GRBIG-ASEP-01- 005
GRB informal group ASEP R51
November 2005
Issued by the Netherlands

# R51.02 → R51.03
# The most important changes in Annex 3 (M1-N1)

## A short introduction for newcomers in GRBIG “ASEP”

# Annex 3 of D/ISO proposal

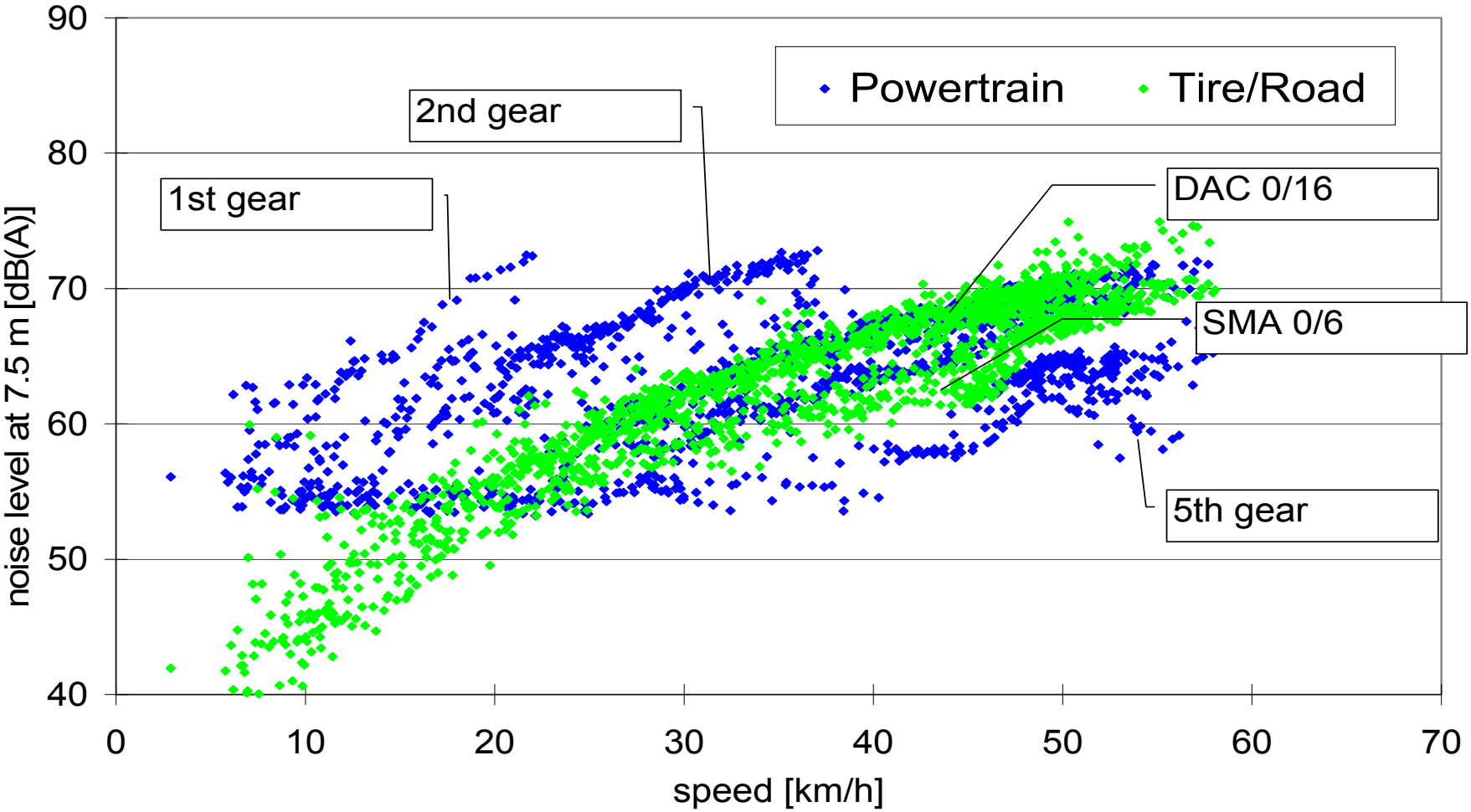
Noise source balance in line with Leq during normal urban driving

# Summary: What has changed?

- Change over from empahasis on powertrain to total vehicle test (including the tyres).

