SCR Retrofit Emissions Reductions for Mining Equipment at Sifto Canada

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Nett Technologies Inc.

The 19th Annual Mining Diesel Emissions Conference

October 9th, 2013

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PRESENTATION OUTLINE

1) **Introduction to Nett Technologies Inc.**
2) **Sifto Canada Salt Mine Background**
3) **Update of Past Work Performed by CANMET at Sifto**
4) **Current Retrofits at Sifto**
   - **Emissions Performance**
   - **Operational Experience**
5) **SCR Systems in Mining Applications**

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NETT TECHNOLOGIES INC.
INTRODUCTION

- Located in the Greater Toronto area
- Emissions control company specializing in the design, development and manufacturing of pollution control solutions for today's compression and spark-ignited engines

Product offerings:

- Diesel oxidation catalysts (DOC)
- Diesel particulate filters (DPF)
- Selective catalytic reduction (SCR)
- Non Selective Catalytic Reduction (NSCR)
- Electronic control units (ECU)
- Engine silencers

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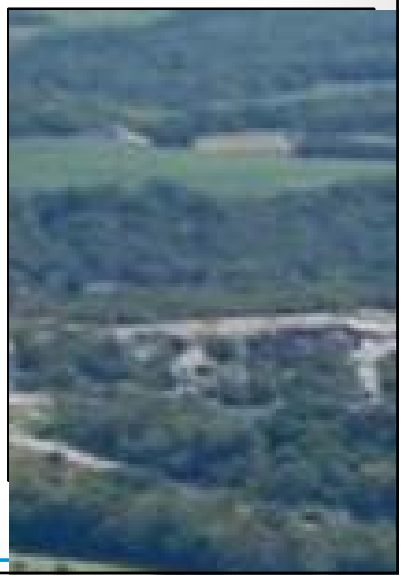
SIFTO CANADA
OVERVIEW

Compass Minerals siffo Canada Corp.

- Located in Goderich, Ontario, Canada
- The world's largest salt mine
- 750, 000 cfm of ventilation air travels 20 km from intake to exhaust
- Intake air enters through two Ø16' shafts and is exhausted through one Ø22' shaft that are less than 100m apart on the surface
- The mine has over 22,000 hp in diesel fleet equipment underground



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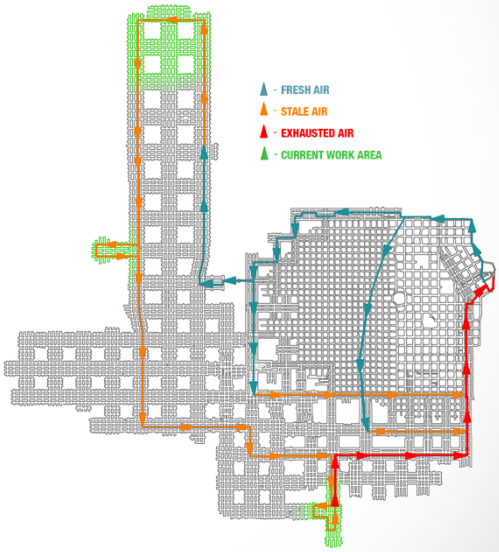
SIFTO MINE LAYOUT

4 sizes of headings exist:

- Development
  (60' wide by 12' high)
- Continuous development
  (60' wide by 14' high)
- Conventional
  (60' wide by 43' high)
- Bench
  (60' wide by 48' high)



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CANMET STUDY OF GODERICH NO_2

- Ventilation studies were performed by CANMET in 1997 and 1999 that are still valid today
- The results showed:
  - Ventilation system is capable of supplying up to 800,000 CFM
  - Air can be in the mine for over 40 hours
  - Using Fine's equation, 61% of the original NO generated converts to NO_2
  - Typical NO:NO_2 ratios in multi-level mines are 10:1. The Goderich mine ratio is 1:1

