

13th UIC Sustainability Conference



Railway Noise Modelling in the Common Method

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Overview



- Introduction
- Basis of Directive 2015/996 Rail Sources
- Conversion of Existing Databases
- Adding to the Databases
- Conclusions





Introduction



Evolution of Rail Source Elements of Directive 2015/996



- HARMONOISE



- IMAGINE



- **Modifications and augmentations from EC JRC Expert Group**



- DG JRC CNOSSOS-EU Final Report



- Directive 2015/996



Evolution of Rail Source Elements of Directive 2015/996



- HARMONOISE



- IMAGINE



- **Modifications and augmentations from EC JRC Expert Group**

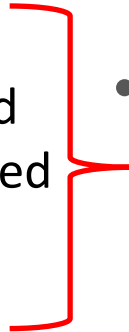


- CNOSSOS Final Report



- Directive 2015/996

Informed by DG Env
project: “Develop and
implement harmonised
noise assessment
methods”



“Develop and Implement Harmonised Noise Assessment Methods” ENV.C.3/SER/2012/0031

VIENNA 2016



- Team: Extrium, Acustica, DGMR, CSTB, Stapelfeldt
 1. Structure design and creation of the Cnossos-EU set of input values (road, railway and industrial noise)
 2. Implementation of the Cnossos-EU software for testing purposes (road, railway and industrial noise) with open-source technologies
 3. Development of guidelines on the competent use of the Cnossos-EU framework (road, railway, industrial and aircraft noise) and creation of a website describing those guidelines.





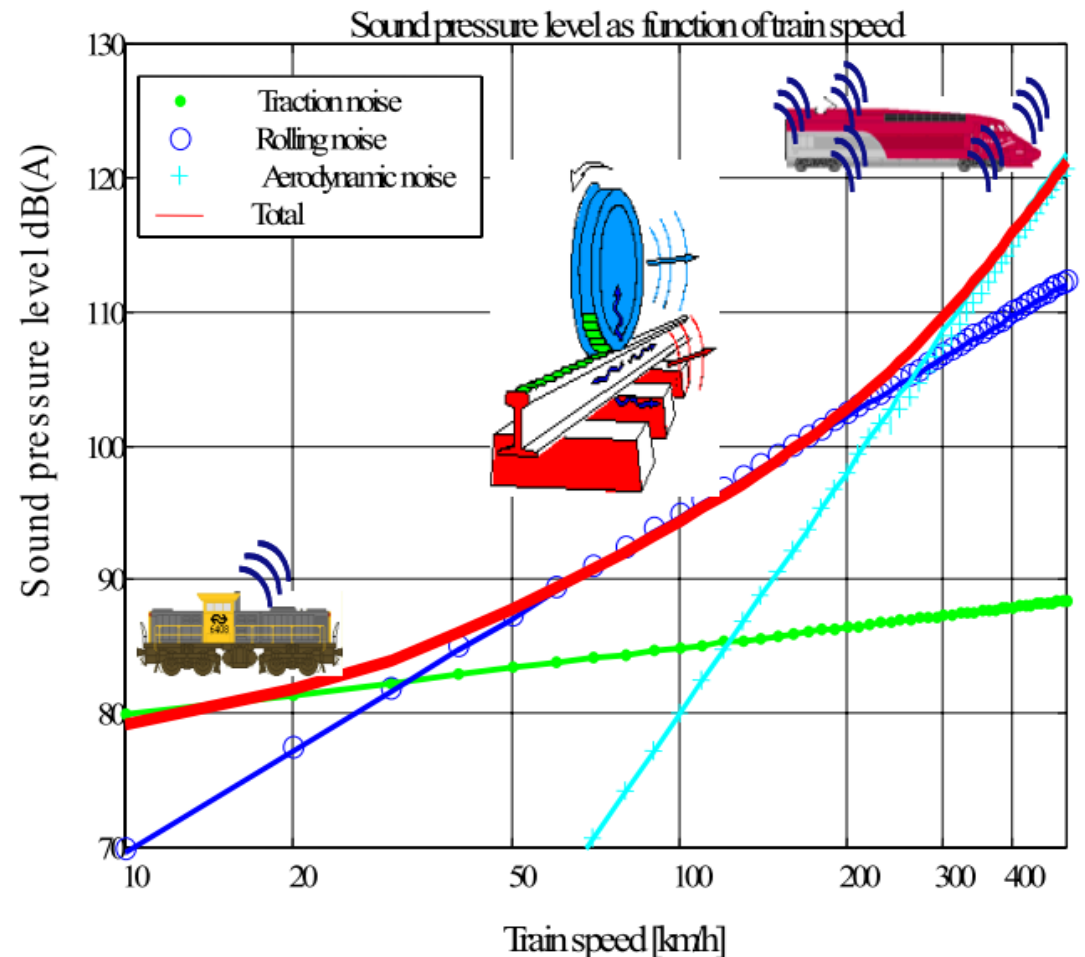
Basis of Directive 2015/996 Rail Sources



