Urea SCR Durability Assessment for Tier 2 Light-Duty Truck

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Research and
Advanced Engineering

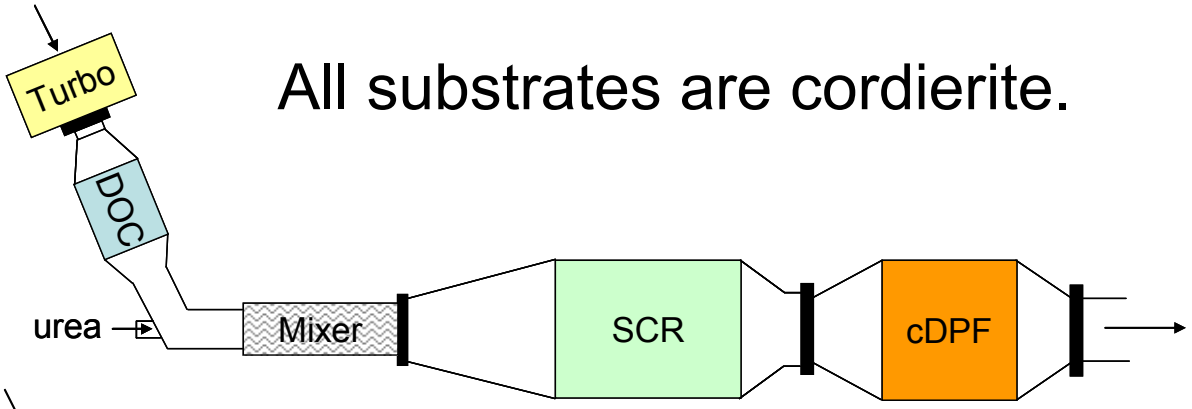
Program Objectives

- Develop **Tier 2/LEV II Urea SCR/DPF systems** for chassis-certified, light-duty diesel trucks

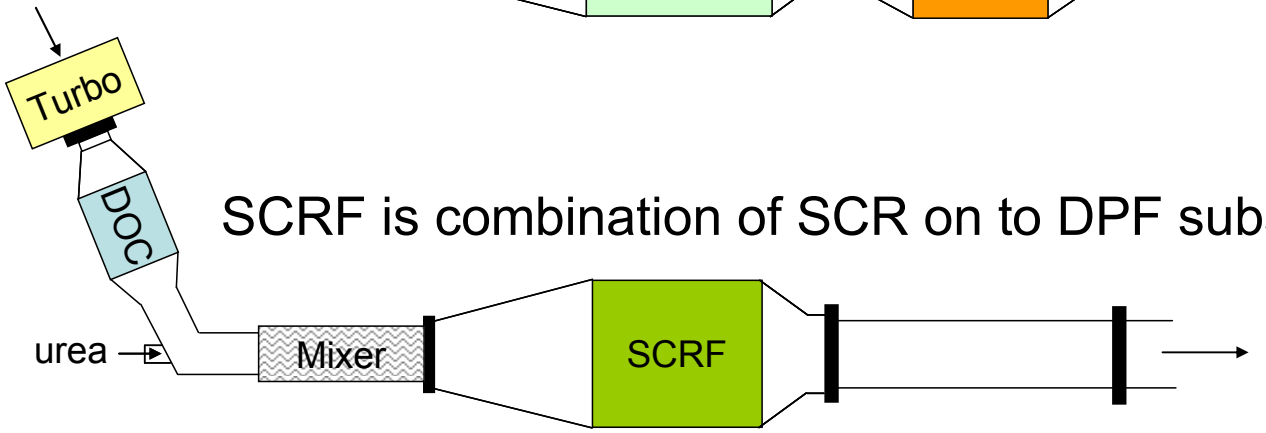
	50k mi Standards					120k mi Standards				
[g/mi]	NO_x	PM	CO	NMOG	HCHO	NO_x	PM	CO	NMOG	HCHO
Tier 2 Bin 5	**0.05**	**---**	**3.4**	**0.075**	**0.015**	**0.07**	**0.01**	**4.2**	**0.09**	**0.018**
LEV II, ULEV	**0.05**	**---**	**1.7**	**0.04**	**0.008**	**0.07**	**0.01**	**2.1**	**0.055**	**0.011**
Tier 2 Bin 2	---	---	---	---	---	0.02	0.01	2.1	0.01	0.004
LEV II, SULEV	---	---	---	---	---	0.02	0.01	1.0	0.01	0.004

