



PuriNOx™ Low Emission Diesel Fuel

Faster Freight Cleaner Air

Oakland, California

December 8, 2004



**Presented by: Ron O. Dunfee
Market Development Manager
The Lubrizol Corporation**

What is PuriNOx™?

- **A pollution mitigation technology**
 - A means of reducing NOx and PM from diesel engine exhaust
 - Competes with other diesel engine mitigation technologies like natural gas
 - Does not compete with diesel fuel

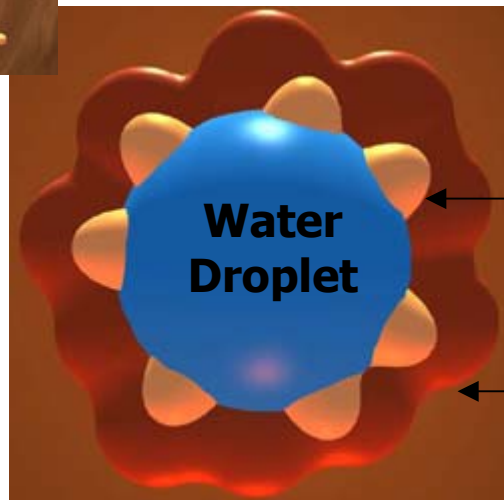
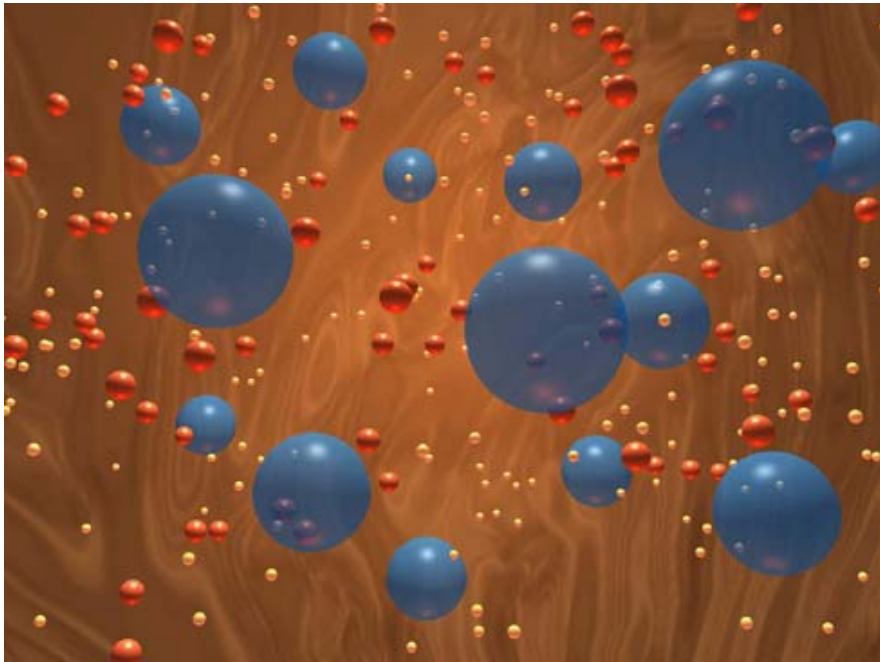
- **An emulsified diesel fuel (EDF)**
 - Contains up to 20% emulsified water
 - Stable emulsion
 - Skim milk in appearance and consistency



PuriNOx™ Fuel

Water-in-Diesel Fuel

- Diesel is the outside phase
- Similar properties to diesel
- Handles like diesel
- Mixes with diesel fuel



Water Soluble
"Head"
of Additive

Fuel Soluble
"Tail" of Additive

How is PuriNOx™ Made?

