Sustainable railways strive to be good neighbours
Day 1: Being a responsible neighbour
Introduction

Moderator: Jakob OERTLI
Swiss Federal Railways (SBB)
Chair of UIC Noise and Vibration Sector

Kara OLDHOUSER
AMTRAK, UIC Sustainability Platform Vice Chair

Lucie ANDERTON
Network Rail (UK), Head of UIC Sustainability
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>8:30 – 9:00</td>
<td>Welcome desk &amp; networking coffee</td>
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<tr>
<td>9:00 – 9:20</td>
<td>Introduction and welcome remarks</td>
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<td></td>
<td>Moderated by Jakob Oertli, UIC Noise &amp; Vibration Sector, SBB</td>
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<tr>
<td></td>
<td>• Kara OLDHOUSER, UIC Sustainability Platform Vice Chair, Amtrak</td>
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<td></td>
<td>• Lucie ANDERTON, UIC Head of Sustainability, Network Rail</td>
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<tr>
<td>9:20 – 10:20</td>
<td>Hackathon (Only in-person participants)</td>
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<td>10:30 - 10:45</td>
<td>Break</td>
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<td>10:45 - 11:45</td>
<td>Policy</td>
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<td></td>
<td>• Pinar YILMAZER, Facilitator of the policy group, UIC Noise and Vibration Sector</td>
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<td>• Marco PAVIOTTI, EU DG ENV Policy Officer</td>
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<td>• Ethem PEKIN, CER</td>
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<td>Question and Answers</td>
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<td>11:45 – 12:00</td>
<td>Sponsor Booth</td>
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<td>@ Room Stephenson</td>
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<td>12:00 - 13:00</td>
<td>Lunch Break</td>
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<td>Time</td>
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<tr>
<td>13:00 - 14:30</td>
<td><strong>Supplier</strong></td>
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<td></td>
<td><strong>Lineside residents</strong></td>
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<td><strong>Research</strong></td>
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<tr>
<td>14:30 - 15:00</td>
<td><strong>Question and Answers</strong></td>
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<td>15:00 - 16:00</td>
<td><strong>Operators</strong></td>
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<td><strong>Infrastructure</strong></td>
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<td><strong>Question and Answers</strong></td>
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<td>Time</td>
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<tr>
<td>16:00 - 16:40</td>
<td>UIC Noise and Vibration Project</td>
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<td></td>
<td>• Louise MORRIS, ATKINS</td>
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<td>UIC report on nuisance and health impacts of railway noise</td>
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<tr>
<td></td>
<td>• Martin RISSMANN, VibraTec</td>
</tr>
<tr>
<td></td>
<td>UIC report on management of parked and stationary trains</td>
</tr>
<tr>
<td>16:40 - 17:00</td>
<td>Closing Session by Jakob Oertli</td>
</tr>
<tr>
<td>17:00 - 19:00</td>
<td>Reception</td>
</tr>
</tbody>
</table>
Thank you for your attention.

#UICRailwayNoiseDays, #UICSustainabilityActionWeek, #MoreTrains
10:30 - 10:45
Coffee Break
Watch at UIC’s YouTube Channel

Pınar Yılmазer
UIC Sustainability Programme Advisor
Noise Vibration Sector
UIC Railway Noise Days - 28 February 2023
Policy

Trend - Easy to split, regulated
- Annoyance / Different Perspectives / Limit Values?
- Sustainability
- Long time - Not clear Continuos Monitoring / 1 - Count
- Not based on Measurement Campaigns!
- Gaps: Operation & Lineside Residents - Community
  Need collaboration among DGs

Innovation - EU projects (Not advanced)

EU projects (Not advanced)
- Implementation missing

Policy as a DRIVER for INNOVATION

Policy:

POLICY

OLD WORLD

NEW WORLD

HOLISTIC VIEW

Innovation:

Policy should challenge, not just enable innovation

Innovation Phase:

Innovation is not easy

POLICY should challenge, but not make building innovation easy

LET'S DO SOMETHING AS PART OF...
Watch at UIC’s YouTube Channel

Marco PAVIOTTI
European Commission, Directorate-General for Environment (DG ENV)
Policy Officer
UIC Railway Noise Days - 28 February 2023
How the European Commission builds up the railway noise policy

Marco Paviotti, Directorate General for the Environment
Content

Making policy

Impact on public health

The implementation of the Directive, and its achievements

The other EU legislation on railway noise

Recommendations and next steps
Before policy making

- Treaties
- Laws
- Facts

Bound by

European Commission

Influenced by

- Citizens
- Member States
- Industry
Facts
# Impact on public health

<table>
<thead>
<tr>
<th></th>
<th>Highly annoyed</th>
<th>Highly sleep disturbed</th>
<th>Cases of ischaemic heart disease</th>
<th>Premature deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road traffic</td>
<td>14 400 000</td>
<td>3 700 000</td>
<td>33 600</td>
<td>8 900</td>
</tr>
<tr>
<td>Rail traffic</td>
<td>3 100 000</td>
<td>1 600 000</td>
<td>5 600</td>
<td>1 500</td>
</tr>
<tr>
<td>Air traffic</td>
<td>900 000</td>
<td>200 000</td>
<td>2 000</td>
<td>200</td>
</tr>
</tbody>
</table>
Impact on public health

Estimated total number of people exposed to noise in the EU, with increase/decrease projections between 2017 and 2030.
Laws
Legal framework

Train

- TSI-noise (limits for new trains and prohibition over specific railways)
  + Commission Regulation (EU) No 1304/2014
  + Commission Implementing Regulation (EU) 2019/774
- NDTAC (differentiated tariffs asking more to noisy and passing these to quiet ones)
  + Commission Implementing Regulation (EU) 2015/429
- GEF funds (fund to renew noisy trains)

Rail

- END (action plans to renew the rail and install noise barriers)
  + Directive 2002/49/EC
  + Commission Implementing Regulation (EU) 2019/774
Member States
Implementation of the Noise Directive

• Maps and plans are improved thanks to 15 infringements
  • 8 remain open

• Maps and plans have to be adopted at ‘whatever noise level’ (ECJ C697-20)

• Despite national limits

solutions are not implemented (maybe due to distribution of responsibilities)
Achievements of the Directive

• The maximum technically feasible noise reduction between 2017 (the date of the last analysis) and the relatively close date of 2030 is approximately 45%

• Direct administrative costs are EUR 0.04 per inhabitant concerned per year

• There is a return of EUR 10 in societal benefits for every euro spent on specific measures

• So: the (cheap) Directive harmonised approaches, but did not trigger noise reduction
Achievements of the TSI-Noise

• Reduce noisy trains ‘by design’

• Limit the noisy trains on EU railways since 2024!
Industry
But...

