Furthering Improvements in Integrated Mobility Management, Noise and Vibration, and Energy in Shift2Rail

D7.1 - Specification of test scenarios and requirements for methodologies

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EXECUTIVE SUMMARY

The FINE-2 project aims to improve the sustainability of rail traffic by enhancing rail traffic management, reducing the operational costs of railways and reducing the annoyance and exposure to noise and vibration related to rail transport in Europe.

The project is divided into sixteen technical work packages (WPs), from which WP6 to WP10 address noise objectives.

The focus of WP7 is noise source separation. This WP aims at enhancing and simplifying the existing methodologies for track versus vehicle noise separation on rolling noise to reduce the costs of mitigation measures. In addition, innovative techniques to separate the different types of acoustic sources during pass-by will be developed.

The purpose of this deliverable is to present the technical specification of the requirements to be fulfilled by the proposed methodologies. The test scenarios, in which the methodologies will be assessed against those requirements, are specified in this document.

GLOSSARY OF TERMS

Acronym or Term	Description
EMU	Electric multiple unit
DMU	Diesel multiple unit
D*n.n*	Deliverable e.g. D1.1 = Deliverable 1.1
HS	High Speed
ISO	International Organization for Standardization
$L_{pAeq,Tp}$	A-weighted equivalent continuous sound pressure level
R2R	ROLL2RAIL
S2R	Shift2Rail
TDR	Track decay rate
T*n.n*	Task e.g. T1.1 = Task 1.1
TSI	Technical Specifications for Interoperability
TSI NOI	Technical Specification for the Interoperability Noise
WP*n*	Work Package e.g. WP1 = Work Package 1
WS	Work Stream

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1. INTRODUCTION

1.1. Background and context

Railway noise is an issue of utmost importance for citizens living in the surroundings of rail tracks. It results from the contribution of various noise sources such as traction noise, noise from auxiliary equipment, rolling noise and aeroacoustic noise for high vehicle speeds.

At conventional speeds rolling noise predominates over other sources. Rolling noise is attributed to structural vibrations of wheels and rails caused by the roughness of both wheel and rail surfaces. In the effort of reducing this type of noise one key question is the separation of the noise radiated by the wheel from that radiated by the track. The current Technical Specification for the Interoperability Noise (TSI NOI) [1] “Homologation test procedure of new vehicles” relies on the use of a reference track to quantify the vehicle noise. The reference track is defined by an upper limit of the rail roughness and a lower limit of the track decay rate (TDR) [2]. As such, the current homologation procedure ensures compliance with a maximum limit for pass-by noise. However, this does not assure that the track contribution is negligible for pass-by noise results. Consequently, different reference tracks may lead to different pass-by noise results since there is neither a lower limit prescribed for the roughness nor an upper limit for the TDR. This may cause different pass-by noise results with the same vehicle on different reference tracks, all being compliant to TSI requirements. Hence the TSI Noise homologation test procedure shows inadequacies when it comes to quantifying the vehicle noise and an improvement would first be the development of test methods that allow separating noise from the wheel and from the track during a pass-by.

In this respect it is worth highlighting the work carried out in the European Research Project ROLL2RAIL (R2R) [3]. Work Package 7 of R2R was dedicated to developing methods for better characterisation and quantification of rolling noise. Several methods for performing the separation of the vehicle contribution and track contribution of rolling noise were proposed and tested with varying results. A general conclusion was that in order to achieve the goal of separation partly complex instrumentation and time consuming procedures are needed, which makes them less suitable for certification procedures of new vehicles where track access and budget are limited. Also the goal associated with the desired accuracy was not met by any method.

At low speeds (below ca. 50 km/h), rolling noise might be masked by other sources of noise, such as traction noise and auxiliary equipment and at high speeds (above ca. 250 km/h) aeroacoustic sources begin to have major relevance on the total noise emission level. Identifying the main noise contributors is relevant for source ranking prior to mitigation measure implementation. In this respect, there is a need to develop innovative techniques to separate and define the sound power level of different types of acoustic sources during a train pass-by. Moreover, the sound power levels of single sources are used as model-input for the prediction of the vehicle noise emission e.g. in virtual testing methods. It is difficult to assess the required input data, especially for traction equipment under the correct load, when the sources are dismounted in a laboratory environment. A method for the characterisation of this kind of sources during pass-by could have the potential to increase the accuracy of such predictions.

