

**Houston Advanced Research Center [HARC]
Texas Commission on Environmental Quality [TCEQ]**

**New NOx R&D Programs Workshop
13 February 2008**

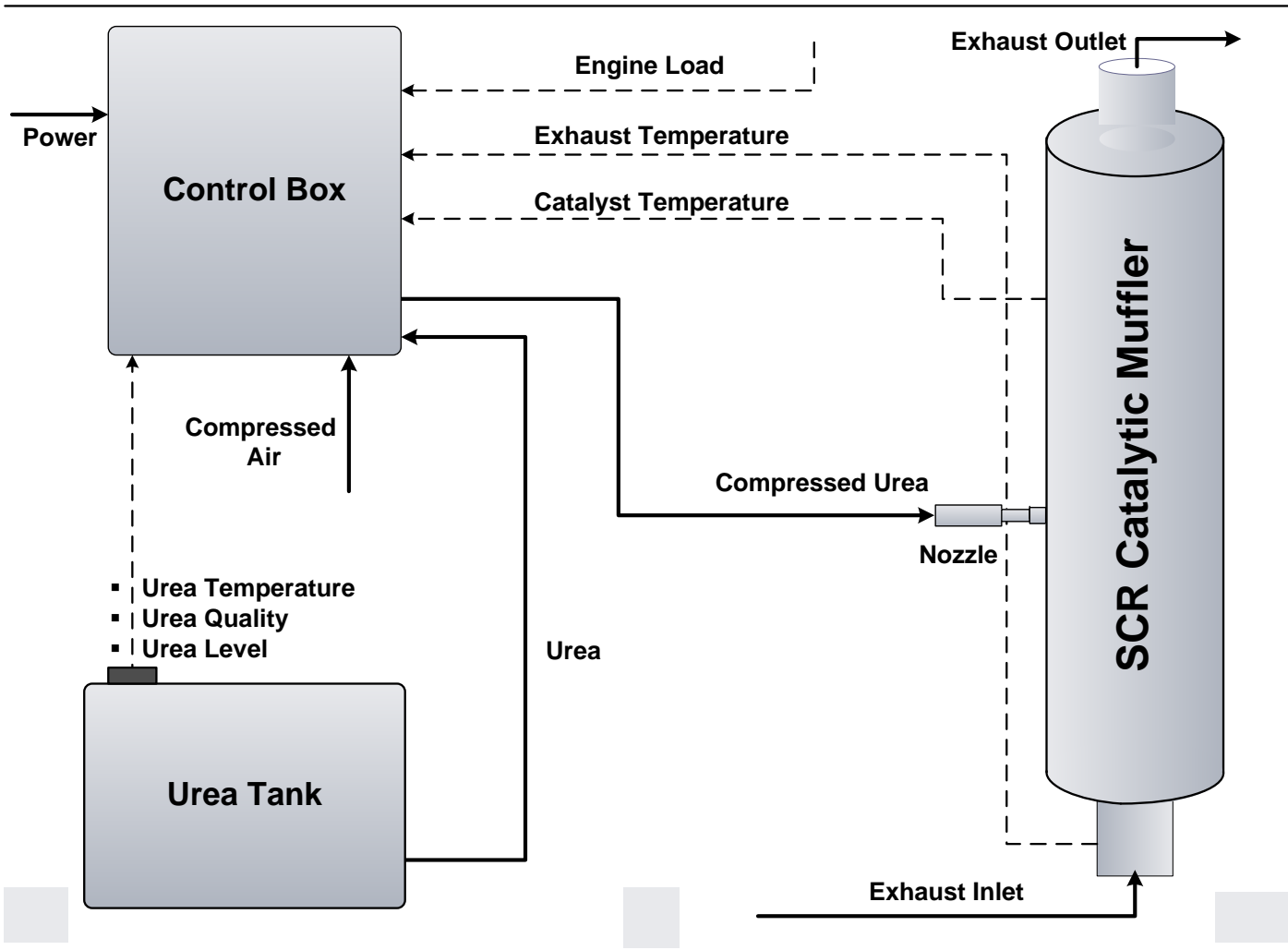
**Progress Report
Engine Control Systems Limited**

Discussion Points

- **System Description**
- **Performance**
- **Installation**
- **Operation & Maintenance**
- **Verification**

