

Noise and Health: Tools for Assessing Night Noise Impact

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Director

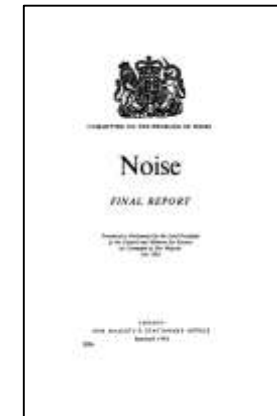
Stephen Turner Acoustics Limited

Wilson Report

- Para 117:

Situation	Day (dB(A))	Night (dB(A))
Country Areas	40	30
Suburban Areas away from main traffic routes	45	35
Busy Urban Areas	50	35

- “A very tentative estimate is that the following levels inside living rooms and bedrooms should not be exceeded for more than ten percent of the time”

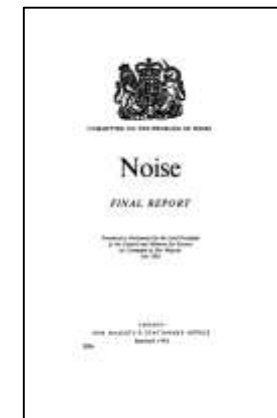


Observations

- Para 117:

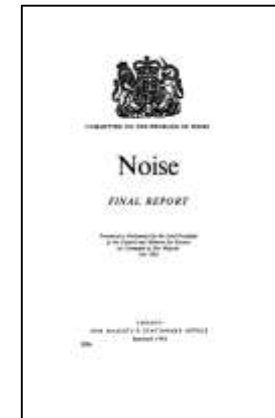
Situation	Day (dB(A))	Night (dB(A))
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- L_{A10} values
- No single figure – depends on location (context)
- Night is 10 dB lower than daytime but with a maximum value.



What would be the effect?

- Based on existing levels.
- Number of people seriously disturbed since 1948 had gone up
- Therefore “some reduction in the present levels to give **more** acceptable conditions”
- Estimated that if achieved would be worth a 5 dB reduction
- More information in Appendix V



Wilson Appendix V

- Recognised individual variability in response
- “The classification given in Paragraph 117 takes some account of these variables in a simplified form. The aim is towards values acceptable to the majority”
- “It is impossible to give accurate figures of what is meant by “the majority” of people being satisfied by the present suggested levels, but the aim is to **include 70 – 75% of people**”

Greater London Council Guidelines

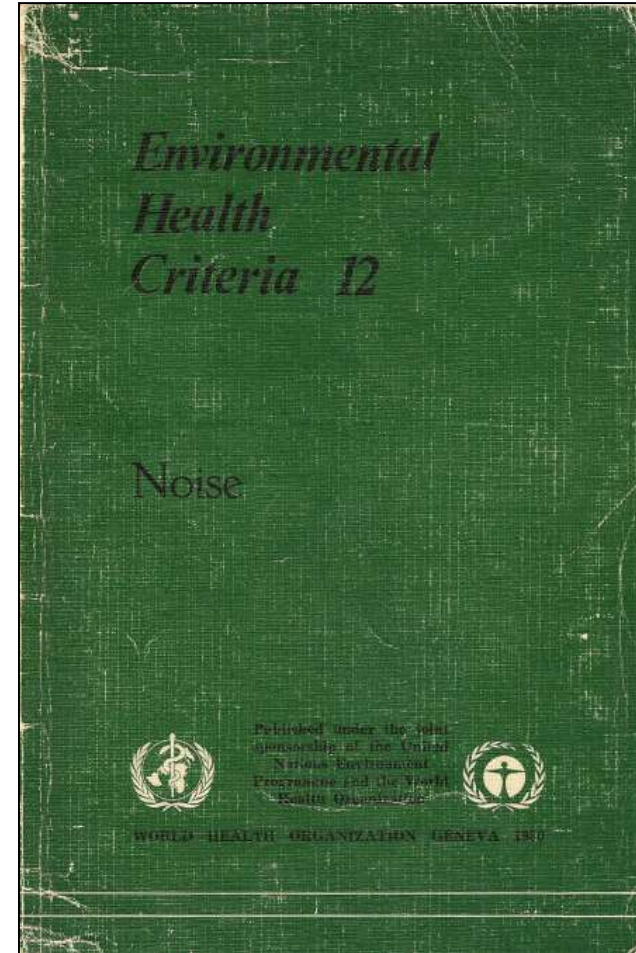
- Design Standard for New Housing
- 35 dB(A) night. (22.00 – 24.00 hrs) (L_{10} internal)
- Focused on the hours when people were trying to fall asleep
- In practice a pragmatic approach adopted and 40 dB(A) often used



