Conférence Européenne
des Directeurs des Routes

Conference of European
Directors of Roads

CEDR TRANSNATIONAL ROAD RESEARCH PROGRAMME

Call 2018

Noise and Nuisance

CEDR Transnational Road Research Programme
funded by
Belgium – Wallonia, Denmark, Ireland,
Netherlands, Norway, Sweden, United Kingdom

Description of Research Needs (DoRN)

December 2018

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Authors of the DoRN

Stephen Byrne – Chair	Transport Infrastructure Ireland, Ireland
Klaus Gspan	Asfinag, Austria
Barbara Vanhooreweder	Flemish Roads Agency, Flanders, Belgium
Sebastien Marcocci	Service Public Wallonie, Wallonia, Belgium
Radek Kropelnicky	Road and Motorway Directorate of the Czech Republic
Lene Nøhr Michelsen	Danish Roads Directorate, Denmark
Jakob Fyd	Danish Roads Directorate, Denmark
Ian Holmes	Highways England, UK
Renez Nota	Rijkswaterstaat, Netherlands
Kamilla Kjølberg	Norwegian Public Roads Administration, Norway
Kirk Ingold	Federal Roads Office FEDRO, Switzerland
Lars Dahlbom	Trafikverket, Sweden

1 General Introduction

This Description of Research Needs (DoRN) relates to a Call for Proposals entitled **CEDR Transnational Road Research Programme Call 2018** launched by the Danish Road Directorate on behalf of the Conference of European Directors of Roads (CEDR). CEDR is an organisation which brings together the directors of 27 European road authorities. CEDR provides a platform for cooperation and promotion of improvements to the road system and its infrastructure, as an integral part of a sustainable transport system in Europe. The website ***www.cedr.eu*** contains a full description of its structure and activities.

CEDR recognises the importance of research in the development of sustainable transport and has established a Working Group (WG) to monitor European research activities and to advise the CEDR Board on issues relating to research. WG Innovation responsibilities include dissemination of research results as well as initiating research programmes that support CEDR members in current and future situations.

The Governing Board of CEDR (CEDR GB) has given a mandate to WG Innovation to identify opportunities for transnational road research programmes on an annual basis. CEDR also requested that:

- WG Innovation only proposes suitable research topics and identifies good research proposals;
- WG Innovation presents research proposals, when appropriate, to CEDR GB for decision; CEDR GB will decide what programmes are taken forward;
- All call procedures shall be open and transparent and organisation from all European countries shall be invited to participate, with no advantages given to preferred suppliers or groups of suppliers; and
- The costs of developing and managing the transnational calls shall be supported only by those CEDR members taking part in the programme.

2 Introduction to Call 2018

The CEDR Transnational Research Road Programme was developed initially within the framework of ERA-NET ROAD and was then taken forward by CEDR WG Innovation to fulfil the common interests of the National Road Administration (NRA) members of CEDR. The participating NRAs in this Call are Belgium - Wallonia, Denmark, Ireland, Netherlands, Norway, Sweden and the United Kingdom. As in previous collaborative research programmes, the participating members will establish a Programme Executive Board (PEB) made up of experts in the topics to be covered: the PEB will act as a steering committee for the programme. The research budget will be jointly provided by the participating NRAs: the participating NRAs will also nominate the individual member of the PEB. The PEB will designate one of its members to act as PEB chair.

WG Innovation has, on behalf of CEDR, appointed a Programme Manager (ProgM) to take over the administration of this Call for Proposals. For this programme, the ProgM will be the Danish Roads Directorate, Denmark. The responsibilities of the ProgM include preparation of the Call for Proposals, financial management of the programme and setting up and managing the contracts with the research providers. These responsibilities will be conducted by the ProgM in its country under its law and regulations under the direction of WG Innovation. The terms under which the ProgM and PEB will operate will be set out in a Collaboration Agreement, signed by senior representatives of each participating NRA.