- Who pays?
- Are there safety issues?
- Can we introduce it in the daily railway operations?
- Railways is the most environmentally friendly transport mean!
Citizens
Schweizergewinde gegen Bahnarm im Mittelwalbeltal – 23.000 Anwohner hätten profitieren
Concluding...
Making policy

- Treaties
- Laws
- Facts

European Commission

Draft

Propose / Impose

- Citizens
- Member States
- Industry
The Sustainable and Smart Mobility Strategy

- The implementation of European rules on rail noise will help alleviate related concerns
The Zero Pollution Action Plan

• Target of reducing by 30% by 2030 the number of people chronically disturbed by transport noise in respect to 2017

• Better focusing on tackling noise at source – in line with the findings of the 2016 evaluation of the Environmental Noise Directive and the 2020 evaluation of the Outdoor Noise Directive, notably by securing proper implementation and, where appropriate, by improving the EU’s noise-related regulatory framework on road vehicles and their tyres, railways, aircraft – accompanied by parallel action at the global level;

• Following up the 2020 evaluation of the Outdoor Noise Directive by addressing outdoor equipment and reviewing progress in 2022; and

• Assessing the need to set noise reduction targets at the EU level in the Environmental Noise Directive.
Legislative options

1. Business as usual
   • Improve guidelines and provide recommendations on what to do.

2. Revise Directive 2002/49/EC (END)
   To introduce an European health improvement objective to be achieved through specific & mandatory targets.

3. Revise other EU legal acts
   Due to the multidimensional nature of the issue (conclusion of Phenomena study): Review a series of EU legal acts (tyres, cars, buildings etc.) ... In case of railway... TSI-Noise
Recommendations
Reducing the number of people chronically disturbed by transport noise in the EU requires action at all levels (EU, national, regional and local).

Cost-effective solutions are already available and should therefore be applied more quickly.

A limited set of harmonised improvements to a very small number of legislative instruments would make it possible to reduce noise exposure.
Thank you

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Ethem PEKIN
Community of European Railway and Infrastructure Companies (CER)
Head of Economic Policy and Sustainability

UIC Railway Noise Days - 28 February 2023
Noise mitigation with modal shift to rail

Ethem Pekin, Head of Economic Policy and Sustainability

UIC Sustainability Action Week
27 February 2023, UIC HQ Paris
Why rail noise mitigation is still so important?

- EU Green Deal and the EU Sustainable and Smart Mobility Strategy proposes a pivotal role for rail
- Rail’s external costs are excellent except for noise
- In some European regions noise is an obstacle for public acceptance for rail
- Noise is mainly generated between the wheels and rail but rail system is very complex
EU noise policy drives rail noise mitigation forward

- Environmental Noise Directive provides a legal basis for rail noise legislation
- Noise limits are in place to tackle rail noise at source through technical specifications
- Focus was given to the existing noisy rail freight fleet unlike any other transport mode
- Noise abatement include infrastructure measures
- Noise is a local externality – national measures are introduced
The European approach
Silent brakes on quieter routes

- In 2019 the Commission created a legal framework on banning noisy wagons from quieter routes
- International rail freight wagons thus be running on silent brakes by end of 2024
- CEF funding and national state aids were offered for retrofitting of brake blocks
- Update on % of silent wagons needed to have an uninterrupted international rail freight services
Rail noise scenarios

<table>
<thead>
<tr>
<th>Rail</th>
<th>Inside Agglomerations</th>
<th>Outside Agglomerations</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Conservative scenario</td>
<td>Best scenario</td>
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<tr>
<td></td>
<td>2022 2030</td>
<td>2022 2030</td>
</tr>
<tr>
<td>A. Population change</td>
<td></td>
<td></td>
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<tr>
<td>B. Transport activity change</td>
<td></td>
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<tr>
<td>C. Projected new urban rail infrastructure</td>
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<tr>
<td>D. Silent brake policy in major railways</td>
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<tr>
<td>E. Maintenance and rail grinding</td>
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<tr>
<td></td>
<td>dB decrease</td>
<td>no dB change (factor not relevant for the scenario)</td>
</tr>
</tbody>
</table>
Comments on noise-free future?

384. Tyres are an important consideration in road safety. Nevertheless, tyres are a significant cause of noise above 30 km/h and low performing tyres increase noise and its health effects. Regulating rolling resistance affects the energy consumption, and emissions of vehicles as well, thus again tyres are key in reducing carbon footprint. Last but not least, tyres are a main cause of the microplastics released in the environment. Different factors influence the abrasion rate of tyres. Tyre design, type of their raw materials, and external parameters such as roads, vehicle characteristics that can be regulated as well as ambient meteorological conditions to be taken into account, are some of these factors.