WHO:

Environmental Health Criteria 12 (1980)

- Based on the limited data available, a level of less than 35 dB(A) is recommended to preserve the restorative process of sleep.
- L_{Aeq}



Move to L_{Aeq}

- For traffic
- $L_{Aeq} = L_{A10} - 3.$
- So 3 dB(A) higher than Wilson in urban and suburban areas

Guidelines for Community Noise – Table 4.1

Table 4.1: Guideline values for community noise in specific environments.

Specific environment	Critical health effect(s)	LAeq [dB]	Time base [hours]	LAmx, fast [dB]
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	
Inside bedrooms	Sleep disturbance, night-time	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60

Guidelines for Community Noise – Table 4.1 – Accompanying Text

- Where noise is continuous, the equivalent sound pressure level should not exceed 30 dBA indoors, **if negative effects on sleep are to be avoided.**
- So no adverse effects at that level?

Guidelines for Community Noise – Table 4.1 – Accompanying Text

- If the noise is not continuous, LAmax or SEL are used to indicate the probability of noise induced awakenings.
- Effects have been observed at individual LAmax exposures of 45 dB or less. Consequently, it is **important to limit the number of noise events** with a LAmax exceeding 45 dB.
- Therefore, the guidelines should be based on a combination of values of 30 dB LAeq,8h and 45 dB LAmax.

Guidelines for Community Noise — LAmax at Night

- For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB LAmax more than 10–15 times per night.
(Para 3.4 of the Guidelines)
- No adverse effect below 45 dB LAmax
- Probably no adverse effect if not exceeded too much and too often

BS 8233:1999 – Table 5

Table 5 — Indoor ambient noise levels in spaces when they are unoccupied

Criterion	Typical situations	Design range $L_{Aeq,T}$ dB	
		Good	Reasonable
Reasonable industrial working conditions	Heavy engineering	70	80
	Light engineering	65	75
	Garages, warehouses	65	75
Reasonable speech or telephone communications	Department store	50	55
	Cafeteria, canteen, kitchen	50	55
	Wash-room, toilet	45	55
	Corridor	45	55
Reasonable conditions for study and work requiring concentration	Library, cellular office, museum	40	50
	Staff room	35	45
	Meeting room, executive office	35	40
Reasonable listening conditions	Classroom	35	40
	Church, lecture theatre, cinema	30	35
	Concert hall, theatre	25	30
	Recording studio	20	25
Reasonable resting/sleeping conditions	Living rooms	30	40
	Bedrooms ^a	30	35

^a For a reasonable standard in bedrooms at night, individual noise events (measured with F time-weighting) should not normally exceed 45 dB L_{Amax} .

Table 5 - Footnote

Table 5 — Indoor ambient noise levels in spaces when they are unoccupied

Criterion	Typical situations	Design range $L_{Aeq,T}$ dB	
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Reasonable industrial working conditions	Heavy engineering	70	80
	Light engineering	65	75
	Garages, warehouses	65	75
Reasonable speech or telephone communications	Department store	50	55
	Cafeteria, canteen, kitchen	50	55
	Wash-room, toilet	45	55
	Corridor	45	55
Reasonable conditions for study and work requiring concentration	Library, cellular office, museum	40	50
	Staff room	35	45
	Meeting room, executive office	35	40
Reasonable listening conditions	Classroom	35	40
	Church, lecture theatre, cinema	30	35
	Concert hall, theatre	25	30
	Recording studio	20	25
Reasonable resting/sleeping conditions	Living rooms	30	40
	Bedrooms ^a	30	35
^a For a reasonable standard in bedrooms at night, individual noise events (measured with F time-weighting) should not normally exceed 45 dB L_{Amax} .			

