ANC Company Meeting 21st January 2025
Jack Harvie-Clark

BS 8233:2014

BSI Standards Publication

Proposed updates

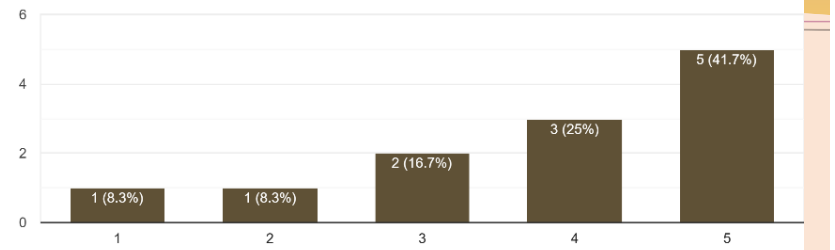
Guidance on sound insulation and noise reduction for buildings

Introduction

- How the proposals change:
  - What we do
  - How we understand what we do
- Your priorities

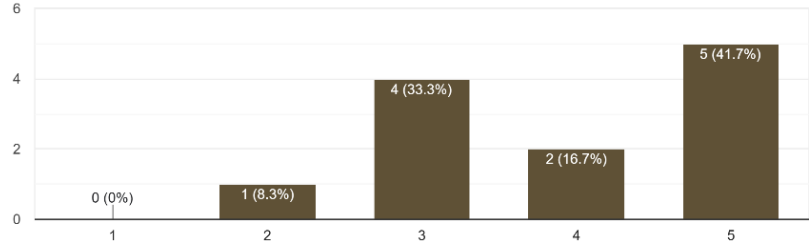
The WHO 2018 Guidelines refer to the WHO 1999 Guidelines for internal levels: why don't we follow this advice?

12 responses



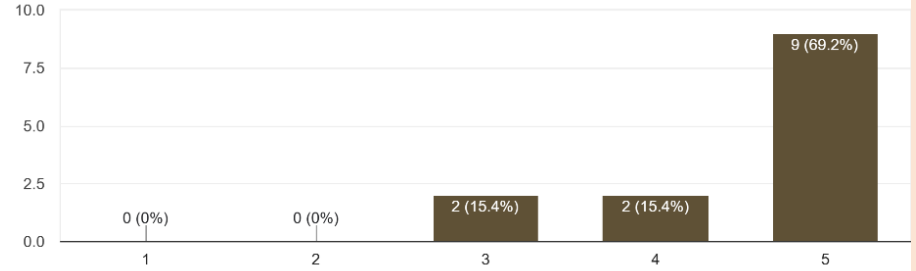
The proposals only cover limited sources of (transportation) sound, so they are not as useful as the WHO 1999 Guidelines

12 responses



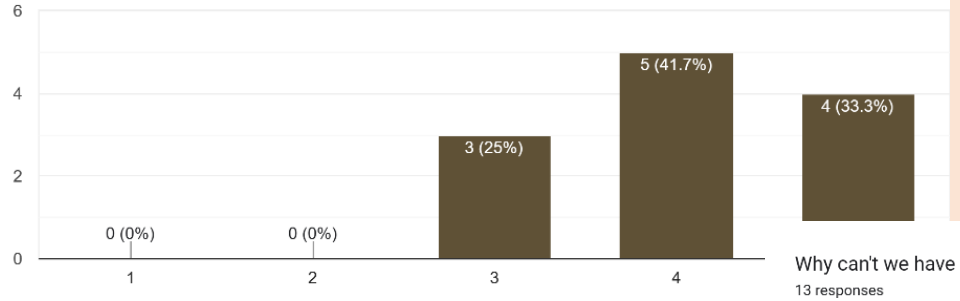
We need guidance that includes criteria for Lmax

13 responses



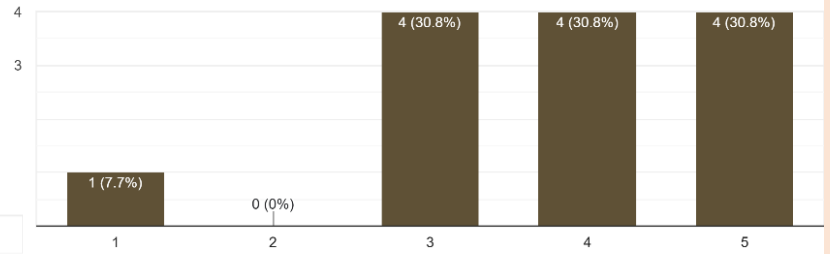
Explanation of how the proposals are consistent with ProPG

12 responses



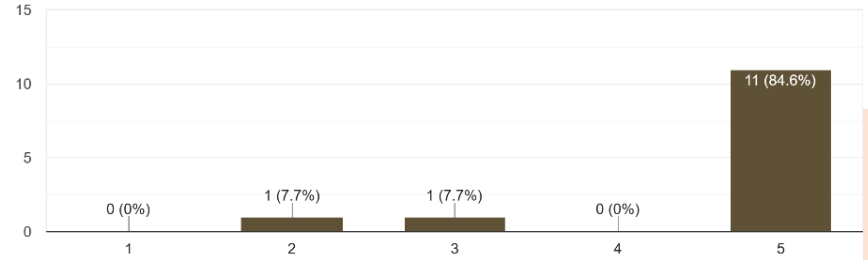
Why do the proposals use L_den and L_night?

13 responses



Why can't we have internal level targets rather than facade sound insulation criteria?

13 responses



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Current & proposed practice

- Current

NOISE RISK ASSESSMENT	POTENTIAL EFFECT WITHOUT NOISE MITIGATION	PRE-PLANNING APPLICATION ADVICE
Indicative Daytime Noise Levels $L_{Aeq,16hr}$ / Indicative Night-time Noise Levels $L_{Aeq,8hr}$		
High / 70 dB / 60 dB	Increasing risk of adverse effect	High risk t grou good a det expe As n suita appli desig ADS will b dem will b At lo from desig an A nois deve
Medium / 65 dB / 55 dB		
60 dB / 50 dB		
Low / 55 dB / 45 dB		
50 dB / 40 dB		
Negligible	No adverse effect	These noise levels indicate that the development site is likely to be acceptable from a noise perspective, and the application need not normally be delayed on noise grounds.

STAGE 2: FULL ASSESSMENT – THE FOUR KEY ELEMENTS

Stage 2: Element 1 – Good Acoustic Design Process

Stage 2: Element 2 – Internal Noise Level Guidelines

Stage 2: Element 3 – External Amenity Area Noise Assessment

Stage 2: Element 4 – Assessment of Other Relevant Issues

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Guidance on sound insulation and noise reduction for buildings

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 $L_{Aeq,8hour}$

- Proposed

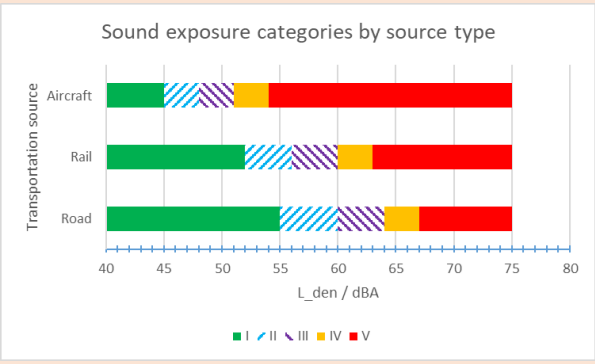
STAGE 2: FULL ASSESSMENT – THE FOUR KEY ELEMENTS

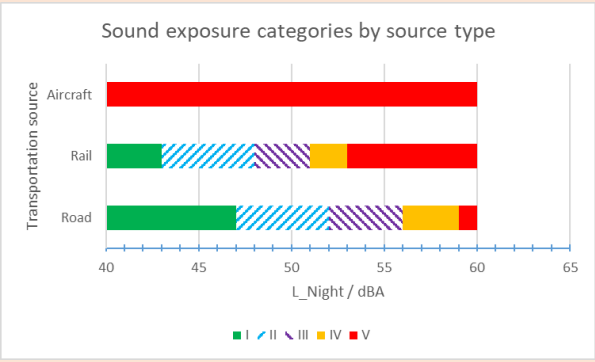
Stage 2: Element 1 – Good Acoustic Design Process

Stage 2: Element 2 – Internal Noise Level Guidelines

Stage 2: Element 3 – External Amenity Area Noise Assessment

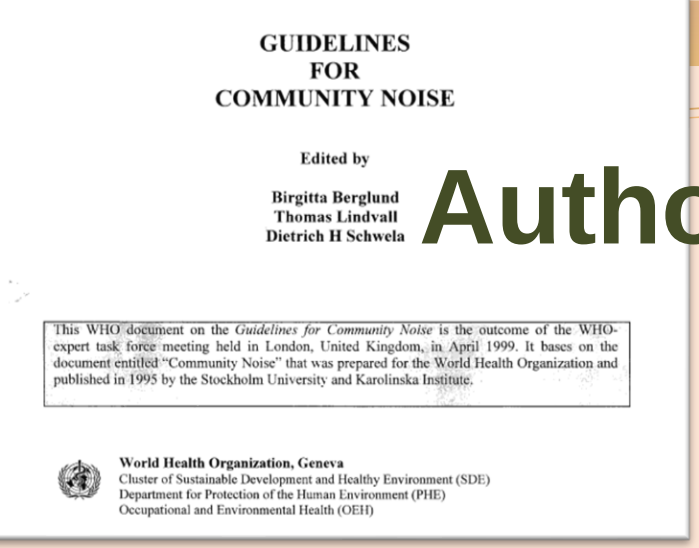
Stage 2: Element 4 – Assessment of Other Relevant Issues





External sound category	Façade sound insulation, $D_{nT,A,tr}$ / dB I	II	III	IV	V	Internal level target L_{den} / dBA
Road traffic	≥ 30	≥ 30	≥ 32	≥ 35	≥ L_{den} - 32	≤ 35
Railway traffic					≥ L_{den} - 28	≤ 31
Air traffic					≥ L_{den} - 19	≤ 22

Authoritative v.s Evidential Guidance


GUIDELINES
FOR
COMMUNITY NOISE

Edited by

Birgitta Berglund
Thomas Lindvall
Dietrich H Schwela

This WHO document on the *Guidelines for Community Noise* is the outcome of the WHO-expert task force meeting held in London, United Kingdom, in April 1999. It bases on the document entitled "Community Noise" that was prepared for the World Health Organization and published in 1995 by the Stockholm University and Karolinska Institute.

World Health Organization, Geneva
Cluster of Sustainable Development and Healthy Environment (SDE)
Department for Protection of the Human Environment (PHE)
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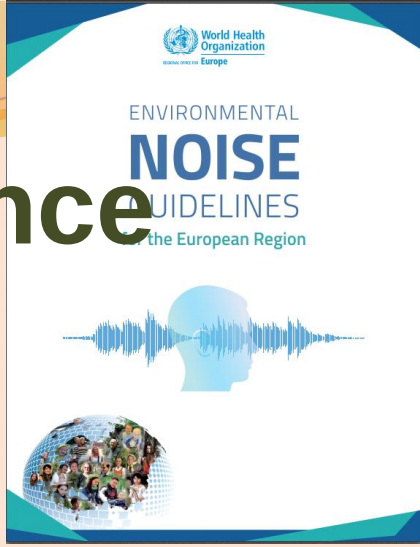

WHO 1999

- Based primarily on expert judgment and opinion
- Relies on limited studies and empirical observations
- Focuses on specific measurable parameters (e.g. speech intelligibility at 35 dBA)
- May oversimplify complex relationships between noise and health
- No opportunity to question the meaning of:
  - "Steady, continuous, … etc"
  - Deviation from the proscribed levels (e.g. what is the effect at + 3 dB?)