**PuriNOx™
Additive
Package**

Water

**Diesel
Fuel**

**Seasonal or
Other
Components**



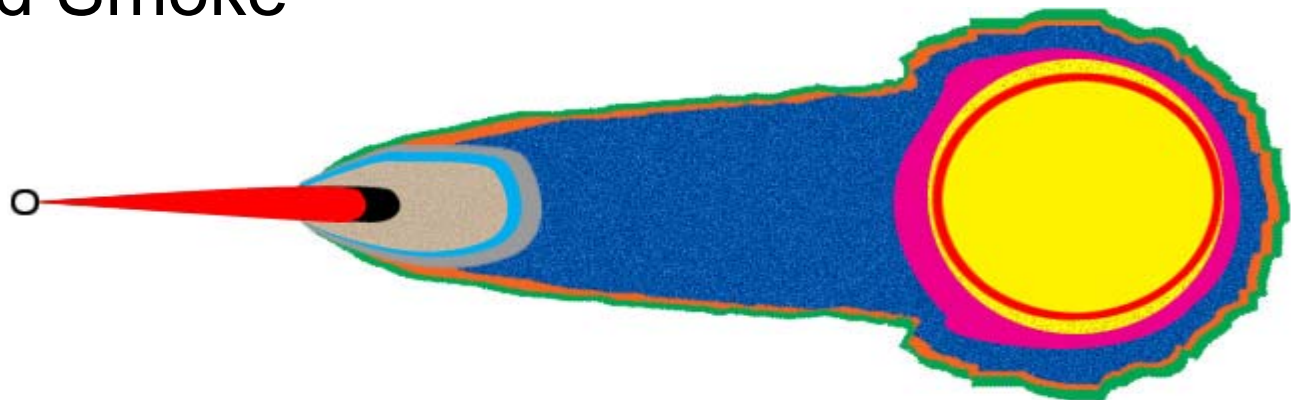
**PuriNOx™
Blending Unit**



**PuriNOx™
Fuel**

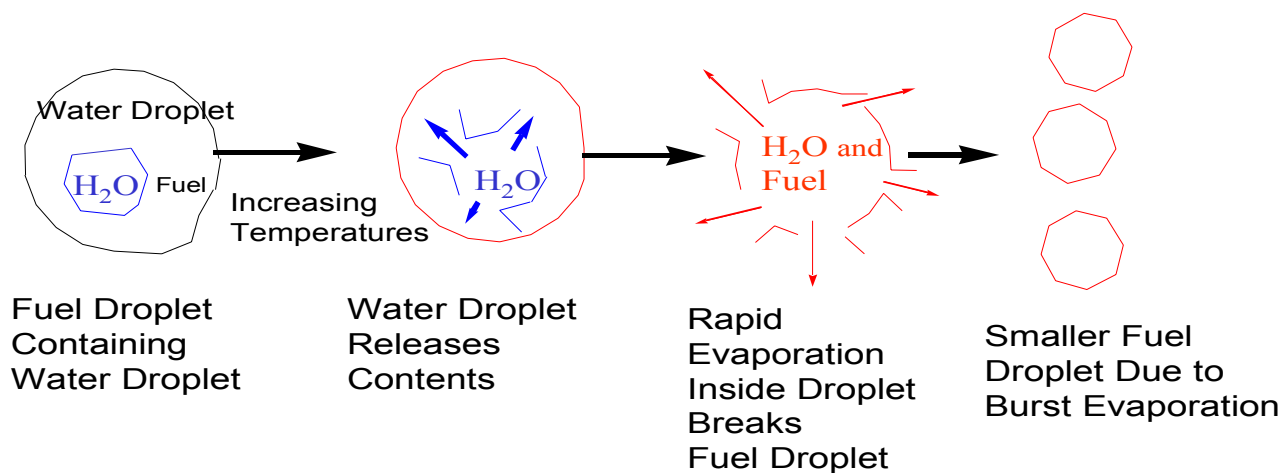
What Water Does in The Emulsified Fuel

- Water Reduces Combustion Temperature Which Reduces NOx
- Water Changes the Combustion Process to Burn the Fuel More Efficiently
 - Which Reduces Particulate Matter and Smoke



Combustion Mechanism

Burst Evaporation Leads to Enhanced Vaporization of the Fuel and Turbulent Mixing Results in Improved Combustion



The Loss of Energy in the Vaporization Process Decreases Combustion Temperature Which Slows the Reaction Between Oxygen and Nitrogen to Form NO_x