Urea SCR System Schematic

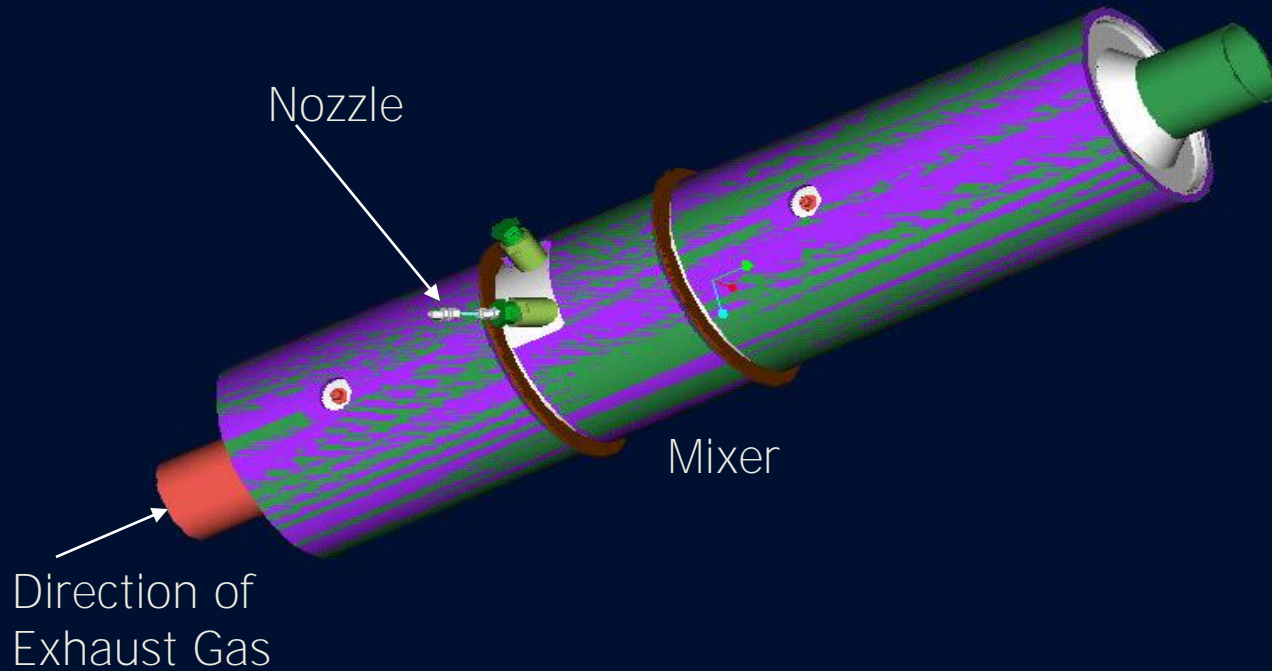
ECS SCR System Schematic



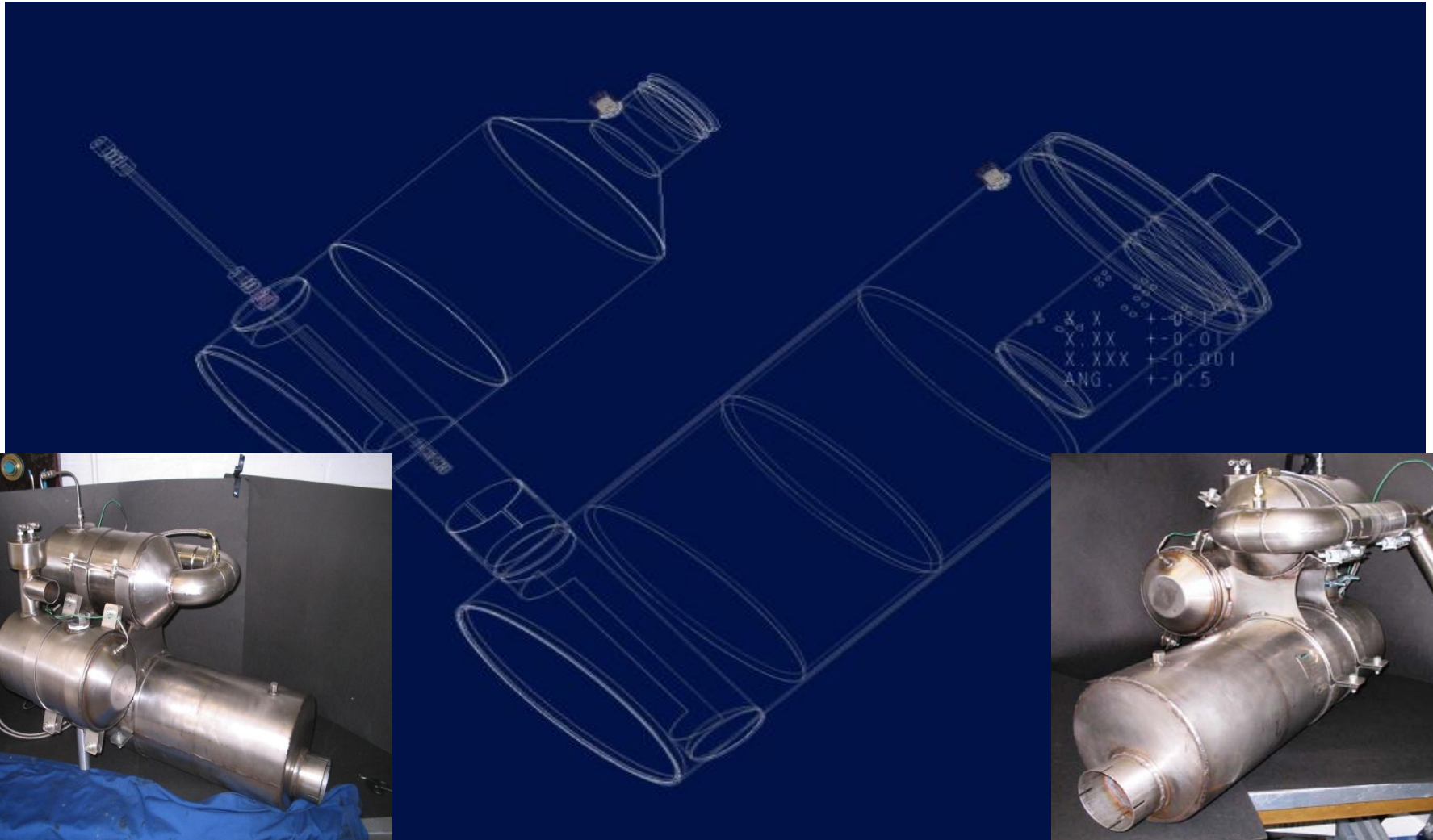
SCR System – Mode of Operation

- Urea injection is metered based on calibration of engine load & engine out NOx
- Conditions for injection;
 - Catalyst bed temperature
 - Urea level & Quality
 - Availability of compressed air at appropriate pressure
- Alarm & System Shutdown at;
 - Low urea level in tank,
 - Poor Urea Quality, i.e. not at required concentration