Guidelines for Community Noise – Table 4.1

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	Wash-room, toilet	45	55
	Corridor	45	55
Reasonable conditions for study and work requiring concentration	Library, cellular office, museum	40	50
	Staff room	35	45
	Meeting room, executive office	35	40
Reasonable listening conditions	Classroom	35	40
	Church, lecture theatre, cinema	30	35
	Concert hall, theatre	25	30
	Recording studio	20	25
Reasonable resting/sleeping conditions	Living rooms	30	40
	Bedrooms ^a	30	35
^a For a reasonable standard in bedrooms at night, individual noise events (measured with F time-weighting) should not normally exceed 40 dB L_{Amax} .			

good

BS 8233:2014

- “Guidance” not a “Code of Practice”
- From the Foreword:

Use of this document

- As a guide, this British Standard takes the form of guidance and recommendations.
- It should not be quoted as if it were a specification or a code of practice and **claims of compliance cannot be made to it.**



BS8233:2014

- It is desirable that the internal ambient noise level does not exceed the guideline values in Table 4.*

Table 4 Indoor ambient noise levels for dwellings

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq,16hour}$	—
Dining	Dining room/area	40 dB $L_{Aeq,16hour}$	—
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

- No more “good” and “reasonable”

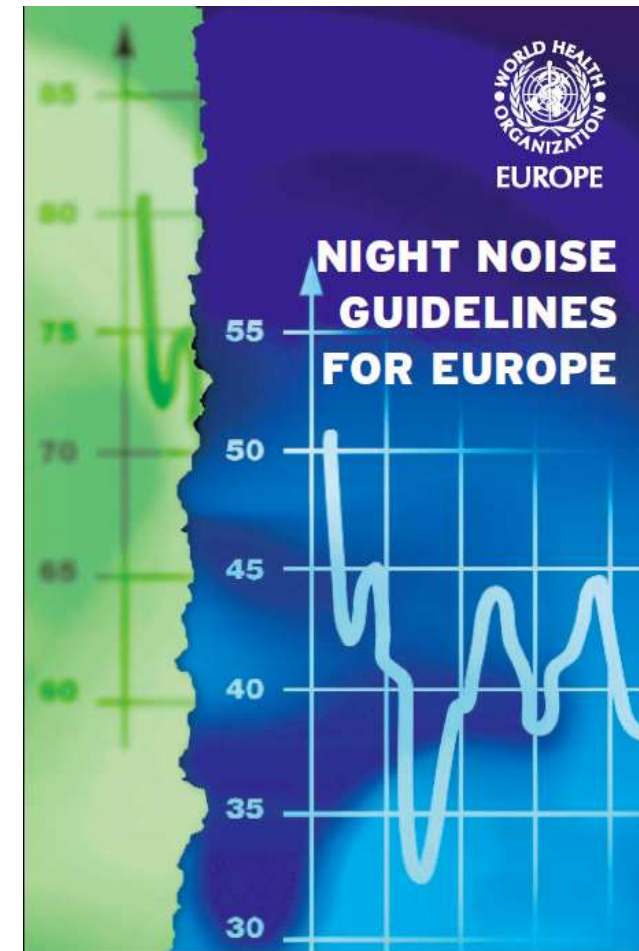
BS 8233:2014 – Table 4 – Note 7

- *Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may **be relaxed by up to 5 dB and reasonable internal conditions still achieved.***
- No mention of an L_{Amax} value in this context
- Table 4 values LOAEL?

