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Characterization of Nanoparticles from a 2010-Type Heavy-Duty Diesel Engine

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Zurich, August 2005

Outline

- Introduction of the APBF* Project
- Description of Emission Control System
- Regulated Emissions Results
- Nanoparticle Emissions Characterization
- Conclusion

* *Advanced Petroleum Based Fuels - Diesel Emissions Controls*



Introduction of the APBF Project

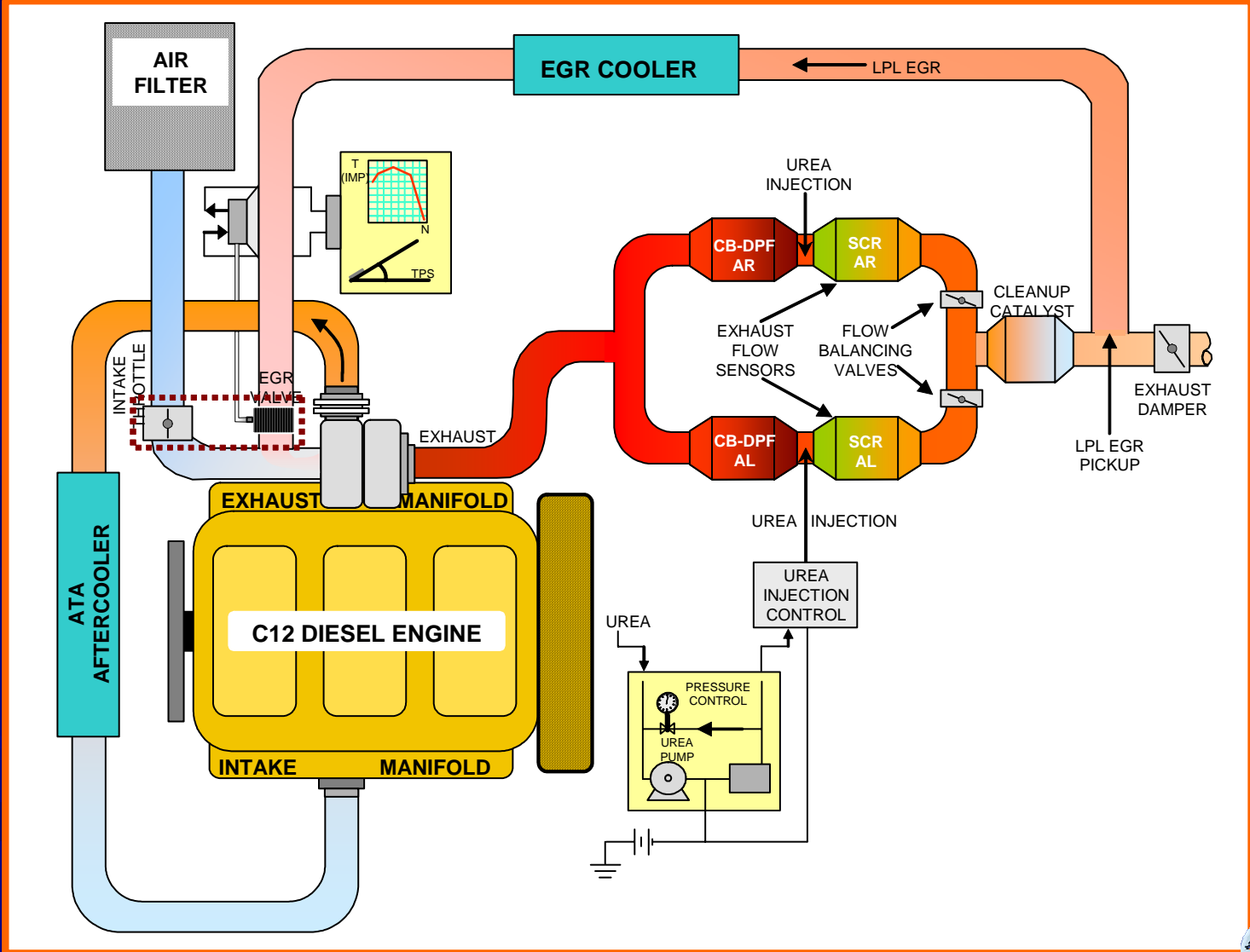
- Sponsored by the US Dept. of Energy
- Contributions by EMA*, MECA**, Other Suppliers
- Objective 1: to develop a 2010-Like Emission Control System (ECS) for a Heavy-Duty Engine Based on EGR, SCR, & CDPF technologies
- Objective 2: to Evaluate Effect of Fuel Sulfur
- Objective 3: to Evaluate the Durability of the ECS

