

---

# Retrofitting Nonroad Equipment With Diesel Emissions Control Technologies

## Croton Water Treatment Plant Case Study

2006 MDEC Conference  
October 11, 2006  
Toronto

Glenn P. Goldstein  
Michael C. Block  
Emisstar LLC



1



---

## Presentation Outline

- **Emisstar LLC – "who we are & what we do"**
- **Project Overview**
  - New York City Local Law 77
- **Project Implementation**
  - Croton Vehicle Profile
  - Equipment characterization
  - Supplier Identification Process
  - Technology Deployment
  - EGBP/EGT Monitoring
  - In-Use Emissions Testing
- **Challenges and Issues**
  - Successes
  - Lessons Learned
- **Technology Transfer to Mining**



2



## 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
  - Regulatory & policy analysis
- 3 Offices in United States



3



## Emisstar LLC

### Focus Areas

- Advanced Technology Development
- Project Management and Implementation
- Research, Technical and Market Analysis
- Technology and Policy Coalitions
- Strategic Advisory Services
- Portable Emissions Monitoring (PEMS)
- Grant Writing and Related Support



4



## 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
- 1<sup>st</sup> U.S. Construction project using “BAT”



5



## Croton – Site Overlook



6



## Croton – Sept '06



7



## Site Activities

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



8



## NYC Local Law 77

---

- Law enacted by NYC Council in 2003
- DEP Rulemaking in 2005
  - Ch. 14 of Title 15, Rules of City of New York
- Addresses emissions from “non-road” diesel equipment using cleaner fuel (ULSD) and “Best Available Technology” or BAT
- All City Agencies and their contractors



9



## Requirements

---

- Any diesel powered equipment > 50 HP must be:
  - Powered by ULSD
  - Utilize BAT for reducing emissions
- Equipment includes:
  - Excavators, backhoes, cranes, compressors, generators, bulldozers, etc.
- Does not include on-highway vehicles



10



## What is BAT?

- Definition:

“technology shall achieve the greatest reduction in emissions of particulate matter (PM) and shall in no event result in an increase in the emissions of either PM or nitrogen oxides (NOx)”



11



## BAT Categories

- Category I
  - System using diesel particulate filter (DPF)
    - Control PM + NOx or
    - PM Only
- Category II
  - System using diesel oxidation catalyst (DOC) or flow-through filter (FTF)
    - PM + NOx or
    - PM Only
- Category III
  - Emulsified Diesel Fuel (ULSD compatible)



12



## BAT Selection Criteria

- Technology must be verified by either:
  - US EPA
  - California Air Resources Board (ARB)
- Non-verified if:
  - OEM installed without compromising performance
  - Demonstration-stage technology

<http://www.epa.gov/otaq/retrofit/retroverifiedlist.htm>

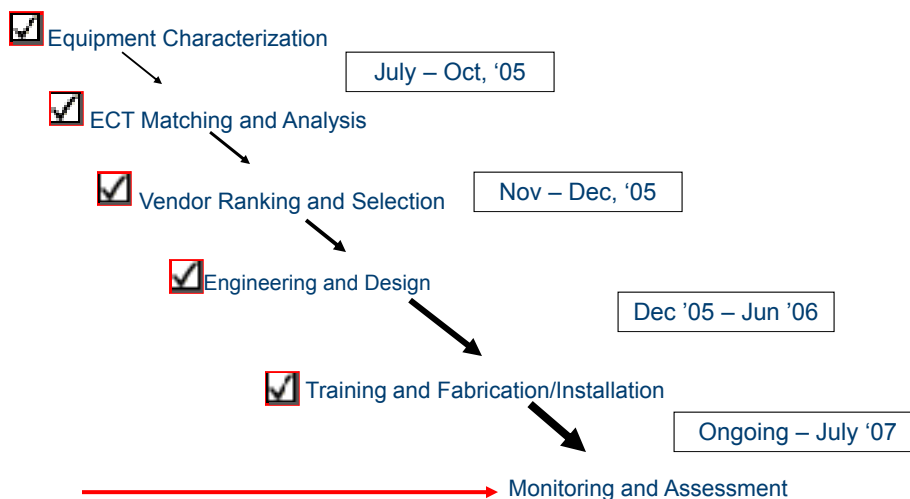
<http://www.arb.ca.gov/diesel/verdev/level1/level1.htm?PF=Y>