Applications are invited from suitable qualified consortia in response to this Call for Proposals. Consortia must be led by a legal entity from a European country and consist of at least two legal entities from two different countries. Individuals and organisations involved in the formulation of the Call specification are prohibited from any involvement in proposals. Applications should focus on the sharing of national research, knowledge and experience at all levels as an important prerequisite for achieving the goals of CEDR and its members. This will accelerate the development of faster and durable methods and techniques for road maintenance and management. It is particularly important that the results be easily implementable by road authorities across Europe, and applicants are encouraged to include case studies and demonstration projects in submissions so as to contextualise the research and illustrate the benefits of transnational collaboration.

Applications will be evaluated by the PEB in relation to:

- Extent to which the proposal meets the requirement of the DoRN
- Technical quality of proposal
- Track record of consortium members
- Management of project
- Value for money.

Details of these evaluation criteria and how they will be interpreted and applied by the PEB are presented in the Guide for Applicants (GfA) which accompanies this Call for Proposals.

3 Aim of the Call

The aim of this research programme is to identify, consider and gain a greater understanding of existing and newer methods to reduce noise exposure and noise nuisance for people living near national roads, and to identify methods that could improve the way noise is perceived by these people. This research programme will examine the following three sub-themes (i) Quieter Tyres, Tyre labelling system and Pavements (ii) Optimization and securing the performance of noise barriers and (iii) Psycho-Acoustics: Improved understanding of people's subjective reactions to road noise.

It is recognised that environmental noise exposure can result in health effects such as annoyance, sleep disturbance and cardiovascular disease. Reducing noise and nuisance will aid in the mitigation of these known health effects. This Transnational Road Research Programme aims to help road authorities with:

- Encouraging governments and industry towards generic reduction of road vehicle noise

  For many years the EU labelling of tyre road noise developed and has now been implemented by tyre manufacturers across the EU. Whilst tyre manufacturing companies encourage consumers to purchase the best performing low noise tyre to help reduce environmental impacts, manufacturers are unable to control and demonstrate the actual noise emissions. As a consequence, it is unclear whether the existing tyre labels have relevance to 'real world' noise emissions. In parallel with the development of low noise tyres, pavements have been developed which are less noisy than more traditional road pavements.

  Low noise tyres and road pavements are two important factors that have the potential to reduce noise level along roads and thereby improve the quality of life of residents. Therefore, research is necessary to i) understand the interaction between tyres and

different pavement types, ii) to improve the tyre labelling system to better reflect this interaction, and iii) to determine the benefits that could be realised if a tyre labelling system accurately reflected 'real world' noise emissions

- Improvements to the effectiveness of existing noise measures

  Different methods are available in order to reduce noise levels associated with road traffic. Noise barriers are one widely used method and they can significantly improve the quality of life for nearby sensitive receptors by reducing road traffic noise emissions experienced. Barriers are also used extensively on railway networks. The performance of environmental noise barriers has been historically determined through laboratory-test standards for absorbing and insulating performances. In recent years new in-situ measurements methodologies have been defined for both road and railway barriers. A growing number of NRAs now include in situ testing in their performance. In parallel NRAs have visual inspection regimes focused on the material and structural aspects of the barrier in order to validate the quality of installation. The approach adopted to testing and acceptance on railways is less clear.

  For NRAs and Railway Organisations, which include Railway Undertakings, Railway Infrastructure managers and Railway Owners, it is important to determine performance following installation but also in the whole lifetime of the devices. Both acoustic and visual control procedures are necessary but further research is required into the frequency and the accuracy of acoustic and visual inspections.

  Noise barriers are a significant asset for NRAs and Railway Organisations. Procurement, installation and maintenance represent a significant long-term investment. However, knowledge is lacking amongst infrastructure administrators on barrier procurement, on site acceptance and long-term management.

  The aim of this research is to aid NRAs and Railway Organisations in becoming Intelligent Customers by improving their knowledge of test methods and acceptance regimes during all project phases.