* *Engine manufacturers Association*

** *Manufacturers of Emission Controls Association*

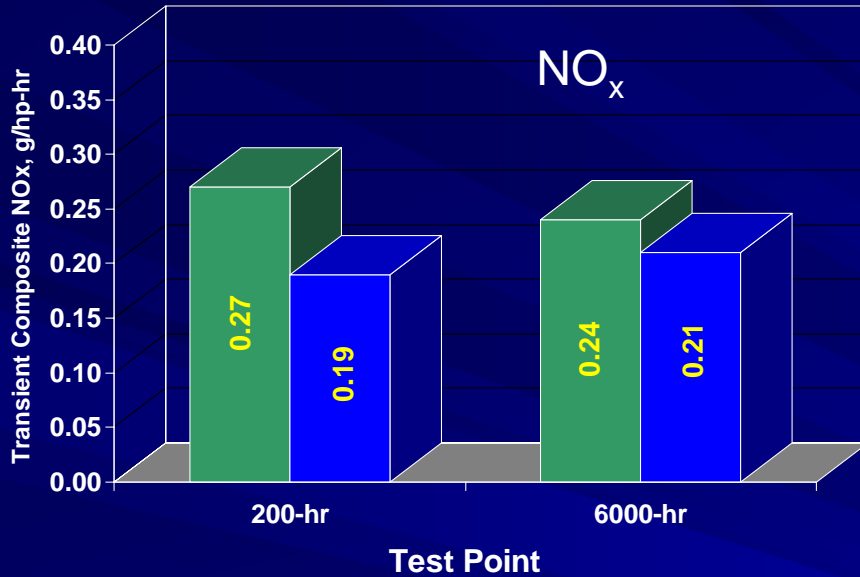


Description of Emission Control System

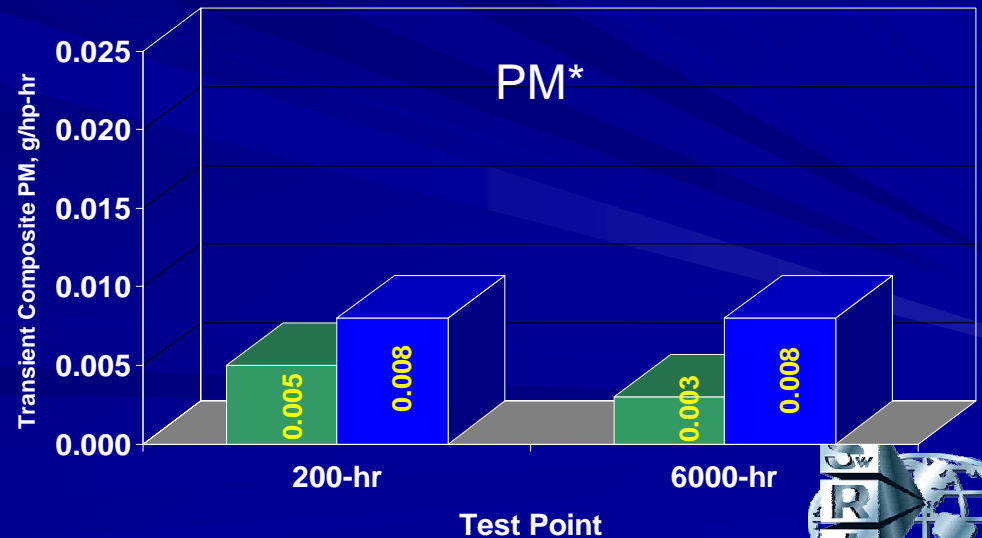