1.2. Objective

Given the presented scenario the goal of FINE-2 WP7 is to push on the development of testing methods that will, on the one hand, highlight the design of silent vehicles, and, on the other hand, gain a better understanding of noise contributors to exterior noise. The objectives are twofold:

- To support both the simplification and the enhancement of methodologies for separation of the track versus the vehicle part of the rolling noise. Validation and data collection including several test scenarios are expected.
- To support the development of innovative techniques to separate and define the sound power level and directivity of the different types of acoustic sources during pass-by at constant speed of a train;

These objectives will be achieved in a close collaboration with S2R Open Call project S2R-OC-CCA-01-2019, TRANSIT. The idea of this collaboration is that, FINE-2 partners, composed of rolling stock manufacturers and operators, bring the vision and the needs of the industry and TRANSIT partners, composed of research centres, universities and consultancies, will enhance existing methods and propose new techniques based on their knowledge and experience.

This first deliverable deals with the first task to be carried out in order to meet both objectives, which are to:

- Specify the requirements to be fulfilled by the different methods
- Define the vehicle scenarios in which the methodologies will be assessed.

1.3. Work package structure

The work is divided into two different work streams.

WS1 - Separation of track versus vehicle noise of rolling noise

The scope of this work stream is to support the development of a method that shows higher comparability and reproducibility of pass-by measurements in order to reduce the need of a TSI-compliant test track. Such a method could form the basis for a new procedure for vehicle noise quantification in homologation procedures. Based upon the foregoing, the focus of this work stream shall be put on the following tasks:

i. Specify the requirements to be fulfilled by the separation methods. This task will take the outputs of the European noise research project ROLL2RAIL WP7 as a starting point and will focus on further enhancing and simplifying the most promising techniques proposed in the project (i.e. ATPA, PBA, TWINS based transfer function methods and classic beamforming).

ii. Specify three vehicle scenarios for TRANSIT to test the proposed methods. Alstom, CAF and Talgo, as FINE-2 partners, will give access to vehicles and tracks to be used for this purpose.

iii. Analyse the strengths and weaknesses of the methodologies proposed by TRANSIT.

iv. Study the feasibility of normalising pass-by noise to a reference TSI/ISO track in terms of roughness and Track Decay Rate.

v. Finally, based on the results obtained, analyse the possibility of proposing an updated methodology for a better vehicle characterisation in current pass-by noise homologation procedures.

WS2 - Pass-by noise source characterisation

The second work stream is focused on supporting the development of innovative techniques to separate and define the sound power level and directivity of the different types of sources during pass-by at constant speed of a train, including traction noise, rolling noise and aerodynamic noise sources. The following tasks shall be carried out:

i. Specify the requirements to be fulfilled by the techniques to be proposed by TRANSIT to separate and define the sound power level and directivity of the different types of sources during pass-by at constant speed. Aerodynamic sources, traction noise sources as well as rolling noise (rolling noise shall be considered as an entity, with no need to separate track noise from wheel noise) are to be considered.

ii. Specify two vehicle scenarios for TRANSIT to assess the proposed techniques. Alstom, CAF and Talgo, as FINE-2 partners, will give access to vehicles and tracks to be used for this purpose.

iii. Analyse the performance of the methodologies proposed for exterior noise pass-by separation technologies and make proposals for improvement.

iv. Use the test results provided by TRANSIT in pass-by noise simulation tools in order to assess the suitability of the test methodologies developed to provide input data for reliable exterior noise predictions.

Note that the tasks of both work streams are very similar. An effort has been done in order to homogenise the tasks so that the test campaigns of both work streams can be combined in order to reduce time, costs and risks.

1.4. Interaction with TRANSIT project

The achievement of work package 7 goals implies a strong collaboration between FINE-2 and TRANSIT consortia.