 - Insufficient air pressure
 - Plugged Nozzle

System Components – Stack-Type SCR Catalytic Muffler Configuration

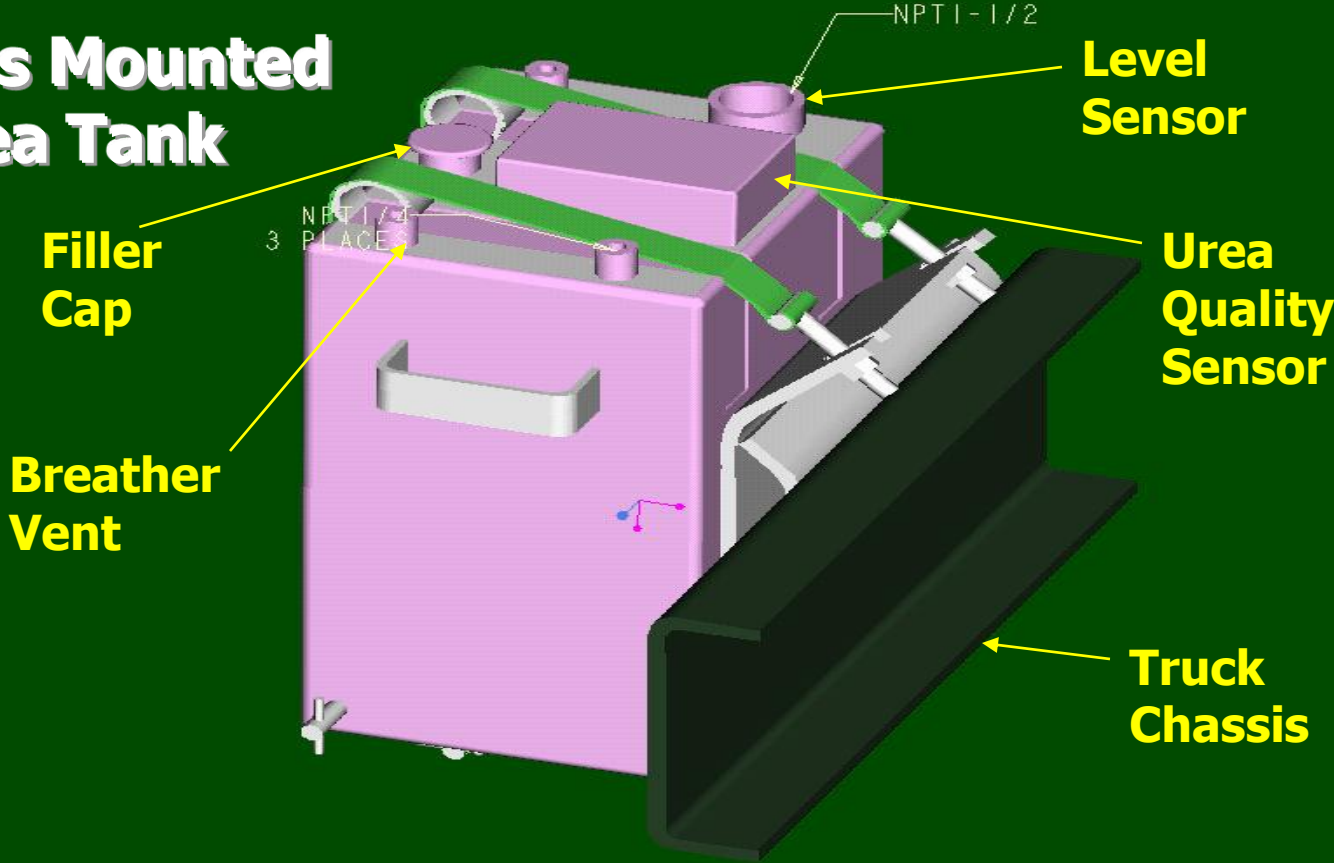


System Components - SCR Catalytic Muffler Configurations



System Components – Urea Tank

Chassis Mounted Urea Tank



System Components – Control Panel

Metered Urea/Air
Mixture to Muffler

Urea From
Tank

- **Houses the controller and metering equipment**
- **Controller calculates NOx output based on the sensor inputs**

