

4 POTENTIAL IMPACT AND MAIN DISSEMINATION ACTIVITIES AND EXPLOITATION RESULTS

4.1 Impact and stakeholders

The project results in a number of tools and solutions for railway rolling noise mitigation, noise mapping and action planning and for condition based maintenance planning.

The tools include on board monitoring of rail wear, track decay rate and rail roughness for determining track locations where maintenance or refurbishment is required.

Validated rail roughness growth models in function of tonnage allow the use of predictive maintenance and the design of low noise rail fixation systems.

The above results are available to the railway maintenance industry (including PPP consortia, providers of grinding services, providers of monitoring services and products) and infra managers.

Simulation software is developed and will be made available to engineering companies, consultants, railway operators and infra managers to compute the rolling noise also at low frequencies characterised by high propagation and high transmission and hence sometimes very disturbing. The simulation tool also includes the possibility of dealing with multiple contact points (e.g. in curves) often associated with locations where complaints are the highest.

Novel track based solutions for rolling noise mitigation are developed and will be made available to the track designers, track work contractors and infra managers. These include novel rail fixation systems based upon a concept for reduced rail roughness growth (no corrugation). The concept of combining existing solutions (track absorption panels, low noise barriers and rail dampers) has given the possibility of gaining more than 10 dB(A) noise reduction. The dissemination of this result to the wide noise community is on-going. Specific embedded low noise rail solutions for urban rail have been developed and validated with attention for low maintenance. Design concepts for minimal rail wear and associated low noise emission growth have been developed. The developed wear calculation tool is very reliable and unique. .

The project includes tools a harmonized procedure for measuring the performance of a track based noise mitigation solution, a procedure for the determination of the track decay rate of embedded track systems and a procedure for the determination of the average wheel roughness. All project findings relevant for TSI Noise have been bundled in a specific deliverable.

The impact of reduced noise emission from operating trains on the comfort and the health of the people are maximal where a maximum number of people are affected. The noise management tools, which are developed in QUIET-TRACK emphasize and integrate this concept. The cost of maintenance actions and noise mitigation solutions is compared with recognized noise cost factors. This analysis take into account the number of people affected, the period of the noise intrusion (day, night, evening), the construction of the buildings (facade orientation), the location of the living rooms and bedrooms and is aimed at maximizing the noise mitigation performance to cost ratio.

The project contributes heavily to sustainable rail transport. Only when the emitted noise levels are considered acceptable, non-intrusive and not harmful by the society, fast installation and operation of new rail transport lines will become a reality, greatly for the benefit of society but also for the European rail supply industry.

4.2 Dissemination

Objectives

A wide range of tools and methods help QUIET-TRACK to spread achieved findings in the project for supporting city administrations, infrastructure maintenance companies and railway track contractors.

The general aims of the dissemination are:

- to set up a dissemination strategy for a wide-spread information transfer among and beyond the members of the consortium;
 - to ensure that the research carried out in the project fully exploits existing knowledge;
 - to form a basis for the continuous uptake of the results of the project;
 - to arrive at convincing project results (methods, developments and recommendations) for integration of the results into existing standards;
 - to reach the relevant stakeholders who will implement the project results;
 - to maximize the market uptake by external dissemination activities towards other non-participating bodies; and
 - to monitor and implement specific national needs of heavy rail operators and infrastructure managers.
- In addition, QUIET-TRACK dissemination activities also help to increase the awareness and the transparency of the existence and the use of EU funds.

Public website

An important dissemination tool for the QUIET-TRACK project is the public website www.quiet-track.eu, which was launched in month three of the project and is continuously updated, building the main online hub for making the project visible and to publish results to the public. The project website will remain online after the project end according to the overall agreement.

This project website acts as a main platform for information exchange and as a source of information about project outcomes. The website is accessible for anyone interested in the project and its area of work.

Besides giving information on the project, the website is also used as the main vehicle to make available all of the public deliverables, as well as other public reports that may be produced during the project lifetime.

The start page of the QUIET-TRACK website is shown in

Figure 1 .



Figure 1: First page of QUIET-TRACK website

QR-Code

To improve access to the QUIET-TRACK website a QR-code was generated. It is posted on any advertising materials to share project information and project results in a short and easy way.



Figure 2: QR-code to reach www.quiet-track.eu

Project Flyer

A project flyer has been produced in the beginning of the project period presenting the QUIET-TRACK project and its main activities, see Figure 3. The flyer is available for download at the project website www.quiet-track.eu/Downloads and this was distributed by partners at dissemination events.

In total around 1 500 project flyers have been distributed during the lifetime of the QUIET-TRACK project.



