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Interpretation of Para 6.2.3 Last Sentence of UN R51.03

Paragraph 6.2.3 Last Sentence of UN R51.03

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Introduction

1. **UN R51.03 Paragraph 6.2.3 specifies in the last sentence:**

   “The sound emission of the vehicle under typical on-road driving conditions, which are different from those under which the type-approval test set out in Annex 3 and Annex 7 was carried out, shall not deviate from the test result in a significant manner.”

Definitions

1. “**Extended Additional Sound Emission Provisions (eASEP)**” means the provisions laid out in paragraph 6.2.3 last sentence, which covers driving conditions outside the type approval range of Annex 3 and Annex 7.
2. “**Typical on Road Driving**” means any driving situation, either cruising, acceleration or deceleration and including standstill at operation conditions of the vehicle which are used by a normal driver in traffic.
3. “**Significant Deviation**” means a variation from a reference value which is acoustically remarkable and higher than variations provided by measurement uncertainties.
4. “The “**Type Approval Test Result**” means a value of the limitations, set out by UN R51.03 Annex 3 or Annex 7 which is closest to the operation condition under consideration.

Typical On-Road Driving

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Gasses Emissions

WLTP (GTR 15) statistics conclude that normal driving is at performances up to **v*a < 20 m²/s³**

RDE Regulation (2017/1151/EG) specifies cycle dependent 95% performances between **20 m²/s³ and 35 m²/s³**

normal and extended driving under RDE

Sound Emissions

Current UN R51.03 covers in Annex 3 normal driving performances dependent on the PMR between **10 m²/s³ and 30 m²/s³**

Current UN R51.03 covers in Annex 7 extreme driving performances **up to 110 m²/s³**

current control area of the sound emission regulation is 3 to 5 times more agressive

Can we adopt the definition for „typical“ driving from RDE to the sound regulation?

Typical On-Road Driving

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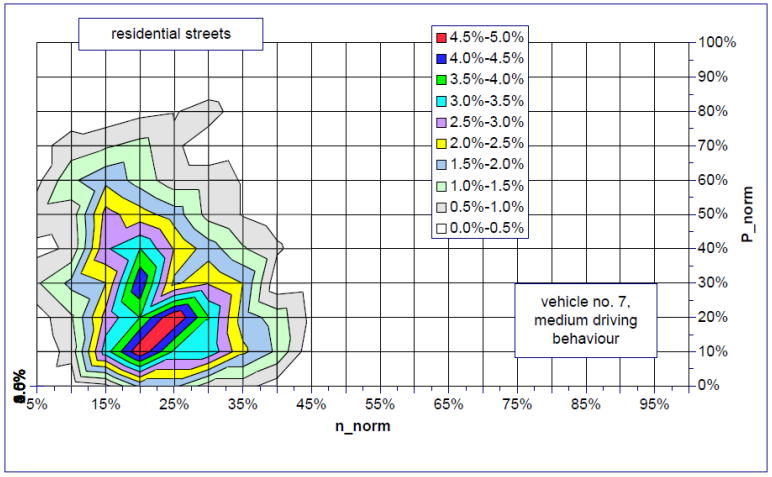
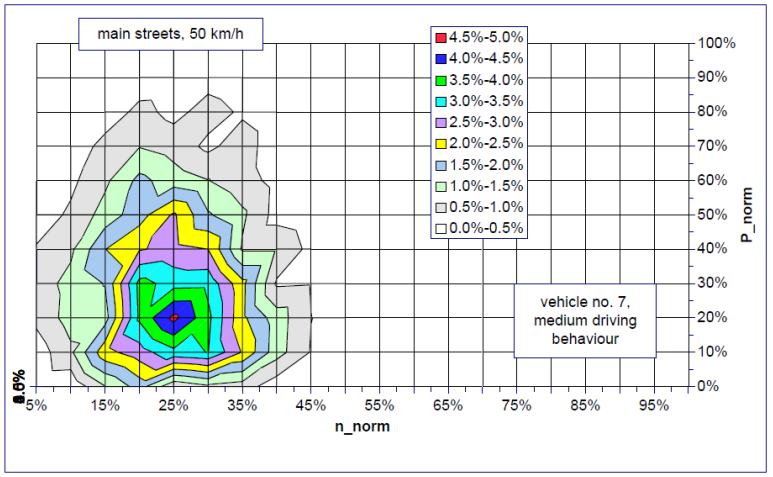
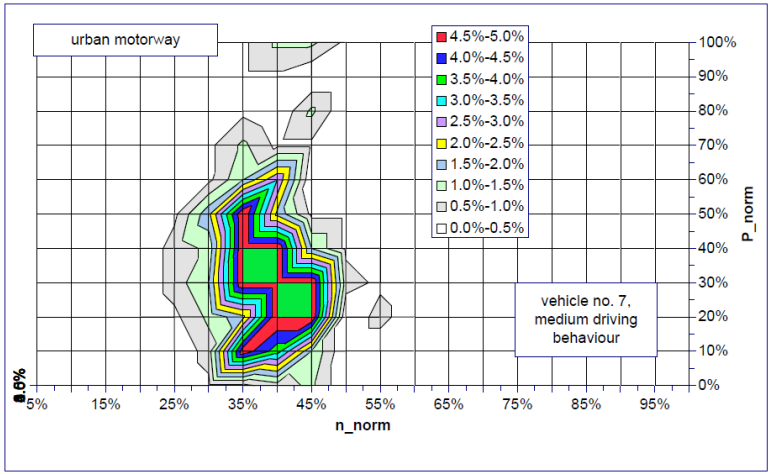
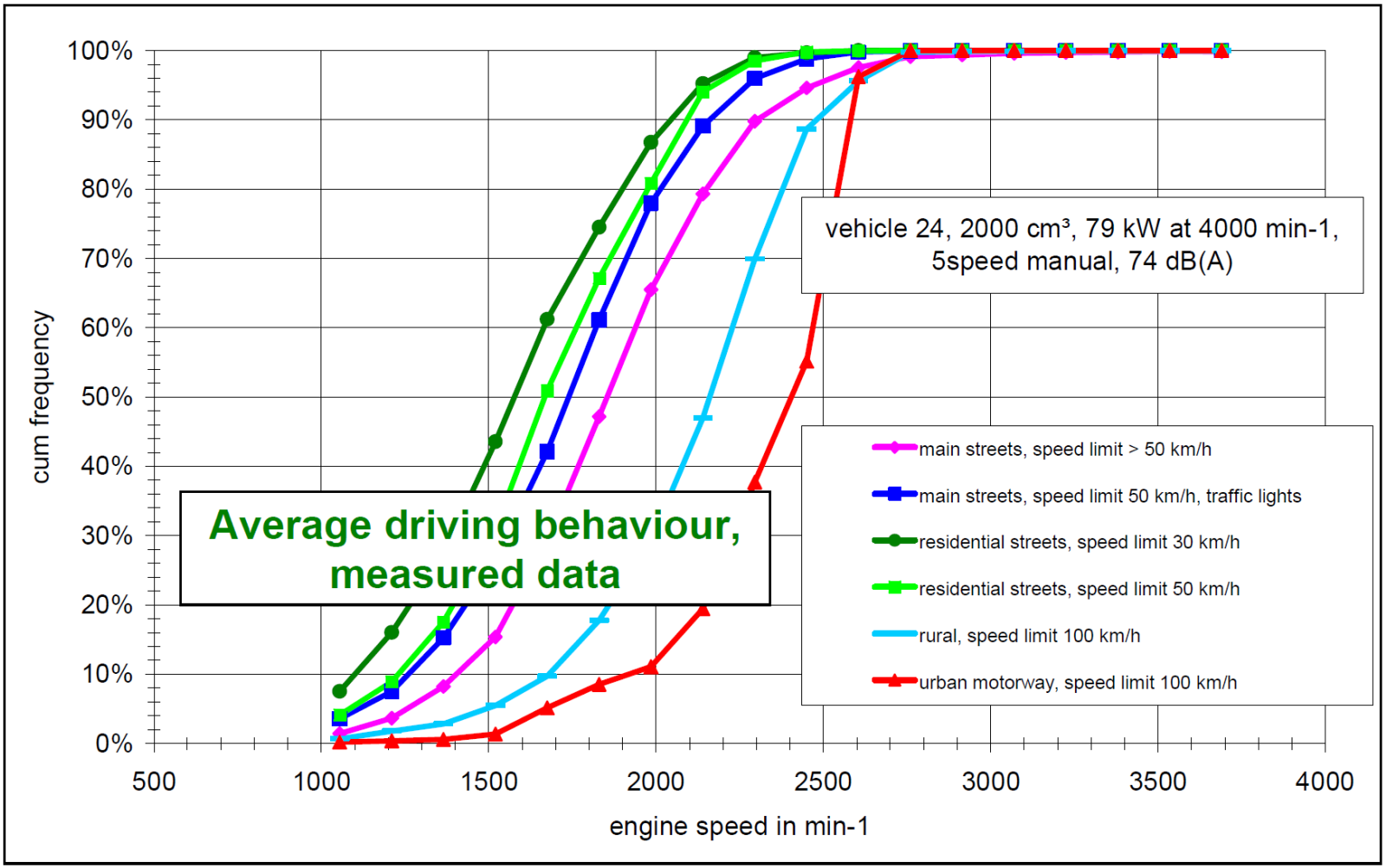