Regulatory Credentials

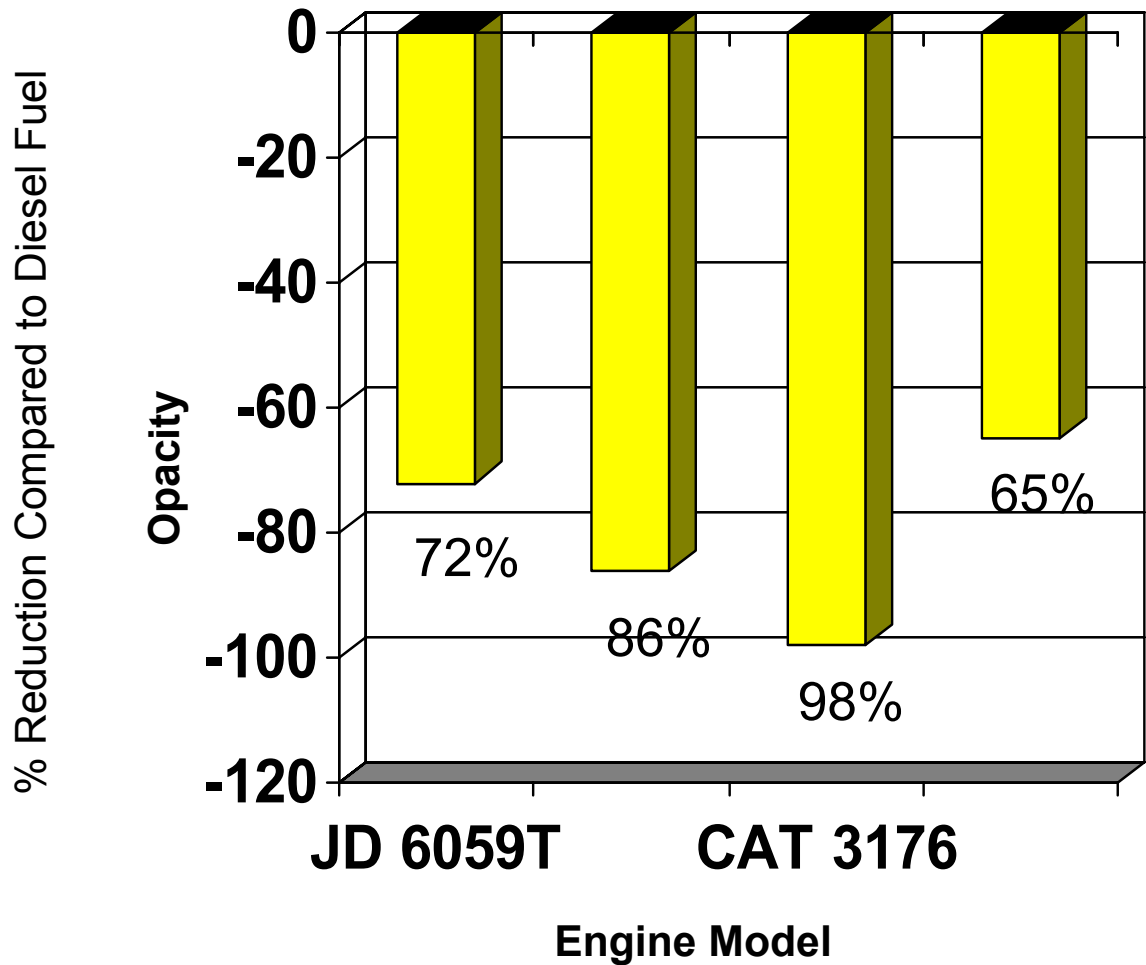
- EPA Registered
- EPA Verified
 - On-Road
 - Off-Road
- CARB Voluntary Verification
- CARB Regulated Verification Level II

Emission Reduction Summary

	NOx	Particulate Matter
Lubrizol Market Claim	5 - 30%	20 - 65%
Average from Dynamometer Tests	12.6%	46.4%
Average from Field Tests	26.6%	45.3%
CARB Voluntary Verification	14%	63%
CARB Regulated Level II Verification	20%	50%
EPA On-Highway Verification	9-13%	51-58%
EPA Off-Highway Verification	17-20%	17-23%