- **Calibration** of surrogate EU3 2.7L European LR3 diesel vehicles for US test cycles (FTP-75 and US06)
- **Mileage accumulation** up to 50,000 miles with periodic emission measurements

Exhaust System Configurations



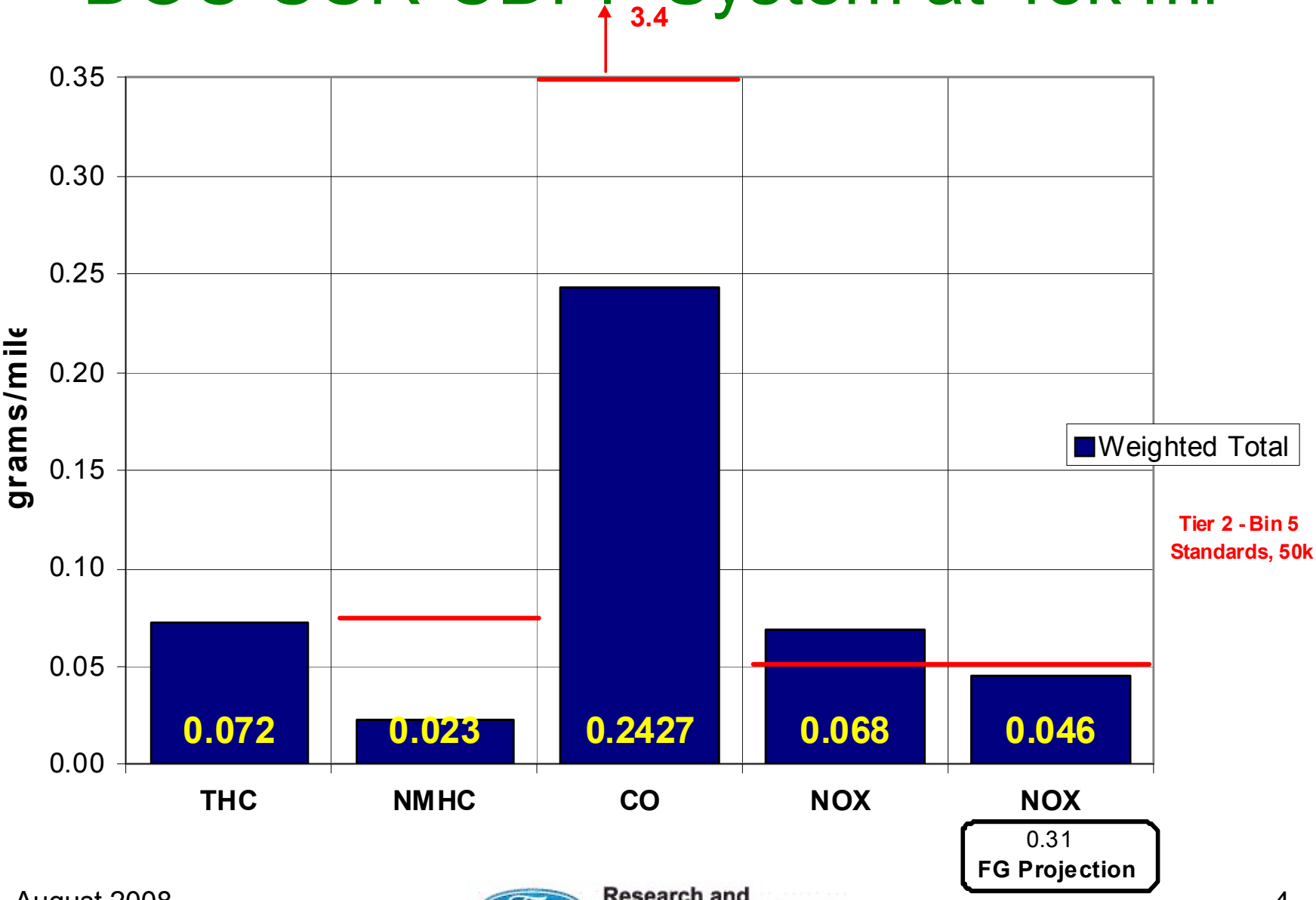
All substrates are cordierite.



