# Noise Emission Measurement campaign for high speed interoperability in Europe: the NOEMIE Project – first results towards an improved definition of reference tracks

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## Introduction

The essential technical requirements for railway interoperability on the trans-European network are prescribed in the Technical Specifications for Interoperability (TSI). In both the High-Speed (HS) and Conventional Rail (CR) TSI's the noise issue is a major concern. The TSI's are considered to be an important means for the abatement of environmental railway noise in Europe by the fact that they contain the definition of more stringent noise emission levels. These are made technically achievable by the results of recent research work.

As the noise emitted by the railway system depends on both the rolling stock and the track noise contributions, the noise limits should be established on specified and tested tracks, so the noise values of the rolling stock under trial would be consistent between several such reference sites in Europe.

In the process of the revision of the HS-TSI, the European Commission (EC) asked the European Association for Railway Interoperability (AEIF) to launch the NOEMIE project (Noise Emission measurement campaign for high speed Interoperability in Europe), with the aims:

- to provide a common database of noise emission values of high-speed trains in Europe,
- to contribute to the definition of an operated reference track, for type testing purposes,
- to propose and validate a common measurement method, to characterise the track parameters, and validate the noise emission limit values.

## The existing reference track definitions

The track definitions are based on the principle of limiting each of:

- the rail surface "roughness", that gives rise to the vibration excitation of the wheel and rail,
- the track radiation, so that the measured pass-by noise levels can be considered to be due only to the rolling stock contribution.

In the scope of the HS-TSI revision process, two reference tracks have been defined:

- the initial reference track definition ('TSI') based on a specification of components (ballasted track with static pad stiffness over 500 kN/mm at a 60 kN preload, and monobloc sleepers), and
- an alternative definition ('ATSI'), based on a level of dynamic performances controlled via the track vibration decay rate (TDR) - the reduction of the vertical and lateral vibration level along the rail length. The TDR is stated in dB/m.

Both defined tracks are associated with their own rail roughness limit (see fig. 2).

In the same way, in the CR-TSI, the ATSI approach is favoured, as it has shown to represent the acoustic performance of the reference tracks better than the static rail pad stiffness description [1].

## The NOEMIE project

The NOEMIE high-speed test campaign is organised in two phases, over five countries (Germany, France, Belgium, Italy and Spain). In phase one, several existing high-speed train series (AVE, TGV-Duplex, Thalys, ETR480, ETR500 and ICE3) have been tested on six TSI or ATSI reference track sections, which have been implemented for the purpose.

The test speeds are 250, 300 and 320 km/h.

As well as the noise pass by and standstill noise values, a complete check has been performed of the main parameters, including the track reference parameters and the wheel roughness, A measurement method specification, improving the existing standards, has been established specially for this purpose [1].

## Results

### Noise Pass by levels (fig. 1)

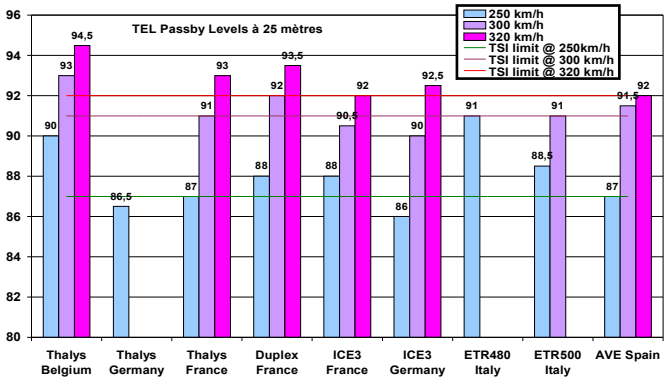


**Figure 1: Noise passby levels**

The results have been found to be in-line with prediction models. They show that:

- the TSI noise emission limits seem difficult to reach, so that current HS-TSI levels can be considered to be very demanding thresholds for existing rolling-stock,
- rail roughness remains the most influential parameter for rolling noise, even if at 320 km/h, the influence of the track is decreasing as aerodynamic noise becomes important.

## Rail roughness (fig 2)

The TSI rail roughness limit was found to be achievable in some cases, but the ATSI limit has been shown to be too difficult with existing operational rail grinding techniques.

