



Southwest
Research
Institute™

**APBF-SCR
DEER 2003**

Low Emissions Potential of EGR-SCR-DPF and Advanced Fuel Formulations-*A Progress Report*

**Department of Emissions Research
Automotive Products and Emissions
Research Division**

August 2003

Outline



- ◆ Objectives
- ◆ Technical Approach
- ◆ Major Accomplishments
- ◆ Test Setup
- ◆ Systems A and B
- ◆ Results
- ◆ Summary & Conclusions



Objectives

- ◆ To Demonstrate Low Emissions Performance of Advanced Diesels+LPL EGR*+Urea SCR+DPF (2 Different Systems)
- ◆ To Evaluate Sensitivities of The Control System Performance To Fuel Variables
- ◆ To Determine The Regulated And Unregulated Emissions W. &W/O Emission Controls
- ◆ To Examine The Emission Control System Durability
- ◆ To Sample Toxic Emissions For Analysis By Outside Lab

Emissions Goals: 2007 EPA NDE Standards



** Low Pressure Loop EGR*

Outline

◆ Objectives



◆ Technical Approach

◆ Major Accomplishments

◆ Test Setup

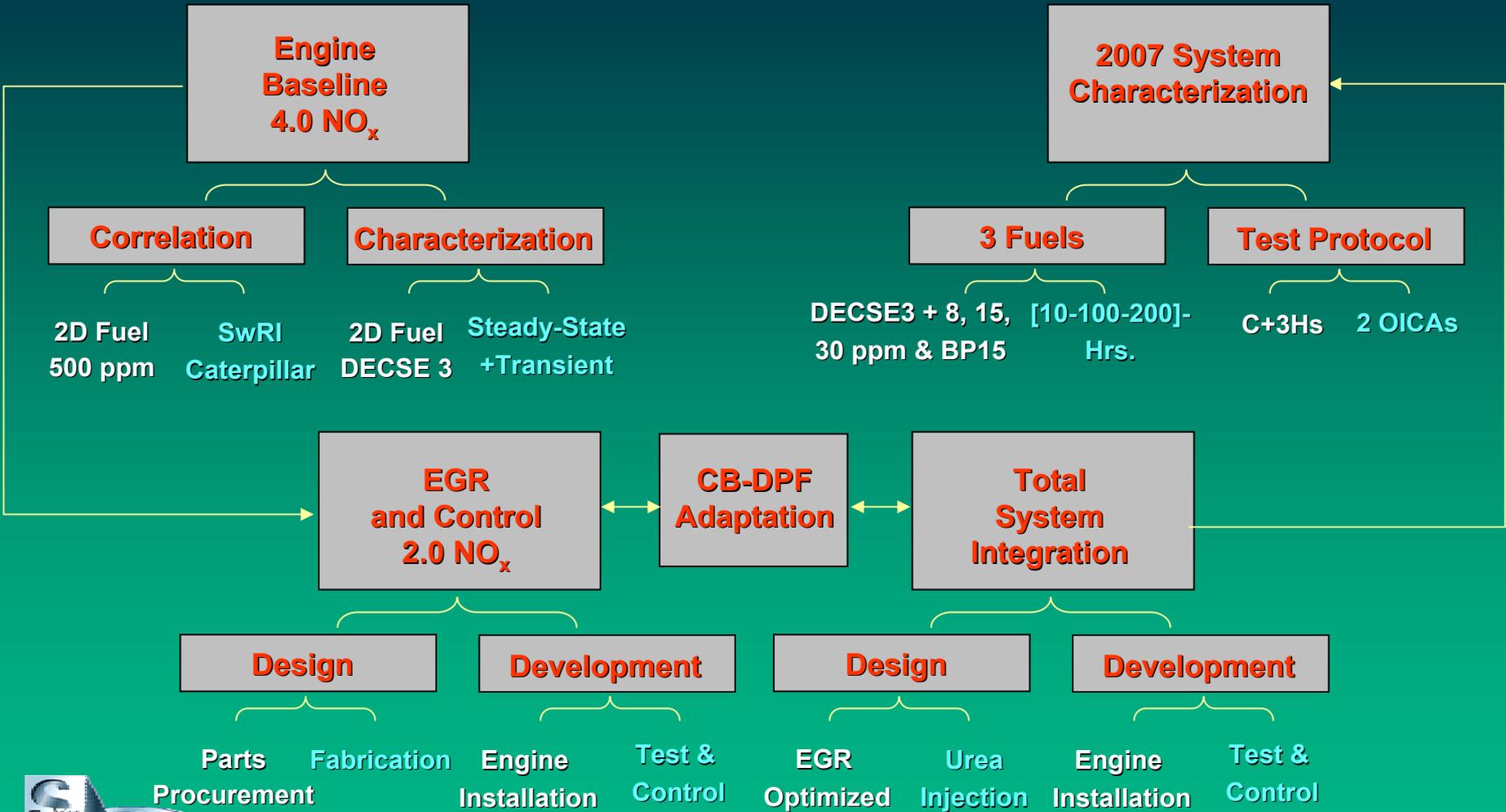
◆ Systems A and B

◆ Results

◆ Summary & Conclusions

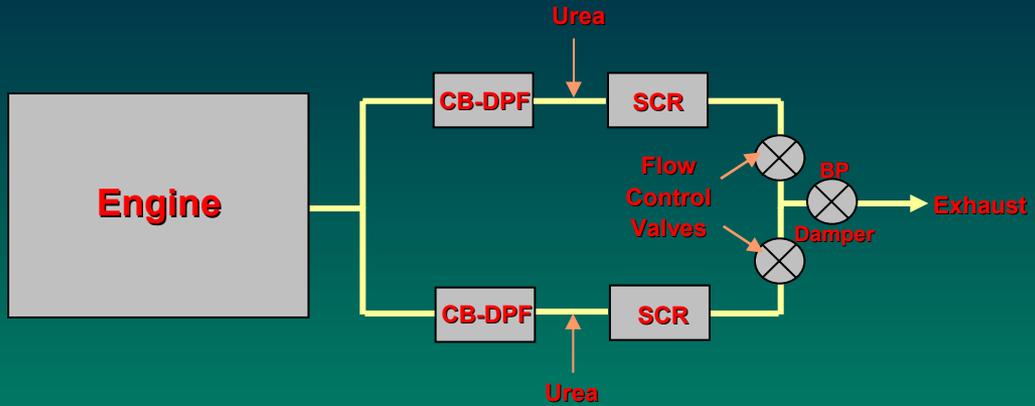


Technical Approach--Development (ϕ 1)