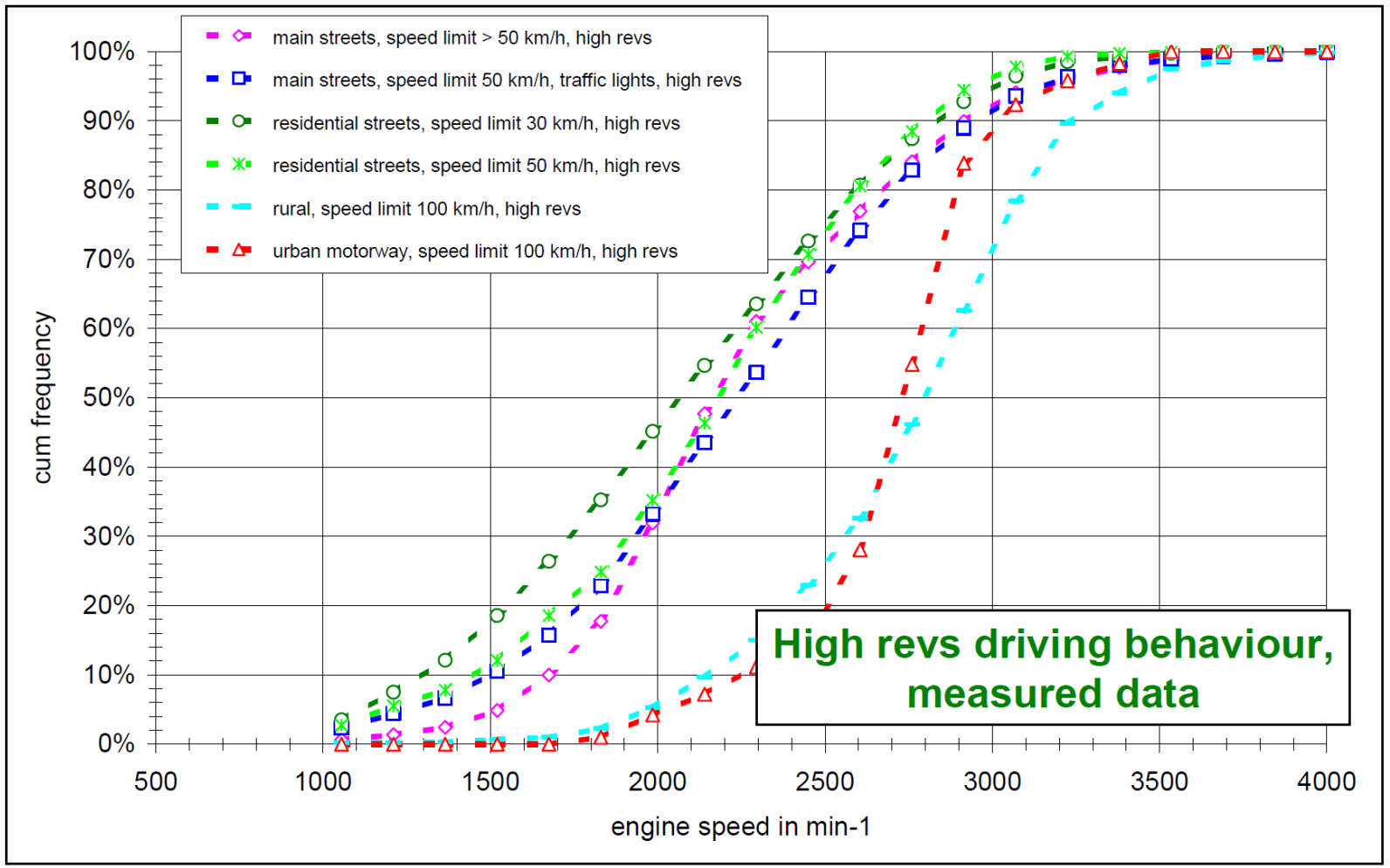
- Driving statistics were made for the development of UN R51.03.
- Theses statistics give an indication for „typical operation“ over a wider range of vehicle speeds.
- On all street types, the engine speed range, the load (used power P) is limited.



Engine Speeds in Real Traffic, veh 24



Engine Speeds in Real Traffic, veh 24



No need to address higher engine speeds

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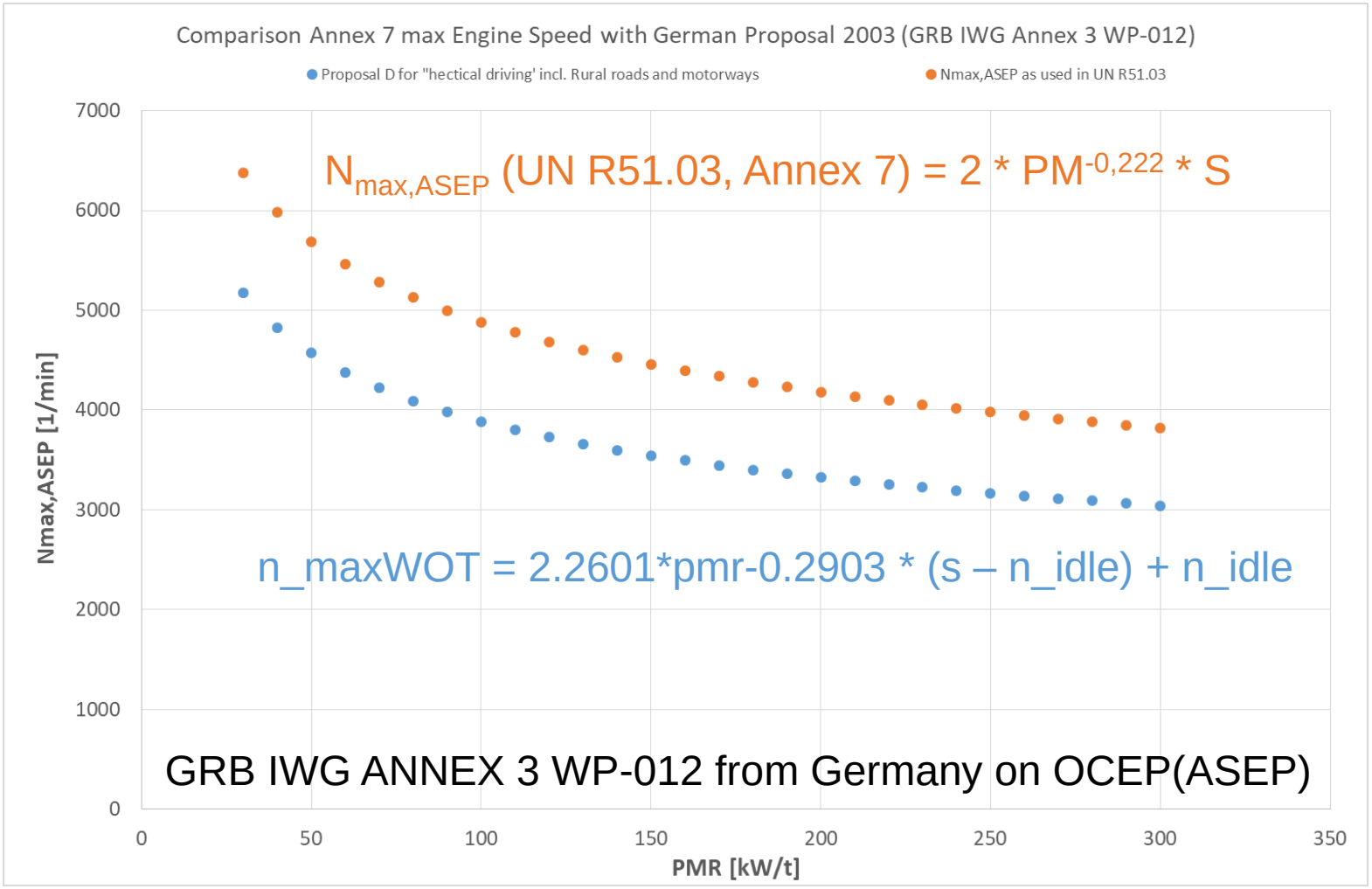

The engine speed border Nmax,ASEP implemented in UN R51.03 Annex 7 exceeds already the original proposed engine speed which was deemed representative for „hectical“ driving on any public roads. Engine speeds exceeding this Nmax,ASEP are not typical driving.