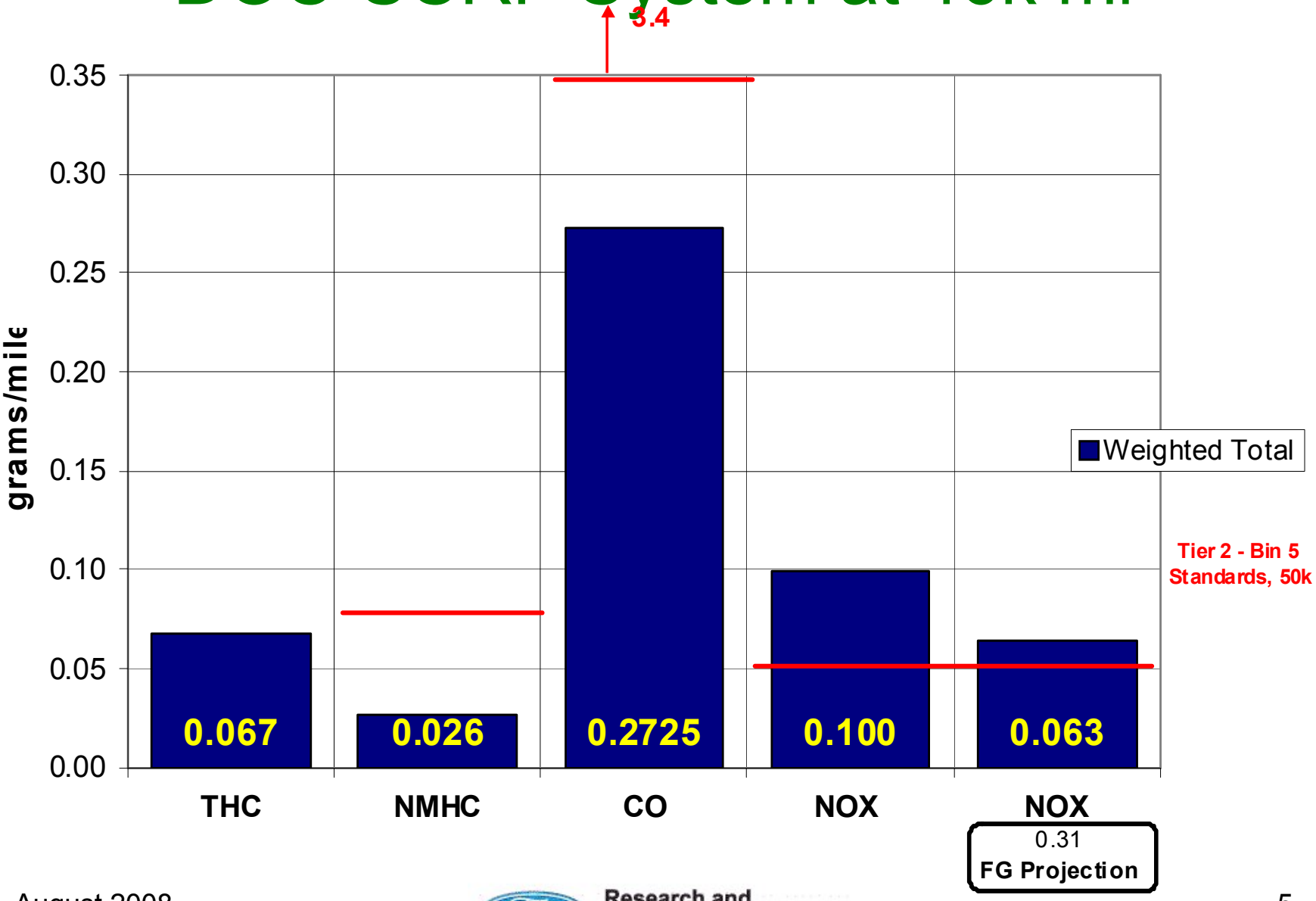
SCRF is combination of SCR on to DPF substrate

Advantages:
- reduced cost
- reduced complexity

DOC-SCR-CDPF System at 48k mi



DOC-SCRF System at 46k mi



NMHC Results Summary

			NMHC Efficiency		
System	**Supplier**	**Type**	**4k**	**20-25k**	**40-50k**
1	A	DOC-SCR-CDPF	**99.0%**	**99.1%**	**98.7%**
2	B	DOC-SCR-CDPF	**99.4%**	**99.1%**	**98.1%**
3	B	DOC-SCRF	**99.4%**	**98.9%**	**--**
4	A	DOC-SCRF	**99.1%**	**98.9%**	**98.2%**