- Understanding and reducing annoyance perceived by people living near major roads

  People's subjective reaction to noise can be changed (positively or negatively) by factors that do not change the actual noise level they experience. An example of this is the removal of trees, often carried out for safety reasons that would not change the measured noise level but often lead to noise complaints from residents. Some noise mitigation measures are better received by residents than others, even if they provide similar levels of noise mitigation. The aim of the research is to identify the factors that can lead to a change in reaction from nearby residents, and to identify how these factors can be used to better manage noise by NRAs, and Railway Organisations if research partners can be identified, both during operation and in planning of major road (and railways).

4 Reasons for the Transnational Road Research Programme

Environmental traffic noise continues to be a growing concern. It affects the health, wellbeing and amenity of those living near major infrastructure such as national roads and railways. NRAs and other infrastructure administrators, in particular Railway Organisations, have an interest in minimising the noise generated by traffic on their operational network to

minimise the effect on these people. In addition, noise can cause issues during the planning, constructing and maintenance of major infrastructure such as national roads and railways.

During the planning stage of new roads and railways, local populations are often very worried about the potential impact of the scheme on the noise levels they may experience. Mitigation measures that could be used to reduce the predicted impact or to improve the perception of the impact of local residents may help to reduce residents' concerns and consequently ease the path of the new road through the planning system.

Many NRAs and Railway Organisations receive complaints due to noise from the operation of their schemes and expend considerable effort in responding to these complaints. Reducing noise exposure for populations near major infrastructure or having a better understanding of how noise levels are perceived, has the potential to decrease the number of noise complaints and lessen the administrative burden of responding to these noise complaints.

This research programme therefore aims to reduce noise exposure and nuisance experienced by residents living adjacent to national roads and railways, and also to improve understanding of how populations react to noise, resulting in tangible benefits to NRAs and Railway Organisations.

There are also wider benefits of reducing environmental noise and in particular road traffic noise. Due to its prevalence, as well as the relative severity of disturbance associated with it, road traffic noise is the most commonly studied noise source in relation to its negative impacts on public health. The European Environmental Agency (EEA) reports that in 2011, around 30 million EU-inhabitants were exposed to noise levels above 55 dB caused by major roads, outside the urban areas only. Inside the urban areas, there was no distinction made between the contribution from major roads and the contribution from other roads, but with around 70 million EU-inhabitants exposed to noise levels above 55 dB it is likely that this number includes several millions of inhabitants whose main noise source is noise from Major Roads.

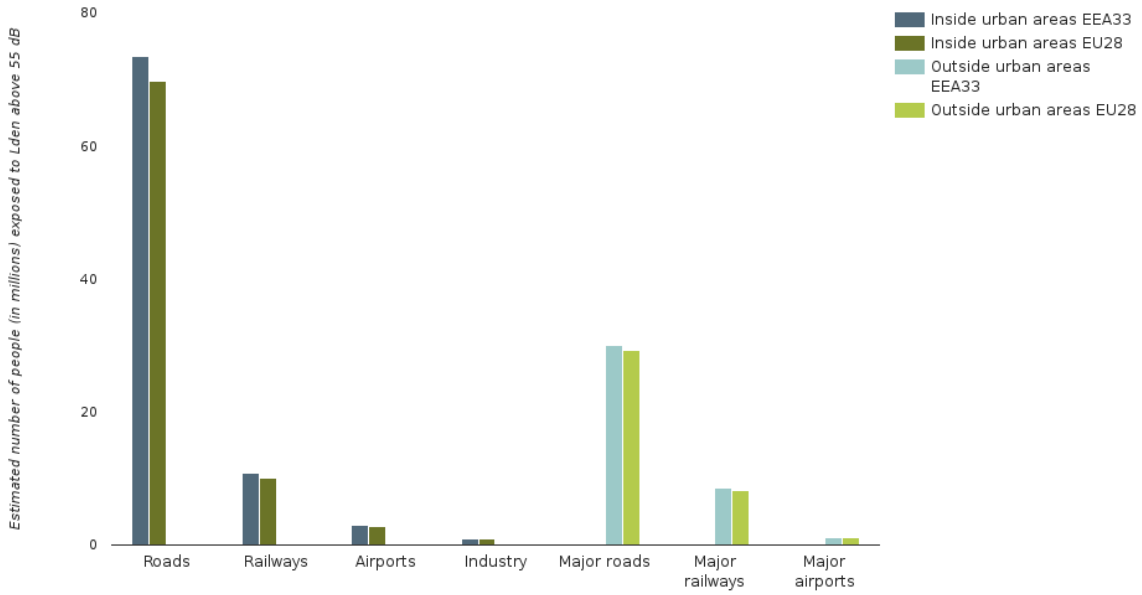

Figure 1: EEA-33 and EU-28: Number of people exposed to noise levels above L_{den} 55dB (EEA, 2011)