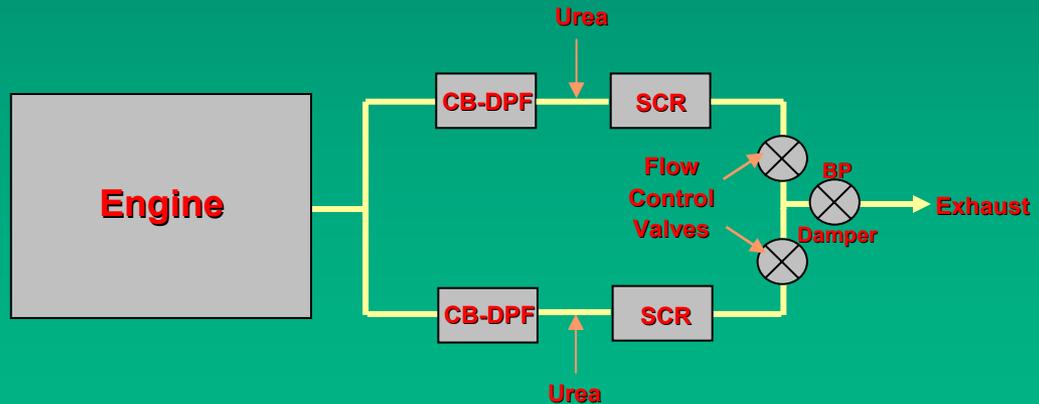


Technical Approach--Durability (ϕ 2)

A



B



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Major Accomplishments - 10-Hour & All DECSE Fuels

◆ LPL EGR Calibration Yielded the Following:

- 1.5 g/bhp-hr NO_x in Transient Cycle
- 2.3 g/bhp-hr NO_x in OICA Composite Test (ESC)

◆ System A Calibrated Yielded the Following:

- 0.22 to 0.24 g/bhp-hr Transient Composite
- 0.14 to 0.18 g/bhp-hr OICA Composite

◆ System B Calibration Yielded the Following:

- 0.33 to 0.38 g/bhp-hr in Transient Composite
- 0.23 to 0.24 g/bhp-hr OICA Composite

◆ In both Systems NH_3 slip < 2 ppm raw (10-15 ppm peaks)

◆ All PM Results Were < 0.01 g/bhp-hr (Except When DPF Failed)

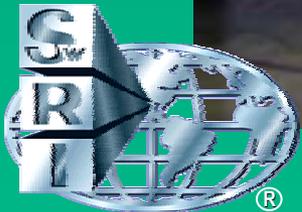


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Test Setup - EGR System

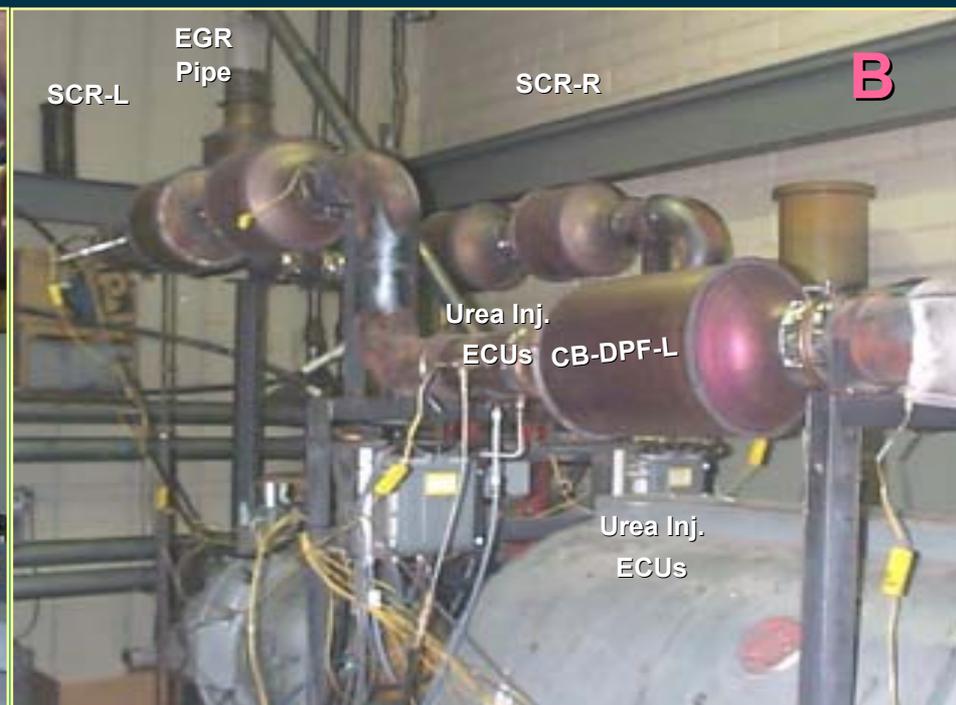
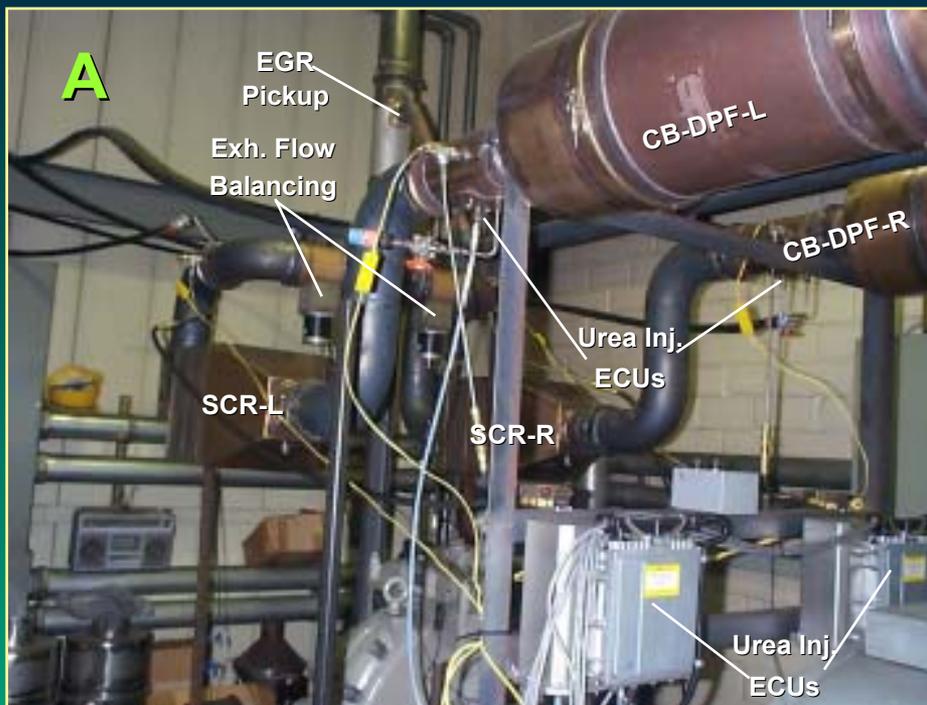


