Retrofitting *& Emissions Testing* Nonroad Equipment With Diesel Emissions Control Technologies

Croton Water Treatment Plant (CWTP) Case Study

2007 MDEC Conference
October 3rd, 2007
Toronto

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Since Last Year……

- Control Technology Deployment Completed.
- In-Use Emissions Measurement (PEMS) Undertaken

The focus of this presentation update is the PEMS Work….

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Presentation Outline

- Emisstar LLC
- Remember From Last Year?.....
  - New York City Local Law 77 (LL77)
  - Project Objectives, Overview, Implementation
- In-Use Emissions Measurement (PEMS)
  - Approach
  - Tested equipment, Emission Control Technologies (ECTs)
  - Results
  - Conclusions

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Emisstar LLC

"Mobile Emissions Technology, Policy, and Implementation"

- Formed in April 2005
- Focus on mobile sources diesel emissions remediation
- Over 60 years collective experience
  - Air quality science & engineering
  - Engineering & project management,
  - Business development, & strategic planning
  - Diesel engine and emissions control technology
- 3 Offices in United States

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NYC Local Law 77 (LL77)

- Law enacted by NYC Council in 2003
- All City Agencies and their contractors
- Requirements:
  - Any diesel powered equipment > 50 HP must be powered by ULSD <15 ppm
  - Utilize “Best Available Technology” (“BAT”) for reducing emissions
  - Applies to nonroad construction equipment

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Project Objectives

- Fleet Characterization
- Implementation of BAT
- In-Use Testing Program –
  - Demonstrate feasibility of BAT
  - Provide empirical evidence to the NYC DEP
  - Address stakeholders’ concerns
  - Assess commercially available ECTs

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Project Overview

- Drinking Water Treatment Plant
- EPA consent decree
- North Bronx (Van Cortland Park)
- 3 phases
  - Excavation → '05 – early '07
  - Tunneling → early '07 – '10
  - Construction → '07 – '12
- $1.5+B
- 1st U.S. Construction project using "BAT"

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Project Site: Croton Water Treatment Plant

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Site Activities

- 16 acre site
  - 9 acre excavation to approx. 100 feet
- Hydraulic Line Drilling
- Blasting
- Excavating/Hoe ramming
- Loading
- On-site hauling
- Rock crushing / stockpiling
- Off-site hauling

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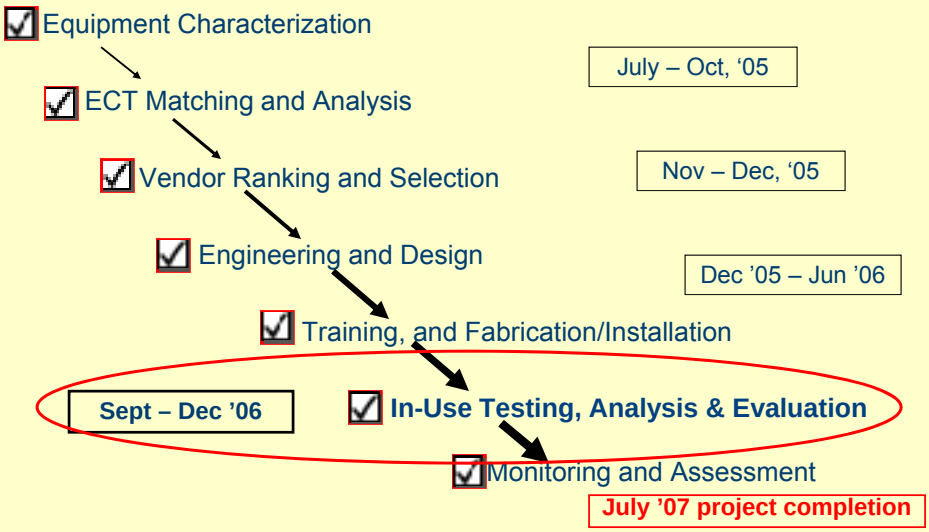
Project Implementation



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Croton Vehicle Profile

- 25 – 30 Non-Road machines
- Six major categories
  - Compressors
  - Loaders
  - Excavators
  - Dozers
  - Drills
  - Quarry Trucks
- 50+ On-Highway Dump Trailers

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Equipment Characterization/Datalogging

- Tier 2 or 3 machines
- High EGT profiles, on average
  - 300 deg. C > 70 % duty cycle
- Quarry Trucks
  - Low to medium EGT
  - ADPF candidates
- Well maintained (Service ~ 250 hours)

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In-Use Emission Measurement

- Objectives
  - Conduct exhaust emission measurements on six diesel powered pieces of construction equipment operating under both real world and repeatable conditions.
  - Evaluate the impact of various emission control technologies – pre and post ECT.
- EPA regulated emissions
  - TPM, THC, NOx, CO
- Engine parameters
  - RPM, Exhaust Gas Temperature (EGT), Intake Air Flow, Manifold Boost Pressure (MBP)