From these figures, it can be concluded that:

- Noise pollution is a major environmental health problem in Europe.

- Road traffic is the most widespread source of environmental noise, with an estimated 100 million people affected by harmful levels in the EEA-33 member countries. Noise from railways, airports and industry are also important sources of noise.
- The European Union's Seventh Environment Action Programme (7th EAP) sets the objective that by 2020 noise pollution in the EU has significantly decreased, moving closer to the World Health Organization (WHO) recommended levels.

According to the findings of the World Health Organisation (WHO), noise is the second largest environmental cause of health problems, just after the impact of air quality (particulate matter).

A study commissioned by DG Environment on the Health implication of road, railway and aircraft noise in the European Union found that exposure to noise in Europe contributes to[1]:

- about 910,000 additional prevalent cases of hypertension,
- 43,000 hospital admissions per year, and
- at least 10,000 premature deaths per year related to coronary heart disease and stroke.

This makes noise and noise nuisance a significant challenge for road authorities. The WHO is currently working on revised Community Noise Guidelines for Europe, which are expected to present state-of-the-art evidence on the health effects of noise and updated recommendations on acceptable exposures levels. This may lead to tighter noise limits in national noise regulations and an increased pressure on road and rail authorities to take noise reducing measures or reduce noise levels and annoyance otherwise.

5 Research Objectives

5.1 Topic A: Quieter Tyres, Tyre Labelling System and Pavements

Description of Problem/Description of Research Need

Summary: The aim of the EU tyre labelling system is to improve environmental efficiency of road transport by promoting tyres with low noise levels. However, recent research has shown there is a poor relationship between the tyre label and 'real world' noise emissions. The aim of this topic is to investigate how a functional tyre labelling system could be used by NRAs to deliver noise improvements for populations near major roads

Tyre-noise is the dominant source of road traffic noise, so quieter tyres are particularly important in a forward-looking strategy to reduce road noise from high speed roads in Europe in order to reduce nuisance or to observe noise limits. Regulation 661/2009 includes minimum legal standards for tyre noise to be phased in from 1st November 2012. Additionally, Regulation 1222/2009 requires that all tyres produced after July 2012 and on sale in the EU from November 2012 should, at the point of sale, be accompanied by a label with performance specification, in order to aid consumers in choosing tyres with a relatively low noise emission, in addition to a low fuel consumption and good wet grip performance.

However, over the last number of decades, passenger cars and trucks have increased in mass and in engine power. The increased use of heavier, more powerful vehicles, with wider

[1] Since this study was based on partial data on noise exposure, the overall health effects in the entire EU are likely to be even higher than currently estimated.

tyres, has offset the positive effects of the improvements in vehicle noise and acoustic performance of newly developed low noise road surfaces.

Moreover, recent studies in Austria, Denmark, Norway and Sweden have shown that the correlation between tyre noise labelling and noise emission under realistic driving conditions may be weak. Possible explanations for this, such as differences in acoustic characteristics between the reference road surfaces used for noise label testing and the predominant road surface types across Europe, have been identified and need further investigation.

Separately, truck tyres are often retreaded one or more times, extending their life cycle. These retreaded tyres form a substantial part of the truck tyre population and since they are not subject to regulation, there is a potential for further decreasing noise emissions if the labelling system would include retreaded tyres as well.

