Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement

Direction territoriale Est

An overview of Directive 2015/996/EC (CNOSSOS-EU) for terrestrial sources

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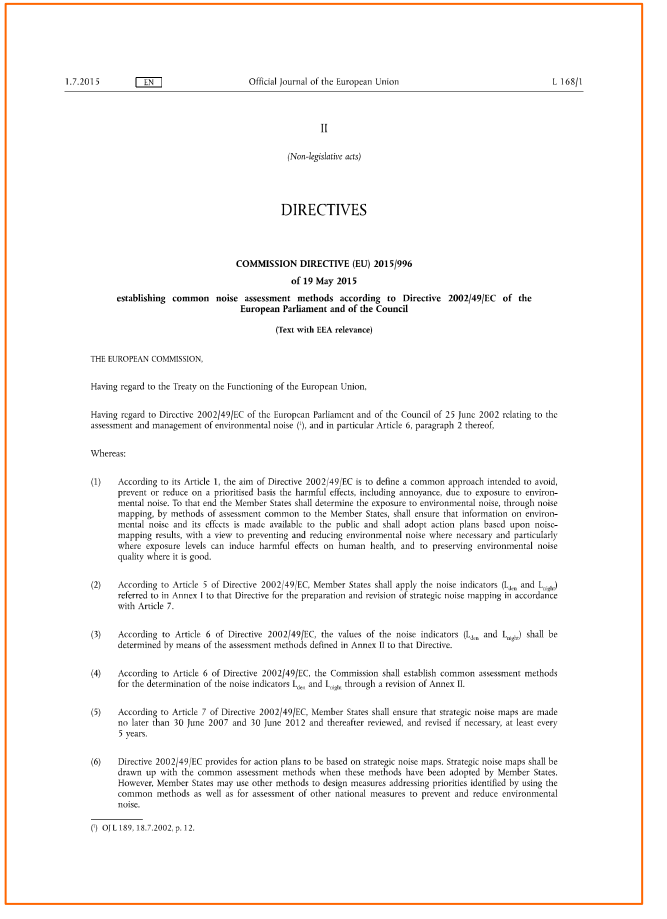


1.7.2015 EN Official Journal of the European Union L 168/1

II

(Non-legislative acts)

DIRECTIVES

COMMISSION DIRECTIVE (EU) 2015/996

of 19 May 2015

establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise [1], and in particular Article 6, paragraph 2 thereof,

Whereas:

(1) According to its Article 1, the aim of Directive 2002/49/EC is to define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise. To that end the Member States shall determine the exposure to environmental noise, through noise mapping, by methods of assessment common to the Member States, shall ensure that information on environmental noise and its effects is made available to the public and shall adopt action plans based upon noise-mapping results, with a view to preventing and reducing environmental noise where necessary and particularly where exposure levels can induce harmful effects on human health, and to preserving environmental noise quality where it is good.

(2) According to Article 5 of Directive 2002/49/EC, Member States shall apply the noise indicators (L_{den} and L_{night}) referred to in Annex I to that Directive for the preparation and revision of strategic noise mapping in accordance with Article 7.

(3) According to Article 6 of Directive 2002/49/EC, the values of the noise indicators (L_{den} and L_{night}) shall be determined by means of the assessment methods defined in Annex II to that Directive.

(4) According to Article 6 of Directive 2002/49/EC, the Commission shall establish common assessment methods for the determination of the noise indicators L_{den} and L_{night} through a revision of Annex II.

(5) According to Article 7 of Directive 2002/49/EC, Member States shall ensure that strategic noise maps are made no later than 30 June 2007 and 30 June 2012 and thereafter reviewed, and revised if necessary, at least every 5 years.

(6) Directive 2002/49/EC provides for action plans to be based on strategic noise maps. Strategic noise maps shall be drawn up with the common assessment methods when these methods have been adopted by Member States. However, Member States may use other methods to design measures addressing priorities identified by using the common methods as well as for assessment of other national measures to prevent and reduce environmental noise.

[1] OJ L 189, 18.7.2002, p. 12.

Introduction

- Directive 2002/49/CE
- 2007 deadline
  - “Interim” methods
  - “Equivalent” methods
- Consistency issues
- Directive 2015/996/EC (CNOSSOS-EU)

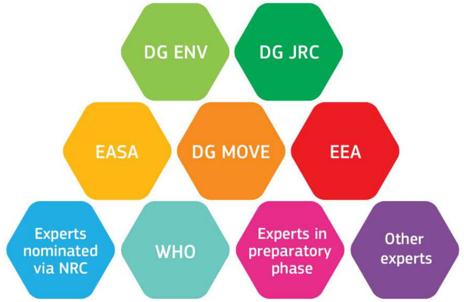
Article 6

Méthodes d’évaluation

1. Les valeurs de L_{den} et L_{night} sont déterminées à l’aide des méthodes d’évaluation définies à l’annexe II.

2. Des méthodes d’évaluation communes pour la détermination de L_{den} et de L_{night} sont établies par la Commission conformément à la procédure prévue à l’article 13, paragraphe 2, par le biais d’une révision de l’annexe II. En attendant que ces méthodes soient adoptées, les États membres peuvent utiliser des méthodes d’évaluation adaptées conformément à l’annexe II et fondées sur les méthodes prévues par leur propre législation. Dans ce cas, ils doivent démontrer que ces méthodes donnent des résultats équivalents à ceux qui sont obtenus avec les méthodes mentionnées à l’annexe II, point 2.2.

CNOSSOS-EU



Outline

- Project organization

- General aspects
- Emission
- Propagation
- Populations

- Pending issues

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[1] OJ L 189, 18.7.2002, p. 12.

CNOSSOS-EU project

PHASE A
Development of CNOSSOS-EU methodological framework

PHASE B
CNOSSOS-EU tools and validation

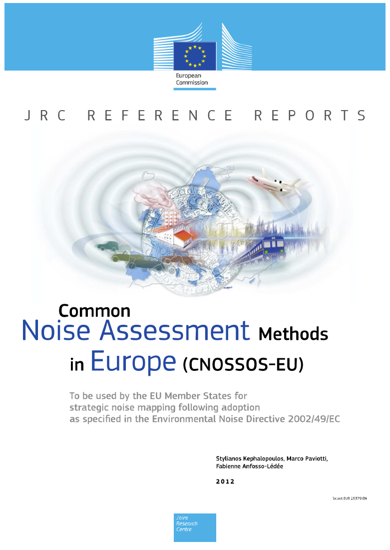
Implementing Act to revise Annex II of END

2008 | 2012 | 2014 | 1.7.2015

Steering DG-JRC
MS strongly involved

8 active working groups

Separation between aircraft and other sources



Steering DG-Env
Extrium consortium
MS (almost) not involved

Reference software
Assessing candidate methods
+ everything else !