13



## Project Implementation



14



## Croton Vehicle Profile

---

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



15



## Equipment Characterization

---

- 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)

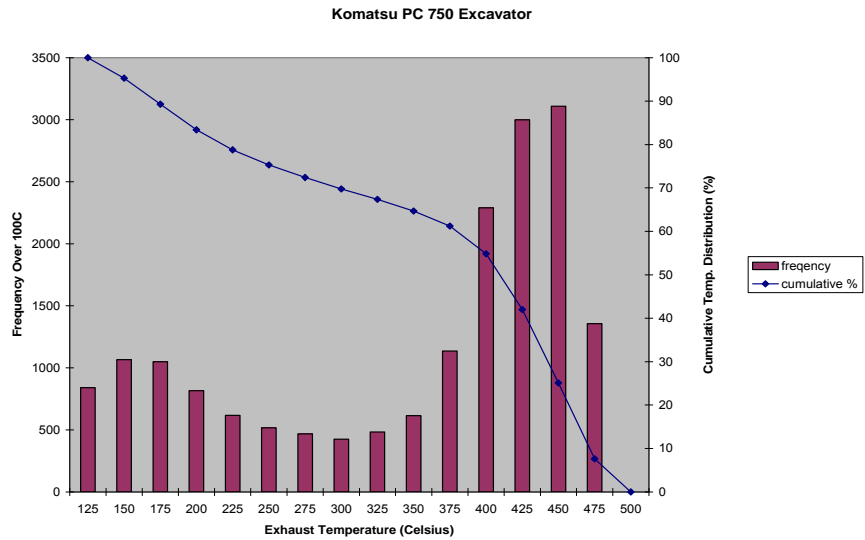


16





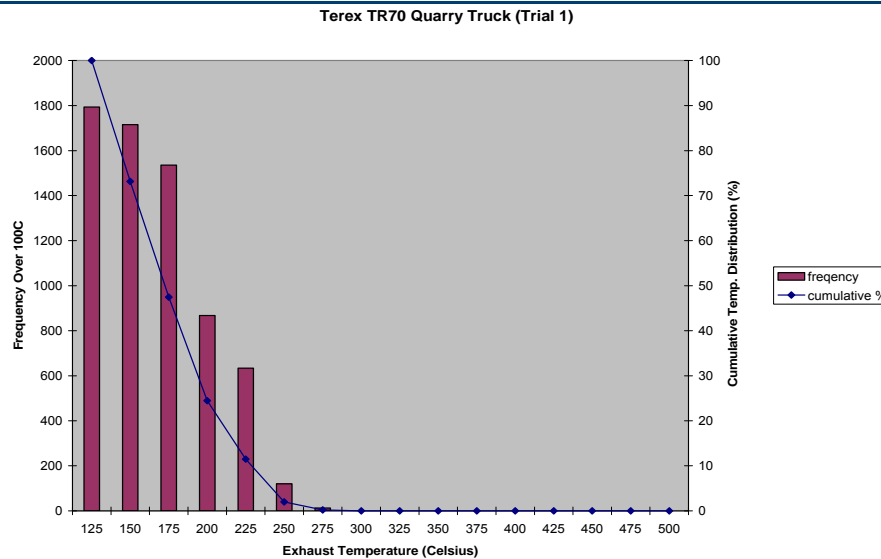
## High EGT profile – Komatsu PC-750



17



## Low EGT profile – Terex TR70



18



## Supplier Identification Process

- Prepared & issued RFP (16)
- Economic / Feasibility Analysis of Responses (7)
- Recommendations to NYCDEP
  - Verified Technologies
  - Advance Development Technologies



19



## ECT Providers

- Engine Control Systems
  - Passive Diesel Particulate Filter (PDPF) – *Purifilter*
  - 80-90% PM Reduction
  - EPA & ARB Verified
  - 75% of the construction equipment –
    - Excavators, dozers, compressors, drills, loaders
- CAT / Johnson Matthey
  - Passive Diesel Particulate Filter (PDPF) – *CRT*
  - 80-90% PM Reduction
  - EPA & ARB Verified
  - 1x Large HP excavator



20



## Providers (cont.)

- Cummins Emissions Solutions/JMI
  - Selective Catalytic Reduction (SCR) + PDPF – *SCRT*
    - 80-90% PM and 70%-90% NOx reductions
    - Advanced Development
    - 1x IR 600 Compressor
- Rypos
  - Active Diesel Particulate Filter (ADPF) – *RT-500 24 volt*
  - On-board electrical regeneration.
  - Terex TR 70 700 HP Quarry Trucks (3)
  - ARB verification for stationary back-up generators (BUGs), Level 2.
  - ARB verification for stationary BUGs, Level 3, in process.