Opacity

In-Service Vehicle Opacity Test SAE J1667



No. 2 Diesel Fuel

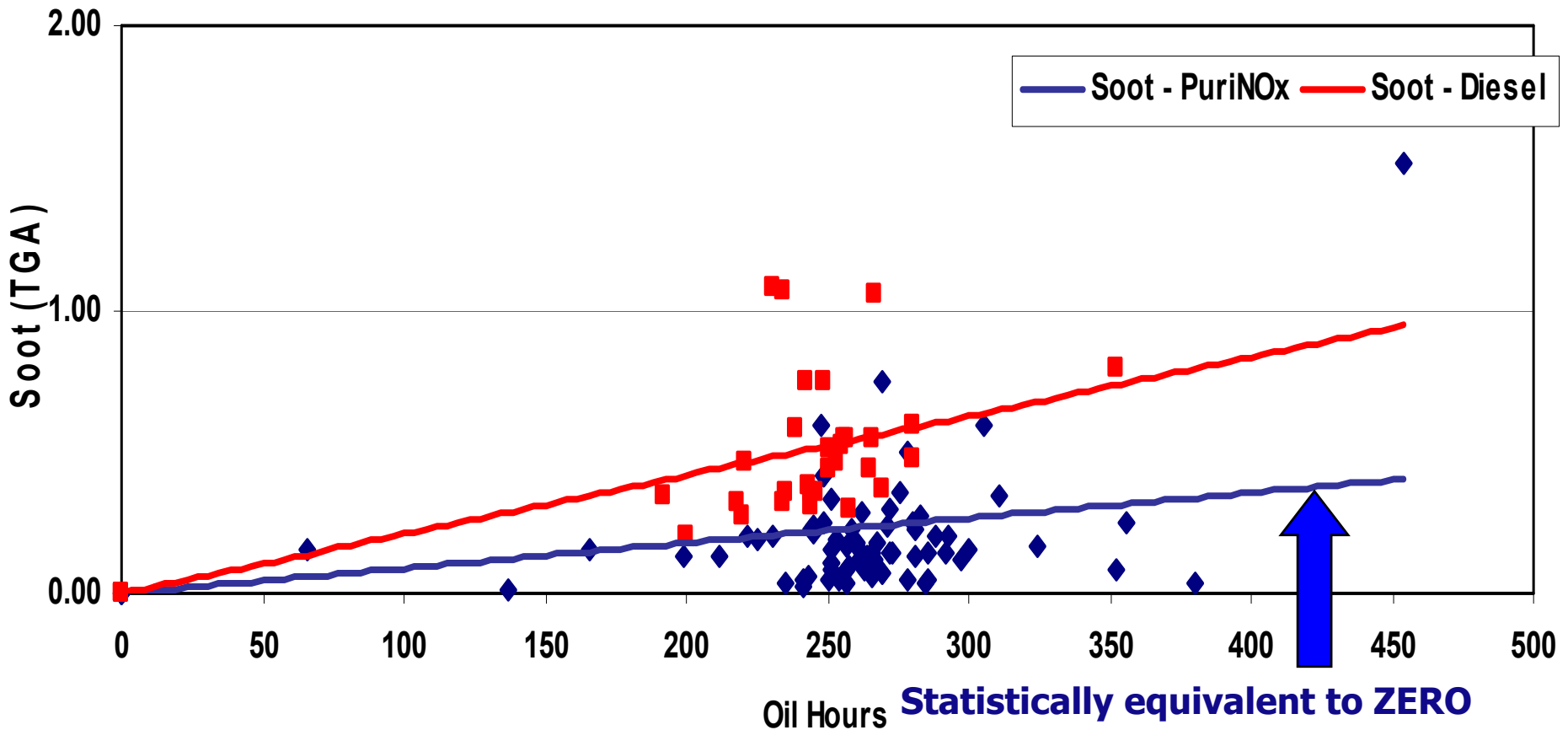


PuriNOx™ Fuel



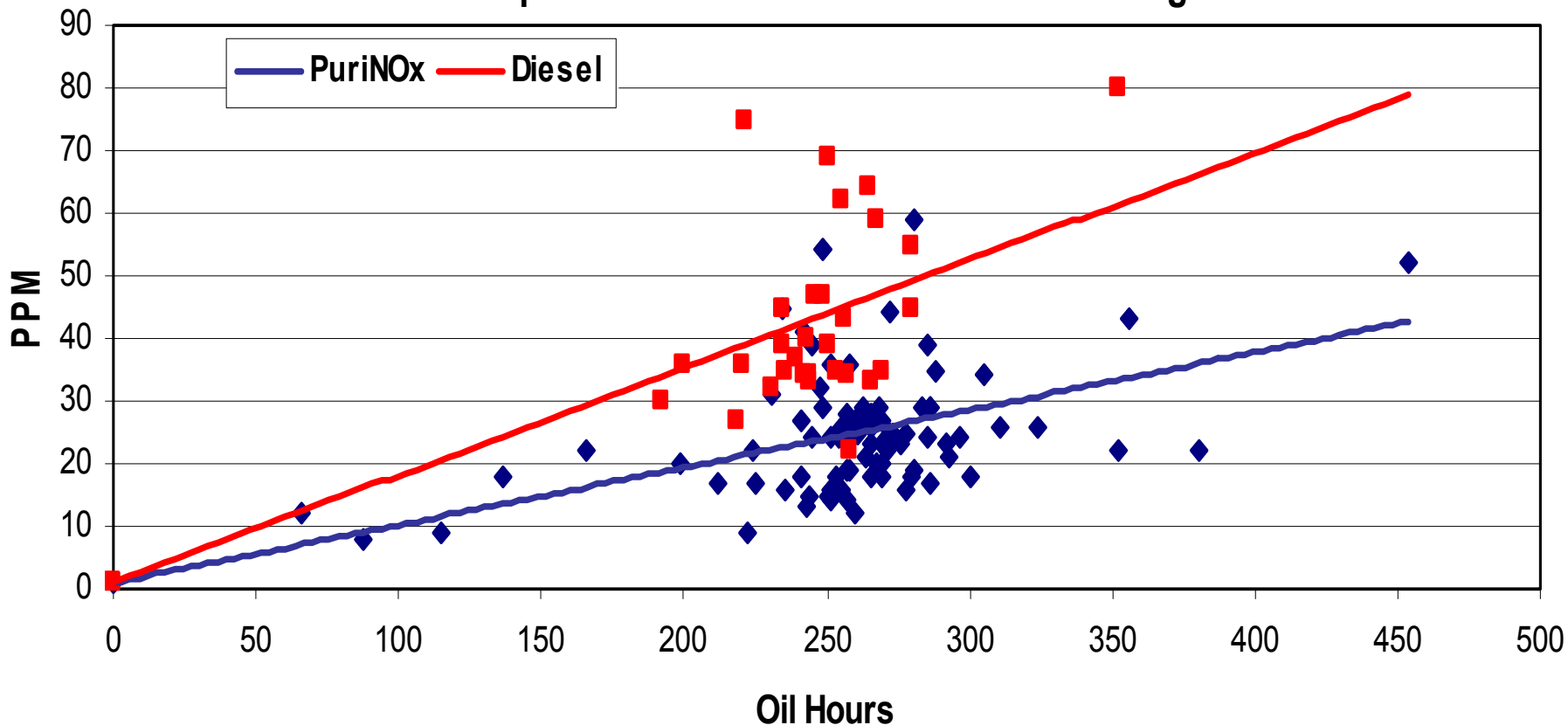
Field Durability - Soot Accumulation in the Oil

Used Oil Analysis - Soot
Caterpillar 988F Wheel Loaders w/3408E engine



Field Durability Update – Wear Metals

Used Oil Analysis - Wear Metals (Iron)
Caterpillar 988F Wheel Loaders w/3408E engine



Pacific Harbor Lines – Port of LA

Unit GP7:

- GM-EMD 1500 HP
- Operating on PuriNOx™ since ~ March 2000
- Top ends passed inspection at 92 day intervals



Unit GP8:

- GM-EMD 1800 HP
- Converted to PuriNOx™ ~ July 2003

Contact Andrew Fox, President
(310/834-4594)

Lubrizol Deer Park, Texas Plant

**Switchers owned and leased
GM-EMD engine models (1200 HP)**

- 12-567-B (owned)
- 12-557-C (leased)
- 12-645-E (leased)



Converted to PuriNOx™ March 2001

Collectively operate ~ 9.5 hrs per day

~ 8,300 operating hours to date

Contact George Kimes

(281/479-2851, Ext. 7131)



