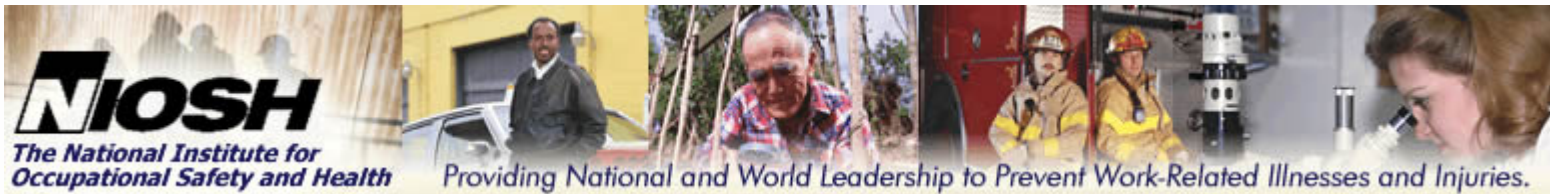




Biodiesel

Basics, Technical Aspects, and Issues for Underground Mining Operations

Diesel Particulate Matter Workshop

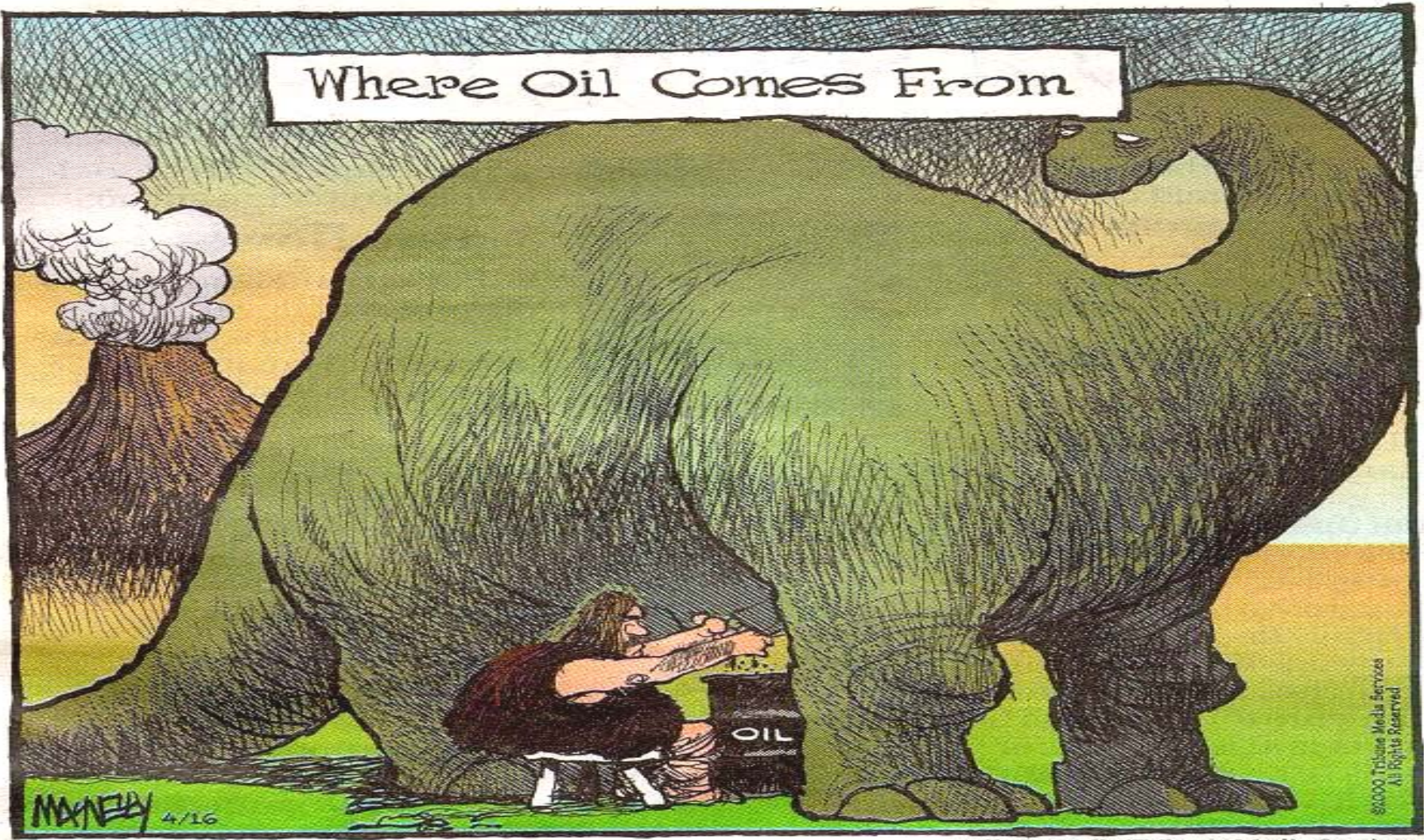


Reno, Nevada
January 24, 2007

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Where Oil Comes From



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Biodiesel Defined

- Biodiesel, n. -- a fuel comprised of **mono-alkyl esters** of long chain fatty acids derived from vegetable oils or animal fats, designated B100, and meeting the requirements of ASTM D 6751.



B100 Properties

- High Cetane (averages >50)
- High Lubricity (<300 HFRR) – (HFRR, High Frequency Reciprocating Rig, accepted ASTM test standard)
- BTU Content (7-9% lower than #2)
 - Some users see better fuel economy with B20
—this is most likely due to the cleaning effect of B20 & higher cetane value
- Cold Flow (3-10° F > for soy-based B20)
- Flash Point (>260°F vs 117° F)
- No nitrogen or aromatics or sulfur



AVERAGE BIODIESEL EMISSIONS COMPARED TO CONVENTIONAL DIESEL, ACCORDING TO EPA

Emission Type	B100	B20
<u>Regulated</u>		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
Nox	+10%	+2% to -2%
<u>Non-Regulated</u>		
Sulfates	-100%	-20%*
PAH (Polycyclic Aromatic Hydrocarbons)**	-80%	-13%
nPAH (nitrated PAH's)**	-90%	-50%***
Ozone potential of speciated HC	-50%	-10%