Regulated Emissions Results – Before & After Aging

APBF-DEC Heavy-Duty SCR Project



Legend: ■ Transient ■ ESC

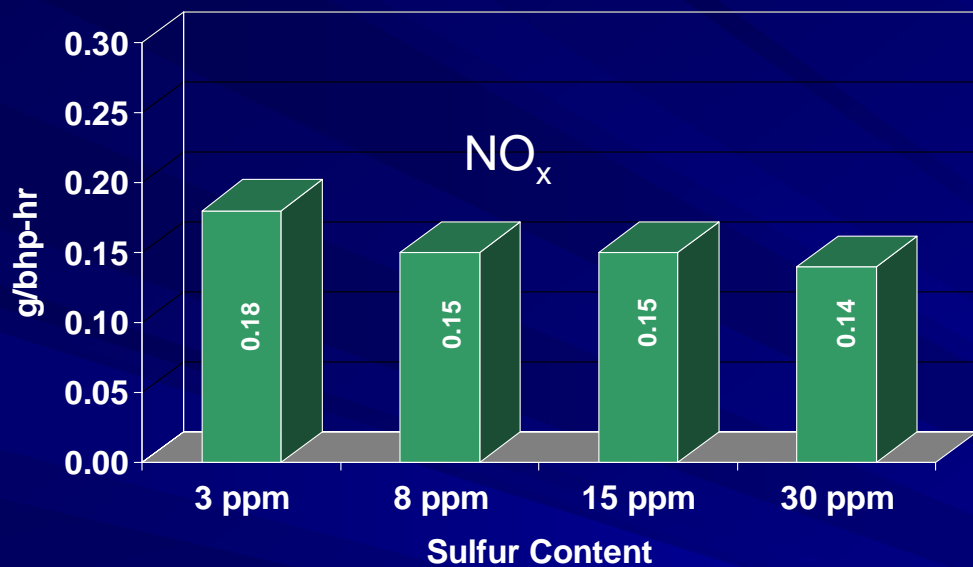


* *Pre-2007 Type Filter Measurement*

