

4.2.10 S2R-OC-CCA-01-2020: Noise and Vibration Call

SPECIFIC CHALLENGE

Noise and vibration (N&V) represent one of the biggest environmental challenges for the railway. The target of this work area is to reduce the exposure to noise and vibration related to the railway sector in Europe. Population in the vicinity of railways no longer accepts the increasing N&V annoyance while on the other hand a shift to rail-traffic is important for environmental reasons. To address these issues, an Open Call consortium shall work complementary to the Member consortium. The Member consortium contains numerous European railway undertakings and manufacturers.

Ground vibrations from passing trains is an ongoing issue for the railway system in parallel to noise exposure. There is great need to develop a commonly accepted, practical and validated prediction tool for ground vibration impact studies. Open points include the quality of predictions depending today on the experience of the engineering company in charge since results are often based on the companies' experimental data. Furthermore, results should be presented with visualisation similar to noise mappings and ensure transferability depending on track as well as vehicle parameters. It must be ensured that the developed programme is also commercially distributed and supported after completion of the project.

New technologies for auralisation and visualisation of noise scenarios is an upcoming area for development. The technology offers the possibility of listening and experiencing visually the noise of trains passing a certain track, long before it is built. This is very important for project communications during planning phase of new or upgraded lines to increase the acceptance of new railways in Europe. A second use case is to demonstrate noise mitigation effects on innovative mitigation measures in most realistic virtual surrounding. In addition, it is of value to assess interior noise on new rolling stock as well using the same basic methods.

SCOPE

In order to address the challenges described above, proposals should address all the following work streams, in line with the S2R MAAP.

Work-stream 1: Ground Vibration

The objective of this work-stream is to develop a commonly accepted, practical and validated prediction tool for ground vibration impact studies during environmental impact assessment of new or upgraded railway projects. In addition, a track independent vehicle indicator (ground borne noise friendly vehicle) shall be investigated.

The activities in this work-stream are expected to focus on the following areas

- 1) Development of a frequency-based simulation and vibration prediction tool allowing to include a data base of typical emission and transmission spectra for different train (high speed, urban/suburban, regional, and freight train platforms), track and ground parameters and building types. The requirement specification for the model development should be based on input from the complementary project S2R-CFM-CCA-01-2019 and shall consider further development of state-of-the-art approaches. Knowledge and experience from approaches used in former EU projects as [RIVAS](#)⁶³ and [CARGOVIBES](#)⁶⁴ is required for this task.

⁶³ <http://www.rivas-project.eu/index.php?id=9>

⁶⁴ <https://cordis.europa.eu/project/rcn/98519/results/en>

- 2) Development of models for the transposition of vibration emission data from one site to another including at least the influence of:
 - different tracks;
 - different substructures and ground conditions;
 - speed variations of trains.

The consortium shall provide measurements if needed for the model development.

- 3) Application of a user-friendly graphical user interface for the usage of the simulation and prediction tool preferable with interfaces to commercial geographical information system (GIS) based software for noise- and general environmental impact studies.

- 4) Approval testing:
 - Testing of correctness to ensure that the program complies with the specifications. Validation of the final results of the models will be done by the complementary S2R-CFM-CCA-01-2019 project.

- 5) Documentation of the tool and the calculation models:
 - User handbook;
 - Documentation of all input and output interfaces;
 - Description and documentation of the calculation models and their functions.

The simulation and prediction tool shall include the different models (e.g. for speed correction functions, different train and track types etc.) developed during the project for the transposition of vibration emission data. Hybrid models shall be applied, which allow change between full calculation of transfer-functions, input of measured or databased data.

In addition, the tool shall provide input for vehicle specific parameters such as primary and secondary stiffness, mass and resilient wheels to identify influencing factors.

The tool shall provide enough open interfaces to be used for further improvements or integration of country specific particularities e.g. different standards or evaluation schemes or descriptors as well introducing mitigation measures.

. The project is expected to reach TRL 5 by the end of the project.

The above work-stream 1 activities are expected to account indicatively for about 70% of the action costs.

An indicative scheduling of the deliverables for work-stream 1 is suggested below⁶⁵ :

- State of the art, concept of software/tool M6
- Collection of vibration and ground database M12
- Software/tool M20
- Validation (approval testing) and uncertainties M22

Work-stream 2: New Technologies Auralisation and Visualisation

⁶⁵ The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling

The objective of this work-stream is the development of a fully functional system for auralisation and visualisation based on physically correct synthesized railway noise and interfaces to a virtual reality visualisation software.