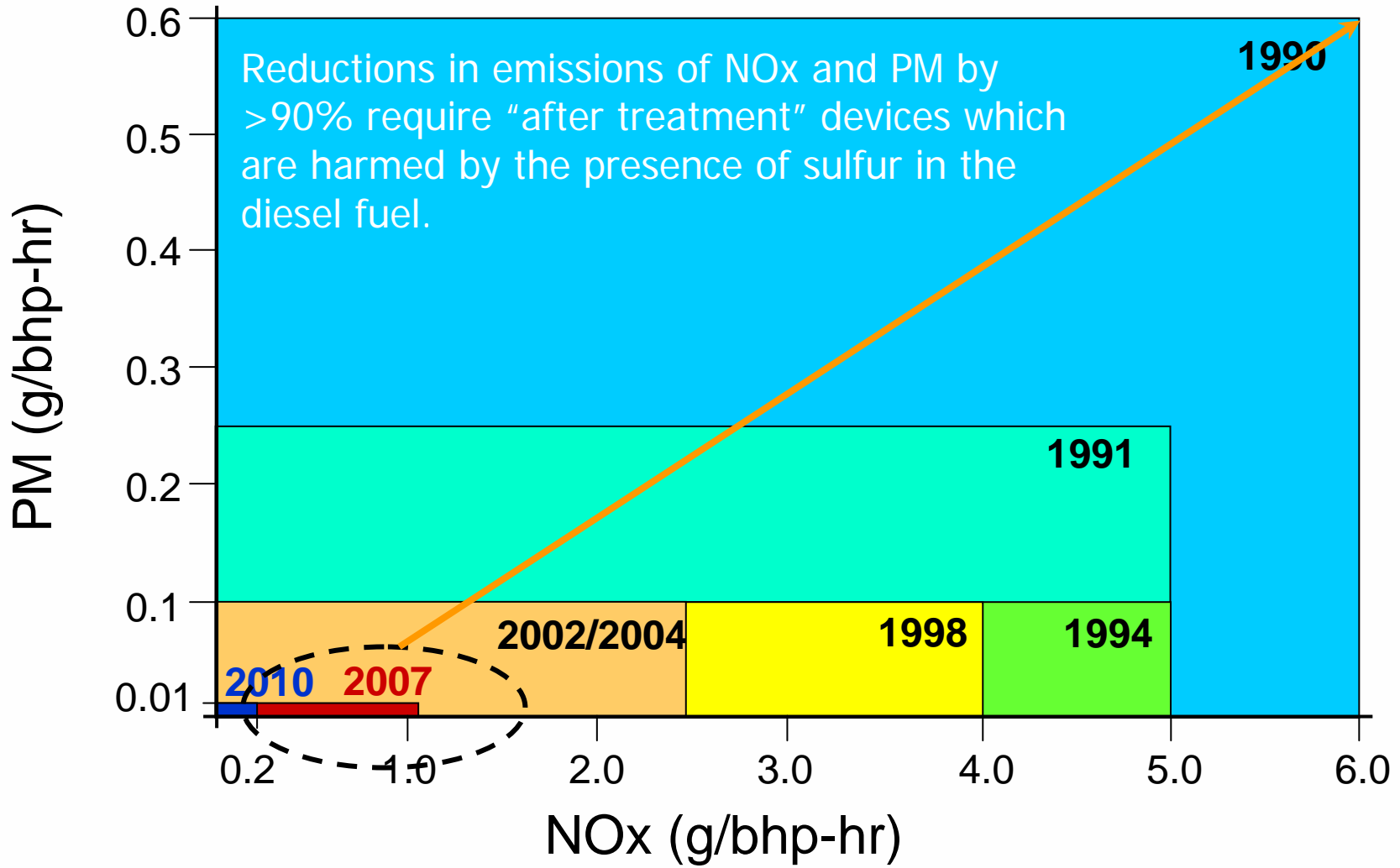
* Estimated from B100 result

** Average reduction across all compounds