

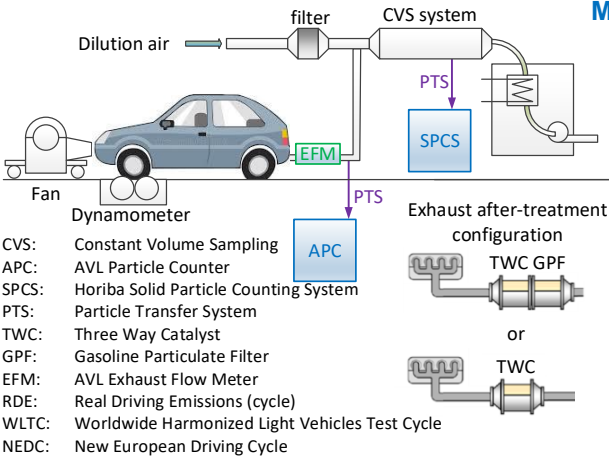
# Solid Particle Number Emissions of Gasoline Direct Injection Vehicles from CVS Versus Raw Exhaust Sampling

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## Introduction & Background

The certification test for determining the Solid Particle Number (SPN) emissions of Gasoline Direct Injection (G-DI) light duty vehicles is conducted by sampling diluted exhaust from a Constant Volume Sampling (CVS) system. Sampling from vehicle's exhaust tailpipe is allowed with Portable Emission Measurement Systems (PEMS), where a Conformity Factor (CF) of 1.5 is considered for the SPN limit, to take account measurement uncertainties of such a sampling method. Differences in the SPN emissions measured at CVS and at the vehicle's tailpipe are evaluated under laboratory conditions. The tests were conducted at three different vehicle benches equipped with CVS tunnels. Two particle counters are employed at each vehicle bench sampling at CVS (considered as reference) and at tailpipe simultaneously. More than 20 cars are tested, equipped with or without Gasoline Particulate Filter.

## Methodology



| Driving cycles       | WLTC | RDE  | NEDC |
|----------------------|------|------|------|
| Duration [s]         | 1800 | 6500 | 1180 |
| Distance [km]        | 23.3 | 87   | 10.9 |
| Average Speed [km/h] | 46.6 | 48.2 | 33.3 |

Figure 1: Experimental setup and abbreviation list

Table 1: Driving cycles

## Results

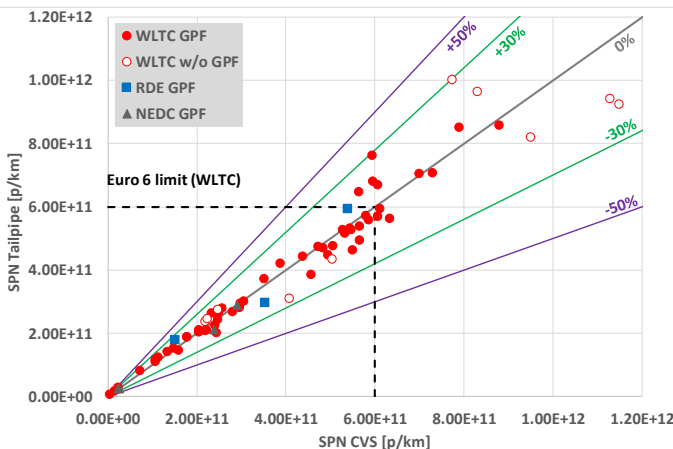


Figure 2: "SPN at CVS (Ref)" vs "SPN at tailpipe"

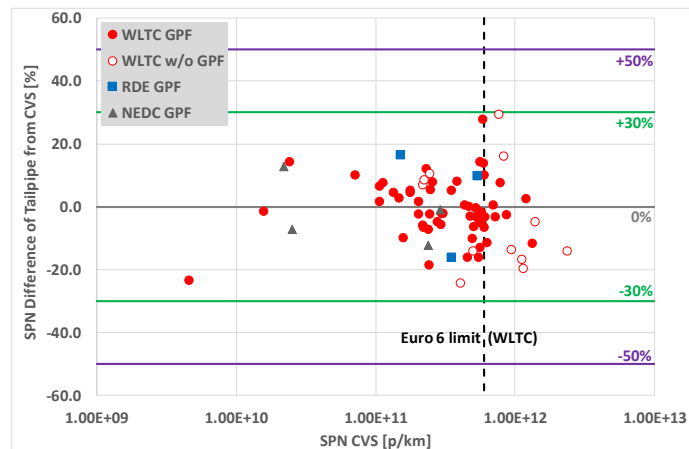


Figure 3: "SPN tailpipe from CVS difference" vs "SPN at CVS"

The SPN differences of CVS vs tailpipe ranged at  $\pm 30\%$  and may be attributed to:

- Different instrument manufacturers (e.g. differences in PTS)
- Different particle losses and particle internal processes (agglomeration, diffusion, thermophoresis) [1]
- Exhaust flow rate uncertainty (3-10% [2]) and signal misalignment

The "tailpipe from CVS difference" is not dependent on the emission level, since no visible trend of the "SPN difference" was identified on the absolute SPN result.

The CF of 1.5 can be employed, irrespective of the vehicle's SPN emission levels.

## Summary

- SPN differences CVS vs tailpipe were found to be up to 30%, in line with previous studies (-25 to +50%) [3]
- Different particle losses and flow rate measurement uncertainty may influence the correlation between different sampling locations (CVS vs tailpipe)
- The CF of 1.5 is justifiable solely due to different sampling locations

## References

- [1] Isella L. et al., Aerosol Science 39, 737-758, (2008)
- [2] Varella R.A. et al., Appl. Sci. 8, 1633, (2018)
- [3] Giechaskiel B. et al., JRC Report EUR 27451 EN, (2015)