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## Laboratory Evaluation of Field Trial DPF's Used for Light Duty Vehicles

11<sup>th</sup> Mining Diesel Emissions Conference  
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M. Gangal, B. Rubeli and D. Young (NRCan)  
J. Stachulak (INCO)

MMSL 05-100(OPJ)

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## Project

- Evaluation of field trial DPFs used at INCO's Stobie mine under DEEP consortium program
- DPFs for Evaluation
  - Three DPFs used with HD vehicles
  - Two DPFs used with LD vehicles
- Laboratory Evaluation
  - Engine dynamometer testing for emissions
  - DPM Characterization
  - Inspection of DPFs for physical damages

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## Engine Dynamometer Testing

- Steady state ISO 8178C1 8-mode test cycle
- Steady state 3-mode test cycle used in field
  - Full torque converter stall
  - High idle, no load
  - Low idle, no load
- Transient smoke snap acceleration tests, SAE J1667

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## DPM Characterization

- Integrated value of 8-mode DPM filters
  - Soluble organic fractions (SOF) by ASE extraction method
  - Sulphate determination by ion chromatography
  - Analysis of EPA-target PAHs (16 items)

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## Inspection of DPFs for Damages

- Prior to emission testing
  - Visual
  - Photograph
  - X-ray
- After emission testing
  - Boroscope analysis
  - Sectioning, coring

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## Presentation

- Emission test results of two DPFs used with LD Vehicles
  - #LD2180, ECS/Unikat Combifilter S5, 460 hours
  - #LD621, DCL Titan filter, 730 hours
- Both are silicon carbide with active regeneration system
- Both used with Kubota M5400 tractor/F2803B engine



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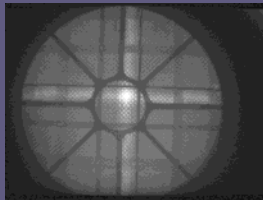
## DPF # LD2180 - Photographs



Inlet side



Outlet side



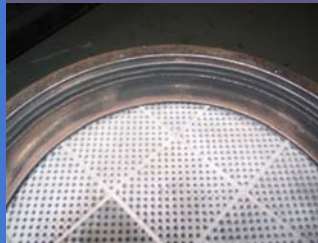
X-ray

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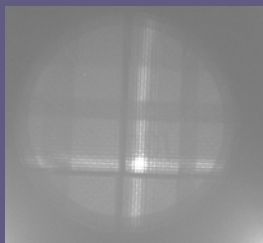
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## DPF # LD621 - Photographs



Outlet side



X-ray

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## Bench Testing

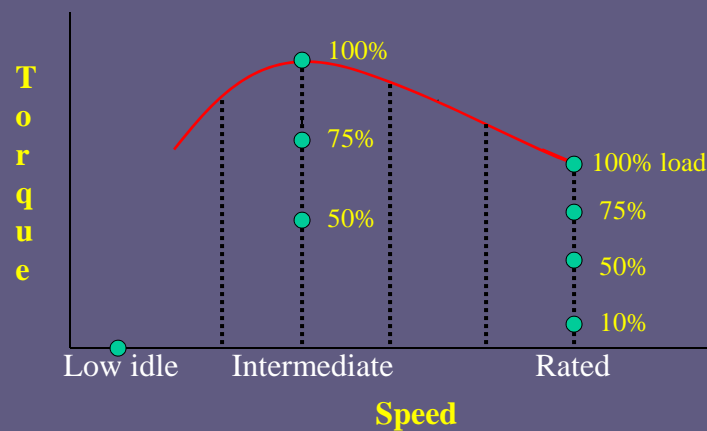
- Engine: Kubota V3300TE, turbo, 87 hp@2600 rpm
- Fuel: CGSB-3.16 Mining Diesel Fuel, S=0.033%
- Test Method: ISO 8178-1
- Test Cycle: ISO 8178-C1, 8-mode
- DPFs: Cleaned with compressed air
- Test Lab: NRCan, CANMET-MMSL, Ottawa
- Lab Accreditation: ISO 9001-2000, ISO/IEC 17025

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## ISO 8178-C1 Test Cycle



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## Exhaust Emission Measurements

- Gases
  - $O_2$ , HC, CO,  $CO_2$ , NO,  $NO_x$ ,  $SO_2$
- Particulates
  - Mass, Size, Number, EC(NanoMet), Opacity
- Exhaust Quality Index (EQI)

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

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## Light Duty Engine DPF Testing

DPF # LD2180

DPF #LD621

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## Engine Power (HP) Data at 8-Modes and Integrated Value