3 parallel drafts of Annex II

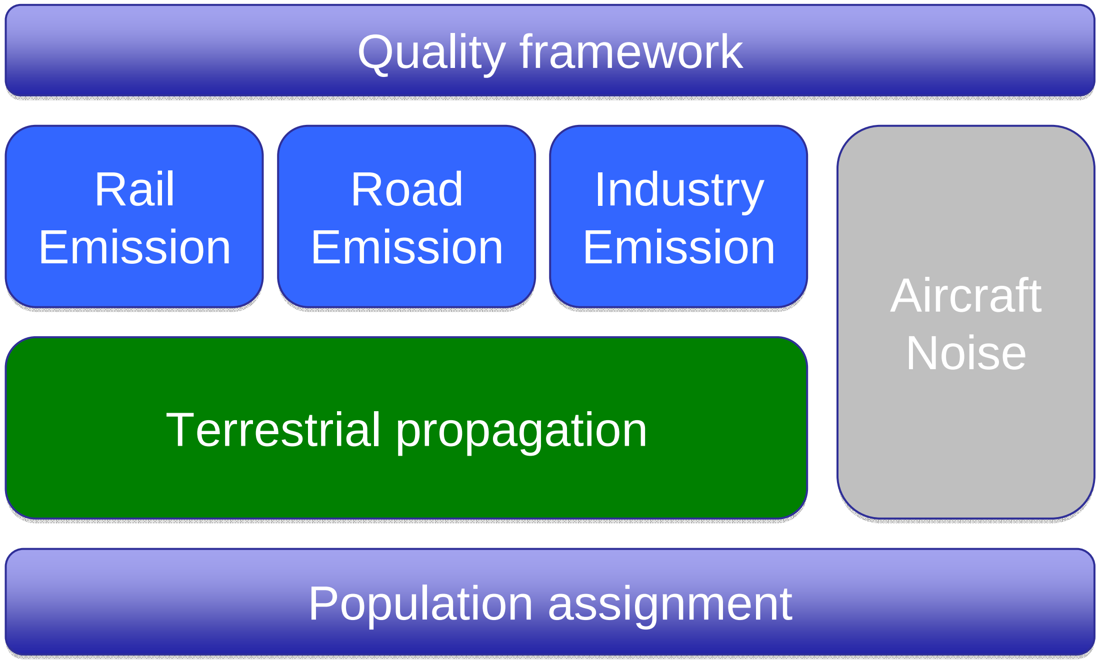
Selection of JRC 2012

Adoption by NRC

Translation

Publication

CNOSSOS-EU structure



CNOSSOS-EU in general

- 2 harmonized methods
- Target: strategic noise mapping
- Octaves from 63 Hz to 8000 Hz
- Point source decompositions
- 2.5D path search

Quality framework

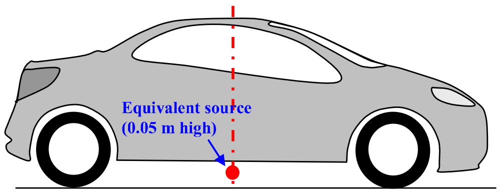
- Accuracy of input values
  - +/- 2 dB on the emission level of the source
  - No confidence interval provided

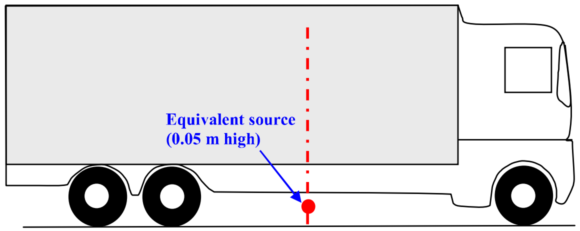
- Use of default values
  - Not allowed unless disproportionately high costs

- Quality of the software used for calculations
  - Compliance with the certification of results against test cases

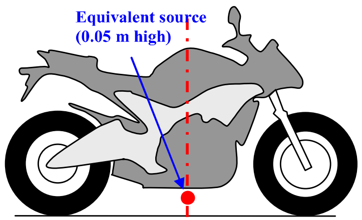
Road emission

Category	Name	Description
1	Light motor vehicles	Passenger cars, delivery vans ≤ 3.5 tons, SUVs(2), MPVs(3) including trailers and caravans
2	Medium heavy vehicles	Medium heavy vehicles, delivery vans > 3.5 tons, buses, touring cars, etc. with two axles and twin tyre mounting on rear axle
3	Heavy vehicles	Heavy duty vehicles, touring cars, buses, with three or more axles
4	Powered two-wheelers	4a mopeds, tricycles or quads ≤ 50 cc
		4b motorcycles, tricycles or quads > 50 cc
5	Open category	To be defined according to future needs





Omnidirectional sources



2 components

$$L_{W,i,m}\left(v_m\right)=10\times\lg\left(10^{L_{WR,i,m}\left(v_m\right)/10}+10^{L_{WP,i,m}\left(v_m\right)/10}\right)$$

Reference conditions

- Flow type
- Gradient
- Temperature
- …

Rolling

$$L_{WR,i,m} = A_{R,i,m} + B_{R,i,m} \times \lg\left(\frac{v_m}{v_{ref}}\right) + \Delta L_{WR,i,m}\left(v_m\right)$$

Propulsion

$$L_{WP,i,m} = A_{P,i,m} + B_{P,i,m} \times \frac{\left(v_m - v_{ref}\right)}{v_{ref}} + \Delta L_{WP,i,m}\left(v_m\right)$$

Speed-dependent spectrum

Road emission - pavements

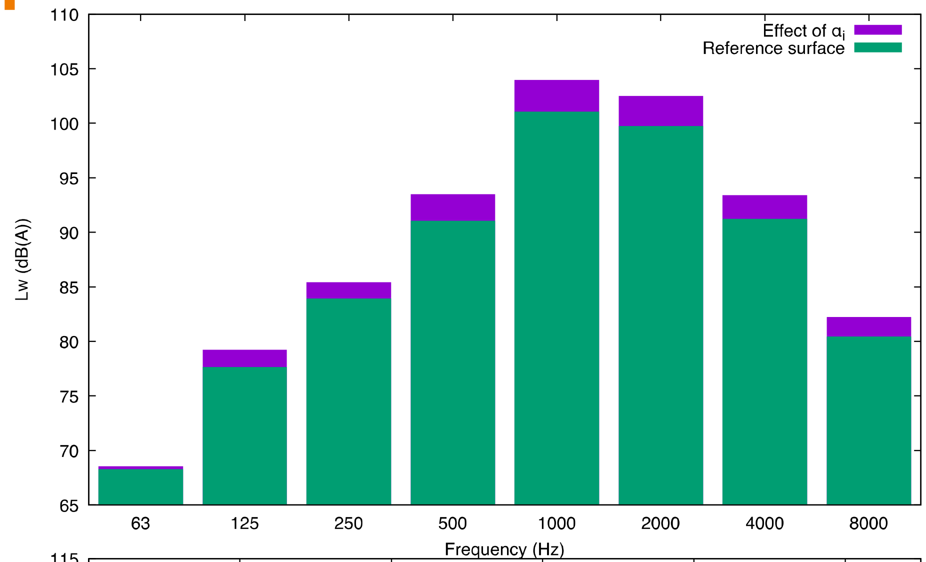
Reference pavement
•DAC 0/11 + SMA 0/11
•2-7 years
•Representative maintenance condition