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Aftertreatment Systems - Systems A & B



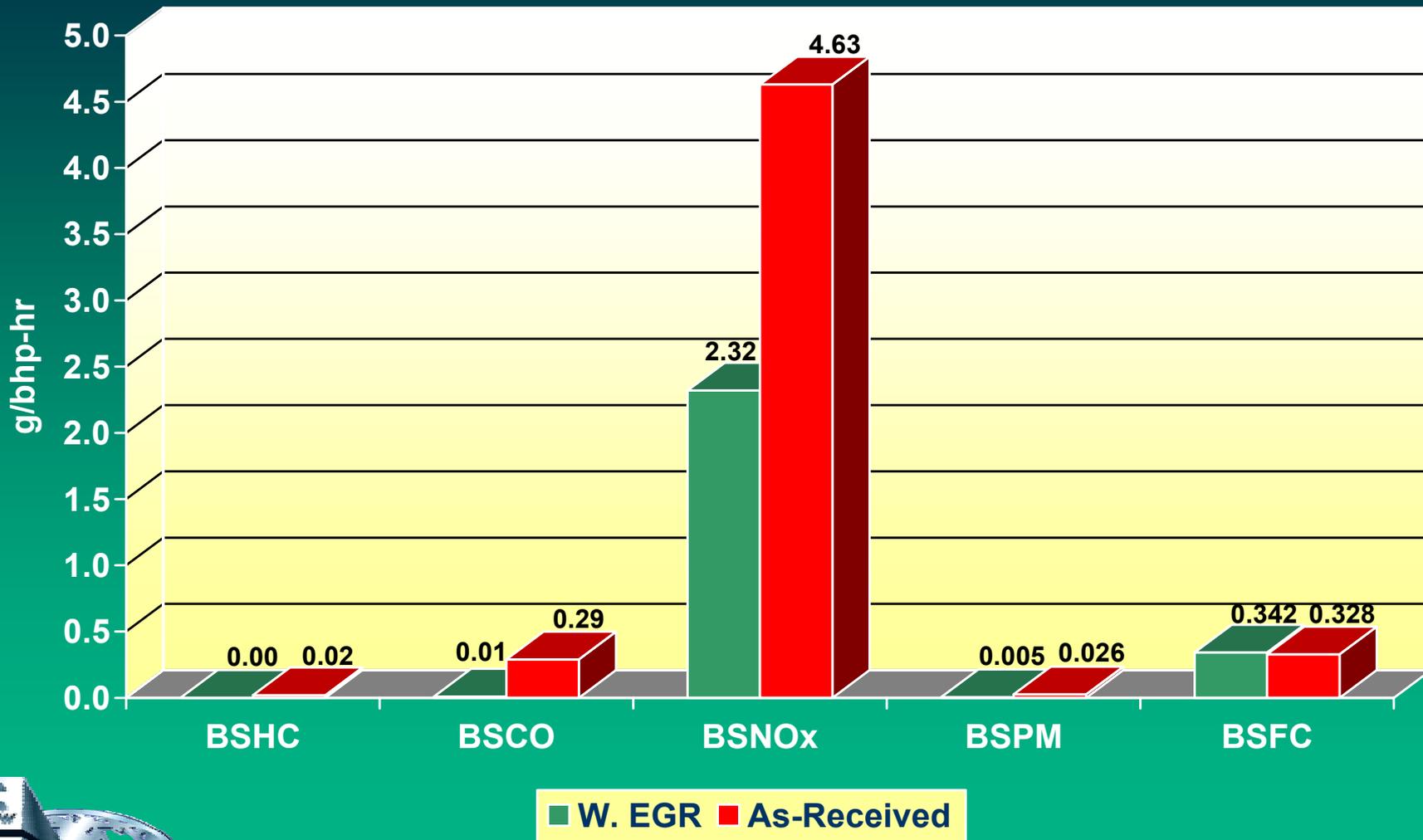
System	No. of Units		Volume, L		Syst. Vol./Eng. Displ.		Remarks	
	A	B	A	B	A	B	A	B
DPF	2	2	45.6	34.1	3.8	2.8	11.25X14"	10.5X12"
SCR	2	4	39.4	31.0	3.3	2.6	-	-
CUC	1	1	8.5	8.5	0.7	0.7	-	-
	-	-	93.5	73.5	7.8	6.1	-	-

