Technical Background
dL_{ASEP} Term
OICA Proposal GRBP 2025-20

(SG R138/R51), Brussels, July 2025

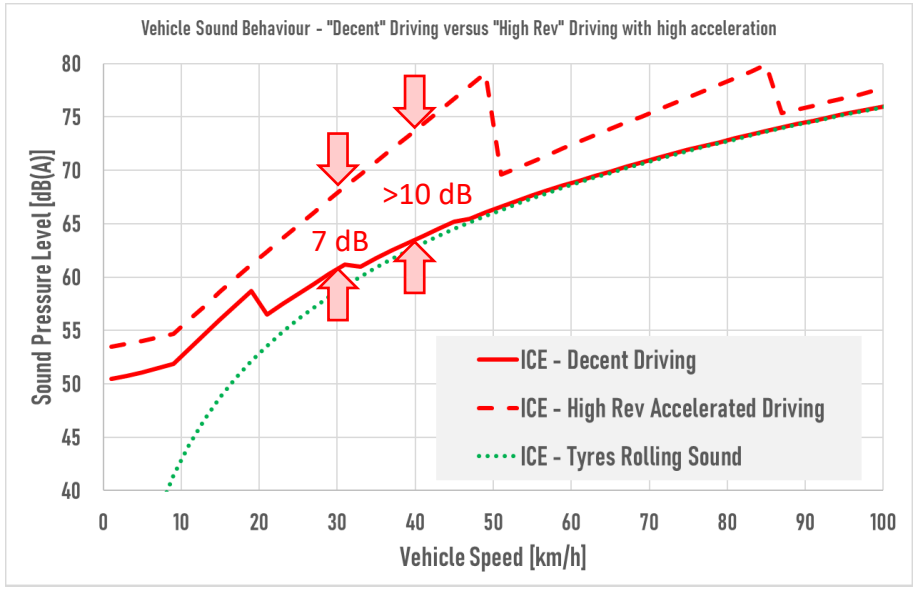
Objective of this Presentation

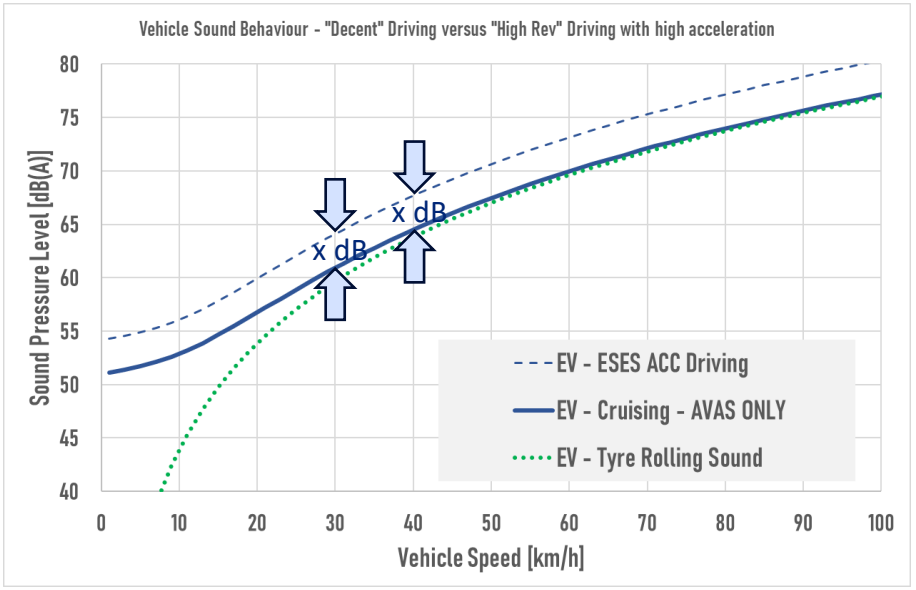
What is the Effect of the ΔL_{ASEP} Term in OICA Proposal GRBP-2025-xx

- The presentation does not address the general principles of ASEP.
  Therefore other OICA presentations have already been prepared.
- This presentations refers to the term ΔL_{ASEP} which appears difficult to understand.
  - Perception of ICE relative to EVs.
  - The following slides provide insight in the effect of this term.
  - Consideration is given on the environmental impact on a driving cycle of a vehicle
  - Consideration is given of the perception of EVs as potential “single events”.
- Discrete vehicle examples are provided, to visualize the application of that term.

Difference Between ICE Vehicles and Electric Vehicles

Impact of Gear Usage and Respectively the Driving Style





The value x can vary from vehicle to vehicle.

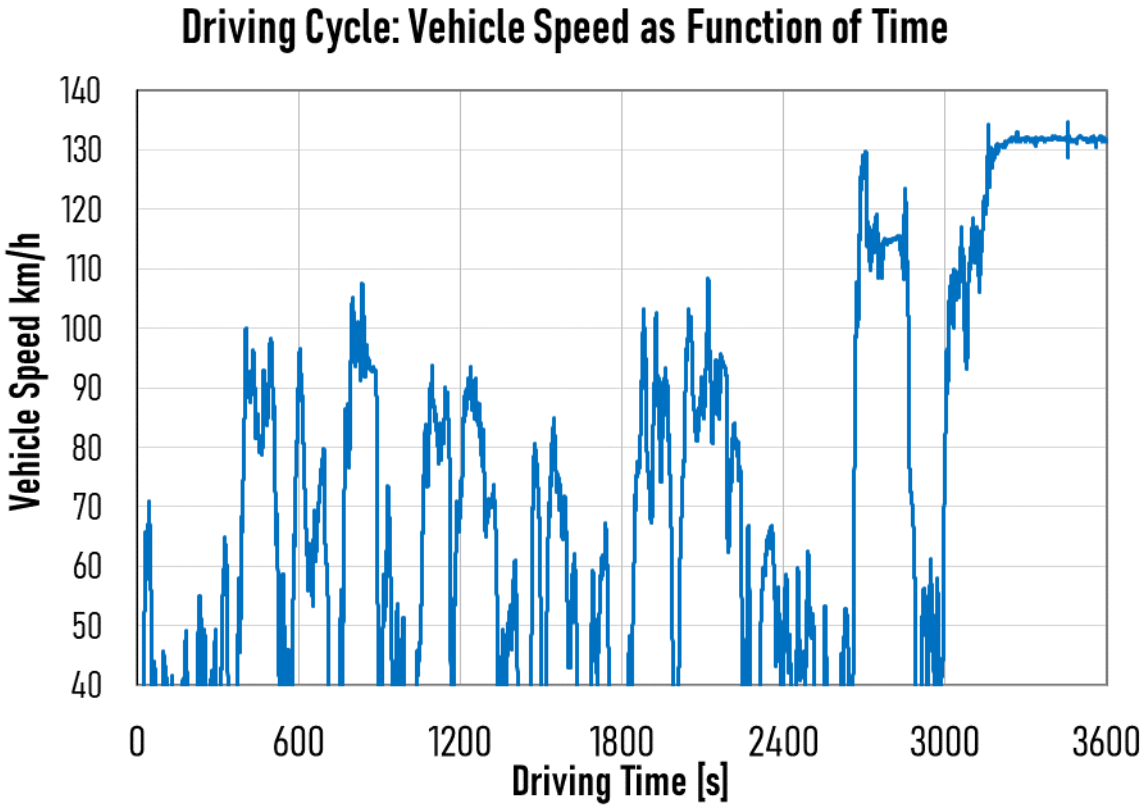
- The sound emission of an ICE depends especially at low vehicle speeds on the selected gear- A driver might use high engine speeds instead of engaging the next higher gear.
- The diagram to the left show the effect for “early” and “late” gear shifting for an ICE vehicle.
- EVs do not have this engine speed dependency, the driver has no choice regarding the engaged gear. He can decide to accelerate moderate or extreme.
- The diagram left shows the effect of moderate and extreme acceleration of an Electric Vehicle. The higher sound emission is no dependent on the vehicle speed.

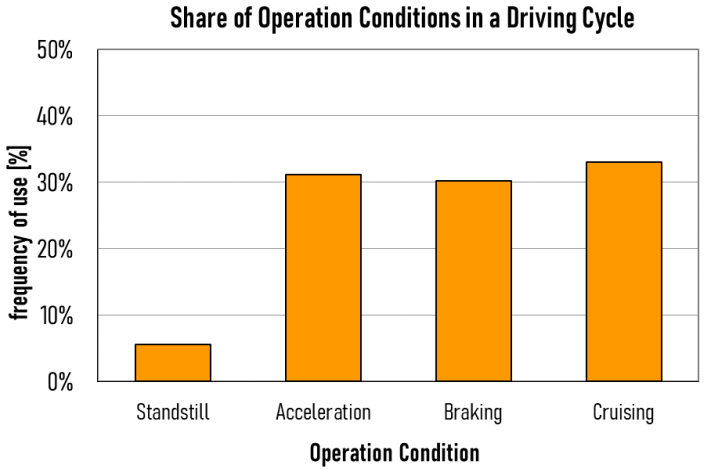
IN THE SPEED RANGE BETWEEN 10 km/h and 50 km/h AN ICE CAN BE MUCH LOUDER THAN AN EV, IF THE VEHICLE IS KEPT IN HIGH ENGINE SPEEDS. AT HIGHER SPEEDS THE TYRE DOMINATES, THE DRIVING STYLE IS LESS IMPACTING.