Note: Highest TP NMHC value for EU4 LR3 was ~0.03 g/mile on FTP (std 0.075)

CO Results Summary

			CO Efficiency		
System	**Supplier**	**Type**	**4k**	**20-25k**	**40-50k**
1	A	DOC-SCR-CDPF	**98.4%**	**98.5%**	**96.4%**
2	B	DOC-SCR-CDPF	**98.0%**	**97.1%**	**95.2%**
3	B	DOC-SCRF	**98.5%**	**98.4%**	--
4	A	DOC-SCRF	**97.7%**	**96.4%**	**95.8%**

Note: Highest TP CO value for EU4 LR3 was 0.27 g/mile on FTP (std 3.4)

NO_x Results Summary

			NOx Efficiency		
System	**Supplier**	**Type**	**4k**	**20-25k**	**40-50k**
1	A	DOC-SCR-CDPF	**91%**	**90%**	**87%**
2	B	DOC-SCR-CDPF	**87%**	**86%**	**85%**
3	B	DOC-SCRF	**78%**	**73%**	**--**
4	A	DOC-SCRF	**88%**	**84%**	**80%**

- Lower 4K NO_x efficiency of combined systems is attributed to washcoating on SCRF bricks @ only 60% of WCL on flow-through bricks.
- Best 50k emissions from EU4 vehicle was 0.057 g/mi.

PM Results Summary

			Filtration Efficiency		
System	**Supplier**	**Type**	**4k**	**20-25k**	**40-50k**
1	A	DOC-SCR-CDPF	**99.7%**	**99.4%**	**34%**
2	B	DOC-SCR-CDPF	**99.4%**	**N/A**	**74%**
3	B	DOC-SCRF	**99.7%**	**91%**	**--**
4	A	DOC-SCRF	**99.8%**	**N/A**	**55%**

- Due to aggressive filter regeneration, some loss in filtration efficiency was experienced for both CDPF and SCRF systems

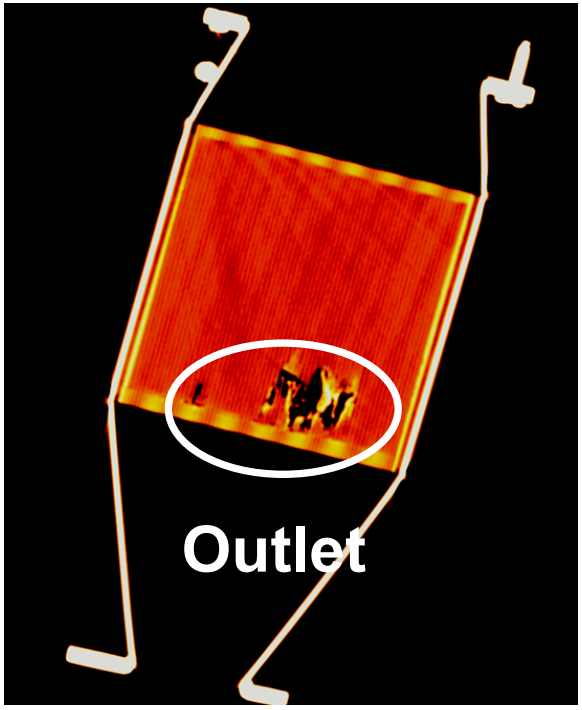
DPF Development Issues

- LR3 fleet was launched with soot loading targets based on lower (~52%) porosity substrates.
  - MSL (maximum soot load) = up to 6.0 g/L.

- EU3 vehicles required aggressive EGR to meet PM targets.
  - Regeneration interval was roughly 350-400 miles.