Figure 3: The QUIET-TRACK flyer

Project Poster

Different QUIET-TRACK posters have been created to present the project at the following international congresses:

- Light Rail 2016, London, UK;
- ASLRRA 2016, Washington, DC-USA;
- DAGA TSI Workshop, Final Dissemination Conference, 2016, Aachen, Germany;
- High Speed Rail Conference, Los Angeles, CA-USA;
- High Speed Rail Conference, Los Angeles, CA-US;
- APTA 2015 Annual Rail Conference, San Francisco, CA-USA;
- ICSV22 (International Congress on Sound and Vibration) 2015, Florence, Italy;
- TRB 2015 in Washington, DC, USA;
- InterNoise 2013, Innsbruck, Austria.

The following pictures show exemplary how QUIET-TRACK posters were presented at congresses.

After the project completion, partners are willing to promote the project results further on, such as the international congress ICSV 23 in Athens, Greece.



Figure 4: Examples of congresses presenting the QUIET-TRACK outcomes through posters

The posters can be downloaded from the project website under: www.quiet-track.eu/Downloads.

Project Newsletters

QUIET-TRACK's yearly digital newsletters give an overview about the project, inform the public about the project objectives, its progress and already achieved project results.

The newsletters were distributed electronically, by e-mail. The pdf file has been circulated to the project partners for their own distribution to relevant contacts and has been made available for download on the QUIET-TRACK website. The newsletters have been issued by the partners to more than 5 000 interested parties.

The newsletter has also been distributed in a printed format together with the project flyer at major events, congresses. In total, 3 Newsletters were issued:

Issue #3: 30 May 2016

Issue #2: 1 June 2015

Issue #1: 28 May 2014

An example of the Newsletter is presented in

Figure 5. All issues of the newsletter can be found in www.quiet-track.eu/Downloads/Dissemination.

The newsletters have been distributed as hardcopy at research seminars, workshops, industrial project presentations and in addition at the following events:

- Light Rail 2016, London, UK;
- ASLRRA 2016, Washington, DC-USA;
- DAGA TSI Workshop, Final Dissemination Conference, 2016, Aachen, Germany;
- High Speed Rail Conference, Los Angeles, CA-USA;
- High Speed Rail Conference, Los Angeles, CA-USA;
- APTA 2015 Annual Rail Conference, San Francisco, CA-USA;
- ICSV22 (International Congress on Sound and Vibration) 2015, Florence, Italy;
- TRB 2015 in Washington, DC, USA;

- 7th Pan-Hellenic Conference «Acoustics 2014», Thessaloniki, Greece;
- 18th Nordic Seminar on Railway Technology, Bergen, Norway;
- ISMA 2014, Leuven, Belgium;
- ICSV21, Beijing/China;
- INNOTRANS 2014, Berlin, Germany;
- RAIL-NOISE 2014, Berlin, Germany;
- InterNoise 2013, Innsbruck, Austria.



Figure 5: Example of the QUIET-TRACK newsletter

QUIET-TRACK in the media

QUIET-TRACK has also made impact in the press, especially in the Swedish-speaking area. An interview about the QUIET-TRACK project was published in the Swedish paper "Innovation" with the title: "Sssssccchhhhh!", this can be also watched at the website

<http://62.13.72.13/fb/Tyren/Innovation%20Tyrens%20TT/HTM/index.html#21/z>.

Another interview about the QUIET-TRACK project was given and published in the Newsletter of TYRENS with the title: "Forskningsprojekt på väg att bli en ny product", see also

<http://www.anpdm.com/article/41435A43784442504578494A5D4B71/16403313/3467638>.

Publication of Papers in Conferences and Journals

Publications in conferences and journals are an important way to disseminate scientific knowledge – QUIET-TRACK also followed this approach to publish its results. All partners carrying out scientific work participated on presenting papers to several conferences and journals. The publication activity of partners has been monitored during the lifetime of the project and the majority can be also found at the QUIET-TRACK website.

Several international conferences were targeted to spread project results. In total

- 13 papers accepted in conferences;
- 4 publications accepted to journals.

Major conferences where QUIET-TRACK papers were published include ICSV, EuroNoise, VTI Transport forum, ISMA, and InterNoise.

Major journals, where peer reviewed publications in journals were placed, are: Science of the Total Environment, Wear and Bygg&Teknik.

At present, 3 more papers for conferences and 1 scientific article for journal publication are currently waiting for the review.

In Annex II of deliverable D7.2 (see quiet-track website) a detailed, complete list of scientific publications can be found including papers in proceedings of conferences and peer reviewed publications in journals.

QUIET-TRACK Workshops

In the QUIET-TRACK project, **two end-user workshops** were anticipated to be organized between M24 and M36.