Interaction for WS1 – Separation of track versus vehicle noise

The Gant chart in Figure 1 includes an overview of the interaction moments between FINE-2 and TRANSIT projects for WS1.The interaction could be summarised as follows:

- FINE-2 will define requirements for the vehicle versus track noise separation methodologies.
- Based on the proposed requirements, TRANSIT will define strategies for enhancing each separation method. The theoretical description of the enhanced methods will be reported shared with FINE-2. In addition, methods to separate wheel and rail roughness and methods to transpose pass-by results from one track to another track will be proposed.
- FINE-2 will analyse the strengths and weaknesses of the methodology proposals

- Field measurements will be carried out to test and validate the proposed separation procedures. Three different vehicle scenarios will be considered.
- TRANSIT will report on the validation and assessment of the methods studied. This information is required by FINE-2 to study the feasibility of the use of methodologies and reference track normalisation in FINE-2-D7.5 (M36).

Interaction for WS2 – Pass-by noise source characterisation

The Gantt chart in Figure 2 includes an overview of the interaction moments between FINE-2 and TRANSIT projects for WS2.

- FINE-2 will define requirements for the acoustic source separation methodologies in the deliverable.
- TRANSIT will review the state of the art of the existing methods for noise source separation. This review will not only cover methods used in the past for railway applications, but also methods from other fields that may be extended or adapted to the needs of railway pass-by source separation measurements. The information will be shared with FINE-2.
- Methods that are identified to be feasible will be adapted and improved by TRANSIT in order to meet the requirements defined by FINE-2.
- FINE-2 will analyse the strengths and weaknesses of the methodology proposals and comment on the definition of railway vehicle pass-by scenarios project.
- Field measurements will be carried out to test and validate the proposed separation procedures. FINE-2 will define and give access to vehicles and tracks to be used for this purpose. Two different vehicle scenarios will be considered including at least one with predominant aerodynamic noise and at least one with predominant traction noise and other sources at different speeds. Both scenarios will also include several speeds at which rolling noise is dominant.
- TRANSIT will report on the validation and assessment of the methods. This information is required by FINE-2 for the validating the use of the outputs from the pass-by noise source separation methodologies outputs for exterior noise simulations.).

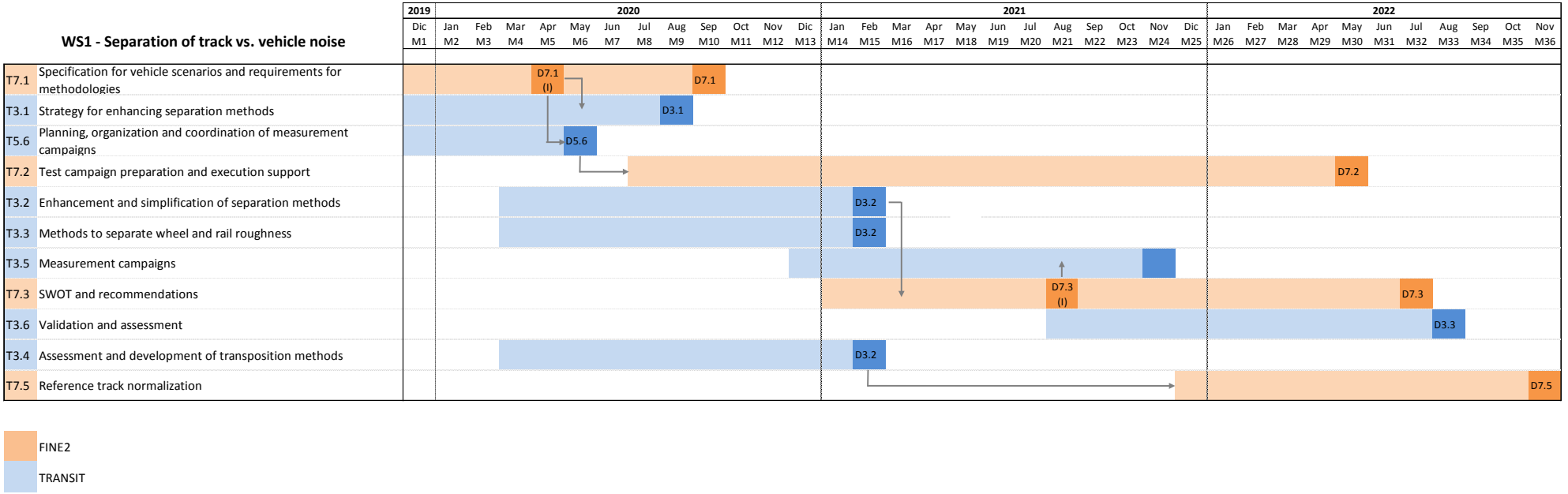

Figure 1. Separation of track versus vehicle noise part of rolling noise work stream interaction chart with TRANSIT.

