

Falconbridge - Sudbury Mines Group

Diesel Emissions Reduction Program



MDEC 2003

DEEP Technology Transfer Workshop

Mike Cousins & Sean McGinn



Falconbridge and CAW



COLLECTIVE AGREEMENT LANGUAGE

The company recognizes the impact of control technologies and maintenance practice on reducing particulate matter in diesel emissions.

In this light the company commits to review the feasibility of the following:

- **Use of low sulfur diesel fuels in underground mobile equipment.**
- **Application of the recommendations of the DEEP program on improved maintenance practice and use of trap filters in our underground operations.**

The feasibility study will be completed in six months following the conclusion of negotiations. Upon completion of the feasibility study an implementation plan will be developed and reviewed with the Union. The Union will be represented by the Union President, CAW Health & Safety Coordinator and one of the Full Time Worker Health & Safety Representatives from the Mines/Mill Business Unit.

DEEP Recommendations & DERP Action Plans

- Team Approach to maintenance
- Use 6 system approach to engine maintenance
- Training for each mechanic on 6 system approach
 - Apply Engine specific Inspections
 - Exhaust emissions testing programs
 - Engine maintenance audit programs



Sudbury Mines Implementation

D
E
R
P
Program



- Fraser Copper
- Fraser Nickel
- Craig
- Thayer Lindsley
- Lockerby



DERP Steering Team

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Coordinator

Mike Cousins - Mobile Equipment
Supervisor - Sudbury Mines

Site Champions

Craig Mine Mtce Foreman
Fraser Copper Mtce Foreman
Fraser Nickel Mtce Foreman
Lockerby Mine Mtce Foreman
T.L. Mine Mtce Foreman

Full Time JHSC Worker Representatives

CAW
USWA

Inside & Outside resources as required

Sean McGinn - McGinn Integration Inc.
Cambrian College
Harper Detroit Diesel
Falconbridge Mines Technology - Ventilation
Falconbridge - Industrial Hygiene



Diesel Engine Maintenance Training

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- Two Days / Mechanic
- Theory / Practical
- UGAS & Emissions Testing
- Six System Maintenance
- Diagnostic Tools
- Five Mines
- 100 Mechanics



Diesel Engine Maintenance Emissions Testing - UGAS

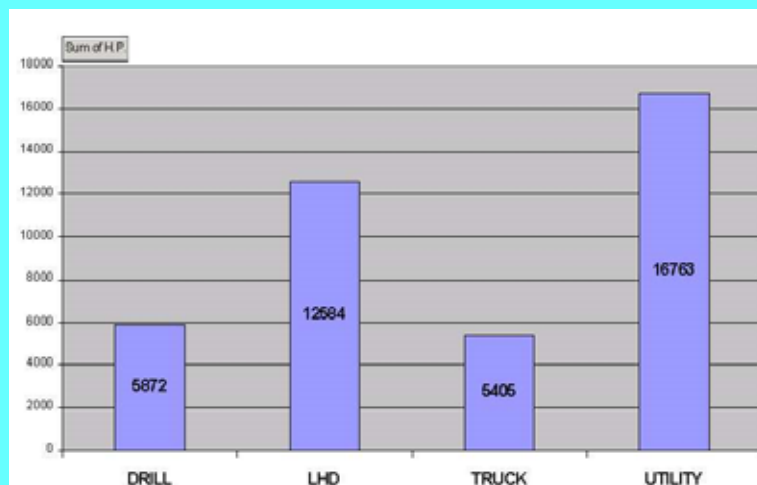
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Four Units Installed / Four Mines



Sudbury Mines - Horsepower Distribution





Diesel Engine Maintenance

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Best Practices

- Engine Specific PMs
- Fuel Distribution Systems
- Standardized Emissions Test Procedure
- Condition Based Maintenance
- Measure-Measure-Measure



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Engine Specific PMs

Engine Preventive Maintenance (EPM)

Pre PM Cleaning

- Steam clean engine and surrounding compartments
- Clean rad and coolers with degreaser and high volume-pressure water hose
- Air Cooled: Remove inspection covers-- degreaser and steam clean cylinders and cooler
- Cleaning Satisfactory? **Y** **N** Initials: _____

Perform Emissions Test

- Turn on ECOM analyzer – Select ‘Diesel’ and press ‘E’ – 3 minute zero calibration with fresh air
- UGAS – User and Vehicle login
- Camera Button (verify vehicle login) – Smoke Test select ‘Yes’ – Full throttle & Stall
- Enter Test ID, RPM and Smoke Test value
- Gas Sampling – Full throttle / Full Stall
- Test Report – Print & Save - verify Current values against Target Values (TV)
- Repeat for opposite side of DOC
- DOC Conversion Efficiency
 - [1 - CO After / CO Before] X 100 = _____%
 - Action required if less than 75% **OR** greater than 75 ppm CO @ tailpipe after DOC
- Note actions required based on emissions and diagnose / repair – if actions required re-do emissions test at finish to verify
- ACTIONS: _____

Intake System

- Measure and record intake restriction: _____ inches of water
- Measure and record charge pressure: _____ psi (full throttle & load)
- DO NOT replace filters if less than 15" restriction
- CAREFULLY remove filter and inspect for proper function of pre-cleaner and make necessary repairs – Clean out pre-cleaner and housing carefully
- Install plug filter and pressure test intake with regulator @ 10 psi – check for and repair all leaks on both suction and charge sides
- Carefully re-install old (or new) filters before starting engine
- ACTIONS: _____

