Considerations on the use of existing road traffic noise models for GRBP work

(CROSSMATRIX Idea of TF-VS)

Geneva, February 2025

Transmitted by the experts of TF VS

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Objective of this Presentation

Resuming the considerations on the CROSSMATRIX

- The crossmatrix idea was established to enable GRBP and subgroups of GRBP to evaluate effects of vehicles, proposals regulation amendments with regard to their potential impact in real world traffic.
- GRBP work addresses the sound emission of vehicles, while for the society the “effect” of it, means the exposure to people is the focus.
- The handshake between the sound emission of road vehicles and a receiver is provided by road traffic noise mode. Such source-to-receiver propagation models are very complex, as they need to address any eventual propagation situation given by local situations.
- For GRBP it is valuable to recognize how its regulations influence the vehicle sound emission, and how the vehicle sound emission is considered by such road traffic noise models.
- GRBP may use such models and evaluate the sound emission by a simplified receiver model, based on the classical regulation microphone position (7.5m distance and 1.2 m height).
- This presentation aims at re-starting the consideration on this crossmatrix idea, by providing a comparison of various existing road traffic noise models used.

Comparison of 4 different models

Parameter Table, which directly impact the sound source modelling

	EU CNOSSOS	CH SonRoad18	JP ASJ RTN Model 2018	HMGerhard Akustiklabor
Data origin	Statistical passby	Statistical passby and other passby measurements	Statistical passby	passby measurements based UN R51.03
Vehicle categories	1 cars / 2 trucks / 2 motorcycles	4 cars / 7 trucks / 6 busses / 3 agriculture / 2 motorcycles	1 light / 1 medium / 1 heavy / 1 motorcycle	3 cars / 1 van (plus CNOSSOS)
Models for EVs	no	yes, many sub-categories	yes, EV and HV	yes, 2 for passenger cars
Sound source location	0,05 m above the ground	0,05 m above the ground	1/20 λ above ground	0,05 m above the ground
Speed range	20 km/h to 130 km/h	20 km/h to 130 km/h	40 km/h to 140 km/h steady 10 km/h to 60 km/h non-steady	10 km/h to 100 km/h
Reference road surface	average of DAC 0/11 and SMA 0/11	ACMR8 / SDA8-12	KOUKINOU II	Average ISO 10844 + 3 dB
Frequency resolution	octave bands	3rd octave bands	octave & 3rd octave bands	overall level
directivity	omnidirectional	specific radiation formula	specific radiation formula	omnidirectional
Filtering	A-weighted	A-weighted	A-weighted	A-weighted
Temperature correction for tyres	no	yes	placeholder dL_{etc}	no
Vehicle operation conditions	cruise / acceleration / deceleration	cruise / acceleration / deceleration / standstill	cruise / acceleration / deceleration	cruise / acceleration / (deceleration) / standstill
Single event evaluation	unclear	unclear	yes	yes (SEL)
Randomized emission variation	no	yes	no	yes
Calculation results	L_{den}	$L_{eq,A}$	$L_{A,eq}$	$L_{A,eq}$