Typical On-Road Driving

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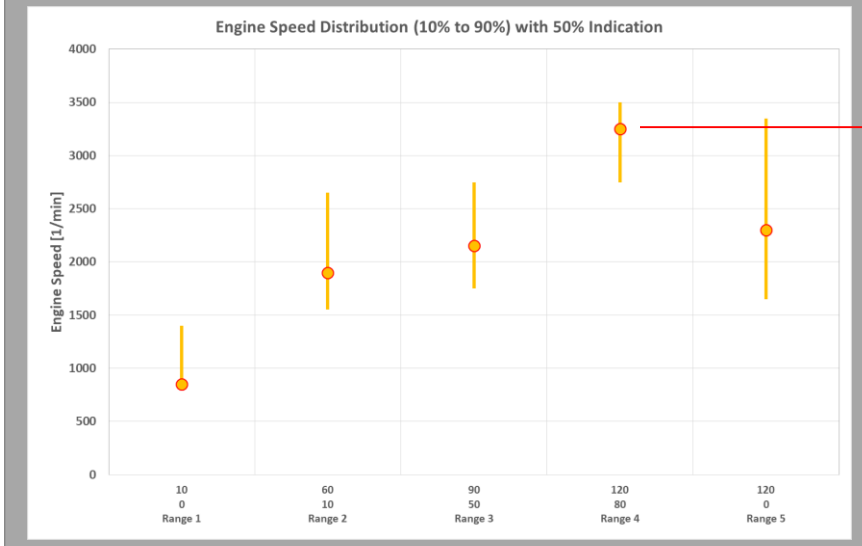
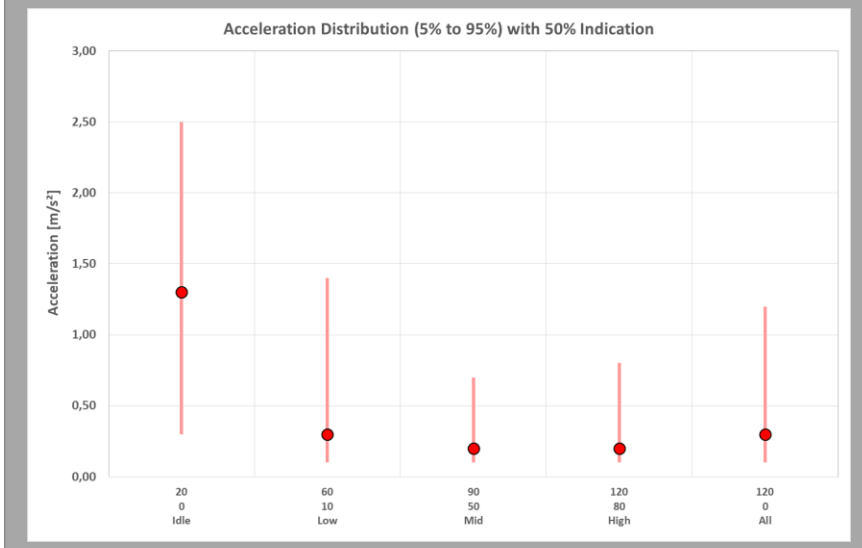
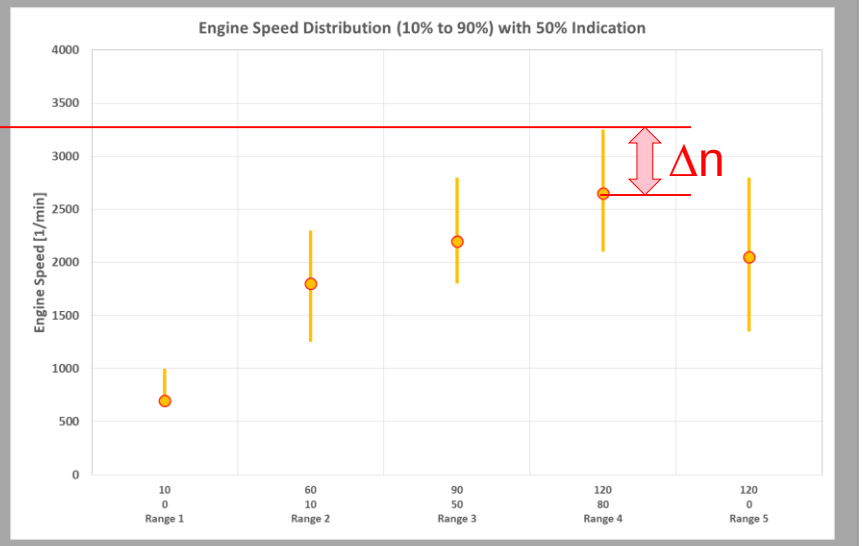
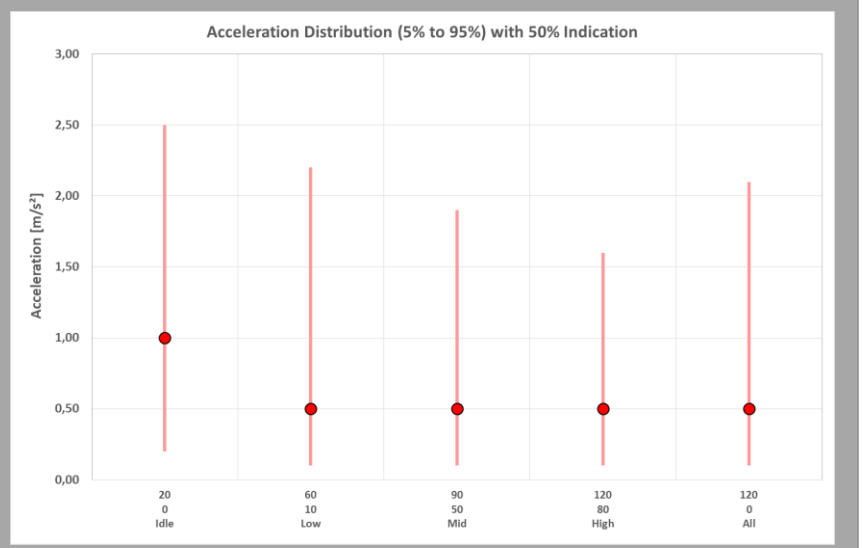
5-speed **low performance** car