1126. Noise in the majority of the real situations depends, for road vehicles, on the tyres and road surface, for railway on the quality of wheels and rails, and for aircrafts on the engines and aircraft frame. Electric vehicles are sometimes associated with ‘no noise’ pollution which is however not the case. As a result, very little benefits are foreseen by a renewal of the fleet or changes in traffic. By 2030 an increase of noise is foreseen for all modes relative to 2015 due to the increase of the number of vehicles. By 2050 the increased number of electric vehicles could lead, for road only, to a limited benefit in terms of noise reduction. The impacts are limited unless other specific measures are adopted that benefit the fleet renewal and at the same time target noise, as well as CO₂ and air pollutant emissions reductions.
316. In spite of technological improvements which have made aircraft less noisy, the problem of aircraft noise in the EU has continuously increased in the past years. This is due to the continuous overall growth of air traffic in Europe as well as the expansion from population affected by aviation noise, linked to demographic growth and weak land use planning. Noise from aircraft is the third largest source of noise pollution affecting EU citizens, and research shows that people perceive noise from aircraft as more annoying than noise from road or rail, at the same noise level exposure. It is estimated that in 2017, more than 2.5 million EU citizens were subject to 55 dB noise level from aircraft, an increase of 12% as compared to 2005. With the expected continued overall growth of air traffic in Europe in the next decades - generating more flights in particular at medium size airports, the total population affected by critical noise levels from aircraft will likely further increase, especially at regional airports. Aircraft noise at night time is also a growing concern. In 2017, around 1 million EU citizens were exposed to at least 50 dB aircraft noise levels at night, an increase by 13% as compared to 2005.

418. **Airport charges** are paid by airlines to airports for the use of facilities and services, which are exclusively provided by the airport managing body and which are related to landing, take-off, lighting and parking of aircraft and processing of passengers and freight. While the Directive requires that airport charges are non-discriminatory, it permits modulations for environmental issues provided that they are relevant, objective and transparent. The 2019 evaluation of the Directive showed that only 61% of airports modulate charges on account of noise and only 20% of airports do so on account of NO\textsubscript{x} emissions. The 2019 evaluation did not find any airports that would modulate airport charges on account of CO\textsubscript{2} emissions. The planned revision of the Airport Charges Directive could aim to ensure the setting of airport charges is strategically aligned with the Green Deal Communication and environmental ambitions of the EU.
Solution?

- Pursue a holistic approach in noise mitigation
- Continue to invest in technology
- Cost-benefit analysis driven measures
- Smart pricing – internalise external costs
- Dialogue with public essential
For further information:

**Ethem Pekin**  
Head of Economic Policy and Sustainability  
Tel: +32 496 599 316  
E-mail: ethem.pekin@cer.be

For regular updates on CER activities,  
visit our website: [www.cer.be](http://www.cer.be)  
or follow [@CER_railways](https://twitter.com/CER_railways) | [CER](https://www.cer.be) | [LinkedIn](https://www.linkedin.com/company/cer)
11:45 - 12:00
Sponsors Booth
@ Room Stephenson

12:00 - 13:00
Lunch Break

With thanks to our Gold sponsor
SEMPERIT
Your worldwide partner in customized railway superstructure solutions

With thanks to our Silver sponsor
Fimor POLYURETHANE
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Participants</th>
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<tbody>
<tr>
<td>13:00 - 14:30</td>
<td><strong>Supplier</strong></td>
<td>Haike BRICK, Facilitator of the supplier group, DZSF</td>
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<td>Joan SAPENA, Alstom</td>
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<td></td>
<td><strong>Lineside residents</strong></td>
<td>Alf EKBLAD, Facilitator of the lineside resident group, Trafikverket</td>
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<td>Laurent DROIN, Centre d'Information sur le Bruit (CidB)</td>
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<td><strong>Research</strong></td>
<td>Lorenzo FRANZONI, Facilitator of the research group, UIC</td>
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<td>Thomas MALY, Technical University of Vienna</td>
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<td>14:30 - 15:00</td>
<td><strong>Break</strong></td>
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<td>15:00 - 16:00</td>
<td><strong>Operators</strong></td>
<td>Jamie WILKES, Facilitator of the operators group, Network Rail</td>
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<td>Martijn WOLF, Nederlandse Spoorwegen (NS)</td>
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<td><strong>Infrastructure</strong></td>
<td>Michael DITTRICH, Facilitator of the infrastructure group, TNO</td>
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<td>Urs SCHOENHOLZER, SBB</td>
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<td></td>
<td><strong>Question and Answers</strong></td>
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</table>
Watch at UIC’s YouTube Channel

Haike BRICK
German Centre for Rail Traffic Research / Deutsches Zentrum für Schienenverkehrsforschung (DZSF)

UIC Railway Noise Days - 28 February 2023
Supplier

Tender:
- Innovate within the scope of each tender?
- What is innovative about your tender?
- Customer/Motor?

Supplier:
- Rules:
  - Innovation
  - Idea

LETS OFFER CHOICE + SOLUTION

LETS LEARN FROM EACH OTHER + NEW SOLUTION

Europe + Tender	+ Project

Operational Change

Joint research projects:
- e.g. European rail
UIC Noise days – Supplier view

Joan Sapena

28/02/2023
Agenda

1. Good Neighbours
2. Interfaces
3. Difficulties
4. Solutions
Good Neighbours

Are Rolling Stock (RS) suppliers good neighbours?

We try to be contractually good neighbours

But, as good neighbours, we need to be flexible to live together in good harmony

- Main relation with our main neighbours is Exterior noise performance
  - Standstill noise
  - Parking noise
  - Pass-by constant speed
  - Acceleration noise
  - Warnings (horns, doors, …)

- Our community is wide..
  - Operators
  - Infra
  - Policy Makers
  - People!
Interfaces

- We are not alone in this world!
- The final noise performance depends on the complete “community” for all of our activities
- Pass-by
  - Track is the key - Infra
  - Hauled loads are important for locomotives – Operators
- Standstill
  - Less dependent of interfaces
- Parking mode
  - Very dependent on operators needs
- Acceleration
  - Depends on operators needs
    - Acceleration rate
    - Loads

We are a community!
Difficulties to be a good neighbour

• Lack of common standardization
• Difficult to develop products that fits everybody - Cost
• Multiple different requirements in function of operator
• Multiple ways of operating a train (specially in parking mode)

Definition of good neighbour is not always the same

Good boys in front of Policy makers but..

