

The Longview Diesel Emission Control
System:
**Emissions Performance of a Combined
DPF and NOx Reduction Catalyst System**

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Outline

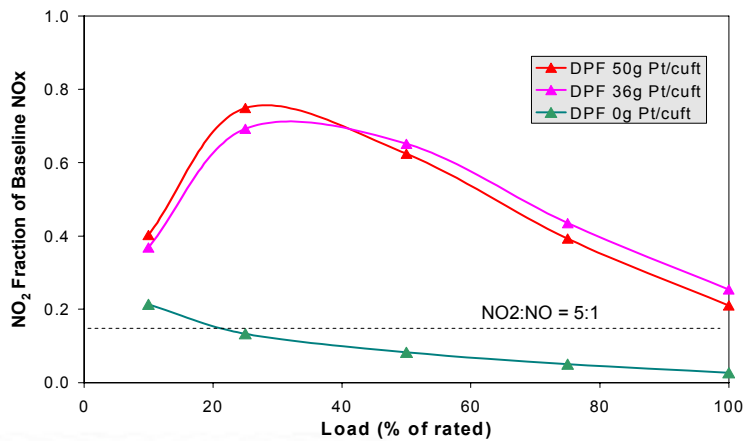
- **Background**
- Longview system
- Testing
- Summary



Background

- PM control (elemental carbon) is required/desired on Diesel engines in underground mines.
- Wall flow filters offer desired levels of PM/EC control, but....
-use of precious metals as part of regeneration strategy has an adverse impact on NO₂ formation.
- Reductions in PM/EC control are offset by increases in NO₂, thus offsetting the benefit of the filter.
- The Holy Grail: A system that offers the benefits of a passive regeneration system without the disbenefit of high NO₂ formation.

Catalyzed DPFs can adversely affect NO₂:NO ratio



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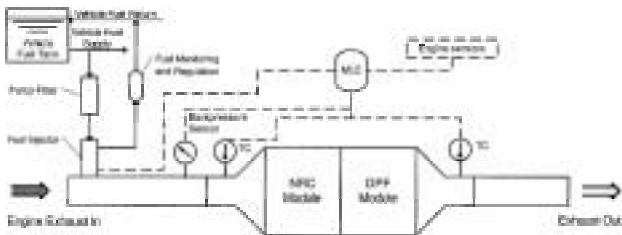
The Longview® System

- Developed for the above ground markets concerned with PM and Ozone
- Combines HC-SCR with catalyzed DPF to reduce NO_x, PM, CO, and HC.
- HC-SCR means active hydrocarbon dosing upstream of a NO_x Reduction Catalyst (aka Lean NO_x Catalyst)
- Patented HC dosing and electronic control components

The Longview® System

- CARB verified for on-road mobile applications in 2003
 - 5 to 15 L diesel engines.
 - Requires exhaust temperatures of 260 dec C for 25% time.
 - 5 year/150,000 mile warranty
 - Annual warranty reports required
- 2800 retrofit applications in California including transit bus, refuse truck, and line-haul vehicles.
 - 7.5 million hours / 142 million kilometers
 - Temperature and backpressure history is constantly logged
 - Warranty claims <1% (no filter or catalyst failures)
- Non-road verification work in progress with many field trials underway.

The Longview System



System Design Features



Modular design



Advanced diagnostics and controls



Rugged components: SiC and Stainless Steel

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Test Objectives

1. Demonstrate emission performance of Longview system.
2. Investigate impact of elevated backpressure on emissions.
3. Investigate impact of fuel sulfur level on emissions.