The activities in this work-stream are expected to focus on the following:

Develop an auralisation and visualisation ready-to-use software in agreement with the existing requirement document (FINE1 D9.1 – Requirements for Auralisation and Visualisation⁶⁶) including both exterior and interior noise. The tool shall be able to meet three basic main requirements:

- i. Demonstration of the results of the work on noise reduction in the S2R JU.
- ii. Demonstration of vehicle performance for customers and development engineers.
- iii. Demonstration of the acoustic situation and the effect of noise mitigation measures in large-scale projects preferable with an interface to commercial 3D Visualisation software.

The main part of the work shall be focused on exterior railway noise auralisation. For the visualisation an already existing software with integrated, usable audio interface shall be used. The audio interfaces shall be able to fully integrate and render the synthesized railway noise generation in high-quality and in accordance with the defined requirements and the proposed A&V technology coming from past projects such as FINE1 requirements (D9.1 Requirements for Auralisation and Visualisation⁶⁷) and DESTINATE (D3.2 Demonstration of railway noise auralisation and visualisation⁶⁸).

The functionality of the software is to be demonstrated using at least three examples of railway scenarios and shall include a database with different typical noise mitigation measures like sound barrier walls in different heights or distances, rail dampers etc (see FINE1-Deliverable 9.1) for different observation points under free combinations selected and adapted by the user. The initial interior noise auralisation can be measurement based: The auralisation shall at least enable interior source positioning, level- selection/adjustment of the measured sound, distance depending level perception).

The software development shall follow requirements proposed by the complementary project S2R-CFM-CCA-01-2019 which are expected to be available the first quarter of 2021.

Knowledge and experience of the FINE 1 and DESTINATE approaches as well as state of the art of Auralisation and Visualisation effects based on synthesized sound generation and virtual reality techniques are required.

The exploitation plan shall elaborate how this combined A&V-tool (as such complete) could be further developed in the future to be used as a commercial tool/integrated module in commercial auralisation and visualisation software.

The project is expected to reach TRL 5 by the end of the project.

The above work-stream 2 activities are expected to account indicatively for about 30% of the action costs

An indicative scheduling of the deliverables for work-stream 1 is suggested below⁶⁹ :

- a) Base-Version Exterior Noise M6
- b) User-Test-Version M12
- c) Final-User-Version M23

⁶⁶ Available for download here : https://projects.shift2rail.org/s2r_ipcc_n.aspx?p=FINE%201

⁶⁷ https://projects.shift2rail.org/s2r_ipcc_n.aspx?p=FINE%201#

⁶⁸ https://projects.shift2rail.org/s2r_ipCC_n.aspx?p=destinate

⁶⁹ The scheduling of the deliverables is provided to facilitate the complementarity with the CFM actions and it is not binding. Additionally, each deliverable may have some flexibility in the scheduling

The S2R Joint Undertaking considers that proposals with a duration of 30 months would allow this topic to be addressed appropriately. Nevertheless this does not preclude submission and selection of proposals with another duration.

COMPLEMENTARITY

As specified in section 2.3.1. of AWP 2020, in order to facilitate the contribution to the achievement of the S2R JU objectives, the options regarding 'complementary grants' of the S2R JU Model Grant Agreement and the provisions therein, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), will be enabled in the corresponding S2R JU Grant Agreements.

The action that is expected to be funded under this topic will be complementary to the actions that are expected to be funded under the following topics:

- S2R-CFM-CCA-01-2019: Integrated mobility management (I2M), Energy and Noise & Vibration

EXPECTED IMPACT:

Ground Vibration:

Improvement of the planning process of new lines or the upgrade of existing lines by a common accepted model for impact studies on ground vibrations. The model will help to evaluate construction projects on their dedicated impact of ground vibration immission for citizens effected by railway vibration near to the tracks.

New Technologies - Auralisation and Visualisation (A&V)

Access to a fully functional software for Auralisation and Visualisation allowing the possibility of listening and experiencing visually the noise of trains passing a certain track, long before it is built and test different noise mitigation measures as well as assess modification of the interior noise. The synthesized noise is based on physically correct noise generation mechanisms. The A&V tools shall be used to enable a clear communication and conscious and knowing decision making by demonstrating the planned railway vehicle or railway project not only visual but also acoustically real and thus more concretely and convincingly.

Type of Action: Research and Innovation Action (RIA)

4.2.11 S2R-OC-IPX-01-2020: Innovation in guided transport

SPECIFIC CHALLENGE

Since the the modern hyperloop proof of concept was coined in a white paper in 2013, and with the creation of Shift2Rail in 2014, many activities touching innovation in guided transport have arisen in Europe and elsewhere in the world. Technologies dealing with innovative control systems for vehicle to vehicle interaction, with communication and positioning systems (incl. in tunnel environments), advanced magnetic levitation, with innovative light materials, with energy storage and regeneration solutions have been investigated in a fragmented and competitive manner. The challenge is to channel