This presentation introduces four different sound source models

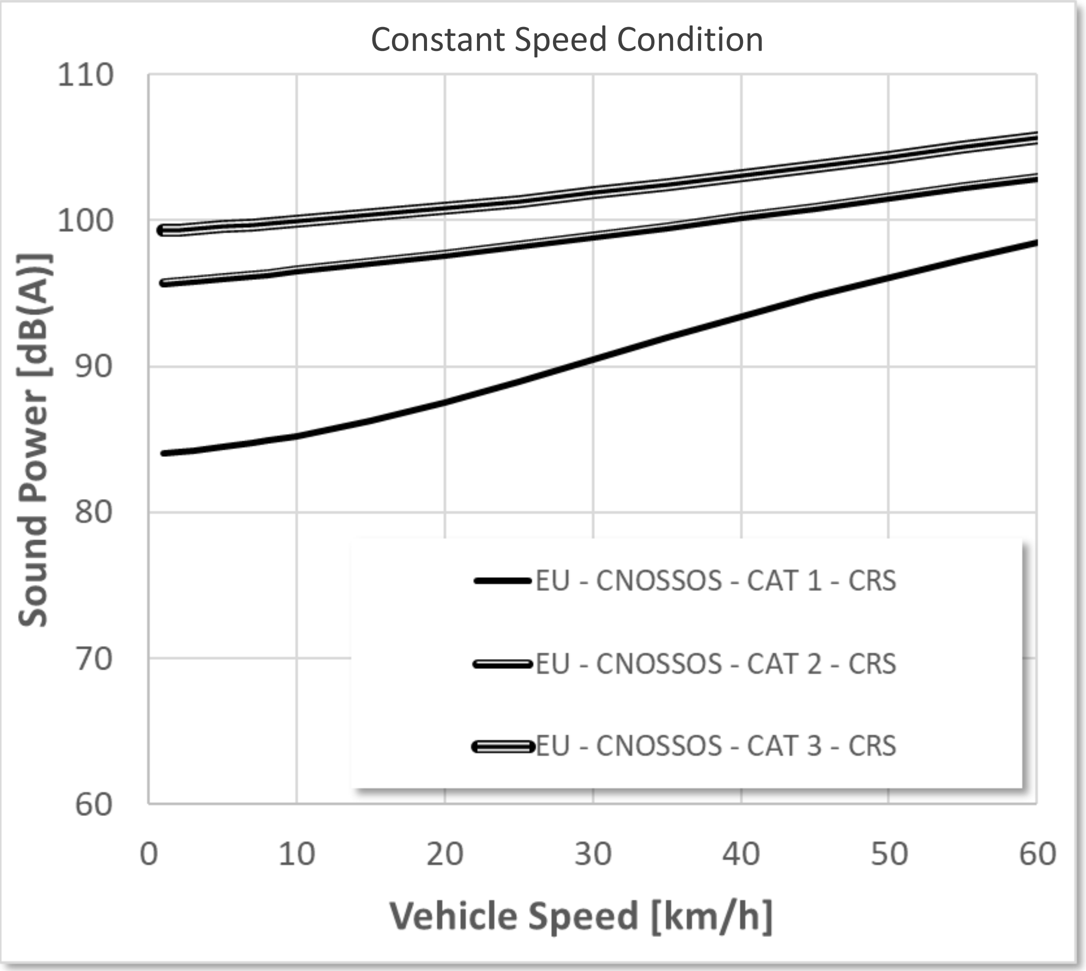
- **EU CNOSSOS from 2012**
- **CH SonRoad18 from 2018 inclusive recent updates**
- **JP ASJ RTN Model from 2018**
- **HMGerhard Akustiklabor from 2024**

The first three models are commonly used in their country/region for the mapping of road traffic noise.

The last model is derived from pass-by measurements according to UN R51.03 (Annex 3, Annex 7, Annex 9). It is explicitly made to enable the an impact assessment for potential regulation changes.