7-speed **high performance** car





What is the performance of a vehicle in real traffic

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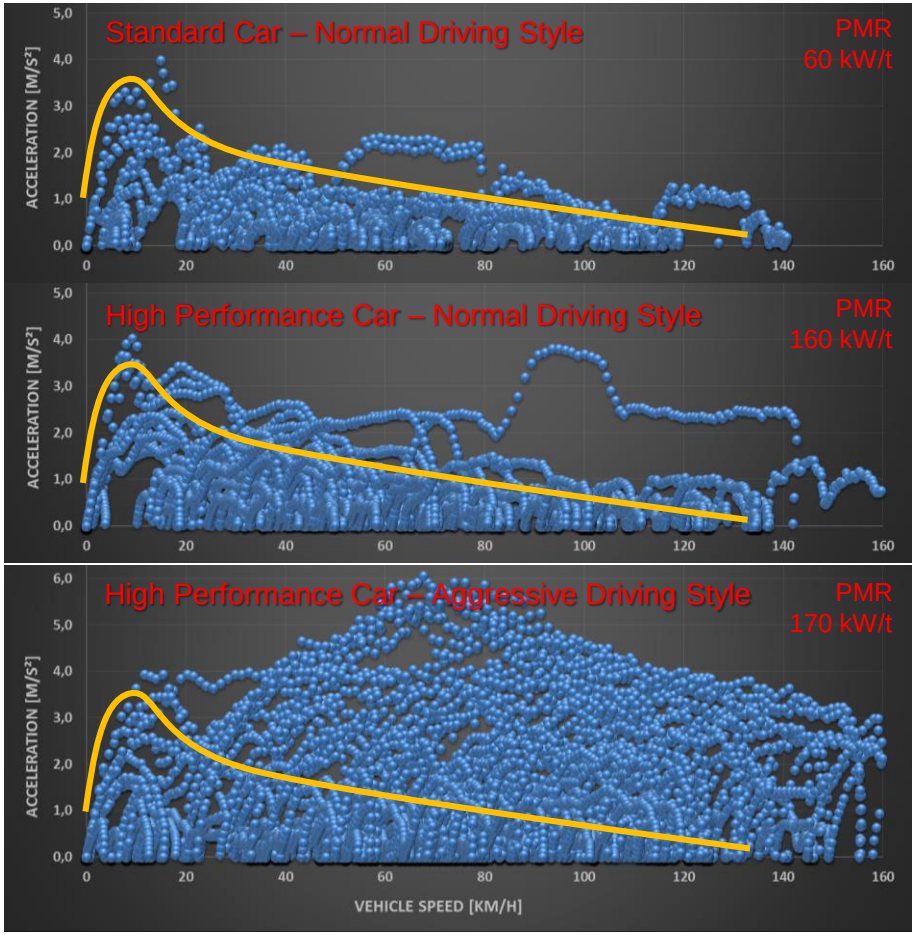

Regardless of the vehicle type and its power, a normal driving style can be characterized, by the orange curve.
Under normal driving this curve is sometimes exceeded, but rarely.

The second example shows, that even high performance vehicles are driven almost the same way as normal cars.

However, high performance cars allow to drive more extreme, so that their driving performance can be much higher.
But, full throttle at low speeds in low gears is even with aggressive driving not given.

Acceleration Performances Versus Vehicle Speed

GTR15 (WLTC) - All Cycles

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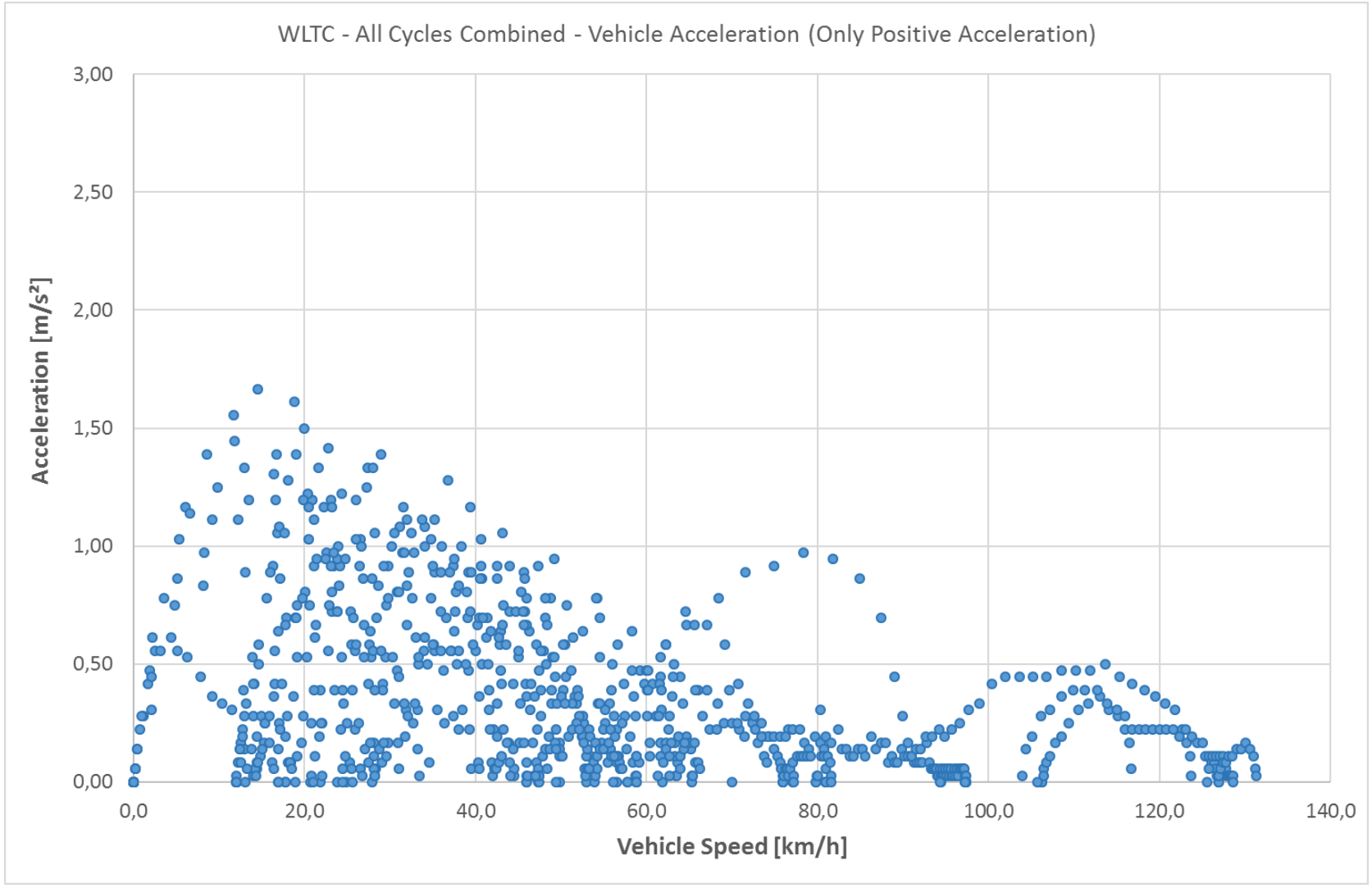

Comparison Max Performances VxA

GTR15 (WLTC) vs UN R51.03 (ASEP) vs 2008-692-EG (RDE)

