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An outsider's view of HS2 airborne noise

Peter Delow

Blogging on *HS2 and the environment*
hs2andtheenvironment.wordpress.com

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QUESTIONS THAT WE SHOULD ASK:

Predicting annoyance levels

- What is the relationship between noise levels and the annoyance caused?
- How can annoyance levels be predicted?
- What approach to predicting annoyance levels is HS2 Ltd taking?
- Does the HS2 Ltd approach represent "current best practice"?

  EU Environmental Noise Directive

  World Health Organisation Advice
- What annoyance thresholds are appropriate?

For more information see the series of blogs on *HS2 and the environment* starting at *Not quite measuring up* (posted 14 October 2012)

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QUESTIONS THAT WE SHOULD ASK (Contd):

Mitigation

- What are the sources of high-speed train noise?
- What is the HS2 Ltd view?
- How significant is pantograph noise?
- What is the likely impact of pantograph noise?
- What does it mean for the design of mitigation?

For more information see the series of blogs on *HS2 and the environment* starting at *Are you taking this seriously*? (to be posted 27 November 2012)

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WHAT IS THE RELATIONSHIP BETWEEN NOISE LEVELS AND THE ANNOYANCE CAUSED?

"Different people will respond quite differently to the same noise stimulus. These individual differences can be quite large and it is often most useful to consider the average response of groups of people exposed to the same sound pressure levels. In annoyance studies the percentage of highly annoyed individuals is usually considered, because it correlates better with measured sound pressure levels."

Paragraph 2.3.6 of World Health Organisation *Guidelines for Community Noise, 1999*

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HOW CAN ANNOYANCE LEVELS BE PREDICTED?

A method consistent with WHO advice:

- Decide on a noise parameter.
- Do some research to determine how what proportion of people in a sample react with annoyance to noise at different values of that noise parameter (or crib the results of someone else's research).
- Decide upon the acceptable proportion of the population to be annoyed.
- Set a noise threshold for the chosen noise parameter at the level that will just cause annoyance to the selected proportion of the population.

WHAT APPROACH TO PREDICTING ANNOYANCE LEVELS IS HS2 LTD TAKING?

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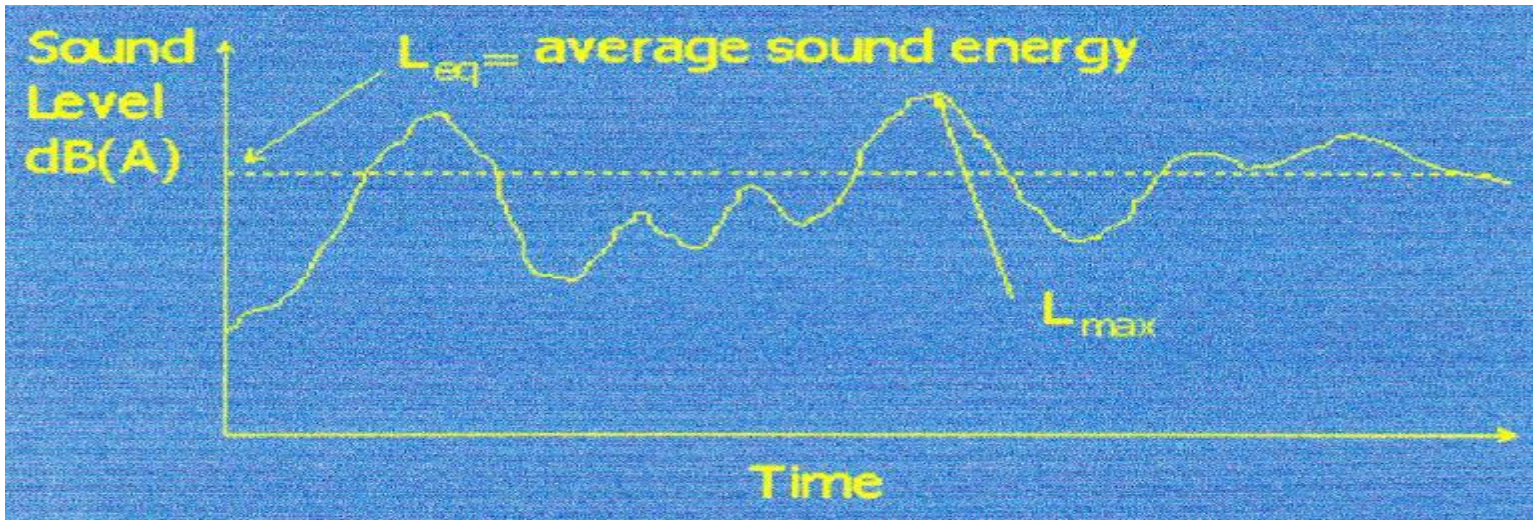
Based on WHO method: parameter is "equivalent continuous sound level" L_{Aeq}