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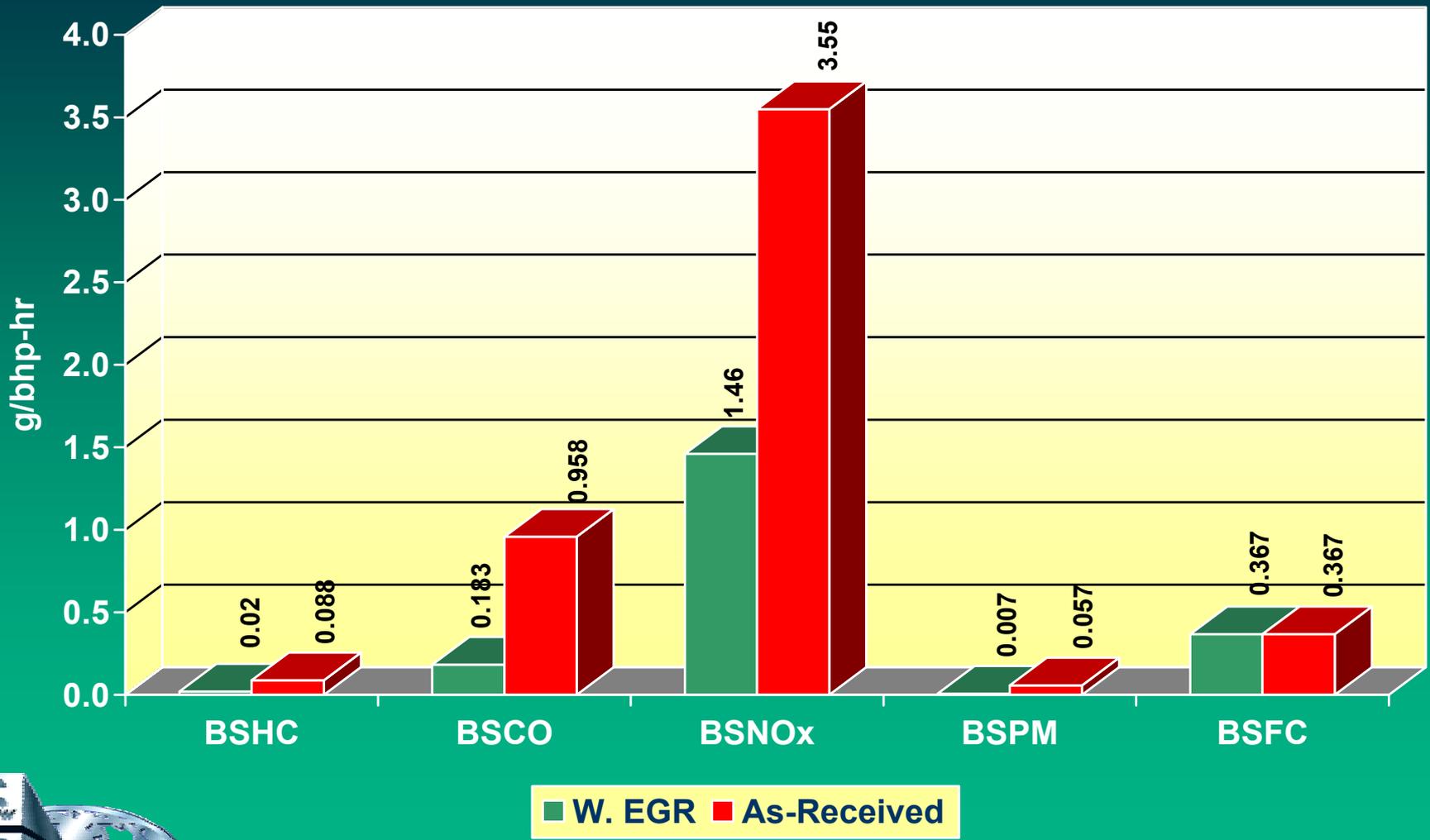


Steady-State Emissions Comparison--As-Received Vs. W.EGR*-- DECSE 3ppm Fuel



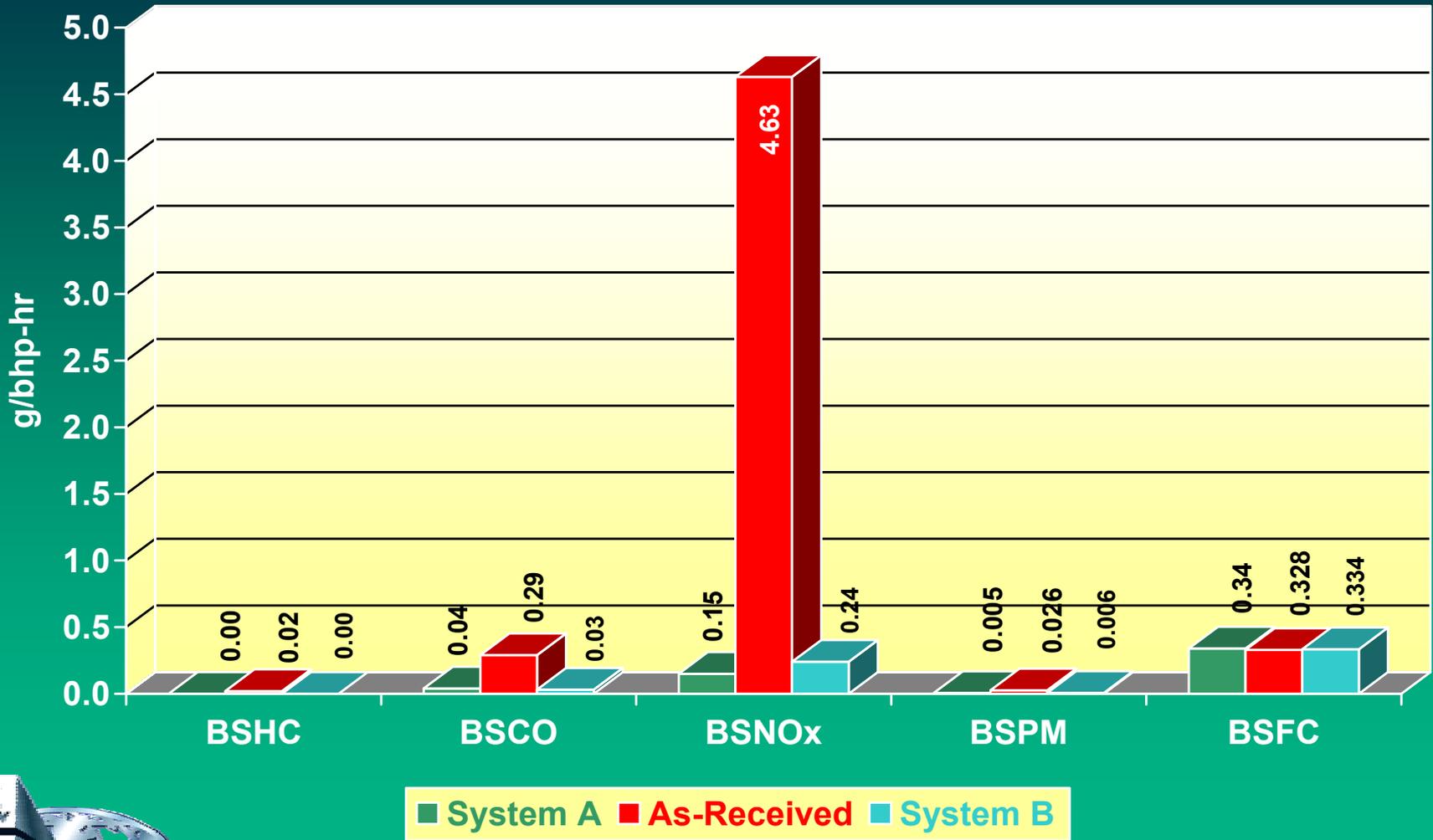
EGR* : Low Pressure Loop EGR With CB-DPF