WHO 2018

- Uses systematic review of epidemiological evidence
- Large-scale population studies over extended periods
- Accounts for multiple health outcomes and pathways
- Incorporates both direct (biological) and indirect (psychological) effects
- Based on real-world living conditions and experiences
- Considers context-specific factors (different noise sources have different health impacts)
- Underlying evidence can be reviewed and updated

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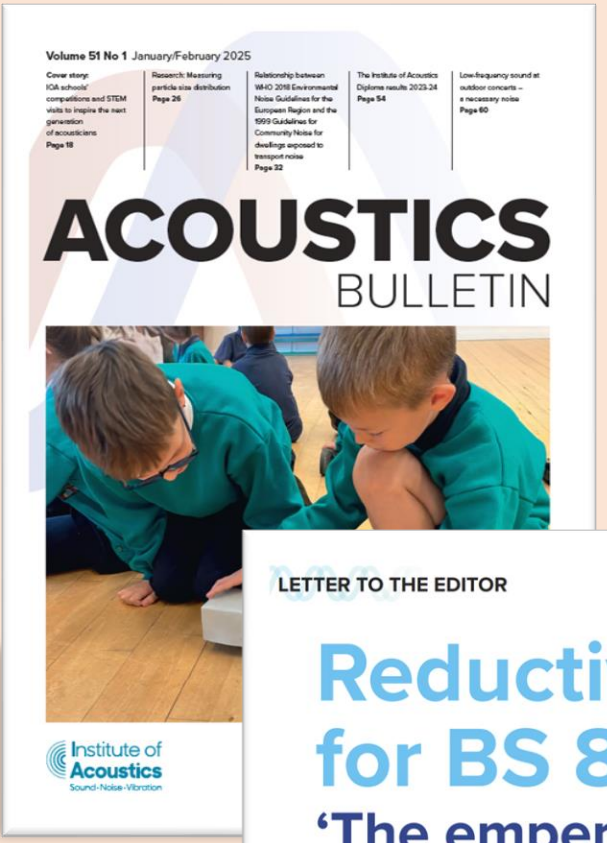
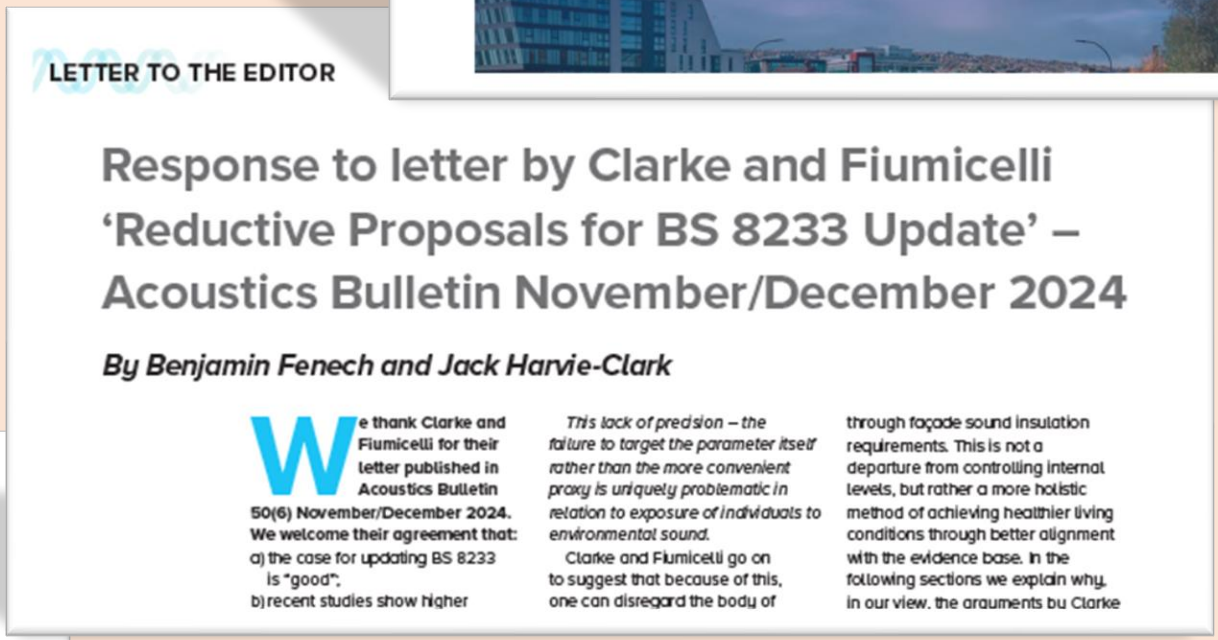
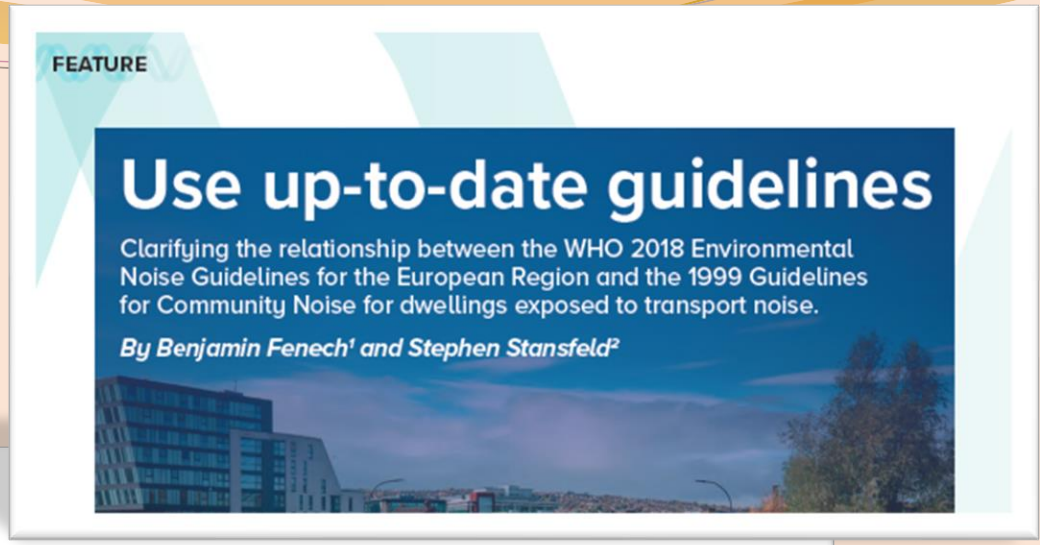
Beware of false narratives!







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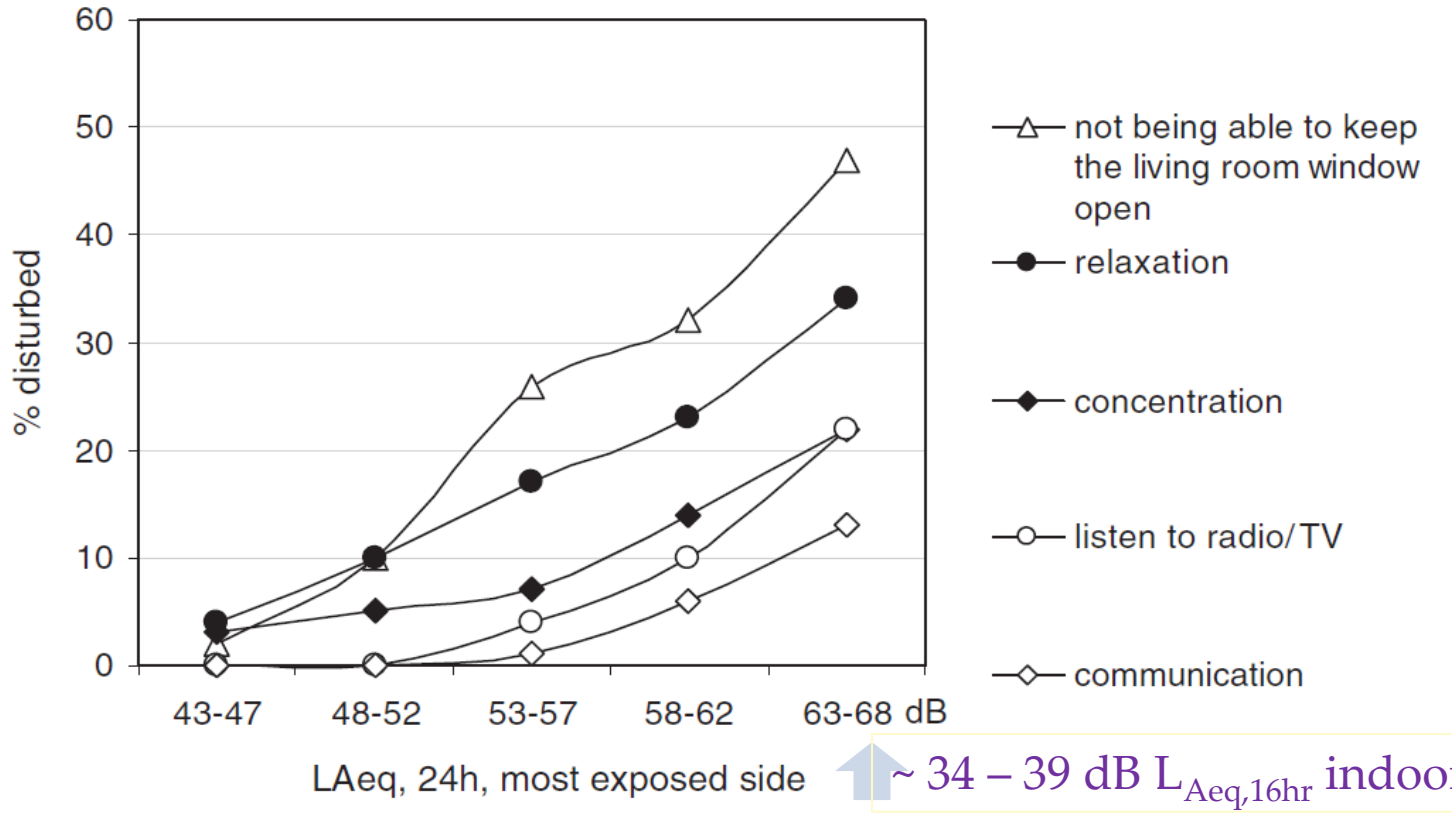
Do external levels matter when you are at home?

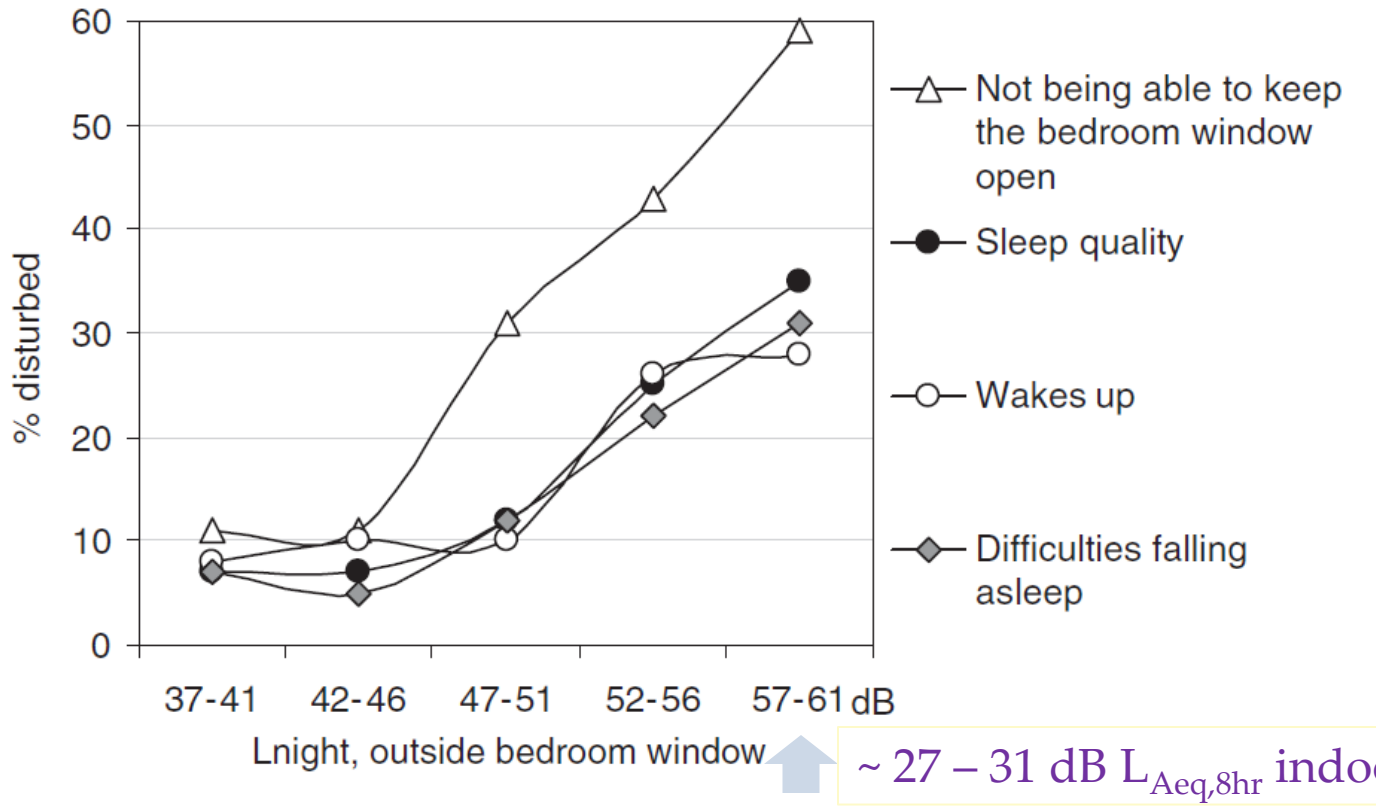


~ 34 – 39 dB $L_{Aeq,16hr}$ indoors

Fig. 6. Activity disturbances (disturbance score >3) indoors with windows closed in relation to sound levels in $L_{Aeq,24h}$ at the most-exposed side.