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Measurement Approach

- Portable Emissions Measurement (PEMS)
  - Emisstar in conjunction with EC-ERMD
  - DOES2: “Dynamic Dilution On/Off-Road Exhaust Emission Sampling System”
- Pre and Post ECT testing
  - Not simultaneous (ECT already installed)
  - Three to four pre-ECT tests
  - Followed by three to four post-ECT tests

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Equipment Tested

Type	Manufacturer	Model #	Date of Mfg.	Engine	HP	Tier	ECT Type	Mfg
Compressor	Ingersoll Rand	IR 600	2005	John Deere-6IRF8TE	170 HP	2	SCR+DPF	JMI SCRT
Dozer	Komatsu	D155-Ax-5B	2004	Komatsu SDA6D140E-3	332 HP	2	DPF	ECS
Excavator	Hitachi	Z Axis-800		Isuzu GWG1XAB	483 HP	2	DPF	ECS
Hydraulic Drill	Tamrock	CHA 700	2005	Caterpillar 3506E	173 HP	2	DPF	ECS
Rubber Tire Loader	Caterpillar	966G	2004	Caterpillar 3176C ATAAC	259 HP	2	DPF	CAT/JMI CCRT
Quarry Truck	Terex	TR70	2005	Detroit Diesel 12V 2000	700 HP	2	ADPF	RYPOS ADPF-C

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ECTs Tested (1)

- JMI SCRT: Selective Catalytic Reduction Technology

Ingersoll Rand Compressor

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ECTs Tested (2)

- ECS PDPF: Passive Diesel Particulate Filter

a) Komatsu Dozer

b) Komatsu Excavator

c) Tamrock Tiger Drill

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ECTs Tested (3)

- Rypos ADPF: Active Diesel Particulate Filter

Terex Quarry Truck

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ECTs Tested (4)

- JMI CRT: Continuously Regenerating Technology

Caterpillar 966G Rubber Tire Loader

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EC DOES2 PEMS Techniques

Compound	Analysis Method
Carbon Monoxide (CO)	NDIR***
Carbon Dioxide (CO_2)	NDIR***
Oxides of Nitrogen (NO_x)	Chemiluminescence Detection***
Nitric Oxide (NO)	Chemiluminescence Detection***
Total Hydrocarbons (THC)	Heated FID***
Particulate Matter (PM)	Gravimetric Procedure****
Ammonia (NH_3)	Citric Acid Coated Filters

*** Sample collection: Cali-5-Bond (five layer sample bag)

**** Sample collection: 70 mm Pall Emfab™ filter

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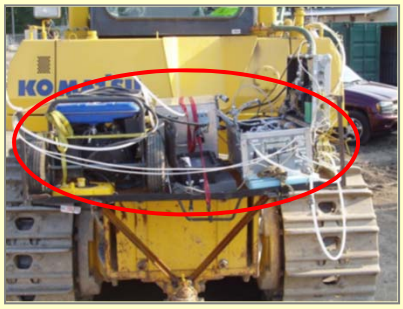
DOES2 Installation

Laminar Flow Element (LFE) for intake air flow measurement

DOES2 installed on the test Dozer



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Bench Emissions Analyzers & Cal Gas

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Results (1)

- QA/QC
  - No errors found in engine data
  - Test cycles were similar and repeatable
  - Difference between test runs for pre and post tests were in range of 5 to 7 percent

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Results (2)

- Emission Reductions

Equipment	ECT	Emission Reduction (%)			
		TPM	THC	NOx	CO
Compressor	SCRT	97	94	67	99
Dozer	PDPF	97	93	5	99
Excavator	PDPF	99	79	12	98
Terex Quarry Truck	ADPF	45	31	3	34
Rubber Tire Loader	CRT	99	81	7	93
Tiger Drill	PDPF	99	52	5	99

- Not statistically significant
- Expected since this is a PM-focused program

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Conclusions (1)

- In-use emissions testing supported verification level performance and expectations about DPF emissions removal efficiency.
- Test data showed significant PM-reduction for all the tested PDPFs and NOx reduction for the SCR.

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Conclusions (2)

- Resultant data and analysis provides quantitative support for the continued application of BAT as an effective retrofit approach.
- The techniques, methodologies and approaches demonstrated at CWTP will support additional projects and testing of this type in the future.

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Acknowledgments

- Environment Canada
- New York City Department of Environmental Protection
- URS Malcolm Pirnie
- The Shaw Group
- Schiavone Construction Company
- ECT suppliers and distributors
  - ECS
  - E-Global Solutions
  - Rypos
  - HO Penn / Caterpillar
  - Cummins Metropower / Emissions Solutions
  - Johnson Matthey

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With special thanks to Kevin Brown, ECS!

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