Reference: Natural Resources Canada – CANMET Mining and Mineral Sciences Laboratories "Mining Diesel Emissions Conference Presentation – 2010"

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NOx IN MINES AND REGULATIONS

- Oxides of nitrogen (NOx) are important pollutants to be observed in mining environments.
- Mine challenges
  - slow air movement
  - oxidation of NO to NO_2
- Provincial regulations limit the level of NO_2 in the ambient air to 3ppm
- American Conference of Governmental Industrial Hygienists (ACGIH) has recommended limits as low as 0.2 ppm
- Diesel engines in the mine are a significant source of NOx
- Urea based SCR systems can provide significant NOx reductions

Reference: Natural Resources Canada – CANMET Mining and Mineral Sciences Laboratories "Mining Diesel Emissions Conference Presentation – 2010"

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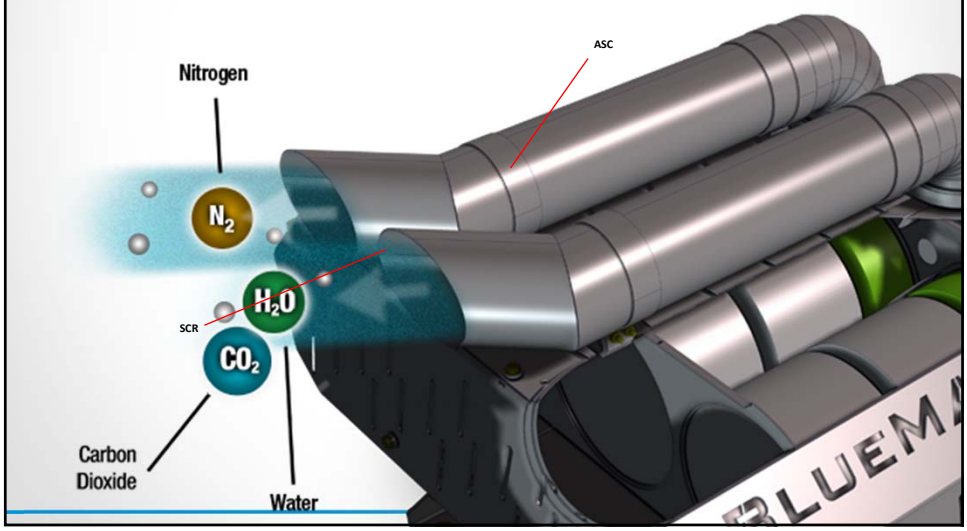
BLUEMAX™ 100 EPA VERIFIED SYSTEM FOR NONROAD APPLICATIONS



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HOW THE SCR WORKS

- Diesel Exhaust Fluid (DEF) is a liquid with a 32.5% urea concentration in water
- Urea is hydrolyzed in the exhaust creating ammonia (NH_3)
- NOx is reduced from the following reactions:
  - $6NO + 4NH_3 \rightarrow 5N_2 + 6H_2O$
  - $4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$
  - $6NO_2 + 8NH_3 \rightarrow 7N_2 + 12H_2O$
  - $2NO_2 + 4NH_3 + O_2 \rightarrow 3N_2 + 6H_2O$
  - $NO + NO_2 + 2NH_3 \rightarrow 2N_2 + 3H_2O$
- Ammonia that is not used in the reaction is oxidized by an ammonia slip catalyst (ASC)