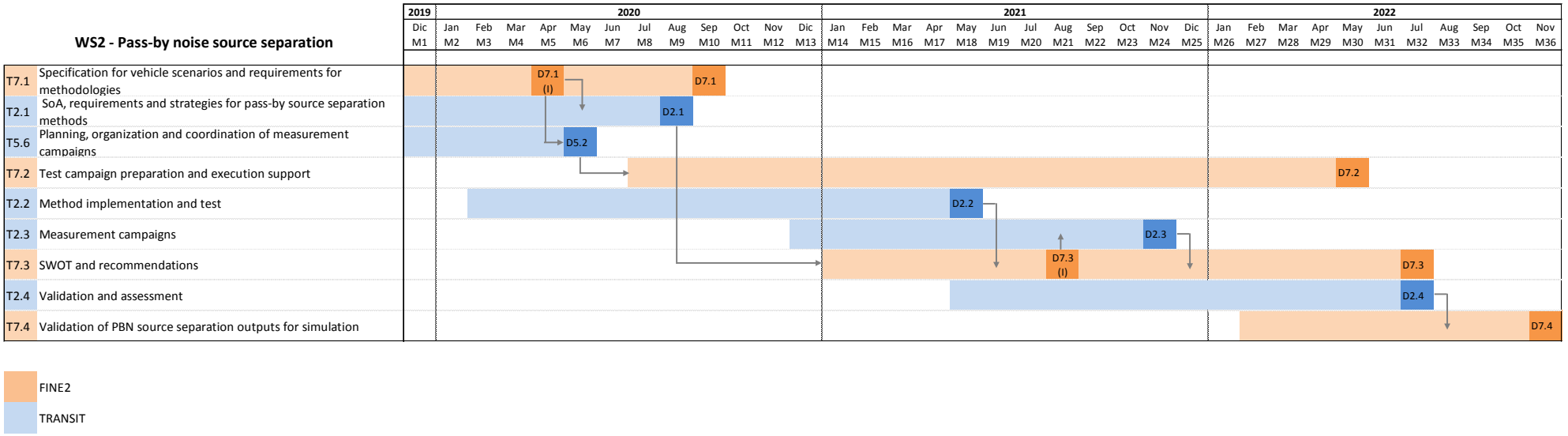

Figure 2. Pass-by noise source separation work stream interaction chart with TRANSIT.

2. REQUIREMENT DEFINITION

The aim of this section is to present the requirements to be fulfilled by the methodologies. The specification has been made based on the results from previous European Research projects (e.g. ROLL2RAIL, ACOUTRAIN and FINE1). The specification is based on the needs identified by FINE-2 partners composed of rolling stock manufacturers and operators. The procedure followed in order to generate the list of requirements is described in section 2.1. The requirements for the WS1- Separation of track versus vehicle noise of rolling noise are listed in section 2.3 and those for WS2 - Pass-by noise source characterisation in section 2.4. Before that, in section 2.2 some definitions that can be helpful to understand some of the requirements are given.

2.1. Procedure followed

This section describes the steps of the procedure followed to specify the requirements that the methodologies should fulfil:

1. Review of previous projects
   The outputs from previous European Research Projects such ROLL2RAIL [3] or FINE1 [5] have been reviewed. Partners shared their experience in previous related projects as well as common problems found in exterior noise tests of railway vehicles. This served as a basis to set a common objective and identify aspects of improvement.

2. Requirements collection
   An Excel template was shared among the partners. Each partner made a proposal for the requirements that the methodologies to be developed by TRANSIT should fulfil. For the “Separation of track vs. vehicle noise” work stream requirements set in deliverable D7.1 of ROLL2RAIL project were taken as a basis.

3. Discussion among FINE-2 partners
   The aim of this task was to discuss the different requirements proposed by the partners and find a consensus for each of them so that the whole specification was accepted by each partner.

4. Share the specification with TRANSIT
   The Technical specification of the requirements to be fulfilled by the methodologies proposed by TRANSIT are reported in this deliverable D7.1. However, it was preferred to have a first informal approach to TRANSIT to share the requirements with them so that they, as partners proposing the methodologies, could review them.