WHO

Night Noise Guidelines for Europe

Average night noise level over a year $L_{\text{night, outside}}$	Health effects observed in the population
Up to 30 dB	Although individual sensitivities and circumstances may differ, it appears that up to this level no substantial biological effects are observed. $L_{\text{night, outside}}$ of 30 dB is equivalent to the no observed effect level (NOEL) for night noise.
30 to 40 dB	A number of effects on sleep are observed from this range: body movements, awakening, self-reported sleep disturbance, arousals. The intensity of the effect depends on the nature of the source and the number of events. Vulnerable groups (for example children, the chronically ill and the elderly) are more susceptible. However, even in the worst cases the effects seem modest. $L_{\text{night, outside}}$ of 40 dB is equivalent to the lowest observed adverse effect level (LOAEL) for night noise.
40 to 55 dB	Adverse health effects are observed among the exposed population. Many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected.
Above 55 dB	The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed. There is evidence that the risk of cardiovascular disease increases.



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40 to 55 dB	Adverse health effects are observed among the exposed population. Many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected.
Above 55 dB	The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed. There is evidence that the risk of cardiovascular disease increases.

Annual Average Free-field at the facade

No Observed Effect Level

Lowest Observed **Adverse** Effect

Increasingly defined as SOAEL

WHO:

Night Noise Guidelines for Europe

- L_{Amax}
- On the basis of the present available evidence we propose to assume that
 $NOAEL_{Amax} = 42 \text{ dB(A)}$ (page 99)
- Threshold of any adverse effect.

So – what is the impact from events?

- Basner approach
- Probability of a noise induced awakening
- Leading the likely number of such awakenings

Probability of 'Awakening'