The L_{Aeq} is the standard and most proven single indicator for determining noise impact of transport schemes and was therefore appropriate for the appraisal of HS2."
Paragraph 7.2.7 *Review of HS2 London to West Midlands Appraisal of Sustainability*

"The annoyance response to noise is affected by several factors, including the equivalent sound pressure level and the **highest sound pressure level** of the noise, the **number of such events**, and the **time of day**."
Paragraph 4.2.7 *Guidelines for Community Noise*

Source: Civil Aviation Authority



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DOES THE HS2 LTD APPROACH REPRESENT "CURRENT BEST PRACTICE"?

"The EIA is the process that leads to the production of the ES to be submitted in support of the hybrid bill. It will be carried out in accordance with applicable legal requirements and with **current best practice** …"

Paragraph 2.1.1 *HS2 London to West Midlands EIA Scope and Methodology Report*

EU Environmental Noise Directive 2002/49/EC

"selected common noise indicator … to assess annoyance" is the day-evening-night level L_{den}

This is a version of the equivalent continuous sound level that takes account of the additional annoyance caused by noise in the evening and at night

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$$L_{den} = 10 \lg \frac{1}{24} \left(12 * 10^{\frac{L_{day}}{10}} + 4 * 10^{\frac{L_{evening}+5}{10}} + 8 * 10^{\frac{L_{night}+10}{10}} \right)$$

Energy contribution:

07.00 to 19.00 (day) – no enhancement

19.00 to 23.00 (evening) – enhanced by 5 dB

23.00 to 07.00 (night) – enhanced by 10 dB

DOES THE HS2 LTD APPROACH REPRESENT "CURRENT BEST PRACTICE" (Contd)?

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World Health Organisation advice

"$L_{Aeq,T}$ should be used to measure continuing sounds such as road traffic noise, many types of industrial noises and noise from ventilation systems in buildings. When there are distinct events to the noise such as with aircraft or railway noise, measures of the individual events should be obtained (using, for example, L_{Amax} or SEL), in addition to $L_{Aeq,T}$ measurements."

Paragraph 2.1.5 *Guidelines for Community Noise*

For residential receptors, direct long term operational sound impacts (positive and negative) will be identified where at the façade of the receptor the Proposed Scheme causes:

- A change in the day or night equivalent continuous sound level as defined in Table 33; or
- **A maximum sound level (LpAFmax) of 85 dB or greater**; and
- Absolute sound levels that are above the values of 50 dB LpAeq,16hr during the daytime or 40 dB LpAeq,8hr at night.

Paragraph 14.3.26 *EIA Scope and Methodology Report*

The parameter L_{pAFmax} was newly introduced for the *EIA Scope and Methodology Report* with no explanation of its purpose

WHAT ANNOYANCE THRESHOLDS ARE APPROPRIATE?

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Equivalent continuous sound level

For residential receptors, direct long term operational sound impacts (positive and negative) will be identified where at the façade of the receptor the Proposed Scheme causes:

- A change in the day or night equivalent continuous sound level as defined in Table 33; or
- A maximum sound level (LpAFmax) of 85 dB or greater; and
- Absolute sound levels that are **above the values of 50 dB LpAeq,16hr during the daytime** or 40 dB LpAeq,8hr at night.

Paragraph 14.3.26 *EIA Scope and Methodology Report*

"To protect the majority of people from being seriously annoyed during the daytime, the sound pressure level on balconies, terraces and outdoor living areas should not exceed 55 dB L_{Aeq} for a steady, continuous noise. **To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB L_{Aeq}.** These values are based on annoyance studies, but most countries in Europe have adopted 40 dB L_{Aeq} as the maximum allowable level for new developments (Gottlob 1995). Indeed, the lower value should be considered the maximum allowable sound pressure level for all new developments whenever feasible."