Operation of a Vehicle in Real Traffic

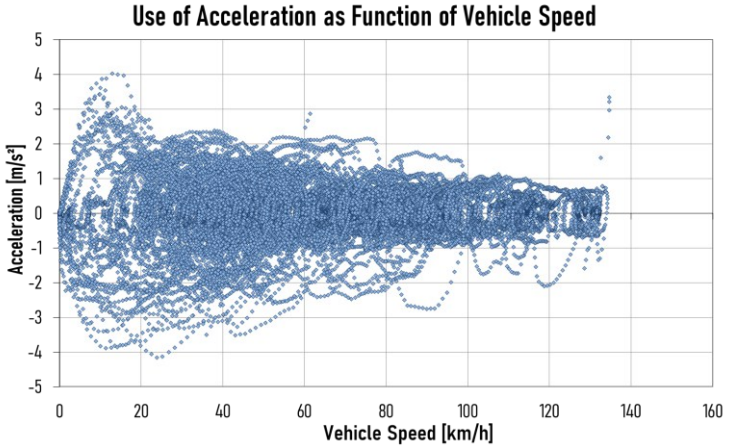
How are vehicles used in real traffic?

- A vehicle driving cycle is the motion of the vehicle as function of time.
- Each cycle consists of four operations conditions which are classified as standstill, acceleration, deceleration and cruising.
- A driving cycle is NOT defined by the propulsion technology.





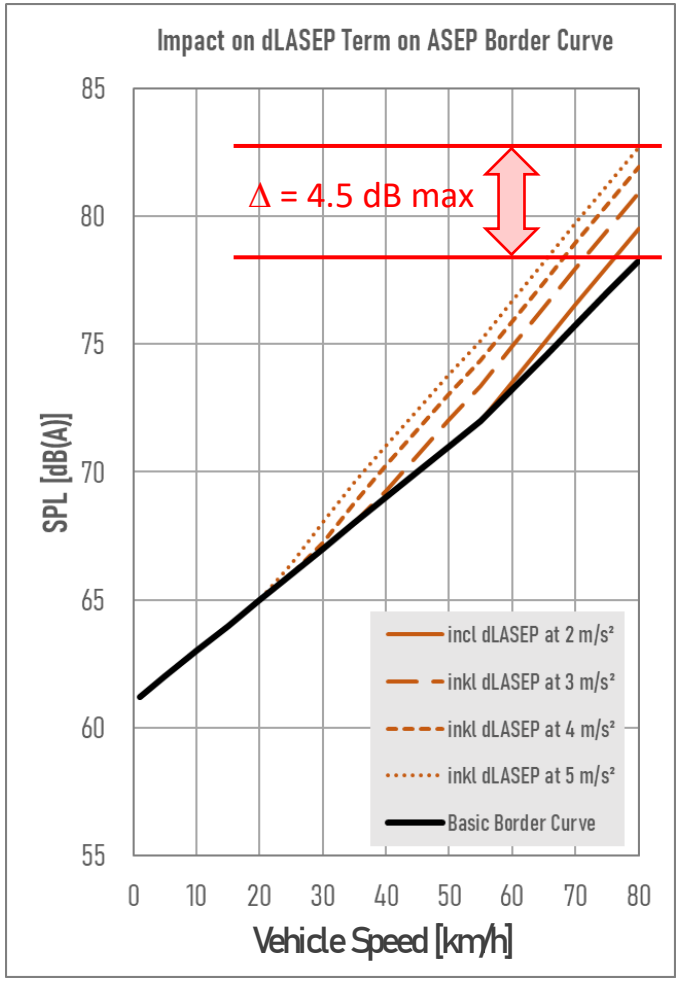
Performance can only be achieved in the acceleration part of a driving cycle.



The acceleration is decreasing with higher speed.

Explanation of the Term ΔL_{ASEP}

What is the Effect on a Pass-by run?



- OICA proposes to reduce the measured sound by the term

$$L'_{ASEP} = L_{ASEP} - \Delta L_{ASEP} \quad \text{with} \quad \Delta L_{ASEP} = 8 \times \log_{10}\left(\frac{MAX(va_{anchor}; va_{test})}{va_{anchor}}\right)$$

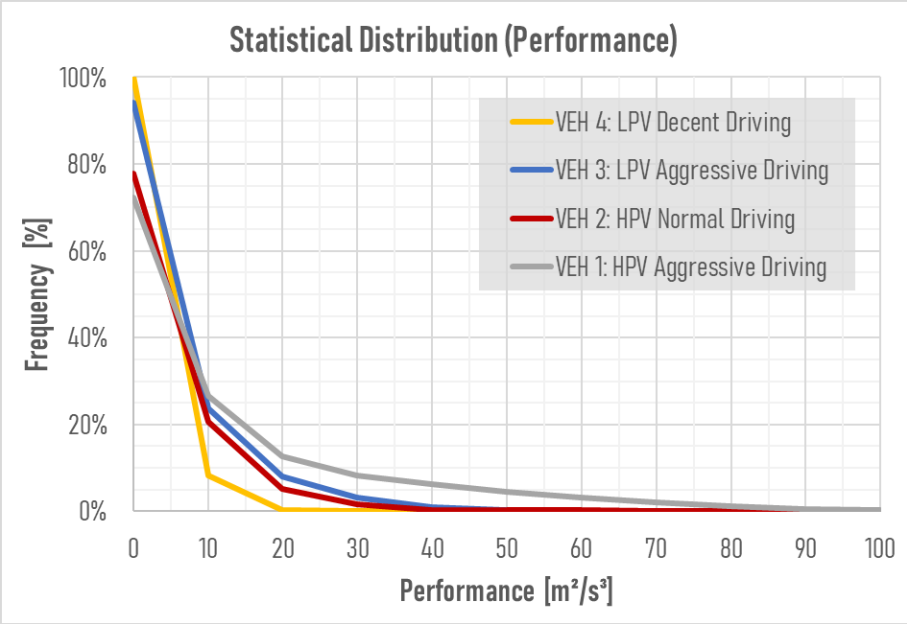
- The term is only applicable to EVs and HEVs driving in EV mode.
- The subtraction means an increase of the ASEP border curve in case the vehicle pass-by run was carried out under an operation condition where the vehicle delivers more performance than it was the case under the type approval condition.
- The **black curve** in the diagram to the left is applicable to all operation conditions with a performance va_{test} lower or equal to the reference performance va_{anchor} .
- The brown curves show the effect of ΔL_{ASEP} as function of acceleration over vehicle speed.

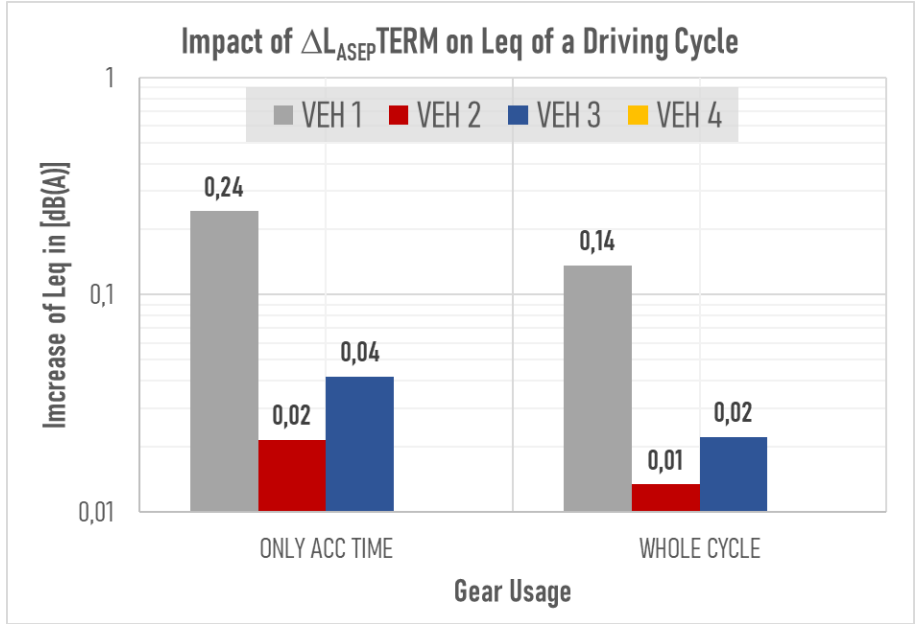
THIS IS NOT AN INCREASE OF A LIMIT, AS TODAY EVs DO NOT HAVE AN ASEP LIMIT!