Sound Power Models – EU CNOSSOS

EU-CNOSSOS model is part of the European Noise Directive (END) 2002/49/EC



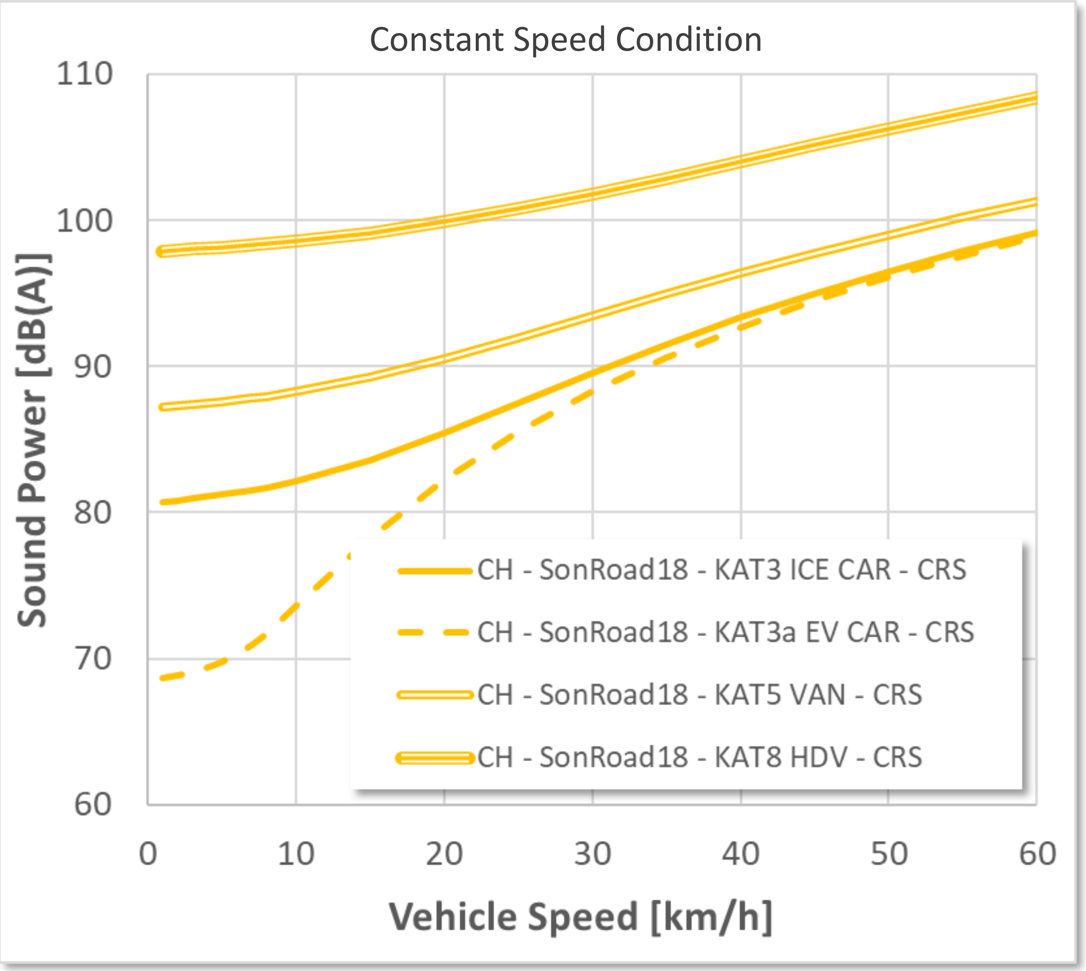
- The sound power models is based on statistical pass-by measurements.
- The models are built on octave bands.
- EU member states can use own national variants which they update periodically by statistical pass-by measurements.
- The application range is between 20 km/h and 130 km/h.
- CNOSSOS calculation result are provided as $L_{day\text{-}evening\text{-}night}$. The figures cannot be compared directly to $L_{A,eq}$ of other models