Sources of railway noise



- The total noise (red) is the combination of:
 - Traction noise from the engine (green)
 - Rolling noise from the wheel on the rail (blue)
 - Aerodynamic noise from the movement through the air (light blue)
- The dominant source depends on the speed



Basis of 2015/996 Rail Sources



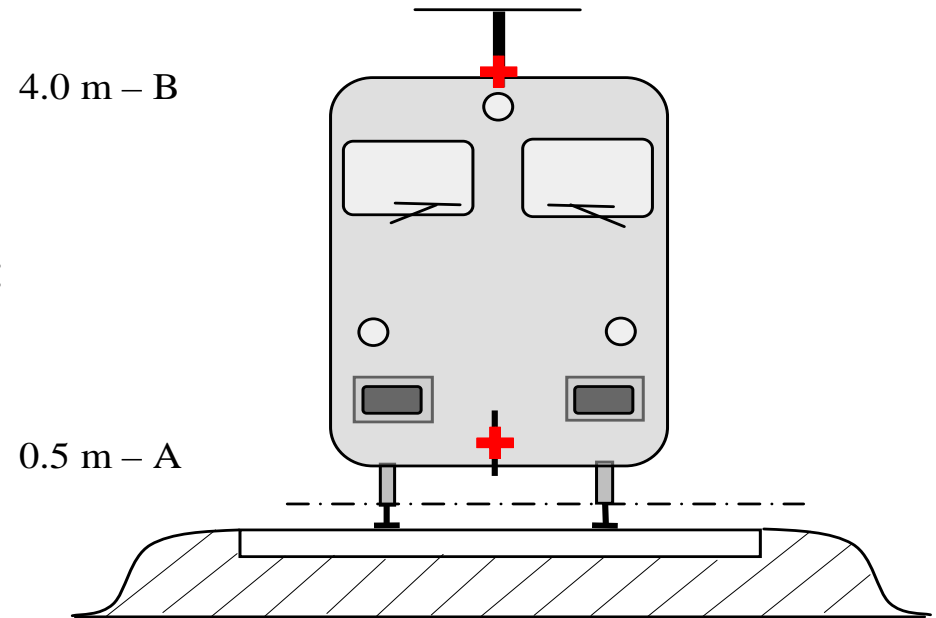
- The source method outputs Sound Power Level (SWL) in 1/3 octave frequency bands
- Elements:
 - Rolling noise from a given vehicle/track combination
 - Traction noise (acceleration, constant, idle)
 - Aerodynamic noise
 - Curve squeal enhancement
 - Bridge and viaduct enhancement