• in real operation we are not visible enough (track is masking good performances)
• Standards don’t cover all possible situations

Example of Parking Mode
- Different operating conditions for parking mode (Eurospec, VDV 1541, operator specific requirements)
- Lack of a current ISO standard (New ISO 3095 expected for the end of 2024) will include parking noise measurement procedure

Lack of standardization for parking mode – Quiet trains are not visible
Solutions (I) – Pass-by constant speed (80 kph to 320 kph)

- We are close to technical limits up to 200 kph
  - Main contributor is track
  - Bogie skirts will not cover track contribution

- For speeds higher than 200 kph
  - Track and wheel could be at the same level of importance
  - Wheel dampers and wheel design could improve a little the overall contribution
  - Aeroacoustics is only dominant for speeds higher than 320 kph – possible to work on overall aerodynamics (panto, bogie fairings, nose shape,…)

- Current measurement standards doesn’t show quiet trains…
  - Search for quietest track for testing is common practice to reduce risks
  - Results from different RS suppliers are not comparable (even if the standards used say so…)
  - Track and Vehicle noise separation (FINE2-TRANSIT Shift2Rail project) could be a future alternative for testing to separate track vs vehicle

For pass-by constant speed – We are close to the limit of feasible performances

<table>
<thead>
<tr>
<th>Simulation - Pass-by levels LpAeqTp</th>
<th>80 kph</th>
<th>160 kph</th>
<th>200 kph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just compliant ISO3095 track (roughness and TDR) vs Typical real test track used by industry (Roll2Rail compliant ISO 3095)</td>
<td>-4.8</td>
<td>-4.8</td>
<td>-4.2</td>
</tr>
</tbody>
</table>
Solutions (II) – Parking mode

- Operating conditions in parking mode or energy saving mode are key
- Each client/country of operation could request different ways of operating and also different temperatures
- Main equipment working in an EMU: Auxiliary converter, Transformer, HVAC (to reach internal temperature targets while parking (and compressor intermittently)
- Technical solutions consist:
  - optimized use of fans (EC fans)
  - EM noise improvement – High switching frequencies (SiC), Silencers, optimized cores

### Example of operating conditions for parking mode

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Condenser fan</th>
<th>Evaporator fan</th>
<th>Compressor</th>
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</thead>
<tbody>
<tr>
<td>Rest</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Rest intermittent</td>
<td>Low Speed</td>
<td>Low Speed</td>
<td>ON</td>
</tr>
<tr>
<td>Preparation for service</td>
<td>High or Low speed</td>
<td>High or Low speed</td>
<td>ON</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Transformer</th>
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<tr>
<td>Cooling Fan</td>
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<tr>
<td>Pumps</td>
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<tr>
<td>Power Module</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Auxiliary Converter</th>
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<td>Fan speed</td>
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<tr>
<th>Traction Converter</th>
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<tr>
<td>Cooling</td>
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<table>
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<tr>
<th>Main Compressor</th>
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<tr>
<td>Load</td>
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</table>

For parking mode – Solutions relies in optimizing the operating conditions of equipment.
Watch at UIC’s YouTube Channel

Alf EKBLAD
Trafikverket, Chair of UIC Noise and Vibration Sector

UIC Railway Noise Days - 28 February 2023
development of citizen groups

Lineside Resident

They are @ the centre

"Nimby" ≠ different ideas and expectations

"Why can’t they ride slower?"

"It’s getting better" but: growth?

→ more complaints vs. worries for on vibrations...? the future

the experience of a train passenger

keep improving

too slow: not satisfied

...misconception

better communication

more information ... no trust

[time to listen]
Watch at UIC’s YouTube Channel

Laurent DROIN
Centre d’Information sur le Bruit (CidB), Director

UIC Railway Noise Days - 28 February 2023
The noise information center (CidB): a tool to help manage (good) neighbourhood relations
What is the CidB?

- CidB is a non-profit association created 45 years ago in France, recognised as a public utility for 16 years.

- It is a reference resource centre for the general public and for all professional actors concerned by the quality of the sound environment.
Our job is to inform, educate, communicate on noise and its effects, transmit good practices and promote innovations.

In others words, we are trying to spread the know-how in this field, in a didactic way, to facilitate relations between stakeholders.
We work on the 3 main dimensions of noise:

physical acoustics ➔ physiology of hearing ➔ psychosociology of perception

\[ L_p = 10 \log \frac{P_d^2}{P_0^2} \] dB A, etc.

indicators

- Pa - Hz - t ➔ dB A - Leq, etc.

![Sensation vs Stimulus Graph](image)
And we work on the 3 main dimensions of sustainable development:
Here is an example of how we use the complaint data we collect via our hotline service:

In 2022, we dealt with approximately 1700 complaints received (mainly on neighbourhood issues): an average of 7 per day.

Of these, 25 complaints related to railway noise problems (train, metro, tramway).

These complaints are dealt with:
- by our team if the issues are regulatory or technically simple
- by experts from our network if they are complicated
- and sent to the operator if necessary!
Here is an example of the educational material we create for a non-expert public (e.g. town planners):
More information on:

- [www.cidb.org](http://www.cidb.org) (our website)
- [www.bruit.fr](http://www.bruit.fr) (the web media on noise in France)
Questions & Answers
Watch at UIC’s YouTube Channel

Lorenzo Franzoni
UIC Noise and Vibration, Facilitator of the research group

UIC Railway Noise Days - 28 February 2023
Research Center

- How much?
- Who pays?
- How to get funds, what after a project?
- Small companies struggle
- Field tests are complicated: DATA + DATA + NDA for DATA
- Cooperation w/ other institution of research

- SAP = Becoming Policy

Need shorter innovation cycles
- Lack of continuity!
- Role of suppliers + steps is complicated
- We have constant,irl safety, and replication
- Can't do a psychological Board approval
- Doesn't come from company
- Enlarge audience/marketing
- Networking, results

Data request and control should be easier
- Big companies = complex, not with anyone
- Challenges:
  - Research should be open, not secret in the big picture
  - Social activities, interactions post-event
  - Keeping proprietary
  - Internal & communicate outside
  - Global issues
  - Small scale, applications, scale

Shorter innovation cycles

Funding

Big Picture

Difficulties

Research Centers

- A huge amount of data
- Accessto original data

Field

Funded

Shall Corp.
Noise prediction as one way to improve the neighbourhood

UIC Railway Noise Days
Feb. 28th – Mar. 1st 2023, Paris, France

Thomas MALY
TU Wien, Institute of Transportation
Research Center for Railway Engineering, Traffic Economics and Ropeways
(from March 1st: Research Center for Track-Bound Transportation Systems)
https://www.tuwien.at/cee/transport
Overview

Introduction (prediction … why?)