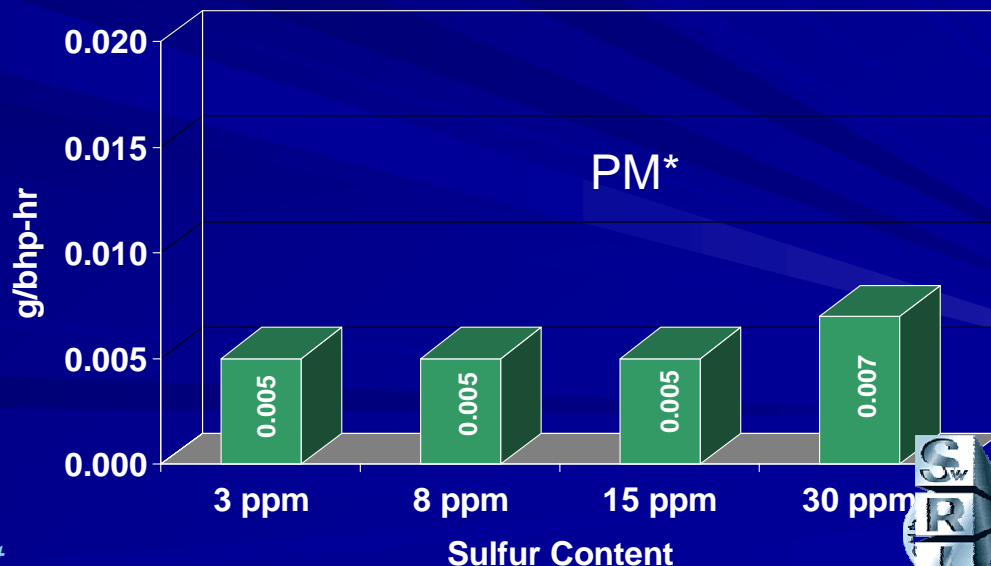


Regulated Emissions Results

(Sulfur Effects – After Initial Calibration)



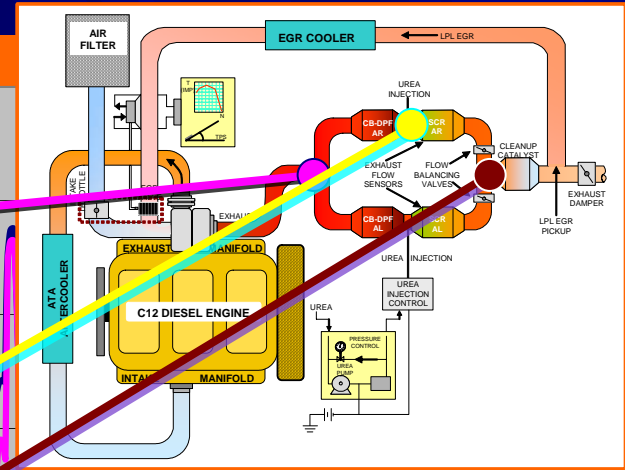
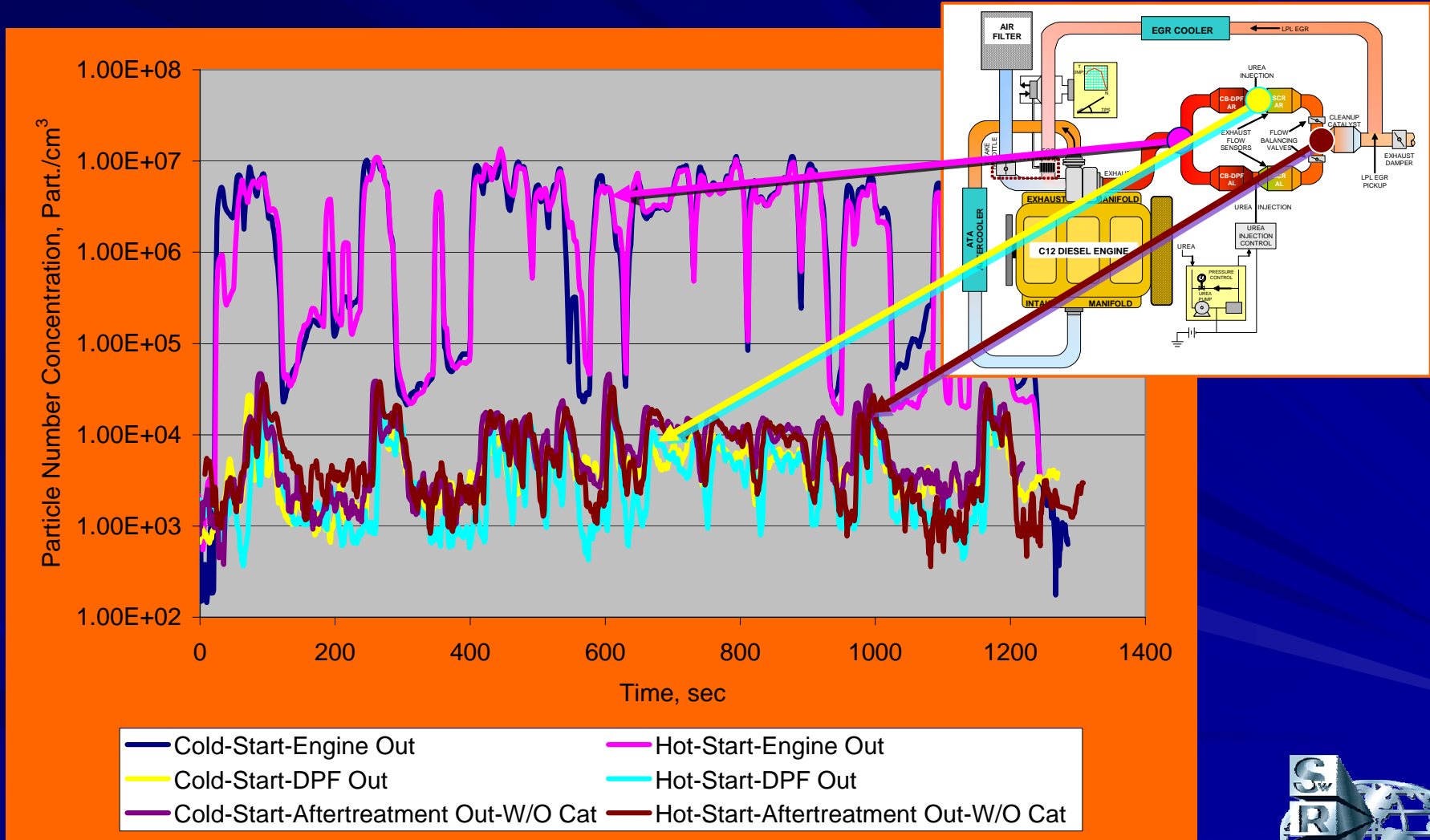
APBF-DEC Heavy-Duty SCR Project