E. Öhrström et al. / Journal of Sound and Vibration 295 (2006) 40–59

Do external levels matter when you are at home?

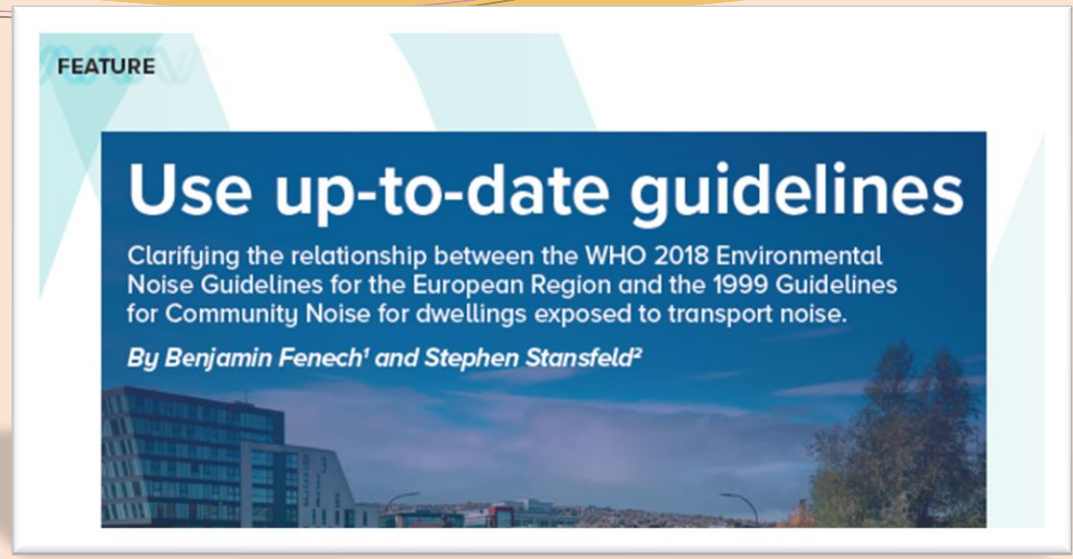


~ 27 – 31 dB $L_{Aeq,8hr}$ indoors

Fig. 9. Noise-related sleep disturbances indoors with windows closed in relation to sound levels in L_{night} outside the bedroom windows.

E. Öhrström et al. / Journal of Sound and Vibration 295 (2006) 40–59

Beware of false narratives!



"In writing the ENG2018 it was clear that the indoor guidelines from the CNG (1999) ***could not and should not be quoted or used in isolation****."*

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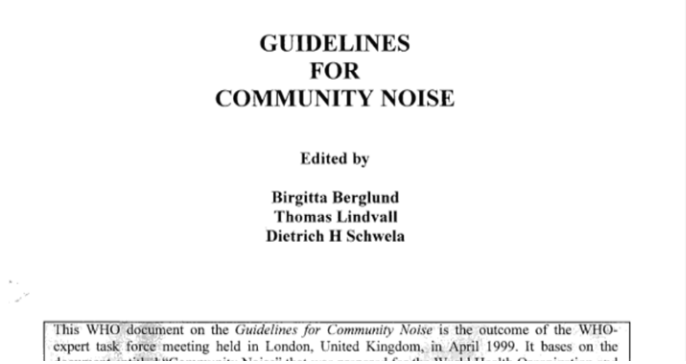
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Table 4.1: Guideline values for community noise in specific environments.

Specific environment	Critical health effect(s)	LAeq [dB]	Time base [hours]	LAmax, fast [dB]
Outdoor living area	Serious annoyance, daytime and evening Moderate annoyance, daytime and evening	55 50	16 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
School class rooms	Speech intelligibility, disturbance of	35	during	-

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The Journal of the Acoustical Society of America

HOME BROWSE COLLECTIONS PUBLISH WITH US ABOUT NEWS

Volume 104, Issue 6
December 1998

DECEMBER 01 1998

Exposure-response relationships for transportation noise

Henk M. E. Miedema; Henk Vos

Check for updates

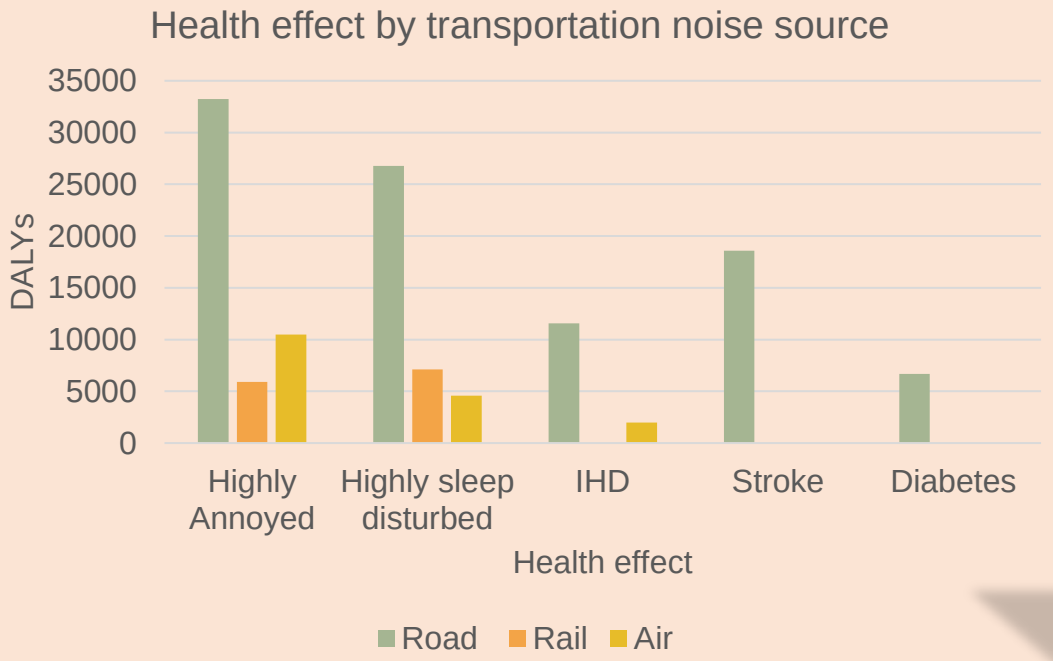
J. Acoust. Soc. Am. 104, 3432–3445 (1998)
https://doi.org/10.1121/1.423927 **Article hist**

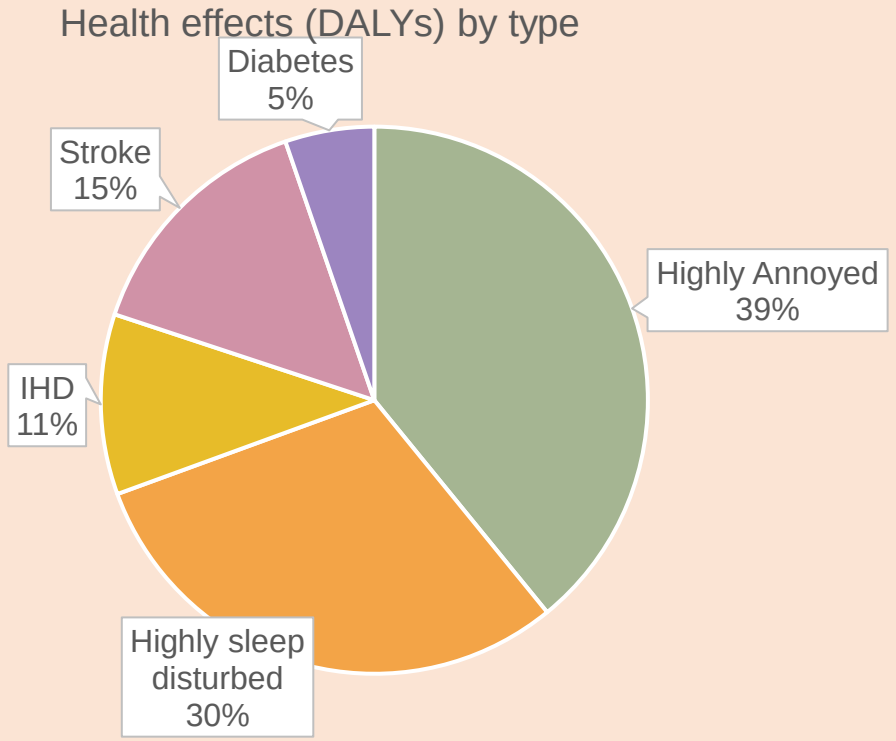
To treat different transportation sources equally with respect to the amount of noise annoyance tolerated, a *noise limit* in terms of DNL at het most exposed facade must be lower for aircraft noise than for road traffic noise, and the limit for road traffic must be lower than for railway noise. Which DNL values correspond to an equal %HA can be read from the curves presented in this paper.

Exposure-response relationships for transportation noise, Miedema & Vos, JASA 1998

Why L_{den} & L_{night}?

- *Chronic* health outcomes ⇒ *long-term* noise metrics
- Noise annoyance determined by day and night exposure
- Epidemiological evidence in terms of L_{den}, L_{night}