- Improved correlation between test result of the vehicle and its contribution to the equivalent sound level (Leq) during normal operation in urban main streets.
  - With respect to ranking of vehicles
  - With respect to noise source contributions
    - Especially tyre/road noise contribution

# Typical noise emission in traffic



# Noise emission depends on

| | Range (dB(A) |
|---|---|
| ***Powertrain*** | |
| Design (van-car; diesel-petrol) | 10 |
| Engine speed (800-4000 rpm) | 20 |
| Engine load (0-100%) | 0-5 |
| ***Tyre*** | |
| Design (tread profile; size) | 10 |
| Vehicle speed (10-70 km/h) | 25 |
| ***Road surface*** | |
| Design | 10 |

# History of noise type approval

- Powertrain
  - ECE R51 since 1982
  - EU since 1970
- Tyres
  - ECE R117 since 2005
  - EU since 2001
- Road surfaces
  - None international
  - scarce national (eg. Netherlands since 2001)

# History

- 1982: R51.01
  - Focus on powertrain
  - Simulation of “worst case event”
    - WOT in 2nd and 3rd gear at 50 km/h start speed
    - Engine load
      - 100%
    - Engine speed
      - 60-80%
  - Tyre-road noise: as low as possible

- 1988: interim lowering of limits by 3-4 dB(A)

# History (cont)

- 1995: R51.02
  - Retain focus on worst case powertrain noise
  - Further 3-4 dB(A) lowering of limit values
  - Tyre-road noise: further specified to keep as low as possible
    - Road surface: ISO 10844
      - Very smooth
      - Dense surface
      - Effectively -3(±1) dB(A) compared to normal surface
    - Tyre: allowance to use worn tyres (qualifier slicks)

# History (cont.)

- 1995-2000 Various evaluations of effect of vehicle noise regulations (e.g.: International-INCE working group)
  - Trucks significant effect
  - Cars
    - Spread in noise has been reduced
    - No big effect on Leq
  - Reasons for lag of effect:
    1. No regulation of tyre/road noise
    2. Limit values not very strict in the beginning
    3. Inertia effect: old vehicles stay in traffic for long time
    4. Trend to buy bigger (noisier) vehicles (SUV, delivery van, wide tyres, diesel)
    5. Measurement method vehicles not sufficient realistic (e.g. trucks are tested without load)

# History (cont)

- 1999: ACEA proposal
  - basis for R51.03 Annex 3
  - bring measurement method R51 more in line with normal urban operation
- 2001: EU tyre noise directive 2001/43
- 2005: ECE R117 tyre noise regulation
- 2005: GRB New informal group ASEP

# R51.02 Operation on the test track

- Example
  - passenger car, petrol, compact class, 5 speed manual gearbox
- Preparation:
  - ISO 10844 test track (specified road surface and dimensions)
  - Measurement equipment
    - 2 sound level meters
    - Speed measuring device (eg radar)
    - Light barriers at AA' and BB' (and PP')
  - check which is lowest speed: 50 km/h or 3/4 S in 2nd gear
- Operation
  - Approach speed 50 km/h
  - Depress accelerator at line AA' in 2nd gear
  - Depress accelerator at line AA'in 3rd gear
- Measure
  - Lmax
  - Vehicle speed at AA' (to be 50 km/h)
- Final result
  - Average of Lmax in 2nd and 3rd gear