Transient Emissions Comparison--As-Received Vs. W.EGR*--DECSE 3ppm Fuel -- Hot Starts



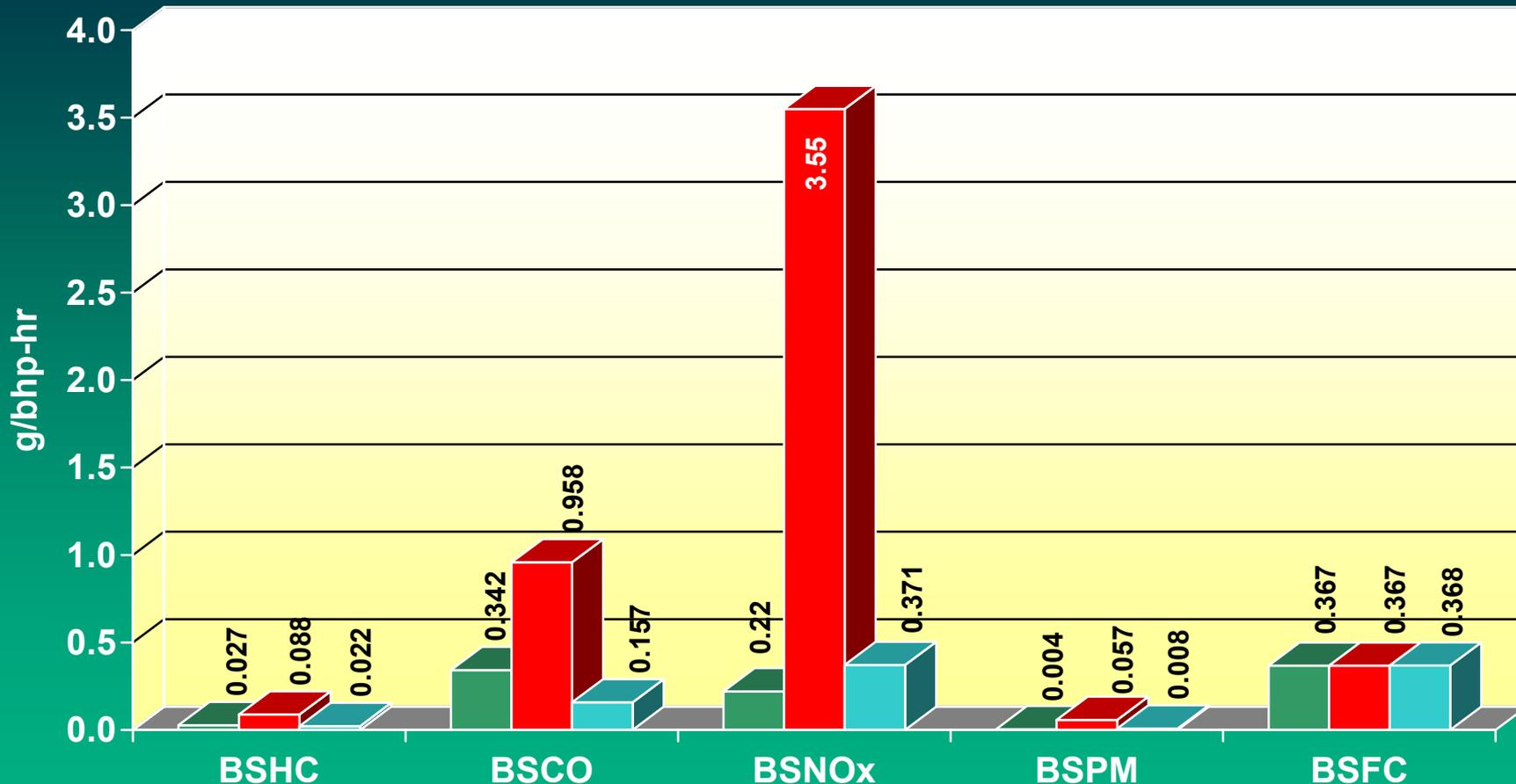
EGR* : Low Pressure Loop EGR With CB-DPF

Steady-State Emissions Comparison--As Received Vs. Systems A & B -- DECSE 8 ppm Fuel at 10 Hours Composite



Results Are Averages of Two OICA Tests

Transient Emissions Comparison--As Received Vs. Systems A & B --DECSE 8 ppm Fuel -- 10 Hours Composite