Lubrizol Painesville, Ohio Plant

1967 GE-EMD 110 Ton Switcher Locomotive

- Cummins NTA engine models (380 HP)
 - 855C
 - 360



Converted to PuriNOx™ March 2001

Operates ~ 9.5 hrs per day

~ 9,500 operating hours to date

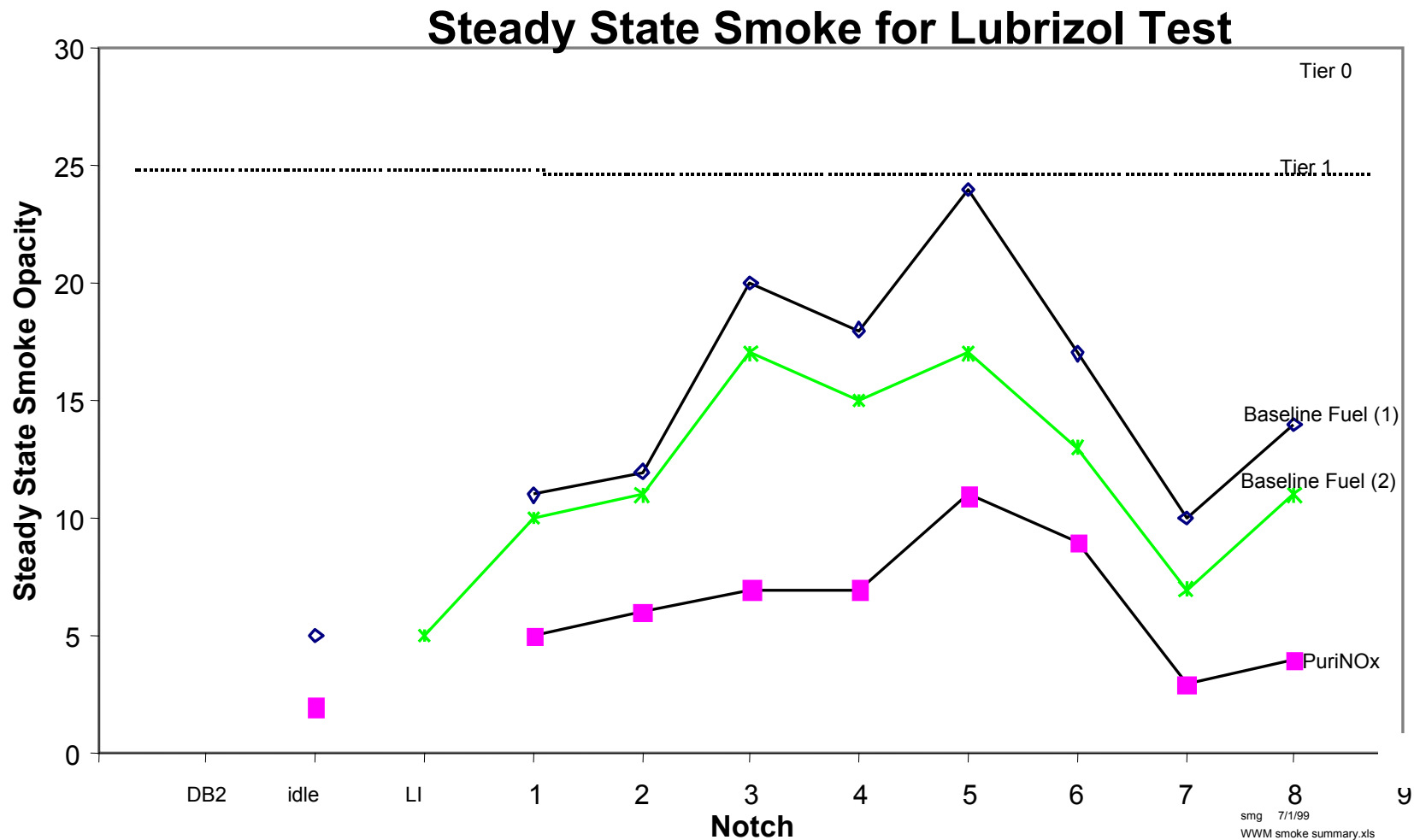
Contact Sam Gillette

(440/347-3756)