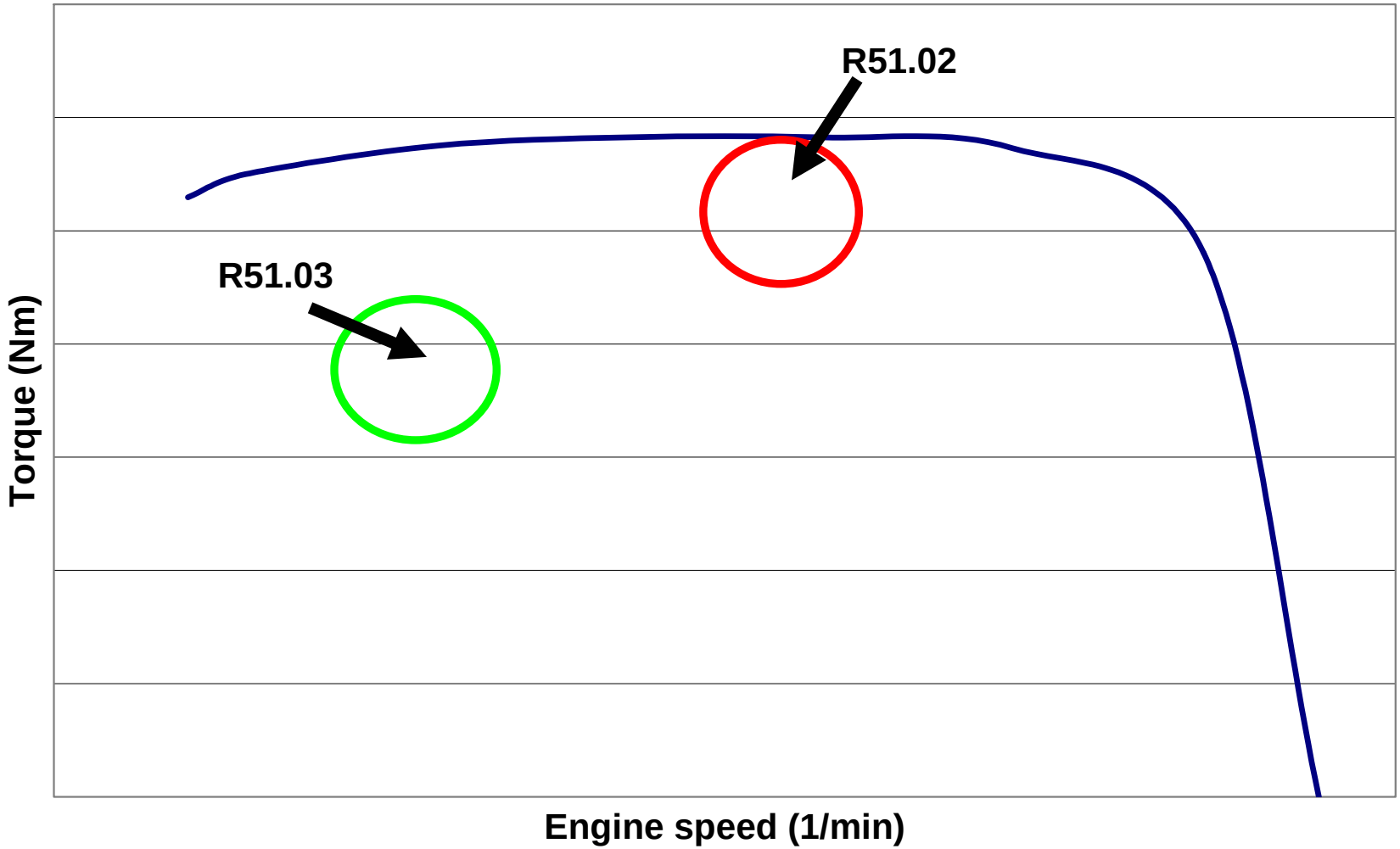
# R51.03 Operation on the test track (1)