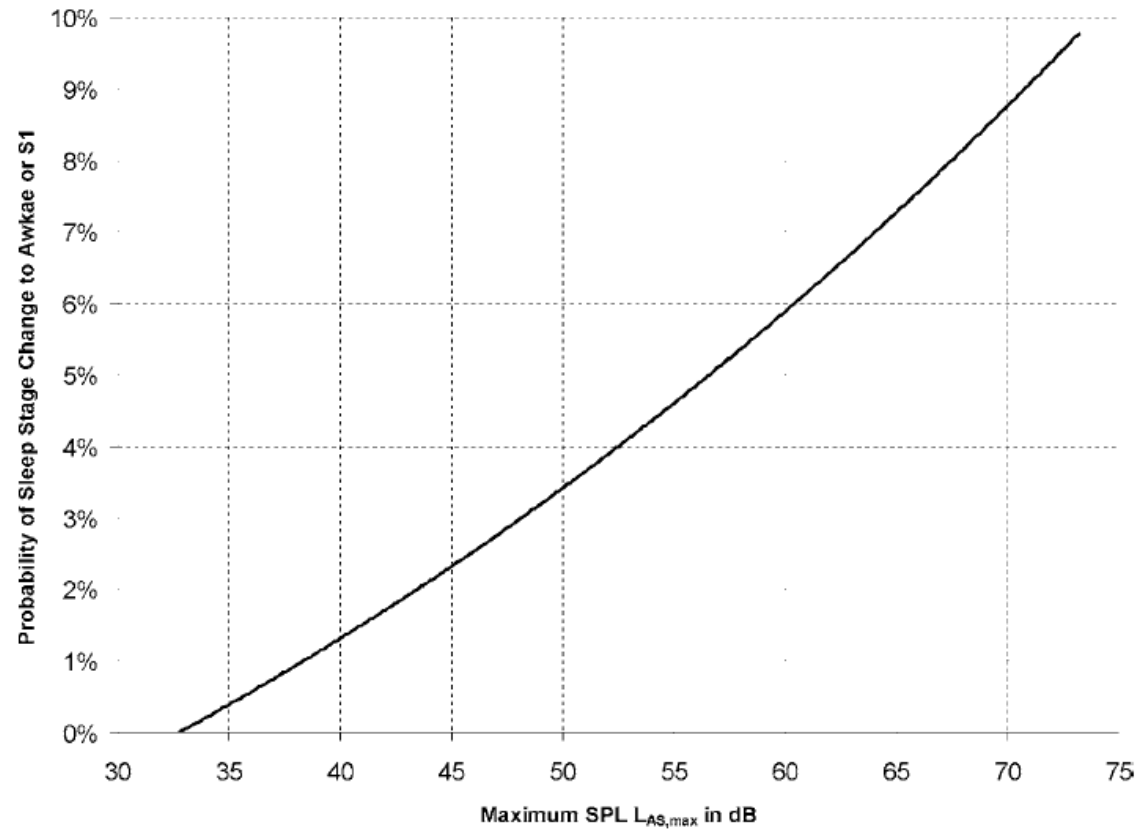


FIG. 2. Probability of aircraft-noise-induced awakenings depending on maximum SPL of ANEs. First reactions occur above maximum SPLs of 32.7 dB. This threshold exceeds the assumed background noise level of 27.1 dB only by 5.6 dB.

Noise Induced 'Awakenings'

- Estimated number of events needed that would be likely to cause one additional noise induced awakening
- Threshold of some effect around 32 dB(A)

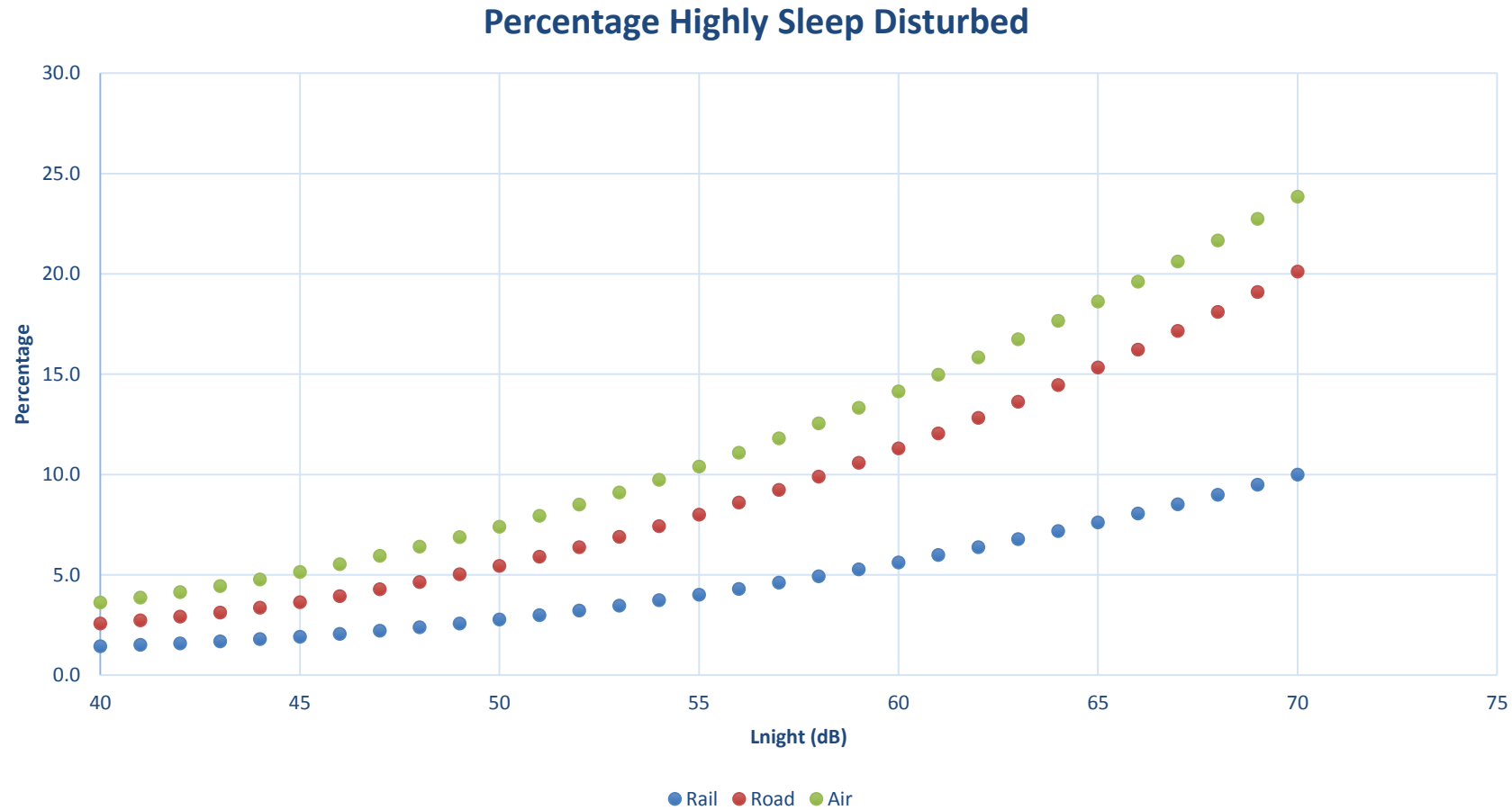
L_{ASmax}	N
40	77
45	43/44
50	29/30
55	21/22
60	17
65	13/14
70	11/12