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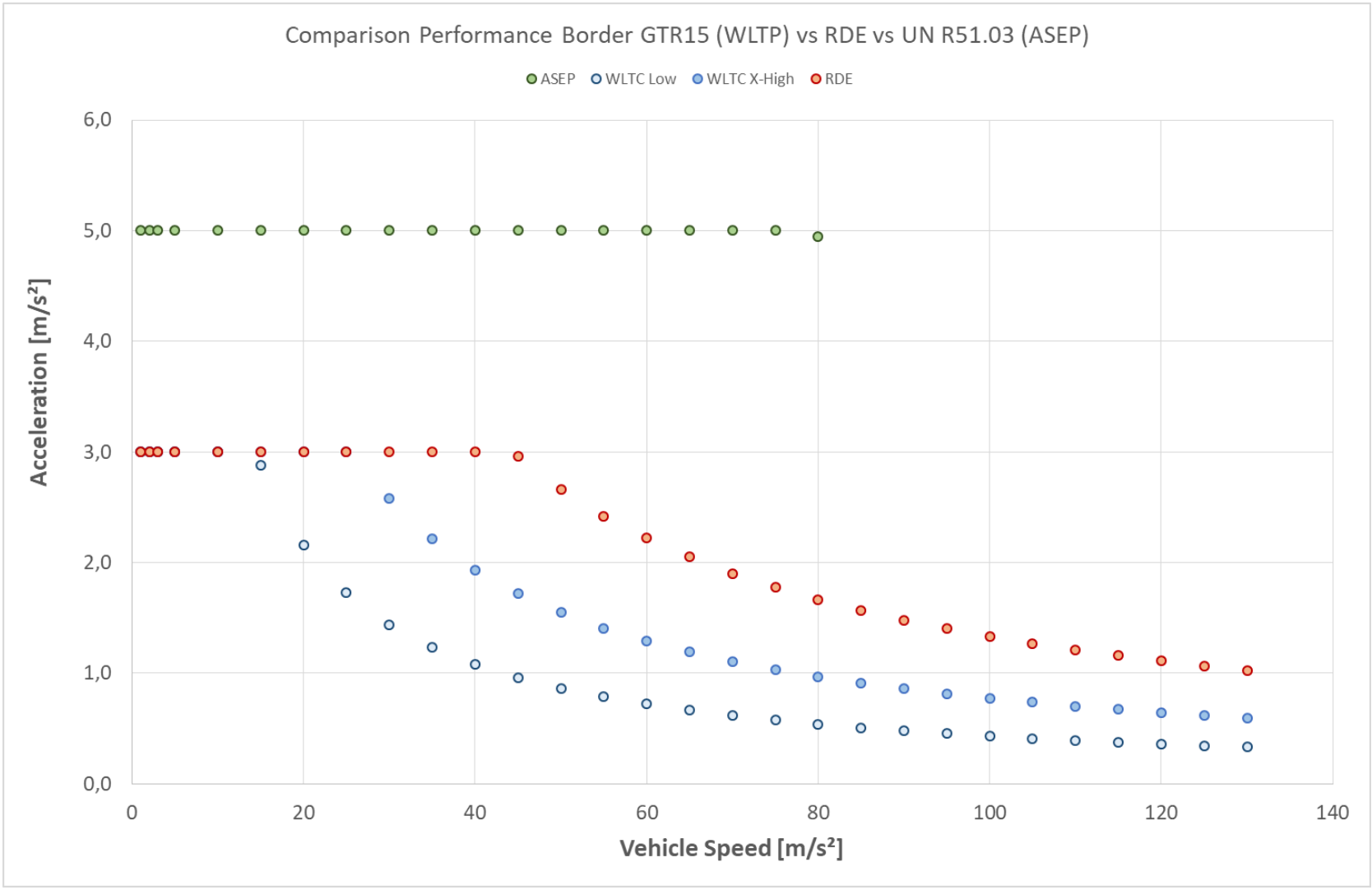

Proposal “CONTROL RANGE eASEP”

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Specification for the Control Range representing “Typical on Road Drving Conditions”

1. ASEP, paragraph 2.3 of Annex 7 of UN R51.03 defines the control range of the mandatory ASEP area.

   The operation conditions covered by this control range covers partly “typical on road driving conditions” but on the other hand, exceeds these conditions as ASEP shall cover “extreme driving”

2. eASEP control range, covering “typical on road driving conditions”
   1. **any gear** (except reverse gear) not covered by ASEP
   2. any **vehicle speed between [10] km/h and [100] km/h**
   3. any performance VxA up to 35, not exceeding an **acceleration of [3] m/s²**
   4. the **same engine speeds as the mandatory ASEP**, not resulting in vehicle speeds exceeding the range specified above
   5. **any load condition**, leading to acceleration not exceeding the performance and acceleration limits specified under point 2.3

Significant Deviation from the Test Result

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Das menschliche Ohr

Treffen Schallwellen auf das Trommelfell, so gerät auch dieses in Schwingung. Der Mensch nimmt dadurch ein Geräusch wahr. Die kleinste Druckschwankung, die vom Ohr aufgenommen und verarbeitet wird, wird als Hörschwelle bezeichnet. Der Hörbereich wird üblicherweise durch den Schalldruckpegel beschrieben. Der Schalldruckpegel ist ein logarithmisches Maß zur Beschreibung der Stärke eines Schallereignisses und bildet in guter Näherung den Höreindruck des Ohres ab. Er wird in Dezibel (dB) angegeben und seine Werteskala umfasst 0 bis 120 dB. Pegelunterschiede lassen sich ab einer Differenz von circa 3 dB als gerade hörbar wahrnehmen, obwohl diese Differenz bereits einer Halbierung der Schallenergie entspricht. Eine Reduzierung von 10 dB wird in der menschlichen Wahrnehmung als Halbierung der Lautstärke empfunden.

Das Hörempfinden

Lärm ist unerwünschter Schall – häufig macht schon eine größere Lautstärke ein Geräusch zum Lärm, Unterschiede ergeben sich aber auch durch die persönliche Einstellung zur Geräuschquelle. In vielen Fällen ist es die Botschaft, die mit dem Geräusch vermittelt wird, die wesentlich über das Empfinden mitentscheidet. Hierunter fallen auch der „Klang“ eines Geräusches sowie sein zeitlicher Ablauf. So signalisiert schnell anschwellender Lärm, wie beispielsweise beim Presslufthammer, eine Bedrohung und wird als besonders störend empfunden. Demgegenüber nimmt das Gehirn langsam zu- und abnehmende Geräusche als weniger belästigend wahr.

Source: https://www1.deutschebahn.com/laerm/grundlagen/physikalische_grundlagen.html

What is acoustically significant?

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Emission

UN R51.03 specifies a run-to-run tolerance of 2 dB(A)

A double energy is +3 dB(A)

L_{eq}

Annex 3

Typical legal tolerances for „sameness“ are +5 dB(A)

Perception

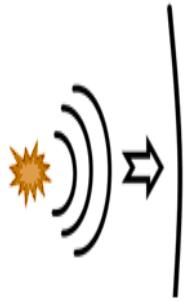
A double sound pressure is +6 dB(A)

A double perceived loudness is +10 dB(A)

L_{max}

Annex 7

Overview of typical values used in the acoustic field

Pegeländerung	Lautstärke Wahrnehmung	Schalldruck Wirkung	Schallintensität Ursache
			
Dezibel	Lautheits-Faktor	Schallfeld-Faktor	Schallenergie-Faktor
+ 20 dB	4,000	10,000	100,000
+ 10 dB	2,000 •	3,160	10,000
+ 6 dB	1,516	2,000 •	4,000
+ 3 dB	1,232	1,414	2,000 •
± 0 dB	1,000	1,000	1,000

A significant deviation (“erhebliche” Abweichung”) means, that the deviation is definitely higher than just uncertainty considerations.

- A sound level increase by 3 dB(A) is hardly audible to untrained people.
- A sound level increase by 6 dB(A) is audible almost everybody, but does not mean that it is significant.
- A sound level increase by 10 dB(A) is for everybody clearly audible.

Abb. 8.6 zeigt den Median, den Interquartilbereich und die Extrema der Änderungen (zur ersten Messung) vom *basis* Programm zu einer gleichlauten Empfindung in allen Bändern (Programm *mod*; mit ISO 226 bei 65 dB). Ein positiver Wert bedeutet, dass das Hörsystem zu leise war, um die Testsignale als gleichlaut zu empfinden. Weiterhin ist bei solchen Darstellungen zu beachten, dass die Extrema nicht von einem Probanden stammen, sondern als Hüllkurve über alle Probanden interpretiert werden muss.