21



## Technology Deployment

- Custom, On-site Installations
  - Mechanics
  - Welders/metal fabricators
  - Technicians
- 8 to 16 hours per installation
- Nights and weekends
- Not pre-designed systems



22



# Technology Deployment

Emisitor Retrofit ID #	Schivone Equip. ID #	Type	Manufacturer	Model #	BAT Mtg	Type	Status	DPF Installation Date	Monitor Installation Date	Comments
E35		Cleaning Station	ECS	Auto Comb/Clean			Delivered	pending		Target completion on 8/19
E38		Compressor	Ingersoll Rand	IR 600	FES	SCRT	Installed	6-Jul-06	6/2 JMT install a CRTdm?	BAT system reconfigured from E02. Install week of 6/25.
E37	728	Compressor	Ingersoll Rand	IR 185	ECS	Purifier	Delivered	27-Jun-06		New machine 406. Installed BAT from E01.
E45		Compressor	Ingersoll Rand	IR 185	ECS	Purifier	REMOVED	2-Jan-06		BAT installed. Removed when machine left site.
E49		Compressor	Ingersoll Rand	IR 449	-	-	REMOVED			Machine removed. BAT system reconfigured for E38.
E03		Dozer	Komatsu	D155-Ax-5B	ECS	Purifier	Installed	10-Mar-06		monitor on, amber & red lights on (move port)
E04		Dozer	Komatsu	D275 Ax-5B	ECS	Purifier	Installed	20-Jan-06		monitor on, amber light on (move port)
E26	1	Excavator	Hitachi	Z Axs-800	ECS	Purifier	Installed	15-Jan-06		monitor on, amber & red lights on (move port)
E25	2	Excavator	Hitachi	Z Axs-800	ECS	Purifier	Installed	14-Jan-06		BAT system & monitor removed, and in stock.
E05		Excavator	Hitachi	EX-1200-5C	ECS	On-Chassis	REMOVED			No BAT will be retrofitted, machine being decommissioned.
E28		Excavator	Komatsu	PC-200	ECS	Purifier	REMOVED: BACK ON SITE IN JUNE 06			BAT delivered. Machine removed prior to installation, but now back on-site.
E07		Excavator	Komatsu	PC-750	ECS	Purifier	Installed	18-Jan-06		monitor on, working OK since port 100B.
E08		Excavator	Komatsu	PC-400	-	-	REMOVED			Machine removed.
E29	2	Hydraulic Drill	Atlas-Copco	RA24-LB-44	ECS	Purifier	REMOVED			BAT delivered. Machine removed prior to installation.
E09		Hydraulic Drill	Atlas-Copco	-	-	-	REMOVED			BAT delivered. Machine removed prior to installation.
E22		Hydraulic Drill	Furukawa	HCR1500-ED	ECS	Purifier	Installed	8-Apr-06		monitor on, working OK.
E14	2	Hydraulic Drill	Sandvik Tamrock	Paritera 1100	ECS	Purifier	Installed	26-Mar-06		monitor on, working OK.
E13	10	Hydraulic Drill	Sandvik Tamrock	Paritera 1100	ECS	Purifier	Installed	25-Mar-06		monitor on, working OK.
E23	2	Hydraulic Drill	Tamrock	Scout 700-B	ECS	Purifier	Installed	24-May-06		monitor on, working OK.
E24	4	Hydraulic Drill	Tamrock	Scout 700-B	ECS	Purifier	Installed	23-May-06		needs monitor.
E48		Compressor	Ingersoll Rand	IR 449	-	-	REMOVED			Machine removed.
E49		Compressor	Ingersoll Rand	IR 449	-	-	REMOVED			BAT delivered. Machine removed prior to installation.
E49		Compressor	Ingersoll Rand	IR 449	-	-	REMOVED			BAT delivered. Machine removed prior to installation.
E49		Compressor	Ingersoll Rand	IR 449	-	-	REMOVED			BAT delivered. Machine removed prior to installation.
E15	855	Loader	Caterpillar	963D	CAJ	JMT CRT	Installed	2-Jun-06		BAT installed. Removed when machine left site.
E16		Loader	Caterpillar	980H	ECS	On-Chassis	Installed	5-Sep-05		Completed. Machine on site.
E17		Loader	Komatsu	WA450-3	ECS	On-Chassis	Installed			No BAT will be retrofitted.
E24		Quarry Truck	Terex	TR70	Rypos	ADPF	Installed	12-Mar-06		Machine removed due to non-compliance (Tier 2 or better).
E29		Quarry Truck	Terex	TR70	Rypos	ADPF	Installed	18-Mar-06		Removed from site.
E20	3	Quarry Truck	Terex	TR70	Rypos	ADPF	Installed	18-Mar-06		Removed from site.
E18	2	Quarry Truck	Terex	TR70	Rypos	ADPF	Installed	12-Mar-06		Rypos' own monitor.
E19	1	Quarry Truck	Terex	TR70	Rypos	ADPF	Installed	11-Mar-06		Rypos' own monitor, targeted for Interfleet GPS.
E20	2	Tiger Drill	Tamrock	CHA 700	ECS	Purifier	Installed	17-May-06		Completed. Machine on site.
E30	3	Tiger Drill	Tamrock	CHA 700	ECS	Purifier	Installed	16-May-06		Completed. Machine on site.
E31	4	Tiger Drill	Tamrock	CHA 700	ECS	Purifier	Installed	15-May-06		needs monitor.
E32	4	Tiger Drill	Tamrock	CHA 700	ECS	Purifier	Installed	15-May-06		Completed. Machine on site.
E39	5	Tiger Drill	Tamrock	CHA 700	ECS	Purifier	Awaiting Installation	TBD		DPF needs to be removed from this machine (E29) and installed on this machine (E39).
E21		Water Truck	Mack		ECS	Purifier	REMOVED: BACK ON SITE IN JUNE 06			DPF needs to be removed from E29 and installed on this machine (E39).