Table III.1: *Vehicle classes*

Category	Name	Description	Vehicle category in EC Whole Vehicle Type Approval[(1)]
1	Light motor vehicles	Passenger cars, delivery vans ≤ 3.5 tons, SUVs[(2)], MPVs[(3)] including trailers and caravans	M1 and N1
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	M2, M3 and N2, N3
3	Heavy vehicles	Heavy duty vehicles, touring cars, buses, with three or more axles	M2 and N2 with trailer, M3 and N3
4	Powered two-wheelers	4a mopeds, tricycles or quads ≤ 50 cc	L1, L2, L6
		4b motorcycles, tricycles or quads > 50 cc	L3, L4, L5, L7
5	Open category	To be defined according to future needs	N/A

Sound Power Models – CH SonRoad 2018

Uses data from SWISS10 Converter which provides road traffic data

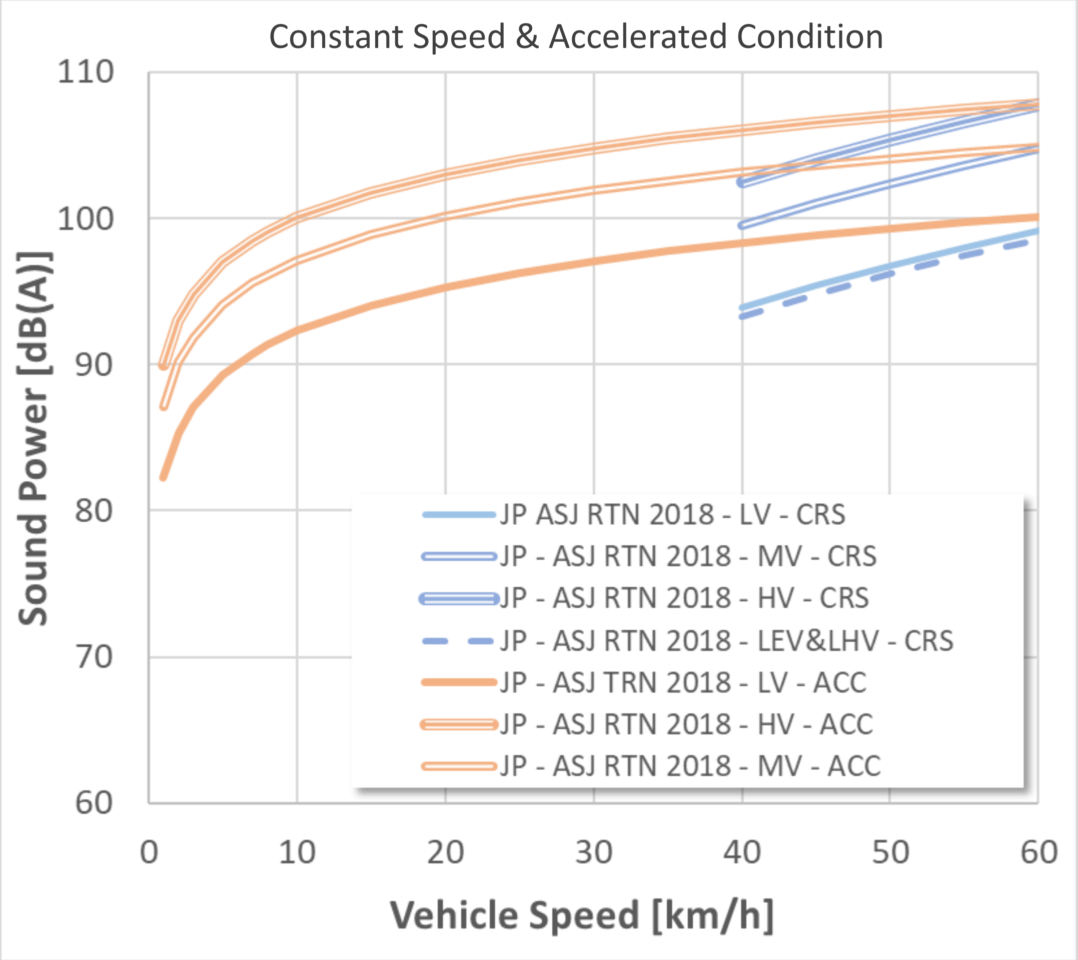


- The sound power models are based on the EU CNOSSOS models, but the parameters have been revised recently, especially new categories for electric and hybrid propulsion have been added.
- SonRoad18 contains a large number of detailed vehicle sub-categories for more accurate prediction.
- The model is based on 3rd octave bands.
- Refined considerations have been given to the sound radiation.
- The application range is between 20 km/h and 130 km/h.

Nr.	Oberkategorie	Unterkategorie		Typ	Bemerkungen
	SWISS10 Kat.	SWISS10+ Kat. (Antriebssystem)			
1	Busse	1a	mit konventionellem Antrieb		Reisecars/-busse, ohne Busse der öffentlichen Verkehrsbetriebe
		1b	mit Hybrid-/Elektroantrieb		
2	Motorräder	2a	mit konventionellem Antrieb		
		2b	mit Elektroantrieb		
3	Personenwagen	3a	mit konventionellem Antrieb		
		3b	mit Hybridantrieb		
		3c	mit Elektroantrieb		
4	Personenwagen mit Anhänger				
5	Lieferwagen bis 3.5 t				
6	Lieferwagen bis 3.5 t mit Anhänger				
7	Lieferwagen bis 3.5 t mit Auflieger				
8	Lastwagen	8a	mit konventionellem Antrieb		
		8b	mit Elektroantrieb		
9	Lastenzüge				
10	Sattelzüge				

Sound Power Models – JP ASJ RTN Model 2018

What benefit can be expected if EVs are restricted to the minimum safety, any sound beyond 30 km/h is not wishful