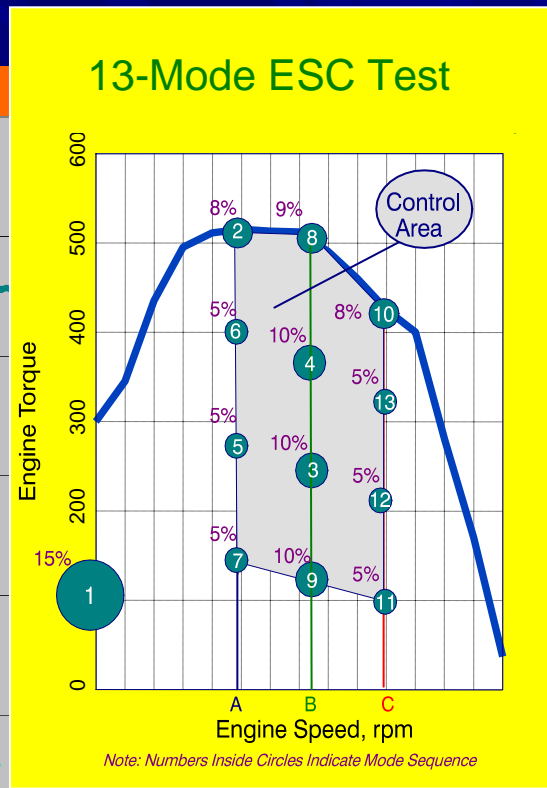
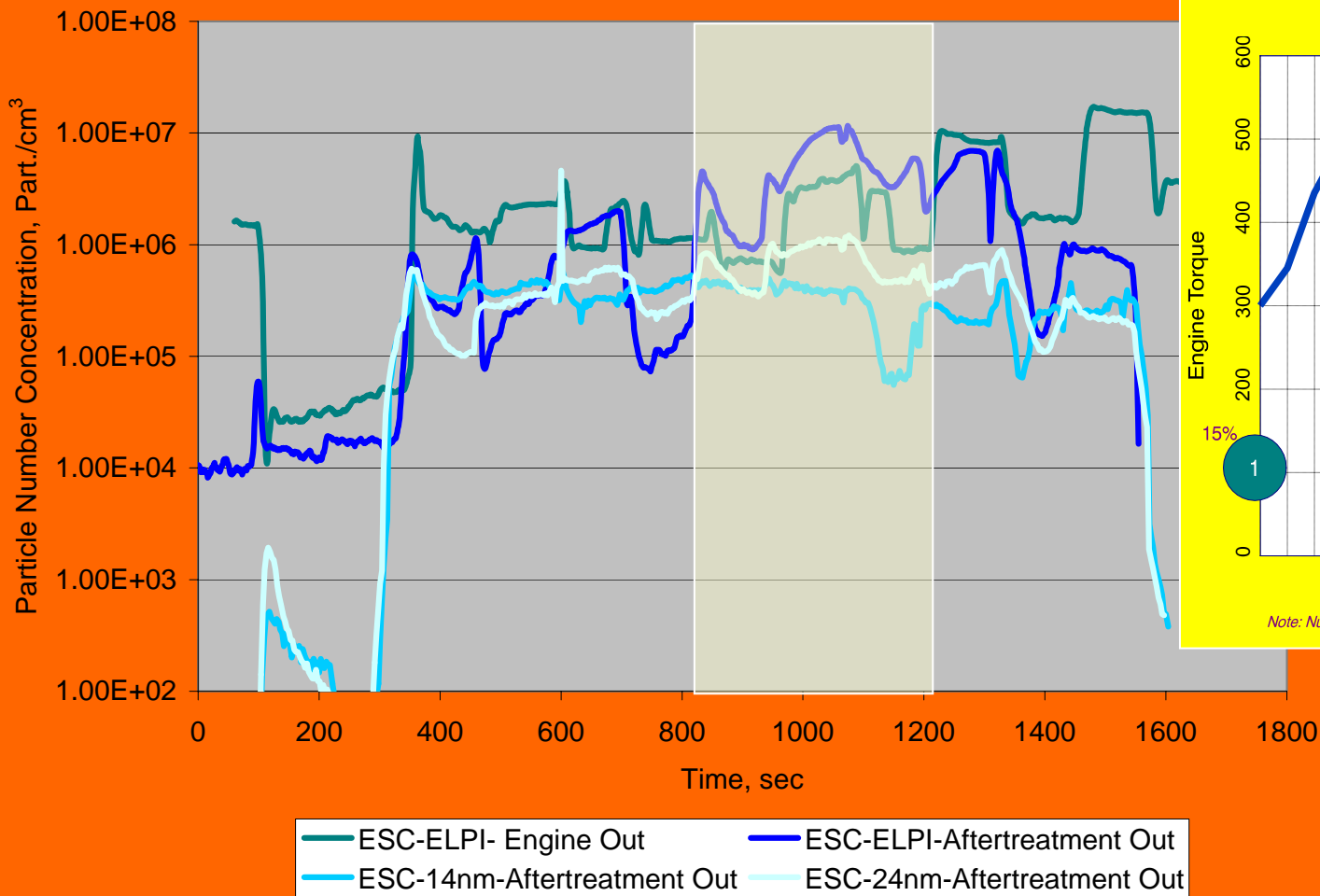
* Pre-2007 Type Filter Measurement