Environment International 178 (2023) 107966

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

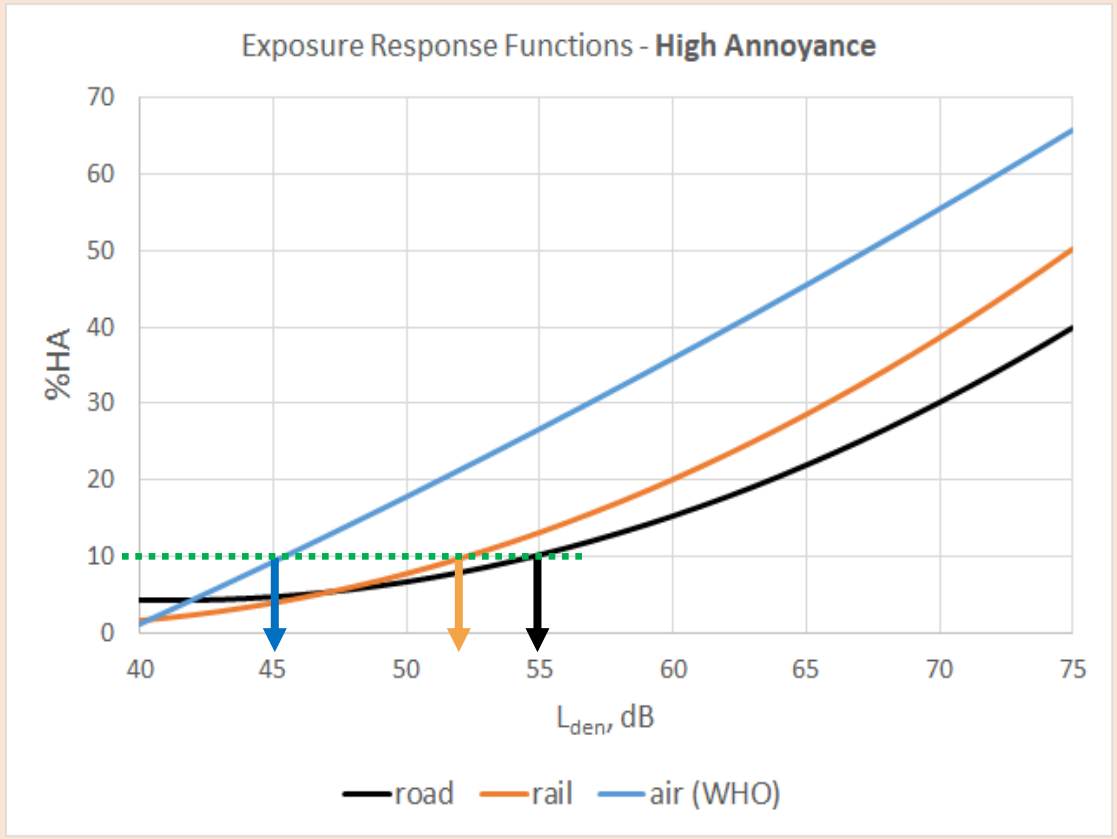
Full length article

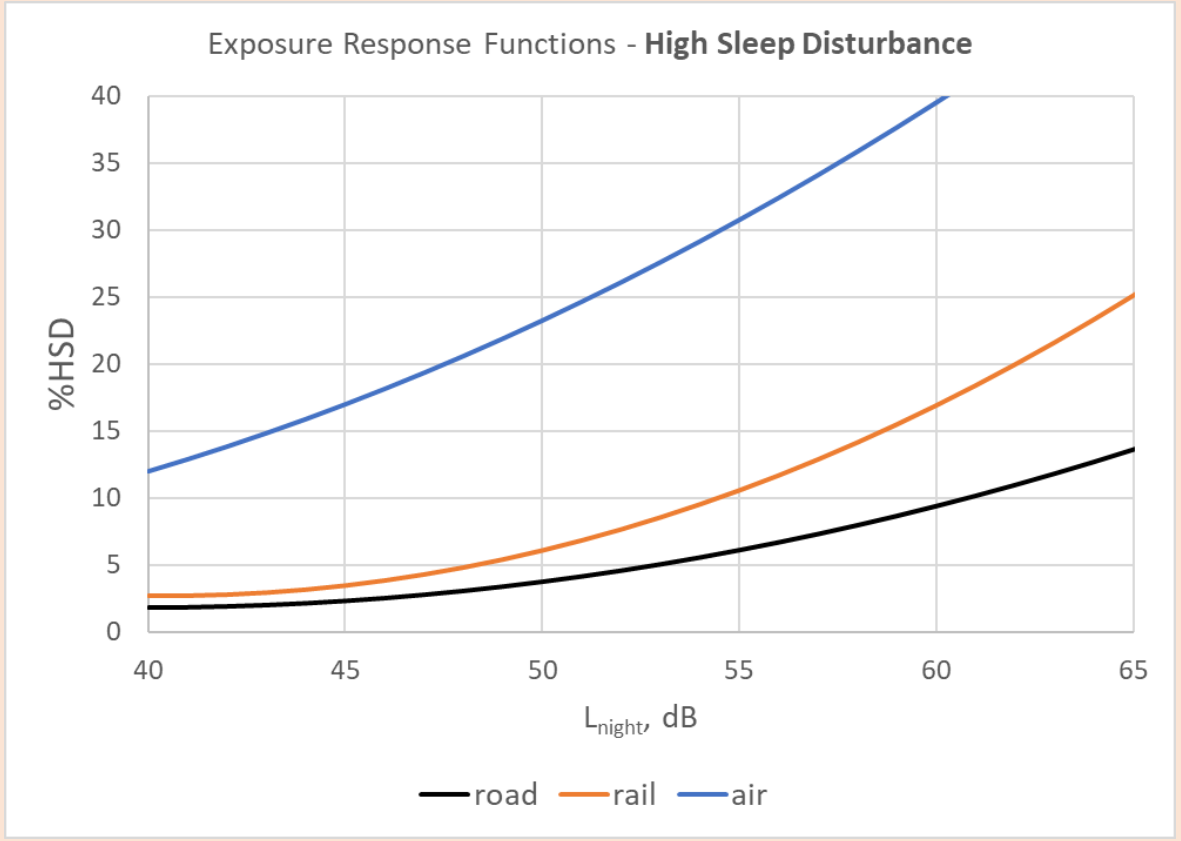
Spatial assessment of the attributable burden of disease due to transportation noise in England

Calvin Jephcote [a,1], Sierra N. Clark [b,1], Anna L. Hansell [a,c], Nigel Jones [d], Yingxin Chen [a], Claire Blackmore [a], Katie Eminson [a], Megan Evans [a], Xiangpu Gong [c], Kathryn Adams [a], Georgia Rodgers [b], Benjamin Fenech [b,c,*,2], John Gulliver [a,c,2,*]

[a] Centre for Environmental Health and Sustainability, University of Leicester, Leicester, UK
[b] Noise and Public Health, Radiation Chemical and Environmental Hazards, Science Group, UK Health Security Agency, UK
[c] NIHR Health Protection Research Unit in Environmental Exposures and Health at the University of Leicester, UK
[d] Extrium, UK

External Sound Exposure Categories





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Sound Exposure Categories

	I	II	III	IV	V
Highly annoyed 	10%	15%	20%	25%	> 25%
	≤ 1 in 10	1 in 7	1 in 5	1 in 4	> 1 in 4
Highly sleep disturbed 	3%	5%	7%	9%	> 9%
	≤1 in 33	1 in 20	1 in 14	1 in 11	> 1 in 11

Façade sound insulation

$L_{den,\ internal} \leq$ 35 dBA

Transportation type	Façade sound insulation, $D_{nT,A,tr}$ / dB
Road traffic	$\geq L_{den}$ - 32

$D_{nT,A,tr} \geq$ 30 dB

Table 3 — Sound insulation in dwellings against exterior noise — Class limits[ab]

	Type of space	Class A dB	Class B dB	Class C dB	Class D dB	Class E dB	Class F dB
1	Façades and roofs of habitable rooms in dwellings; in specific environment with sound sources characterized by L_{den}	$D_{nT,A,tr} \geq L_{den} - 20$	$D_{nT,A,tr} \geq L_{den} - 24$	$D_{nT,A,tr} \geq L_{den} - 28$	$D_{nT,A,tr} \geq L_{den} - 32$	$D_{nT,A,tr} \geq L_{den} - 36$	$D_{nT,A,tr} \geq L_{den} - 40$

[a] The sound insulation values are expressed as a weighted standardized sound level difference with a spectrum adaptation term for road traffic noise. For other types of sound source than road traffic noise, $D_{nT,A,tr}$ shall be determined from the relevant level and spectrum of the sources. $D_{nT,w} + C_{tr,50-3150}$ may be used where low frequency sound influences the indoor sound pressure level, e.g. where the sound comes from mechanical equipment placed outside the building.

[b] $D_{nT,A,tr} \geq 30$ dB applies as a minimum requirement to classes A–D.

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Façade sound insulation

$L_{den,\ internal} \leq$ 35 dBA

Transportation type	Façade sound insulation, $D_{nT,A,tr}$ / dB
Road traffic	$\geq L_{den}$ - 32

$D_{nT,A,tr} \geq 30$ dB

Sound Exposure Category	Façade sound insulation, $D_{nT,A,tr}$ / dB				
	I	II	III	IV	V*
Road traffic	≥ 30	≥ 30	≥ 32	≥ 35	
Railway traffic					
Air traffic					

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Façade sound insulation

Transportation type	Façade sound insulation, $D_{nT,A,tr}$ / dB
Road traffic	≥ L_{den} - 32

$D_{nT,A,tr}$ ≥ 30 dB

Sound Exposure Category	Façade sound insulation, $D_{nT,A,tr}$ / dB				
	I	II	III	IV	V*
Road traffic	≥ 30	≥ 30	≥ 32	≥ 35	≥ L_{den} - 32
Railway traffic					≥ L_{den} - 28
Air traffic					≥ L_{den} - 19

* Minimum value in SEC V is 35 dB $D_{nT,A,tr}$

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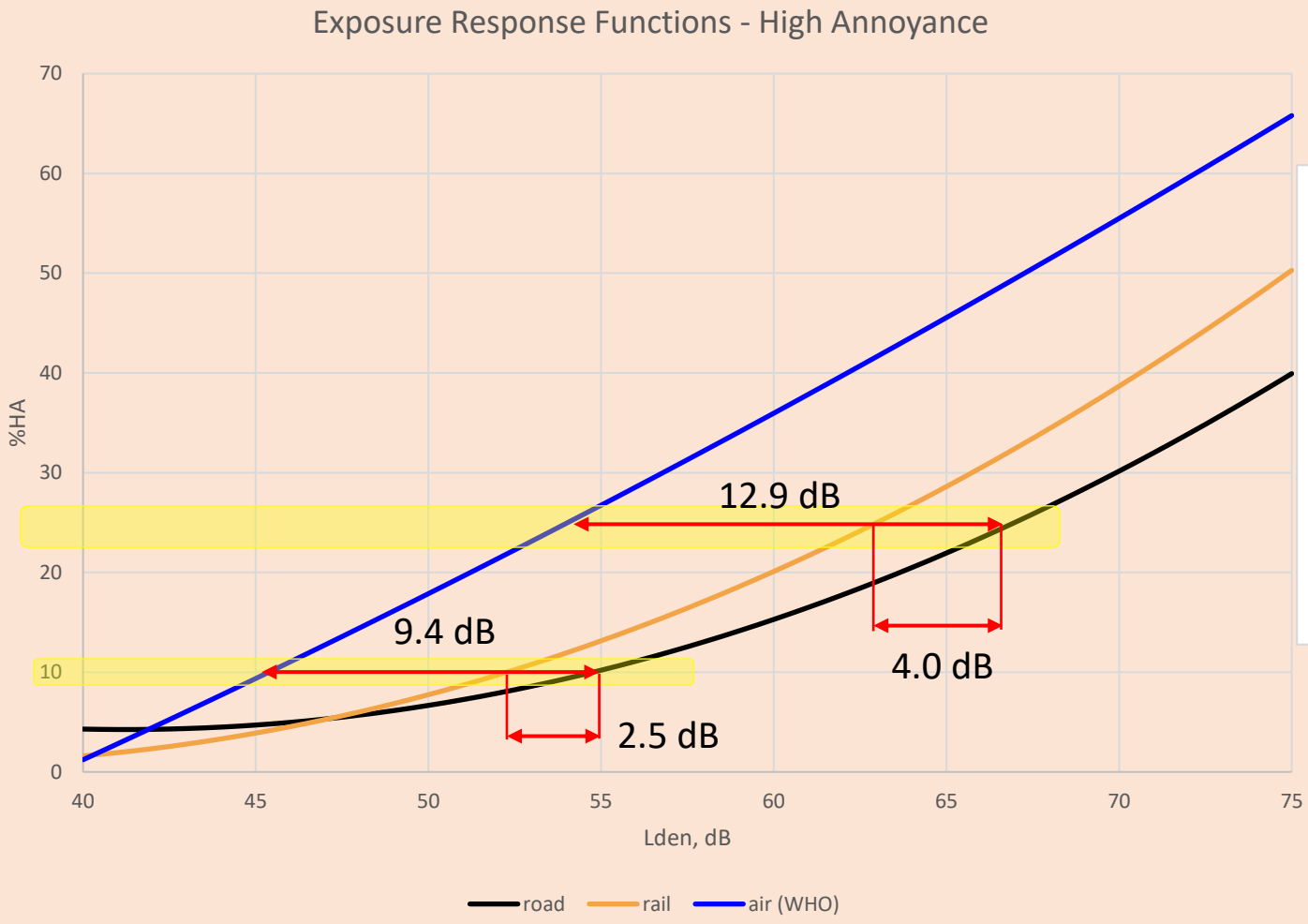
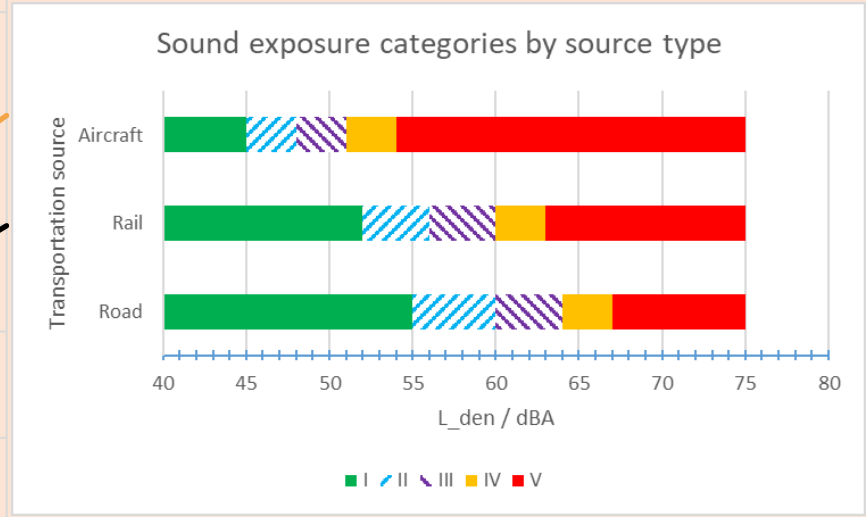
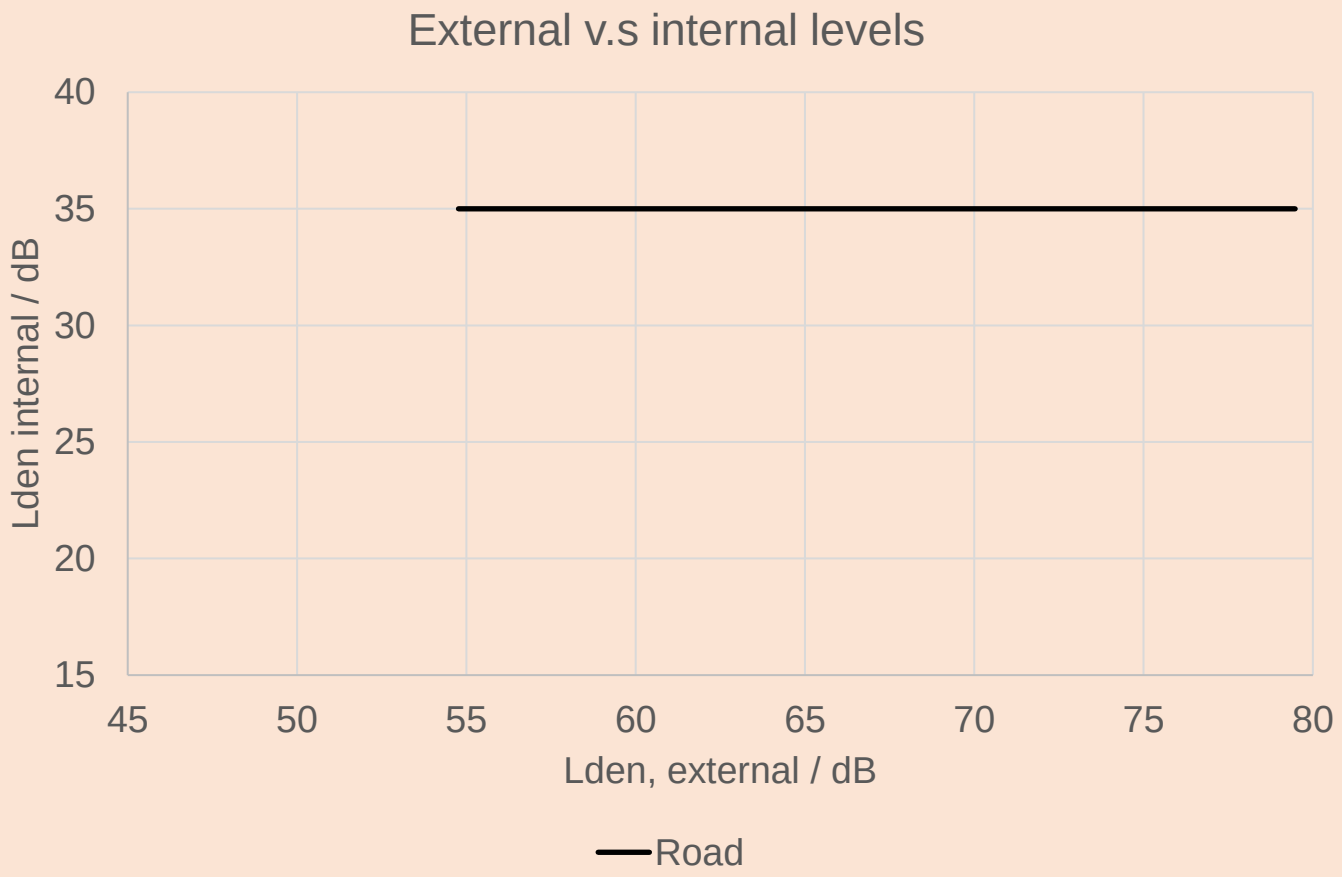
What internal levels?