Although road authorities are not *responsible* for the promotion of quieter tyres, they will clearly benefit form a successful reduction of rolling noise emission from vehicles. Reduced emissions from the source will result in lower noise levels experienced at the facades of dwellings and other sensitive receptors. This will potentially reduce the costs for noise abatement measures, as well as resulting in more positive health outcomes for residents. The forthcoming publication of the WHO's Environmental Noise Guidelines for the European Region, expected later this year and may increase the urgency to reduce noise levels in member states.

There are at least three requirements for exploiting the potential for tyre road noise reduction at its best:

- A tyre labelling system that has a good correlation with noise emission under realistic driving conditions and on common pavements across Europe
- Optimal proliferation of tyres labelled as relatively silent
- Stricter legal noise standards for tyres in the future.

The WHO's Environmental Noise Guidelines for the European Region are an additional reason to update and extend the existing cost-benefit analyses for tighter and more effective regulations on tyre noise.

Expected Outputs

- Investigations of the correlation between labelled values and real emission values on typical European road surfaces
- Recommendations for improvement of the tyre labelling system to obtain an acceptable correlation between labelled values and measured values on actual road surfaces both for passenger cars and trucks
- Analysis of the impediments for tyre manufacturers to produce quieter tyres (cost factors, technical constraints)
- Analysis of the effectiveness of different strategies/scenarios for the proliferation of quieter tyres by promoting it to car owners (e.g. campaigns, financial incentives, green deals) and how new technology will influence this.
- Interpretation of existing business case analyses from NRAs that have quantified the benefits of realistic scenarios for a successful tyre labelling system, in terms of for example health benefits, avoided costs for noise mitigation, and in the light of the WHO's Environmental Noise Guidelines for the European Region.
- Analysis of the short-term benefits of noise reduction to 2030 due to the impact of Regulation 661/2009 but also an analysis of the possible benefits of implementing a stricter low noise tyre regime

5.2 Topic B: Optimization and Securing the Performance of Noise Barriers

Description of Problem/Description of Research Need

Summary: Noise barriers: Noise barriers are used extensively throughout Europe and are potentially the most effective mitigation measure to reduce environmental traffic noise associated with road and rail traffic. Significant resources are invested every year by NRAs and Railway Organisations, which include Railway Undertakings, Railway Infrastructure managers and Railway Owners, in the installation and maintenance of noise barriers. These infrastructure administrators must be cognizant of the relevant test standards when procuring and maintaining noise barriers. This topic will analyse the performances of noise barriers, against in particular in situ barrier test methods such as EN-1793-5 and 1793-6, TS 16272-5 and EN-16272-6 and compare these with the visual inspections. This topic will also aim to inform infrastructure administrators of key considerations during the planning, procurement and management of barriers along their networks.

Noise Barriers are the most commonly implemented mitigation measure utilized by NRAs to reduce road traffic noise emission. Noise barriers are also the most commonly used mitigation measure on railways with the UIC reporting that seven networks have installed over 3,000km of noise barrier and that another 500km are expected to be installed within the next ten years. Many factors need to be considered in the detailed design of noise barriers. First of all, barriers must be acoustically adequate. Factors that affect the performance of noise barriers are (i) the insulation capability of the barrier i.e. ability to interrupt the sound path from the road/rail and (ii) the screen's ability to absorb noise if there is a need to prevent reflection of noise from the barrier.

Historically, when detailing the specifications/characteristics for insulation and absorption of new barriers, NRAs and Railway Organisations have been informed by the laboratory-based standards developed by CEN TC226/WG6 (the standards group which develops road traffic noise barrier standards) and CEN TC256/WG40 (the standards group which develops railway traffic noise barrier standards). Furthermore, for noise barriers to be installed on national roads, tests must be performed in accordance with the harmonized product standard EN 14388:2005 to obtain CE marking under the Construction Products Regulations (CPR) 305/2011. This harmonized standard is focused on the laboratory methods without particular specifications of the performances to reach. Railway noise barriers are considered to be outside the scope of the CPR 305/2011 but, according to Directive 2008/57/EC, they must conform to the Technical Specifications for Interoperability (TSI). Therefore, noise barriers utilized on railways are approved on a country-by-country basis. This approach has the possibility to lead to inconsistencies in acceptance between countries.