Engine- & Aftertreatment-Out Number Concentration Profile During the FTP *Transient* Cycle (8 ppm Sulfur)

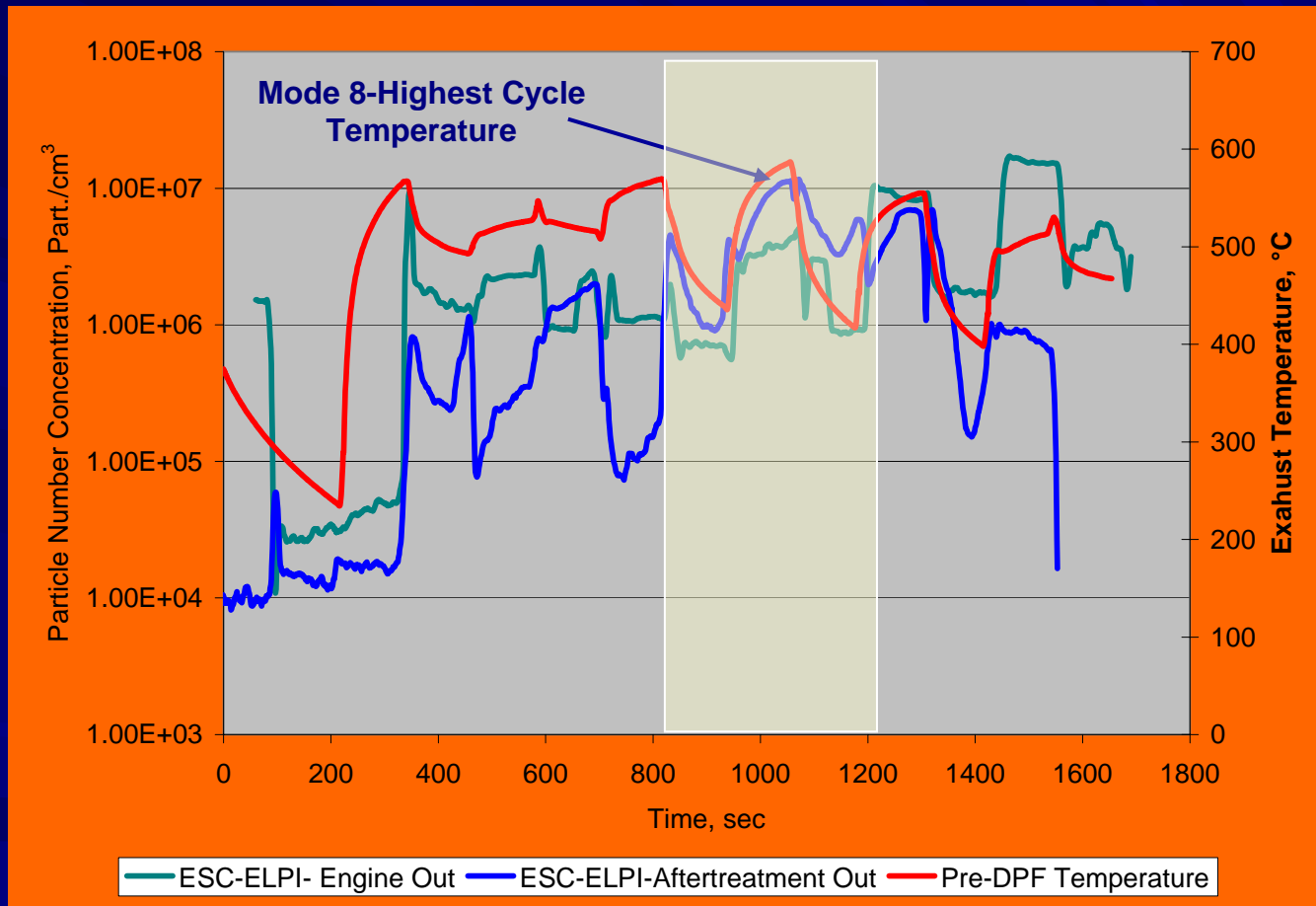


Engine- & Aftertreatment-Out Number Concentration Profile During the *ESC* Cycle (8 ppm Sulfur)