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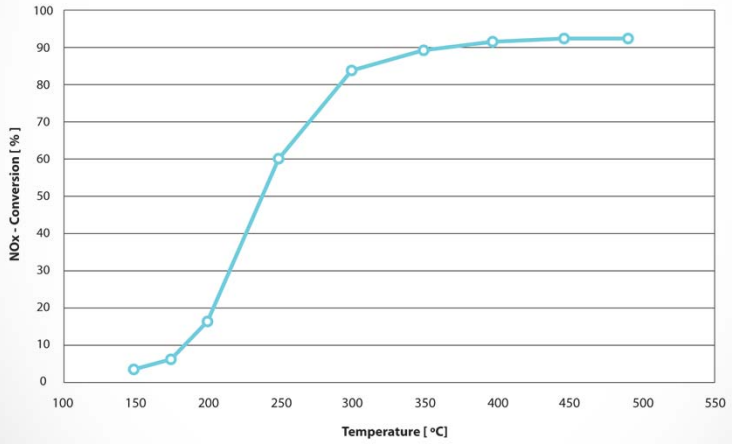
NETT BLUEMAX™ 100

IRON ZEOLITE SCR CATALYST PERFORMANCE



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NETT BLUEMAX™ 100
SYSTEM DESIGN CONSIDERATIONS

- Temperature/Duty Cycle profile of equipment
  - >225 °C for 30% of the time to achieve 65%
- Variables to consider during design of system:
  - Urea dosing gain tuning
  - Catalyst space velocity
  - Inlet piping design (Computation Fluid Dynamics – CFD, to ensure adequate urea mix)
  - Mining environment (exposure to salt and dust, mechanical durability)
  - Thermal management (larger system)
  - Urea custom tank design (robustness, matches diesel fueling intervals)

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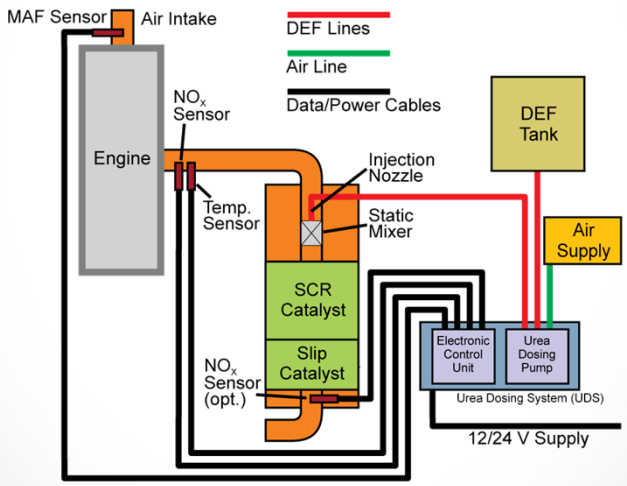
NETT BLUEMAX™ 100
SCR SYSTEM SCHEMATIC



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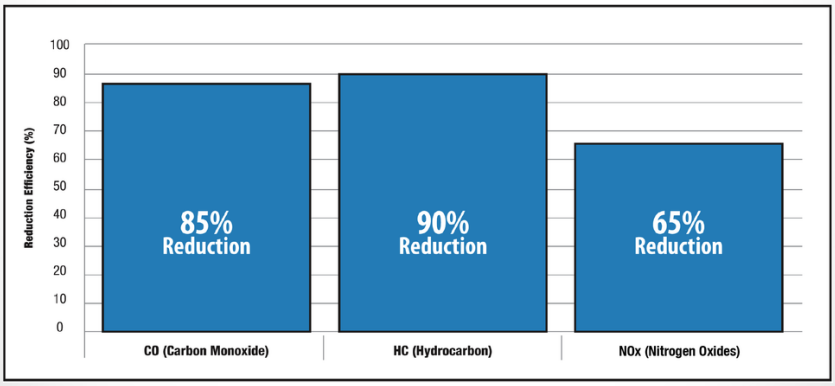
NETT BLUEMAX™ 100
SYSTEM PERFORMANCE



http://www.epa.gov/cleandiesel/verification/techlist-nett.htm

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2010 SIFTO/CANMET DEMONSTRATION PROJECT

