nature of data in terms of L_{den} that caused it to be used rather than a specific hypothesis that L_{den} with its evening and night time weightings perfectly describes the

dose that causes the effect. Consequently, although in the case of L_{den}, one can calculate a change in L_{night} and its subsequent impact on L_{den}, It would almost certainly not reflect the change in residential noise exposure (primarily driven by L_{eve} and L_{night}).

3.1.4 An alternative approach might be to adjust the dose-response functions for the smaller duration of the exposure, correcting a 24 or 12 hour time period down to 8 hour or 6.5 hour. Analysis shows that at the designated airports, $L_{6.5\ hour}$ is highly correlated to L_{den} with a slope near unity, but with noise levels 13 to 16 dB lower. Further lowering the contribution to reflect the shorter exposure period would be inconsistent with the way these dose-response relationships have been derived. Thus, it is proposed that the noise exposure indicator $L_{6.5\ hour}$ or L_{night} be substituted for either L_{day} or L_{den}. By doing so, the proposed methodology is conservative.

3.2   Dose-response relationships

Acute Myocardial Infarction

3.2.1 The WHO Night Noise Guidelines for Europe proposes odds-ratios (ORs) for the increased risk of acute myocardial infarction due to noise exposure as:

<55 dB: 1.0
55-60 dB: 1.1
60-65 dB: 1.2

3.2.2 A more refined dose-response relationship defining the increased risk of AMI is given by Babisch (Ref 8):

$$OR_{AMI} = 1.629567 - 6.13 \times 10^{-4} \times L_{eq,16\ hour}{}^{2} + 7.36 \times 10^{-6} \times L_{eq,16\ hour}{}^{3} \quad (7)$$

3.2.3 As discussed in section 3.1 it is proposed that the exposure metric $L_{6.5\ hour}$ or L_{night} can be substituted for $L_{eq,16\ hour}$. Babisch proposes a low threshold of 55 dBA $L_{eq,16\ hour}$, i.e. no effects are found below this level. Assessing at 1 dB intervals, the centre-band values are 55.5 dB etc. to 69.5 dB and the number of additional AMI resulting from noise exposure is then given by:

$$\text{No. of AMI} = \left(\sum_{55.5}^{69.5} OR_{AMI} \times \text{Population} \right) \times \text{AMI risk} \quad (8)$$

3.2.4 The 2010 Mortality statistics reported 23,705 fatal cases of AMI in England and Wales from a population of 55.24 million. Taking into account the IGCB(N) risk of death from AMI as 72 percent, the AMI risk is estimated to be 5.9 per 10,000 (0.0596 percent) (Ref 9).

Hypertension

3.2.5 The IGCB(N) identified a possible dose-response function for hypertension of the form:

$$OR_{hypertension} = 0.013 \times L_{den} + 0.285 \quad (9)$$

3.2.6 Again, in the absence of data to contrary, it is considered that the noise exposure term L_{den} may be replaced with $L_{6.5,hour}$ or L_{night}. In contrast to AMI, the prevalence of hypertension is greater than ten percent of the population, such that the odds ratio

requires conversion into a relative risk, taking into account that the risk varies by age group and sex (Ref 10). This is further complicated by the fact that it considered that hypertension can also lead to different health outcomes, principally stroke and dementia.

3.2.7 Ref 10 proposes that the additional risk due to hypertensive related stroke for a y dBA increase above baseline levels is given as:

Additional risk of noise related hypertensive strokes =

$$0.001 \times \begin{bmatrix} 0.006188 \times \left(1.096^{y/10}-1\right) \\ +0.01887 \times \left(1.072^{y/10}-1\right) \\ +0.05322 \times \left(1.053^{y/10}-1\right) \\ +0.43392 \times \left(1.045^{y/10}-1\right) \\ +0.004773 \times \left(1.103^{y/10}-1\right) \\ +0.012063 \times \left(1.082^{y/10}-1\right) \\ +0.039823 \times \left(1.058^{y/10}-1\right) \\ +0.16292 \times \left(1.039^{y/10}-1\right) \\ +0.65852 \times \left(1.031^{y/10}-1\right) \end{bmatrix} \qquad (10)$$

3.2.8 Similarly, reference 10 presents the additional risk of hypertensive dementia for a y dBA increase in noise as:

Additional risk of noise related cases of hypertensive dementia =

$$0.001 \times \begin{bmatrix} 0.0614 \times \left(1.053^{y/10}-1\right) \\ +0.5951 \times \left(1.045^{y/10}-1\right) \\ +0.0622 \times \left(1.058^{y/10}-1\right) \\ +0.3126 \times \left(1.039^{y/10}-1\right) \\ +1.165 \times \left(1.031^{y/10}-1\right) \end{bmatrix} \qquad (11)$$

3.3   Disability weighting

3.3.1 The WHO Burden of Disease estimates the DW for AMI with survival as 0.405. Disability weighting varies with age group and sex for hypertensive related effects and these are incorporated directly into the monetary estimation process in section 3.4.