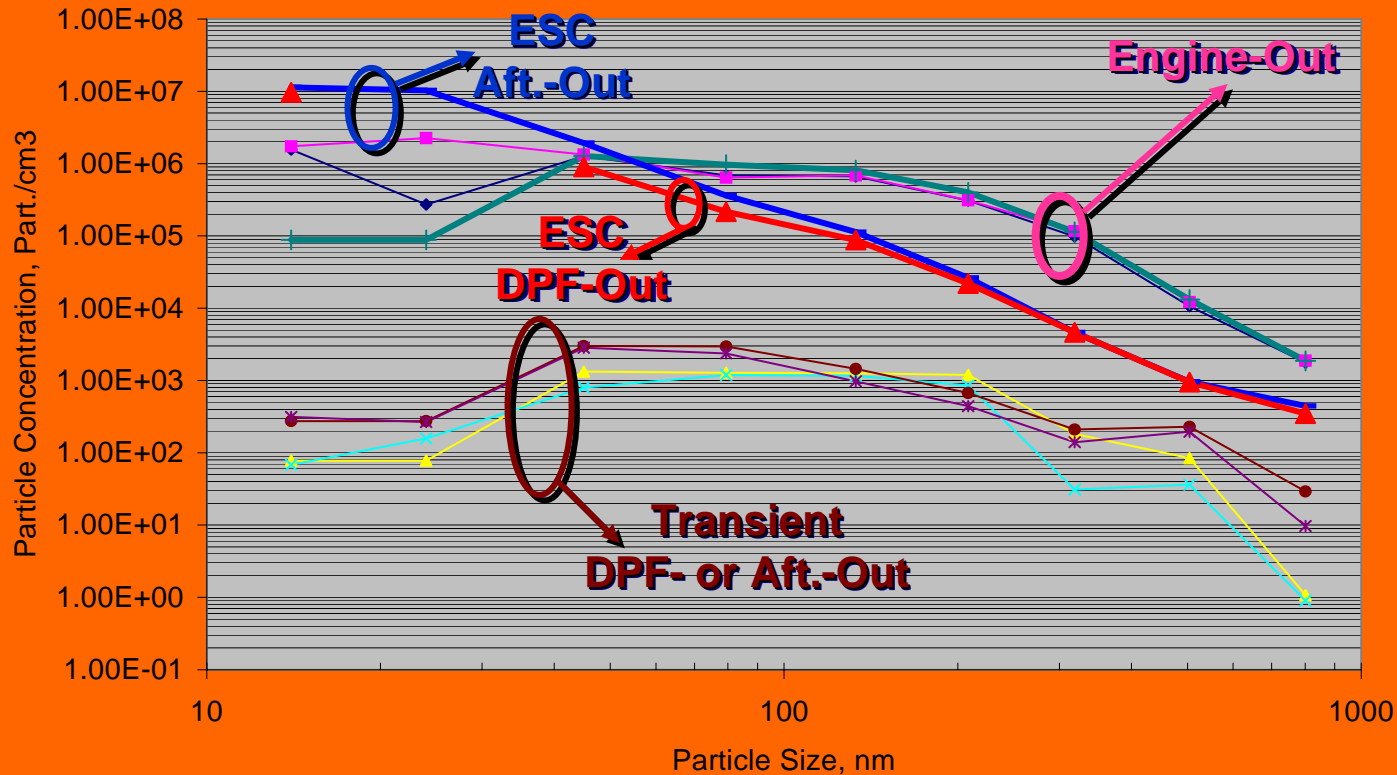


Relationship Between T_{exh} & Particle Number Concentration

(8 ppm Sulfur)



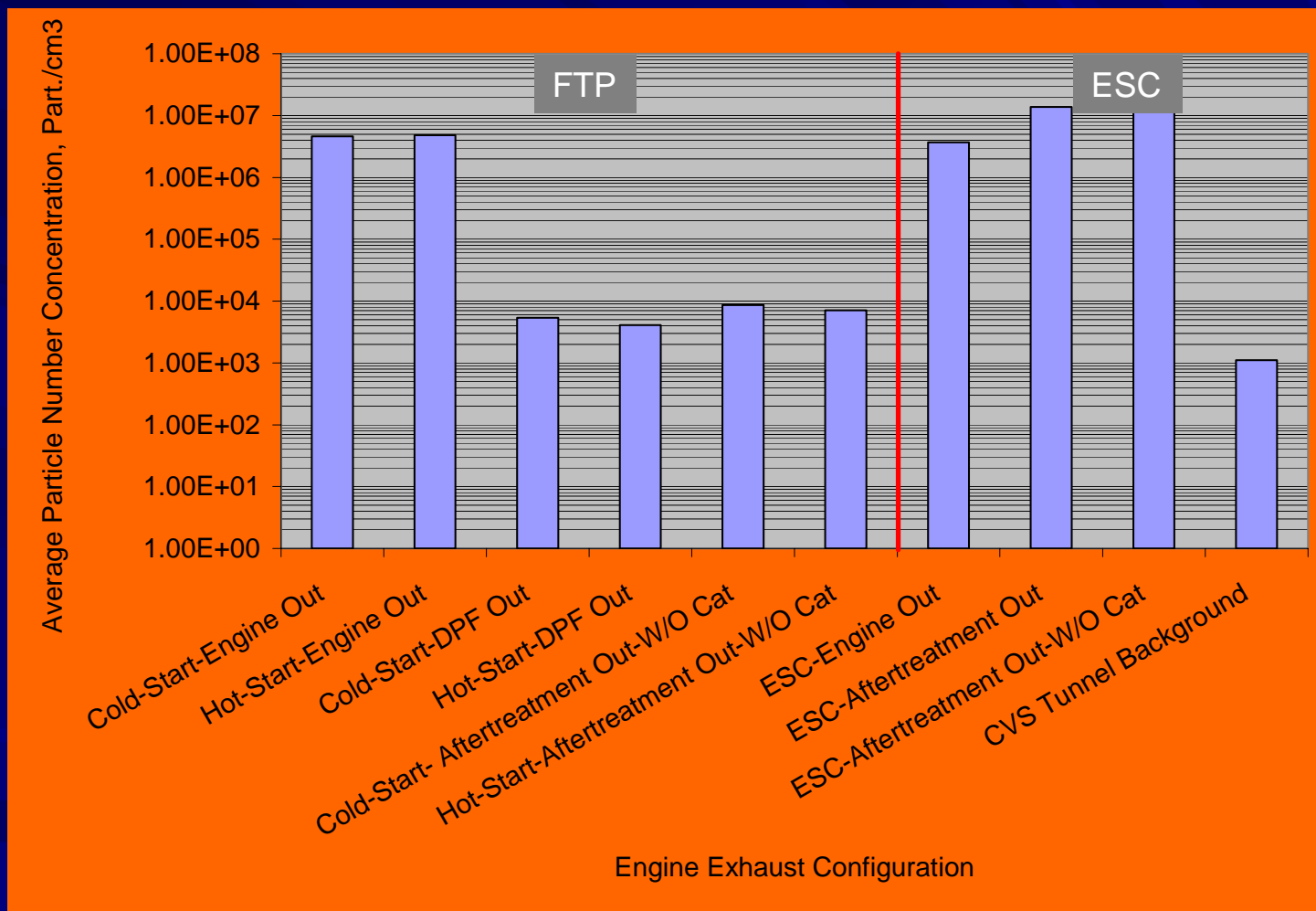
Engine- & Aftertreatment-Out Size Distribution for the FTP and ESC (8 ppm Sulfur)