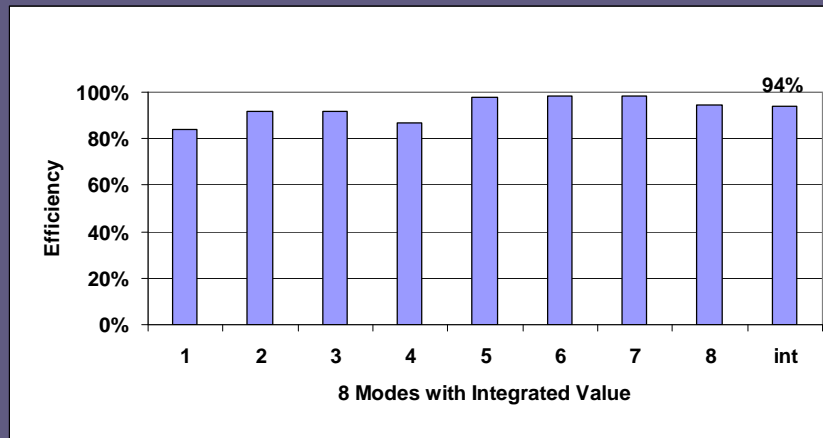
Mode →	1	2	3	4	5	6	7	8	INT
Baseline (Kubota)	85.6	64.4	43.0	8.7	63.7	47.7	31.8	0.5	44.2
LD#2180	84.8	64.3	42.9	8.7	62.2	47.8	31.9	0.4	43.9
LD#621	85.7	64.3	43.0	8.8	63.0	47.8	31.8	0.4	44.1

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## DPM (Mass) Based Efficiency (LD 2180)

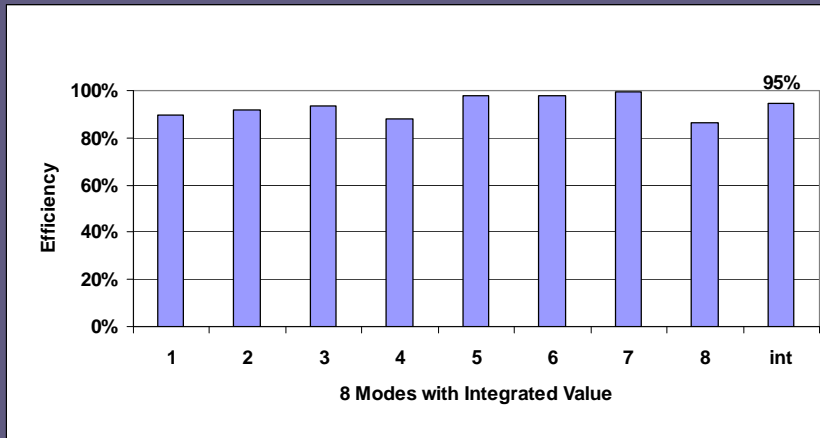


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## DPM (Mass) Based Efficiency (LD 621)

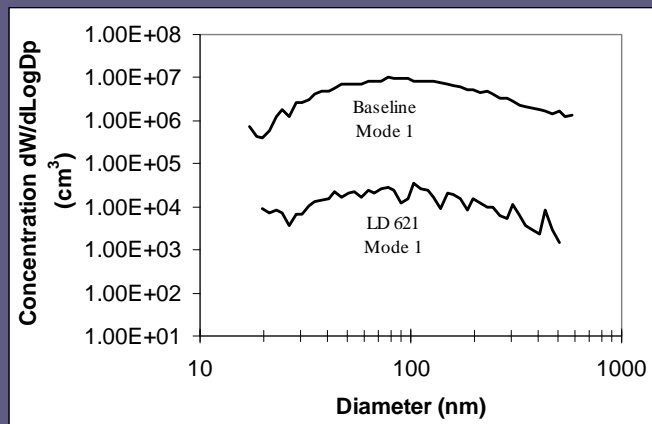


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## Particle Size Distribution



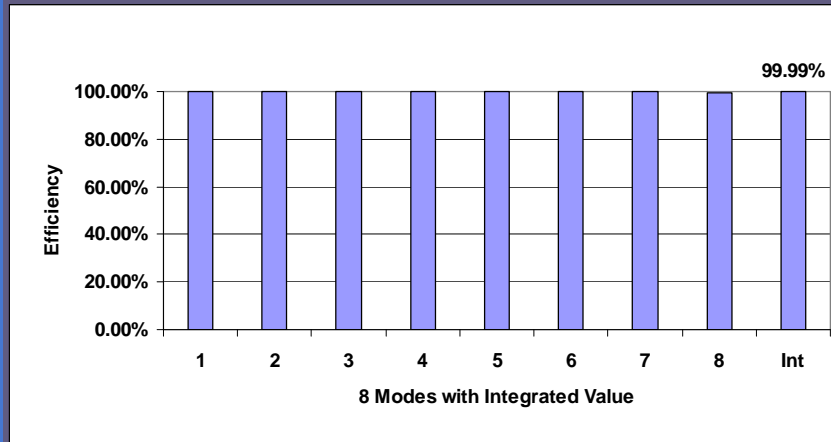
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## DPM (Number) Based Efficiency (LD 2180)