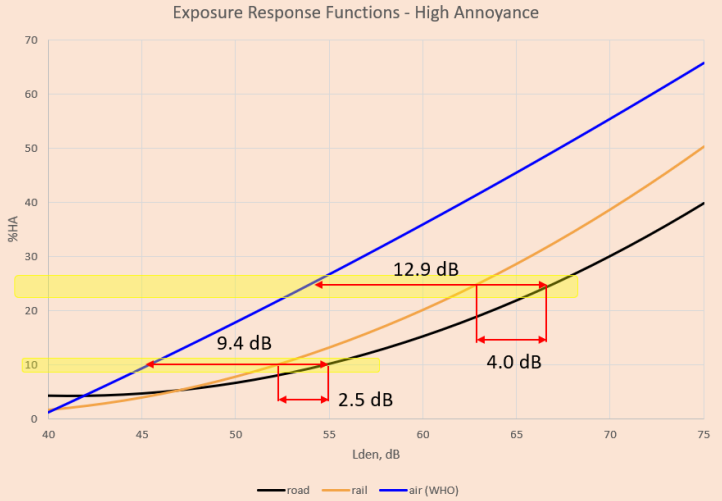
Transportation type	Façade sound insulation, $D_{nT,A,tr}$ / dB
Road traffic	≥ L_{den} - 32



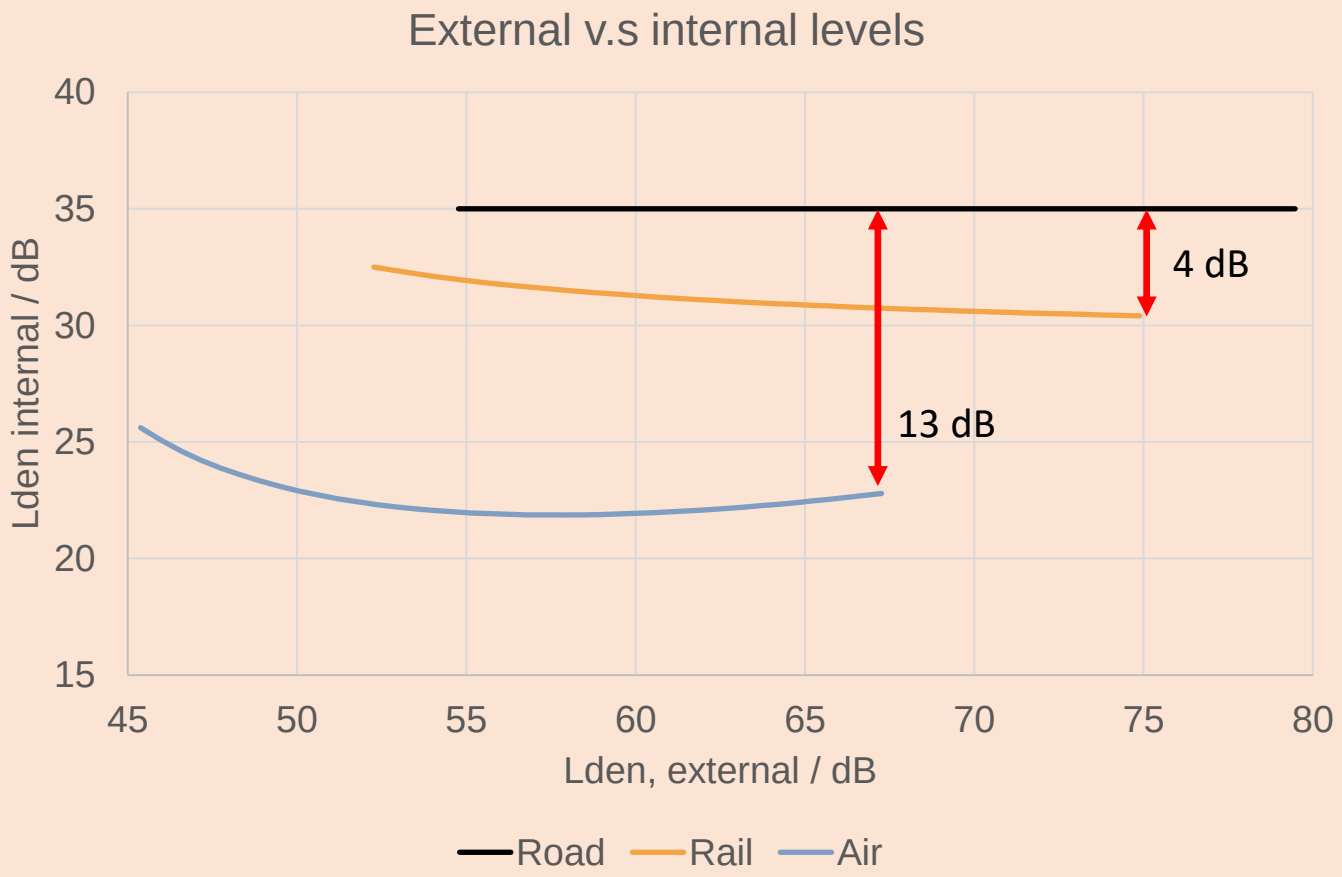


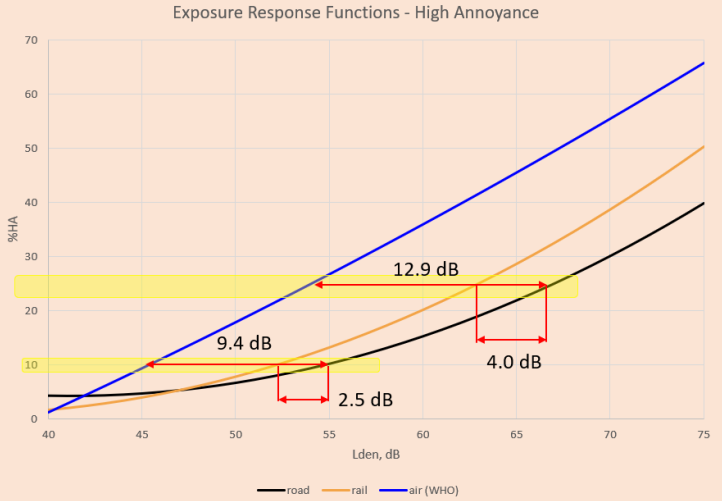
What internal levels?





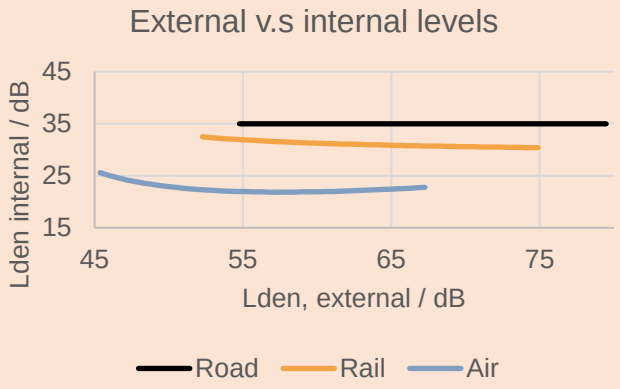
What internal levels?

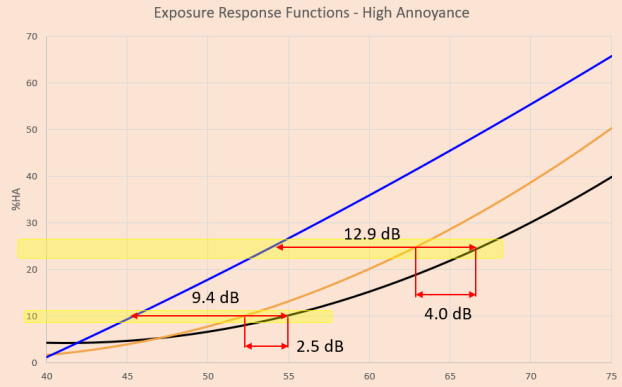




Internal sound levels

Sound Exposure Category	Façade sound insulation, $D_{nT,A,tr}$ / dB					Internal level target L_{den} / dBA
	I	II	III	IV	V*	
Road traffic					≥ L_{den} - 32	≤ 35
Railway traffic					≥ L_{den} - 28	≤ 31
Air traffic					≥ L_{den} - 19	≤ 22





Should we use L_{max} ?

If a noise is not continuous, sleep disturbance correlates best with $L_{A,max}$
WHO Guidelines (1999)

… the assessment of the relationship between different types of single-event noise indicators and long-term health outcomes at the population level remains tentative. The guidelines therefore make no recommendations for single-event noise indicators.
WHO Guidelines (2018)

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Assessing L_{max} for residential developments, B Paxton, J Harvie-Clark, N Conlan, A Chilton, D Trew. IOA 2019

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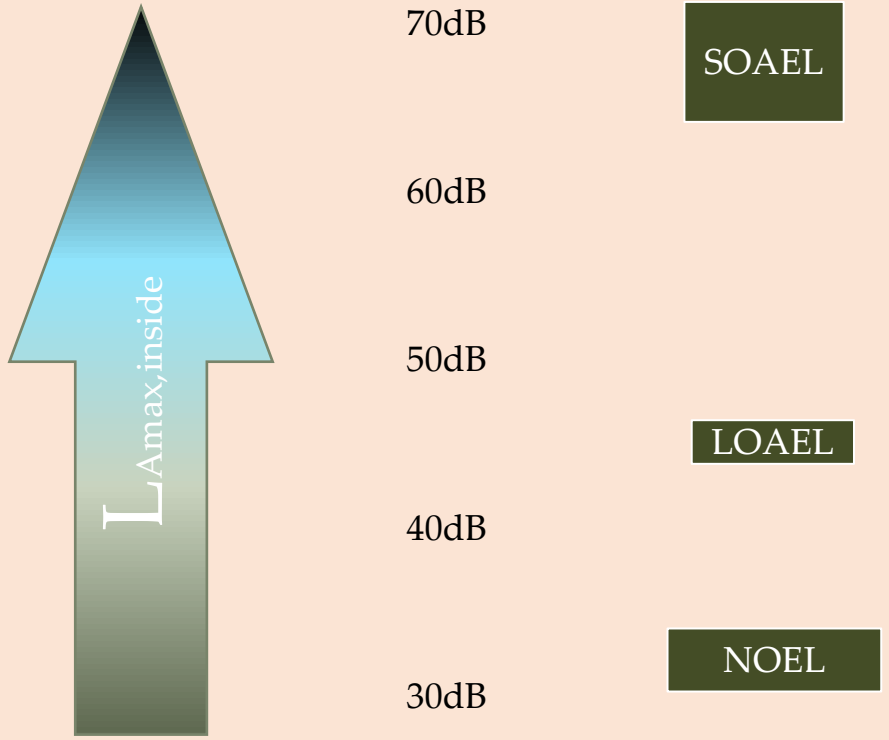
Historical L_{max} guidance: Precedence ≠ Evidence!

events. In noise-sensitive rooms at night (e.g. bedrooms) individual noise events (from all sources) should not normally exceed 45dB $L_{Amax,F}$ more than 10 times a night as this represents a threshold below which the effects of individual noise events on sleep can be regarded as negligible.