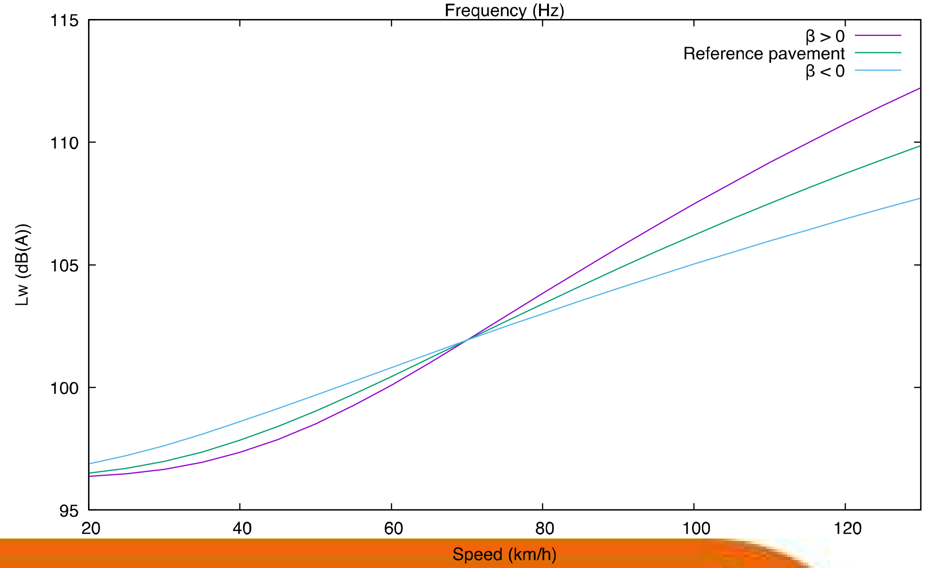
Real world pavements

$$\Delta L_{WR,road,i,m} = \alpha_{i,m} + \beta_m \times \lg\left(\frac{v_m}{v_{ref}}\right)$$

$$\Delta L_{WP,road,i,m} = \min\{\alpha_{i,m};0\}$$

•Table for Dutch pavements
•Computing new coefficients for each vehicle category
- SPB measurements
- Converting existing models

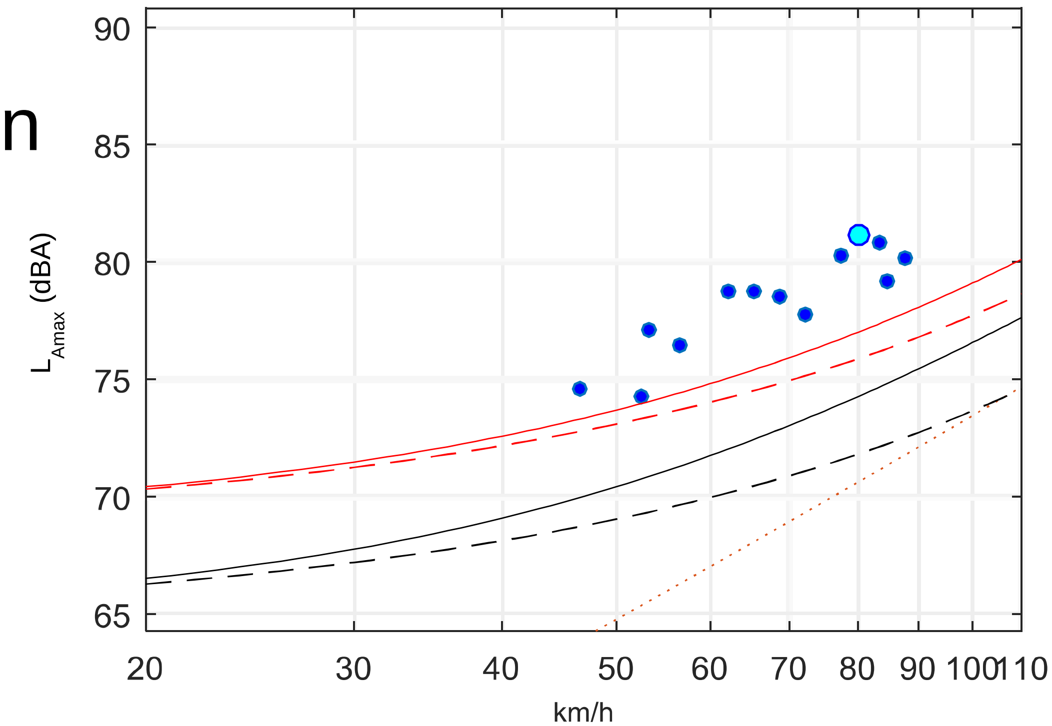




Road emission

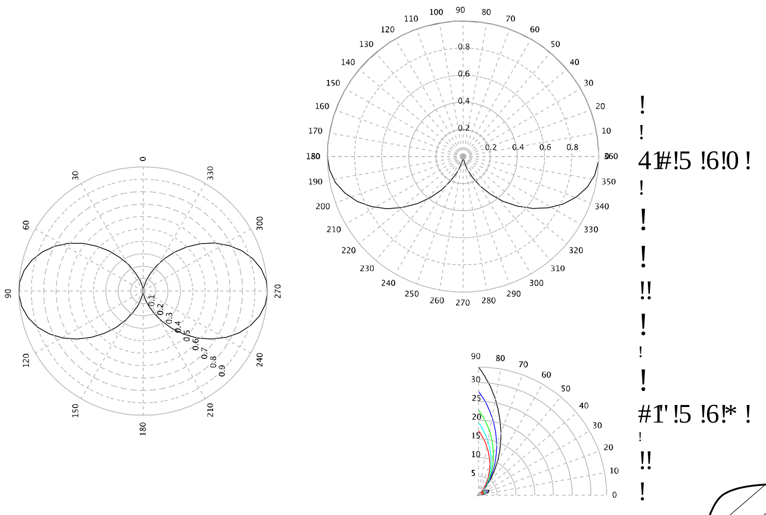
- Pavement emission not age-dependent

- Unsteady flow-type close to intersections only
  - Exercise caution on tabulated data