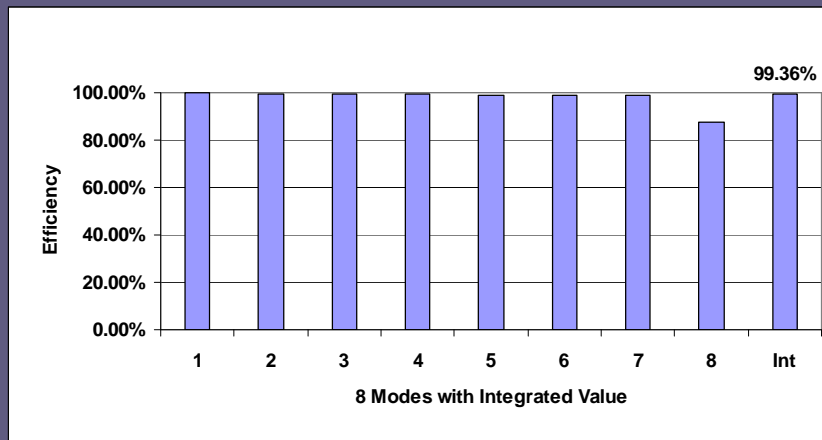


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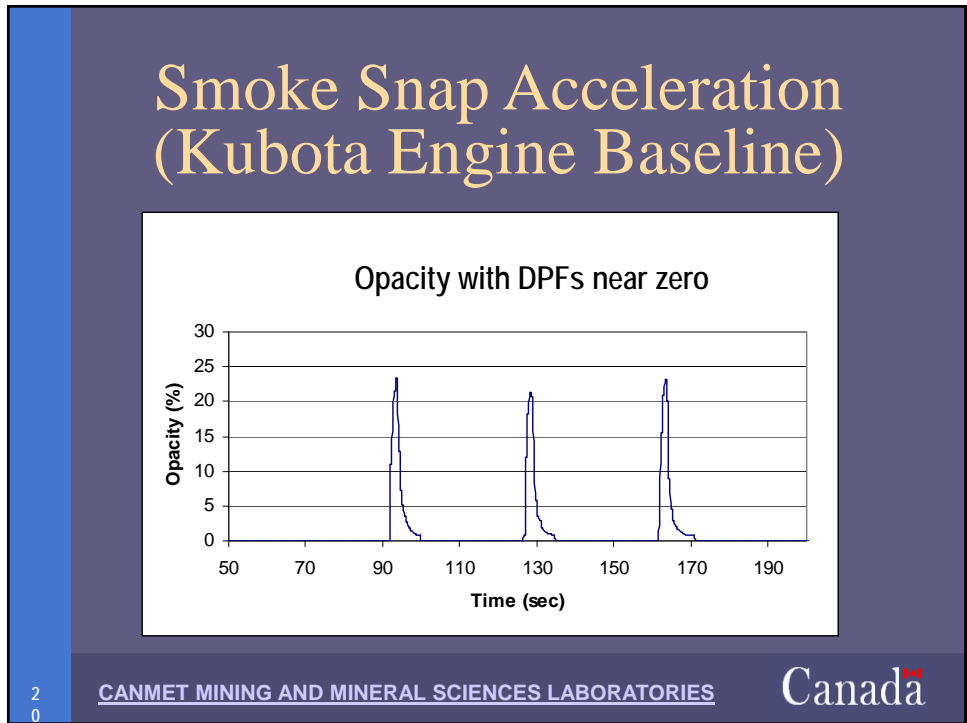
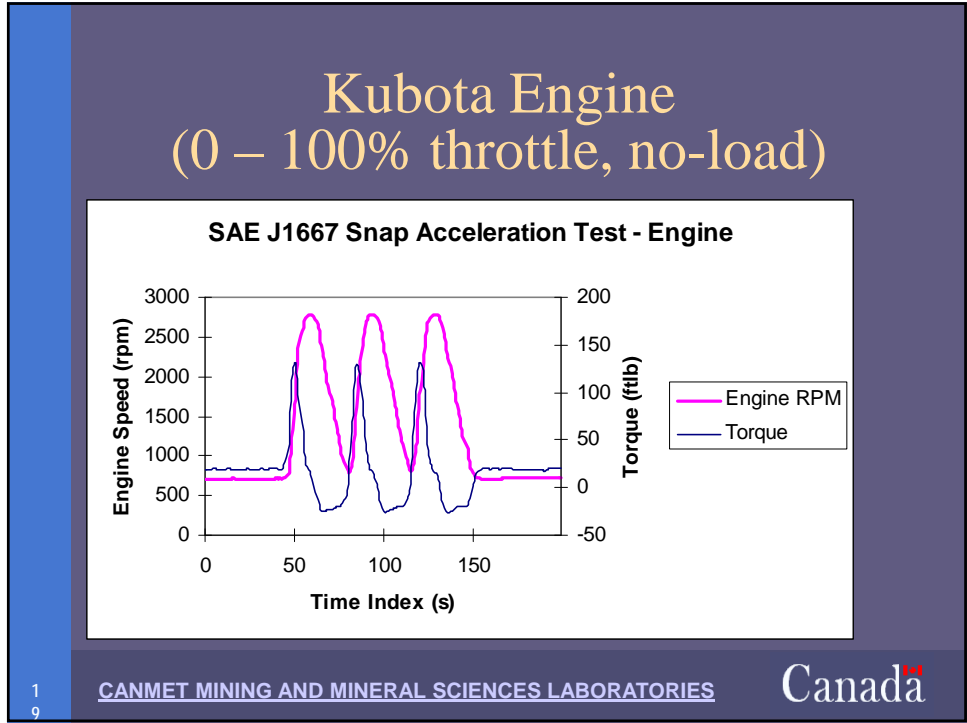
## DPM (Number) Based Efficiency (LD 621)