WHAT IS THE EFFECT OF THAT TERM IN REAL TRAFFIC? HOW MUCH DOES IT AFFECT A DRVING CYCLE?

How often is high vehicle performance used in a driving cycle

Various Driving Styles and Driving Behaviours





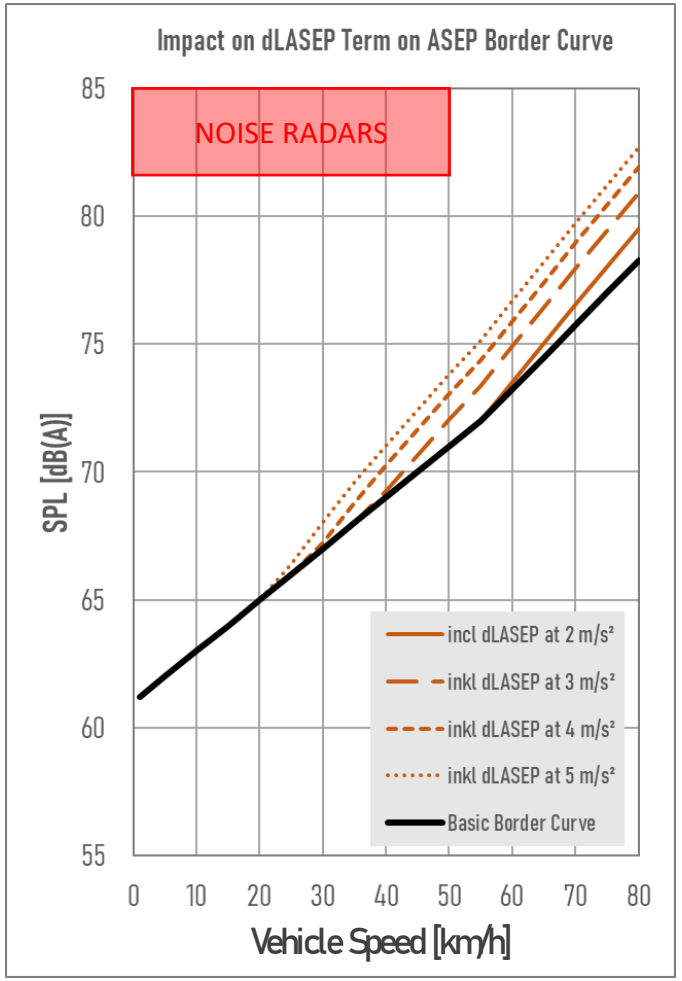
VEH 4 is not shown, as there is no impact of the term.

- The example above shows 4 difference vehicles, two low powered vehicles (LPV) and two high powered vehicle (HPV).
- A decent (adjusted and anticipative) driving behaviour with a low powered vehicle uses very little performance (VEH 4).
- An aggressive driving style with a HPV uses much more performance (VEH 1) but 90% of the cycle is well below the WLTP performance of 25.

- The impact of the term ΔL_{ASEP} can be calculated by adding up the time a certain performance was used in the driving cycle.
- The diagram above shows the effect of the vehicles and driving styles in terms of change of the L_{eq}. **Even under aggressive driving the impact is almost neglectable.**
- **The shown impact is only given if the vehicle would have been designed to make full use of the term ΔL_{ASEP} in its sound design.**

Maximum Sound Output of EVs relative to Noise Radars

How loud can those vehicle become in real traffic as potential single annoyance?

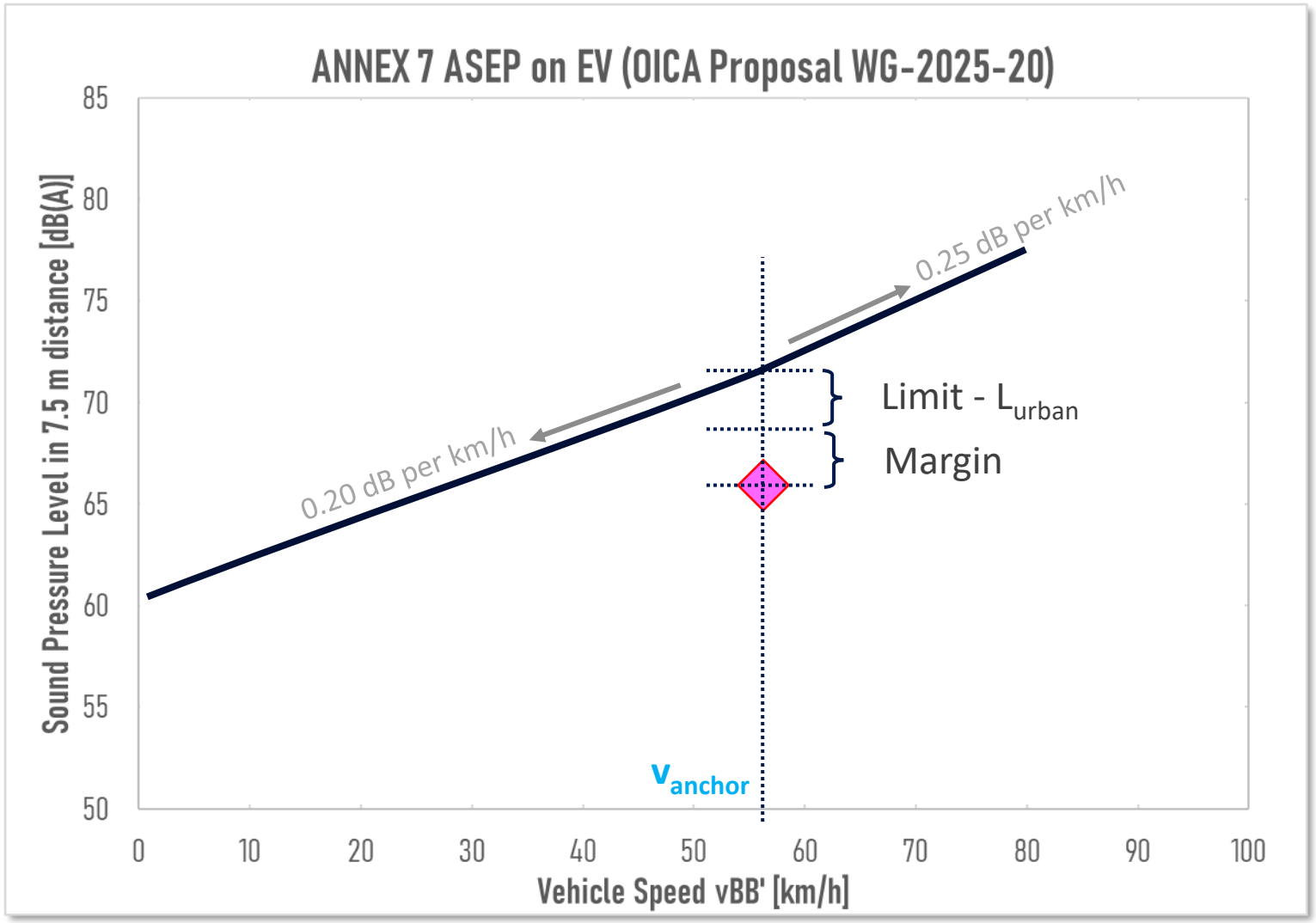


- Noise radars for catching noisy vehicles (passenger cars and motorcycles) are in use or discussed to be installed in various countries.
- Sirens, horns and other “socially relevant events (garbage collection, road cleaning)” are excluded, although their sound emission is much higher.
- The applied / discussed limits start from 82 dB for the speed range up to 50 km/h.

None of the EVs have any capability to be designed or be used by the driver in a way to become a subject for single event case in the speed range where noise radars are considered.

ASEP Border Curve Construction

How to come from the Annex 3 Type Approval Test Result to the ASEP Border Line



- The vehicle speed reference of the anchor point is the exit speed of the vehicle at line BB' of the accelerated test in Annex 3

$$v_{anchor} = v_{BB',woti,Annex3}$$

- The anchor point is the pass-by test results under Annex 3.