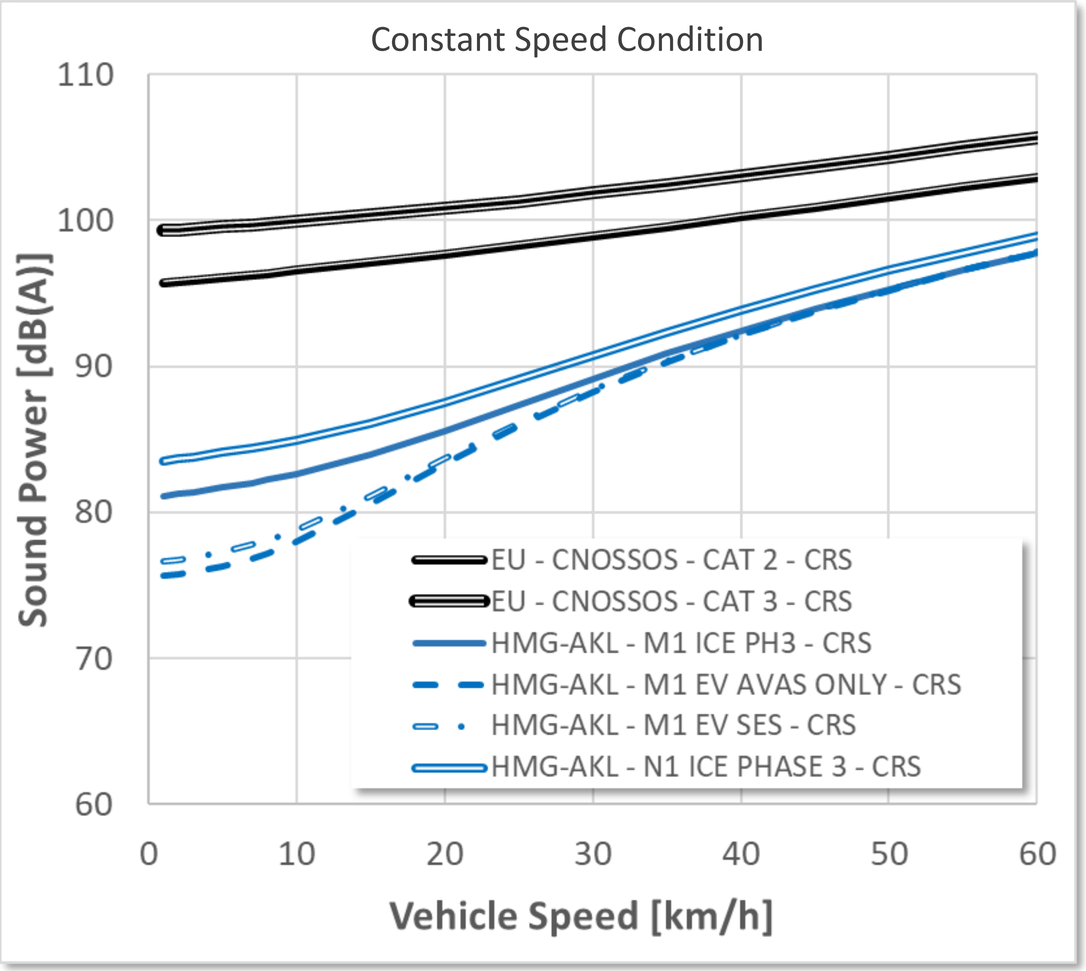
- The JP ASJ RTN Model 2018 has a different approach regarding low speed evaluation and can simulate single events.
- The model is based on 3rd octave bands.
- Additional considerations of the sound propagation have been added
- The application range is between 40 km/h and 140 km/h for steady speed conditions, and 10 km/h to 60 km/h for non-steady conditions.
- Below a vehicle speed of 40 km/h it is assumed that traffic is always "non-steady", means a mix of acceleration and deceleration.

Table 2.1 Vehicle categories (excluding motorcycles).

Two-category	Three-category	Characteristics
Light vehicles		Passenger cars used exclusively for carrying passengers with capacity of 10 or fewer
		Small-sized vehicles with engine displacement exceeding 0.050 liter and with overall length of 4.7 m or less
Heavy vehicles	Medium-sized vehicles	Vehicles with overall length exceeding 4.7 m excluding large-sized vehicles (most vehicles in this category have 2 axles).
		Medium-sized buses with capacities from 11 to 29 passengers
	Large-sized vehicles	Vehicles with gross vehicle weight of over 8 t or maximum authorized payload of over 5 t (most vehicles in this category have 3 or more axles).
		Large-sized buses with capacity of 30 or more passengers
		Large-sized special motor vehicles