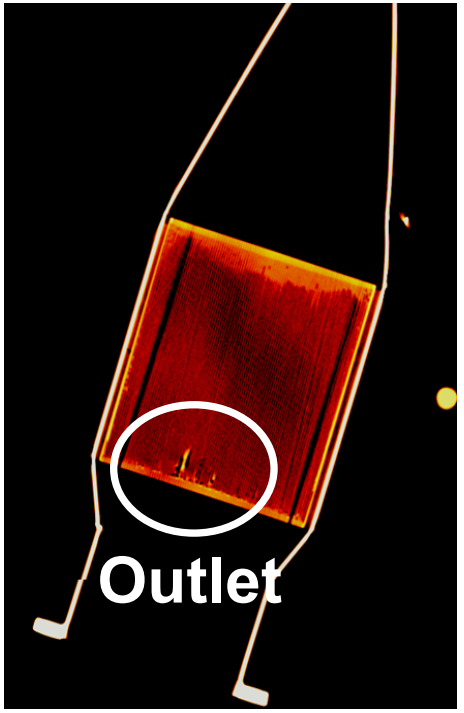
Filter Post Mortem Results

System 1 CDPF at 48k mi



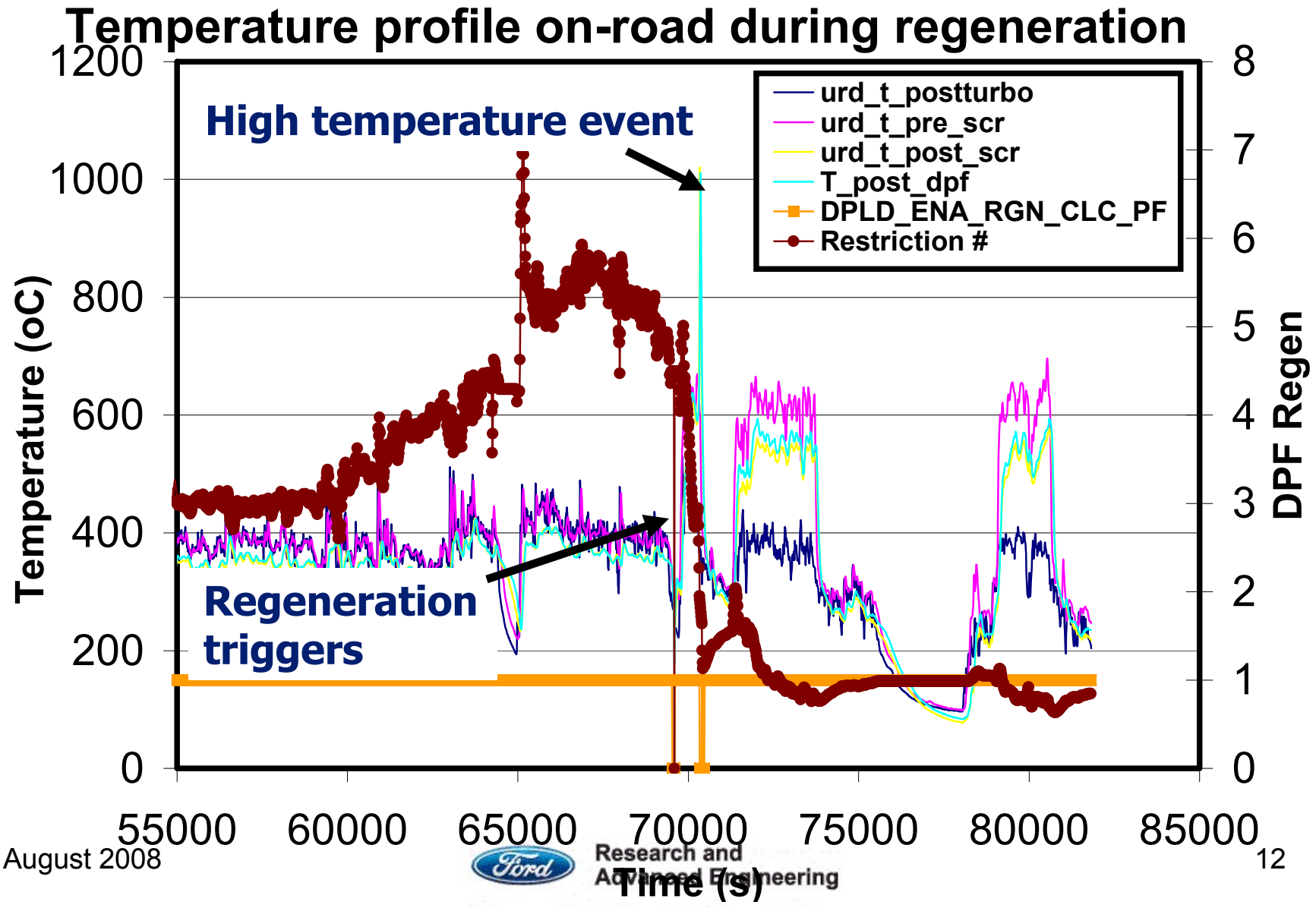
Filtration Efficiency: 74%

System 4 SCRF at 46k mi

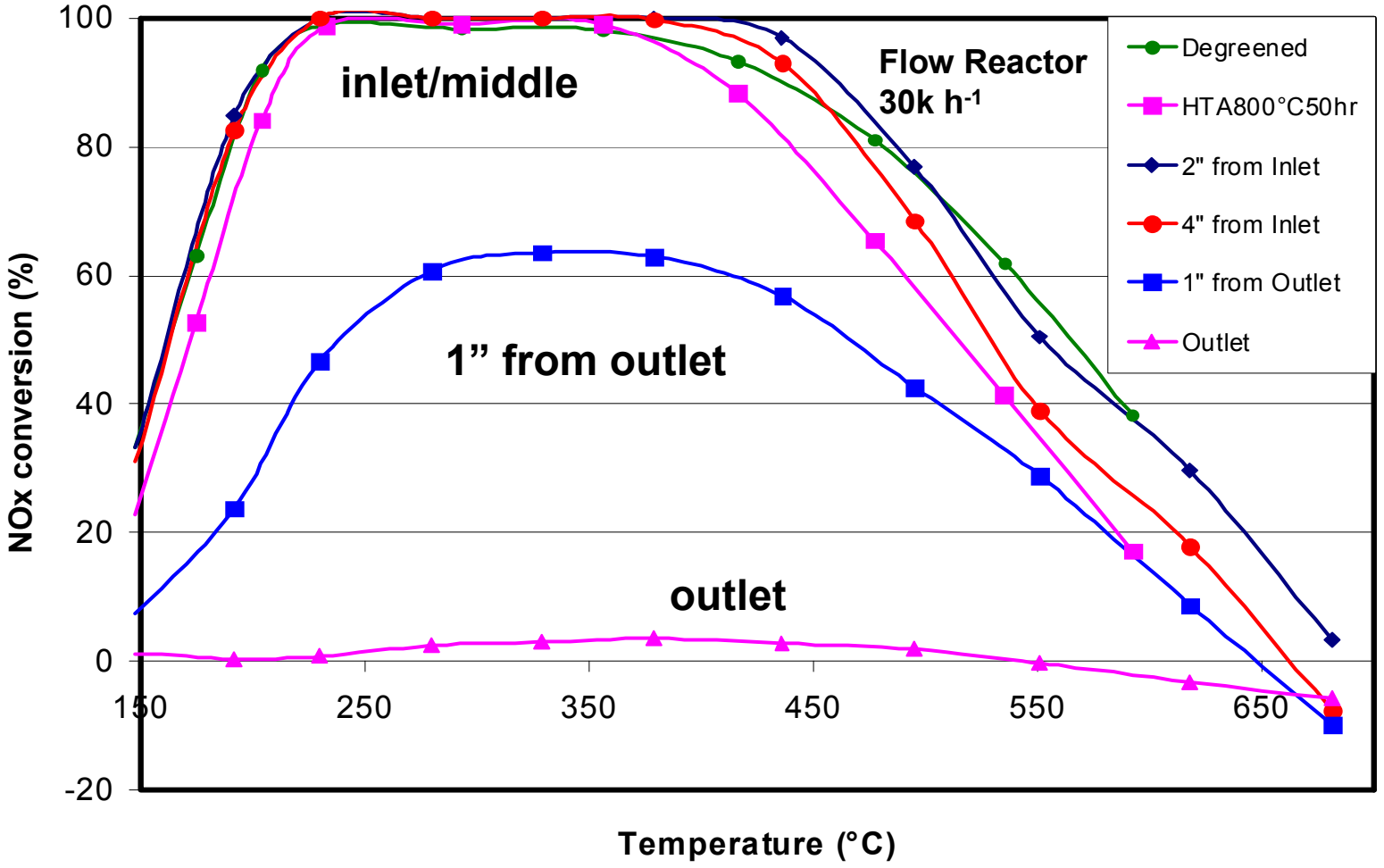


Filtration Efficiency: 55%