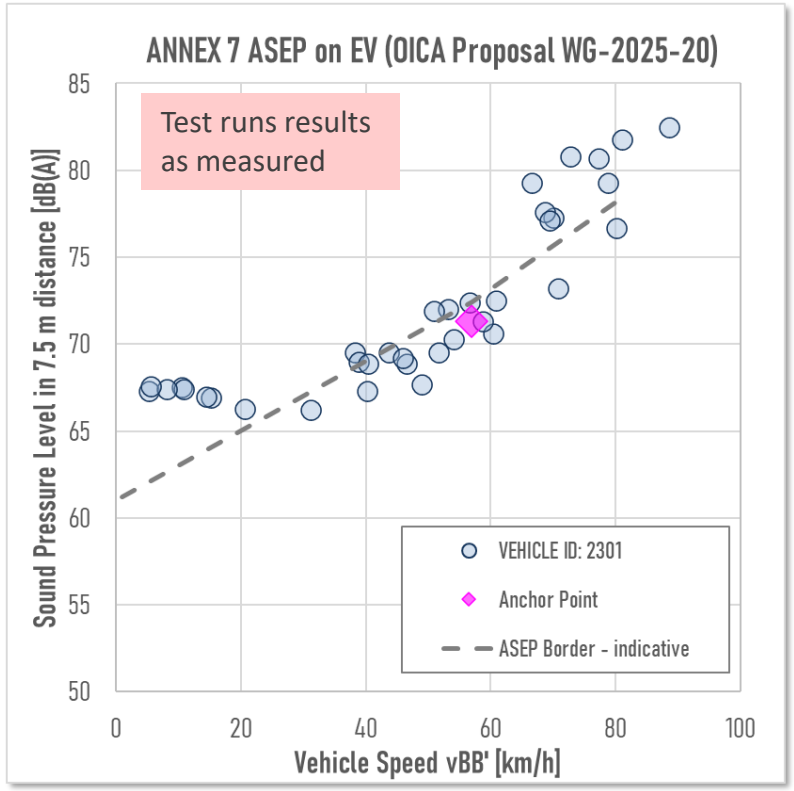
$$L_{anchor} = L_{wot,ref,i,Annex3}$$

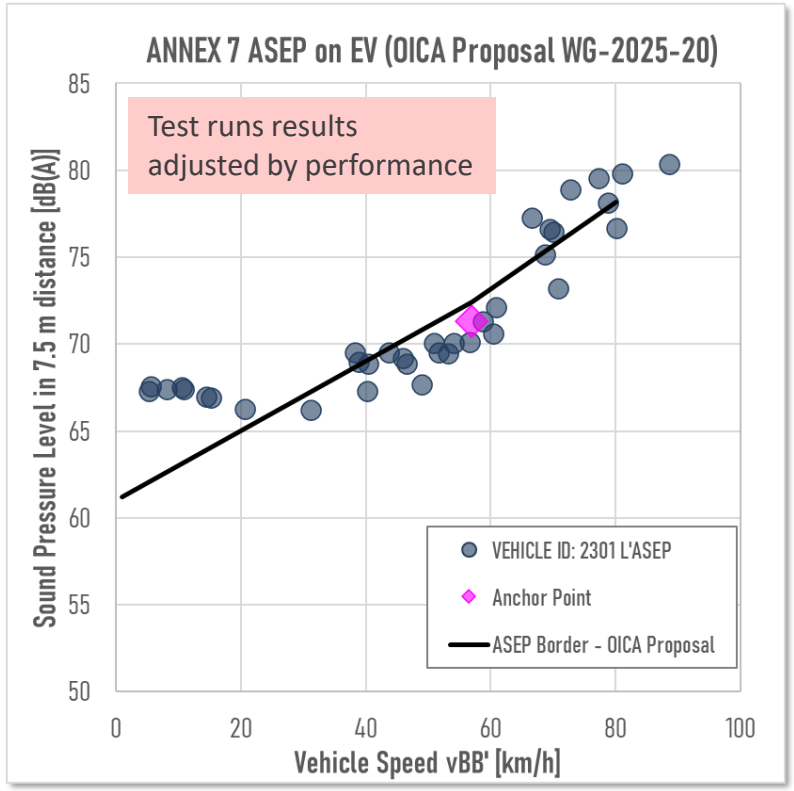
- The distance of the border curve to the anchor point is defined by Annex 7 paragraph 3.5:
  - The margin
  - The difference between the Limit and the type approval values L_{urban}.

Application of ASEP on EV on individual vehicles (Impact of ΔL_{ASEP} Term)

Example 1 – EV with Sound Enhancement especially at low speed, but as well at higher speeds

ACEA Database 2024/09 on EV





THE VEHICLE CANNOT COMPLY WITH ASEP AS DRAFTED BY OICA. BUT KEEP IN MIND, EVEN WHILE FAILING ASEP, THE VEHICLE IS NOT REALLY NOISY.

- Vehicle **2301** is **a full electric vehicle equipped with a sound enhancement system**.
- The ESES is working especially at low speeds up to 25 km/h, and as well at higher speeds above 70 km/h.
- The light blue pass-by runs are measured results on the test track.
- The **dark blue** pass-by runs represent the pass-by runs adjusted by the ΔL_{ASEP} term, provided their performance is greater than the reference performance va_{anchor} achieved in Annex 3 during type approval

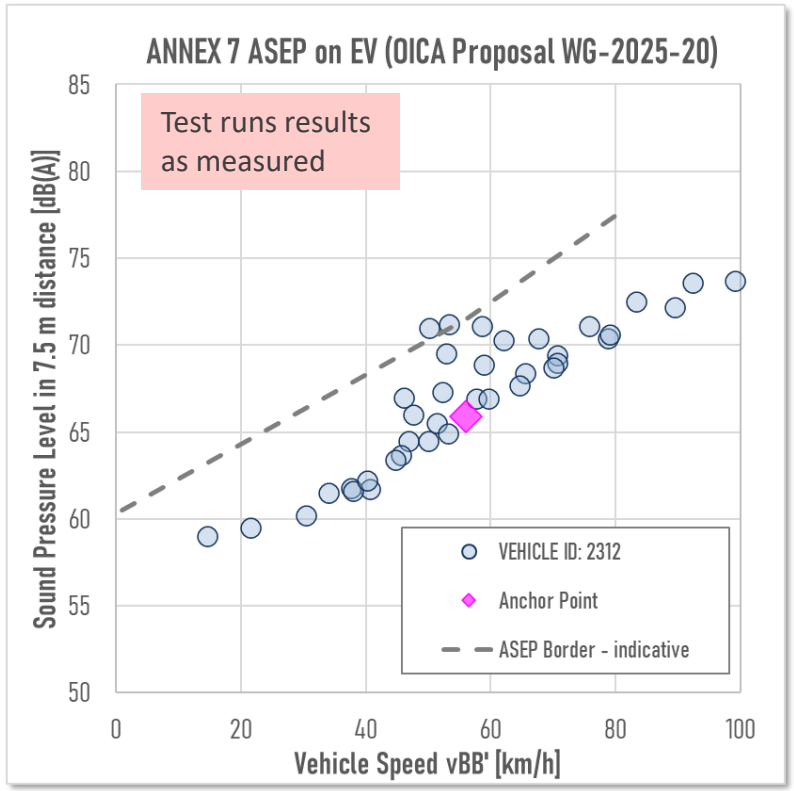
$$va_{anchor} = \frac{v_{bb',wot}}{3{,}6} \times a_{wot,test} = 31{,}7\ \frac{m^2}{s^3}$$

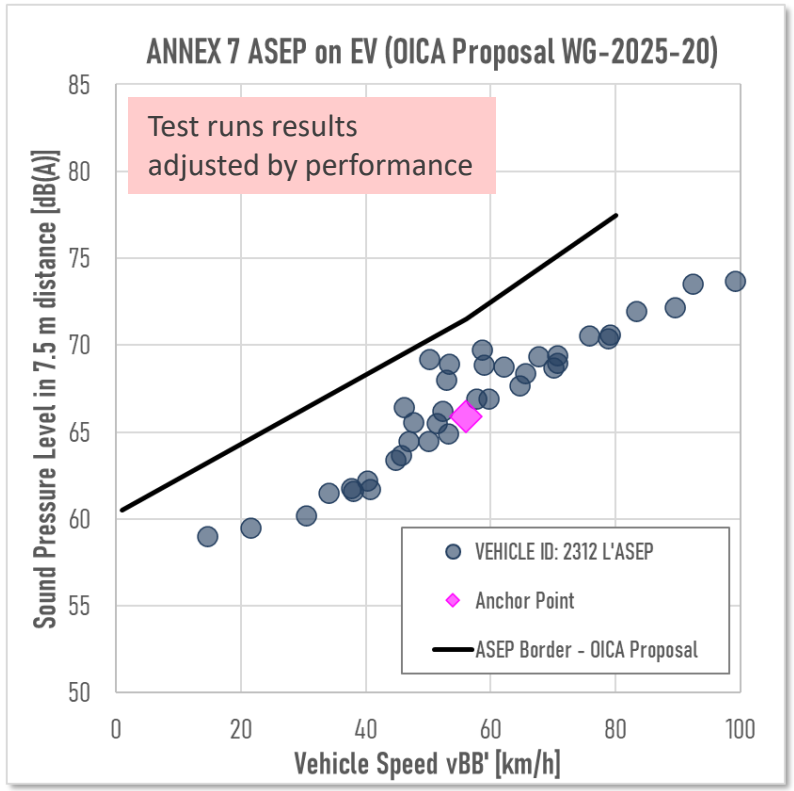
- Still when adjusted by ΔL_{ASEP} term, the vehicle does not satisfy ASEP.