Pressurized Air
Inlet



System Performance

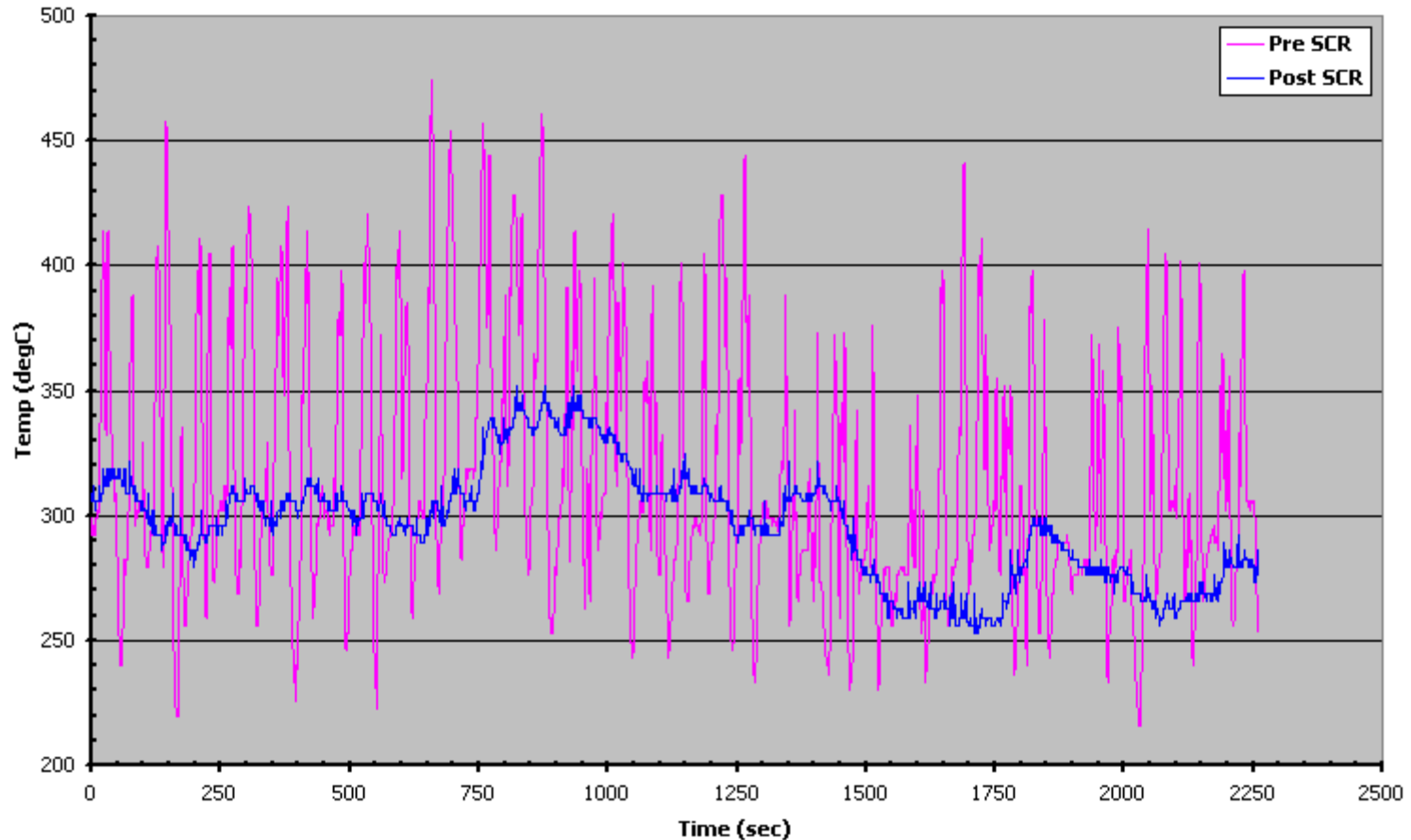
2.5 g/bhp-hr NOx Test Engines					
Make	Model	Year	Family #	Control	Rating
Cummins	ISBE	Euro III			
CAT	C11	2004	KCA018109	Electronic	11.1L, inline 6, 305 @2100rpm
Cummins	ISM 280	2004	35095401	Electronic	10.8L, inline 6, 280bhp @2100rpm

Engine	Model	Control Strategy	Protocol	% Emission Reduction				NH ₃ Slip [ppm]
				CO	THC	NOx	TPM	
Cummins	ISBe	1-Cal1	London Bus/Chassis	80	99	66	37	25
CAT	C11	1-Cal2	FTP/Bench	92	91	74	20	32
CAT	C11	1-Cal2	ESC/Bench	98	99	85	24	32
Cummins	ISM	2	FTP/Bench	80	98	62	34	4
CAT	C11	2	FTP/Bench	Ongoing				