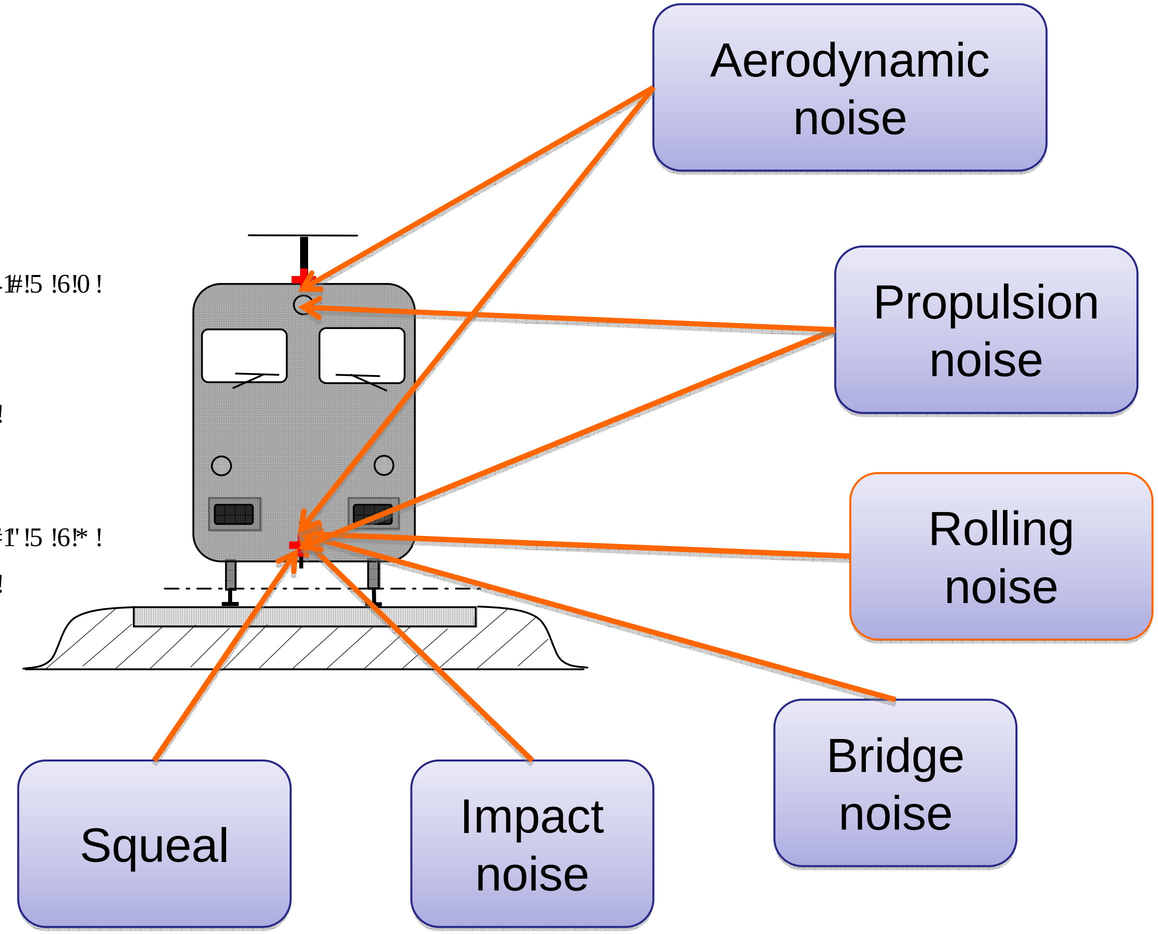


Railway emission

Directivity



Horizontal Vertical



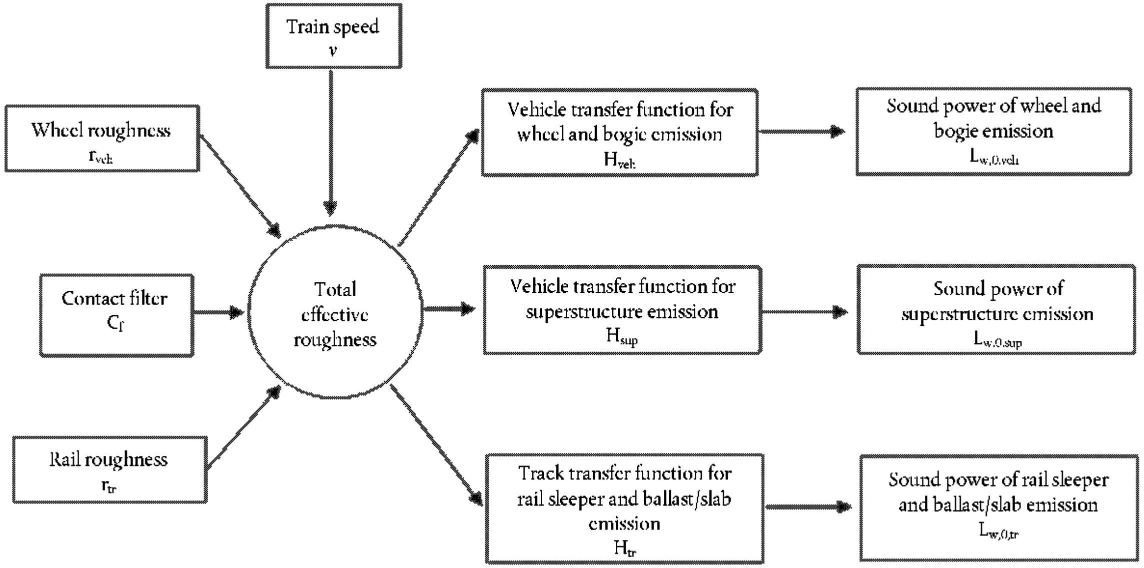
Railway emission

Digit	1	2	3	4
Descriptor	**Vehicle type**	**Number of axles per vehicle**	**Brake type**	**Wheel measure**
Explanation of the descriptor	A letter that describes the type	The actual number of axles	A letter that describes the brake type	A letter that describes the noise reduction measure type
Possible descriptors	**h** high speed vehicle (>200 km/h)	**1**	**c** cast-iron block	**n** no measure
	m self-propelled passenger coaches	**2**	**k** composite or sinter metal block	**d** dampers
	p hauled passenger coaches	**3**	**n** non-tread braked, like disc, drum, magnetic	**s** screens
	c city tram or light metro self-propelled and non-self-propelled coach	**4**		**o** other
	d diesel loco	etc.		
	e electric loco			
	a any generic freight vehicle			
	o other (i.e. maintenance vehicles etc.)			

Digit	1	2	3	4	5	6
Descriptor	**Track base**	**Railhead Roughness**	**Rail pad type**	**Additional measures**	**Rail joints**	**Curvature**
Explanation of the descriptor	Type of track base	Indicator for roughness	Represents an indication of the 'acoustic' stiffness	A letter describing acoustic device	Presence of joints and spacing	Indicate the radius of curvature in m
Codes allowed	**B** Ballast	**E** Well maintained and very smooth	**S** Soft (150-250 MN/m)	**N** None	**N** None	**N** Straight track
	S Slab track	**M** Normally maintained	**M** Medium (250 to 800 MN/m)	**D** Rail damper	**S** Single joint or switch	**L** Low (1000-500 m)
	L Ballasted bridge	**N** Not well maintained	**H** Stiff (800-1000 MN/m)	**B** Low barrier	**D** Two joints or switches per 100 m	**M** Medium (Less than 500 m and more than 300 m)
	N Non ballasted bridge	**B** Not maintained and bad condition		**A** Absorber plate on slab track	**M** More than two joints or switches per 100 m	**H** High (Less than 300 m)
	T Embedded track			**E** Embedded rail		
	O Other			**O** Other		

Railway emission

- Rail roughness



- Very small set of tabulated vehicles

Frequency	$L_{W,0,idling}$													
	Min		Max		Diesel locomotive (c. 800 kW)		Diesel locomotive (c. 2 200 kW)		Diesel multiple unit		Electric locomotive		Electric multiple unit	
	SourceA	SourceB	SourceA	SourceB	SourceA	SourceB	SourceA	SourceB	SourceA	SourceB	SourceA	SourceB	SourceA	SourceB
50 Hz	0,0	0,0	140,0	140,0	98,9	103,2	99,4	103,7	82,6	86,9	87,9	92,2	80,5	84,8
63 Hz	0,0	0,0	140,0	140,0	94,8	100,0	107,3	112,5	82,5	87,7	90,8	96,0	81,4	86,6

- Adapting to other (national) rolling stock ?