5. Discussion with TRANSIT partners
   Some of the requirements, although desirable, were not feasible. A common discussion between FINE-2 and TRANSIT partners served to identify these requirements and agree on more feasible or realistic requirements.

2.2. Accuracy, repeatability and reproducibility

Some of the specified requirements are focused on the assessment of the test results. A distinction between the different ways in which a measurement may be repeated can be made.

- **Accuracy** is defined as a measure of the capability of the instrument to faithfully indicate the value of the measured signal.
- **Repeatability** is the variability of physical mechanisms and uncertainties in the measurement conditions leading to a spread in the results when consecutive measurements are taken. Repeatability implies the same location; the same measurement procedure; the same observer; the same measuring instrument, used under the same conditions; and repetition over a short period of time.
- **Reproducibility** depends on both measurement accuracy and repeatability but additionally on measurement conditions at different locations. Reproducibility, on the other hand, refers to the degree of agreement between the results of measurements conducted by different individuals, at different locations, with different instruments.

Supposed the pass-by noise from a train was to be repeated several times in succession by the same test engineer with the same measurement equipment and conditions, the variation of the results would give an indication of repeatability of the measurement. The spread gives an indication of the stability of the method and the influence of non-controllable random errors. If the measurements were to be repeated according to the same defined method but by different test engineers, each using their own measuring instruments then the variation in results would give an indication of reproducibility of the measurements. The variation in reproducibility tests is usually greater than that from repeatability measurements.

2.3. Requirements for separation of track vs. vehicle noise methodologies

The requirements of the methodologies for the vehicle versus track noise separation are specified based on the results from ROLL2RAIL-WP7 [3] and FINE 1-WP8 [5], as well as on the industrial needs for practical use of the methods.

2.3.1. General requirements

TS-WS1-GEN-01

Category:	Essential
Description:	Provide simplify and enhance methodologies for separation of rolling noise with the track versus vehicle part.

TS-WS1-GEN-02

Category:	Essential
Description:	Extend the validation and data collection of R2R methodologies to several vehicle scenarios.

TS-WS1-GEN-03

Category: Essential

Description: Provide a method to determine wheel and rail roughness separately.

TS-WS1-GEN-04

Category: Essential

Description: Methods should be in line with vehicle homologation test procedures. They should be able to give results at 80 km/h and v_{max} and at standard positions (1,2 m height above top of rail /7,5 m distance from the centre of the track).

TS-WS1-GEN-05

Category: Desirable

Description: Method shall be compatible to complementary rolling noise calculations (for enhanced accuracy or substitution of cost driving parts of the measurements).

2.3.2. Vehicle related requirements

TS-WS1-VEH-01

Category: Desirable

Description: The number of vehicle runs should remain the same as required by ISO3095 [2].

TS-WS1-VEH-02

Category: Essential

Description: The method should be applicable for vehicles running above 60 km/h.

TS-WS1-VEH-03

Category: Essential

Description: The method should be applicable for vehicles running up to 320 km/h.

TS-WS1-VEH-04

Category: Essential

Description: The method shall be applicable for vehicles defined in TSI Noise [1].

TS-WS1-VEH-05

Category: Desirable

Description: The method shall be applicable for metro vehicles running in free-field (not underground or tunnels).

2.3.3. Track related requirements

TS-WS1-TRA-01

Category: Essential

Description: The method shall be applicable to TSI-compliant tracks [1]-[2].

TS-WS1-TRA-02

Category: Essential

Description: The method shall be applicable to TSI non-compliant tracks.

TS-WS1-TRA-03

Category: Essential

Description: The method shall be applicable to ballast tracks.

TS-WS1-TRA-04

Category: Desirable

Description: The method shall be applicable to slab tracks.

2.3.4. Accuracy and reproducibility

TS-WS1-ACC-01

Category:	Essential
Description:	The reproducibility of the vehicle contribution to the overall pass-by noise level needs to be equal to or better than that obtained with the current TSI method [1]-[2].

TS-WS1-ACC-02

Category:	Essential
Description:	The accuracy and the reproducibility[1] of the measurements and the separation need to be evaluated for each method.