European prediction model

Some of our research activities

• rail roughness
• wheel defect noise
• curve squeal
• transparent noise barrier elements

Concluding remarks
Predictions … why?

Good neighbours know very well

• how loud they are
• how loud they will be, e.g.
  ▪ in future with increased traffic or new lines
  ▪ with new vehicles and/or changed emissions
• how disturbing, annoying or even harmful to health their noise may be

Only then appropriate measures can be taken (early enough)
Predictions … why?

Good neighbours know

- how loud they are
- how loud they will be

How can we obtain this knowledge?

Often heard answer: sound measurements!

- Example: what time will be sunset next Sunday?
  → will you really wait and measure it?
  → or will you prefer to ask Mr. Google (= simple prediction with trusted model)?
    AND: now you are able to take measures against darkness if the sunset is surprisingly early 😊
- predictions often offer advantages, depending on the particular application
Predictions … why?

Predicting of noise enables

- consideration of huge amount of peoples & looking to future situations
- calculation of annual averages (→ mean values over several years!)
- estimation of the achievable effect of mitigation measures
- measurements are very important for model verification, but not very suitable to estimate annual mean values

Development of models as base of predictions implies

- to understand essential mechanisms, relations and influences (best prerequisites to develop mitigation measures / strategies)
- to choose meaningful result quantities which well describe the effects under investigations

Preceding, comprehensive research is fundamental for modelling

- beside acoustics, also materials science, economics, civil engineering, etc.
European prediction model

Uniform prediction approach was introduced 2015 (CNOSSOS-EU)

- yields noise indicators $L_{\text{den}}$ & $L_{\text{night}}$ that can be assessed by dose-response relations
- European wide mandatory for strategic noise mapping (low accuracy)
- some countries will use the model for legally binding immission limitation
  - higher accuracy needed (e.g. even <1 dB may decide on the noise barrier heights)
  - balance between level of abstraction, applicability and accuracy

Provide default input parameters for source power determination

- national adaptions or extensions allowed, if verifiable

National research as basis of the national implementation and future adaptions
Some of our research activities

Rail roughness

Curve squeal

Transparent noise barrier elements

Wheel defect noise
Influence of rail and wheel roughness on emissions

Changes in energetic sum of rail & wheel roughness leads to similar changes in the sound power of rolling noise

Default roughness spectra

- 2 default rail roughness spectra
- 3 default wheel roughness spectra
  - silent brakes: near rail roughness

Several national research projects regarding model input parameters

- in collaboration with Christian Kirisits
- some rail roughness measurement at various sites in Austria (EN 15610)
  - very smooth rails although no special maintenance (e.g. acoustical grinding)
  - median clear below all default rail (and wheel) roughnesses
Variation analysis and calculations

- shown differences in rail roughness spectra cause changes in the A-weighted level for trains with silent brakes up to several decibels

Indicates demand of verifying default values of the model

- continuous rail roughness measurements of network preferable
- further thoughts: are other default input parameters applicable (e.g. wheel roughness)?
Some of our research activities

- Rail roughness
- Curve squeal
- Transparent noise barrier elements
- Wheel defect noise
Curve squeal

2 research projects with long-term measurements in narrow curves with different radii (2013 – 2019)

• partner: psiacoustic

• empirically developed squeal detection for automatic assessment of ~55,000 pass-bys
  ▪ distinction between tonal and broadband components

• investigation of the influence of radius, train type, speed, weather, wheel and top-of-the-rail conditioning

• verification of default surcharges in prediction model:
  +8 dB (r < 300 m) / +5 dB (300 m ≤ r < 500 m)

• according to the research results:
  lowered surcharges in national implementation of the model for loud vehicles (e.g. +5 dB / +0 dB for cast iron braked vehicles)
Some of our research activities

- Rail roughness
- Curve squeal
- Transparent noise barrier elements
- Wheel defect noise
Multiple reflections between trains and reflecting noise barrier lower shielding effect

- usually noise barriers with absorbing surface

Transparent barrier elements cause similar effects up to several decibels

- European prediction model provides calculation scheme only for completely reflecting barriers

Research project (2019 – 2022)

- Acoustic Research Institute, Austrian Academy of Science
- reference calculations with 2.5D-boundary element method (ARI)
- validated by measurements with different noise barrier configurations
Development of a **calculation scheme for partly reflecting noise barriers**

- by comparative calculations with propagation of European prediction model
- based on current calculation scheme (extended by fresnel zones)
- prepared for integration into national implementation of the European prediction model

**Shortcomings of current prediction model, e.g.**

- no definition of vertical angle $\Psi$ of emission in case of noise barriers
- no definition of the number of multiple reflections to be taken into account
- unfavourable position of source & vehicle wall for multiple reflections

→ potential for improvements
Some of our research activities

- Rail roughness
- Curve squeal
- Transparent noise barrier elements
- Wheel defect noise
Wheel defect noise

Research project to compare wheel defects with their noise (2015)

• wheel load & defects measurements (argos®, HBK) and acoustic monitoring (acramos®, psia acoustics) at same site / cross section

• 2 months with ~3.800 train pass-bys (~138.000 axles)

Degree of modulation found as good descriptor for periodic impact noise

\[ m = \frac{p_{\text{max}} - p_{\text{min}}}{p_{\text{max}} + p_{\text{min}}} \]

• build from A-weighted sound pressure (2 kHz octave)
• modulation at fundamental frequency (singular defects)

approximated by amplitude modulation
Wheel defect noise

Major findings

• best correlation with measured rail accelerations
• rolling noise of loud vehicles can mask wheel defect noise
• more silent vehicles probably lead to more frequent occurrence of perceptible wheel defect noise

Due to averaging $L_{\text{den}}$ and $L_{\text{night}}$ almost insensitive

• model extension for this type of noise?