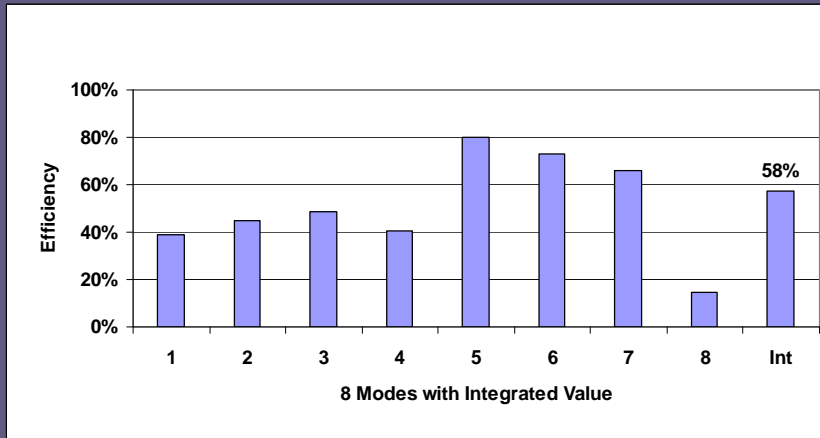
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## EQI Based Efficiency (LD 2180)

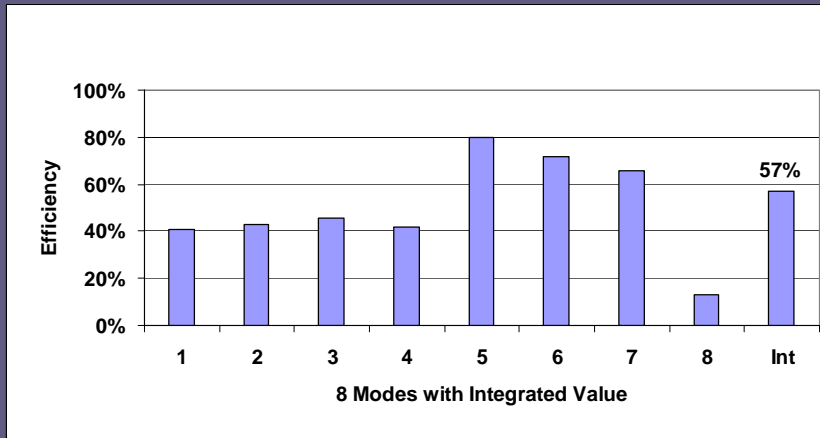


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## EQI Based Efficiency (LD 621)



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## Percent Efficiency - Summary

DPF	DPM (Mass)	DPM(Number)	EQI
#LD 2180	93.9	99.99	57.5
#LD 621	94.8	99.36	56.9

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## Summary

- The DPFs showed good efficiency by all parameters after the field trials
- Slight damage to LD621 DPF did not affect the performance.
- Test data from DPFs used with HD vehicles are currently being analysed
- Conclusions will be made in the final DEEP report

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