- In 2010 a SCR demonstration project was conducted to evaluate performance of 2 retrofit solutions
- Long term goal was to prepare Sifto for future retrofit of underground fleet
- Equipment retrofitted:
  - Caterpillar 775E truck (Nett Technologies Inc.)
  - Caterpillar 990G wheel loader (Alternate Supplier)
- Emissions sampling was performed over production duty cycles by CANMET
- The Nett BlueMAX 100 system was shown to provide the best overall performance (65% reduction) and selected to for additional retrofits within the remain high engine horsepower fleet

Reference: Natural Resources Canada – CANMET Mining and Mineral Sciences Laboratories "Mining Diesel Emissions Conference Presentation – 2010"

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NETT BLUEMAX™ 100
RETROFITS AT SIFTO

Make	Model	Installation Date	Total Operation Hours
Caterpillar	775E Truck	18-Sep-09	12,544
Komatsu	HD605 Truck	28-Feb-12	4,397
Komatsu	HD605 Truck	29-Mar-12	4,621
Caterpillar	990H Loader	4-Jan-13	2,200
Komatsu	WA900 Loader	10-Jan-13	801
Komatsu	PC650 Excavator	5-Mar-13	110
DUX	DT50 Truck	25-Apr-13	N/A
DUX	DT50 Truck	15-May-13	822
DUX	DT50 Truck	16-May-13	711
DUX	DT50 Truck	Pending	

* Operation Hours recorded September 9, 2013

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CATERPILLAR 775E TRUCK

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KOMATSU HD605-7 HAUL TRUCK

- Direct Fit Design
- Does not obstruct driver sight lines
- Durable stainless steel construction

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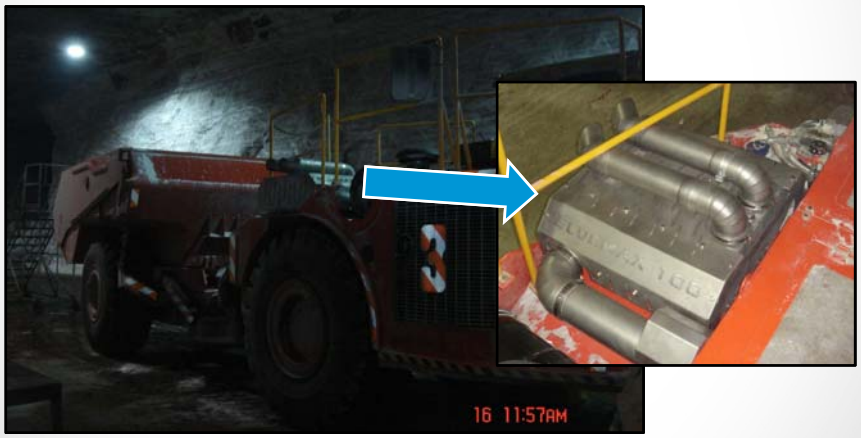
DUX DT-50 HAUL TRUCK



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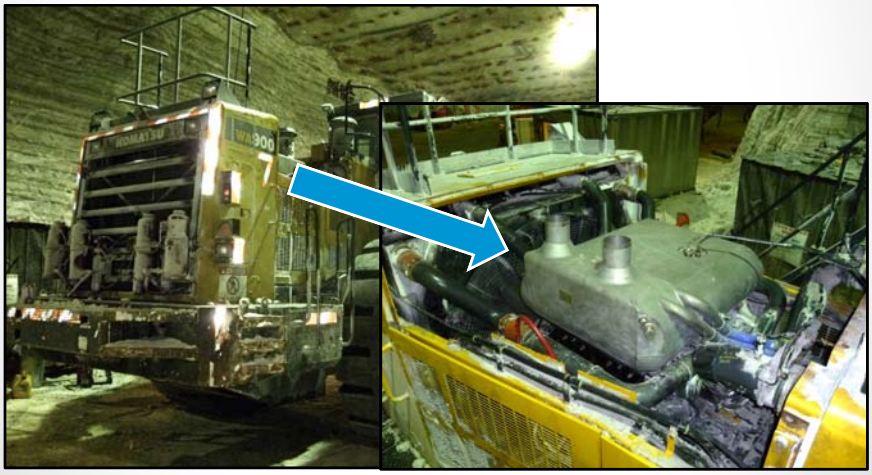
KOMATSU WA 900 WHEEL LOADER