Sound Power Models – HMGerhard Akustiklabor

The model has been made to evaluate directly discussed regulation changes

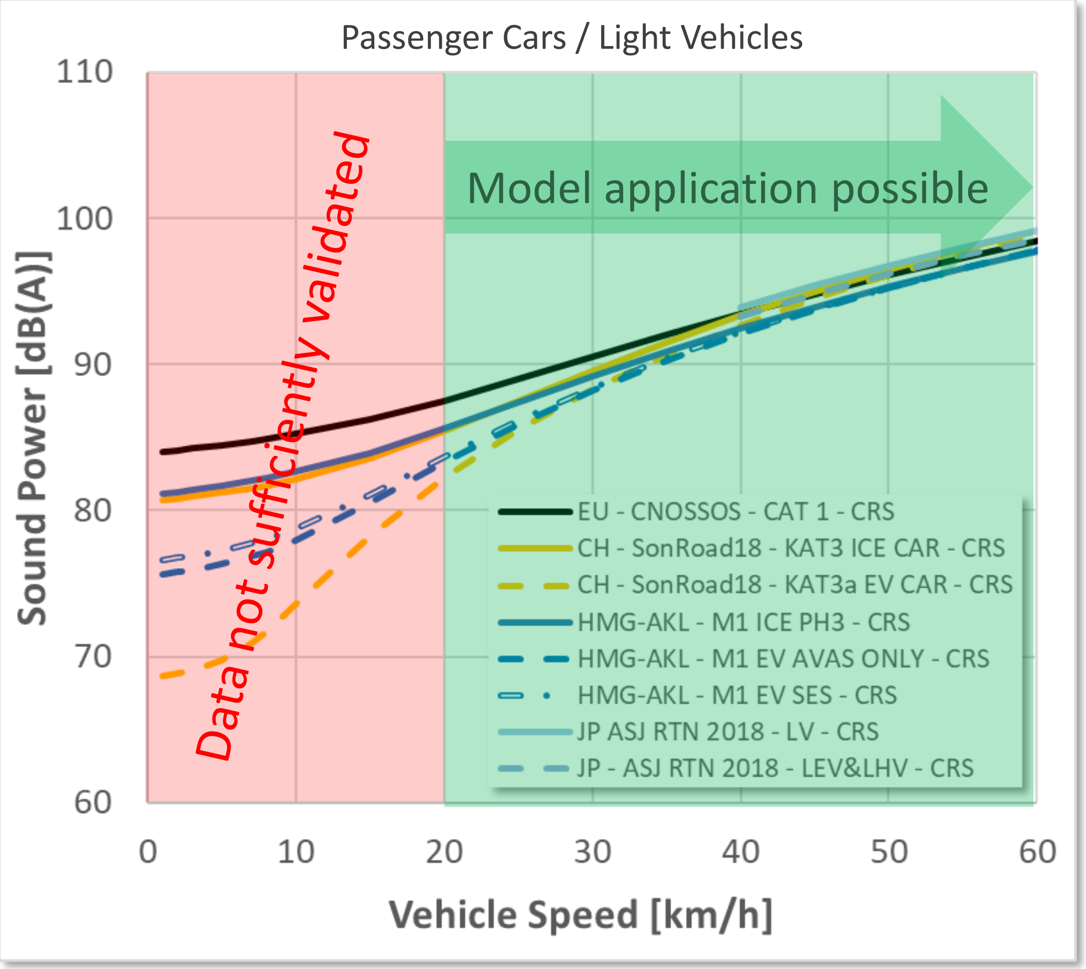


- The sound power models are derived from pass-by data performed on ISO test tracks.
- Two models evaluate EV with AVAS only, and EV with SES systems.
- Model data origin (2024)
  - Type approval data for ASEP and RD-ASEP
  - Data are made on ISO 10844 compliant test tracks
  - The tyre rolling sound curve cannot directly be compared with standard public roads used by other models
  - A correction of +3.0 dB*) for the tyre road curve has been applied to match the CNOSSOS tyre rolling sound curve.
  - Medium and heavy truck models are taken from CNOSSOS
- The model is based on overall sound levels.
- In difference to CNOSSOS, the evaluation result is $L_{A,eq}$
- The model is validated between 10 (20) km/h and 100 km/h
- The model can assess single event situations.

*) Source: fka study 2023 „ New procedure for the derivation of CNOSSOS EU coefficients from type approval data" Author: Olaf Uszynski & Carolin Schliephake