Test Setup

Cummins Test Laboratory in Rocky Mount, North Carolina

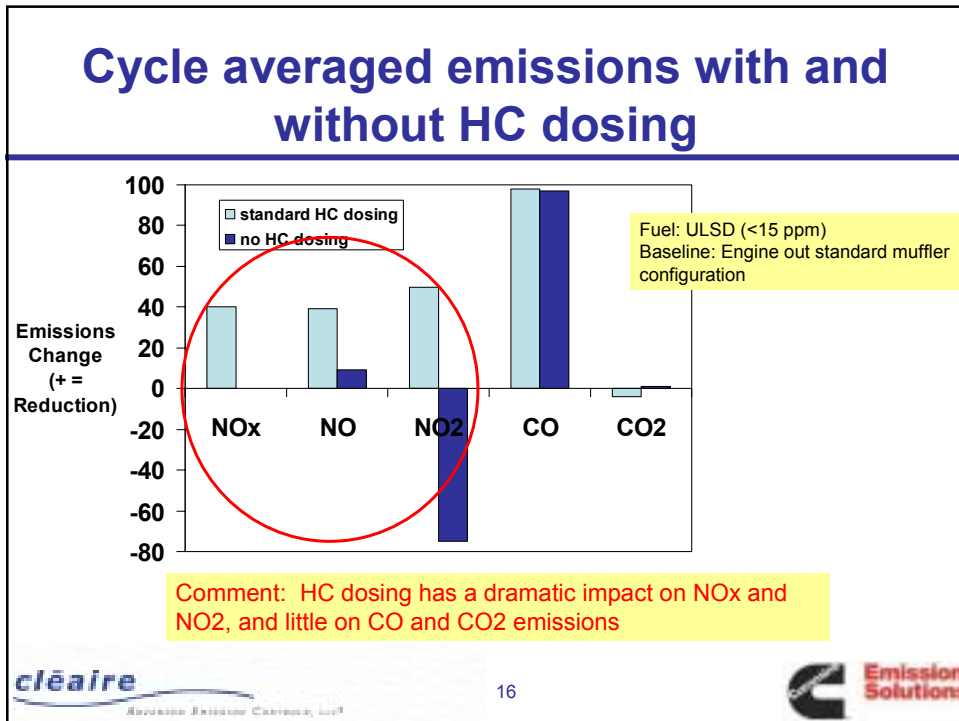
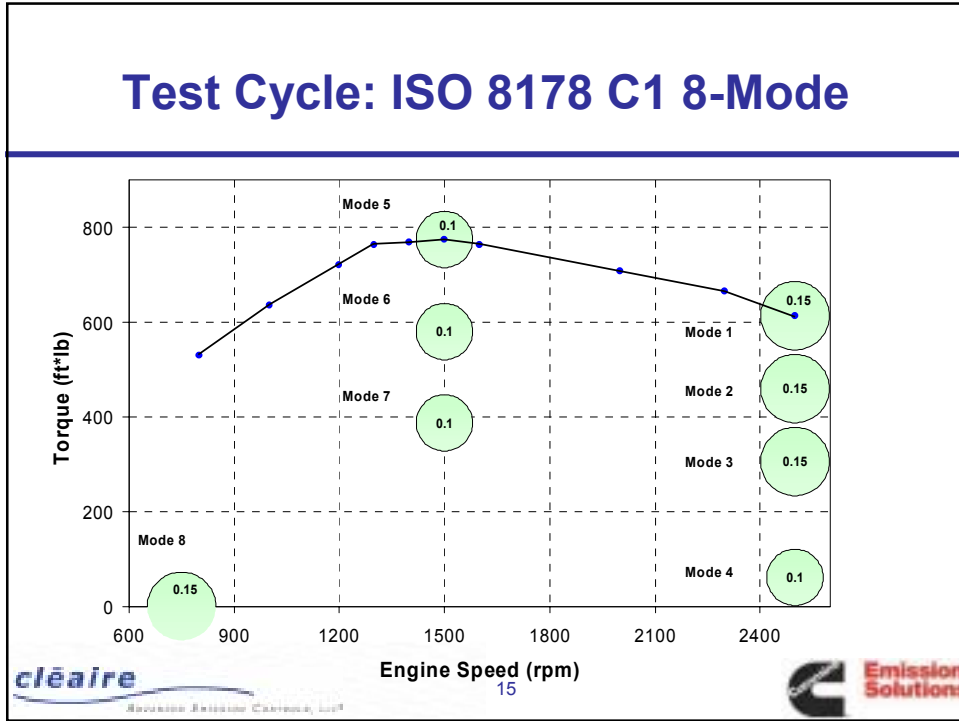
- Raw emissions sampling of:
 - NO and NO_x (NO₂ inferred by subtraction)
 - CO
 - CO₂
- Filter composed silicon carbide,
 - CARB verified and VERT approved at >85% efficiency.
 - Performance of SiC wall flow filters are very well understood