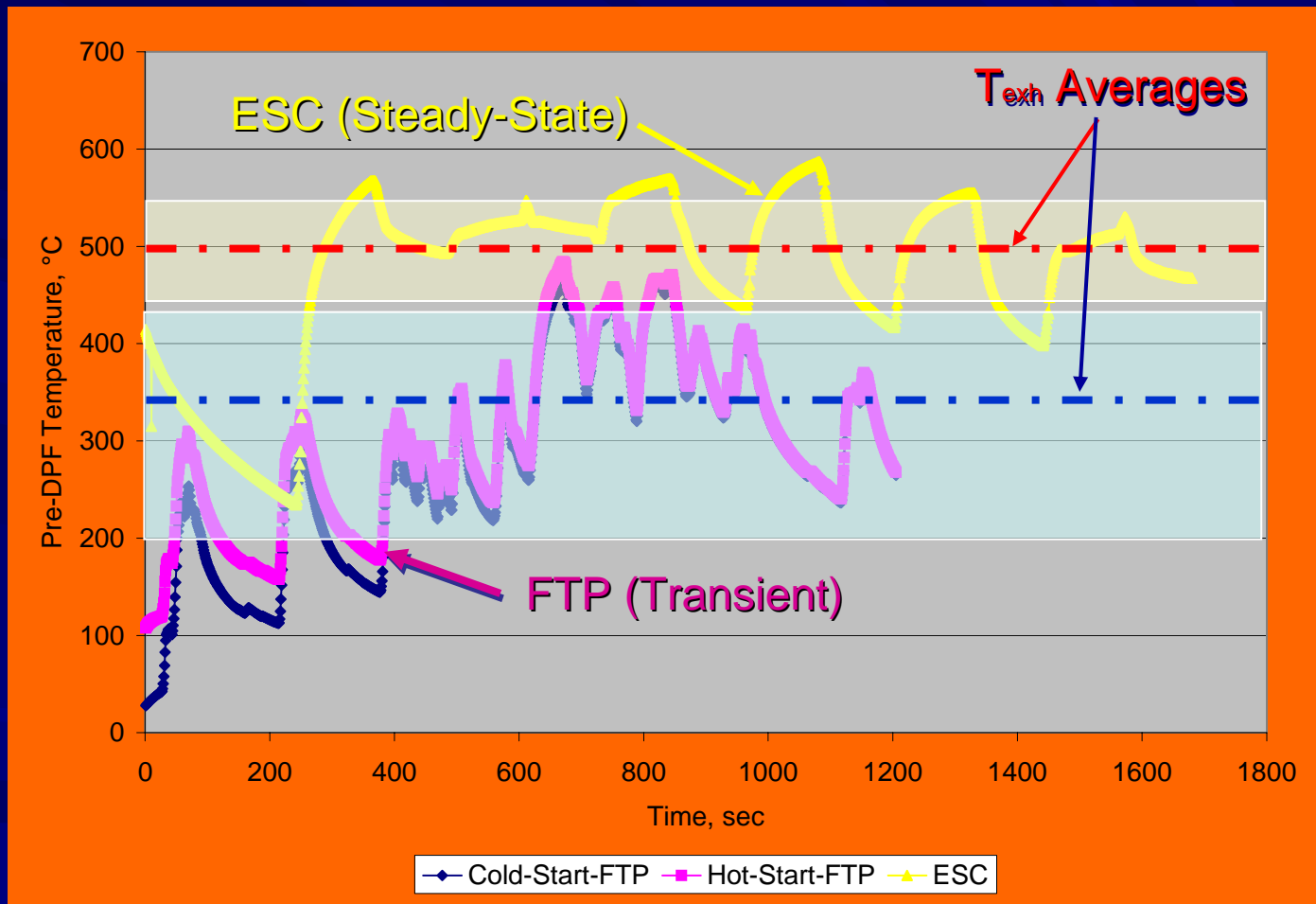
- | | | |
|-------------------------|--------------------------|--------------------------------|
| ◆ Cold-Start-Engine Out | ◆ Hot-Start-Engine Out | ▲ Cold-Start-DPF Out |
| × Hot-Start-DPF Out | ● Cold-Start-DPF Out | * Hot-Start-Aftertreatment Out |
| + ESC-Engine Out | — ESC-Aftertreatment Out | ▲ ESC-DPF Out |



Engine- & Aftertreatment-Out Average Total Number Concentration for the FTP and ESC (8 ppm Sulfur)



Pre-Trap Temperature Profile for FTP and ESC Cycles



Conclusions

- Particle number emission is close to ambient concentration downstream of Aftertreatment during the FTP transient cycle.
- Significant number of nanoparticles is emitted downstream of Aftertreatment during the ESC.
- Average particle number concentration for Engine-out during ESC is similar to the average particle number concentration at DPF exit.
- The Higher Temperature of the ESC, compared to the FTP, is likely responsible for the formation of sulfate nanoparticles downstream of DPF.