Follow-up project started 2023

classified as data

pass-by of a cargo train with cast iron braked and composite braked vehicles
Concluding remarks on the prediction model

**Reliable prediction essential for reasonable and timely noise protection**

- European approach is useful, but should be seen as the **beginning of an ongoing process**
- Current prediction model leads to (partly unnecessary) **national research efforts**!
  - provides too less different or inappropriate default input parameters
  - contains some shortcomings in the calculation scheme
  - does not include many **noise protection measures** (even if state-of-the-art)
    (TDR-influencing measures, wheel absorber, vehicle side noise protection shields, etc.)
  - no standardized procedures defined to determine input parameters

**Improvements will be required (especially for legally binding predictions)**

- many aspects concerns not only Austria → European initiatives preferable
- science can help to build the basics for improvements
Thank you for your attention!

Any questions?
14:30 - 15:00
Coffee Break
Watch at UIC’s YouTube Channel

Network Rail, Principal Engineer, Facilitator of the operators group

Jamie WILKES

UIC Railway Noise Days - 28 February 2023
Watch at UIC’s YouTube Channel

Martijn WOLF
Nederlandse Spoorwegen (NS)
UIC Railway Noise Days - 28 February 2023
Being a responsible neighbour – view of NS

UIC Railway Noise days

Martijn Wolf

28 February 2023, Paris
Contents

- Background noise policy being a good neighbour
- Parking noise – practical reduction examples
- Present and future actions
- Questions and Discussion
Background noise policy being a good neighbour

- NS goal is to operate trains and to be a good neighbour
- Pass-by, starting and parking noise are important.
- → additional procurement specification on noise

Pass-by noise:

Stricter limits for commuter trains than TSI limits: 76 dB(A) instead of 80 dB(A)

Starting noise:

Stricter limits for commuter trains than TSI limits: 75 dB(A) instead of 80 dB(A)
Background noise policy being a good neighbour

Parking noise

- Stricter limits than TSI stationary noise limits: 62 dB(A) instead of 65 dB(A)
- Limits set for single noise source instead of average for all noise sources
- Creation of EuroSpec Parking noise requirements together with DB, SBB, SNCF

(https://eurospec.eu/parking-noise/)
Parking noise

- Too much parking noise:
  - Causes nuisance for neighbours
  - Reduces parking space at railway yards due to environmental laws.
Parking noise – practical examples

HVAC Noise commuter train

- Original HVAC had a condenser fan which can only run at one speed.
- This caused many complaints from citizens when a train was parked near their houses.
- By adding a lower fan, the noise for a parked train was reduced with almost 9 dB(A). (Year 2021)

Compressor Noise commuter train

- The blow off valve of the compressor on the roof (which needs to blow off every hour for ~3 minutes) caused many complaints.
- By adding a damper, the noise was reduced with almost 6 dB(A). (Year 2021)
Parking noise – practical examples

Emergency brake venting Intercity train

- Before modification, venting was outside the train. LpAF,max 7.5 m was ~100 dB(A)
- After modification, venting was done inside the floor of the driver’s cab
  - Inside noise LpAF,max: 83 dB(A)
  - Outside noise @7.5m: LpAF,max: 64 dB(A)
Present and future actions

- Update EuroSpec Parking noise requirements with experiences and updated EN ISO 3095:2013

- Parking noise working group in UIC NNV:
  - UIC report on management of parked and stationary train (see presentation Vibratec)
  - Ideathon on parking noise: workshops with (sub) suppliers, operators and IM on (innovative) noise reduction possibilities of single sources (planned for 2023)

- Europe’s Rail – Rail4Earth: Squeal noise and Tonal noise

- Next? TSI update: include parking noise with limit values
Questions and discussion
Watch at UIC's YouTube Channel

Michael DITTRICH
TNO, Facilitator of the infrastructure group

UIC Railway Noise Days - 28 February 2023
How to get 10dB more noise reduction?

- Complete system: Track/Vehicle
- Substantial changes in design?
  - Doubt about effects
    - Monitor/Measure
    - Learn from findings

- Responsible roles for Noise: Infra/Rolling Stock, Pay per Passby, As for Aircraft
- Real Noise

- NDTAC based on MAC, Leq

- Holistic approach - all aspects/impacts
  - Infr + Rolling + Track + not all known
  - Energy Synergy next to lines
  - Rail grinding/scheduling/coordination optimised for noise

- Obstacles: Money, Regulation, Traffic growth
  - Lead of best tracks for new innovations
  - Risks: Understand physics, supply ideas, interfaces, fit in
  - Innovations that are needed and used
  - Streamline standards/organisation

- Stakeholder management: Internal/External
  - Decisions, materials for components/barriers
Watch at UIC’s YouTube Channel

SBB, Head of Track system

Urs SCHOENHOLZER
SBB, Head of Track system

UIC Railway Noise Days - 28 February 2023
Infrastructure Manager

Urs Schönholzer, SBB Infrastructure
UIC Noise Days, Paris 2023
Noise Sources
Traffic Noise

- Rolling noise, combined roughness of wheel and rail
- Aerodynamic noise
- Traction motors, cooling fans, air compressors
- Curve squeal
- Noise TSI defines measurement, but only for new rolling stock on smooth track
- Quieter routes will limit cast-iron brakes
Temporary Anomalies, Track Maintenance

- Insulating joints, jointed track
- Bad welds
- Corrugated rails
- Noise after track works, e.g., grinding
- Maintenance of switches and crossings
- Electrical sparks, contact line in cold weather
Noise Emission of Parked Trains

– Sources are motors, compressors, and other auxiliary units.
– Different regulation from rolling noise, different distinction between day and night
– Shutdown often not feasible for operational or safety reasons
– Interlocked with rail yard infrastructure, e.g. amenities for railway personnel
Construction Noise