Test Plan

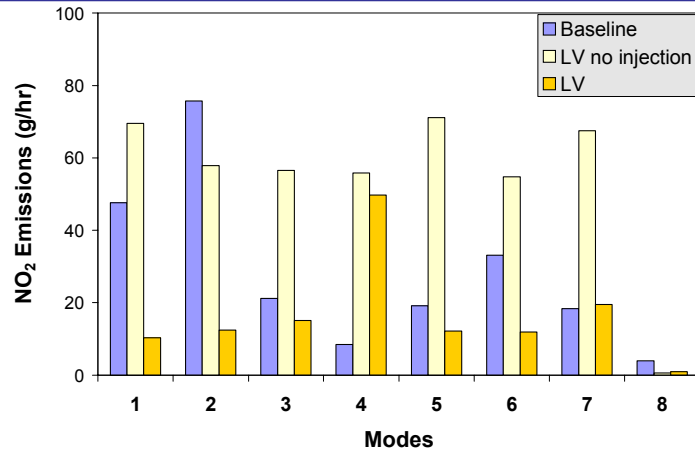
- ISO 8178 D1 8-Mode Test Cycle
- Baseline Emissions
 - Standard (3”Hg) and high backpressure (11” Hg)
 - Fuels: ULSD (<15 ppm S) and #2 diesel (308 ppm S)
- Longview
 - With and without HC injection
 - Standard (6” Hg) and high backpressure (11” Hg)
 - Fuels: ULSD (<15 ppm S) and #2 diesel (308 ppm S)

Test Engine

- MY 2005 Cummins QSB Tier III engine
- 6.7 L Displacement
- 285 hp at 2500 rpm
- Common rail fuel injection system