Example

- From external measurements:
- Estimated the number of events and the maximum level
- For various window configurations estimated the impact

Location	Glazing System	Number of Additional awakenings
Internal	Open window	1.3
Internal	Poorly fitting closed single glazing	1.0
Internal	Good fitting closed single glazing	0.7
Internal	Standard good fitting closed double glazed unit	0.4

Percentage Highly Sleep Disturbed



TAG Data Book March 2017 (July 2016)

webtag-databook-march-2017-release-v1-7 (Compatibility Mode) - Excel

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Department for Transport

WebTAG Table A 3.1

Noise

This version: Spring 2016 release v1.6

Links: Contents WebTAG v1.3.2 WebTAG v1.3.1

Parameters: Price year: 2010 Value year: 2010

Sheet Navigator:

Notes: These values are sourced from Delta research and guidance, embodied in their 'Transport Noise Modelling Tool' spreadsheet, available at: <https://www.southcoastnoise.co.uk/pollution-economic-analysis>. Values for daytime noise impacts are sourced from the 'Marginal values' sheet, based on central QALY valuation and Disability Weight assumptions, and the highly annoyed response function. Values have been converted from a 2014 to 2010 price base and, for road values, converted from LA10, 10hr to LAeq, 10hr by a factor of -2.82(A) in line with Delta guidance. Daytime measures for rail and aviation noise are assumed to be equivalent. Values for sleep disturbance are sourced from the 'Sleep disturbance summary' sheet, and are given against the LAeq, 10hr metric. For road-based sleep disturbance only, the transition between daytime and nighttime noise measures is sufficiently reliable for sleep disturbance impacts to be estimated from daytime noise measures. Therefore, for road only, sleep disturbance values are also given against the LAeq, 10hr metric, sourced from the 'Marginal values' sheet and converted from LA10, 10hr.

Valuation of changes in noise level is calculated by multiplying the value for the source year by the ratio of GDP deflators and the growth in GDP per capita.

Databook source worksheets: User Parameters, Default Parameters, Annual Parameters, Noise

WebTAG v1.3.2 (Tables 1 and 2)