- Construction often during the night
- Construction emissions during work, and during maintenance work on equipment in a siding
- Safety alerts for personnel when adjacent track is in operation
- Traffic on unfinished track in operation during the day (joints)
Other Sources

- Acoustic door signals for trains stopped at stations, mainly affect lineside residents close to small stations
- Loudspeaker announcements at stations with low background noise levels, at night
Mitigation
Established Mitigation Methods

- Noise barriers
- Effective, but
  - Vandalism, graffiti
  - High, intransparent wall
  - Different opinions of residents
  - Not suitable for higher residential buildings
  - Limited track access for maintenance crews and emergency services
  - Wildlife migration paths blocked
Other Methods, suitable for local application

- Friction modifiers, against curve squeal
  - Some effect, but noise is not entirely eliminated
- Rail dampers, increasing mass, de-tuning of the rail
  - Maintenance concern for vision-based automated detection systems
- Effect varies with superstructure material
Ongoing Research

Reducing noise at the source:
- Novel rail pads
- Rail surface roughness optimization
- Understanding curve squeal
- Mitigation methods for vehicles: brake systems, wheel dampers
- Battery-powered construction equipment

Reduce sound radiation:
- Sound barrier elements with diffractive effect (Helmholtz resonance)
Conflicts of Interest

- More traffic – more noise
- Higher speed – more noise
- More mitigation – higher cost, e.g. electrification of lines
- More components in track – higher complexity
  - Every new element needs to be procured, installed, maintained, renewed
- Environmental concerns of wheel/rail friction modifiers
- Deregulated markets need external incentives for noise mitigation. Infrastructure managers cannot put noise requirements on rolling stock operators without legal basis
We are working on it...
Thank you!

Contact: urs.schoenholzer@sbb.ch
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>16:00 - 16:40</td>
<td><strong>UIC Noise and Vibration Project</strong></td>
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<tr>
<td></td>
<td>• Louise MORRIS, ATKINS</td>
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<td>UIC report on nuisance and health impacts of railway noise</td>
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<td></td>
<td>• Martin RISSMANN, VibraTec</td>
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<td>UIC report on management of parked and stationary trains</td>
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<td>16:40 - 17:00</td>
<td><strong>Closing Session by Jakob Oertli</strong></td>
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<tr>
<td>17:00 - 19:00</td>
<td><strong>Evening Reception @ UIC Mezzanine</strong></td>
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Watch at UIC’s YouTube Channel

Louise MORRIS
ATKINS, Principal Acoustician

UIC Railway Noise Days - 28 February 2023
Project context and objectives

Railway noise emissions are decreasing… …but… …the rate of complaints from communities living along parts of the railways remains high

The objectives of this scoping study are:

1. To acquire a representative picture of the *nuisance* effect of rail noise and its impact on **human health** in European railways in 2022 and to prepare a proposal to determine the next steps and make suggestions for the global railway community.

2. Provide an **evidence basis** on the impact of noise nuisance on human health for UIC participation in the European Commission meetings with the aim that it will inform EU or national governments **funding** and **legislation** decisions.
Project scope

This scoping study report provides a critical assessment of the existing research covering the themes below:

- The big picture
- Annoyance curves
- Noise indicators
- Health indicators
- Complaints
- Methods to address noise impacts
- Economic considerations
- Survey to UIC members
- Knowledge gaps
Complaint psychology

A noise complaint is a written or verbal expression of dissatisfaction with the noise environment.

- Human brain has a ‘neural template’. It gathers more information when exposed to a new stimulus.
- If the stimulus is unusual, there is an arousal – a conscious recognition of a change.
- This intrusion into conscious thought can be an annoyance, leading to actions to reduce or stop the noise.

- Annoyance is a function of average noise exposure and arousal, complaints are a function of arousal only.
- The act of complaining is a reaction and coping mechanism.
- Complaint behaviour is influenced by a variety of factors and not all annoyed people complain.
- Intermittent events of higher intensity or distinct character cause arousals more than steady-state conditions.
- There are qualitative differences in complaints for different sources, linked to perceptions and fear.

Source: Luz et al 1983
Objectives and methodology

An online questionnaire was issued to railway infrastructure managers and operators to:

› Better understand the **underlying reasons** for continued high rates of **complaints** along railways
› Identify **features of railway noise** which elicit adverse subjective responses.

The survey was open from 24 November 2021 to 22 March 2022.

Respondent information

› Responses received from **18 stakeholders** from European and international railways, representing 15 countries and **64%** total railway length in Europe
Survey Outcomes – Causes of Complaint

The top three railway features causing complaints were:
1) Freight trains
2) New, upgraded or altered infrastructure
3) Maintenance operations (e.g. rail grinding)

Other common causes were the frequency of services, turnouts and crossovers, tight curves and train horns

The biggest concern raised by complainants was sleep disturbance. Other key factors raised were:
1) Health
2) Real estate depreciation
3) Inaction
Conclusions

› **Significant growth** expected in high-speed and freight rail transportation expected in the coming years.

› Exposure-response relationships **no longer favour railway noise** over other transportation sources and the numbers of people annoyed by railway noise may have increased.

› **Freight trains** operating during night-time is the most common cause for complaints.

› Situations where there is a change in noise, “**atypical noise**”, areas of extreme sensitivity or where noise limits are exceeded are linked to complaints.

› **Intermittent high noise events** or sounds of distinct character cause an **arousal effect** more than steady-state conditions, leading to complaints. **Short-term indicators** (e.g. $L_{A_{max}}$) capture this better than long-term indicators (e.g. $L_{den}$, $L_{night}$).

› Future mitigation will likely need to combine the conventional mitigation efforts with **innovative** ways to more specifically address annoyance/complaints caused by railways.

› Infrastructure managers and operators need to **work together** to achieve cost effective mitigation to further reduce railway noise.
Potential next steps

Complaints

› Further analysis of complaints data to establish the priority of rail noise sources causing disturbance.
› Sharing of best practice.
› High speed rail study on complaints and noise management.
› Influence of local acoustic and non-acoustic factors on exposure-response relationships and complaint generation.