System Performance

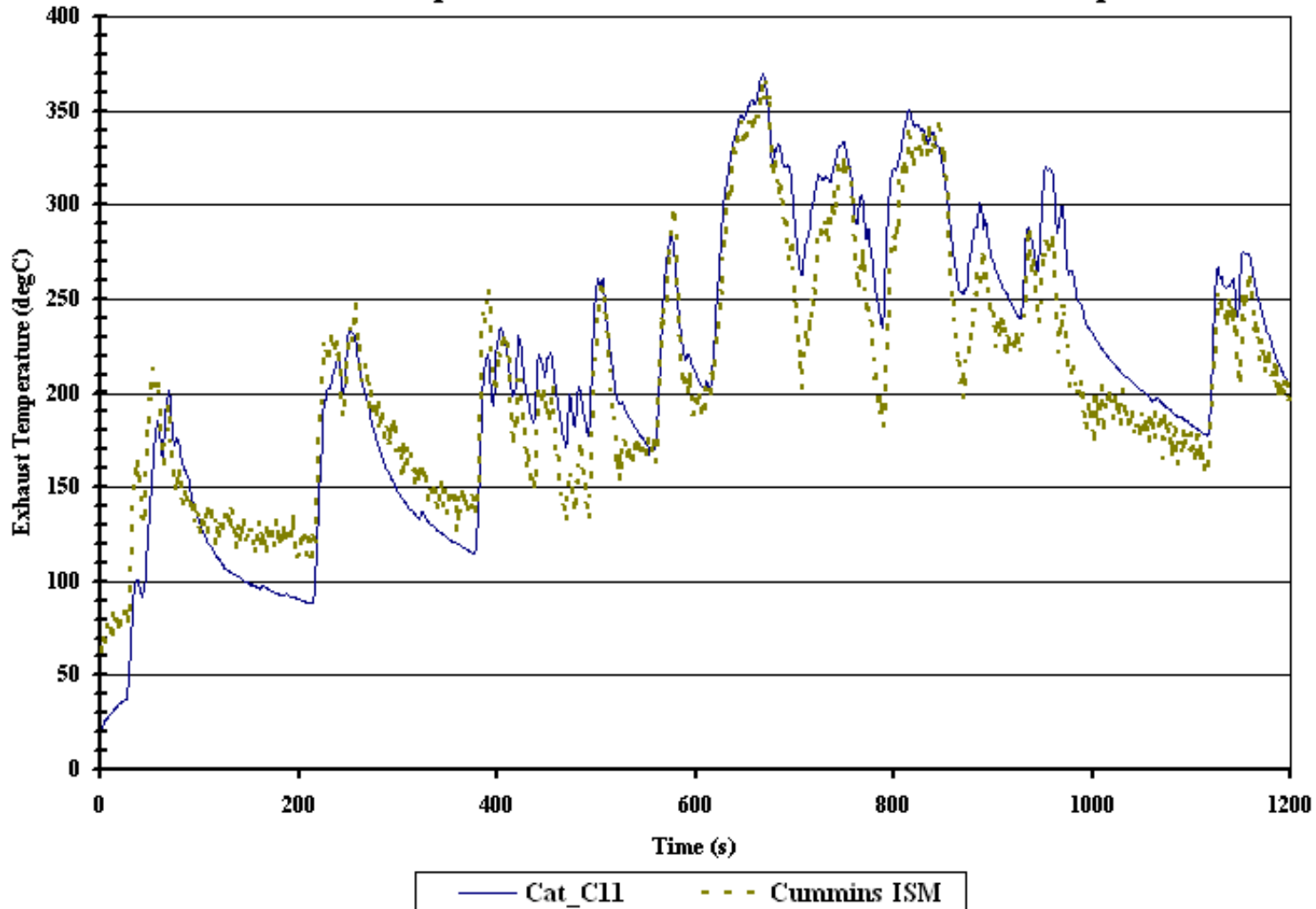
London Bus – Temperature Traces

Temperature Traces - MLTB Cycle
Dennis Dart Bus - Cummins ISBE Euro-III
Run 200670 - Cal 5