Compare same vehicle categories in the various model

Passenger Cars / Light Vehicles - ICE and EV/HV

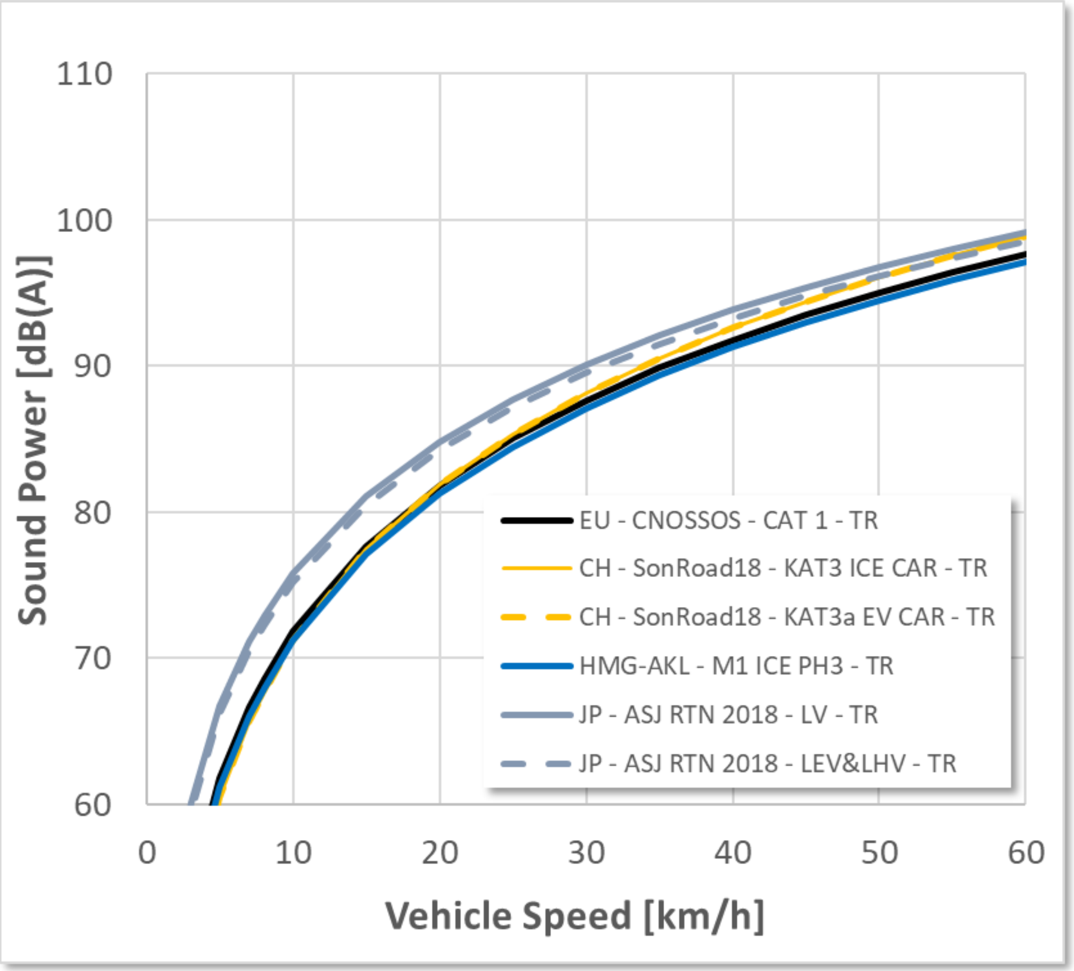


- It is now possible to compare the various model with each other to evaluate the differences.
- The graph shows the comparison for passenger cars / light vehicles.
- At speeds above 40 km/h all model are very similar, the variation is less than 2 dB.
- At speeds below 40 km/h the variation becomes bigger and increase up to 6 dB (JP model disregarded).

What is the background for the differences at speeds below 20 km/h.

Detailed look on the Tyre Rolling Sound for Passenger Cars /Light Veh

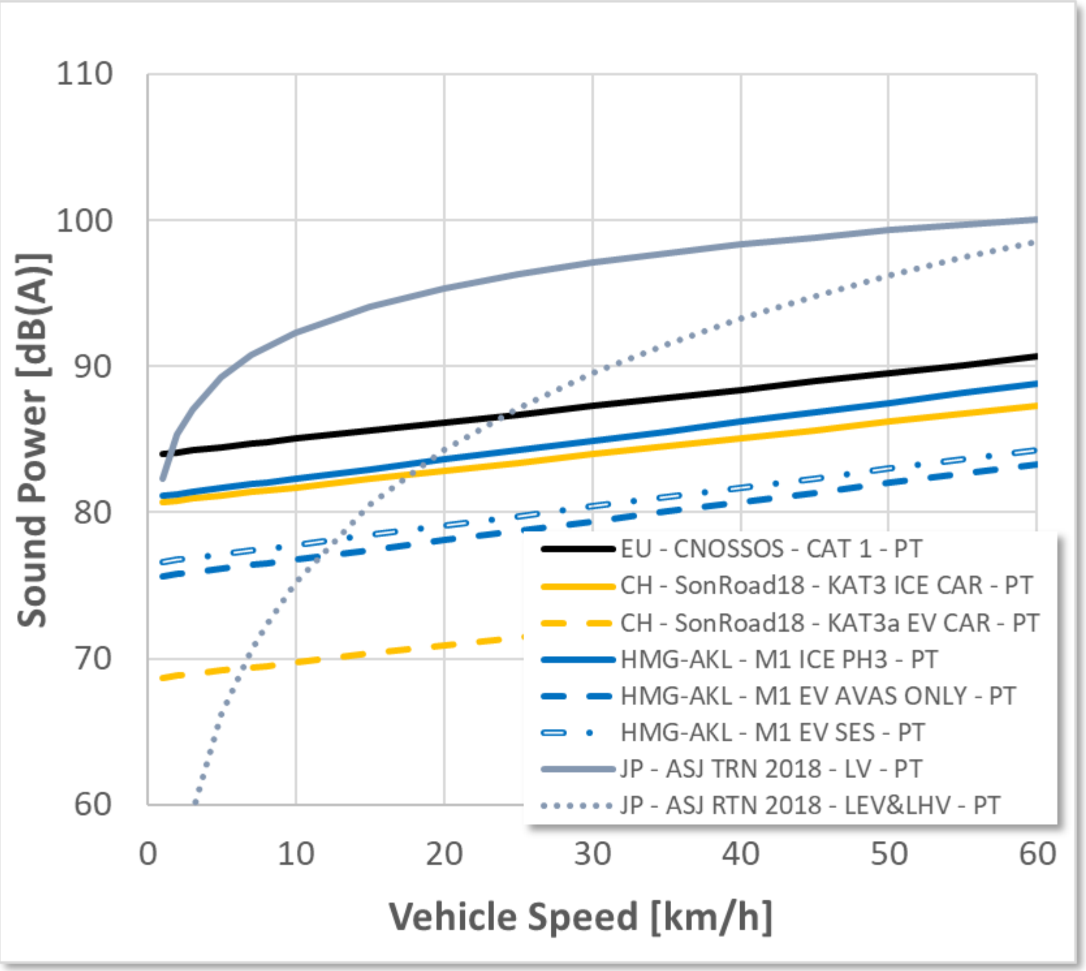
Passenger Cars / Light Vehicles - ICE and EV/HV