- Example 1
  - passenger car, petrol, compact class, 5 speed manual gearbox
- Preparation:
  - ISO track and layout as in R51.02
  - Measurement equipment as in R51.02 (sound level meters, radar and light barriers)
  - Power (40 kW) declared by manufacturer
  - Test mass (1025 kg) to be measured
  - Calculate PMR (39 kW/t) and a,WOTref (1,12 $m/s^2$) and a,urban (0,92 $m/s^{2)}$
  - Check on tyres: full tread depth and type/size as released by veh. manufacturer
- Measure
  - Lmax
  - Vehicle speed
  - Acceleration (from V at AA' and BB' and/or PP')
- Operation
  - Approach speed: to be found by operator (probably 43-46 km/h)
  - Point of depressing accelerator: to be declared by manufacturer (0-10 m before AA')
  - Seek for
    - 50 km/h on line PP' and
    - Gear in which a,WOTtest is closest to a,Wot
  - Depending on the a,WOTtest 1 or 2 gears have to be measured at WOT acceleration;
    - Eg $3^{rd}$ gear (aWOTtest = 1,36 $m/s^2$) $4^{th}$ gear (aWOTtest = 1,0 $m/s^2$)
  - The same gears have to be measured cruising at 50 km/h
- Final result
  - Average of 4 Lmax values according to formulas and depending on a,WOTtest
    - In this example 66% of $4^{th}$ gear and 33% of $3^{rd}$ gear
    - In this example 82% of WOT and 18% of cruise

# R51.03 Operation on the test track (2)

- Example 2
  - passenger car, petrol, sports car, 5 speed manual gearbox
- Preparation:
  - ISO track and layout as in R51.02
  - Measurement equipment as in R51.02 (sound level meters, radar and light barriers)
  - Power (150 kW) declared by manufacturer
  - Test mass (750 kg) to be measured
  - Calculate PMR (200 kW/t) and a,WOTref (2,25 $m/s^2$) and a,urban (1,36 $m/s^{2)}$
  - Check on tyres: full tread depth and type/size as released by veh. manufacturer
- Measure
  - Lmax
  - Vehicle speed
  - Acceleration (from V at AA' and BB' and/or PP')
- Operation
  - Approach speed: to be found by operator (probably 40-45 km/h)
  - Point of depressing accelerator: to be declared by manufacturer (0-10 m before AA')
  - Seek for
    - 50 km/h on line PP' and
    - Gear in which a,WOTtest is closest to a,Wot
  - Depending on the a,WOTtest 1 or 2 gears have to be measured at WOT acceleration;
    - Eg 3rd gear (aWOTtest = 2,9 $m/s^2$); 4th gear (aWOTtest = 2,2 $m/s^2$); 5th gear (aWOTtest = 1,8 $m/s^2$)
    - In principle 3rd and 4th should be used (aWOTref is between aWOTtest of 3rd and 4th gear)
    - However skip 3rd and 4th gear because aWOTtest > 2 $m/s^2$: test only 5th gear
  - 5th gear has to be measured cruising at 50 km/h
- Final result
  - Average of 2 Lmax values according to formulas and depending on a,WOTtest
    - In this example 1,36/1,8 =76% of WOT and 24% of cruise

# Changed operation condition in engine map



# Annex 3: the changes (M1-N1)

| | R51.02 | R51.03 |
|---|---|---|

## Principal choices

| | | |
|---|---|---|
| Operation condition represents | Worst case propulsion noise | Leq total vehicle under normal driving behavior |
| Balance noise sources | Focused on propulsion | In line with Leq,urban |