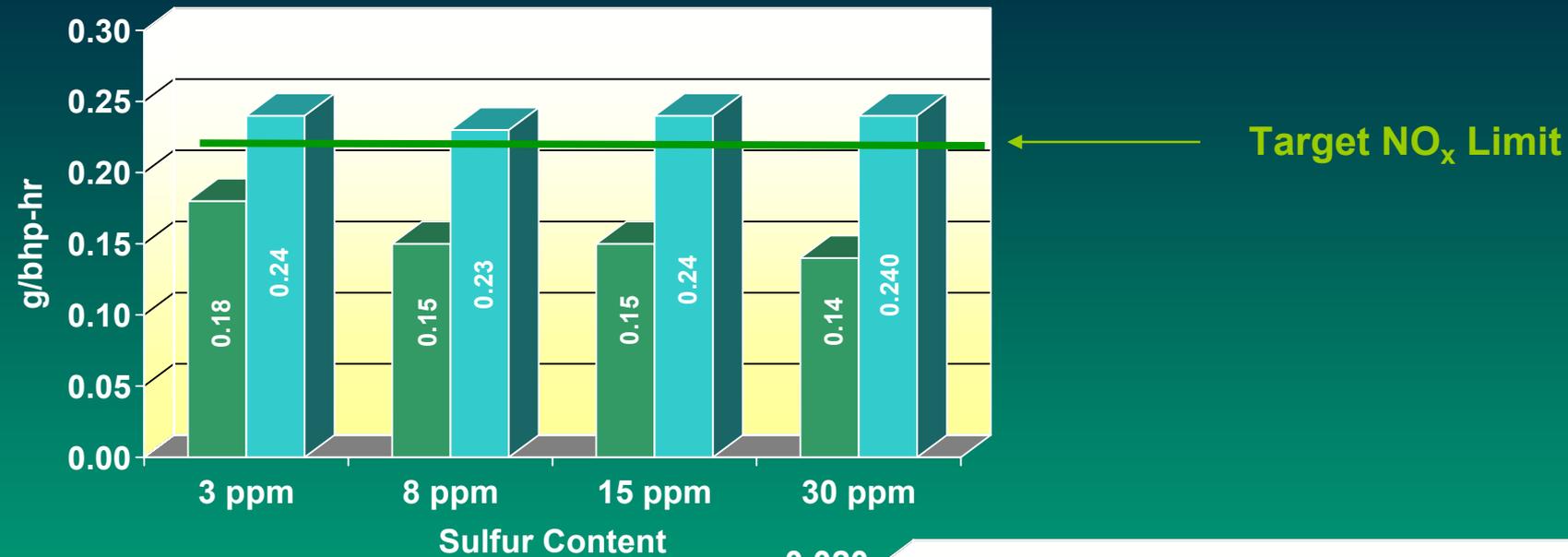
■ System A ■ As-Received ■ System B

* Composite Based on Cold + First Hot-Start EPA Transient Tests

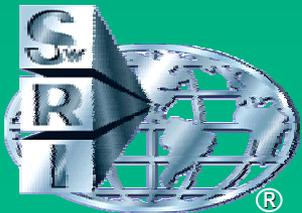
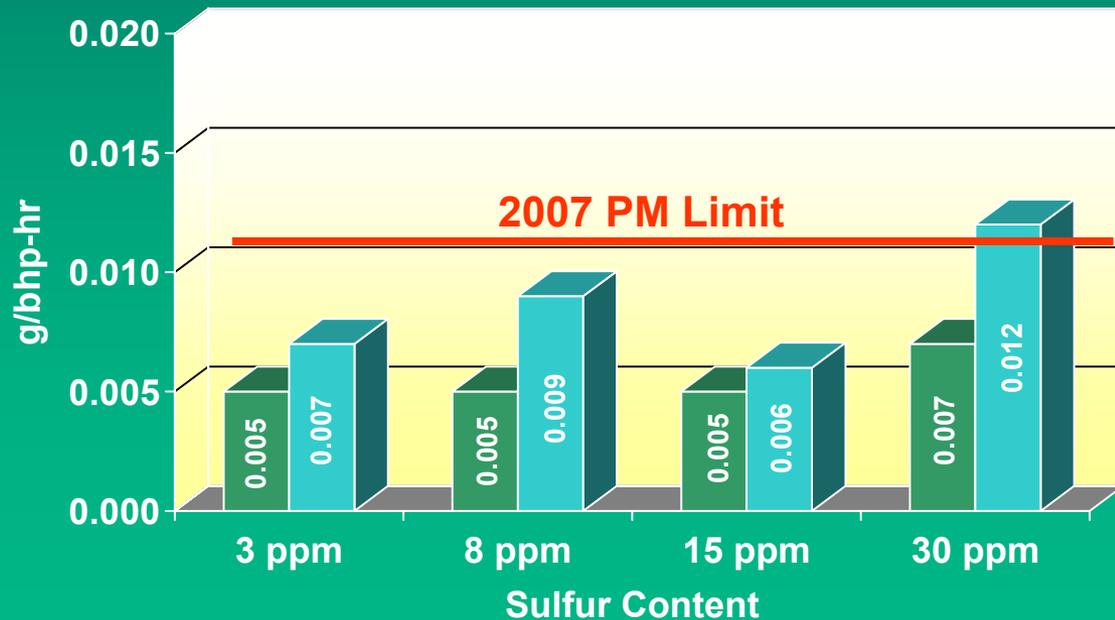