Application of ASEP on EV on individual vehicles (Impact of ΔL_{ASEP} Term)

Example 2 – EV NO Sound Enhancement System struggles with the ASEP border curve

ACEA Database 2024/09 on EV





THE OICA PROPOSED BORDER CURVE CAN AS WELL BECOME CHALLENGING FOR PURE ELECTRIC OPERATION.

- Vehicle **2312** is a hybrid electric vehicle in EV mode that has only AVAS and no Sound Enhancement System.
- The light blue pass-by runs are measured results on the test track.
- The **dark blue** pass-by runs represent the pass-by runs adjusted by the ΔL_{ASEP} term, provided their performance is greater than the reference performance va_{anchor} achieved in Annex 3 during type approval

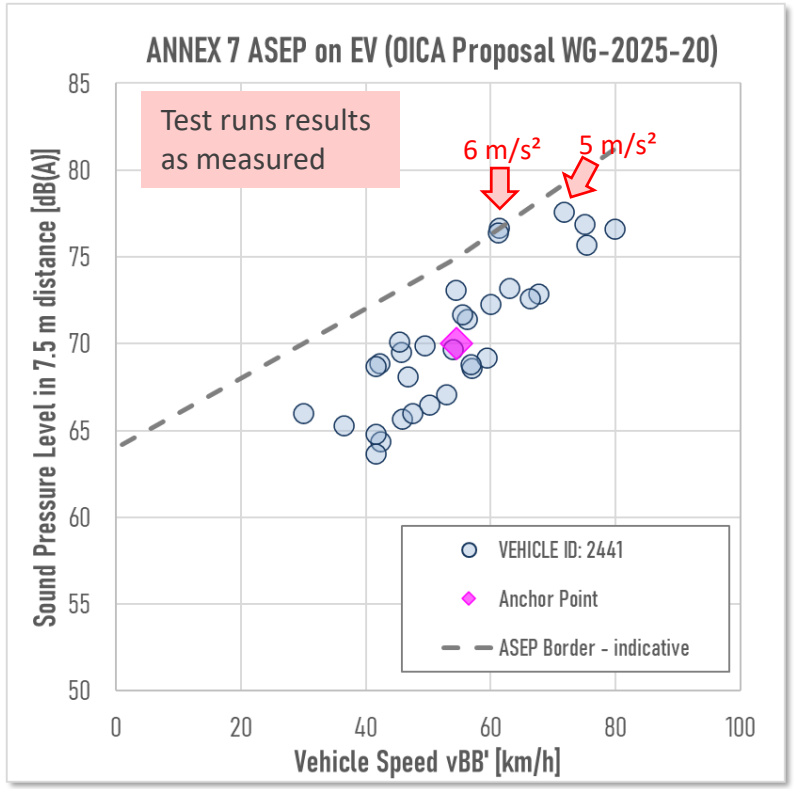
$$va_{anchor} = \frac{v_{bb',wot}}{3{,}6} \times a_{wot,test} = 32{,}6\ \frac{m^2}{s^3}$$

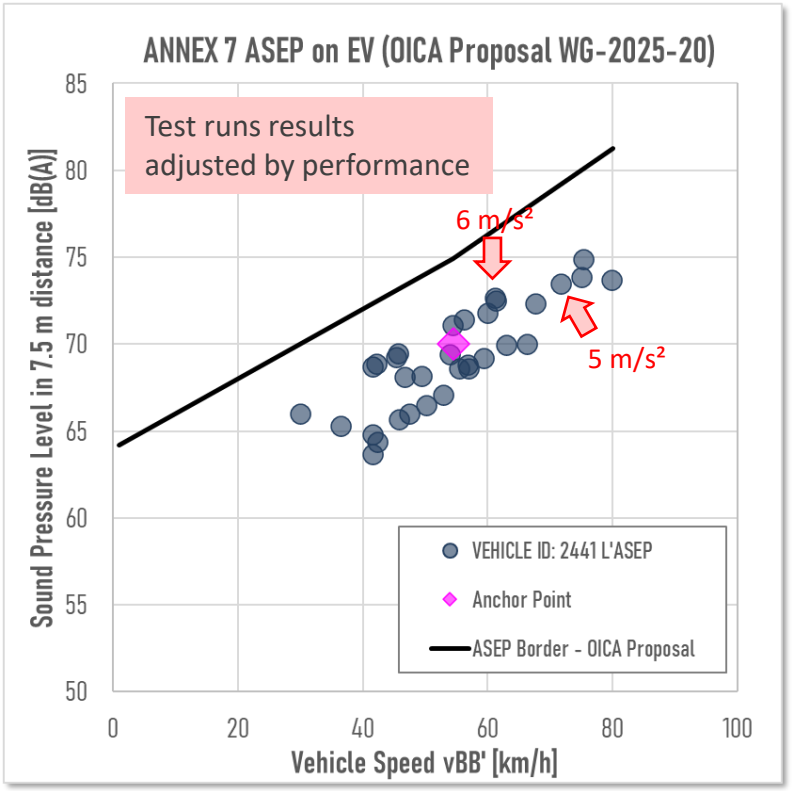
- The vehicle can satisfy ASEP, but is critical to the ASEP border curve between 45 km/h and 65 km/h.
- With the performance adjustment, critical points are adjusted, so that the vehicle can conform to ASEP.
- Still, the vehicle is close to the border.

Application of ASEP on EV on individual vehicles (Impact of ΔL_{ASEP} Term)

Example 3 – EV with Sound Enhancement System in a decent manner

ACEA Database 2024/09 on EV





A VEHICLE WITH AN ESES IS NOT AUTOMATICALLY „NOISY“. THE BASIC SCOPE OF AN ESES IS NOT TO BE LOUD, BUT TO PROVIDE GOOD SOUND CHARACTERISTICS.

- Vehicle **2441** is a **full electric vehicle and has a Sound Enhancement System**.
- The **light blue** pass-by runs are measured results on the test track.
- The **dark blue** pass-by runs represent the pass-by runs adjusted by the ΔL_{ASEP} term, provided their performance is greater than the reference performance va_{anchor} achieved in Annex 3 during type approval

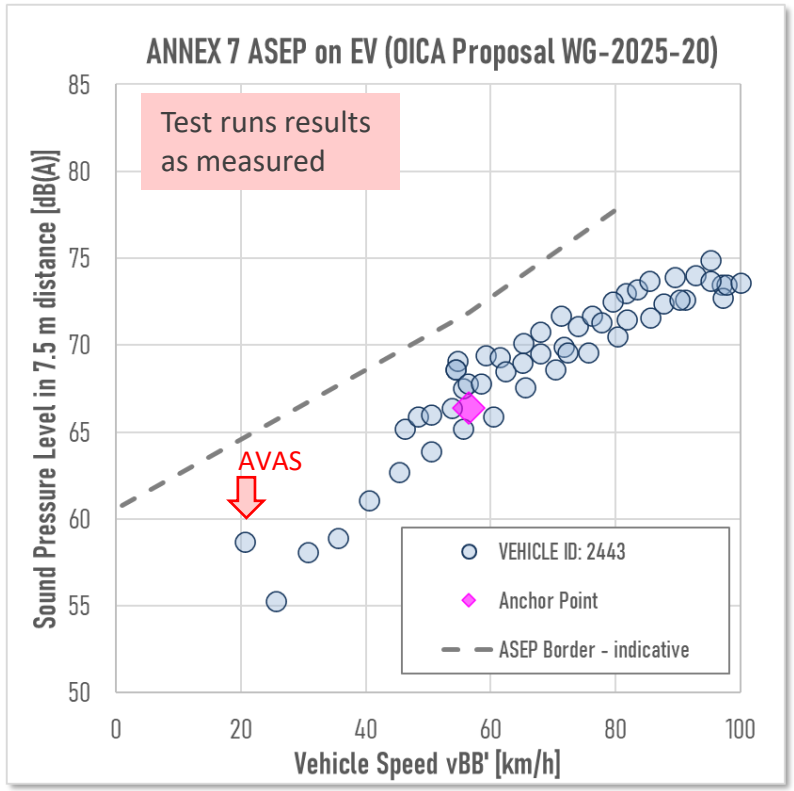
$$va_{anchor} = \frac{v_{bb',wot}}{3{,}6} \times a_{wot,test} = 30{,}4\ \frac{m^2}{s^3}$$