Table A 3.1: Monetary valuation of changes in noise level

L _{night} (dB(A))		Road				Rail				Aviation				Sleep disturbance values against LAeq (per household, 2010 prices, 2010 values)	
Low	High	Amenity	Direct A88	Stroke	Dementia	Amenity	Direct A88	Stroke	Dementia	Amenity	Direct A88	Stroke	Dementia	Low	High
45	46	£10.05	£0.00	£0.00	£0.00	£3.48	£0.00	£0.00	£0.00	£13.87	£0.00	£0.00	£0.00	45	46
46	47	£10.23	£0.00	£0.00	£0.00	£3.51	£0.00	£0.00	£0.00	£13.74	£0.00	£0.00	£0.00	46	47
47	48	£10.53	£0.00	£2.31	£3.50	£3.05	£0.00	£0.00	£0.00	£17.60	£0.00	£0.00	£0.00	47	48
48	49	£10.94	£0.00	£2.32	£3.51	£3.91	£0.00	£0.00	£0.00	£19.45	£0.00	£0.00	£0.00	48	49
49	50	£11.47	£0.00	£2.32	£3.52	£3.00	£0.00	£0.00	£0.00	£21.28	£0.00	£0.00	£0.00	49	50
50	51	£12.11	£0.00	£2.33	£3.53	£3.00	£0.00	£0.00	£0.00	£23.10	£0.00	£0.00	£0.00	50	51
51	52	£12.06	£0.00	£2.34	£3.53	£3.31	£0.00	£0.00	£0.00	£24.90	£0.00	£4.51	£6.42	51	52
52	53	£13.72	£0.00	£2.34	£3.54	£22.83	£5.99	£0.00	£2.53	£26.70	£0.00	£4.53	£8.85	52	53
53	54	£14.79	£0.00	£2.35	£3.55	£24.90	£6.77	£0.00	£2.54	£28.48	£0.00	£4.56	£8.87	53	54
54	55	£15.79	£0.00	£2.35	£3.56	£26.96	£7.67	£0.00	£2.55	£30.24	£0.00	£4.58	£8.90	54	55
55	56	£16.99	£0.00	£2.36	£3.56	£29.03	£8.66	£0.00	£2.55	£31.99	£0.00	£4.60	£8.93	55	56
56	57	£18.39	£1.38	£2.36	£3.57	£31.09	£9.73	£0.00	£2.56	£33.73	£0.00	£4.62	£8.96	56	57
57	58	£19.73	£2.72	£2.37	£3.58	£33.16	£10.90	£0.00	£2.57	£35.46	£0.00	£4.65	£9.00	57	58
58	59	£21.27	£3.87	£2.38	£3.59	£35.22	£12.30	£1.38	£2.57	£37.17	£1.38	£4.67	£9.02	58	59
59	60	£22.93	£5.24	£2.38	£3.60	£37.29	£13.73	£2.73	£2.58	£38.88	£2.73	£4.69	£9.05	59	60
60	61	£24.69	£6.24	£2.39	£3.60	£39.35	£15.28	£3.87	£2.59	£40.55	£3.87	£4.72	£9.07	60	61

Ready

BS 4142

The Test (1997)

- Assess the likelihood of complaints by subtracting the measured background noise level from the rating level.
- NOTE. More than one assessment may be appropriate.
- The greater this difference the greater the likelihood of complaints.
- A difference of around +10 dB or more indicates that complaints are likely.
- A difference of around + 5 dB is of marginal significance.
- If the rating level is more than 10 dB below the measured background noise level then this is a positive indication that complaints are unlikely.

Assessment Outcome (2014)

- Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level (see Clause 8) from the rating level (see Clause 9), and consider the following.
- *NOTE 1 More than one assessment might be appropriate.*
- a) Typically, the greater this difference, the greater the magnitude of the impact.
- b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, **depending on the context.**
- c) A difference of around +5 dB is likely to be an indication of an adverse impact, **depending on the context.**
- d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, **depending on the context.**

Context – Clause 11

Where the initial estimate of the impact needs to be modified due to the context, take all pertinent factors into consideration, including the following.

- **Absolute level of sound**
- Character of specific and residual sound
- Sensitivity of receptor / **existence of building envelope insulation**

BS 4142:2014 – Night Noise

- Probably no justification for solely considering the external difference between rating and background.

Conclusions

- Various guidance values exist
- Essential to be totally clear over the meaning of those values and the consequential effect expected
- Then policy can be applied
- Evidence continuing to emerge regarding adverse effects and significant adverse effects

Thank You

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