Sensitivity To Fuel Sulfur--Steady-State Composite Emissions

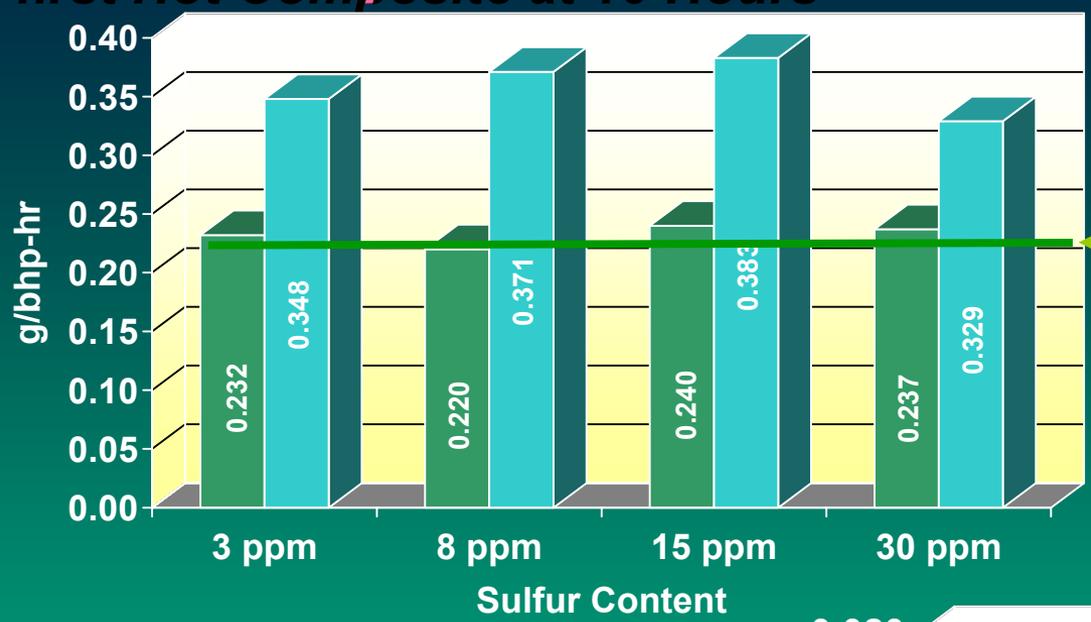
-- Average of 2 OICA Tests at 10 Hours



System A
System B

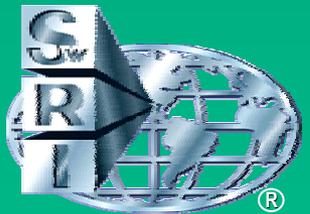
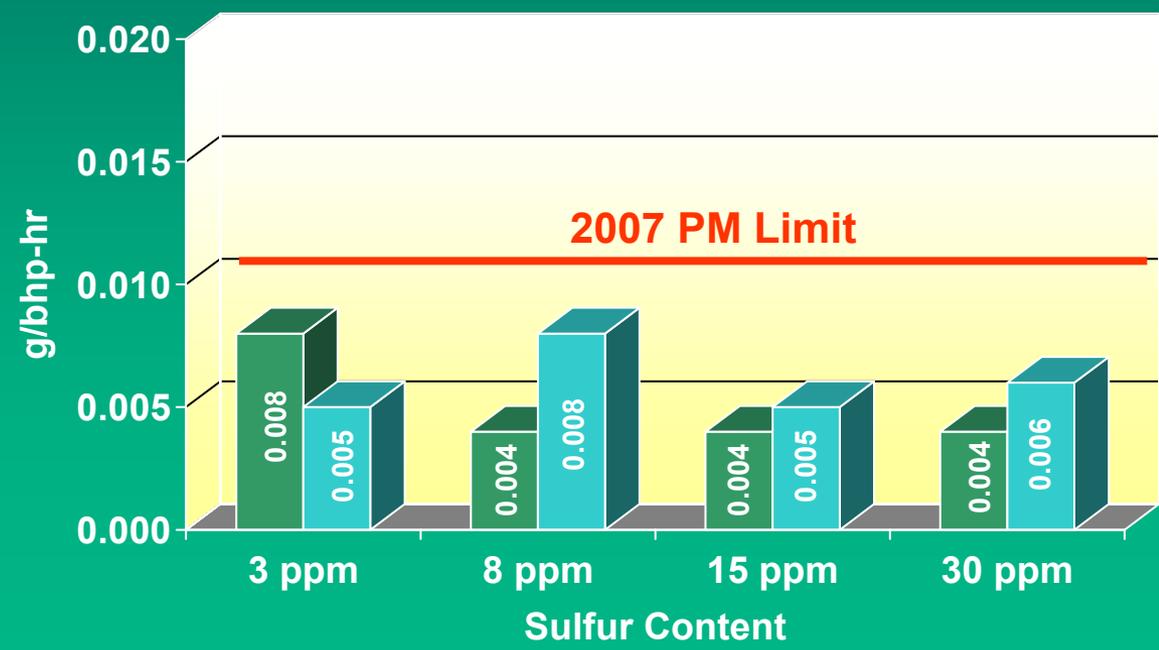


Sensitivity To Fuel Sulfur--Transient Emissions -- Cold and first Hot Composite at 10 Hours