- ProPG (2017) Appendix A - External levels at the façade
  - 85 dB L_{AFmax} up to 20 times a night.
  - 80 dB L_{AFmax} for more than 20 events per night.
- HS2 – different method but similar level to ProPG.

WHO guidelines for community noise (1999), BS 8233 (1999) "single sound events", "Should not normally exceed 45 dB L_{Amax}" ProPG (2017) "not normally exceed 45 dB $L_{AF,max}$ more than 10 times a night"

32 – 35 dB $L_{Amax,\ inside}$ WHO NNG 2009

Assessing L_{max} for residential developments, B Paxton, J Harvie-Clark, N Conlan, A Chilton, D Trew. IOA 2019

Historical L_{max} guidance: 45 dB $L_{A,max}$

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 (Vallet & Vernet 1991), and most studies show an increase in the percentage of

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World Health Organization, Geneva
Cluster of Sustainable Development and Healthy Environment (SDE)
Department for Protection of the Human Environment (PHE)
Occupational and Environmental Health (OEH)

inter-noise 91

NIGHT AIRCRAFT NOISE INDEX AND SLEEP RESEARCH RESULTS

VALLET Michel, VERNET Isabelle

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Historical L_{max} guidance: 45 dB $L_{A,max}$

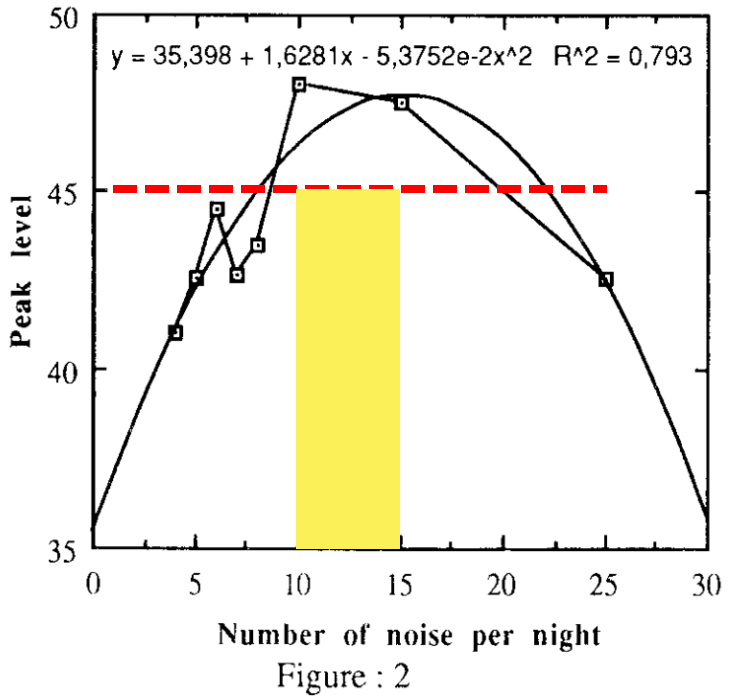
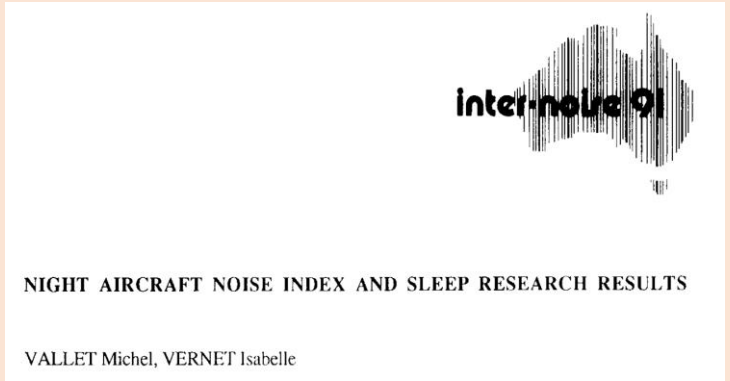


Figure : 2

However with a 2nd degree polynomial function we were able to account for a large proportion of the variance ($r^2 = 0.79$). We retain this function as a model of the probability of waking up (10 %) when a noise occurs.

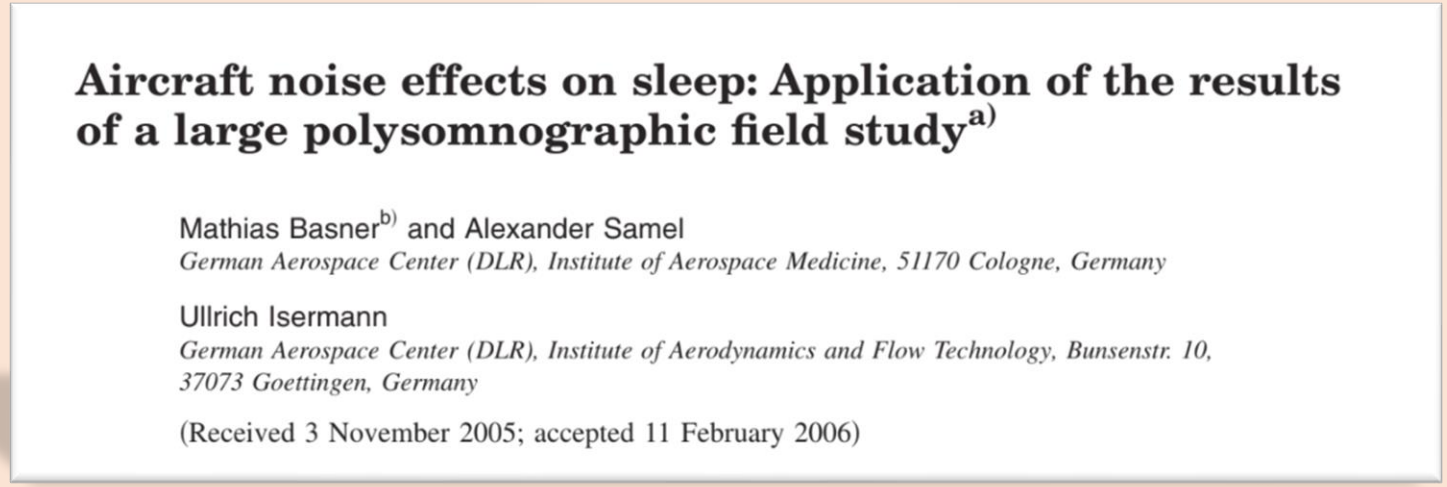
CONCLUSION

On conforming strictly to the curve it will be seen that the noise of only one flight per night gives rise to awakenings for a noise level of 42 dB(A). It will be noted in particular that the tolerance to noise with regard to sleep passes through a maximum value for an optimum number of 10 to 15 flights per night and that beyond 20 to 25 occurrences of noise per night the aircraft need to be very quiet or the dwellings provided with excellent sound proofing. The peak noise measured within the dwellings should not exceed 48 dB(A) according to this method of evaluation which is a little more severe than the German and Dutch proposals.



Objectives for preserving sleep quality

1. On average, less than one additional awakening per night on account of noise
2. Awakenings recalled in the morning should be avoided as much as possible.
3. Noise should interfere as little as possible with the process of falling back to sleep again.



Aircraft noise effects on sleep: Application of the results of a large polysomnographic field study[a)]

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Aircraft Noise Effects on Sleep: Application of the results of a large polysomnographic field study, 2006

Exposure response relationships

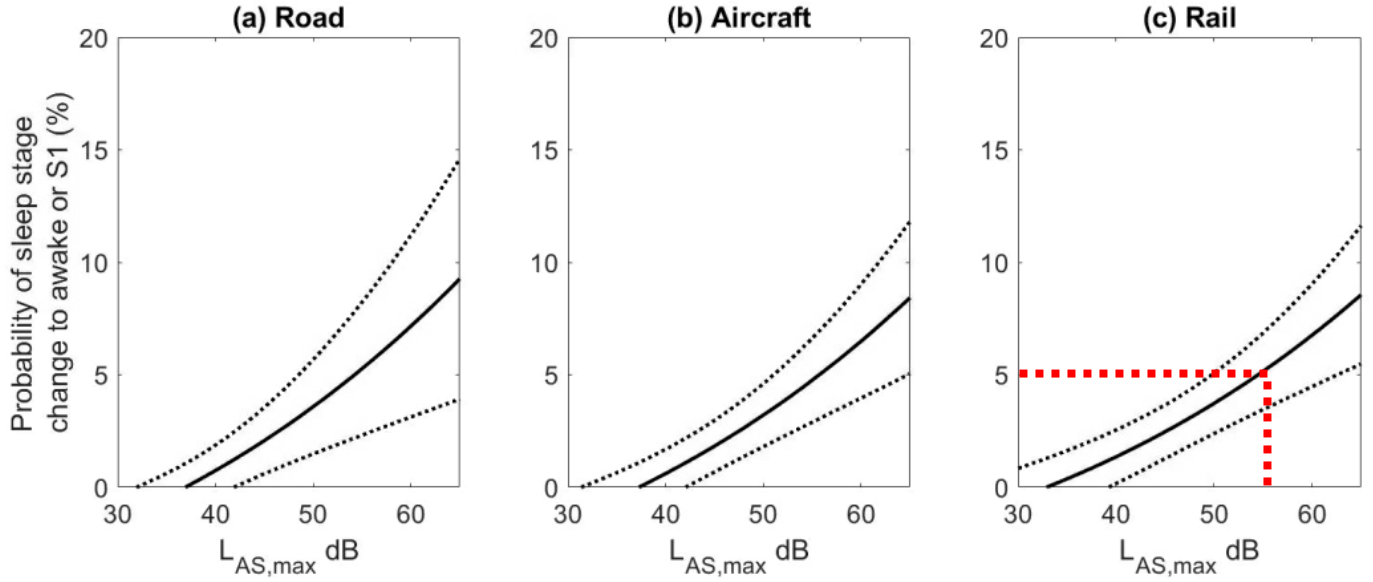
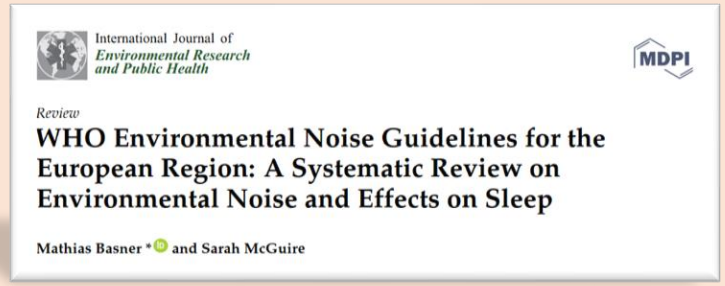


Figure 6. Probability of additional sleep stage changes to awake or S1 in a 90 s time window following noise event onset depending on the maximum indoor sound pressure level ($L_{AS,max}$) for (**a**) road (STRAIN and DEUFRAKO, N = 94 subjects); (**b**) aircraft (STRAIN, N = 61); and (**c**) rail noise (DEUFRAKO, N = 33). 95% confidence intervals (dashed lines). Results are for the three unadjusted models.