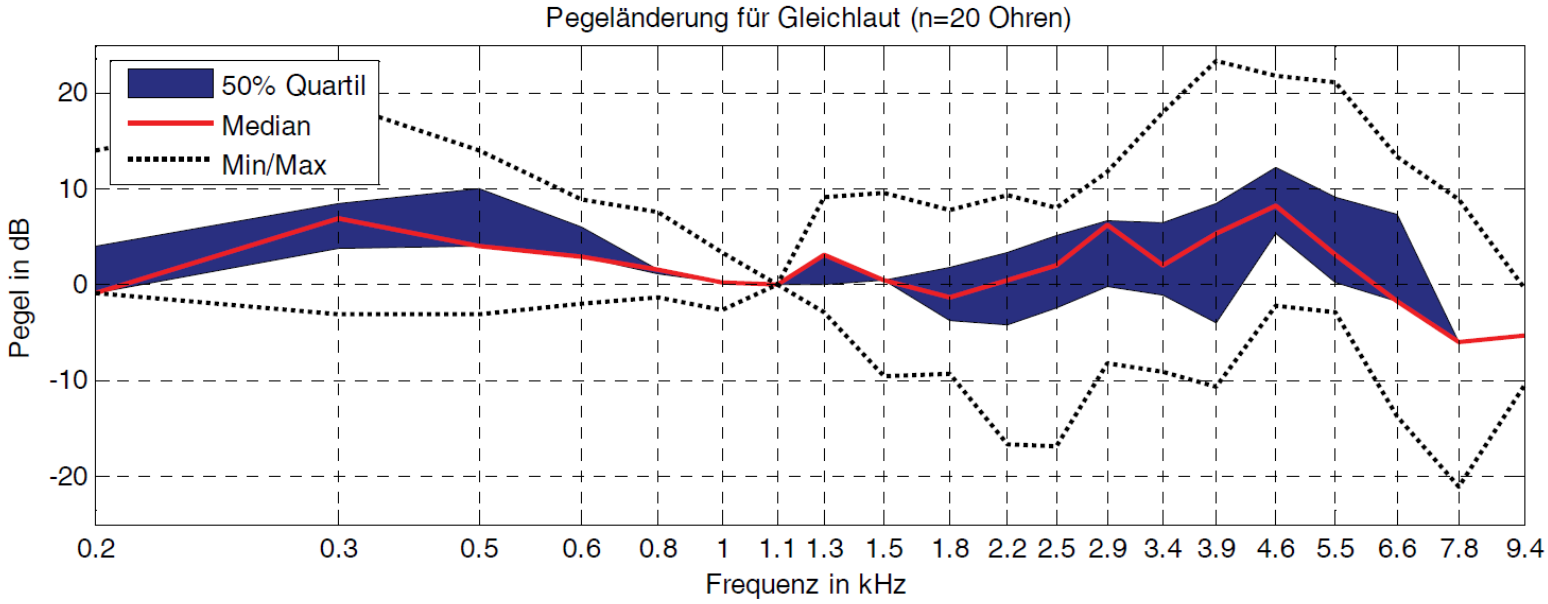


Abb. 8.6: Pegeländerung zum *basis* Programm für ein gleichlautes Empfinden

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Specification for "Significant Sound Levels", different from the Type Approval Test Result of Annex 3 and Annex 7.

For the "SLOPE-Assessment"

1. **For all gears not covered by the mandatory ASEP**, the maximum sound level is given by the ASEP borderline plus an addition ΔL_{eASEP} representing the border to a significant deviation.

   $$\Delta L_{eASEP} = +[6]\ dB(A)$$

2. For all speeds exceeding the mandatory control range of ASEP, the borderline is enhanced by linear extrapolation from the anchor point with the applicable slope.
3. The vehicle is compliant to paragraph 6.2.3 last sentence (eASEP), if the sound emission of the vehicle in any operation condition within the control area of eASEP does not exceed the borderline of ASEP shifted by ΔL_{eASEP} .
4. The chart on the next page provides a scheme for orientation

DRAFT Interpretation of Para 6.2.3 Last Sentence of UN R51.03

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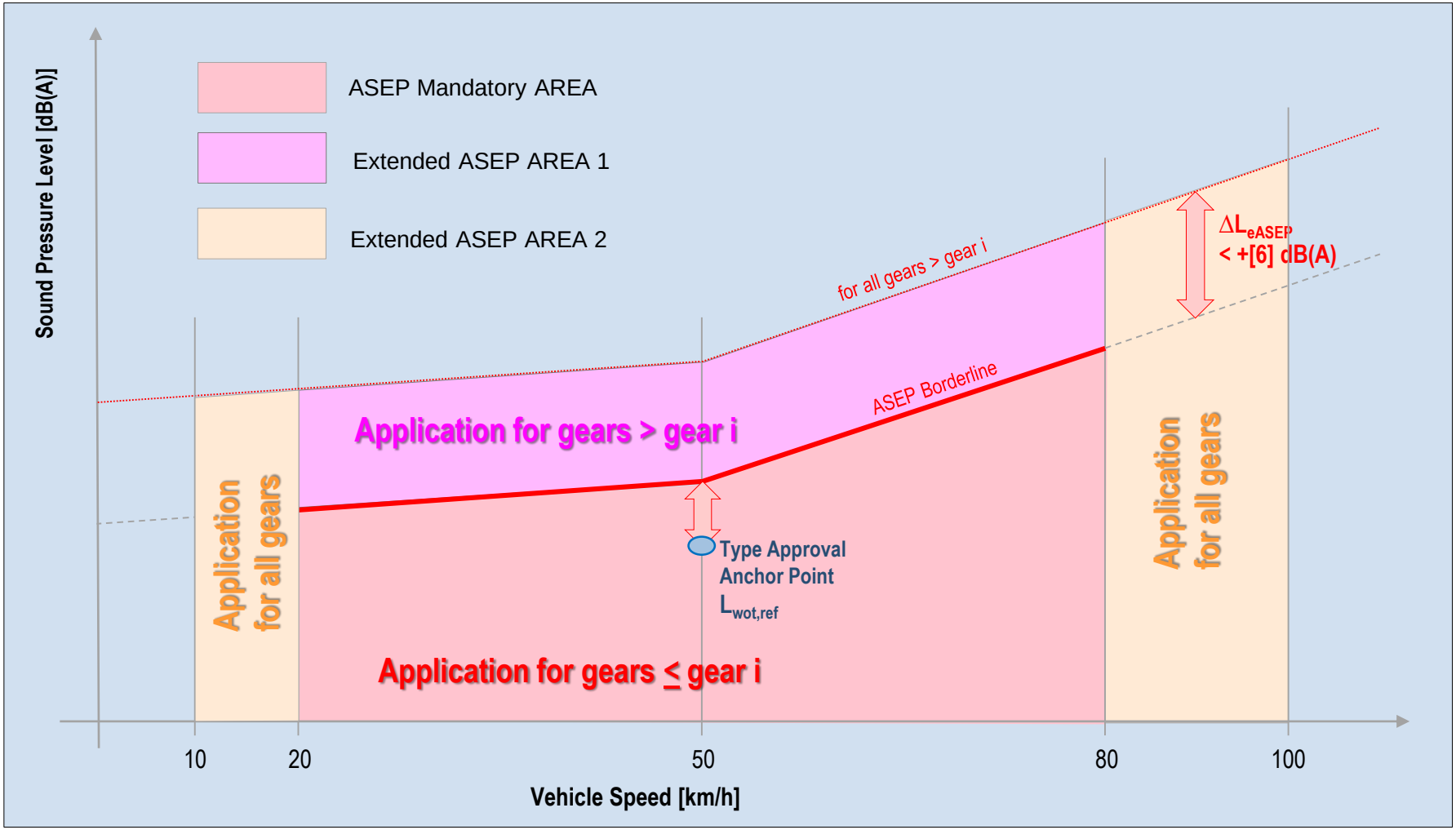