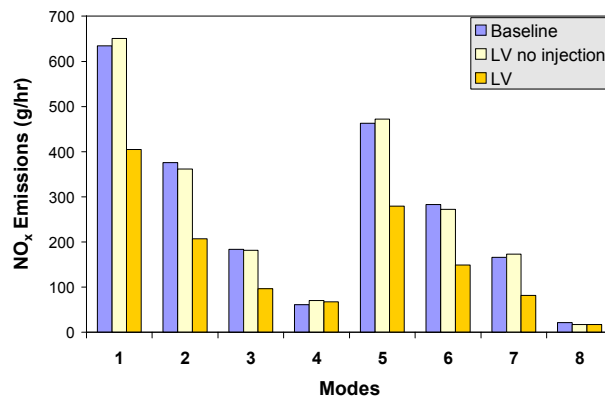


Impact of HC dosing on NO₂ by mode

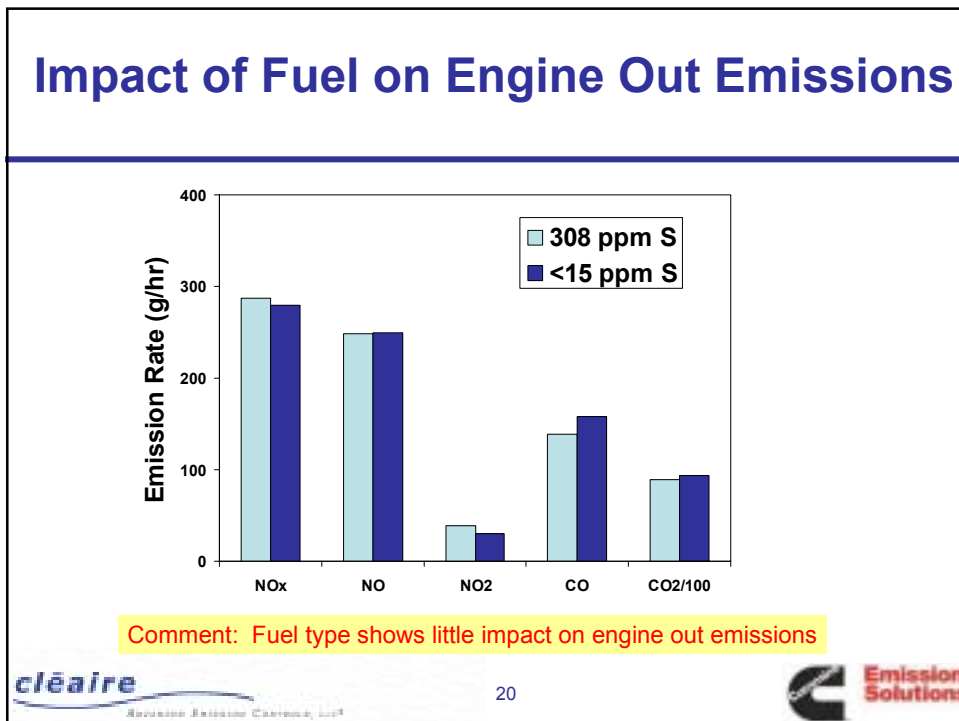
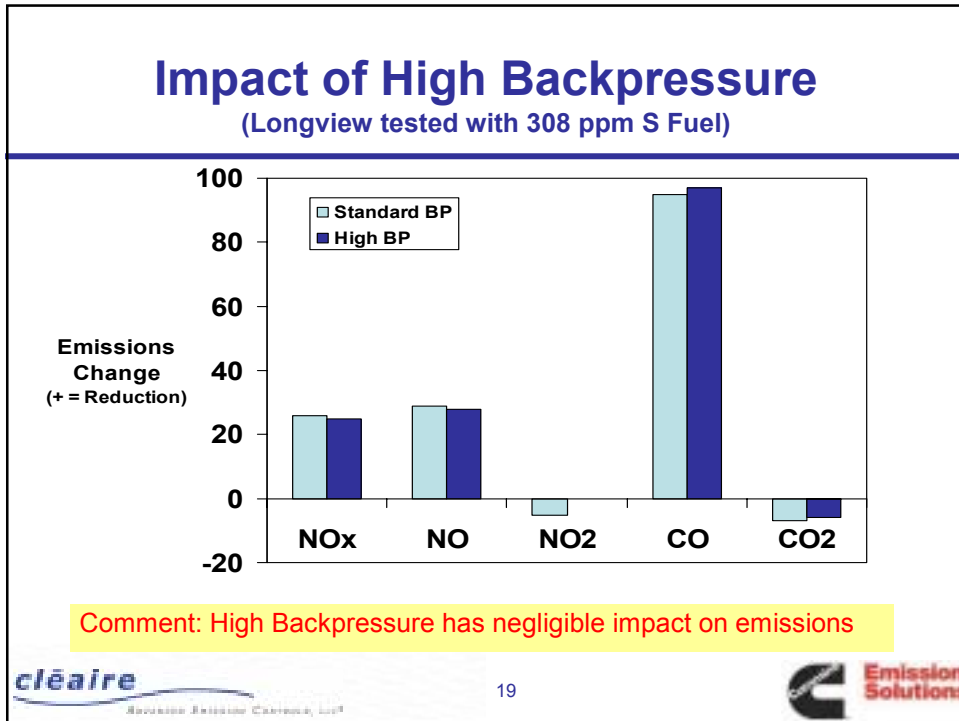


Comment: NO₂ below baseline in all modes except mode 4 (high idle)

Impact of HC dosing on NO_x by Mode



Comment: NO_x is reduced not just shifted between NO and NO₂



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Summary: Data

Cycle averaged emissions from Longview System using ULSD

- NO_x reduction of 40%
- NO₂ reduction of 50%
- CO almost completely removed
- CO₂ increase of 5%

Summary: Comments

The system's fuel injection and NOx reduction catalysts play an important role on NO, NO2, and NOx emissions.

The catalyzed DPF plays an important role in CO (and HC & PM) reductions.

Artificially high backpressure levels showed no adverse effects on emissions, in fact NO2 emissions were reduced.

Baseline and system emissions showed little difference when operated with #2 diesel and ULSD fuel.

Summary: Next Steps

Longview systems currently operating in underground mining field trials.

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