DIESEL VEHICLE WITH ULTRA-LOW NOx EMISSIONS ON THE ROAD

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RDE requirements ensure that emissions are controlled over wider range of conditions
SAE INTERNATIONAL

On-road emissions of Euro 6d-Temp cars are well within standards

RDE legislation has significantly improved real-world NOx emissions

Source: PEMS results from ACEA and JAMA RDE database
Objective: demonstrate consistent low NOx emissions

Challenging driving conditions

- Low speed/load
e.g. city driving

- High speed/load
e.g. motorway driving

- Transients
e.g. overtaking

![Image of cars in city and on motorway]

![Diagram showing tailpipe NOx emissions vs. average vehicle speed/load]

Majority of EU driving conditions

Pre-RDE

RDE benefit

Euro 6d

Demonstrator

Type Approval in lab

Low

Average vehicle speed/load

High

Tailpipe NOx (mg/km)

High

Low
• Concept: Emissions control technologies combined in integrated system approach

• Tailpipe emissions measured
  – NOx
  – PM & PN
  – THC & CO
  – NH₃

• Conclusions
Base vehicle and powertrain characteristics

- **Vehicle**
  - C-segment
  - 1700 kg

- **Drivetrain**
  - Manual gearbox, 6-speed
  - 48 Volt mild-hybrid (belt-driven, P0)

- **Engine**
  - 1.5l, 4-cylinder, 2-valve
  - EGR: uncooled HP and cooled LP

- **Euro 6b type approval (LNT + DPF)**
Emissions control technologies and system architecture

- LNT + dual-SCR to cover wide range of driving conditions
- Model-based SCR control

EGR: Exhaust Gas Recirculation
HP/LP: High/Low pressure
cc: close-coupled
LNT: Lean NOx trap
SCR: Selective Catalytic Reduction
DPF: Diesel Particulate Filter
SDPF: SCR on DPF
uf: underfloor
ASC: Ammonia Slip Catalyst
Robust NOx control across wide range of driving conditions
Robust NOx control in the city

- Consistent low NOx achieved, including on challenging Berlin and Transport for London (TfL) tests
- 80% improvement due to refined calibration
  - LNT regeneration stabilisation
  - Active thermal management

![Graph showing urban NOx emissions and cumulative NOx](image)
Particulate emissions controlled by SDPF under all driving conditions.
THC & CO emission well within standards on WLTC and RDE

- Remain below 50 mg/km on WLTC and RDE
- Increase on TfL due to impact of thermal management (optimisation was outside programme scope)
• NH₃ slip control implemented
  – Model-based calculation of NH₃ load
  – Benefit of dual-SCR with twin-urea injection
    • Separate control of NH₃ load for each SCR
    • Presence of underfloor SCR allows higher target NH₃ load for cc SCR+SDPF
  – Ammonia slip catalyst converts remaining NH₃
• Illustration for RDE test
  – Higher target NH₃ load for SDPF compared to underfloor SCR
  – NH₃ slip from SDPF is used on underfloor SCR

Tailpipe NH₃ slip controlled below 10 ppm on RDE
Conclusions

- RDE requirements have ensured better control of NOx emissions under real-world driving conditions.

- This demo car shows that diesel NOx emissions can be kept at a very low level in a consistent way, over a wide range of driving conditions.

- This is achieved by combining existing catalyst technologies with improved emissions control functions supported by hybrid technology.
Thank you

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