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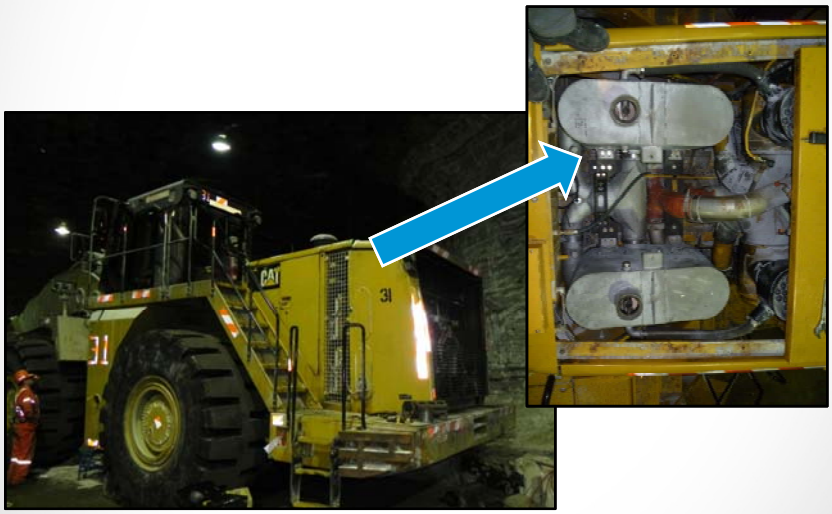
CATERPILLAR 990H WHEEL LOADER



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KOMATSU PC650 EXCAVATOR

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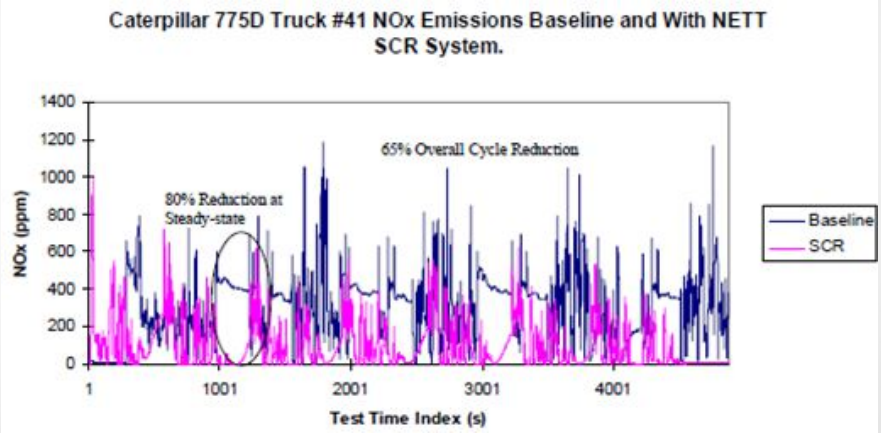
EMISSIONS PERFORMANCE