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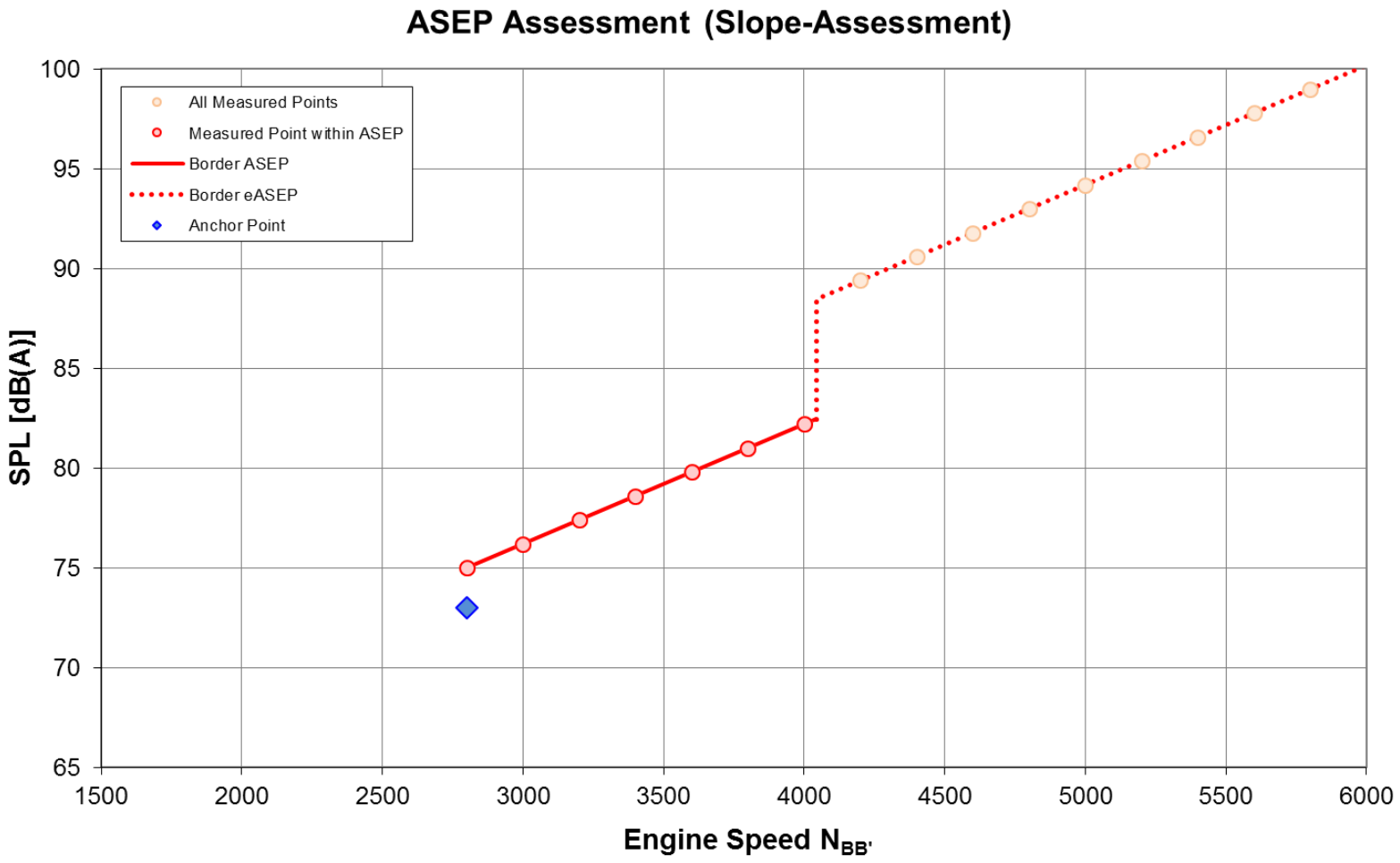

DRAFT Interpretation of Para 6.2.3 Last Sentence of UN R51.03

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Specification for "Significant Sound Levels", different from the Type Approval Test Result of Annex 3 and Annex 7.

For the "L_{urban}-Assessment"

1. For all partial load driving conditions, the $\mathbf{k_{P\_ASEP}}$ of the correlated full load acceleration condition applies.
2. In cases, where the maximum acceleration for a gear ratio during the test is lower than a_{urban}, the partial power factor $\mathbf{k_{P\_ASEP}}$ is set to zero:

   $$\mathbf{k_{P\_ASEP} = 0}$$

3. For all gear ratios covered by ASEP, but assessed outside the speed control range specified by ASEP, an additional tolerance is applied

   $$L_{urban\_normalized} - L_{urban} \leq 3\ dB + (Limit\text{-}L_{urban}) + \Delta\mathbf{L_{eASEP}} \qquad \textbf{where } \Delta\mathbf{L_{eASEP}} \textbf{ = +[2] dB(A)}$$

4. For all gear ratios not covered by the mandatory ASEP, the maximum sound level is given by the ASEP borderline plus an addition ΔL_{eASEP} representing the border to a significant deviation.

   $$L_{urban\_normalized} - L_{urban} \leq 3\ dB + (Limit\text{-}L_{urban}) + \Delta\mathbf{L_{eASEP}} \qquad \textbf{where } \Delta\mathbf{L_{eASEP}} \textbf{ = +[3] dB(A)}$$

5. The chart on the next page provides a scheme for orientation

DRAFT Interpretation of Para 6.2.3 Last Sentence of UN R51.03

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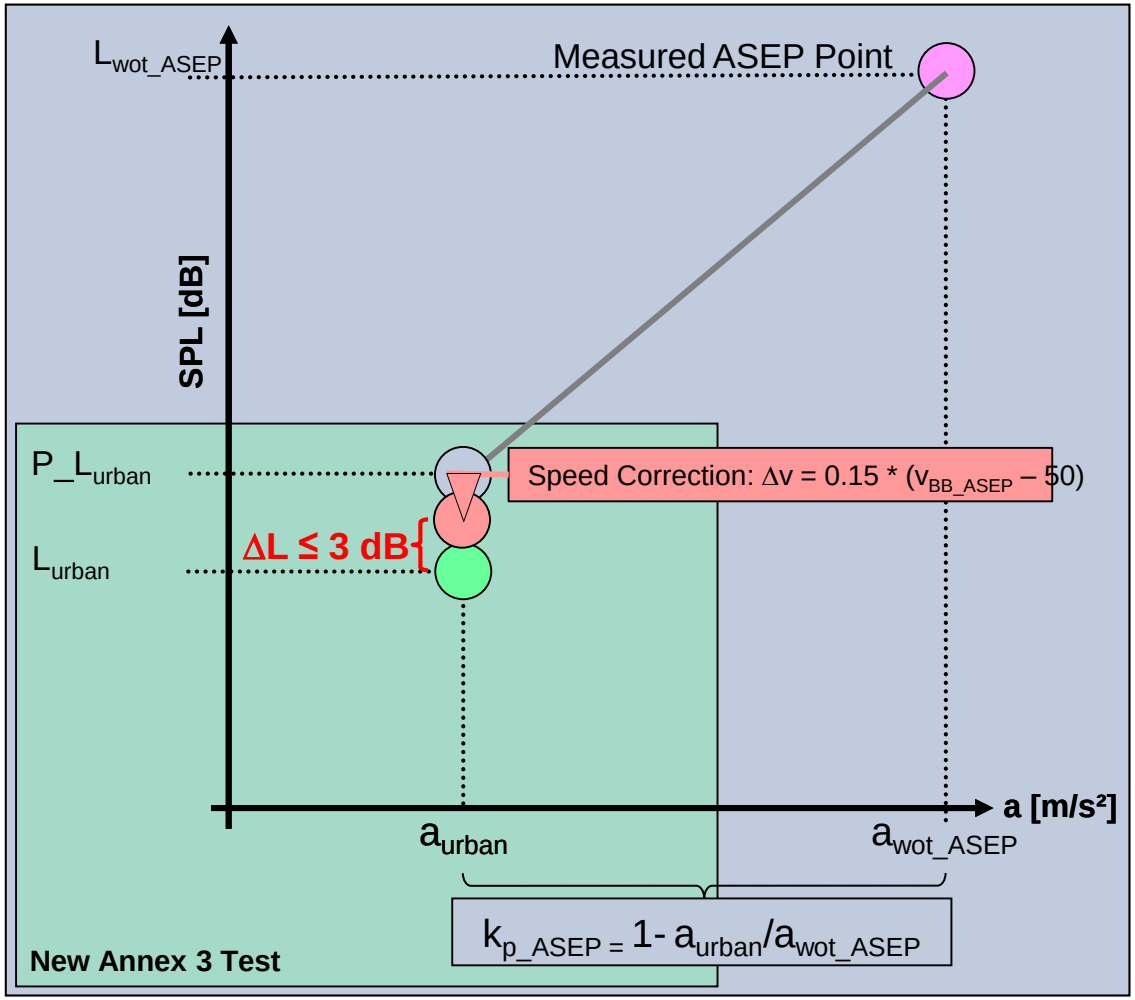

Flow Chart for Assessment of ASEP using Pseudo L_urban

1	Perform the Type Approval Test according to Annex 3 of ECE R51; Report the following parameter: **a_{urban}; L_{urban}; L_{crs_rep}**
2	Perform a sound measurement on the test track (operation conditions within the ASEP boundaries) Reported results are: **v_{bb_ASEP}; a_{wot_ASEP}; L_{wot_ASEP}**
3	Calculate the particular partial power factor kp: **$k_{p\_ASEP} = 1- a_{urban}/a_{wot\_ASEP}$**
4	Calculate the Pseudo L_urban: **$P_{L\_urban} = L_{wot\_ASEP} – k_{p\_ASEP} *(L_{wot\_ASEP} - L_{crs\_rep})$**
5	Compensate for the speed influence, **$P_{L\_urban\_ASEP} = P_{L\_urban} - L_{urban} - 0{,}15 * (v_{BB\_ASEP} - 50)$**
6	Check vehicle compliance with ASEP **$P_{L\_urban\_ASEP} = P_{L\_urban} – L_{urban} \leq 3$ dB**

The method allows to assess individual runs. Step 2 to step 6 have to be repeated after every test run.