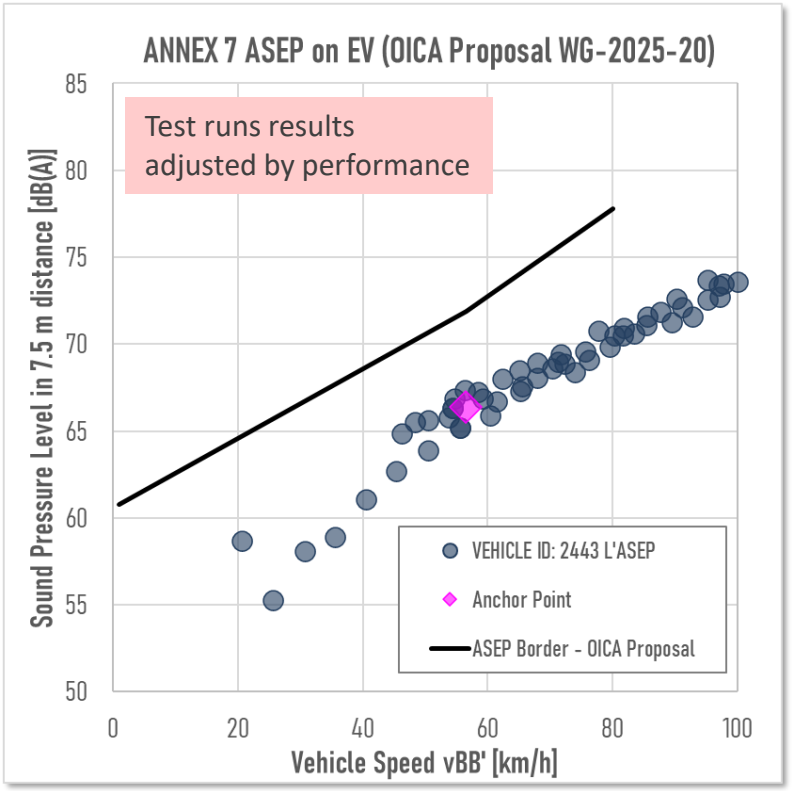
- The vehicle has acceleration point up to 6 m/s² acceleration. The points with the high acceleration are closest to the border curve.
- After the adjustment, all points conform to ASEP.

Application of ASEP on EV on individual vehicles (Impact of ΔL_{ASEP} Term)

Example 4 – EV no Sound Enhancement System

ACEA Database 2024/09 on EV





- Vehicle **2443** is a **full electric vehicle and an only AVAS**.
- The light blue pass-by runs are measured results on the test track.
- The **dark blue** pass-by runs represent the pass-by runs adjusted by the ΔL_{ASEP} term, provided their performance is greater than the reference performance va_{anchor} achieved in Annex 3 during type approval

$$va_{anchor} = \frac{v_{bb',wot}}{3{,}6} \times a_{wot,test} = 30{,}8\ \frac{m^2}{s^3}$$

- The performance adjustment term balances as well torque effects from the tyres.

THE ADJUSTED POINTS BRING THE SOUND OUTPUT OF THE VEHICLE ALMOST IN A PERFECT LINE. THE VEHICLE CAN SATISFY ASEP, BUT THERE IS NOT TOO MUCH ROOM.

Conclusions & Recommendations

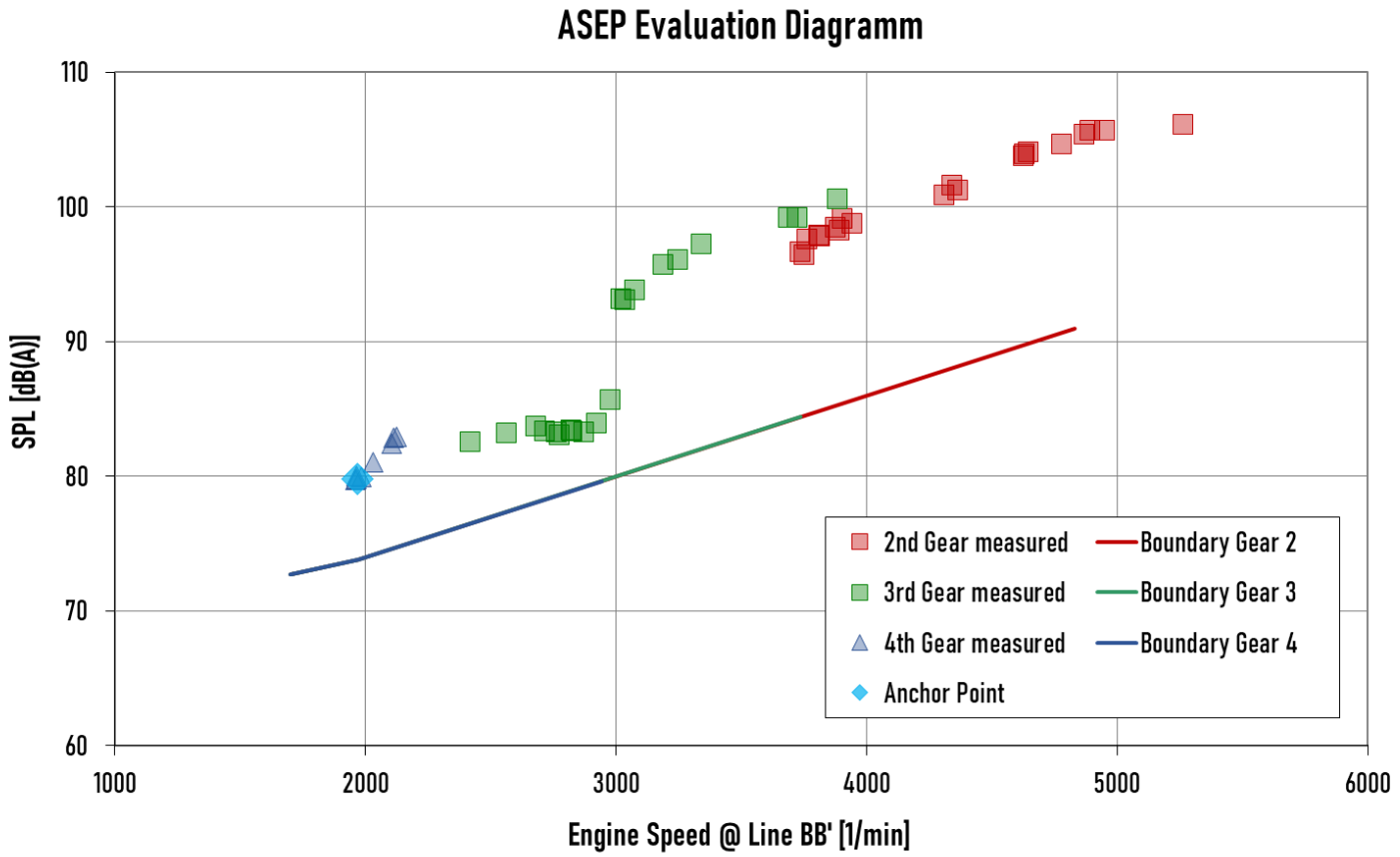
Benefit to GRBP for having such models available for their discussions

- The term ΔL_{ASEP} accounts for high performance and applies to EVs with and without SES in the same way.
  - Examples show, that even AVAS ONLY EVs can only pass ASEP safely, if the correction term is applied.
- The ASEP border as proposed by industry is demanding not only for EVs with ESES.
  - The proposal from OICA aims at freezing the current status without impacting the market too much. This shall enable an adoption as supplement without going to a new series of amendments.
  - A further tightening of the Industry proposed border curve would require more detailed impact assessments and could jeopardize the growing market for EVs.
- By this approach, EVs regardless of their individual technology will in future be recognized in traffic as quiet vehicles, as they are recognized today.
  - Any new registered EV with or without ESES that replaces and ICE, will help to improve environmental noise.
  - EVs reduce much better the effect of driving behaviour.
- ESES might increase a bit the individual vehicle sound, but the not necessarily the environmental noise.
  - A manufacturer aiming for high sound dynamic would have to reduce over-proportionally tyre rolling sound to gain dynamic sound potentials. A vehicle with low tyre rolling sound is contributing more to a quieter environment.
  - A bit more dynamic under accelerated condition is supporting request to improve vehicle sound under accelerated condition.