CANMET 2010 STUDY



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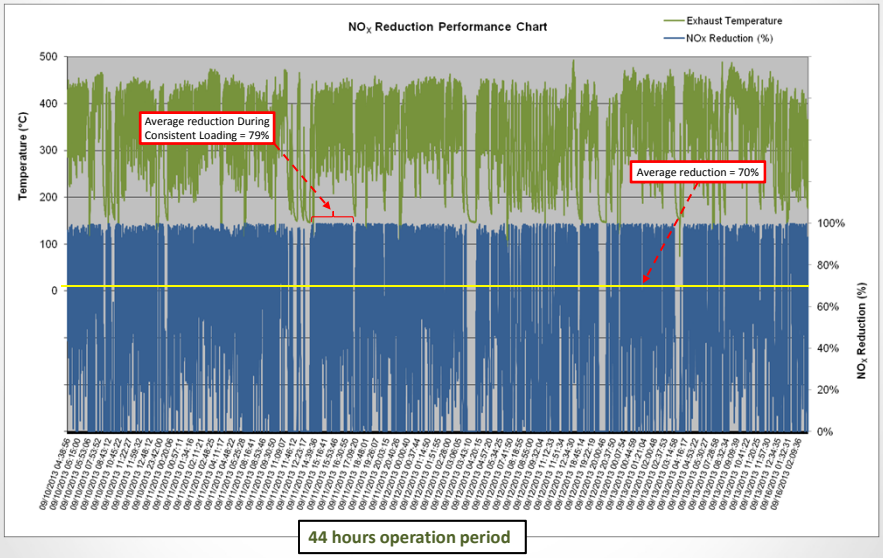
EMISSIONS PERFORMANCE for CATERPILLAR 990H



44 hours operation period

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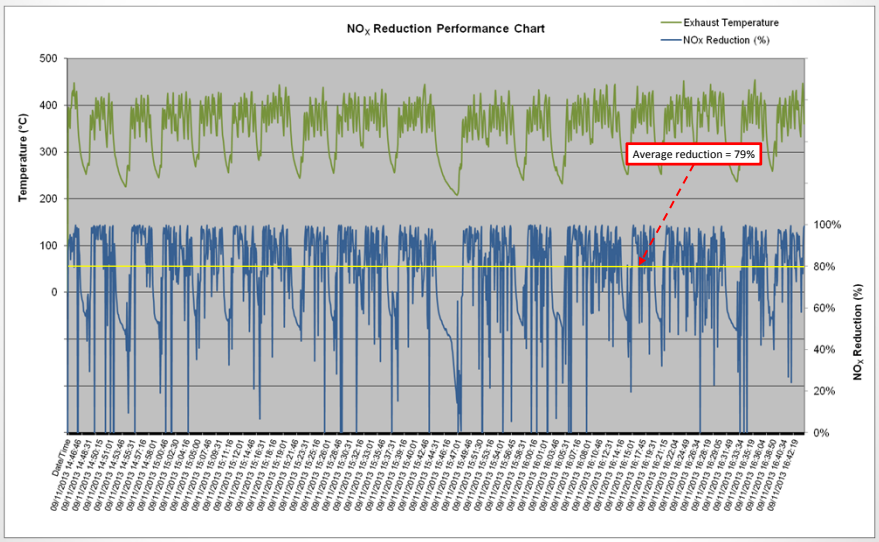
EMISSIONS PERFORMANCE for CATERPILLAR 990H



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LATEST ADVANCEMENTS
PTLOG™270SCR

PTLOG™270SCR monitor and data logger provides:
- Instantaneous system performance
- Data logging capability
- Expanded OBD over the base Alarm Box

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OPERATIONAL EXPERIENCE
TAKE AWAYS

- The system has provided long durability from both mechanical and operational perspectives
- Similar experience and performance is expected from subsequent custom fit installations
- System's simplicity requires minimum operator interaction (from the simple OBD error interface to service requirements)
- System malfunctions do not cause the equipment downtime
- Like with the introduction of any new technology, training in maintenance and trouble shooting is required
- Sensors to be "guarded" for damage protection

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SCR SYSTEMS IN MINING APPLICATIONS

- SCR systems offered for none-road application have not only proven to be robust in various applications but can "easily" be transferred to any mining environment
- Outside of specifics for Sifto mine, SCR systems can be adopted as a technology of choice as a mining NO_2 reduction measure
- Focusing on large horsepower and/or the hottest working equipment produces a best ROI approach
- Systems can be designed to fit any engine size from 100 hp to 3,500 hp operating underground as well as in open pit applications where stagnate NOx is problematic

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THANK YOU

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