Noise levels and perceptions of different railway noise sources

› Short-term objective effects of noise to build up evidence base.
› Exposure-response relationships for freight and passenger trains.
› Studies linking perceptions of different types of rail service (passenger, freight, high speed) and atypical rail noise (such as curve squeal, joints) to noise indicators representing railway noise characteristics.
› Scope of study to include noise exposure-response relationships and use of psychoacoustic indicators.

Innovative mitigation

› Infrastructure managers and operators to work together to achieve cost-effective mitigation.
› Combining conventional mitigation efforts with innovative ways to more specifically address annoyance/complaints.
› The efficiency of improving health through noise could be compared with improvements in other areas of health and their cost (e.g. nutrition).
Our values are the essence of our company’s identity. They represent how we act, speak and behave together, and how we engage with our clients and stakeholders.

**SAFETY**

We put safety at the heart of everything we do, to safeguard people, assets and the environment.

**INTEGRITY**

We do the right thing, no matter what, and are accountable for our actions.

**COLLABORATION**

We work together and embrace each other’s unique contribution to deliver amazing results for all.

**INNOVATION**

We redefine engineering by thinking boldly, proudly and differently.

Watch at UIC’s YouTube Channel

Martin RISSMANN
VibraTec
UIC Railway Noise Days - 28 February 2023
UIC SUSTAINABILITY

Noise from parked and stationary trains:
An analysis of operational and technical solutions

Noise and Vibration Technical Advice (NOVITÀ) Project

February 2023
Why trains stand still?

Stationary = in service

- in a station or at a signal
- technical components are running

Parked = out of commercial service

- in depots, stations, termini of secondary lines
- overnight or during week-end
- some technical components are running, e.g. to protect other components

Low value = mode active

— parked — standby — pre-heating — commercial service

28/02/2023

Noise from parked and stationary trains
How to define a train at a standstill?

Stationary

Parked

Train speed

Time

Stationary  Stationary

Train speed

Time

Preparation for resting  Resting  Preparation for service

Parking

Still a lot of work to do

Already well-framed: ISO 3095, TSI Noise, etc.
Noise emission strongly depends on activity.

- A stationary train is generally louder than parked trains since all technical components are running.
- For a parked train, the noise emitting activities depend
  - On the train operating condition:
    - Preparation for resting
    - Resting
    - Preparation for service
  - On the equipment:
    - Continuous or intermittent activity
    - Weather

Sound pressure level at the vicinity of a parked EMU
A survey was conducted with great success!

Survey with in total 29 contributions from 16 countries
→ Infrastructure managers (69 %)
→ Operators (24 %)
→ Both (7 %)
→ 11 participants provided measurement data
→ contribution from
Noise complaints increased over the last 5 years for 45% of the participants.

→ Locomotives & DMUs are the most critical
→ EMUs have intermediate criticality

![Bar chart showing the criticality of noise from parked and stationary trains, with EMUs, DMUs, and Locomotives.](chart)

*Figure 20: Reasons for noise complaints regarding parked trains – 25 answers, multiple answers possible* - [7]
Standstill noise measurements exist, but are difficult to compare!

- Some countries, e.g. NL & CH, have acoustic databases, others single measurements
- Comparison difficult due to different
  - Assessed quantities
  - Operating points or missing description
  - Measurement conditions
- Example: HVAC components
  ➔ Dispersion up to 40 dB
  ➔ Sleeping mode has lower levels as expected
  ➔ Highspeed tends to have higher levels
Variability in measurements can be important!

- HVAC units measured at 1 m from the HVAC fans
- Variability of
  - 0.7 dB for driver cabin
  - 2.1 dB above the doors

→ Need to specify measurement procedure, error assessment
→ Operating and measurement conditions repeatable?
→ Variability from on train to the other within the same type?

Data provided by ARUP, UK

28/02/2023
Regulatory frameworks need further harmonisation!

- Future version of ISO 3095 will include parking noise
  - UIC NV sector sees this as a step forward
  - However, still open points, e.g. detailed description of single component measurement → environmental noise
- Some frameworks (VDV, EuroSpec, NSW) propose noise limit values
  - However based on different assessment conditions
- Parking noise = industrial noise 🏭 → lower limit values
There are many ways to reduce parking noise!

**Vehicle side**
- Retrofit, silencers, encapsulation, etc.
- Software: demand-controlled operation, optimization of operating modes (e.g. fan speed)
- Energy-optimization = noise reduction

**Infrastructure side**
- Noise barriers → no solution for roof mounted sources
- Special parking orders
- Automated acoustic surveillance → Train in the right mode?

*Figure 21: Parking noise mitigation measure (46 answers) – from [7]*

28/02/2023 Noise from parked and stationary trains
Noise reduction is not always easy, but...

→ Reducing noise requires cooperation between stake holders!

→ Costs, modifications, homologation, etc. need to be considered!

→ But 2 simple measures are identified:
  • Check correct application of the required standstill mode by the train driver!
  • Rise awareness of local authorities with regard to land use planning and regional authorities defining tenders for new rolling stock
Further work is needed on the track towards noise limits!

**Decreasing railway noise** is a priority for UIC’s NV sector

Still **no TSI NOI limit values** on parking noise

**Critical analyse** of the current state of noise from trains at a standstill

**Diverging opinions** between stakeholders, e.g.:

- Infrastructure managers have to deal with environmental noise limits
- Rolling stock manufacturers need clear and simple homologation procedures

**Noise limit values**

- agreement has to be found on the assessment procedure including train operation modes.
- a common shared database is required in order to define feasible, but also incentive limits
THANK YOU FOR YOUR ATTENTION

MARTIN RISSMANN

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QUESTIONS & ANSWERS
Closing Session

Jakob OERTLI
Swiss Federal Railways (SBB)
Chair of UIC Noise and Vibration Sector
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#UICrail

#UICRailwayNoiseDays, #UICSustainabilityActionWeek, #MoreTrains

noisevibration@uic.org

Thank you for your attention.