# Conversion of the Railway Source Description of CNOSSOS - EU to CNOSSOS - DE

Ulrich Möhler, Christine Huth, Manfred Liepert
Möhler + Partner Ingenieure AG, Munich, Germany

**Summary**
The noise emission levels calculated with the "assessment methods for noise indicators" published by the EU in 2016 differ from the noise levels calculated by means of the existing national calculation method in Germany (Schall03), which is considered as state of the art for the German railway emission. In a process of adjustments the CNOSSOS - EU calculation method was adapted to the technical acoustic conditions in Germany. These conditions concern innovative noise protection measures for the track (e.g. rail dampers) and for vehicles. The calculation method was adjusted by comparing the CNOSSOS - EU method with the national calculation method Schall03. As a result the CNOSSOS - EU calculation method was converted into the CNOSSOS - DE method including the adaption of the railway source data in appendix G of CNOSSOS - EU. In order to assure the quality of the software application test cases were developed and the results of the test cases calculated with CNOSSOS - DE and Schall03 were compared.

**PACS no. 43.50Lj; 43.50Sr**

## 1. Introduction

In 2012 the EU published the Common Noise Assessment Methods in Europe (CNOSSOS - EU) [1]. The calculation methods for determining the levels of noise assessment of railway noise were documented in the context of the EU Environmental Noise Directive (2002/49 / EC). Finally in May 2015 the Commission published the Directive 2015/996 [2] as the common noise assessment methods following the Directive 2002/49 / EC of the European Parliament and of the Council; this directive is referred to below as "CNOSSOS - EU".
For the implementation of the EU Environmental Noise Directive into national law, a steering committee was built consisting of representatives of the Federal Ministries for Transport and Digital Infrastructure (BMVI), Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) as well as the associated specialist authorities Federal Railway Authority (EBA ), Federal Highway Research Institute (BASt), Federal Environmental Agency (UBA) and the German Aerospace Center (DLR). This steering committee decided that for the transposition of the Directive into national law the calculation rule for railway noise and the associated data bases should take into account the specific characteristics of both the rail and tram vehicles operating in Germany. The specific properties are to be derived from the calculation specifications of Schall03 [3], which is relevant for the calculation of the sound emissions of rail traffic, provided that no current basic data are available. The calculation rule adapted in this way will be referred to below as "CNOSSOS - DE".
The present paper refers to the definition of data bases for the calculation of railway noise listed in Annex G of CNOSSOS - EU or CNOSSOS - DE. For the quality assurance of the software used for the calculations according to CNOSSOS - DE, test tasks were developed for the sound source model. These test tasks are also part of the present explanatory report.

## 2. General Approach

At first step the noise sources of CNOSSOS-EU and Schall03 were compared. One difference is, that for example the height of the rail sources differs in the German Schall03: there the rolling noise is situated on the rail head, in CNOSSOS-EU the chosen height is 0,5 m above the rail head; furthermore the parameters for wheel diameters and wheel load differ from those typically used in Germany. For some parameters, especially for special, in Germany com-

mon tracks, for example slab tracks with and without absorbers and rail dampers, the parameters had to be derived from the Schall03. Finally the correction of the data in Appendix G led to a representation of the German acoustic railway situation.

In detail the following vehicle types and track types, which are often used in Germany, were complemented:

Vehicle types

- High-Speed Trains (ICE 1, 2, 3, tilting train)
- Diesel and electric self-propelled passenger coaches
- City trams (low and high floor trams)
- Subways

Track types

- Ballast track with concrete and wooden sleepers
- Green tracks
- Absorbers on slab tracks
- Monitored tracks
- Rail dampers and rail web noise shielding
- Railroad crossings

Some measures and parameters, which are described in CNOSSOS – EU, are not used in the German calculation methods:

- Rail pads with differing degrees of stiffness
- Rail joints

Calculation methods for the combination of different vehicles with different track types are also to be considered.

## 3. Calculation of corrections

After the general procedure of drafting a German version of CNOSSOS - EU based on the data comparison between CNOSSOS - EU and Schall03, the adaptation of the individual worksheets is described for the example of tracks:

The procedure for the implementation of new coefficients for the transmission function of tracks was basically the following:

1) Derivation of differential values for the rolling noise of various kinds of tracks in comparison to the standard track (ballasted track) from Schall03

2) Calculation of the rolling noise according to CNOSSOS - DE using standard values for the coefficients for a monoblock track on a medium rail pad

3) Calculation of the target state: Addition of the rolling noise calculated under 2) and the differential values derived from Schall03 under 1)

4) Calculation of the actual condition: calculation of the rolling noise according to CNOSSOS - DE with new values for the coefficients; iterative modification of the coefficients in order to minimize the difference to the nominal state minimum.