## Consequences

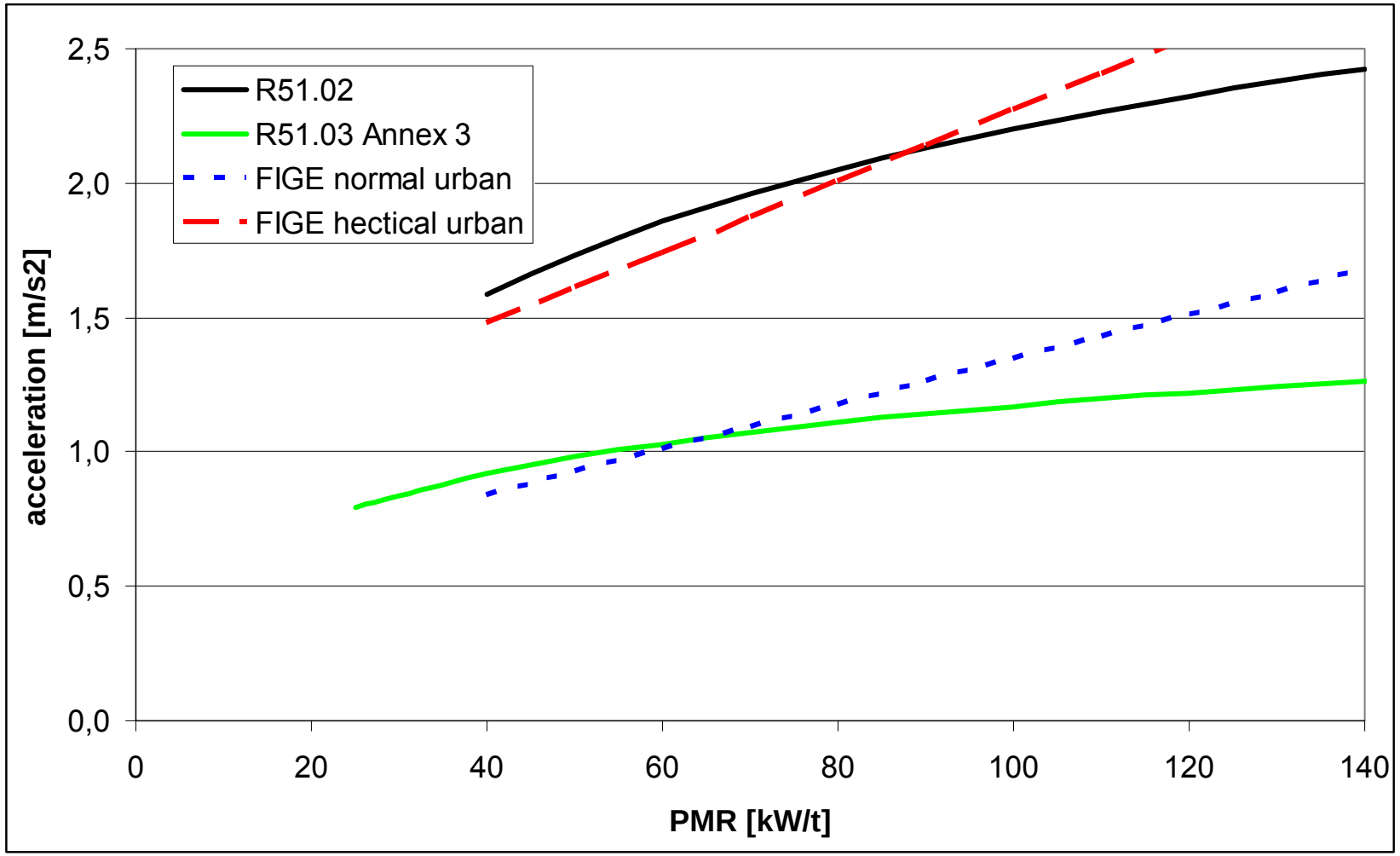
| | | |
|---|---|---|
| Powertrain | | |
| –Engine speed | 50-80% of S | 30-50% of S |
| –Engine load | 100% | 70-90% |
| Tyre | Slick qualifiers allowed | Full tread depth realistic tyres |
| –Vehicle speed | 55 km/h | 50 km/h |
| Road surface | ISO 10844 (-3 dB(A)) | ISO 10844 (-3 dB(A)) |