Industrial sources

- Geometry
  - Source types
  - Discretization rules

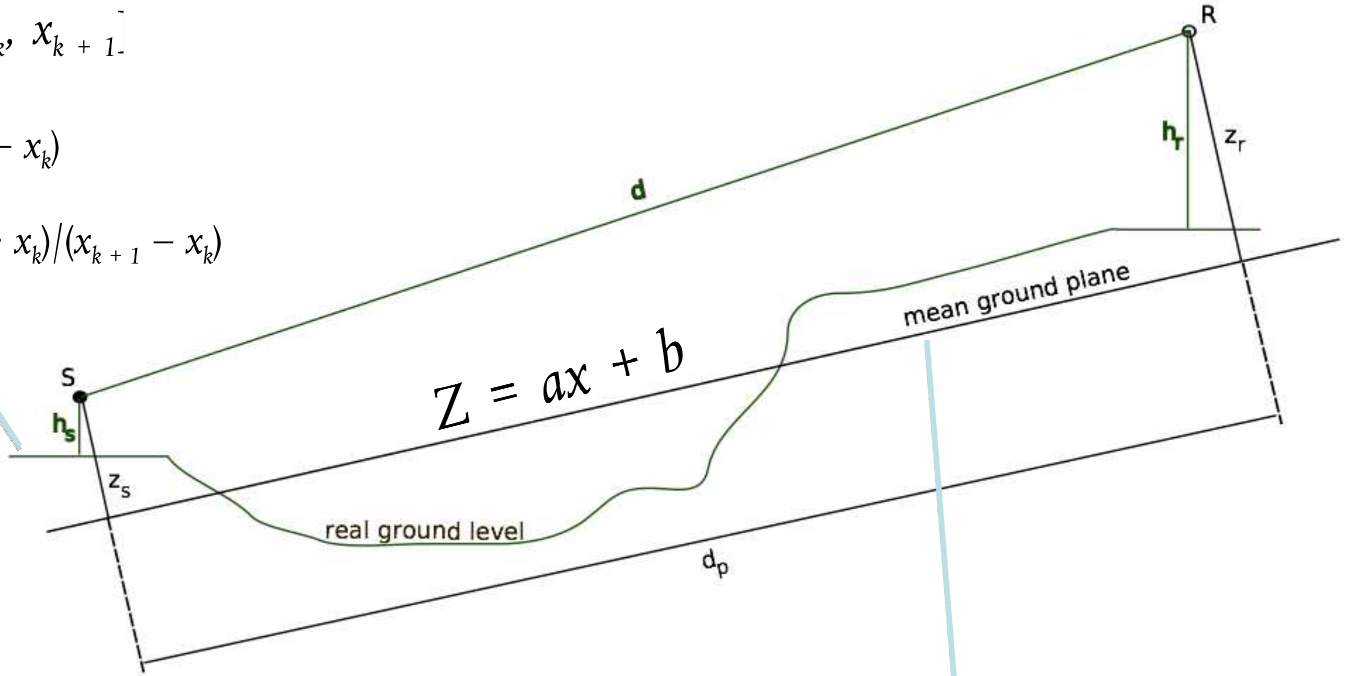
Description	Type of source	Source directivity	63	125	25
Grit blasting — outside — with nozzle	PointSource	FreeField	108,77	110,37	112
Rotary kiln	LineSource	FreeField	79,27	84,17	86,
Ship yard	AreaSource	HemiSpherical	67,17	69,07	74,
Gas terminal	AreaSource	HemiSpherical	74,17	70,07	65,

- Sound power
  - Operating cycles
  - Directivity
  - Quite limited default database
  - Measurements are recommended

Propagation – mean ground plane

$$H_k = a_k x + b_k,\ x \in [x_k, x_{k+1}]$$

$$\begin{cases} a_k = (H_{k+1} - H_k)/(x_{k+1} - x_k) \\ b_k = (H_k \cdot x_{k+1} - H_{k+1} \cdot x_k)/(x_{k+1} - x_k) \end{cases}$$

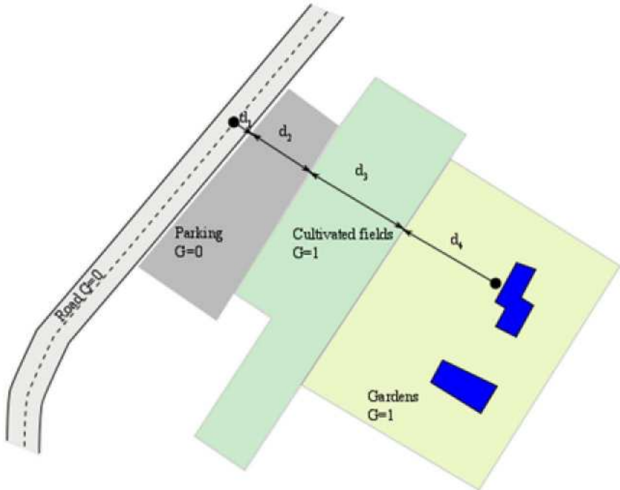


$$\begin{cases} A = \frac{2}{3}\sum_{k=1}^{n-1} a_k (x_{k+1}^3 - x_k^3) + \sum_{k=1}^{n-1} b_k (x_{k+1}^2 - x_k^2) \\ B = \sum_{k=1}^{n-1} a_k (x_{k+1}^2 - x_k^2) + 2\sum_{k=1}^{n-1} b_k (x_{k+1} - x_k) \end{cases}$$

$$\begin{cases} a = \frac{3(2A - B(x_n + x_1))}{(x_n - x_1)^3} \\ b = \frac{2(x_n^3 - x_1^3)}{(x_n - x_1)^4} B - \frac{3(x_n + x_1)}{(x_n - x_1)^3} A \end{cases}$$