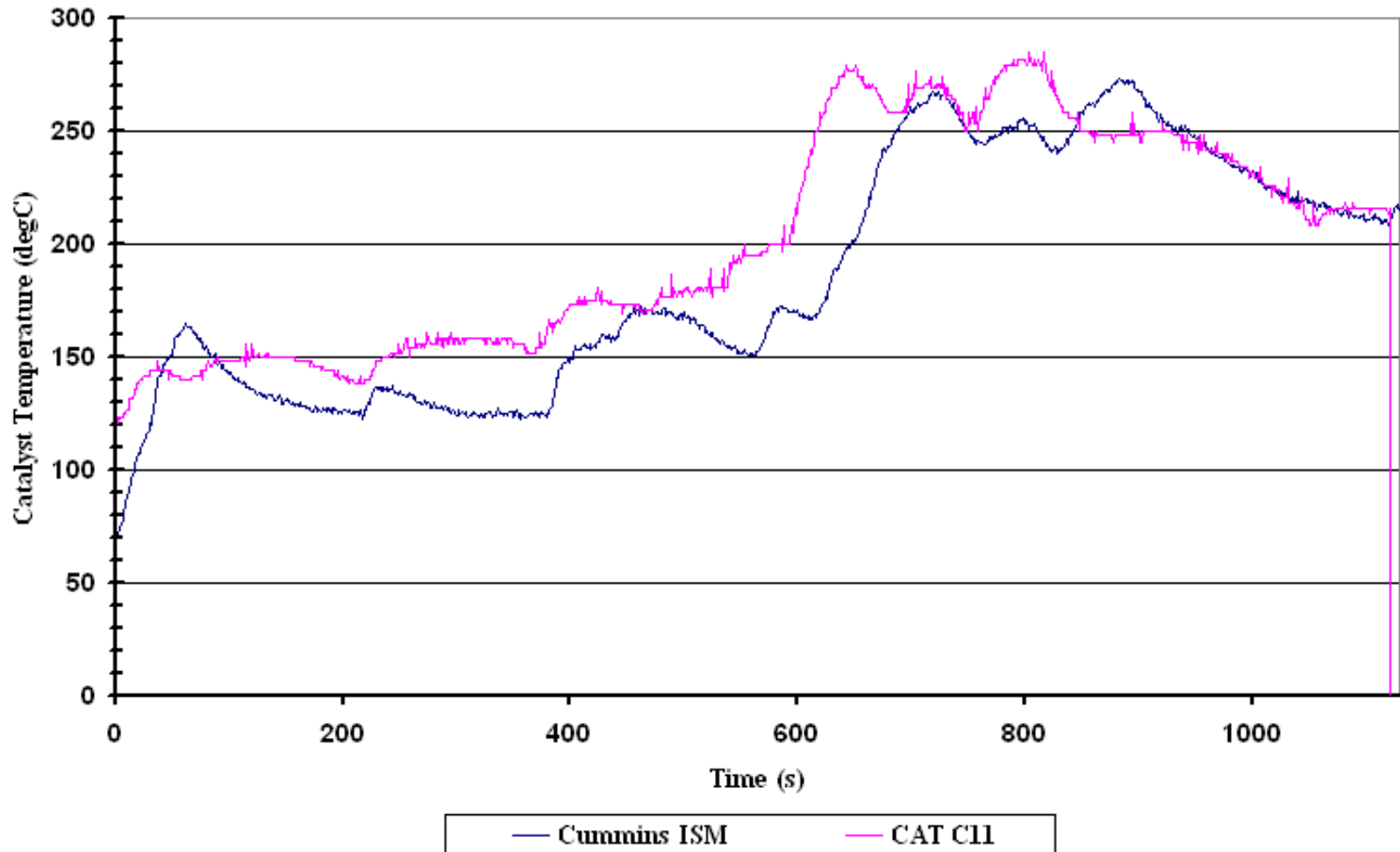
System Performance

Exhaust Temperature - Cummins ISM Vs Caterpillar C11



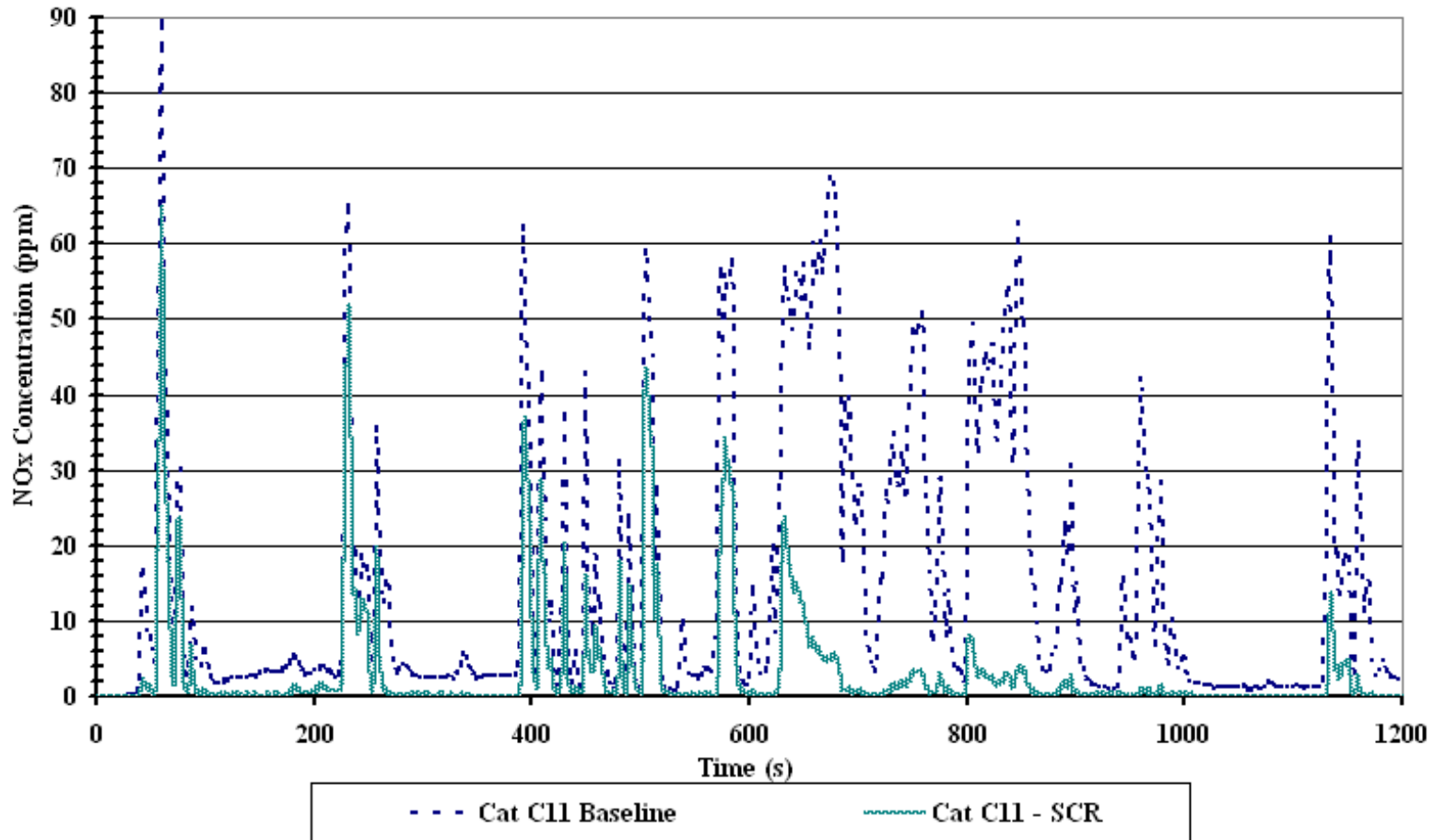
System Performance

Catalyst Temperature - Cummins ISM vs Cat C11



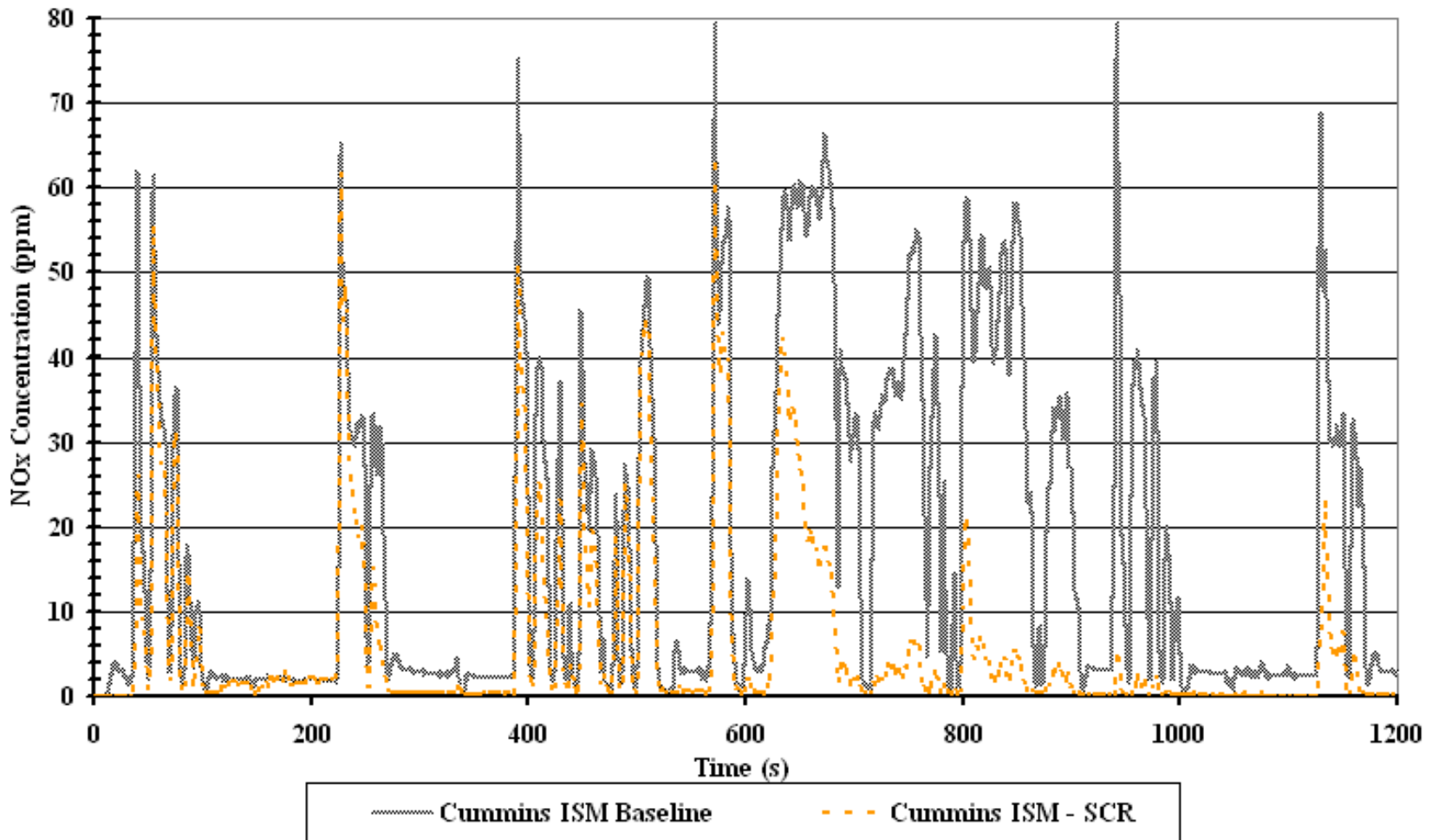
System Performance

Cat C11 - Tailpipe NOx Baseline vs SCR system

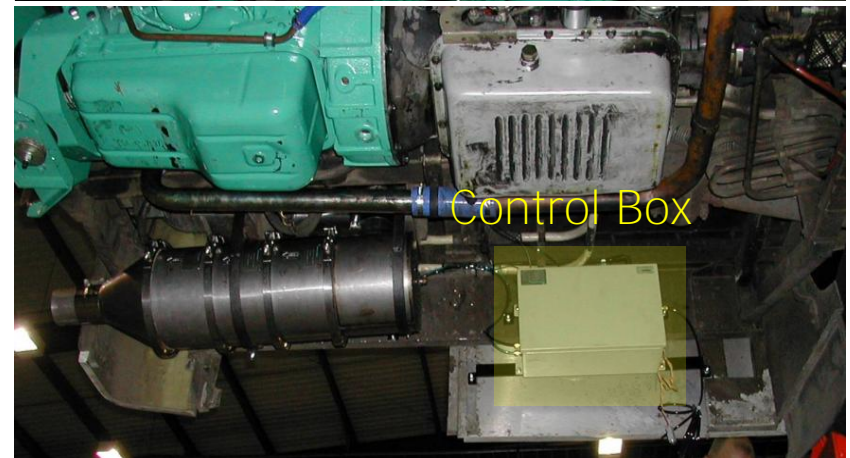
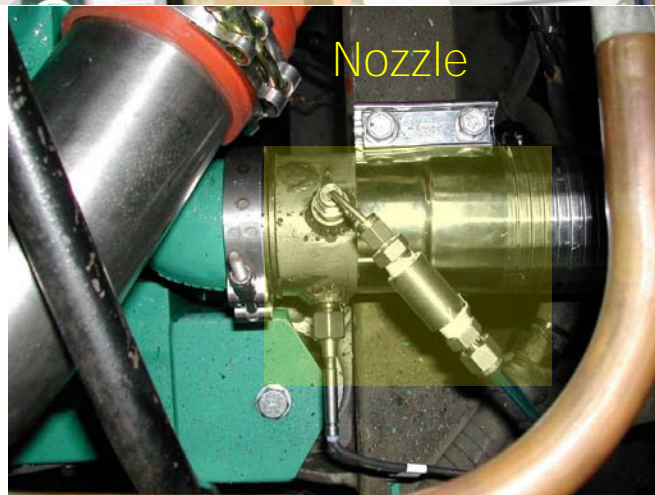