Exhaust System

- Measure and record backpressure: _____ inches of water (max 30")
- Attach UGAS emissions printouts pre – post DOC from above
- Inspect clamps, connections, flanges for leaks and repair as required
- Inspect turbo, piping, deflectors
- Inspect insulation, check for fire hazards, repair as required
- ACTIONS: _____



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Engine Specific PMs

Fuel System

- Service water separator and/or drain water from bottom fitting on tank
- Replace primary and secondary fuel filters and bleed system
- Visual inspection for tank contamination, condition of lines, hoses, cooler
- ACTIONS: _____

Cooling System

- Measure and record temperature differential across rad _____ degrees
- Measure and record charge air temp at cooler outlet _____ degrees (max 50C)
- Verify operation of thermostats cycling with IR temp gun
- Visual inspection of rad, fan, belts, leaks,
- Air cooled engines:
 - Verify cylinder temperatures
 - Verify engine oil cooler temperature differential
 - Verify condition of belts, drive, blower, sensors and alarms
- ACTIONS: _____

Lubrication

- Drain oil and take sample (from drain not filters)
- Replace lube filters (do not pre-fill on bench)
- Fill crankcase with new oil – run/stop engine and verify proper level
- Visual inspection for external leaks, internal leaks (consumption) at exhaust or turbo, crankcase breather blow-by

Detroit Diesel Electronic (DDEC) Engines

- Tools Menu – Engine/Trip Data – Print and re-set Trip Data
- Diagnostics Menu – Cylinder Cutout – Automatic @1000 RPM and Print
- Diagnostic Menu – Fault Codes – Verify and Clear Inactive
- Full RPM – No Load: _____ RPM
- Full RPM – Converter Stall: _____ RPM ---- Turbo Boost _____ psi
- Full RPM – Converter – Hyd Stall: _____ RPM
- NOTES: _____

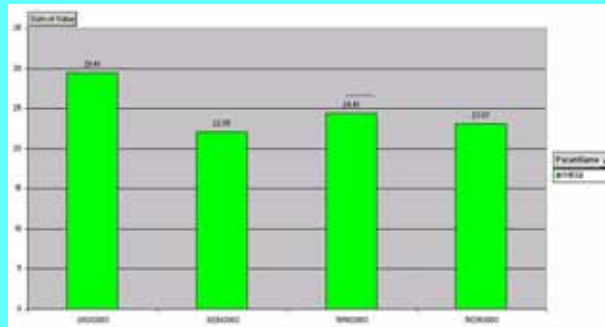



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Diesel Engine Maintenance

Results - Emissions Reduction

- UGAS Emissions Measurement and Tracking
- Tracking by MEQI
- Maintenance Exhaust Quality Index





Diesel Engine Maintenance

Tracking Emissions Reduction

Diesel Emissions Reduction Program


MEQI = Maintenance Exhaust Quality Index
 $CO/25 + NO/25 + NO_2/3$

Modelled On

CAN/CSA M424.2-90 Engine Certification

$$EQI = \frac{CO}{50} + \frac{NO}{25} + \frac{DPM}{2} + 1.5 \left[\frac{SO_2}{3} + \frac{DPM}{2} \right] + 1.2 \left[\frac{NO_2}{3} + \frac{DPM}{2} \right]$$

Ventilation (CFM/BHP) = (EQI / 3) X Exhaust Gas Flow Rate



Diesel Engine Maintenance

Results - Cost Reduction

Diesel Emissions Reduction Program

- Condition Based Engine Maintenance
- Minimize Instinct Based Decisions
- Maximize Measurement Based Decisions
- Example - Intake Filter Replacement
 - Based on intake restriction measurement -reduced \$\$\$
 - Focus on maintaining intake integrity - leaks



Future Engine Selection

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- Engine certification, from CANMET, will be used to determine exhaust emissions.
- New equipment specifications have been changed, so that if there is a choice, the cleanest engine will be purchased



Ultra Low Sulphur Diesel Fuel

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- Present sulphur content is 0.05% (reduced from 0.25% as per regulations)
- Until recently this was best quality available for both U/G and surface.
- Falconbridge and INCO proposing to co- test ultra-low sulphur diesel (<0.005%) to be commercially available



Ultra Low Sulphur Diesel Fuel

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- **Proposing Thayer Lindsley Mine for test period of one year**
- **Estimated fuel consumption - 0.7M Liters**
- **Measurement - baseline at current 0.05% fuel**
- **Measurement - study at proposed 0.005% fuel**
- **Measurement - ambient DPM concentrations**
- **Measurement - undiluted (raw) diesel emissions**
- **Technology Enabler - "CRT" type DPFs**




Diesel Particulate Filters (DPFs)

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- **To begin implementation once maintenance has been audited as successful by DERP steering committee**
- **Focus will be put towards heavy production haulage equipment - scooptrams and trucks**
- **Selection and implementation criteria assisted by results of DEEP trap projects**
- **Gradual implementation at each site with emphasis on application engineering for success**
- **Possible testing of "CRT" traps with ultra-low sulfur diesel fuel testing at T.L.**



Diesel Emission Reduction Program



**“Back to Basics”
Maintenance**

**Team
Approach**

**Priority &
Focus**

Training

Needs to become a “way of life” & has to involve everybody