On-road truck.

## EGBP/EGT Monitoring

- All Croton Category 1 BAT systems require monitoring
- Utilized:
  - CRTdm for PDPF
  - Supplier installed monitors for ADPF & SCRT
  - Handheld digital manometers as backup
- Periodic diagnostics
- Alarm Triggered Event
  - Establish Retrofit Case History



## EGBP/EGT Monitoring

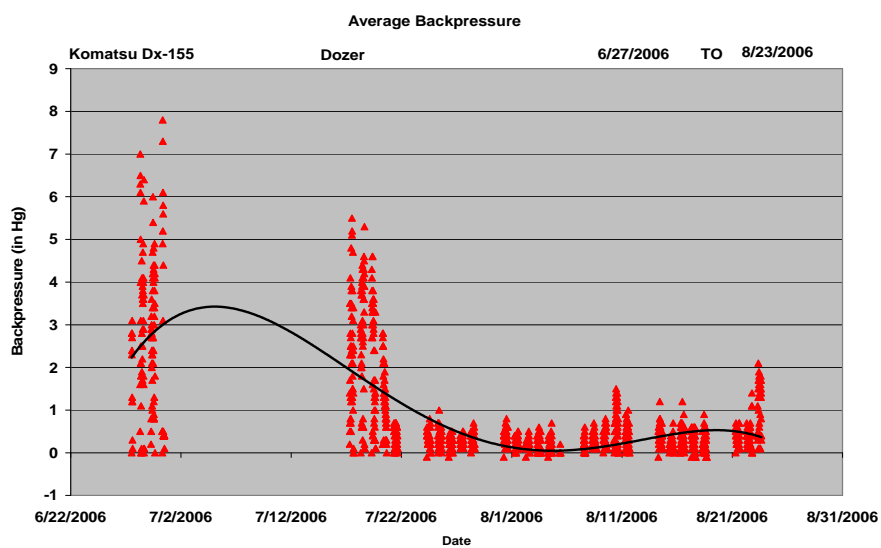


EMISSTAR

25

MINING DIESEL  
**mdec**  
EMISSIONS COUNCIL

## Komatsu Dx-155 EGBP



EMISSTAR

26

MINING DIESEL  
**mdec**  
EMISSIONS COUNCIL

## In-Use Emissions Testing

### Environment Canada DOES2

- 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.
- Why 'DOES2?'
  - It most closely replicates engine laboratory conditions.
  - Is the most accurate and repeatable under varying equipment operation and climatic conditions.
  - Is capable of measuring PM.
  - It references EPA's CFR new engine certification techniques for PM measurement.



27



## In-Use Emissions Testing



28



## In-Use Emissions Testing



EMISSTAR



MINING DIESEL  
**mdec**  
EMISSIONS COUNCIL

29

## 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

EMISSTAR

MINING DIESEL  
**mdec**  
EMISSIONS COUNCIL

30

## Challenges and Issues

- Rotating equipment stock (66% turnover)
- ECT Suppliers for the nonroad market
- Technical
  - OEM Backpressure compliance
  - Well engineered & robust design
- Operational
  - Interrupting site-operations
  - Harsh conditions
    - Vibration
    - Dust
- Variability in Service & Support
  - Lead times
  - Servicing units



31



## Challenges and Issues



32





## Filter substrate failure



33



## Successes

- Assuaged community concerns about health impacts of pollution.
- Deployed Category 1 BAT or higher on all 25+ machines.
- Working for over 1 year w/minimal downtime or interference.
- Quantified in-use emission reductions through ISS testing



34



## Lessons Learned

---

- Fleet participation is critical
- Trained mechanic/support for large deployments
- Move project from “orphan” to “owner” phase as quickly as possible
- Engineer for Nonroad environment
- Keep spare parts, supplies & filter cleaning station on-hand (cost justified)
- Documentation – installation, maintenance, repair, warranty



35



## Technology Transfer To Mining

---

What are the similarities;  
what are the differences?

---

- Operating environment?
- Variability of equipment type?
- Interest from ECT providers?