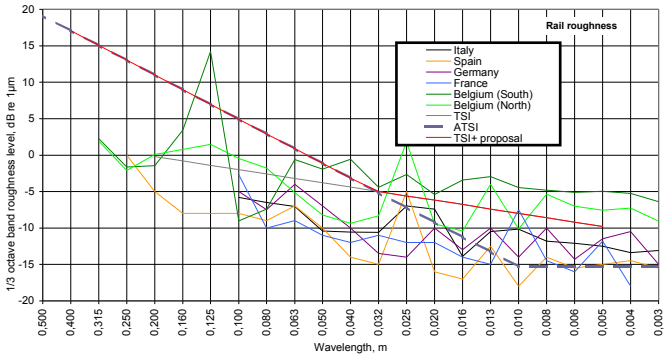


**Figure 3: rail roughness data of the tracks**

## Dynamic performances

The results show that the vertical TDR of various tracks comply with the ATSI limit. A threshold improvement is therefore possible.

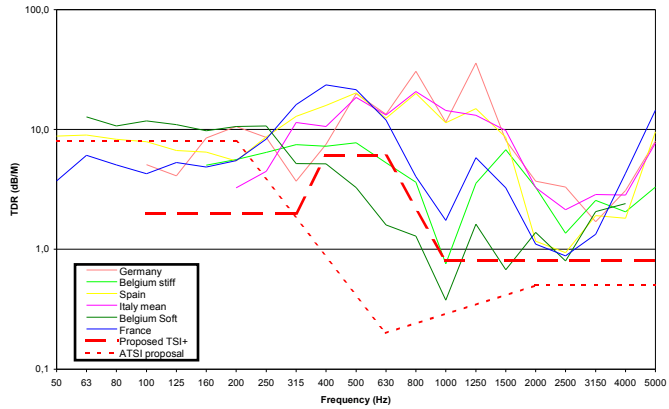


**Figure 3: Vertical track decay rates**

# Improving the track specification

Testing the ATSI track specification showed that:

- the initially proposed rail roughness spectrum amplitude limits (ATSI) were not realistically available on operational lines,
- the TDR criteria should be tightened to produce a test that is less dependent on variations of the track design, and so that the wheel noise component is in comparison as high as reasonably possible.

For these reasons, a new 'TSI+' track specification has been proposed, in terms of rail roughness (fig. 2), vertical (fig 3) and lateral TDR. This proposal was launched taking in consideration:

- the theoretical optimum dynamic characteristics for reducing acoustic radiation from the track, issued from the Silent Track Project [3];
- the characteristics of most of the tracks that are operated in Europe: in that respect, softer pads typical of both HS and CR commercial traffic lines (France, Germany, Belgium), were considered as representative enough not to be excluded for type testing purposes.

In the mean time, the pass-by noise limit criteria for the CR-TSI were launched on the assumption that the ATSI track specification would be used in the HS-TSI.

Then, a parametric study using the TWINS rolling noise model [2] was carried out to evaluate the changes in rolling noise sound power for the change in the track from the ATSI to the TSI+ specification. The study covered both speed ranges (HS & CR) using representative wheel models.

In the first step of the study, the roughness has been changed from the ATSI spectrum limit to the TSI+ spectrum limit. Since a higher limit has been set in TSI+, the noise is expected to increase. In the second step, the decay rate spectrum has been changed from one that is ATSI compliant to one that is TSI+ compliant.

The following conclusions can be drawn:

- The change from ATSI to TSI+ makes only a maximum 0.5 dB decrease in allowed noise level for the HS TSI, and 2.0 to 2.6 dB decrease for the CR TSI. In that respect, the more stringent decay rate specification compensates the required allowance in rail roughness.
- The sum effect therefore is that the CR TSI targets are hardly affected but the HS TSI becomes 2 dB easier to meet.
- In all cases, the wheel noise is greater than the track noise. However, by the change to TSI+, the difference is reduced. This means that tests on a TSI+ track are more likely to show the effects of quiet wheel design when noise spectra are examined.

Such modifications lead to a significant dynamic stiffening of the track towards its practical limit, so that the possible range of track noise level from different tracks having TSI compliant pads is reduced by about 4 dB.

# Conclusion

In the scope of railway interoperability, the noise emission values of high-speed trains have been assessed within the NOEMIE project (phase 1). In that respect, specific measurement methods have been used to assess the track characteristics. New improvements in the reference track definition have been proposed, so that it can be applicable with operational track, allowing the least influence of the track on the overall noise emission of the railway.

# Acknowledgements & References


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[2] Experimental validation of the TWINS prediction program, Thompson & al., 5th IWRN, June 95, JSV, 96.

[3] Silent track report n°80209/3/ISVR/T/A/djtsynth.doc



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