Propagation – ground absorption

- Ground factor G $G \in [0, 1]$

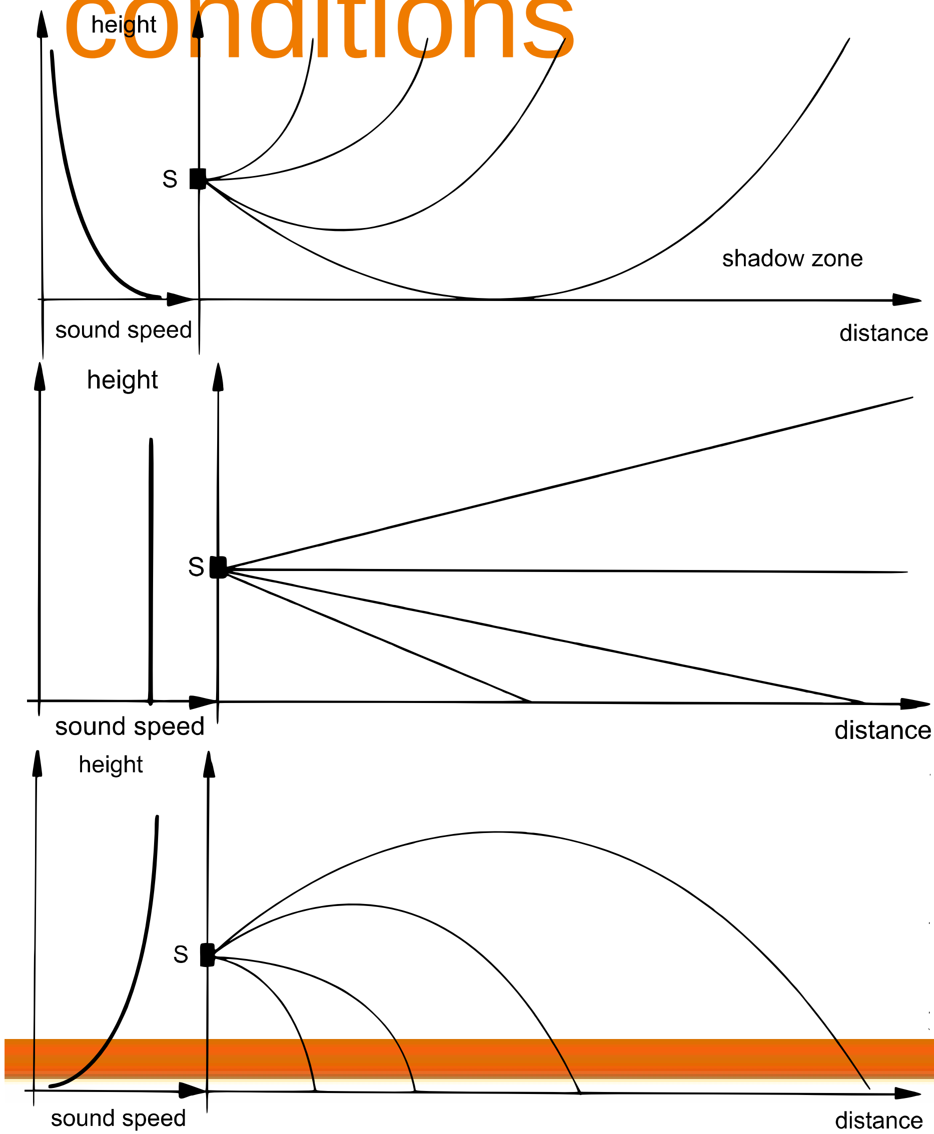


Description	Type	(kPa · s/m²)	G value
Very soft (snow or moss-like)	A	12,5	1
Soft forest floor (short, dense heather-like or thick moss)	B	31,5	1
Uncompacted, loose ground (turf, grass, loose soil)	C	80	1
Normal uncompacted ground (forest floors, pasture field)	D	200	1
Compacted field and gravel (compacted lawns, park area)	E	500	0,7
Compacted dense ground (gravel road, car park)	F	2 000	0,3
Hard surfaces (most normal asphalt, concrete)	G	20 000	0
Very hard and dense surfaces (dense asphalt, concrete, water)	H	200 000	0

- Defined for each ground element
- Average along a path: Gpath
- Close to the source

$$G'_{path} = \begin{cases} G_{path}\dfrac{d_p}{30(z_s + z_r)} + G_s\left(1 - \dfrac{d_p}{30(z_s + z_r)}\right) & \text{if } d_p \le 30(z_s + z_r) \\ G_{path} & \text{otherwise} \end{cases}$$

Propagation – propagation conditions



Upward refraction

Non refracting conditions

Downward refraction

Propagation – 2 conditions

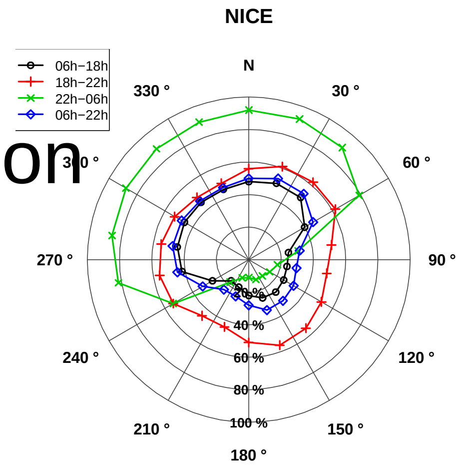
- Downward conditions (F)

$$L_{i,F} = L_{Awi} - A_{i,F}$$
$$A_{i,F} = A_{div} + A_{atm} + A_{boundary,F}$$

- Homogeneous conditions (H)

$$L_{i,H} = L_{Awi} - A_{i,H}$$

  - Safe-side estimate of upward refraction



- Occurrences of downward refraction p_i
- Long term sound level

$$L_{i,LT} = 10\log_{10}\left(p_i 10^{L_{i,F}/10} + (1-p_i)10^{L_{i,H}/10}\right)$$

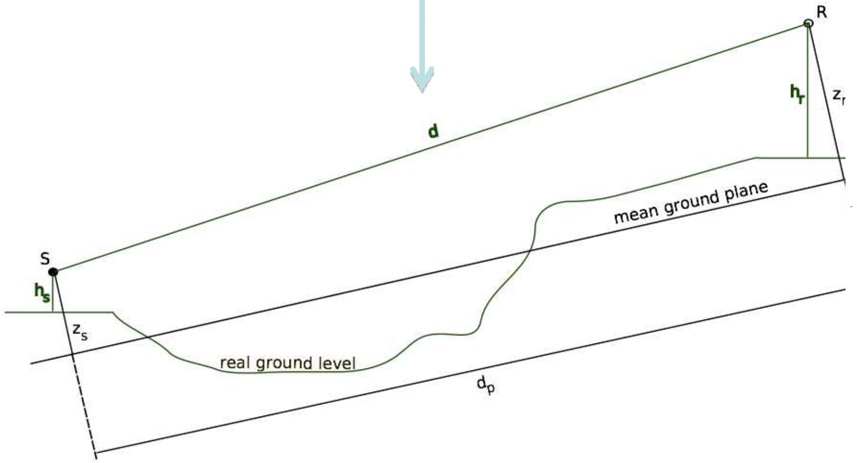
Propagation – $A_{boundary}$

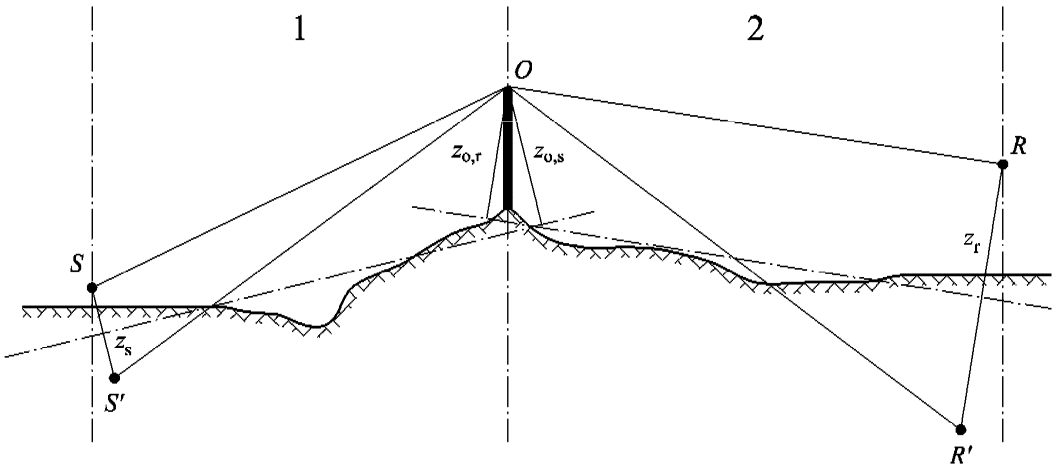
For each octave band

Diffraction ?