- The tyre rolling sound curves are very similar, especially when comparing the EU, CH and HMG-AKL curves.
- The HMG-AKL curve are derived from pass-by test on ISO Test tracks. When using the model (as show here), the tyre rolling sound needs to be increased by + 3 dB to account for the difference between ISO roads and normal roads.
- Japan ASJ RTN 2028 does not provide a split model for power train and tyre rolling sound; the model curve for steady speed is prolonged down to 1 km/h, but below 40 km/h the Japan model assumes that traffic is always non-steady.
- Tyre rolling sound is not explicitly differentiated for EVs, except for the HMG-AKL model, which set the tyre rolling sound +0,5 dB higher.

Detailed look on the Power Train Sound for Passenger Cars /Light Veh

Passenger Cars / Light Vehicles - ICE and EV/HV



- For the power train sound, the models have very different approaches, especially when considering the electric and hybrid vehicles
- Japan model ASJ RTN 2018 highlights the importance to collect here more data

> The noise reduction effect of these low-emission vehicles can be expected in the vicinity of signalized intersections or expressway tollgates, where the propulsion noise of vehicles predominates. Therefore, it is important to accumulate measurement data of HVs and EVs running at low speeds or accelerating.

- The HMG-AKL model is based on available data from type approval on EVs which follow already mandatorily the provisions of UN R138

More data is needed to validate the sound models for EV and HV.

How to use the models for our purposes?

Use the models for evaluation purposes

- The models can be used to simulate discrete scenarios from an emission perspective
- The effect of considered changes to a regulation can be evaluated by GRBP.

- The needed information for a scenario are:
  - Vehicle speed (if needed per category separately)
  - Vehicle operation condition (cruising, partial load or full load)
  - Fleet composition (share per category)
  - Observer distance (focus should be on 7.5 m)
  - [Traffic Volume] (not really needed, but maybe helpful)

- Other important parameters, like topography, reflection, temperature effect, road surface, road slopes. (A topic for further analysis is the impact of the sound radiation directivities)

- The focus is in on a **relative** comparison of measures against each other.

Example: What is the impact, when EVs cars replace ICE cars?

This question can be evaluated by the models

HMG AKUSTIK LABOR

Scenario for cruising / steady speed condition

TODAY

Potential Noise Reduction when all 10% of ICE are replaced by EV			
Speed km/h	CH SonRoad18 dB	JP ASJ RTN 2018 dB	HMG AKL *) dB
30	-0,1	-0,1	-0,2
60	0,0	-0,1	-0,1
80	0,0	-0,1	0,0

MID-TERM

Potential Noise Reduction when all 30% of ICE are replaced by EV			
Speed km/h	CH SonRoad18 dB	JP ASJ RTN 2018 dB	HMG AKL *) dB
30	-0,4	-0,2	-0,5
60	-0,1	-0,2	-0,2
80	-0,1	-0,2	-0,1

LONG-TERM

Potential Noise Reduction when 100% ICE are replaced by EV			
Speed km/h	CH SonRoad18 dB	JP ASJ RTN 2018 dB	HMG AKL *) dB
30	-1,4	-0,6	-2,1
60	-0,3	-0,6	-0,6
80	-0,2	-0,6	-0,4

*) Calculated against the EU CNOSSOS CAT 1 model

The results are relatively close together, especially when the contribution of EVs to the fleet is small.

In a long-term perspective the impact of EVs can get more visible, however the models show here some variations

At lower speeds it is difficult to make any reliable prediction, as long as not more data help to validate the models.

Conclusion

Benefit to GRBP for having such models available for their discussions

- Having such models available, GRBP can assess the impact of proposals for the real world more closely.
- The comparison of the models helps to understand different views.
- The use of the models helps to avoid misunderstandings.
- It is valuable to implement more models from other Contracting Parties as well.
- It can support the decision making process, as it is already one step towards an impact assessment.

Thank you very much!

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