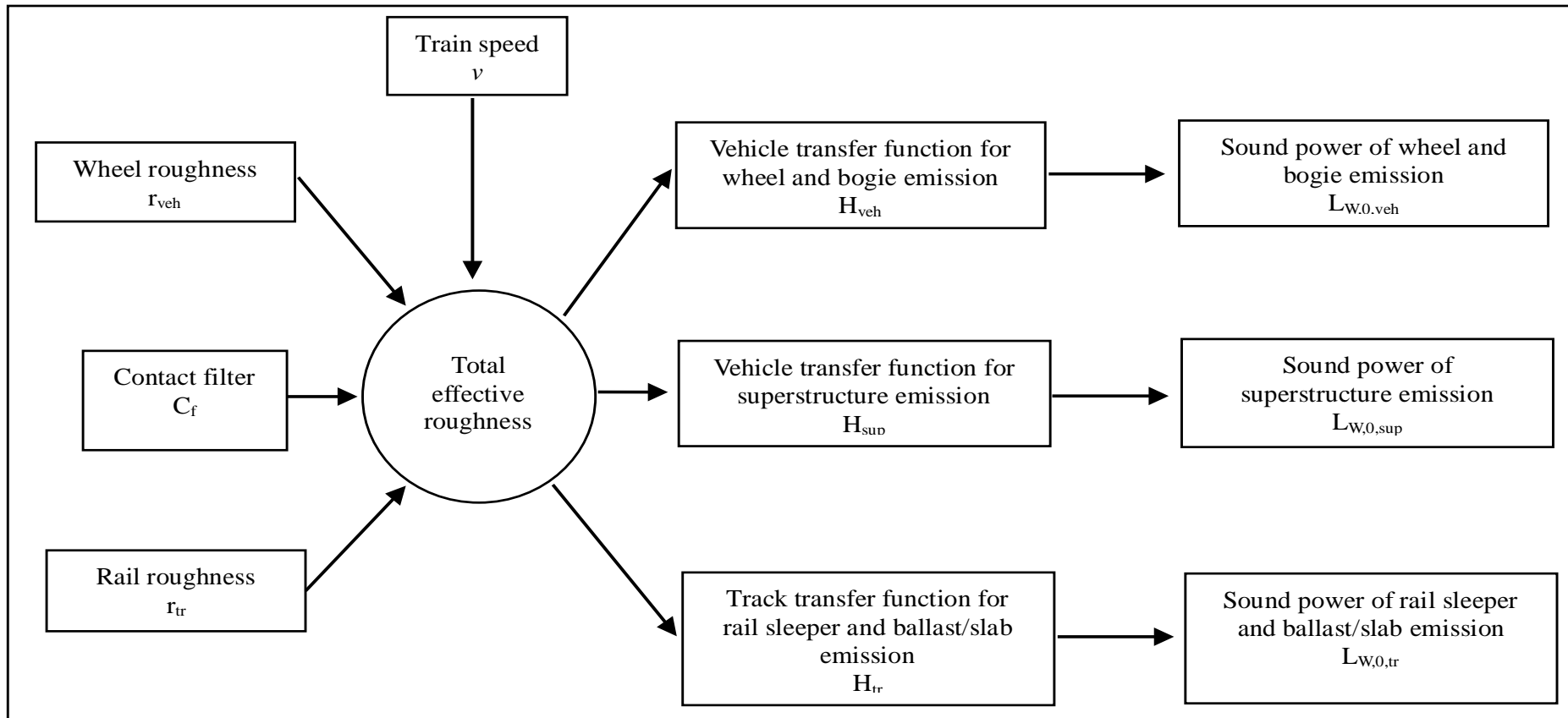
Features



- 2 source heights
- Railway **vehicles** described in function of:
 - Vehicle type
 - Axles/vehicle
 - Brake type
 - Wheel measure
- **Track** described in function of:
 - Type of track base
 - Roughness
 - Rail pad
 - Additional measure
 - Joints
 - Curvature