Additional Slides

Compare ASEP Curve for EVs with ASEP Border for ICE

How big is the difference in sound when ASEP as proposed by OICA is applied

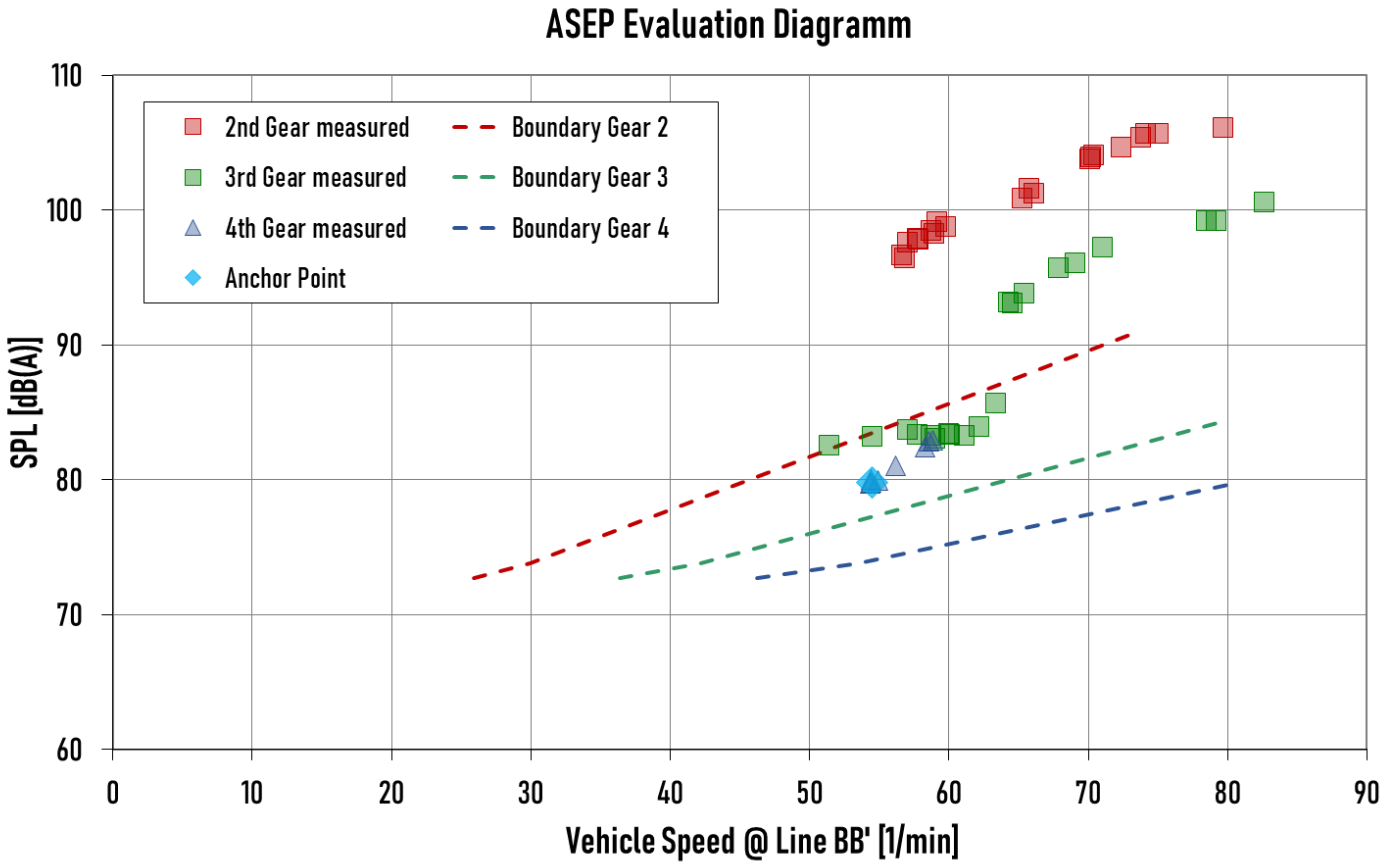


Vehicle ID-211 from UN-ECE IWG-ASEP data base 2007

- Basically ASEP for ICE vehicles is assessed over engine speed.
- The border curve is based on the Annex 3 type approval result.
- The example (ID-211) to the left shows a vehicle approved under UN R51.02, where ASEP was not existing.
- The border curves shown are applicable for limit values UN R51.03 PHASE 3 (M1-d)
- The border curves are determined by gear, in this case they all have the same shape, but different end points.
- The end point is the engine speed where the vehicle reaches in the particular gear 80 km/h.

Compare ASEP Curve for EVs with ASEP Border for ICE

How big is the difference in sound when ASEP as proposed by OICA is applied



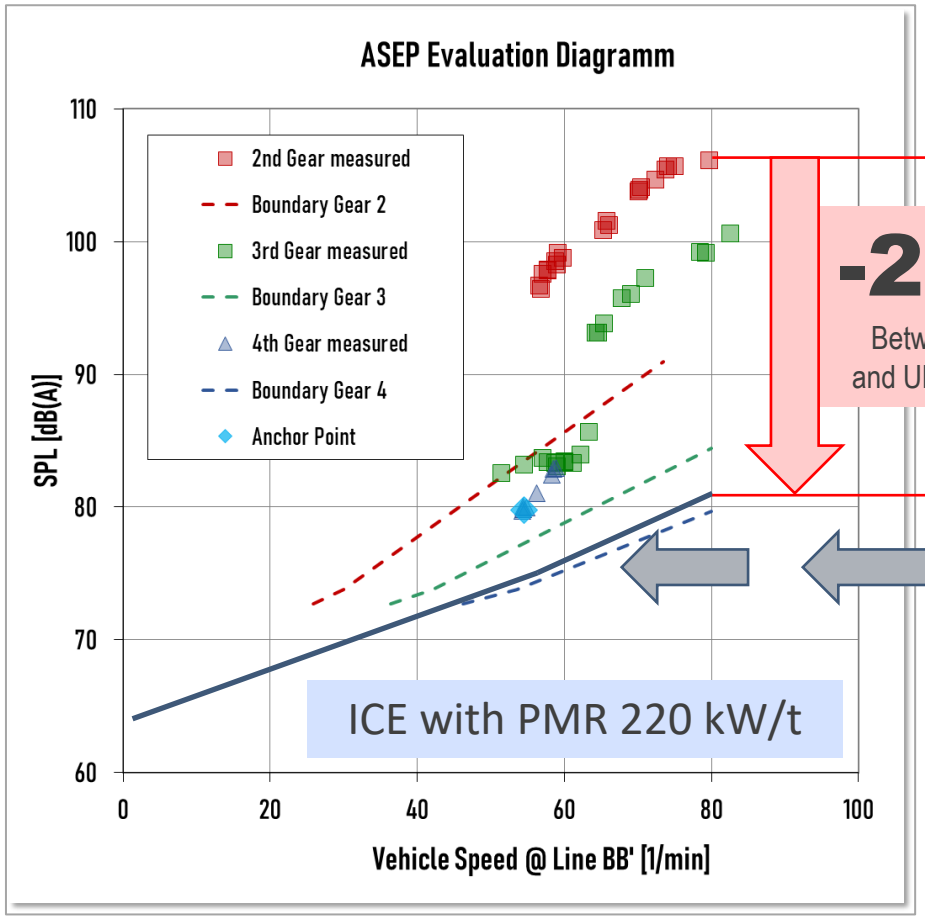
Vehicle ID-211 from UN-ECE IWG-ASEP data base 2007

- For better comparability, the vehicle test data and the gear specific border curves are shown in this diagram over vehicle speed.
- The border curves are now separated, as the used engine speeds are different from gear to gear.
  - In 2nd gear the engine speed at 60 km/h is roughly 4.000 rpm
  - In 3rd gear the engine speed at 60 km/h is roughly 2.800 rpm
  - In 4th gear the engine speed at 60 km/h is roughly 2.200 rpm