Section 4.3.1 *Guidelines for Community Noise*

WHAT ANNOYANCE THRESHOLDS ARE APPROPRIATE?

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Section 4.3.1 *Guidelines for Community Noise*

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WHAT ANNOYANCE THRESHOLDS ARE APPROPRIATE (Contd)?

Equivalent continuous sound level (Contd)

"... it is recommended that appraisal is undertaken for noise above a cut-off level below which only a small percentage of the population would be annoyed. Research conducted by the Department suggests a positive willingness to pay to avoid transport related noise from **45dB $_{LAeq,18hr}$, and this level is used as the cut-off for both annoyance and valuation calculations**."

Paragraph 1.4.8 in Unit 3.3.2 of Department for Transport *Transport Analysis Guidance* (WebTAG)

"A mitigation strategy that takes into account the relative importance of different factors affecting relative tranquillity, as identified in the CPRE/NU study and mapping, could help to reduce the potential impacts."

Paragraph 8.5.2 in Appendix 5 to *HS2 London to the West Midlands: Appraisal of Sustainability*

Using a fixed threshold of 50dB(A) does not appear to be consistent with such a strategy.

WHAT ANNOYANCE THRESHOLDS ARE APPROPRIATE (Contd)?

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Maximum sound level of pass-by

For residential receptors, direct long term operational sound impacts (positive and negative) will be identified where at the façade of the receptor the Proposed Scheme causes:

- A change in the day or night equivalent continuous sound level as defined in Table 33; or
- **A maximum sound level (LpAFmax) of 85 dB or greater**; and
- Absolute sound levels that are above the values of 50 dB LpAeq,16hr during the daytime or 40 dB LpAeq,8hr at night.

Paragraph 14.3.26 *EIA Scope and Methodology Report*

85 dB maximum corresponds to 71 dB equivalent continuous sound level (FOI10/032)

71 dB is 21 dB above L_{Aeq} threshold

6 dB above sound insulation qualification level

It has no value as a threshold of annoyance

WHAT ARE THE SOURCES OF TRAIN NOISE?
At 320 kph

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Source: *High Speed Trains external noise: a review of measurements and source models for the TGV case up to 360 km/h* – Gautier, Poisson and Letourneaux (SNCF)

Pantograph

Aerodynamic

Low frequency High on train

250 Hz

315 Hz

Bogie

Aerodynamic and rolling

High frequency Low on train

2000 Hz

2500 Hz

WHAT IS THE HS2 LTD VIEW?

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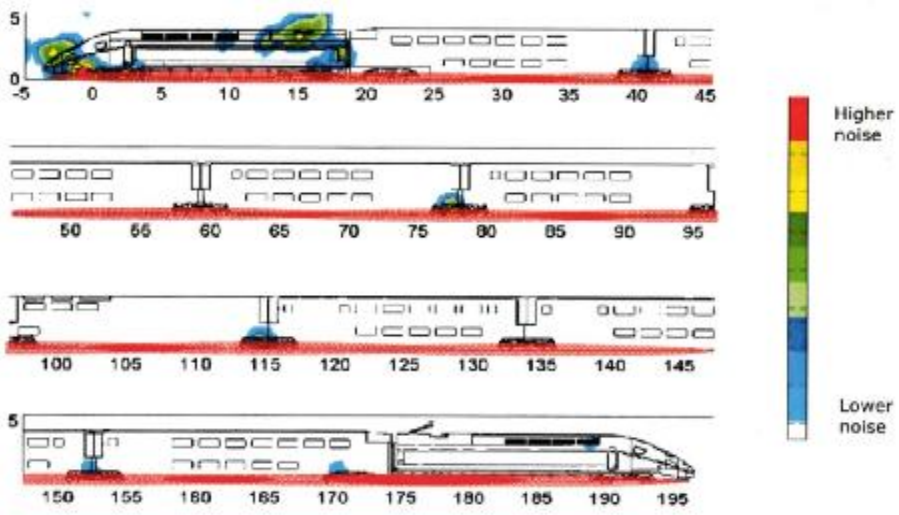
Fears are due to “misunderstandings” – HS2 Ltd presentation, September 2012

Image based on SNCF 1/3 Octave Noise Map of TGV at 360km/hr modified to represent L_{pAeq} using output from TWINS modelling
TWINS is Track Wheel Interface Noise Software

Source: HS2 Ltd



“While noise from the pantograph does need to be considered, and will be reviewed at the time of the EIA, its significance is often overstated. The wheel-rail interface will remain the most significant part of the noise from the train, even at high speed.