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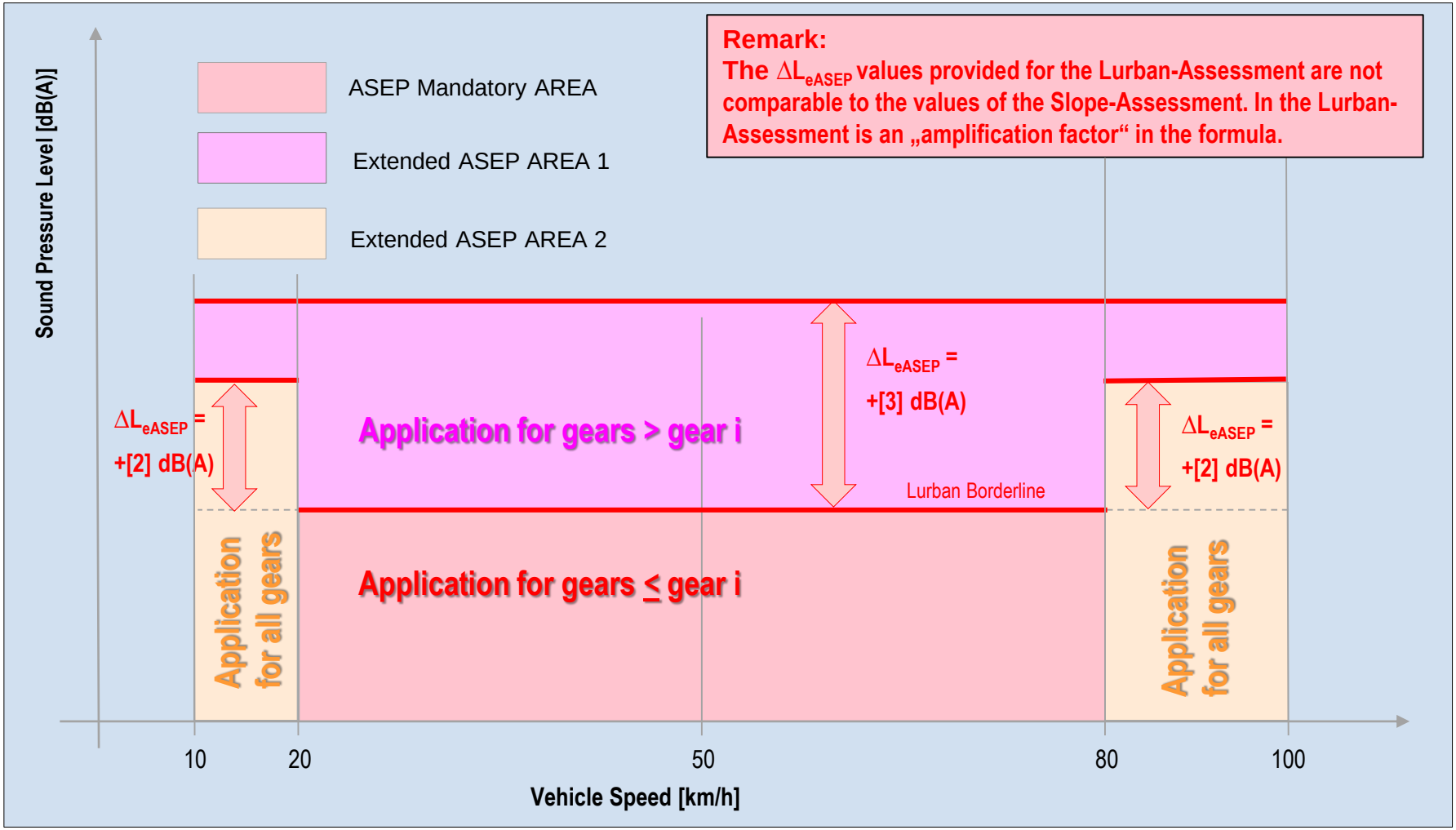

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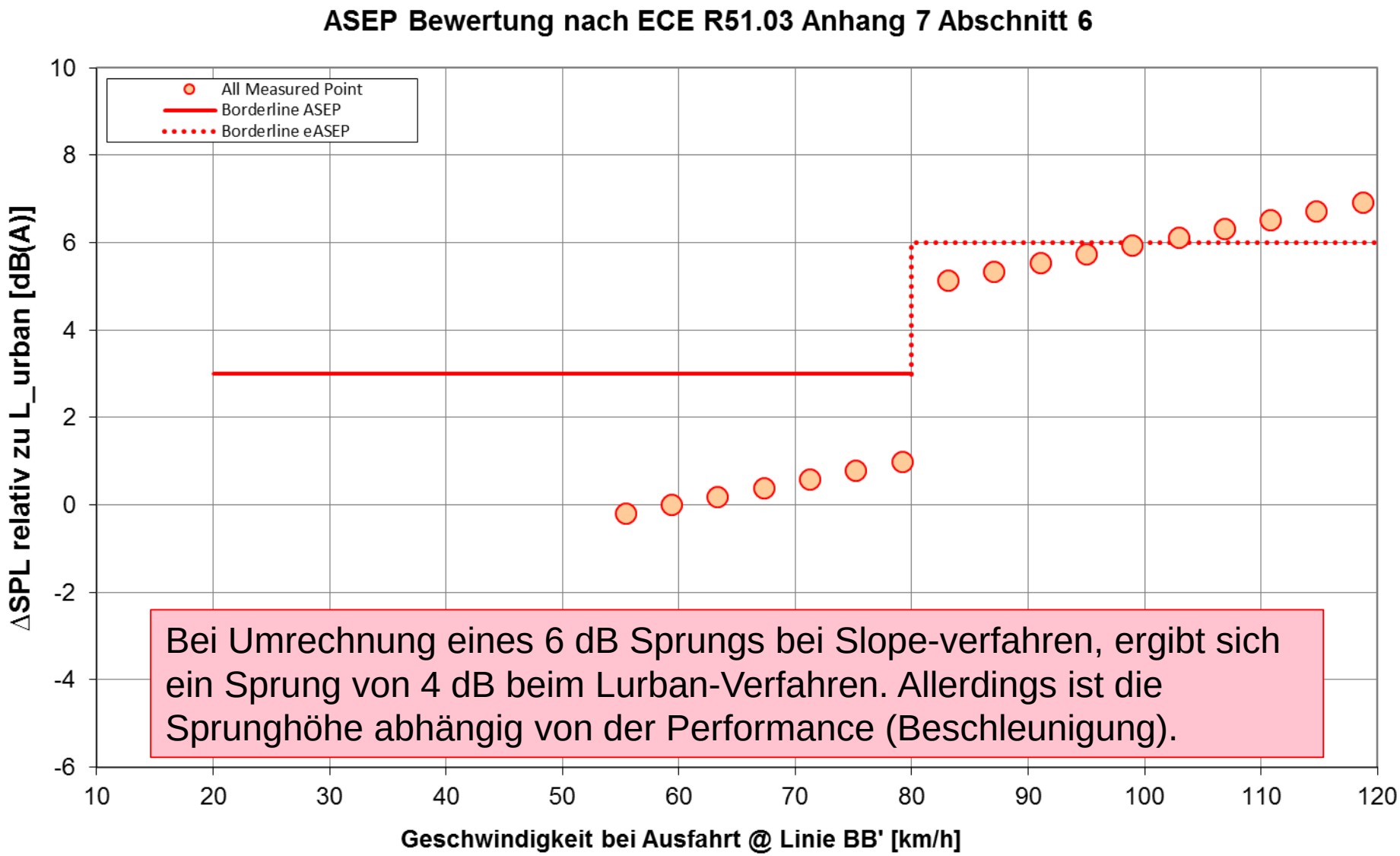

Bei Umrechnung eines 6 dB Sprungs bei Slope-verfahren, ergibt sich ein Sprung von 4 dB beim Lurban-Verfahren. Allerdings ist die Sprunghöhe abhängig von der Performance (Beschleunigung).