The targeted **first dissemination workshop** has been undertaken on July 15, 2015 at the 22nd International Congress on Sound and Vibration ICSV 22 in Florence, Italy. In the session T05.SS06 "Predictive Maintenance Employing Non-Intrusive Inspection & Data Analysis" topics of presentations included prediction of low frequency railway rolling noise, noise management tool for track maintenance activities and noise mitigation solutions, methods of high rolling noise reduction, noise related track maintenance tool, monitoring system for track roughness. The session targeted urban transport noise experts from industry and research, heavy rail operators and infra managers. In six scientific presentations, the mid-term achievements of the research project were introduced. All papers are available on the QUIET-TRACK website for download.

In the frame of the first dissemination workshop a QUIET-TRACK booth was also implemented, showing results of project results and distributing flyers and newsletters.

The QUIET-TRACK **Final Dissemination Conference & Second TSI Workshop** at DAGA 2016, on 14/03/2016, was a combined event addressing urban transport noise experts from industry and research, heavy rail operators and inframanagers. This event – undertaken in the frame of the noise conference DAGA 2016 – had the objective to disseminate the project results to the broadest audience possible.

Effective track based rolling noise mitigating solutions for trams, regional trains, surface metro and trains in an urban environment with direct application possibility to conventional railway tracks outside the city, rolling noise calculation strategies and further maintenance and management tools for cost optimized noise reduction at urban railway network were presented to the public.

The list of presented results is shown in Annex III, number 50-53. Final achievements of the project have been presented on posters. Project flyer, newsletters and 8 additional flyers related to the individual outputs for dissemination and exploitation were distributed to the participants, see Figure 7.

All presentations, special flyers of individual outputs and posters are available on the QUIET-TRACK website [www.quiet-track.eu/Downloads/QT Final Dissemination Conference & Workshop March 13, 2016 – Aachen](http://www.quiet-track.eu/Downloads/QT%20Final%20Dissemination%20Conference%20&%20Workshop%20March%2013,%202016%20%E2%80%93%20Aachen) for download.

Dissemination activities

Project partners participated in industry events, conferences, seminars and workshops in order to highlight the project contents and methodology, as well as the project results. The complete list of dissemination activities of the QUIET-TRACK partners were monitored during the lifetime of the project and are shown in deliverable D7.2 Annex III (see quiet-track website). This list includes also different dissemination event after project completion and will help to exploit project results optimally.



Figure 6: Examples of distributed conference material of the QUIET-TRACK Final Dissemination Conference & Second TSI Workshop at DAGA 2016

4.3 Exploitation

QUIET-TRACK has produced innovations that are very close to market. By working with an advisory board, exploitation will be facilitated since the solutions are easily adaptable to eventual national needs expressed by the advisory board members.

The project's outputs such as procedures, simulation tools, monitoring solutions, measurement procedures, noise mitigation solutions and noise management tools, are be end-user driven and practice orientated. Procedures are public and readily available for integration in other software tools than the ones used within QUIET-TRACK (e.g. for integration within TWINS). As the project brings together specialized solution providers and infrastructure managers, the innovations developed and specifications set up are directed at tackling the most problematic areas in the area of track noise control with highest demand for innovative and very effective solutions. It is expected that the developed solutions will be implemented by infra managers and railway industry partners and that the developed procedures will lead to a European-wide harmonised approach in the field of rolling noise control.

Each partner will apply its internal rules and procedures in order to assimilate the application of results of each work packages making them available for the interested divisions within each company.

Derived guidelines, internal rules, recommendations, manuals for practical personnel education and experience-sharing will developed following their respective internal policies and regulations in order to implement the project results.

In more detail, it is expected that the partners will exploit the following project outputs:

Monitoring systems

- validated on-board monitoring systems for determining the rail roughness and track decay rates (as input to the noise models and as track quality measurement device) mounted on measurement vehicles in the Stockholm network, easily installable on other vehicles in other networks.
- validated on-board monitoring systems for determining the track decay rates (as input to the noise models and as track quality measurement device) mounted on measurement vehicles in the Stockholm network, easily installable on other vehicles in other networks.



- validated on-board monitoring systems for determining the noise related wear in curves (as input to the maintenance plans and as track quality measurement device) mounted on measurement vehicles in the Stockholm network, easily installable on other vehicles in other networks.

Noise simulation software

Enhanced rolling noise modelling software will be delivered which includes the low frequency noise emission and which includes the actual wheel rail contact conditions for more accurate predictions of the noise emitted by the track, for use in noise mapping according to the END and for use in action planning. The input data for this software tool will be drastically enhanced by providing exact and network wide rail roughness and TDR from the on-board monitoring systems, by providing a procedure for determining the average wheel roughness and by providing a procedure for determining the model input parameters (TDR, receptances) for embedded rail systems (where applicable)

Innovative and effective solutions

- solutions for track noise mitigation by effective combination of existing solutions for specific cases where e.g. completely new track systems cannot be considered, validated in the network of Attiko Metro.
- innovative new track solutions for track noise mitigation by reduction of the rail roughness growth rate (very resilient rail fixation systems and track systems which ensure a very stable track geometry), validated in the network of Infrabel.
- innovative new track solution by optimisation of the embedded track system characteristics for combined noise and vibration mitigation, validated in the network of DL.
- a procedure for selecting optimal rail types and hardness with aim of optimally reduced noise related wear, validated in the network of DL.