Paragraph 7.2.5 *Review of HS2 London to West Midlands Appraisal of Sustainability*

HOW SIGNIFICANT IS PANTOGRAPH NOISE?

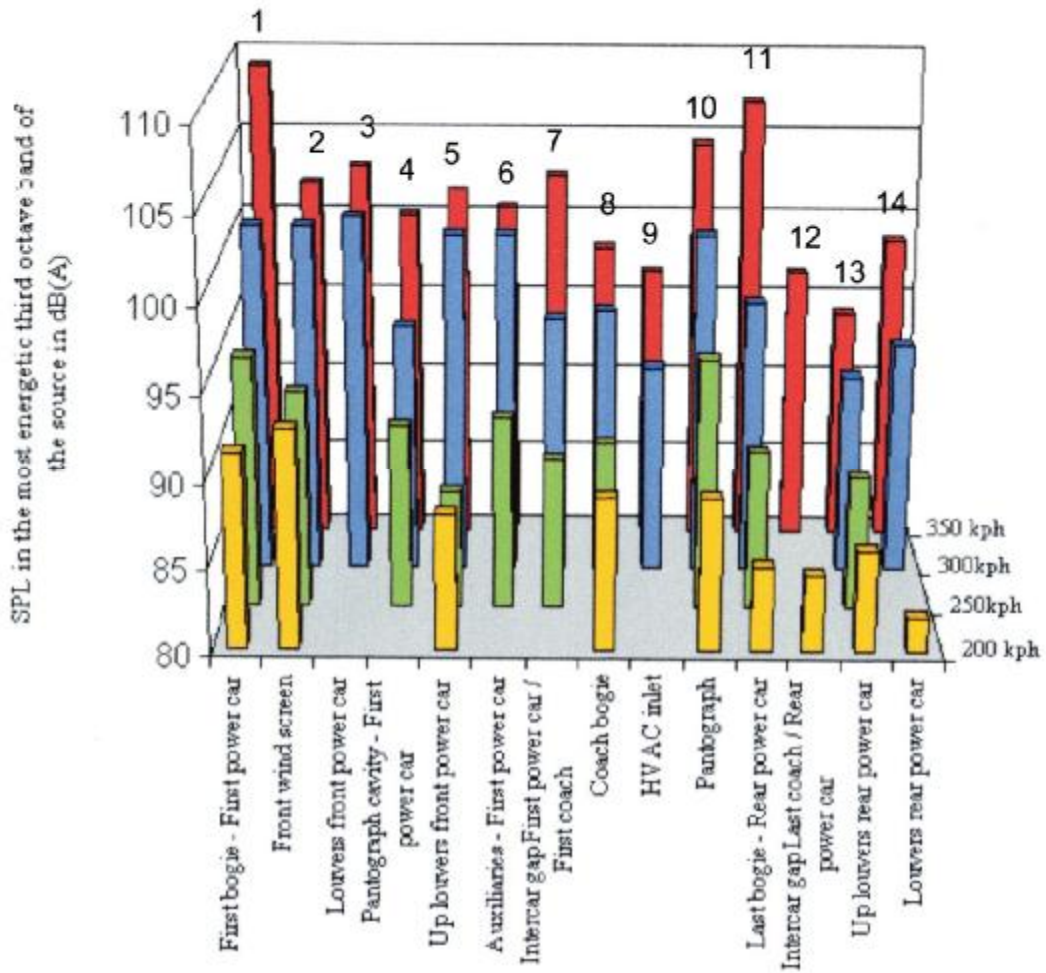
RED=350 kph

BLUE=300 kph

1=First bogie

10=Pantograph

Source: *High Speed Trains external noise: a review of measurements and source models for the TGV case up to 360 km/h* – Gautier, Poisson and Letourneaux (SNCF)



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WHAT IS THE LIKELY IMPACT OF PANTOGRAPH NOISE?