TS-WS1-ACC-03

Category:	Desirable
Description:	The reproducibility of the total A-weighted sound pressure level results shall be below ± 2 dB. The reproducibility of the track contribution and the reproducibility of the vehicle contribution shall be calculated.

TS-WS1-ACC-04

Category:	Desirable
Description:	The reproducibility per third-octave band in the range 315 Hz - 5 kHz shall be below ± 3 dB.

TS-WS1-ACC-05

Category:	Desirable
Description:	The reproducibility per third-octave band in other frequency bands shall be below ± 6 dB.

TS-WS1-ACC-06

Category:	Desirable
Description:	The overall accuracy of the results shall be below ± 2 dB.

[1] With the given test scenarios, it will not be possible to evaluate the reproducibility of the methods, as it will not be possible to test the same vehicle on different sites. Instead, the repeatability will be assessed.

TS-WS1-ACC-07

Category:	Desirable
Description:	The accuracy per third-octave band in the range 315 Hz - 5 kHz shall be below ± 3 dB.

TS-WS1-ACC-08

Category:	Desirable
Description:	The accuracy per third-octave band in other frequency bands shall be below ± 6 dB.

TS-WS1-ACC-09

Category:	Desirable
Description:	The method needs to determine wheel and rail roughness separately. The accuracy in third-octave bands in wavelengths equivalent to 315 Hz-5 kHz shall be below ± 2 dB.

TS-WS1-ACC-10

Category:	Desirable
Description:	The accuracy in third-octave bands in wavelengths equivalent to other frequency bands shall be below ± 5 dB.

TS-WS1-ACC-11

Category:	Desirable
Description:	Method should be simple in terms of test setup to achieve desired accuracy and reduce testing time and cost. A simplification with respect to the methods tested in R2R is expected.

TS-WS1-ACC-12

Category:	Essential
Description:	Method should be able to re-use set of previously acquired data (i.e. track transfer functions) when the track characteristics are similar to the tested track.

2.3.5. Expected output requirements

TS-WS1-RES-01

Category:	Essential
Description:	Method shall provide the $L_{\rho Aeq,Tp}$ for rolling noise as overall level at 7.5 m from the centre of the track and 1.2 m above the top of the rail.

TS-WS1-RES-02

Category:	Essential
Description:	Method shall provide the $L_{\rho Aeq,Tp}$ for rolling noise as 1/3rd octave bands at 7.5 m from the track and 1.2 m above the rail. Results should be given in the frequency range of 100 Hz-8 kHz, being the most important range from 315 Hz - 5 kHz

TS-WS1-RES-03

Category:	Essential
Description:	Method shall provide the $L_{\rho Aeq,Tp}$ separately for the vehicle (without the contribution of the track) as overall level at 7.5 m from the track and 1.2 m above the rail.

TS-WS1-RES-04

Category:	Essential
Description:	Method shall provide the $L_{\rho Aeq,Tp}$ separately for the vehicle (without the contribution of the track) as 1/3rd octave bands at 7.5 m from the track and 1.2 m above the rail. Indicate the frequency range. Results should be given in the frequency range of 100 Hz - 8 kHz, being the most important range from 315 Hz - 5 kHz.

TS-WS1-RES-05

Category:	Essential
Description:	Method shall provide the $L_{\rho Aeq,Tp}$ for track as overall level at 7.5 m from the track and 1.2 m above the rail.

TS-WS1-RES-06

Category:	Essential
Description:	Method shall provide the $L_{\rho Aeq,Tp}$ separately for the track as 1/3rd octave bands at 7.5 m from the track and 1.2 m above the rail. Results should be given in the frequency range of 100 Hz - 8 kHz, being the most important range from 315 Hz - 5 kHz.

TS-WS1-RES-07

Category:	Essential
Description:	The track contribution to rolling noise should be divided into the noise emission of sleeper, rail vertical and rail lateral components.

TS-WS1-RES-08

Category:	Essential
Description:	The method needs to determine wheel and rail roughness separately in third-octave bands in wavelengths equivalent to the specified vehicle speed (60 – 320 km/h) and indicated frequency range (100 Hz – 8 kHz) of interest.

TS-WS1-RES-09

Category:	Essential
Description:	Method shall provide the $L_{pAeq,Tp}$ separately for vehicle noise as it would be on a reference track (defined in terms of TDR & roughness).