# Principal choices in constructing R51.03 from urban statistics

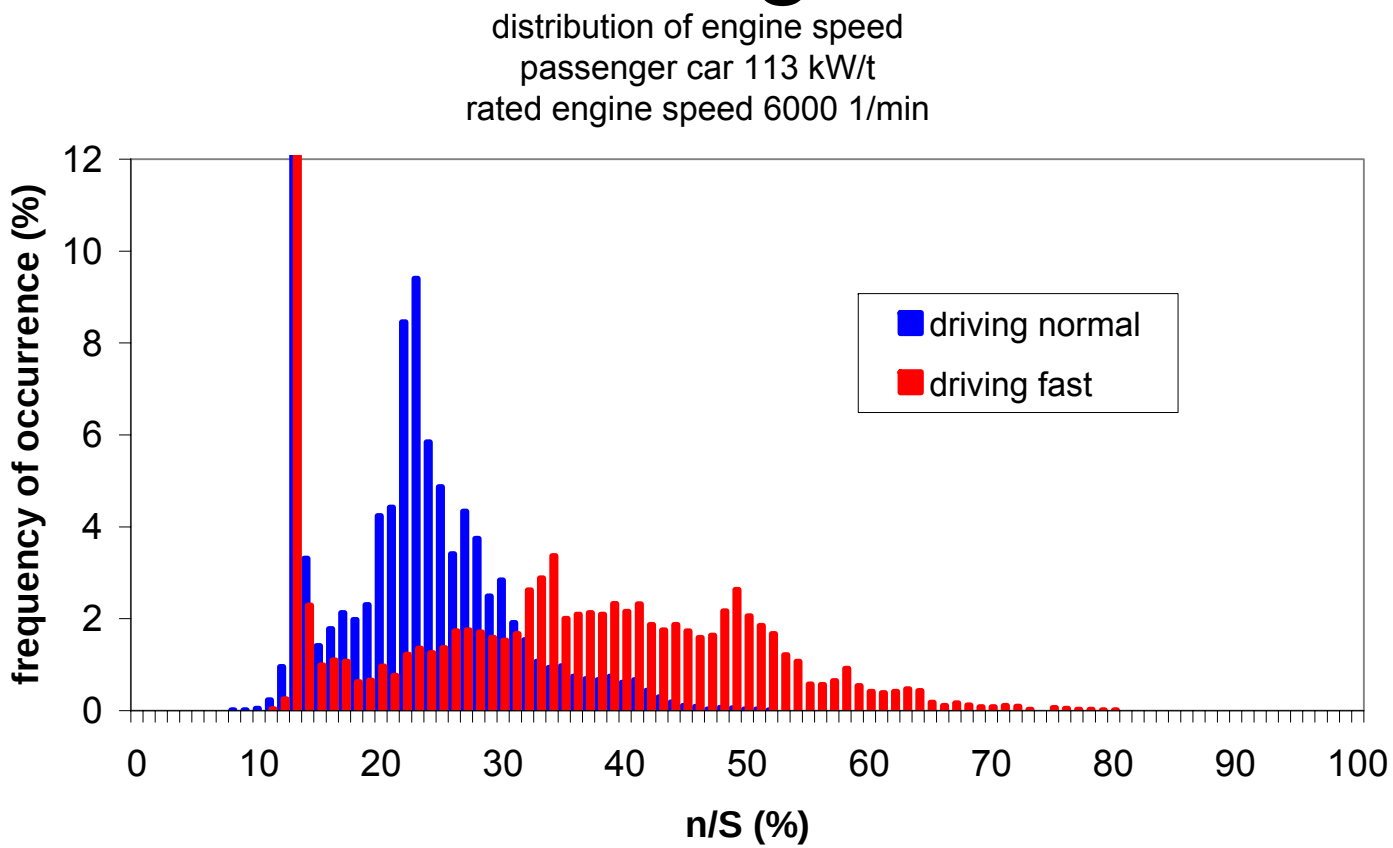
- Simulate normal urban driving behavior
  - 50% of engine speed*
  - 90% of acceleration*
  - 90% of noise emission*
  - Noise source balance in line with Leq*
    (Powertrain versus tyre/road)