In recent years a direct field in situ method has been developed for sound absorption (EN-1793-5 for roads and TS 16272-5 for railways) and for sound insulation (EN-1793-6 for roads and EN-16272-6 for railways). Whilst there are some countries already using the in-situ method (1793-5 and 1793-6) for roads, testing is difficult to undertake alongside an operational highway. Often it requires the closure of one traffic lane and thus safety and financial implications can arise. However, with a new version of the product standard EN 14388 due for publication shortly, CE marking may soon be based on both laboratory and in situ testing. Some NRAs also undertake visual inspections in order to verify the integrity of the different parts of the devices. There is limited information available for in situ testing undertaken on railway noise barriers and associated technical difficulties encountered.

There is still uncertainty amongst NRAs and Railway Organisations with respect to barrier testing and acceptance. The relationship between in situ testing and the established laboratory-based test results is unclear. In addition, the relationship between visual inspection and the in-situ test findings remain unknown. Infrastructure administrators need to

control and maintain the devices and thus are required to know how many tests should be undertaken in order to ensure appropriate maintenance. With the removal of 'barrier categories' from the most recent version of EN 1793-5 and EN 1793-6, there is no guidance on what constitutes 'good' barrier performance upon installation. Also the influence of e.g. acoustical leakages or loss of insulation/absorption on total noise reduction at the receivers is unclear.

Noise barrier purchase, installation and maintenance are a significant investment by infrastructure administrators. However, knowledge is lacking within NRAs and Railway Organisations on barrier procurement, on site acceptance, testing and long-term management and associated expected barrier performance.

The research need is for NRAs to (i) have a better understanding of in situ barrier test methods and (ii) be better informed in relation to the planning, procurement and management of barriers along their networks.

Expected Outputs

- A study of available laboratory data and in situ data for different barrier types to determine the relationship between the two testing regimes and the evolution over time for different barrier types.
- An analysis of in situ measurements and the visual inspections, including recommendations for the most cost-effective methods for the inspection of noise barriers acoustical performance in different situations.
- Development of a quicker and safer in situ test method
- Development of a model to predict the acoustical degradation of noise barriers for different scenarios (e.g. road or rail, barrier type, height, geographical location etc.)
- Provision of practical guidance on noise barriers for NRAs and Railway Organisations to ensure appropriate consideration of the acoustic properties in different stages and situations, such as
    - (i) planning stage (including recommendations of minimum requirements for insulation and absorption values for different situations (e.g. different heights of the barriers and distances of the receiver))
    - (ii) procurement stage (including request of and interrogation of Declaration of Performance and CE marking (where required) - Procurement Pass or Fail? sustainability of the product, acceptance criteria for railway barriers),
    - (iii) acceptance upon arrival on site, installation (including competence of installers), on site testing, acceptance or rejection and associated contractual management of this issue considering risk management/risk appetite,
    - (iv) long term performance including a monitoring (acoustic and visual) regime and guaranteed performance,
    - (v) decommissioning stage.

5.3 Topic C: Psycho-Acoustics: Improved Understanding of People's Subjective Reactions to Road Noise

Description of Problem/Description of Research Need

Summary: People's subjective reaction to noise can be changed (positively or negatively) by factors that do not change the actual noise level they experience. For example, if a line of trees next to a road is removed, noise complaints will often be received even if the trees did not affect the noise levels the population received. This topic will examine and quantify these subjective reactions, to enable NRAs (and Railway Organisations if research partners can be

identified) to improve practices to minimise adverse reaction to noise, without necessarily changing noise levels, from existing or proposed roads (or railways).

The assessment of highway noise is based on determining the sound pressure levels (in decibels) emitted by road vehicles and experienced by sensitive receptors, in particular human beings. The decibel levels are then compared to results of research that has been undertaken to show how people typically react to the noise. There is quite good knowledge about dose-response relationship, which can describe the general annoyance compared to a certain noise level. Annoyance has been identified as the most important psychological impact arisen from noise. However, the way in which a person feels about the noise source, can significantly affect their annoyance if they feel good about the noise source.