*What do you think?*



36



## Croton Picture Gallery



## Croton – Furukawa Hydraulic Drill



## Croton – Hitachi Z-Axis 800 Excavator (2)



39



## Croton – Hitachi Z-Axis 800 Excavator (2)

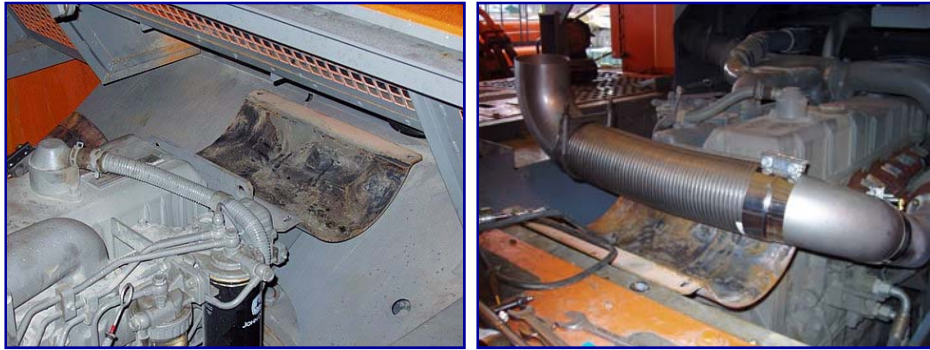


40





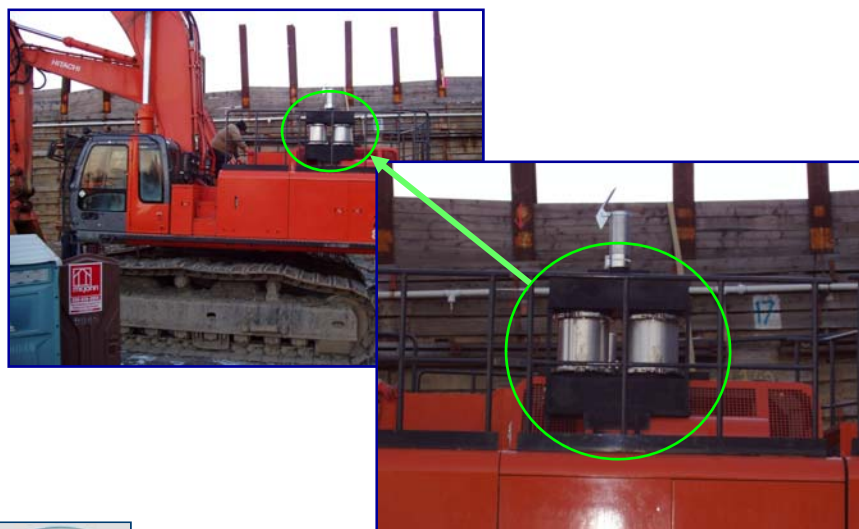
## Croton – Hitachi Z-Axis 800 Excavator (2 machines)



41



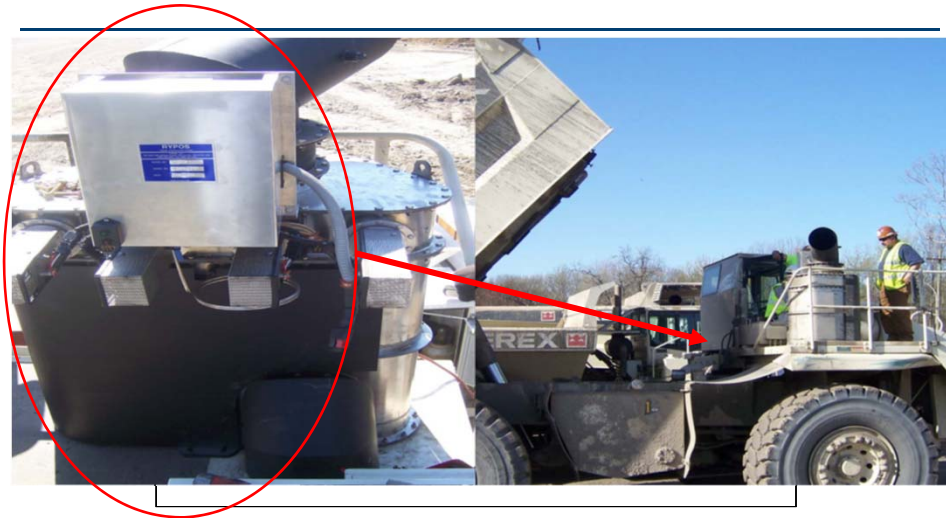
## Croton – Hitachi Z-Axis 800 Excavator (2)



42