Compare ASEP Curve for EVs with ASEP Border for ICE

How big is the difference in sound when ASEP as proposed by OICA is applied

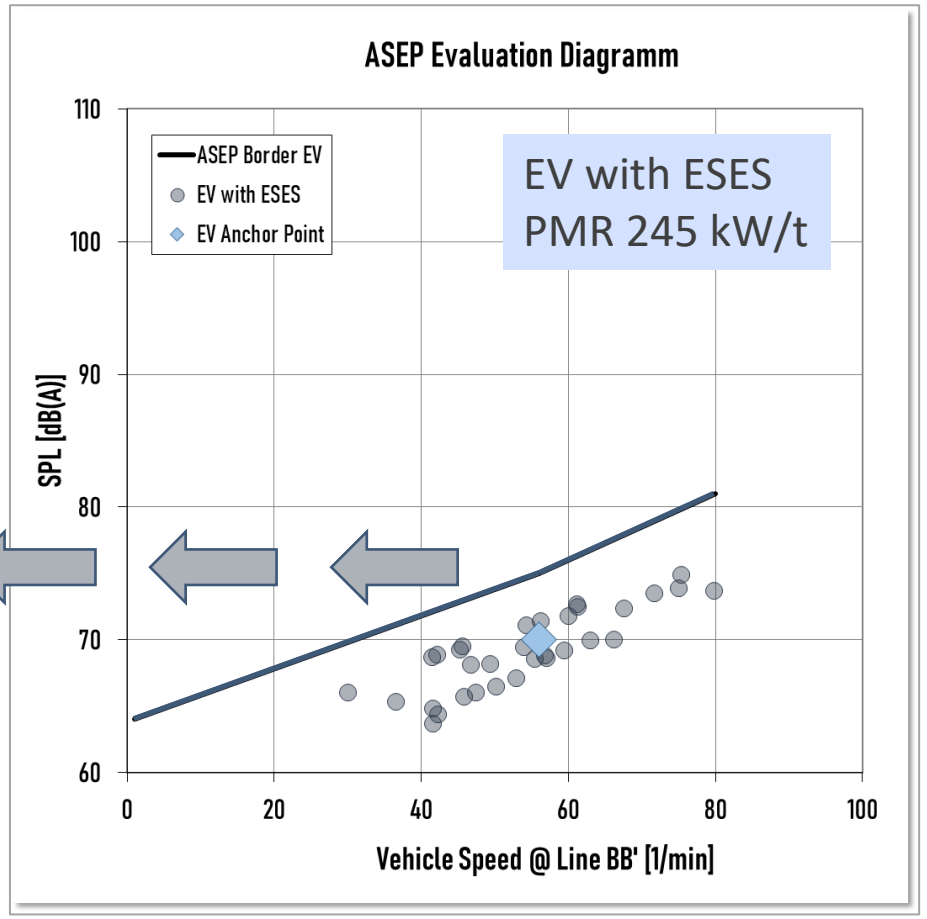
Vehicle ID-211 from UN-ECE IWG-ASEP Database **2007**



-25 dB

Between UN R51.02
and UN R51.03 Phase 3

Vehicle ID-2441 from ACEA/OICA EV Database **2024**

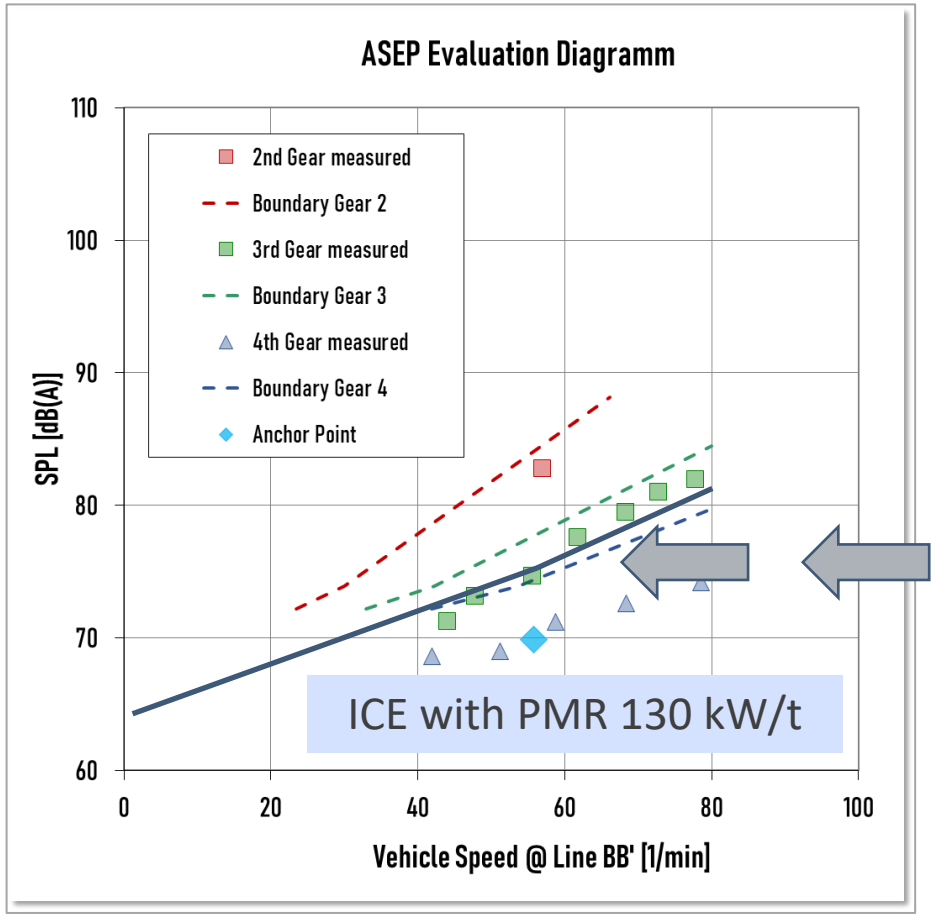


➢The ASEP limit curve proposed for EVs is substantially lower than the ASEP for ICE.

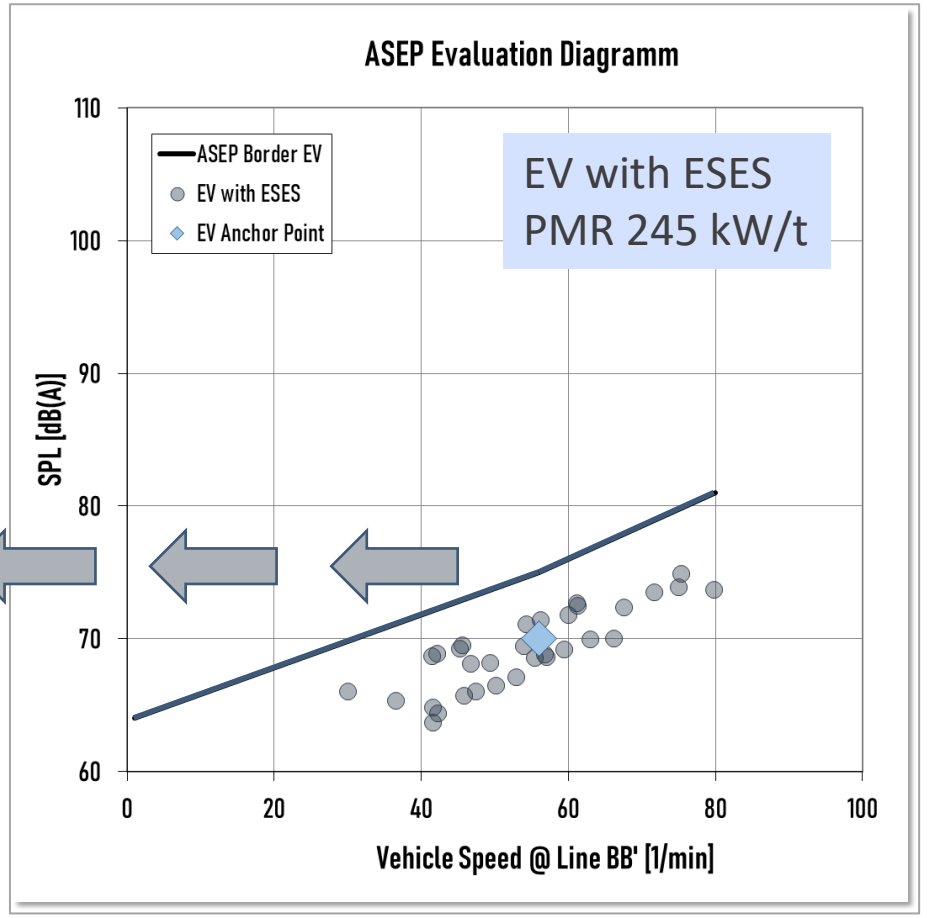
Compare ASEP Curve for EVs with ASEP Border for ICE (MY 2023)

How big is the difference in sound when ASEP as proposed by OICA is applied

Vehicle **Type Approved in 2023** UN R51.03 Phase 3 limit



Vehicle ID-2441 from ACEA/OICA EV Database **2024**



➢The ASEP limit curve proposed for EVs is still lower than for ICE Phase 3 compatible vehicles.

Thank you very much!

Dipl.-Ing.
Hans-Martin Gerhard

Fahrzeugakustik – Verkehrsgeräusche - Umgebungslärm
Vehicle NVH - Traffic Noise – Environmental Noise

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