- 10 trains at 55 dB L_{ASmax} implies a 50% probability of awakening

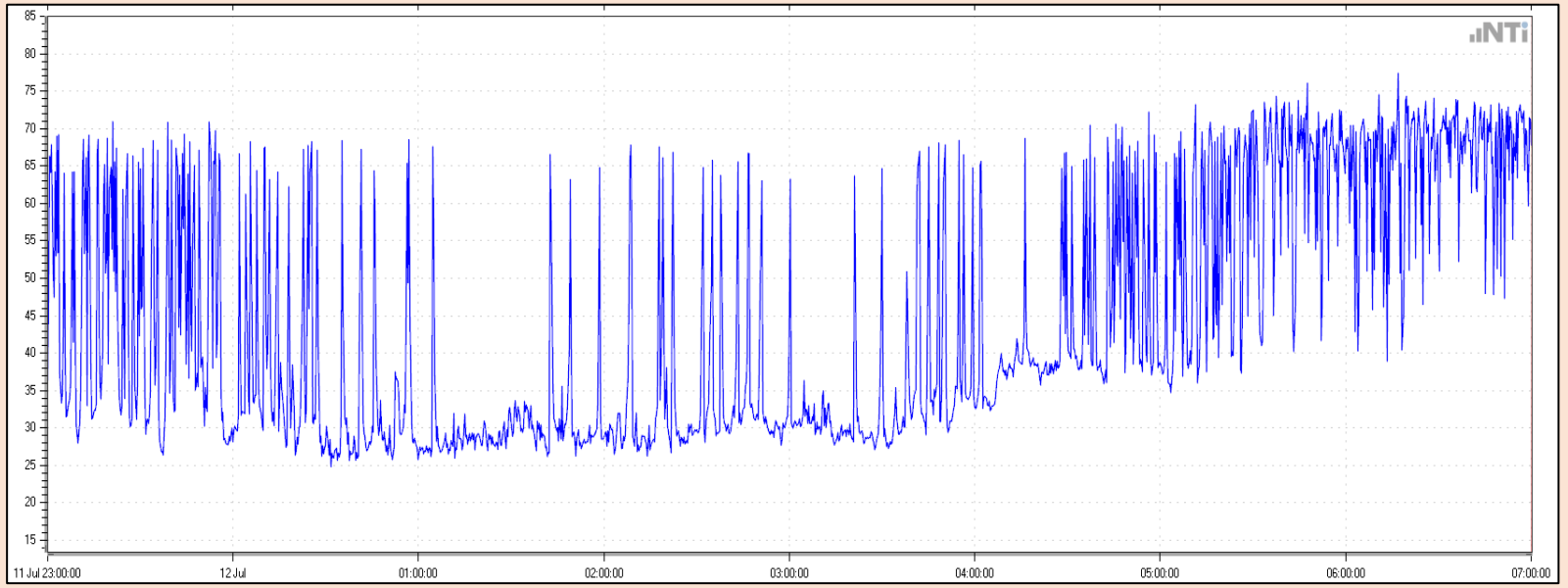


[WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep](). Mathias Basner & Sarah McGuire, 2018

Example application – additional awakenings

- Close to a rural A-road
- Each vehicle pass easily distinguishable
- 13 dB subtracted for open window
- Probability of noise induced awakening calculated for each event

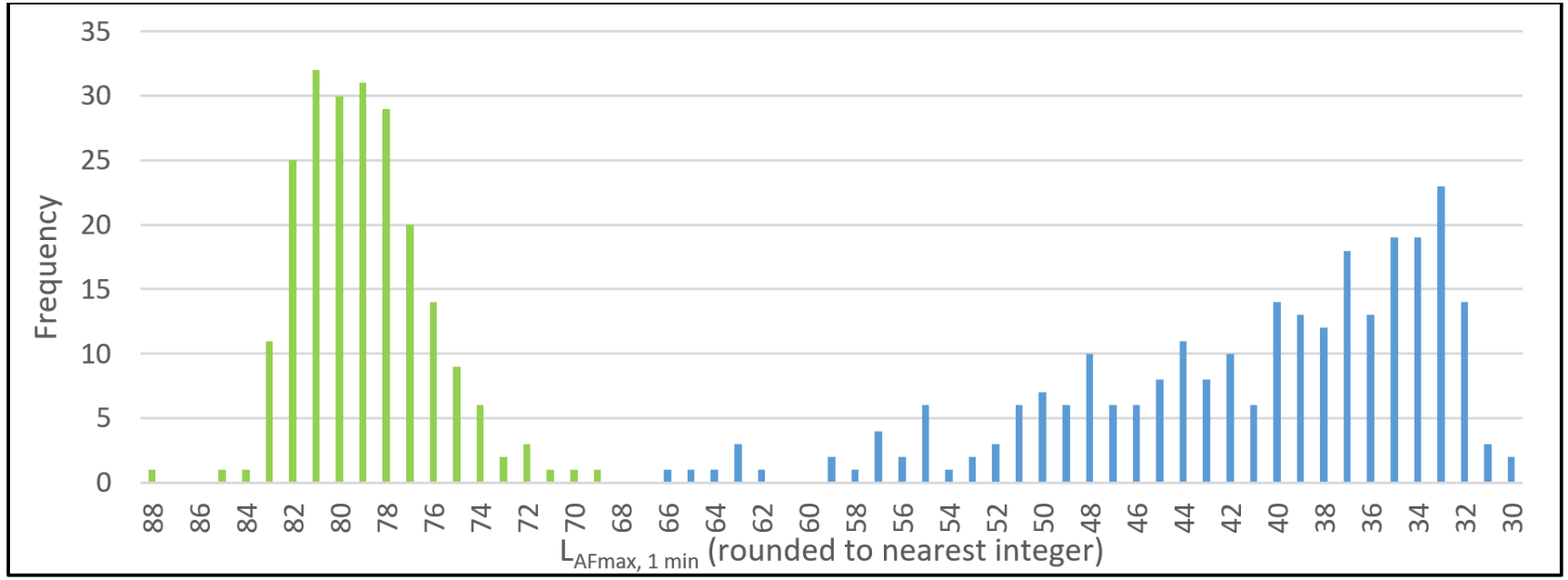
$$Road: Prob.of\ Wake\ or\ S1 = -3.3188 - 0.0478 * L_{AS,max} + 0.0037 * (L_{AS,max})^2$$

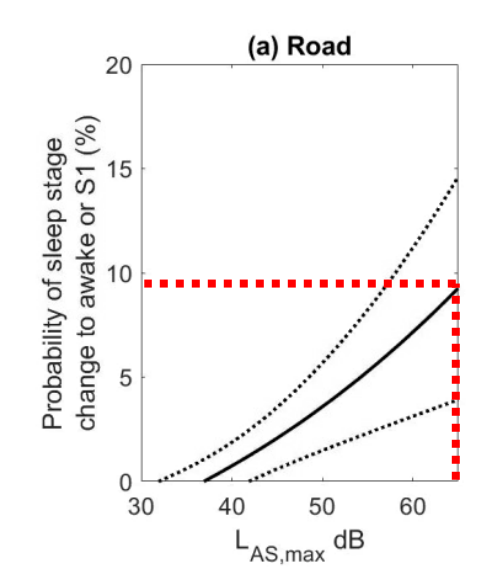


Assessing L_{max} for residential developments, B Paxton, J Harvie-Clark, N Conlan, A Chilton, D Trew. IOA 2019

Example – additional awakenings

- **Probability of noise-induced awakenings = 21 no. (i.e. 2100%)**

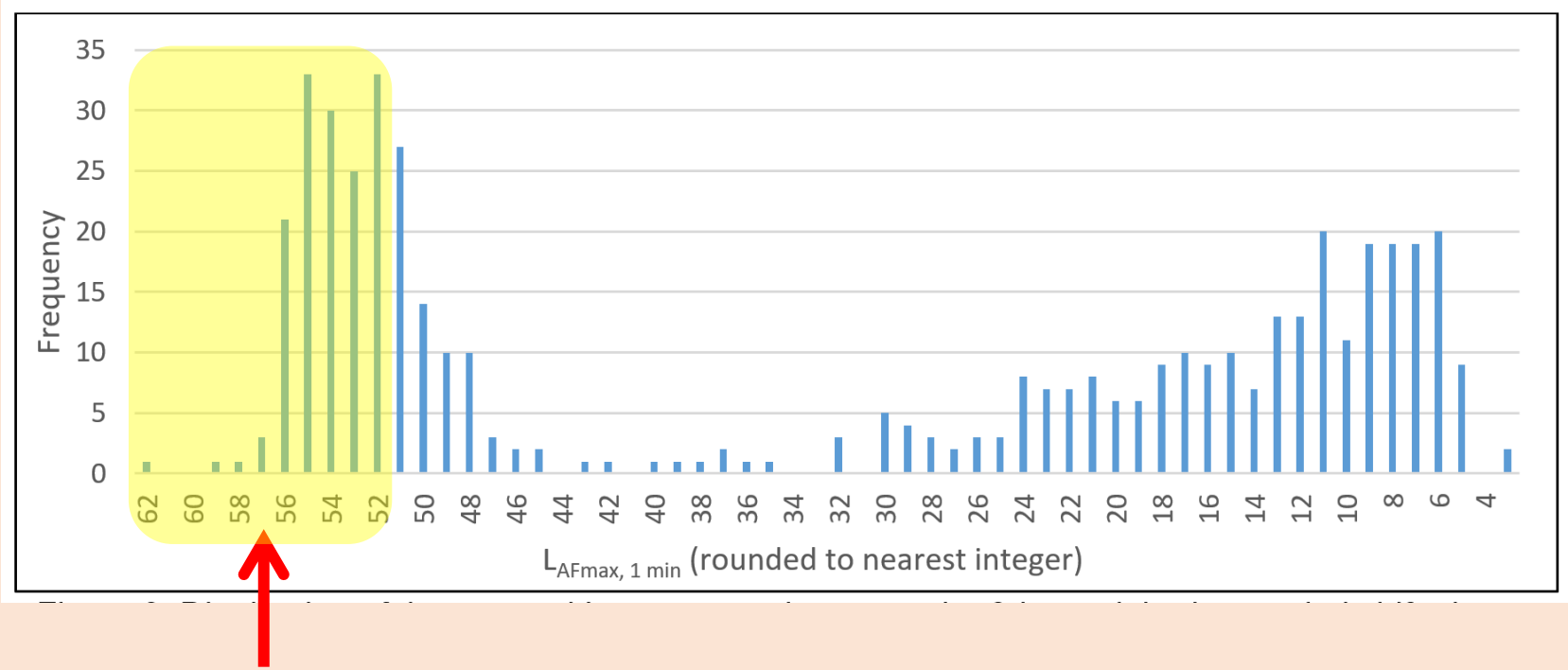


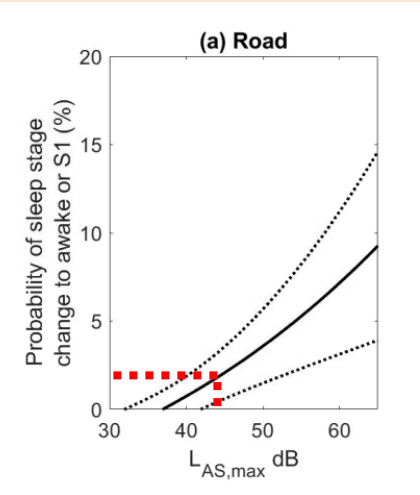


Assessing L_{max} for residential developments, B Paxton, J Harvie-Clark, N Conlan, A Chilton, D Trew. IOA 2019

Levels for one additional awakening?