PuriNOx™ GETS Testing

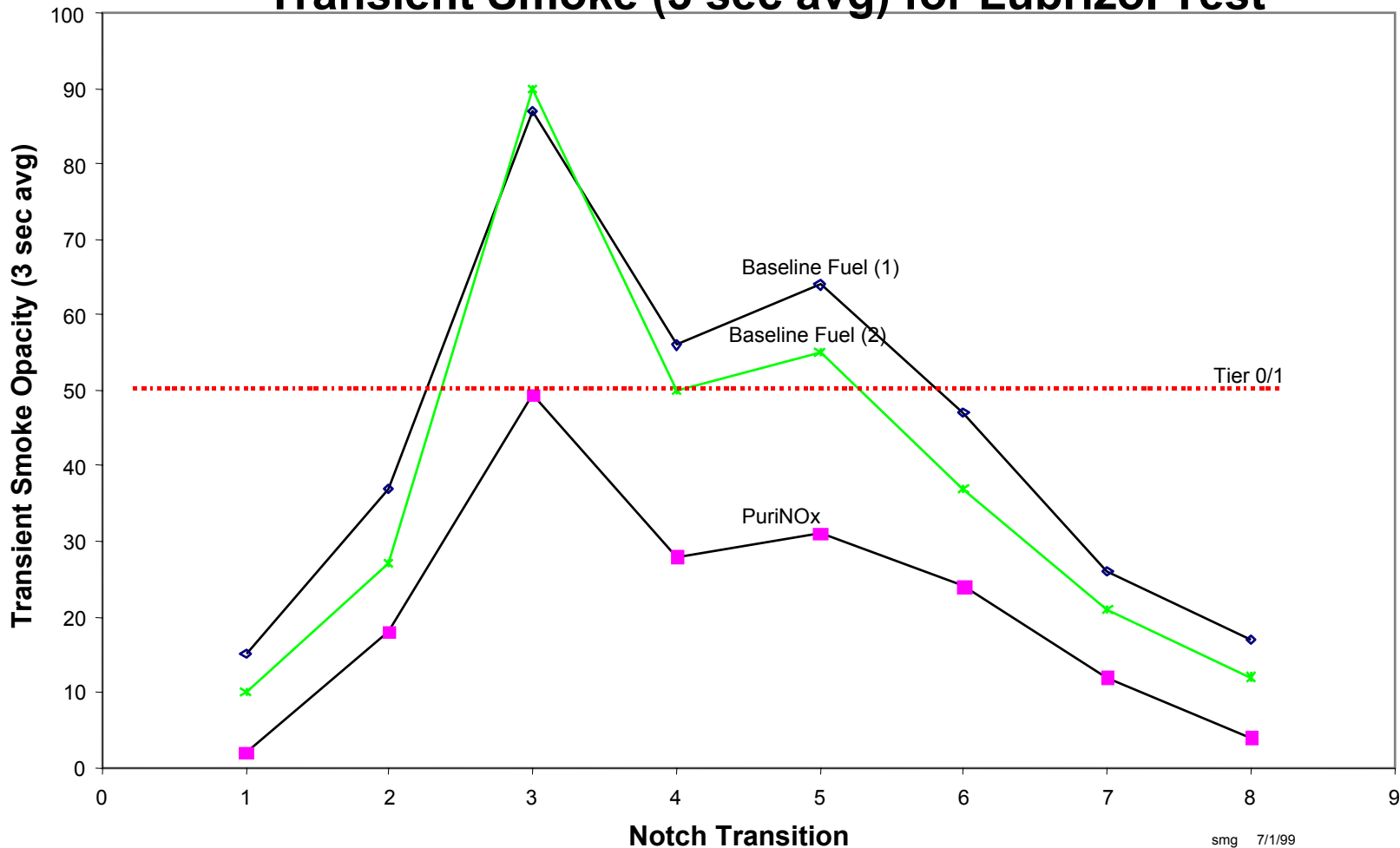
- PuriNOx Fuel was tested in a GETS Locomotive GECX001 3300 bhp @ 1050 RPM
- Base fuel used for comparison and for PuriNOx blend was GE low cetane fuel
- Line Haul and Switch Haul Conditions
- No significant wear of injectors
- 7 to 8% NOx Reduction, 59% avg. Opacity Reduction and 30 to 45% PM Reduction
- Fill and Go, No Engine Adjustments

PuriNOx™ GETS Emissions



PuriNOx™ GETS Emissions

Transient Smoke (3 sec avg) for Lubrizol Test



PuriNOx Technology California Suppliers



Conclusions

PuriNOx



- ✓ can lower NOx AND Particulates at the same time
- ✓ lowers emissions immediately
- ✓ can be used in most centrally fueled fleets
- ✓ can be used with most generations of diesel engines with excellent durability characteristics
- ✓ Requires no significant capital expense for the end user

Thank You

- **Ron O. Dunfee**
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