System 4 SCRF at 46k mi

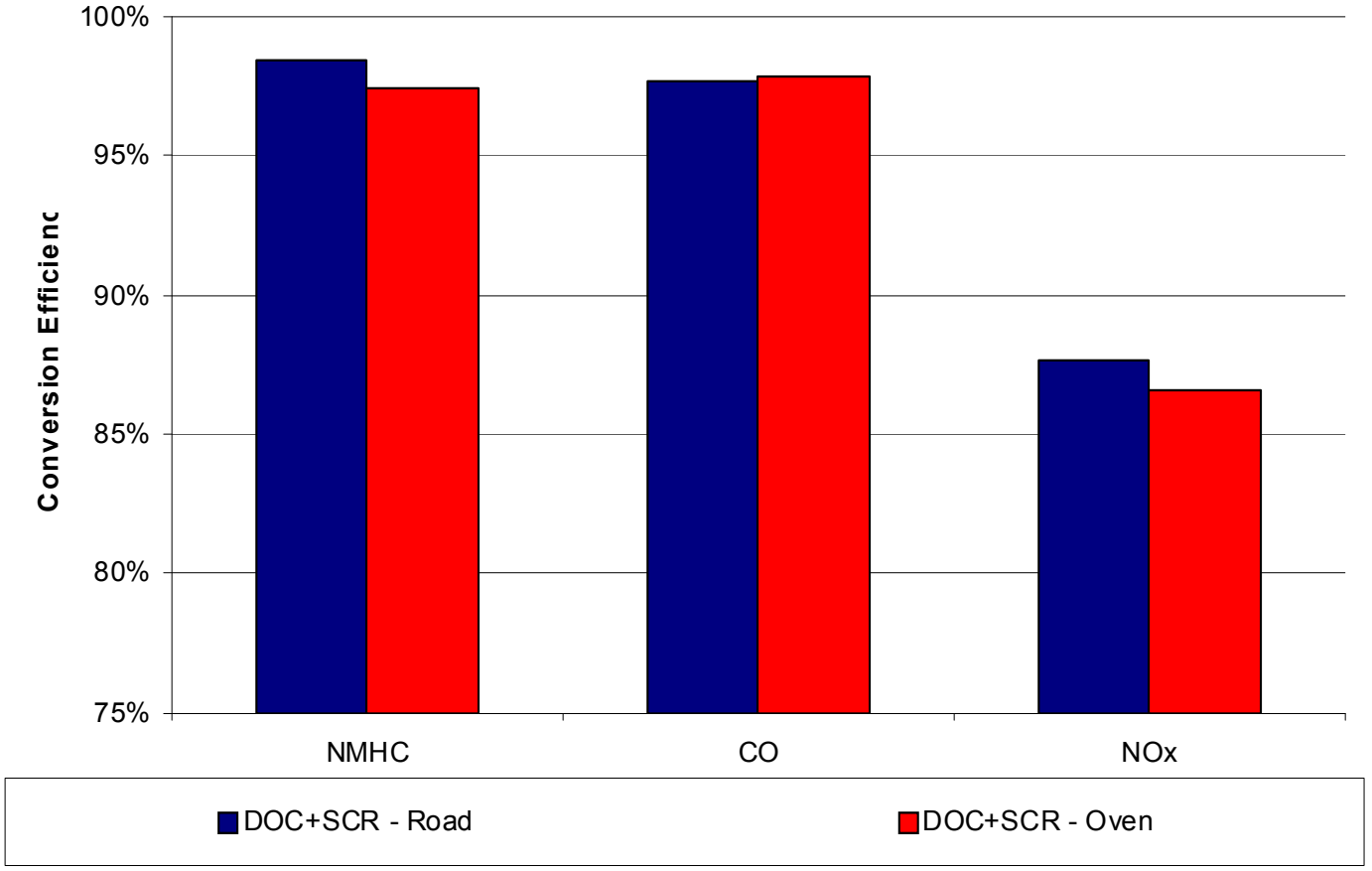


System 4 SCRF at 46k mi



Majority of SCRF remained active for high NOx conversion

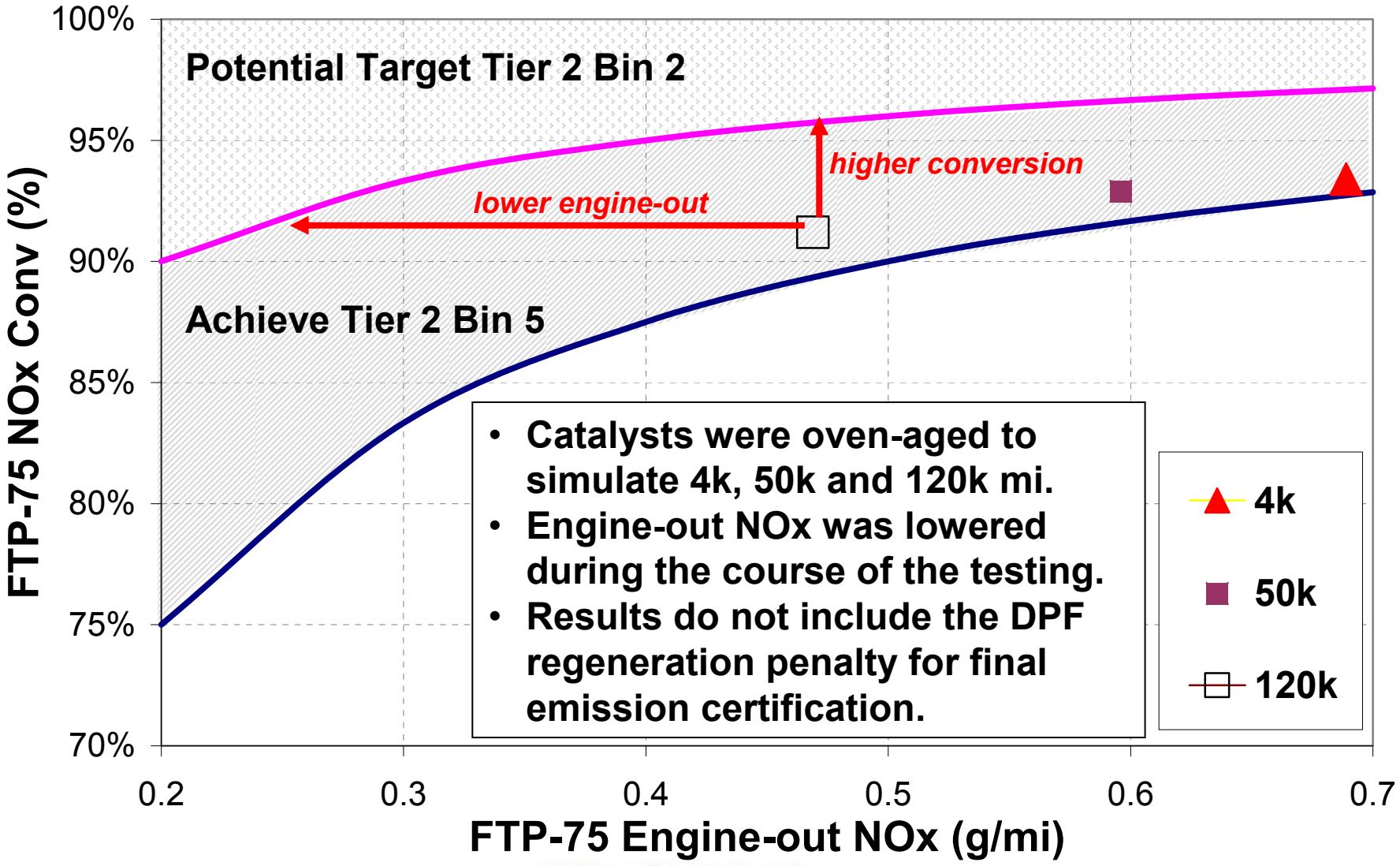
50k mi Aging Correlation



- On-Road 50k mi samples show similar FTP conversion performance as oven-aged 50k equivalent samples.

Potential for T2B2 Diesel

Advanced SCR Concept on LR3 surrogate vehicle



Conclusions

- DOC-SCR-CDPF systems were Tier 2 capable with little deterioration over 50k mi except for PM
- Robust filter regeneration critical for cordierite
- SCRF retained high NOx conversion despite loss in filtration efficiency
- SCRF systems require additional development to achieve full useful life (120,000 mile) T2B5 emissions