3.4   Monetary estimate

3.4.1 The IGCB(N) notes that there is a high risk of death from AMI, the UK estimate of the risk of death being 72 percent. Thus, a majority of AMI occurring due to noise exposure will therefore result in premature death and lost years, i.e. YLL is not zero for AMI.

3.4.2 The IGCB(N) identified that in the UK, where AMI was fatal, an average 11 years loss of life resulted (Ref 31 from IGCB(N) second report). However, not all of the impact of AMI is experienced in the first year. Because costs and benefits are accounted for

over longer periods of time, it is preferable to compress the impact of AMI into a single year. Simplistically, this would equate to 0.72 x 11 years, giving 7.92, however after taking into account discounting and uplifting, the mean disability weighting for AMI mortality in the year of occurrence is 7.94 (source Defra). The years of life lost due to premature death from AMI noise exposure is therefore given by:

$$YLL_{AMI} = \text{No. of AMI} \times 7.94 \quad (12)$$

3.4.3 The years lost due to disability are given by the number of noise-related AMI, the likelihood of surviving an AMI (0.28) and the WHO disability weighting after surviving an AMI (0.405):

$$YLD_{AMI} = \text{No. of AMI} \times 0.28 \times 0.405 \quad (13)$$

3.4.4 Because hypertension may lead to a range of health outcomes with a wide range of disability weightings, the second IGCB(N) report concluded that the uncertainty was so large that it was inappropriate to consider the monetisation of the effects of environmental noise on hypertension. However, more recent research in reference 10 proposes that is possible to monetise the effects of noise-related hypertension leading to hypertensive strokes and dementia.

3.4.5 The years lost due to noise related-related hypertensive strokes per person exposed to a y dBA increase above baseline levels from Ref 10 is:

$$\text{YLD per person}_{\text{hypertensive strokes}} = 0.001 \times \begin{bmatrix} 0.1402 \times \left(1.096^{y/10}-1\right) \\ +0.3175 \times \left(1.072^{y/10}-1\right) \\ +0.6118 \times \left(1.053^{y/10}-1\right) \\ +2.185 \times \left(1.045^{y/10}-1\right) \\ +0.1190 \times \left(1.103^{y/10}-1\right) \\ +0.2279 \times \left(1.082^{y/10}-1\right) \\ +0.5269 \times \left(1.058^{y/10}-1\right) \\ +1.344 \times \left(1.039^{y/10}-1\right) \\ +2.844 \times \left(1.031^{y/10}-1\right) \end{bmatrix} \quad (14)$$

3.4.6 The years lost lost due to hypertensive related dementia per person exposed to a y dBA increase above baseline levels from Ref 10 is:

$$\text{YLD per person}_{\text{hypertensive dementia}} = 0.001 \times \begin{bmatrix} 0.8552 \times \left(1.053^{y/10}-1\right) \\ +3.567 \times \left(1.045^{y/10}-1\right) \\ +1.100 \times \left(1.058^{y/10}-1\right) \\ +3.295 \times \left(1.039^{y/10}-1\right) \\ +5.095 \times \left(1.031^{y/10}-1\right) \end{bmatrix} \quad (15)$$

3.4.7   The number of additional cases of hypertensive strokes and hypertensive dementia
are then given by the following equations:

$$\text{Total YLD}_{\text{hypertensive strokes}} = \left(\sum_{55.5}^{69.5} \text{YLD}_{\text{hypertensive strokes}} \times \text{Population} \right) \qquad (16)$$

$$\text{Total YLD}_{\text{hypertensive dementia}} = \left(\sum_{55.5}^{69.5} \text{YLD}_{\text{hypertensive dementia}} \times \text{Population} \right) \qquad (17)$$

4   Application

4.1.1   **Figure 2** presents a flow diagram of the calculation process. The starting points are
night-time operations for the baseline and with proposed new policy measures. From
these, night-time noise exposure contours are computed. For sleep disturbance and
AMI, the impacts are quantified separately and the change of impact is simply the
difference between the baseline and policy option costs.

4.1.2   In case of hypertensive stroke and dementia, the methodology requires change in
noise exposure as an input. From this the number of additional cases of hypertensive
stroke and dementia are estimated, the corresponding QALYs and finally the
additional costs for stroke and dementia respectively. The total cost for the proposed
policy measure is then the sum of the change in costs for sleep disturbance, AMI, and
hypertensive stroke and dementia.

4.1.3   Initial analysis suggests that the monetary values associated with sleep disturbance
are substantially larger than those for the acute health effects. Noting that the sleep
disturbance dose-response function has been derived from studies of self-reported
sleep disturbance, it possible that the effects and monetary values are over-
estimated. Sensitivity analysis of both the lower sleep disturbance threshold and the
disability weighting should provide some insight into how sensitive critical
assumptions are.