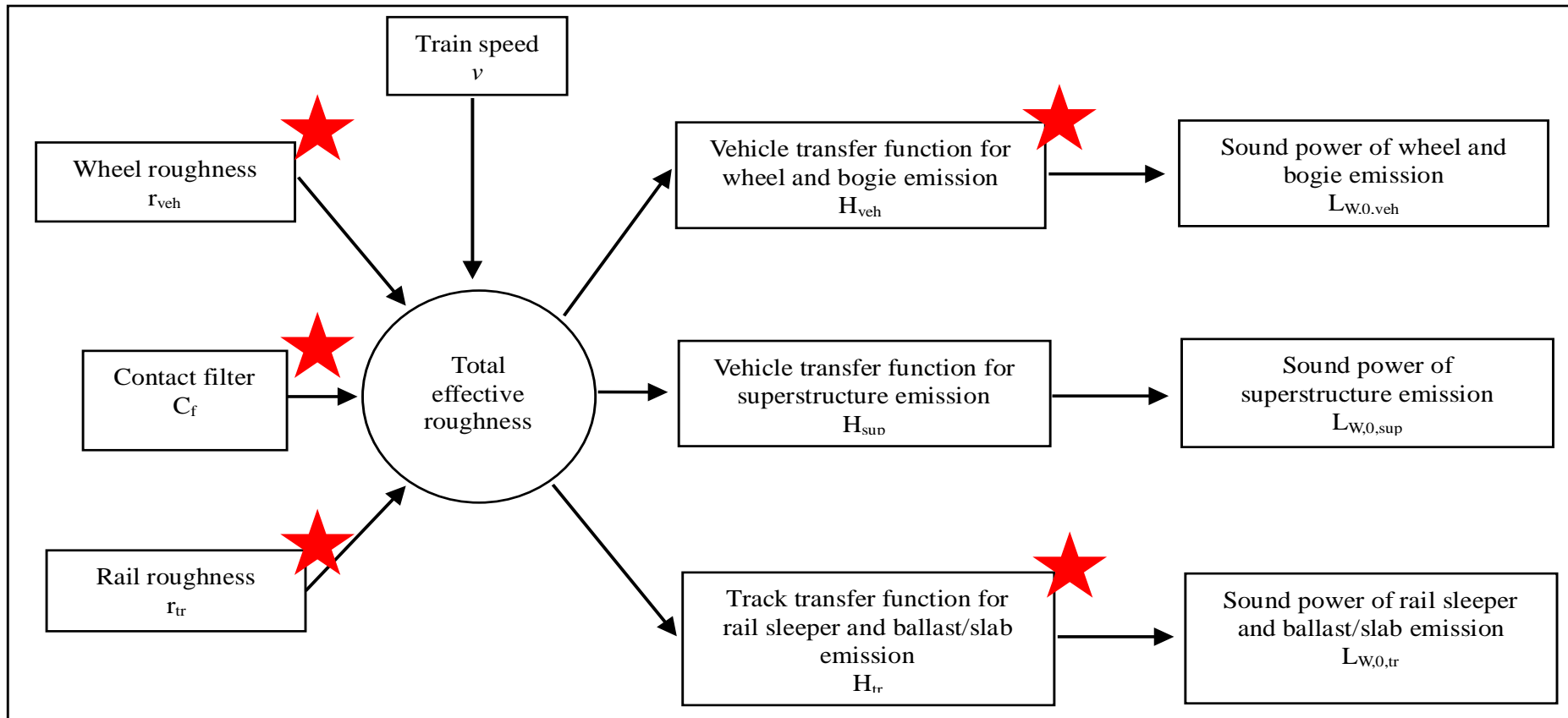
Features



Features



★ Default values available within 2015/996 Annex G



Input Databases



- Default values currently within Annex G comprise:
 - Wheel roughness
 - Rail roughness
 - Additional rail roughness due to joints etc
 - Roughness “Contact Filter”
 - Transfer functions: sound power from (a) vehicle, (b) track vs combined wheel/rail roughness
 - Traction noise (constant speed only)
 - Aerodynamic noise
 - Enhancement for bridges and viaducts



General approach



- Envisaged that MS will expand databases from records or new measurements
- As an interim approach look-up tables have been provided between several existing national methods and CNOSSOS-EU
 - *CNOSSOS-EU_Rail_Input_Database_Tables_Final - 01April2014_revANNEXII v1.1 09April15.xlsx*
- on EC webpage:
 - *<https://circabc.europa.eu/w/browse/477df8f1-1dc3-4e37-bda0-28e56a6595cb>*





Conversion of Existing Databases



Vehicles: conversion of existing databases



- Single vehicles method
 - Split existing trains or vehicles (as defined in national methods)
- Assess wheel size
- Braking system in use
 - cast-iron tread brakes, composite tread brakes or disc brakes
 - assumed roughness
- Only vehicles with wheel dampers are excluded
- Traction noise
 - Diesel Multiple Unit, Diesel Locomotive, Electric Multiple Unit and Electric Locomotive
- Aerodynamic noise
 - Depending on max speed



Vehicles: RMR '96 example conversion



RMR Train Cat		CNOSSOS ID					
		Veh TF	Contact filter	Wheel roughness	Traction noise*	Default length m	Axles/ vehicle
Cat 1	All	3	6	3	10	26	4
Cat 2	ICM-III, ICR trailer vehicles, DDM-1 trailer vehicles, SNCF passenger coaches and TEE	3	6	3	10	26	4
	ICR 1700 locomotive, DDM-1 1800 locomotive and Belgian locomotives	6	6	3	9	18	4
Cat 3	All	3	6	5	10	26	4
Cat 4	Freight wagons	3	6	3	-	Variable	Variable
Cat 5	DE1, DE2, DE3	3	6	3	8	25	4
	2200 and 2300 locomotive	3	6	3	3	14	4
	2400 and 2500 locomotive	3	6	3	3	13	4
Cat 6	All	3	6	5	8	26	4
Cat 7	All	3	6	5	10	15	3
Cat 8	ICM IV and IRM	3	6	5	10	26	4
	DDM 2/3	3	6	3	10	26	4
Cat 9	TGV PBA type, power car	3	6	3	9	20	4
	TGV PBA type, trailer car adjacent to power car	3	6	5	-	20	3
	TGV PBA type other trailer cars	3	6	5	-	20	2
Cat 10	ICE-3 type assuming no wheel dampers	3	6	5	10	25	4
					*Where appropriate		