Noise maintenance and management tools

- a track maintenance tool based on a data base gathered with the on-board monitoring systems, including rail roughness and noise related wear in curves.
- a noise management tool for track maintenance activities based upon a global cost approach.
- a noise management tool for the introduction of noise mitigating solutions at the track level based upon a global cost approach.

Partner	Knowledge / Outputs of the project	Use for the partners & targeted market/ Type of exploitation - Benefits
AKRON	- Enhanced models for wheel-rail noise simulation including the low frequency bands, better description of the wheel/rail contact conditions. - Procedure for the average wheel roughness determination. - Procedures for validation of acoustic simulation models. - Procedures for measuring the performance of track based solutions on	- Gain knowledge about simulation lacks and needs to work on the development of improved simulation techniques. - Better characterisation of the track related noise. - Better characterisation of the performance of noise abatement solutions with a common measurement procedure. - Sales of software.



Partner	Knowledge / Outputs of the project	Use for the partners & targeted market/ Type of exploitation - Benefits
	site.	
ACCON	- Procedures to cope with embedded track systems in the noise mapping - Procedure for designing low noise embedded track systems - Noise management plans related to noise related track maintenance - Noise management plans related to introduction of noise abatement solutions.	- Better product design → strengthen competitiveness. - Competitive products with optimal performance in terms of noise AND vibrations. - Better tools for noise mapping and action planning yielding a better use of resources spend for these activities.
DL	- Optimal rail types and rail hardness in function of minimized wear and noise taking into account the different types of rolling stock and the network topology. - Improved knowledge about low noise embedded track systems. - Determination of wear limits with aim of optimally reduced noise.	- Improved design tools for track renewal and for new track taking into account wear AND noise. - Possibility for standardisation of track between and within the different tram networks. - Show case of a low noise embedded track system in DL network. - DL is involved in ERA working groups and CEN Technical Committees and will bring the TSI related project developments into the standardisation bodies working on the revision of the TSI Noise.
IMOSS	- Track solutions with reduced rail roughness growth. - Maintenance tool for preventive grinding - Models to control and monitor the rail roughness growth rate. - A track maintenance tool based on a data base gathered with the on-board monitoring systems, including rail roughness and noise related wear in curves. - Enlarge methodologies and tools.	- Show case of these solutions/products in the network of Infrabel. - Help customers to plan their maintenance activities: acoustic rail grinding and rail maintenance in curves by providing services or products (monitoring, data base set-up, maintenance plan). - Sales of rail fixation systems which are corrugation free and related consultancy.
KTH	- Knowledge in the area of noise related rail wear in curves.	- Possibility to disseminate that knowledge through scientific publications and in further developing working relationships with companies in this field.
MRTS	- Improved knowledge about track quality resulting from on-board monitoring in the Stockholm metro	- Direct use within its rail maintenance operations in Stockholm metro.
SLL	- On board monitoring measurement systems for rail roughness, TDR and noise related wear in curves.	- Show case for other infra managers-operators worldwide. - Direct use of the developed monitoring systems directly in the daily operation of



Partner	Knowledge / Outputs of the project	Use for the partners & targeted market/ Type of exploitation - Benefits
		the network (regional and metro) for a.o. maintenance planning.
STRUKTON	- Improved knowledge about relationship between rail maintenance and noise. - Improved knowledge about track quality resulting from on-board monitoring in the SLL regional network.	- Direct use within its rail maintenance operations in Stockholm regional network and its wider European operations - Disseminate results toward EFRTC (European Railway Track Contractors).
TTE	- Procedure for combining optimally the performance of existing track based noise abatement solutions.	- Improved knowledge about track contribution to total pass-by noise. - Toolbox of solutions and how to combine these for optimal noise reduction. - Show case of the solutions in the network of Attiko metro.
TYRENS	- New on-board monitoring system for rail roughness. - New on-board monitoring system for track decay rate. - New on-board monitoring system for noise related rail wear in curves.	- Higher reliability in rail roughness measurements, covering the complete network → better input to modelling and improved track quality assessment. - Higher reliability in track decay rate measurements, covering the complete network → better input to modelling. - Higher reliability in noise related wear measurements, covering the complete network → improved track quality assessment and input to track maintenance plan. - A rail roughness and TDR monitoring procedure covering the complete network will simplify the dialog between all the actors. It leads to a harmonization of rolling noise calculations.
D2S	- Valuable extra input to data base with wheel and rail roughness measurement data.	- Direct use in service contracts. Tool for sales of wheel and rail roughness measurement equipment.