There are a lot factors which can affect the individual´s experience of the noise. Besides, for example, socioeconomic status, residing neighbourhood characteristics such as greenery has been shown to be able to reduce noise annoyance. A Danish study has shown that people along motorways are more annoyed than people along main urban roads, when they are exposed by the same noise level.

Other factors can also influence people's reaction to noise. These factors are linked more to the general perception of the road surroundings and landscaping, attractiveness or a feeling of well-being for people (quality, safety and security of urban road space, surroundings and green infrastructures, lighting, colour etc.). In the same manner, other environmental factors including vibration, air pollution, odour as well as good spatial and road planning aspects influence people's reaction to noise. Most of these factors are often unconsciously perceived by people but have a high influence on the degree of and whether people feel annoyed by noise.

In many situations, the way people feel about the noise, or the national road making the noise, can mean that their reaction to noise, at a particular dB level, is very different to a 'typical' reaction that the research results would suggest.

Such alternative solutions and measures to "classical" noise protection measures i.e. barriers or low noise surface, may contribute to a better appreciation and acceptance of the existing noise levels and mitigation methods.

Examples of this include:

- Removal of thin lines of vegetation can lead to noise complaints, even though the dB level of the noise will not have given rise to a 'noticeable' change
- Planning a new scheme in an area can lead to increased awareness and complaints from an existing population
- Planting and landscape screening can lead to a less adverse reaction to the noise when compared to the 'typical' expected reaction.
- Different reactions to different types of mitigation measures, even if they provide similar levels of noise level reduction.
- Poor reaction to a reduction in noise from a mitigation measure installed, for example a new barrier not providing as much benefit as the residents had imagined it would.
- Negative feeling towards the road in general which influence reaction to the noise it generates
- General planning measures for raising attractiveness of road like better road safety, cleanliness, creative architectural and planning measures of public space and green infrastructures, soundscapes, etc. may lead to better acceptance of high noise levels or existing noise mitigation measures.

The research need is to identify factors which can lead to changes in people's responses to noise when the dB level does not change and quantifying them.

Expected Outputs

- Identification of factors which can result in changes to the subjective reaction to noise from road traffic but also possibly other modes of transport if research partners can be identified (e.g. rail authorities) that wish to contribute to funding as the research will also be relevant to railway noise.
- Establishing a method to quantify the impact of these factors, perhaps using research based on public reaction to sound demonstrations of the same noise with different visuals, or by using questionnaires, sound demonstration or soundwalking methodologies for identifying and understanding people's experiences and perceptions of the acoustic environment This could lead to assigning a dB correction based on the presence of these factors, or an alternative method.
- Provision of practical guidance for NRAs (and Railway Organisations) on techniques that can be used to positively change subjective response to noise, but not necessarily dB levels, both for new and existing roads (and railways).

6 Overview of current and previous activities

A general overview of current and existing relevant research projects undertaken across Europe and other sources of information are outlined in Appendix A. These resources and subsequent reports will provide the starting point for proposals submitted in response to this Call and proposals will be evaluated on this basis. **Applicants must not duplicate existing results or ongoing projects**. Proposals should be based on the outcomes and state-of-the-art identified in these projects listed below. Failure to take account of available research conclusions will disqualify proposals from this call.

7 Additional information

The aim of this Transnational Road Research Programme is to provide applied research services for the benefit of national road administrations in Europe. The Call is open to any consortium that is led by a legal entity established in Europe. Applications using the templates provided must be submitted by a coordinator of a consortium of at least two independent organisations from different countries. A maximum 75% of the workload can be assigned to one partner.

The expected duration of this programme is 36 months. The target dates within this programme are as outlined in the Guide for Applicants.

The duration for individual projects can be up to 24 months within the programme timescale.

The programme language is English: only proposals submitted exclusively in English are acceptable.

The budget provided by the participating national road administrations for this research programme is EUR 1.000.000.

Please refer to the Guide for Applicants (GfA) for full details of how to submit proposals in response to this Call. Submissions using the templates provided must be made electronically using the iBinder. Submissions received after the deadline cannot be considered.