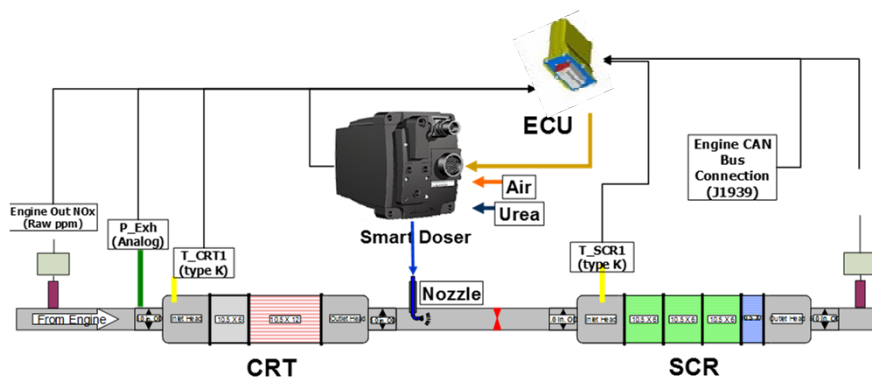
## Croton – Terex TR 70 w/Rypos ADPF/C



43



## JMI SCRT



44



## SCRT (cont.)



3 Tail Pipe

2 SCR Module

1 CRT Module



45



## Contact Information – Emisstar LLC

Glenn P. Goldstein, Principal  
631-363-3730

[glenn.goldstein@emisstar.com](mailto:glenn.goldstein@emisstar.com)

Michael C. Block, Principal  
603-520-4147

[michael.block@emisstar.com](mailto:michael.block@emisstar.com)



46