No: $A_{boundary}=A_{ground}$

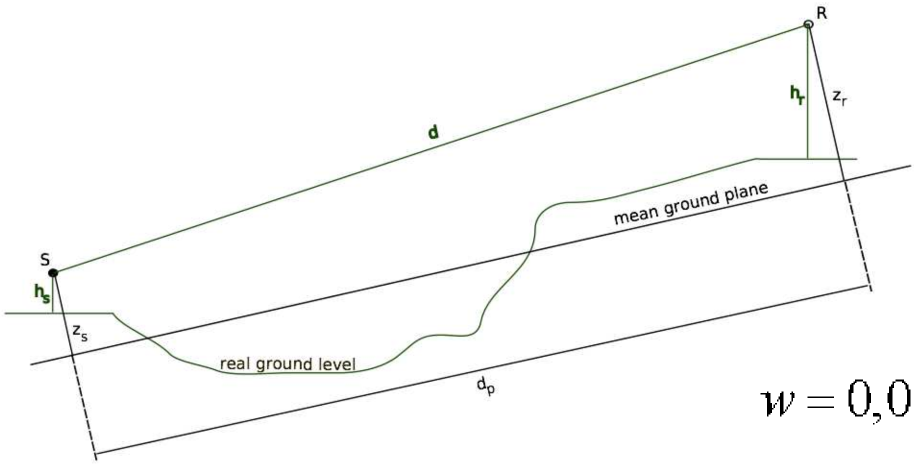
Yes: $A_{boundary}=A_{dif}$





Propagation – Aground,H

$$A_{ground} = -10\log_{10}\left[4\frac{k^2}{d_p^2}\left(z_s^2 - \sqrt{\frac{2C_f}{k}}z_s + \frac{C_f}{k}\right)\left(z_r^2 - \sqrt{\frac{2C_f}{k}}z_r + \frac{C_f}{k}\right)\right]$$



$$C_f = d_p \frac{1 + 3wd_p e^{-\sqrt{wd_p}}}{1 + wd_p}$$

$$w = 0{,}0185 \frac{f_m^{2.5}\,\overline{G_w}^{2.6}}{f_m^{1.5}\,\overline{G_w}^{2.6} + 1{,}3\cdot 10^3 f_m^{0.75}\,\overline{G_w}^{1.3} + 1{,}16\cdot 10^6}$$

$$A_{ground,H,\min} = -3(1-\overline{G_m})$$

Propagation – Aground,F

- Aground,F=Aground,H for a different geometry

$$A_{ground} = -10\log_{10}\left[4\frac{k^2}{d_p^2}\left(z_s^2 - \sqrt{\frac{2C_f}{k}}z_s + \frac{C_f}{k}\right)\left(z_r^2 - \sqrt{\frac{2C_f}{k}}z_r + \frac{C_f}{k}\right)\right]$$

- Corrected heights

Source

$$\delta z_s = a_0\left(\frac{z_s}{z_s+z_r}\right)^2\frac{d_p^2}{2}$$

Turbulence

$$\delta z_T = 6\times 10^{-3}\frac{d_p}{z_s+z_r}$$

Receiver

$$\delta z_r = a_0\left(\frac{z_r}{z_s+z_r}\right)^2\frac{d_p^2}{2}$$

$$z_{s,F} = z_s + \delta z_s + \delta z_T$$

$$z_{r,F} = z_r + \delta z_r + \delta z_T$$

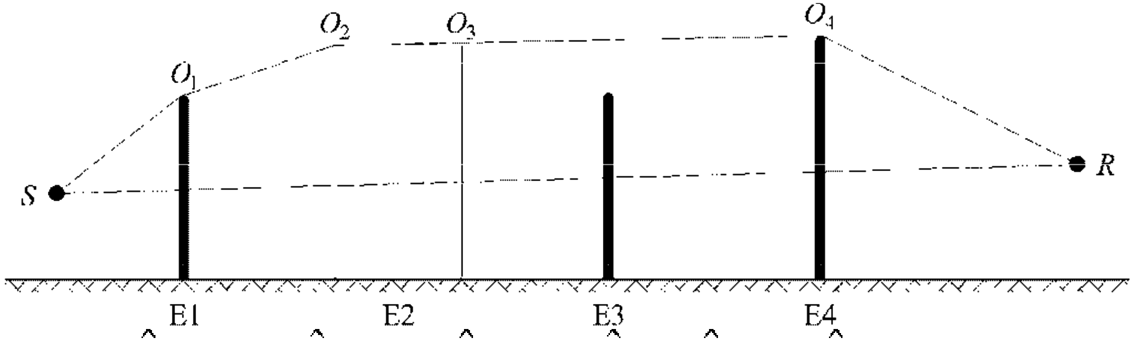
$$A_{ground,F,min} = \begin{cases} -3(1-G'_{trajet}) & \text{si } d_p \leq 30(z_s+z_r) \\ -3(1-G'_{trajet})\left(-1-2(1-30(z_s+z_r)/dp)\right) & \text{otherwise} \end{cases}$$

Propagation – Adif - horizontal

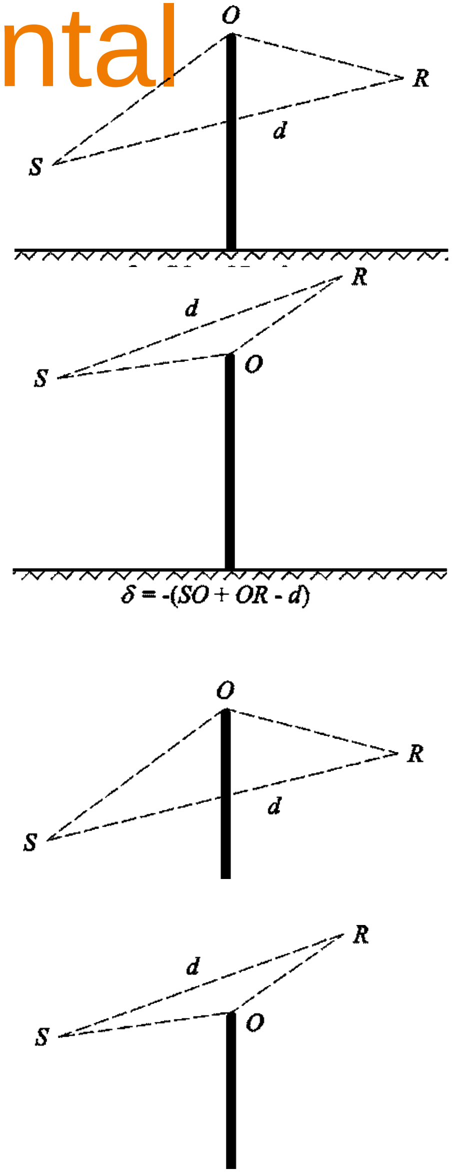
$$A_{dif} = \Delta_{dif(S,R)} + \Delta_{ground(S,O)} + \Delta_{ground(O_n,R)}$$

$$\Delta_{dif} = \begin{cases} 10 C_h \cdot \lg\left(3 + \frac{40}{\lambda} C''\delta\right) & \text{if } \frac{40}{\lambda} C''\delta \geq -2 \\ 0 & \text{otherwise} \end{cases}$$

$$\Delta_{ground(O,R)} = -20 \times \lg\left(1 + \left(10^{-A_{ground(O,R)}/20} - 1\right) \cdot 10^{-\left(\Delta_{dif(S,R')} - \Delta_{dif(S,R)}\right)/20}\right)$$