Tracks: conversion of existing databases



- Rail roughness
 - Very few cases of definition of this parameter in EU, most likely assumed and not explicitly mentioned in calculation methods
- Track base & rail pad type
 - Where track types are described in national methods it has been possible to choose an appropriate equivalent CNOSSOS type in a selection of cases



Vehicles: RMR '96 example conversion



RMR Track Cat "b"		Track Transfer ID
1	Monoblock	4
	Bi-block	7
2	Wooden	9
3	See impact correction table below for jointed track	
4	"Blocks" - not catered for in CNOSSOS - would require additional source data acquisition	
5	"Blocks" - not catered for in CNOSSOS - would require additional source data acquisition	
6	"Adjustable rail fixation" - not catered for in CNOSSOS - would require additional source data acquisition	
7	"Adjustable rail fixation" - not catered for in CNOSSOS - would require additional source data acquisition	
8	"Poured in" not catered for in CNOSSOS - would require additional source data acquisition	
9	"Level crossings" not catered for in CNOSSOS - would require additional source data acquisition	

RMR Joints "m"		Impact noise ID	RMR Structure	Bridge constant ID
1	Jointless rails (fully welded tracks) with or without jointless switches or crossings	1	TT & U-type bridge - predominantly concrete or masonry	3
2	Rails with joints (= tracks with joints) or an isolated switch	3	TT & U-type bridge - predominantly steel	4
3	Switches and crossings with joints, 2 per 100m	3	Plate & girder bridge	4
4	More than 2 switches per 100m	2	Steel deck bridge	4



Accuracy Considerations



- The content of the databases in 2015/996 are examples, and should be viewed as a seed for the database
- The techniques used to produce the existing content of the rail source databases involve a great deal of theoretical manipulation, approximation, and rationalisation
 - They have not, as yet, been comprehensively validated
- The tables to migrate from national methods to the common method are based upon a concept of providing similar responses to changes in input data, NOT demonstrating the same emission level is calculated at the reference location
 - This should be sufficient for strategic noise mapping where hot spots are to be identified, and differences between railway lines should be similar to the existing national method



Accuracy Considerations



- From 2015/996, 2.1.2:
 - “All input values affecting the emission level of a source shall be determined with at least the accuracy corresponding to an uncertainty of $\pm 2\text{dB(A)}$ in the emission level of the source”,
 - BUT: “Default input values and assumptions are accepted if the collection of real data is associated with disproportionately high costs”





Adding to the Databases



Adding to the Databases



- IMAGINE Deliverable D12/D13 “Rail noise database and manual for Implementation”, 14 February 2007
- ISO 3095:2013 – Railway applications - Measurement of noise emitted by railbound vehicles
- EN 15610:2009 – Noise Emission - Rail roughness measurement related to rolling noise generation (under revision to include wheel roughness measurement)
- EN 15461+A1:2010 – Noise emission - Characterisation of the dynamic properties of track sections for pass by noise measurements
- PD CEN/TR 16891:2016 - Railway applications - Acoustics. Measurement method for combined roughness, track decay rates and transfer functions
- COMMISSION REGULATION No 1304/2014 of 26 November 2014 on the technical specification for interoperability relating to the subsystem ‘rolling stock — noise’





Conclusion



Conclusions



- CNOSSOS-EU has been adopted within a revision of Annex II of Directive 2002/49/EC
- As an interim solution, look-up tables have been developed to support migration from existing national railway traffic noise methods to CNOSSOS-EU
- It is envisaged that use of these look-up tables will reduce over time as:
 - experience with the new method increases,
 - specific railway vehicles and track supports within each country are captured in line with the CNOSSOS-EU methodology, and
 - the CNOSSOS-EU databases are extended



Acknowledgements



- CNOSSOS-EU WG3
- Marco Paviotti, DG Environment
- Extrium project for DG Environment
 - Develop and Implement Harmonised Noise Assessment Methods – ENV.C.3/SER/2012/0031
 - Issues Log 1
 - Railway Equivalence Note
 - <https://circabc.europa.eu/w/browse/477df8f1-1dc3-4e37-bda0-28e56a6595cb>



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Thank you for your attention



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