2.3.6. Cost and time requirements

TS-WS1-COS-01

Category:	Desirable
Description:	A total cost increase of max. 10% compared to current costs of homologation tests is the target.

TS-WS1-COS-02

Category:	Desirable
Description:	The increase of measurement effort shall be less than a test ring slot (8 hours including safety procedures) compared to current homologation tests.

2.4. Requirements for pass-by noise source separation methodologies

The requirements of the methodologies for pass-by noise source separation are specified based on the results from ACOUTRAIN [4], Roll2Rail [3] and FINE1 [5], as well as on the industrial needs for source ranking and vehicles design, validation and homologation.

2.4.1. General requirements

TS-WS2-GEN-01

Category:	Essential
Description:	Provide a novel and innovative techniques to obtain the sound power level and directivity of the different types of noise sources during pass by at constant speed of a train.

TS-WS2-GEN-02

Category:	Essential
Description:	Techniques proposed shall present improvements and benefits in comparison to separation techniques used in the past.

TS-WS2-GEN-03

Category:	Essential
Description:	The type of sources to be considered shall include aerodynamic sources, traction noise sources and rolling noise as an entity.

TS-WS2-GEN-04

Category:	Desirable
Description:	The technique shall be capable to be included in pass-by noise measurements relevant for authorisation.

TS-WS2-GEN-05

Category:	Essential
Description:	The noise separation shall work for different pass-by speeds between 40 km/h and 320 km/h.

2.4.2. Vehicle related requirements

TS-WS2-VEH-01

Category:	Essential
Description:	The number of vehicle runs per speed should correspond to the present method for measuring pass-by noise (ISO 3095 [2])

TS-WS2-VEH-02

Category: Desirable

Description: The method shall be applicable for vehicles defined in TSI Noise [1].

TS-WS2-VEH-03

Category: Essential

Description: The method shall be applicable to the following vehicle types: EMU, DMU, Locomotive, Highspeed, single and double deck trains.

TS-WS2-VEH-04

Category: Desirable

Description: The method shall be applicable to the following vehicle types: Metros and trams.

2.4.3. Track related requirements

TS-WS2-TRA-01

Category: Essential

Description: The method shall be applicable to TSI-compliant tracks.

TS-WS2-TRA-02

Category: Essential

Description: The method shall be applicable to TSI non-compliant tracks.

TS-WS2-TRA-03

Category: Desirable

Description: The method shall be applicable to any type of track (ballast, slab, ...).

2.4.4. Accuracy and reproducibility

TS-WS2-ACC-01

Category:	Essential
Description:	The accuracy and the reproducibility of the measurements and the separation need to be evaluated for each method.

TS-WS2-ACC-02

Category:	Essential
Description:	The repeatability of the sound power level results per source within 3 measurements shall be bellow ±3 dB.

TS-WS2-ACC-03

Category:	Essential
Description:	Associated with methods developed for rolling noise, the overall noise reconstruction should be below 1 dB from measured values.

2.4.5. Expected output requirements

TS-WS2-RES-01

Category:	Essential
Description:	The methodology shall be capable of providing the sound power and directivity of the each of the separated sources at least in 1/3 octave band.

TS-WS2-RES-02

Category:	Essential
Description:	The methodology shall be able to consider the following traction/equipment sources: Traction engine, gearbox, electrical converter, transformer and HVAC.

TS-WS2-RES-03

Category:	Essential
Description:	The methodology shall be able to consider the following aeroacoustic sources: Bogie, inter-coach gap, pantograph and train nose.

TS-WS2-RES-04

Category: Desirable

Description: $L_{pAeq,Tp}$ train speed and pass-by time to be provided according ISO 3095 [2]

TS-WS2-RES-05

Category: Essential

Description: The characteristics of separated sources (strength, directivity) shall be usable as input for exterior noise propagation models.

TS-WS2-RES-06

Category: Desirable

Description: Outputs should be suitable to perform tonality analysis (overall and per source) as per ISO1996-2 Annex K[6].

TS-WS2-RES-07

Category: Desirable

Description: Directivity per source shall be provided with an angular resolution and frequency range appropriate for exterior noise simulations.