In order to implement the slab track in CNOSSOS-DE, the rolling noise was calculated for the following trains according to:

- ICE powerhead, 100 km/h, ballasted track
- ICE powerhead 100 km/h, slab track

For the implementation of the slab track, the following variable values for the rolling noise calculated according to Schall03 were used. Figure 1 shows the difference of the rolling noise on slab tracks compared to ballasted tracks calculated with the Schall03 for a HGV power head at 100 km / h in the altitude range 0 m.

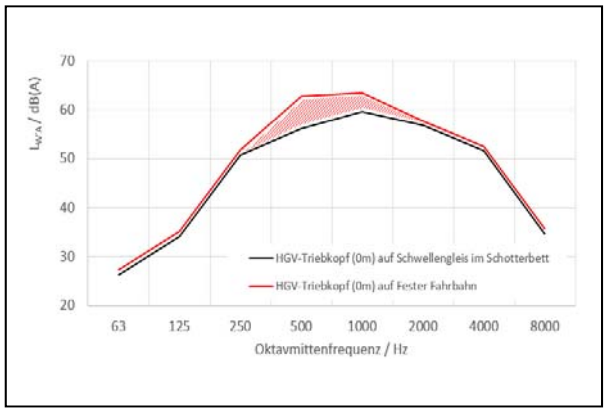


Figure 1. length related A weighted soundpower level for a slab track and a ballasted track calculated with Schall03 (Highspeed powerhead, 100 km/h)

## 4. Quality assurance of calculations

In order to ensure the correct calculation of the CNOSSOS DE software, a procedure was implemented following the Standard of DIN 45687 “Acoustics - Software products for the calculation of the sound propagation outdoors - Quality requirements and test conditions” [4]. For every single step of calculation, the results and the interim results certain test tasks are used to evaluate the simulation by the software. The set of test tasks covers the part of sound emissions of rail vehicles according to Chap. 2.3 (rail noise) of the revised document concerning the assessment methods for noise indicators. All results of the test tasks are specified with an accuracy of three decimal places. The accuracy of the test result is verified by comparing it with the specified result of the test tasks. The maximum permitted deviation for the last decimal place is "1. For a value of e.g. 1.000, the calculated result may also be 0.999 or 1.001. For the test task parameters only the numerical values are given, whereas the units are omitted.

In a document the software provider declare the conformity of the product with the test cases.

## 5. Results

The implementation of CNOSSOS EU in CNOSSOS DE leads to the following results:

1.) In section 2.3 concerning railway noise editorial revisions were supplemented with the introduction of a list of abbreviations, the definition of formula symbols, the numbering of equations and the introduction of cross-references. In addition the in Germany common vehicles and superstructures were supplemented. Rail joints were not taken into account as they are compensated by the minimum velocity. The equation for directivity was modified and for the calculation of trams and metros a change in the basic calculation method was necessary.

2.) In the tables in Annex G only the coefficients required for the calculation are listed; therefore the information on Min Max is omitted. The units of measurement were added and the text section coding was adopted.

3.) The data for ground tracks (Table G-1.2), the applicable wheel loads and the wheel diameters (Table G-2) for vehicles used in Germany as well as the coefficients for additional track types (Table G-3) were added. Aggregate noises of vehicles, including trams, used in Germany as well as the coefficients for bridge constructions also used in Germany were added.

CNOSSOS-DE is to be implemented in a national directive at end of the year 2018.

### Acknowledgement

The funding of this project by the Federal Railway Authority, Bonn, Germany and the Federal Ministry of Transport and Digital Infrastructure is gratefully acknowledged.

### References

[1] Stylianos Kephalopoulos, Marco Paviotti, Fabienne Anfosso-Lédée (2012) Common Noise Assessment Methods in Europe (CNOSSOS – EU) to be used by the EU Member States for strategic noise mapping following the adoption as specified in the Environmental Noise Directive 2002/29/EC.

[2] Richtlinie (EU) 2015/996 der Kommission vom 19. Mai 2015 zur Festlegung ge-meinsamer Lärmbewertungsmethoden gemäß der Richtlinie 2002/49/EG des Europäischen Parlaments und des Rates

[3]Verordnung zur Änderung der Sechszehnten Verordnung zur Durchführung des Bundes – Immissionsschutzgesetzes Verkehrslärmschutz-verordnung – 16. BlmSchV) vom 30.04.2014 (Schall03).

[4] DIN 45687:2006-05 Acoustics - Software products for the calculation of the sound propagation outdoors - Quality requirements and test condition