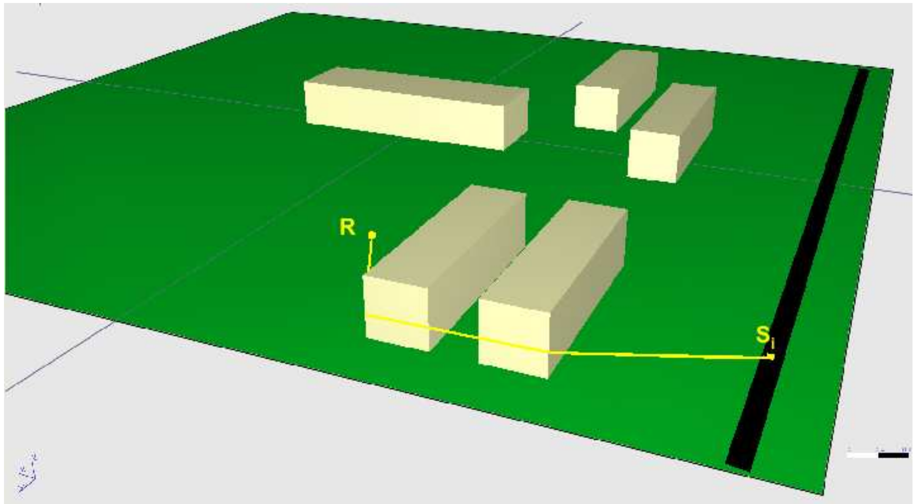
$$\delta_F = \hat{S}O_1 + O_1\hat{O}_2 + O_2\hat{O}_3 + O_3\hat{O}_4 + \hat{O}_4 R - \hat{S}R$$



Propagation – Adif – vertical edges

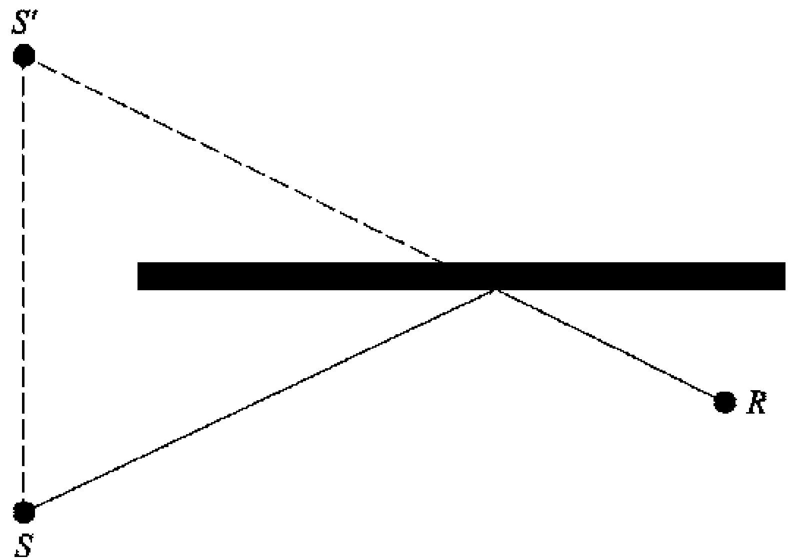
$$A_H = A_{div} + A_{atm}^{path} + A_{ground,H}^{path} + \Delta_{dif,H\,(S,R)}$$

$$A_F = A_{div} + A_{atm}^{path} + A_{ground,F}^{path} + \Delta_{dif,H\,(S,R)}$$



Propagation – Reflections

- Vertical obstacles
- Image sources
- Absorption coefficient in diffuse field EN 1793-1



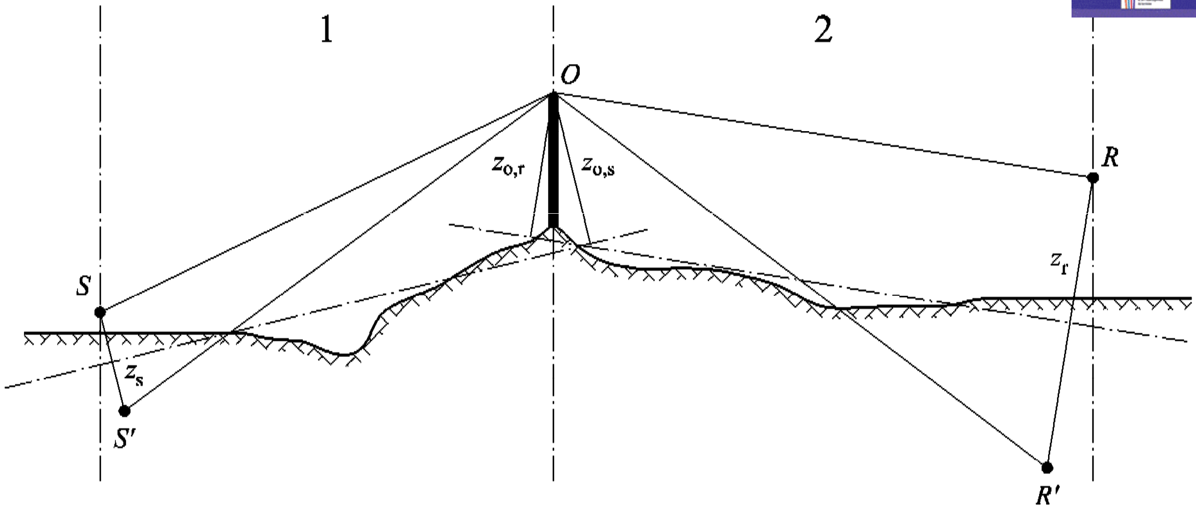
$$L_{WS'} = L_{WS} + 10 \cdot \lg(1 - \alpha_r)$$

Also available: attenuation by retrodiffraction

Propagation – subset of NMPB 2008

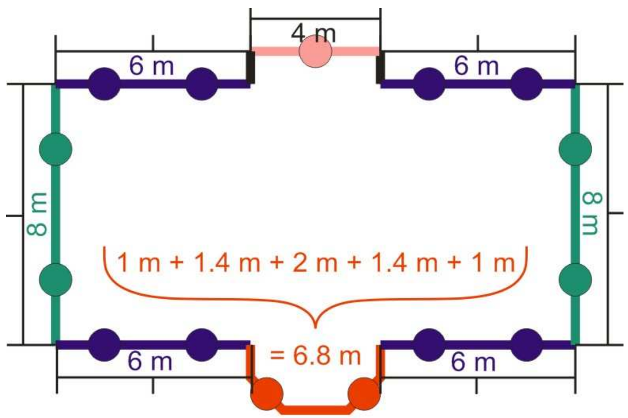
- Source NF S 31-133:2011

- Simplifications
  - No reflection on embankment slope
  - No small barrier
  - No body barrier interaction for railway noise



Populations: VBEB 2007

- Two levels of information
  - Population data available
    - Population known at the scale of the building
    - Known at a more global scale
  - Data not available -> habitable surface
    - By flat
    - By building
    - By larger entity
    - Unknown



- Allotment
  - Population at 4 m
  - At most 5 m broad segments at the receiver

Conclusions

- CNOSSOS-EU: a major step toward consistency
  - 1 model for terrestrial sources
  - 1 model for aircraft sources

- A few pending issues for the member states
  - Input data for emission models
    - Road (pavements)
    - Railway (rail roughness, rolling stock)
  - Deriving occurrences from meteorological data
  - Quality assurance for software -> ISO 17534 series
  - Path finding algorithms not specified

Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement

Direction territoriale Est

Thank you for your attention

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