TS-WS2-RES-08

Category: Essential

Description: Directivity per source shall be provided per direction (horizontal, vertical) indicating whether the source directivity can be approximated by a simple source (monopole, dipole, …).

3. VEHICLE SCENARIOS

FINE-2 has specified three test scenarios for assessing the proposed simplified and enhanced methodologies for separation of rolling noise with the track versus vehicle part and two vehicle scenarios for the proposed innovative techniques to separate and define the sound power level and directivity of the different types of acoustic sources during pass-by at constant speed of a train.

The vehicles and track access shall be provided by three partners; Alstom, CAF, and Talgo. The following tables describe with more detail the different vehicle scenarios provided by each of the three partners.

Table 1. High speed train vehicle scenario.

Company	Talgo
Test Site	Barcelona-Madrid HS-Line
Test campaign	Feb-March 2021
Train type	High speed train
Train description	Talgo AVRIL is based on the traditional Talgo's running gear and short coaches technology. The traction is located in the powerheads, where both bogies are motorised. The intermediate coaches rely on a non-powered Talgo's running gear (so-called "rodal"), characterised for its mono-axle independent guided wheel technology.
Max. speed	280 km/h
Type of noise sources	Traction noise, Rolling noise, Aerodynamic noise
Methods to be assessed:	WS1: Methodologies for separation of the track versus the vehicle part of the rolling noise WS2: Pass-by noise source separation methodologies

Table 2. Regional train vehicle scenario

Company	Alstom
Test Site	Velim test ring (Czech Republic)
Test campaign	Summer 2021
Train type	Regional train EMU/DMU bi-mode

Train description	REGIOLIS Crossborder version France-Germany is part of Alstom Coradia Polyvalent regional train family. It is a 4-cars articulated train with low floor design and all main equipment on roof. Head bogies are motorised, each equipped with 2 traction motors + gearbox directly connected to axle shaft. Traction chain is bi-mode: electric mode with supply though pantographs (15 kV AC or 25 kV AC) or thermal mode with diesel powerpacks that provide energy to traction chain and allow the train to run on non-electrified lines.
Max. speed	160km/h
Type of noise sources	Traction noise, Rolling noise
Methods to be assessed:	WS1: Methodologies for separation of the track versus the vehicle part of the rolling noise WS2: Pass-by noise source separation methodologies

Table 3. Metro train vehicle scenario.

Company	CAF
Test Site	Commercial line near Bilbao (Spain)
Test campaign	Sept. - Oct. 2021
Train type	Metro train
Train description	Operated by Euskotren this metro units are metric gauge units made of up to four cars, two motor cars and two intermediate trailer cars.
Max. speed	90 km/h
Type of noise sources	Traction noise and Rolling noise.
Methods to be assessed:	WS1: Methodologies for separation of the track versus the vehicle part of the rolling noise

4. CONCLUSION

The deliverable “D7.1 - Specification of test scenarios and requirements for methodologies” is part of “WP7-Noise sources separation” of FINE-2. The objectives of this work package are twofold:

- To support both the simplification and the enhancement of methodologies for separation of the track versus the vehicle part of the rolling noise.
- To support the development of innovative techniques to separate and define the sound power level and directivity of the different types of acoustic sources during pass-by at constant speed of a train;

The present report gives an answer to the first task of WP7, T7.1, which aims at specifying the requirements to be fulfilled by the different methodologies and defining the test scenarios in which the proposed methodologies should be assessed.

The requirements of the methodologies for the vehicle versus track noise separation have been specified based on the industrial needs for practical use of the methods. In a similar way, the requirements of the methodologies for pass-by noise source separation have been specified based on the industrial needs for source ranking and vehicles design, validation and homologation. The final lists of requirements have been presented in chapter 2. The results of previous European Research projects, such as ACOUTRAIN, ROLL2RAIL and FINE1 have been used as a starting point.

The specification has been delivered to the S2R Open Call project S2R-OC-CCA-01-2019, TRANSIT; to propose different methodologies. Based on this, TRANSIT will propose different methodologies which performance will be assessed in the three test scenarios defined in chapter 3. Three FINE-2 partners will give access to vehicles and track. Alstom will give access to a regional bimodal train, CAF to a metro train and Talgo to a high-speed train.

5. REFERENCES

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