Figure 2 Assessment calculation process
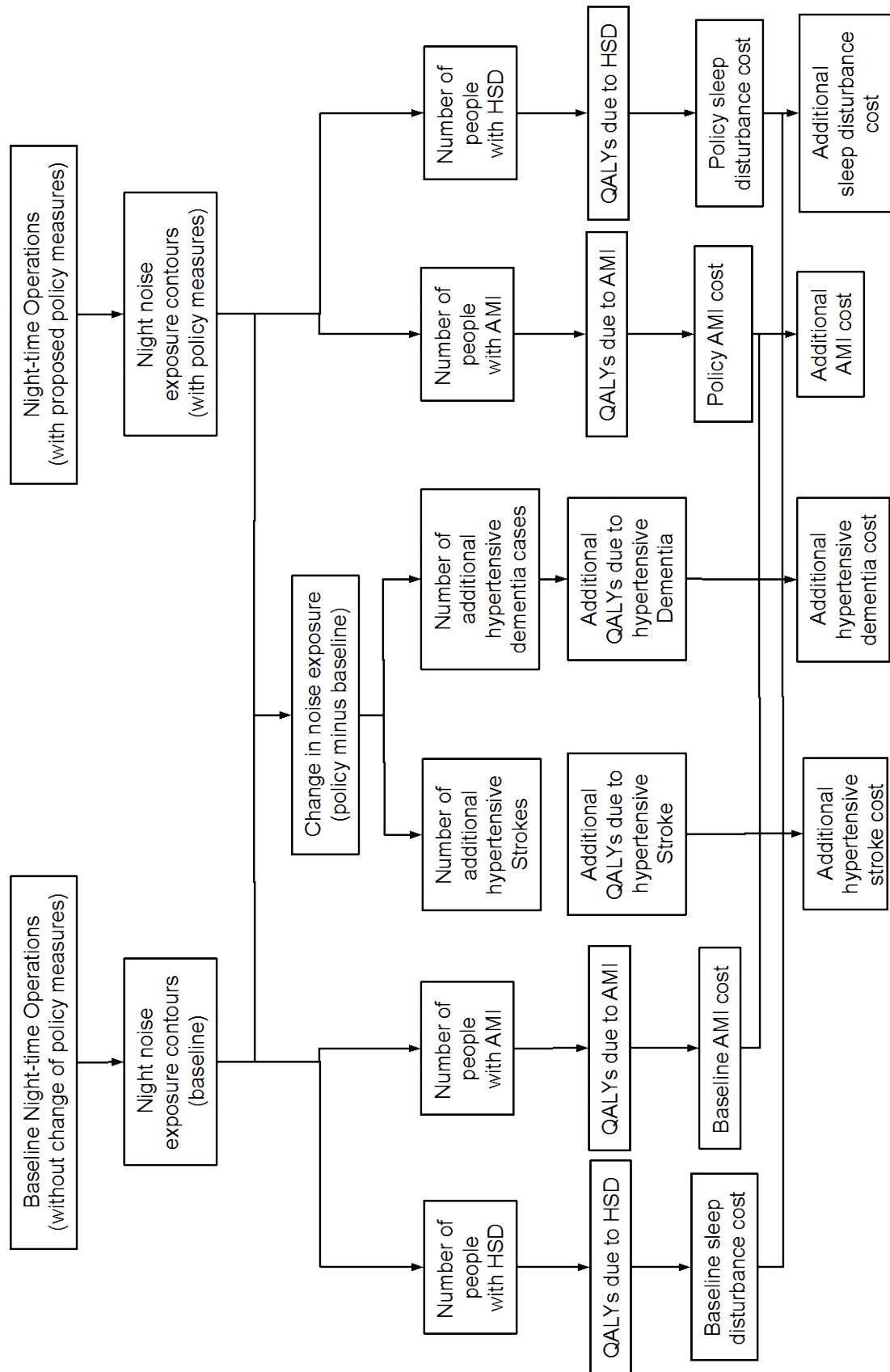
5   Conclusions

5.1.1   As noted earlier this work is intended to feed into the Government's commitment to understanding the impacts of any proposed interventions in the private, public or third sectors, which includes estimating the full range of costs and benefits associated with such proposals. This report takes evidence from the ERCD literature review of noise, sleep disturbance and health effects, along with the significant work published by the WHO and the UK Interdepartmental Group on Costs and Benefits on environmental noise, IGCB(N) and proposes a methodology for the monetary evaluation of the impacts of aircraft noise during the night quota period.

5.1.2   The impacts evaluated include loss of productivity resulting from sleep disturbance, the health impacts resulting from the increased risk of hypertension that can lead to acute myocardial infarction (heart attack), hypertensive strokes or dementia.

5.1.3   Whilst there is still uncertainty surrounding the links between environmental noise and acute health effects, the IGCB(N) has concluded that the science is mature enough to include monetary estimation of the effects of sleep disturbance and acute myocardial infarction. Evidence is due to be put to the Committee that the science has developed sufficiently also to include monetary impact of noise on hypertensive strokes and dementia and hence the methodology has been included here for completeness. The IGCB(N), however considers that the science is not robust enough to monetise the cognitive impairment in children at this time. This is not considered significant, since these costs are expected to be significantly lower than the costs associated with sleep disturbance.

5.1.4   To reflect uncertainty, especially in sleep disturbance costs, the methodology considers a range of values for critical parameters, however, this is likely to lead to a wide range in estimated costs.

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