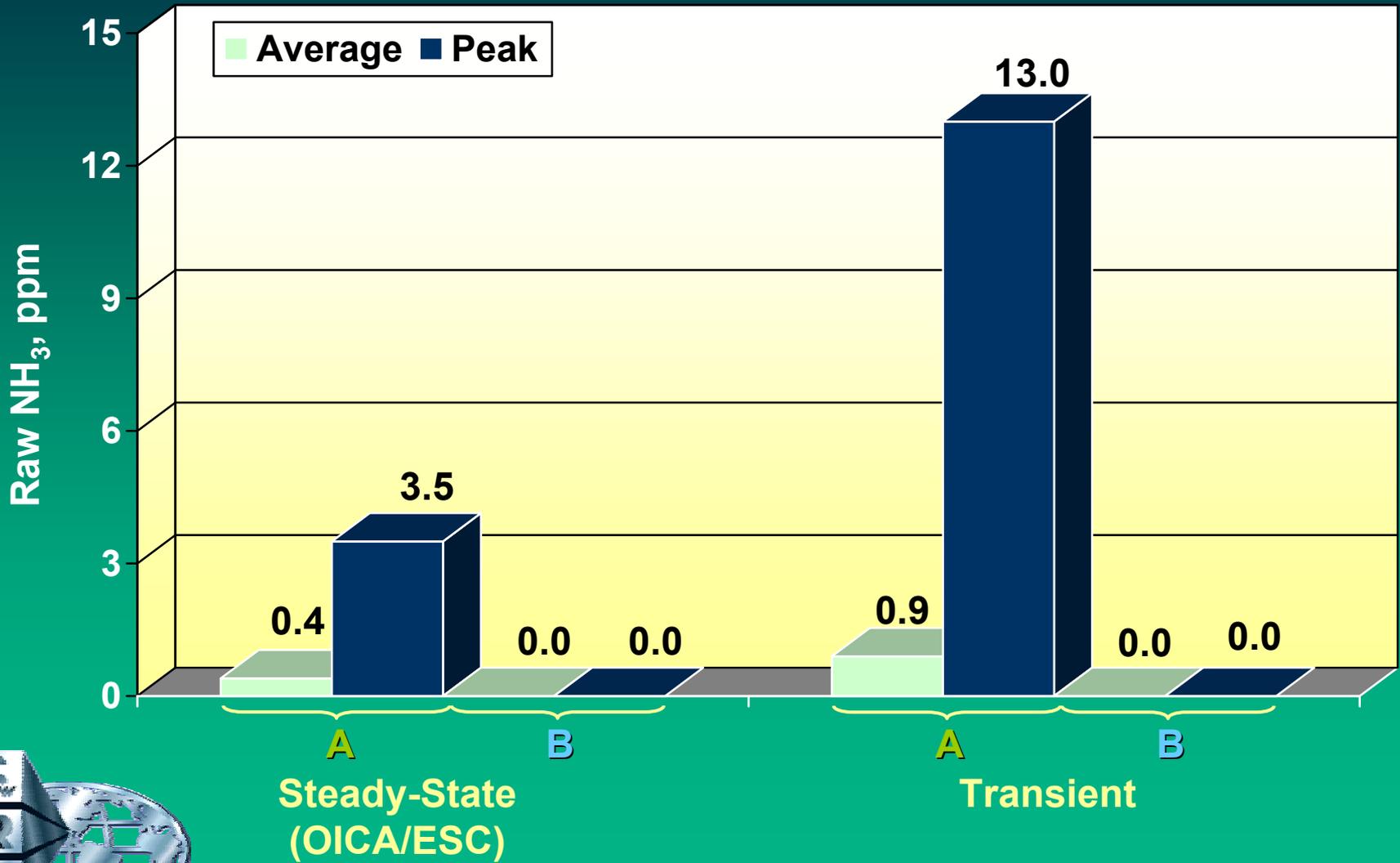


* Composite Based on Cold + First Hot-Start EPA Transient Tests

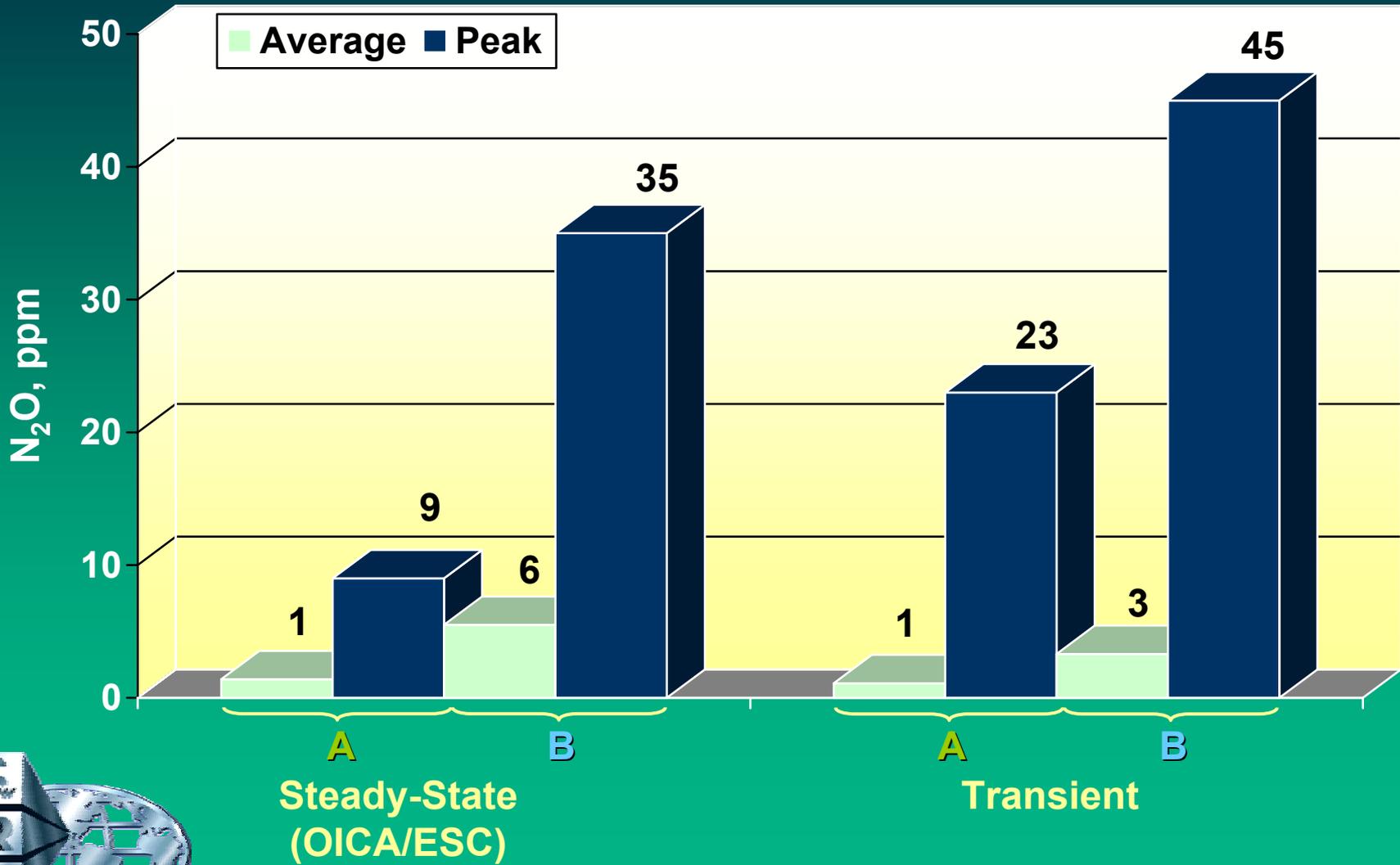
System A
System B



Ammonia Slip--Steady-State & Transient --At the 10-hour Point



Nitrous oxide--Steady-State & Transient --At the 10-hour Point



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Summary and Conclusions

- ◆ The LPL EGR system was installed and calibrated to yield:
 - over 50% NO_x reduction and,
 - about 90% PM reduction
- ◆ System A was optimized and yielded an average of 0.16/0.006 g/bhp-hr NO_x/PM for all fuels in the OICA test.
- ◆ System B was optimized and yielded an average of 0.24/0.009 g/bhp-hr NO_x/PM for all fuels in the OICA test.
- ◆ System A calibration for the EPA transient test cycle yielded composite average for all fuels of 0.232/0.005 g/bhp-hr NO_x/PM.
- ◆ System B calibration for the EPA transient test cycle yielded composite average for all fuels of 0.358/0.008 g/bhp-hr NO_x/PM.
- ◆ Fuel sulfur content did not appear to have a discernable effect on emissions at the 10-hour test point.