measured

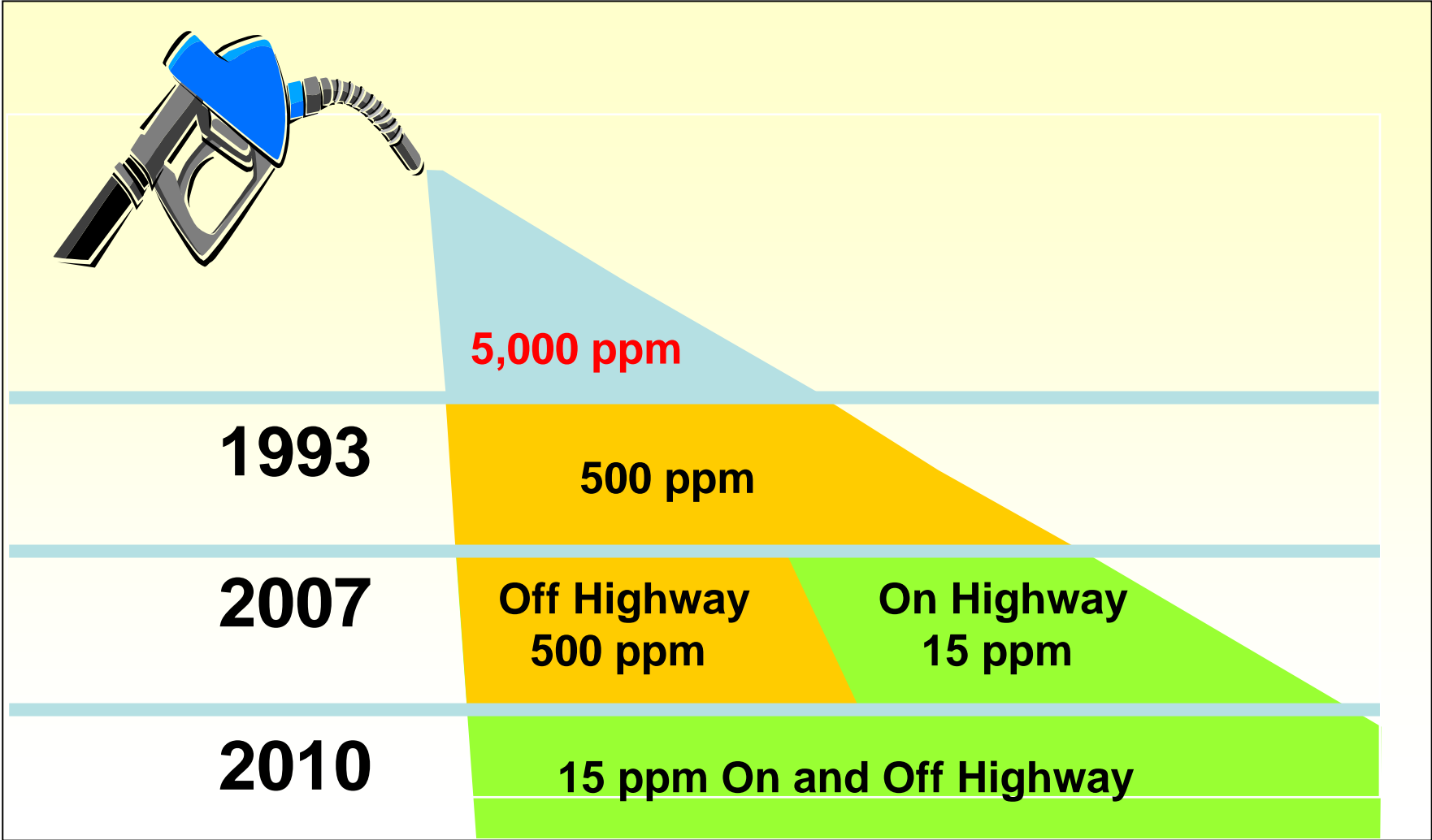
*** 2-nitroflourine results were within test method variability