* As found in statistics during normal urban driving

# R51.03: Principal choice for normal driving behavior

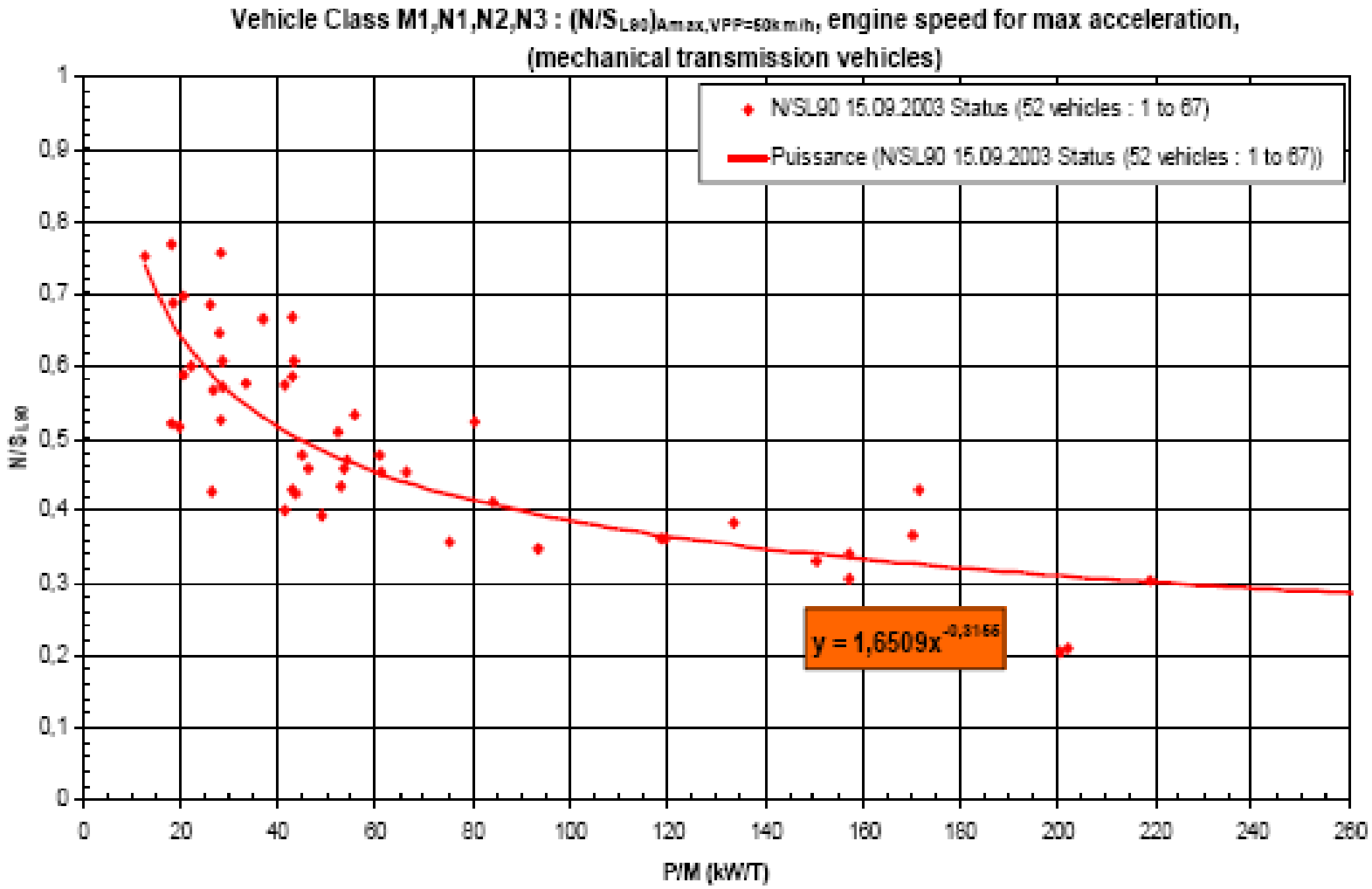


# R51.03: Principal choice for normal driving behavior




- Shift in driving behavior leads to shift in engine speed

# Engine speed in R51.03 depends on power/mass ratio



# Noise source balance in line with Leq during normal urban driving

- The combination of
  - Representative, full tread depth tyres
  - 50 km/h
  - ISO test track
  - 50% of engine speed during urban driving

  Leads to a balance between powertrain noise and tyre/road noise which is in line with the Leq during normal urban driving

Thank you for your attention