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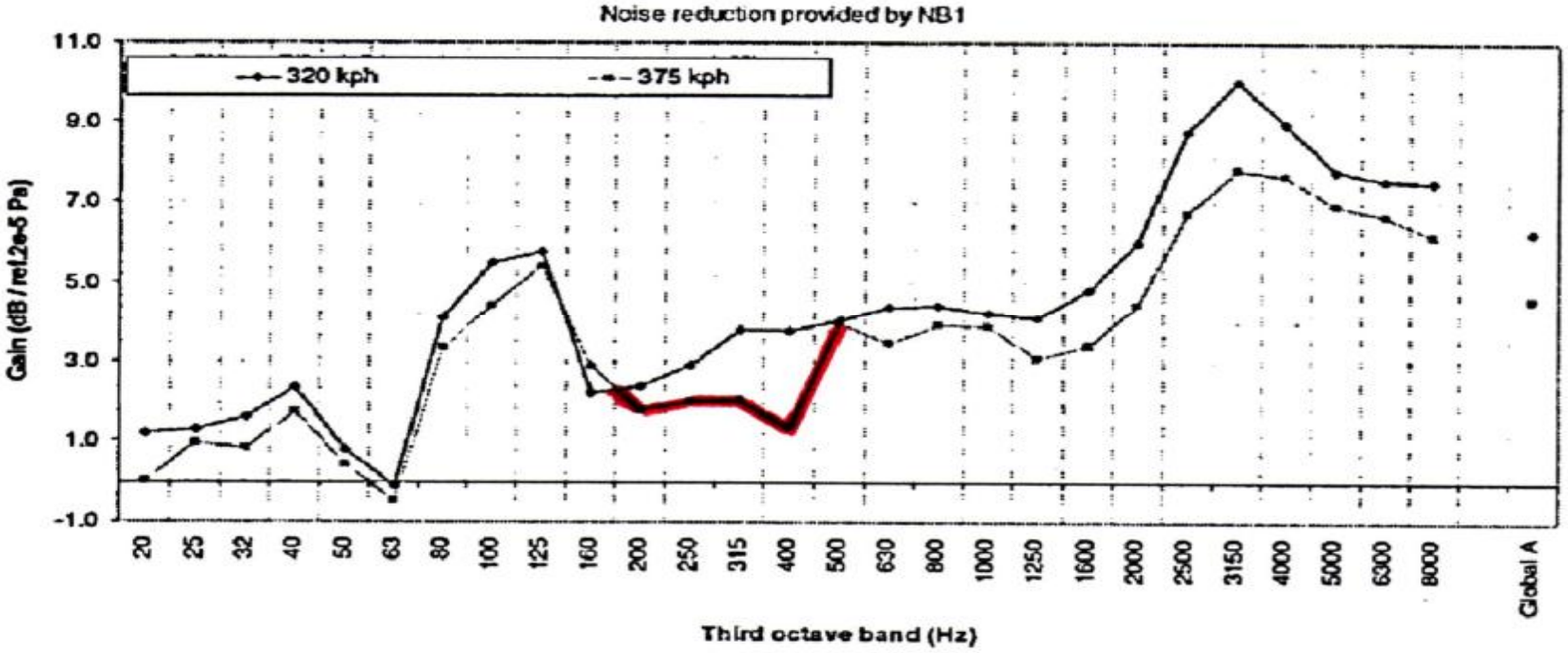
3 metre reflective barrier (2.1 metre effective height)

"… these solutions [improvements to noise barrier design] are limited at higher running speed when aerodynamic noise sources located on the roof of the train cannot be neglected."

"At higher running speeds, the energy of aerodynamic noise sources located on the roof of the train increases and the barrier height is not sufficient."

Experimental Study of Noise Barriers for High-Speed Trains – Belingard, Poisson, Bellaj



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WHAT DOES IT MEAN FOR THE DESIGN OF MITIGATION?

"To mitigate potential impacts in areas of high operating speeds, there is a need to control aerodynamic noise through advanced rolling stock design. Without first mitigating the source of aerodynamic noise, wayside noise barriers are not likely be as effective or feasible, due to the required increase in barrier height, to provide shielding to the entire train."