Appendix A: Existing projects and resources

Europe wide

Activities related to the assessment of Health effects due to noise
http://ec.europa.eu/environment/noise/health_effects.htm

https://www.eea.europa.eu/airs/2017/environment-and-health/environmental-noise

CEDR Task Group Road Noise
http://www.cedr.eu/publication-three-technical-reports-noise/

CEDR Transnational Road Research Programme Call 2012 Noise
http://www.cedr.eu/download/other_public_files/research_programme/call_2012/road_noise/DoRN_NOISE_CALL2012_Final1-2.pdf

Topic A (Quieter Tyres, Tyre Labelling System and Pavements)

- NordTyre 3 project
  - Tyre labelling and Nordic traffic noise – Analysis of data on passenger car tyres
  - Noise from Truck Tyres
  - Potential society effects of regulation tyre/road noise – Summary report of the NordTyre projects
  - CPX Measurement journal – Danish and Swedish test sites
  - Results of tyre/road noise measurements
- Lärmarme Reifen für leise Straßen LARA, M. Haider, R. Wehr, M. Conter, G. Strohmayer and H. Hoislbauer
- "A glimpse on the noise reduction potential due to lower tyre noise emission limits", R. Wehr, M. Haider and M. Conter, Inter Noise 2013
- "The noise reduction potential of "silent tyres" on common road surfaces", E. Hammer and E. Bühlmann, Euronoise 2018
- "Factors affecting Statistical Pass-by measurements", S. Phillips and P. Abbott, Inter Noise 2001
- "Aspects of vehicle and traffic noise control", S. Phillips and P. Kinsey, Transport Research Laboratory 2001
- "Potential benefits of Triple-A tyres in the Netherlands", S. van Zyl, F. de Roo, S. Jansen and E de Graaf, TNO 2014 R10735
- "Value for money in road traffic noise abatement", Milford, I. et. al. (CEDR, 2013)

Topic B (Optimization and Securing the Performance of Noise Barriers)
Activities related to CEN Technical Committee 226 Working Group 6 Noise Reducing Devices
https://standards.cen.eu/dyn/www/f?p=CENWEB:7:0::::FSP_ORG_ID:7542&cs=1D7C2953C1EEBF16258D492504B8DE506

Euronoise 2018
On the reproducibility of airborne sound insulation measurements of noise barriers; a case study (Conference Proceedings Pages 961-966)

http://www.euronoise2018.eu/docs/papers/164_Euronoise2018.pdf

International Conference of Sound and Vibration 24
Proposal for an in-situ approval testing and quality assurance procedure for assessing sound reflection properties of noise barriers (Paper 728)

Improving the in-situ determination of the intrinsic characteristics of noise barriers (Paper 824)

QUIESST: Quietening the Environment for a Sustainable Surface Transport Website: http://www.quiesst.eu/

Railway Noise in Europe: State of the art report (International Union of Railways) https://uic.org/IMG/pdf/railway_noise_in_europe_2016_final.pdf

Topic C (Psycho-Acoustics: Improved Understanding of People's Subjective Reactions to Road Noise)
HOSANNA Project
http://www.greener-cities.eu/

National programmes

Topic B (Optimization and Securing the Performance of Noise Barriers)
Austria REFLEX Project

https://www.ait.ac.at/en/research-fields/acoustics-and-noise-abatement/projects/reflex/

Finland

Sound reflection from different noise barriers

https://julkaisut.liikennevirasto.fi/pdf8/lts_2017-29eng_sound_reflection_web.pdf

Topic C (Psycho-Acoustics: Improved Understanding of People's Subjective Reactions to Road Noise)
Denmark
Noise Annoyance from urban roads and motorways
http://www.vejdirektoratet.dk/DA/viden_og_data/publikationer/sider/publikation.aspx?pubid=822025326

Netherlands
Hamersma, M. (2017). Living near highways: The impact of existing and planned highway infrastructure on residential satisfaction [Groningen]: Rijksuniversiteit Groningen
https://www.rug.nl/research/portal/files/39910584/Chapter_2.pdf