- **10th highest L_{AFmax} = 44 dB (internal)**

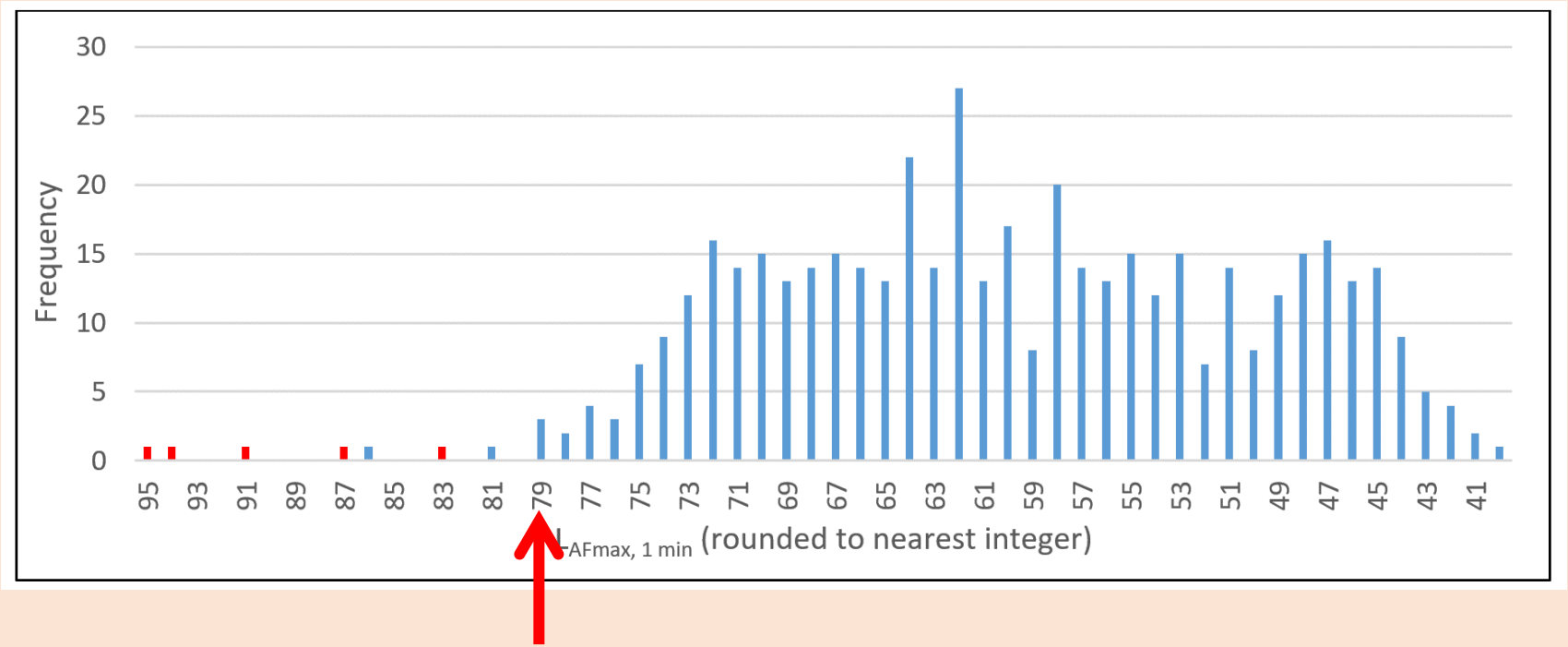




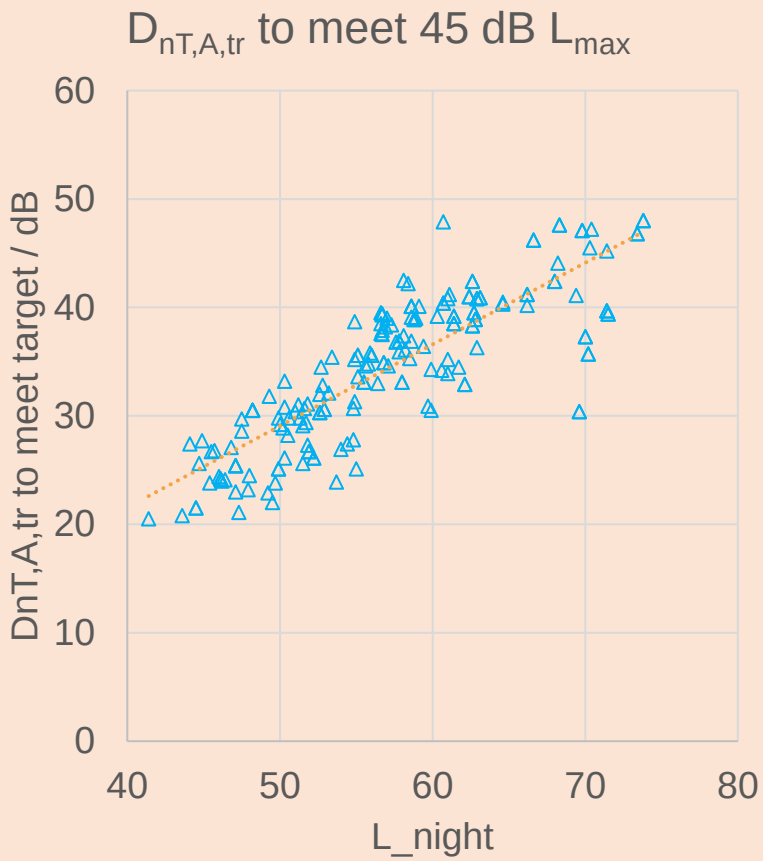
Assessing L_{max} for residential developments, B Paxton, J Harvie-Clark, N Conlan, A Chilton, D Trew. IOA 2019

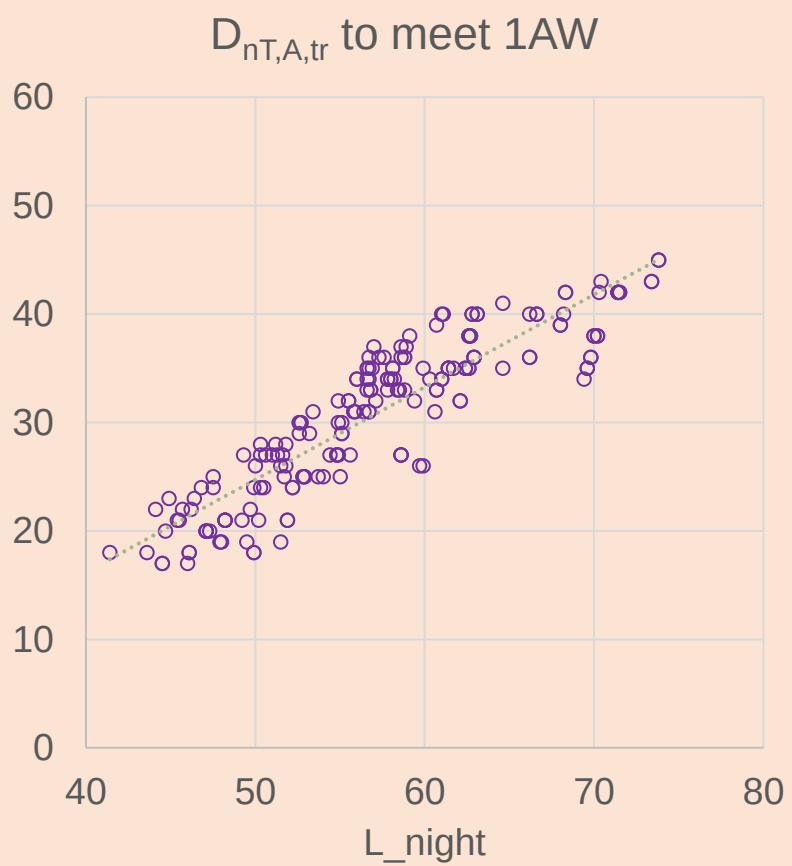
Example #2

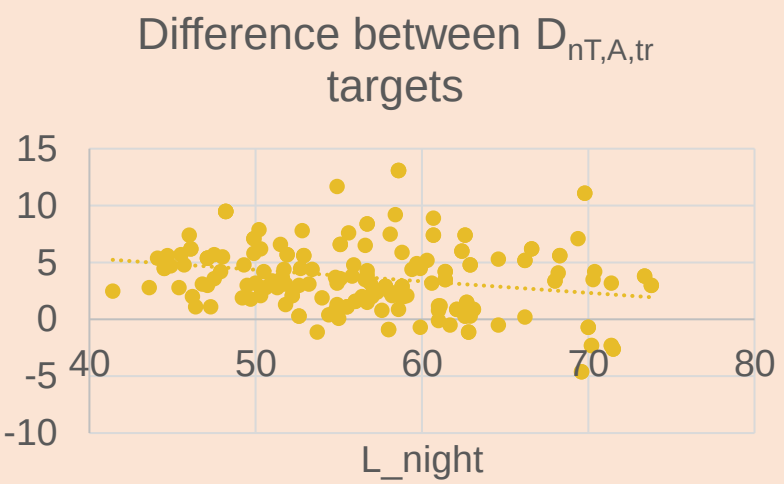
- City centre
- Emergency vehicle sirens, trains, cars and people



45 dB L_{max} v.s One additional awakening (1AW)







	$D_{nT}(L_{max}) - D_{nT}$(1AW)
Mean	**4.0**
SD	**3.2**

Current challenges with L_{max}

- How long to measure for?
- How to model environmental sound propagation? (Where was the source?)
- Façade sound insulation model EN 12354-3 is for continuous equivalent sound only (no L_{max})
- Partition data is for diffuse sound incidence
- Different frequency content to L_{eq}
- 10^{th} highest outside is not 10^{th} highest inside…
- NOT Standardised!

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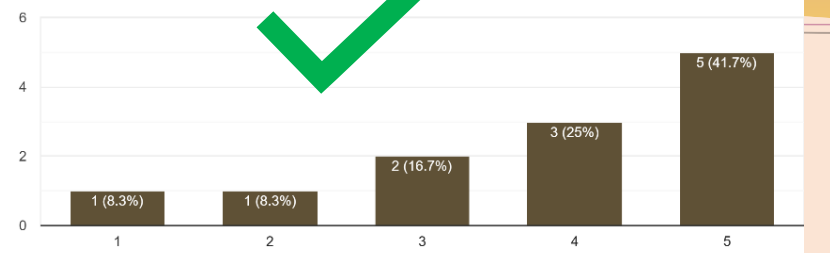
Conclusion

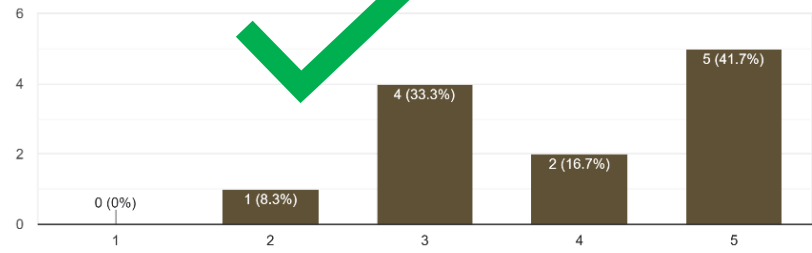
The WHO 2018 Guidelines refer to the WHO 1999 Guidelines for internal levels: why don't we follow this advice?

12 responses



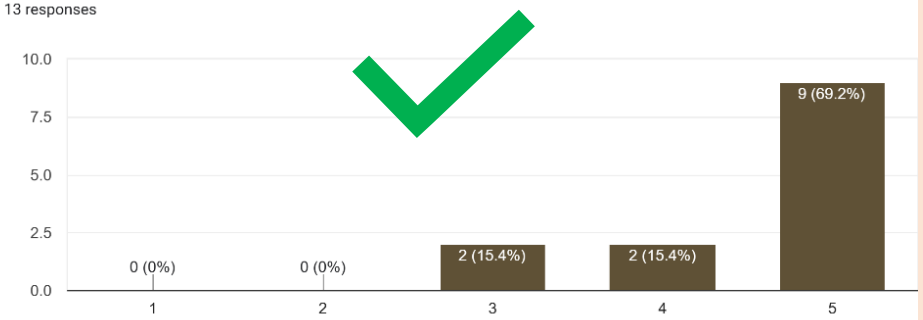
The proposals only cover limited sources of (transportation) sound, so they are not as useful as the WHO 1999 Guidelines

12 responses



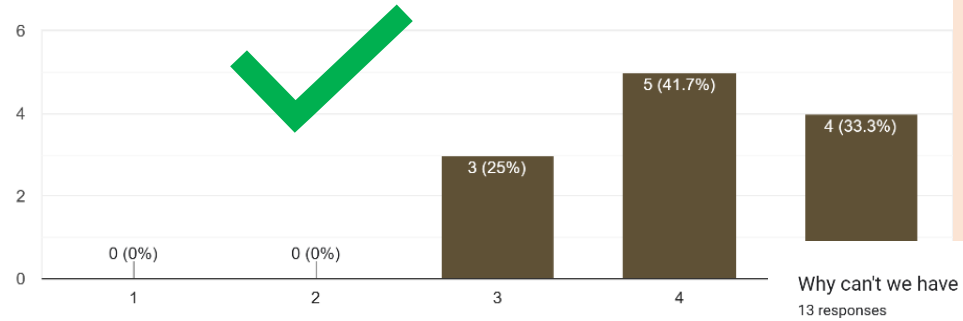
We need guidance that includes criteria for Lmax

13 responses



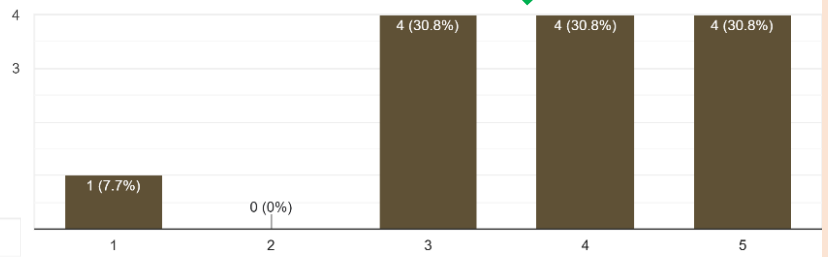
Explanation of how the proposals are consistent with ProPG

12 responses



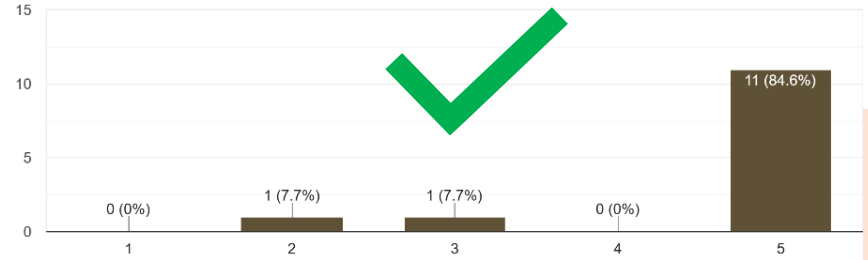
Why do the proposals use L_den and L_night?

13 responses



Why can't we have internal level targets rather than facade sound insulation criteria?

13 responses



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Three questions

A Alternative approaches to aligning residential acoustic design with health evidence

B Façade sound insulation v.s internal sound levels: arguments for/ against, either/ both, and the target levels

C Approaches for sources other than transport