Paragraph 6.3.3 in Appendix 5 to *HS2 London to the West Midlands: Appraisal of Sustainability*

Pass-by noise reduction at 350 kph: a parametric study – Poisson, Gautier, Fortain, Margiocchi (SNCF)
Found that the maximum achievable noise reduction at source is between 4 dB(A) and 5 dB(A) and that, if only aerodynamic noise reduction measures are employed, barely 2 dB(A) improvement can be achieved. They conclude that the most efficient solution is "the reduction of the rolling noise combined with the reduction of the aerodynamic noise of the first bogie".

WHAT DOES IT MEAN FOR THE DESIGN OF MITIGATION (Contd)?

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Aerodynamic Noise Reduction in Pantographs by Shape-smoothing of the Panhead and Its Support and by Use of Porous Material in Surface Coverings – Ikeda, Mitsumoji, Sueki, Takaishi

The authors claim that "the prototype pantograph [resulting from their design work] reduces aerodynamic noise by approximately 4 dB in comparison with the current low-noise pantograph".

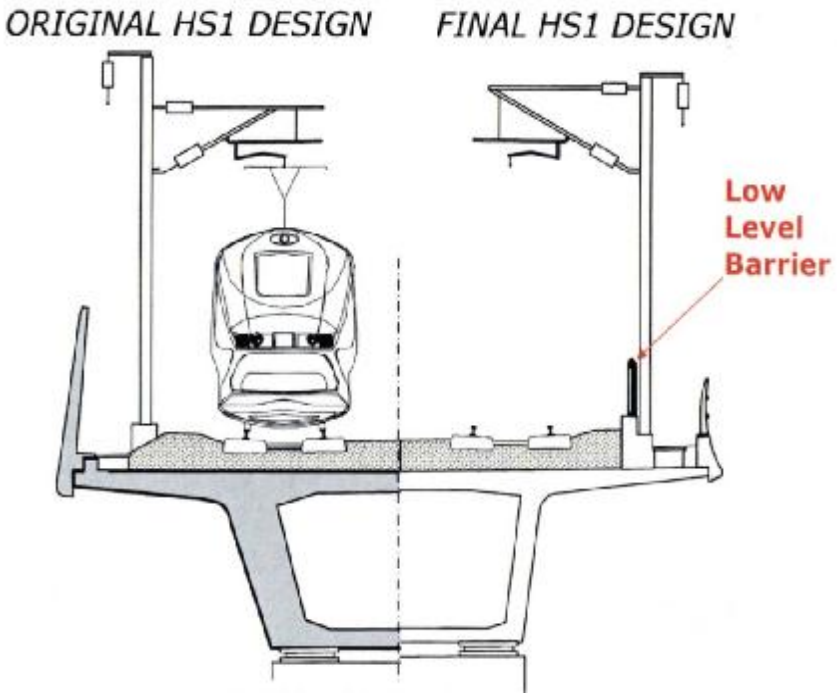
HS2 Ltd advises that the noise reduction of a 3 metre absorptive barrier is 10.1 dB (FOI11/327) – but this will not help with pantograph noise

WHAT DOES IT MEAN
FOR THE DESIGN OF MITIGATION (Contd)?

Surely, it means higher barriers

Would this HS1 design shield the pantograph?

Source: HS2 Ltd



WHAT DO THE COMMUNITIES NEED FROM HS2 LTD?

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- Direct and meaningful engagement
- A best practice approach to assessing annoyance, moving forward from HS1 methodology
- A review of how annoyance can be most accurately represented, with the results published
- A review of how relative tranquillity can be taken into account, with the results published
- A review of the impacts of aerodynamic noise upon the practicality and efficiency of mitigation measures, with the results published

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OTHER ISSUES

- Noise propagation model (CRN limitations)
- Technical risk of 3dB anticipated noise control improvements
- Need for margin for track roughness degradation
- Appropriateness of A-weighted measurements
- Impact of noise peaks at night
- Noise emission limits
- Clarification of free-field and facade measurements
- Verification of mitigation proposals
- Need for truly independent scrutiny

ANY QUESTIONS?