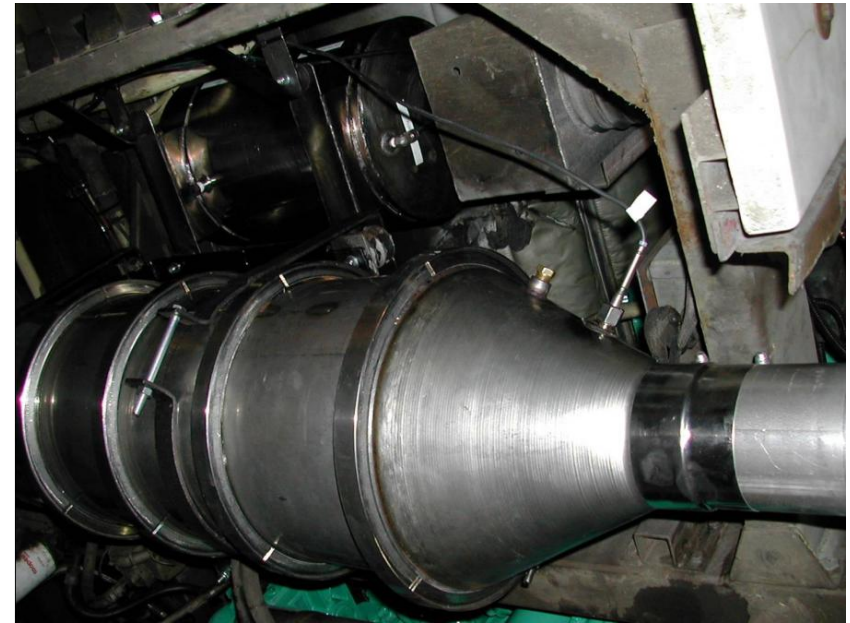


System Performance

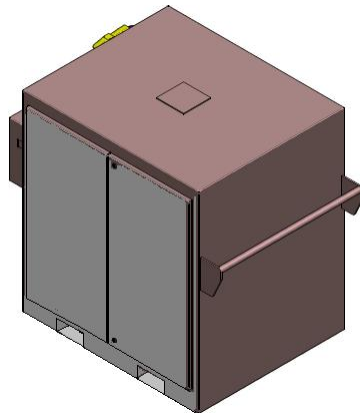
Cummins ISM - Tailpipe NOx Baseline vs SCR system



Installation



Operation & Maintenance



- Urea supplier/Partner offers;
 - Dispensing Station
 - Regular urea supply @ approx \$5/gal
- Urea dispensing @ Fueling Island
- Regular Totes refills
- Optional Weather Enclosure
- Periodic Nozzle Inspection during scheduled preventive maintenance

Verification

- **Initial communication with EPA**
 - **System Description**
 - **Test Plan proposal including demo program**
- **Elected 3 potential durability demo sites in TX**
 - **Selected 3 different applications (buses & Trucks)**
 - **Completed application survey**
 - **Building 6 systems**
 - **Ready to mobilize upon EPA green light**
- **Pre-Application to RTI after mobilization to demo program**

Thank you for your time!