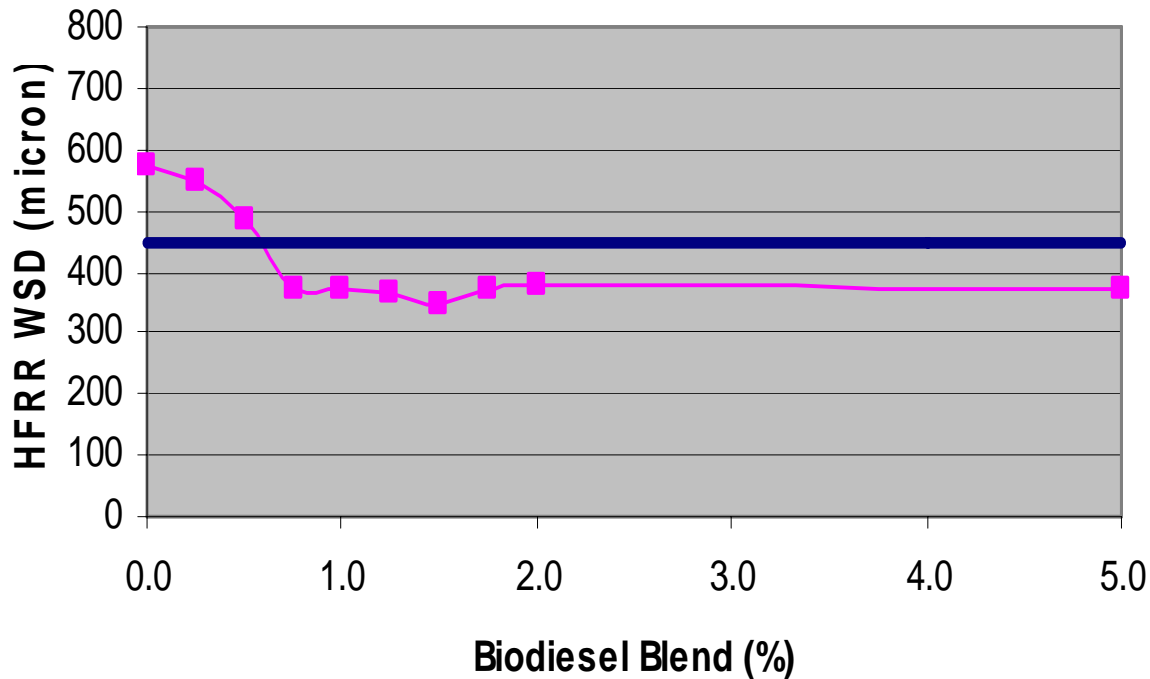
TWO DECADES OF EPA DIESEL EMISSIONS REGULATIONS



Reducing Diesel Fuel Sulfur



Ultra-low Sulfur Diesel

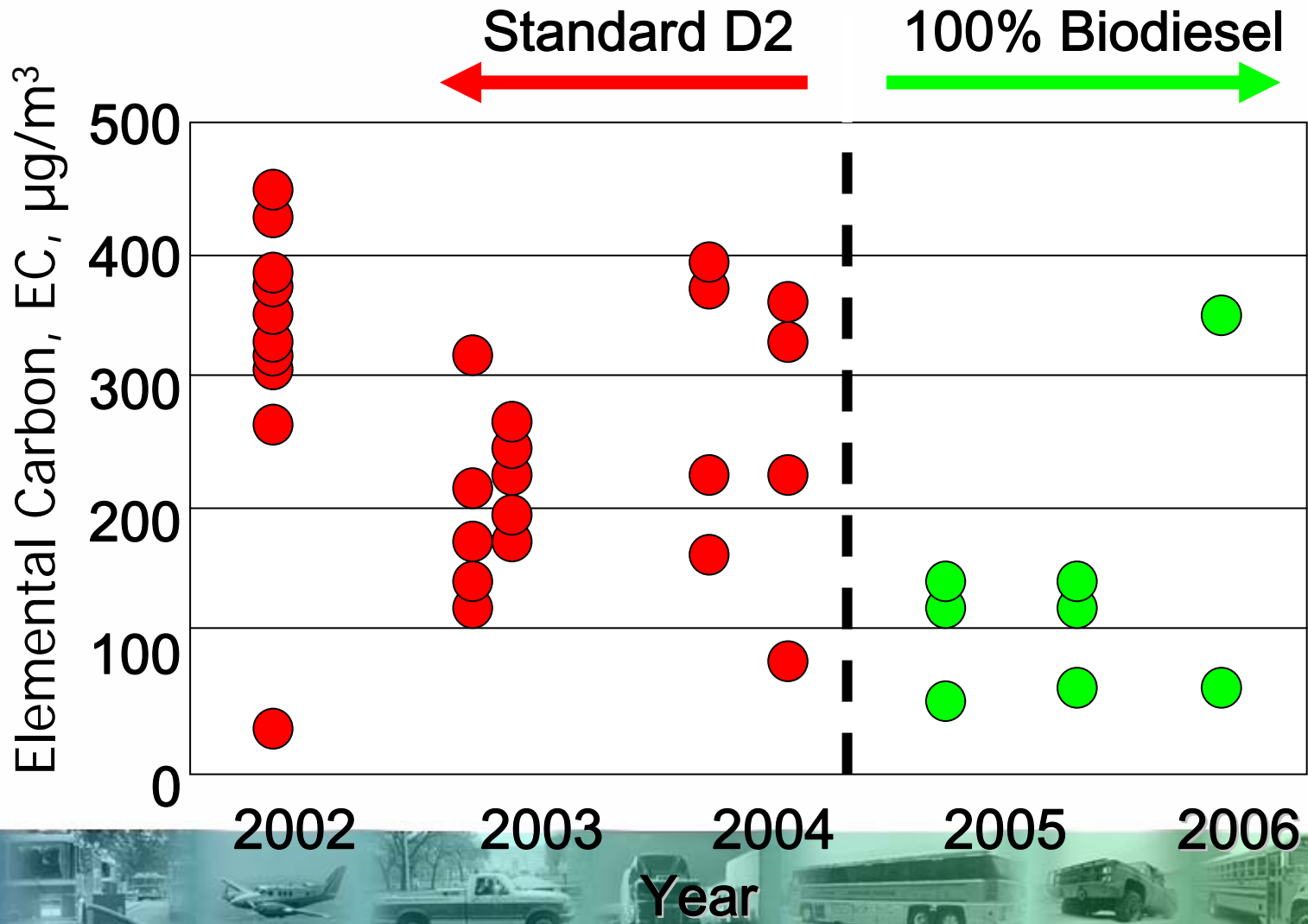


- Testing confirms biodiesel's ability at low levels to provide sufficient lubricity

- 2% biodiesel used as a lubricity additive in ~37 billion gallons of on-road fuel = 740 million gallons of biodiesel



MSHA compliance samples, EC





■ Fuel quality is of the utmost concern and importance to the biodiesel industry.

■ ASTM D 6751 is the specification for biodiesel fuels irrespective of the feedstock source and/or processing method.

■ Standard ensures safe operation in a compression ignition engine.

ASTM D6751 = Fuel Quality!!!

ASTM International Specification

D6751: Standard Specification for Biodiesel Fuel

In 2002, ASTM International issued a standard specification for biodiesel fuel called D6751. This specification states that the only form of biodiesel that can be legally resold for commercial operations must meet ASTM specifications.

TABLE 1: Detailed Requirements for Biodiesel (B100)

Property	Test Method	Limits	Units
Flash point (closed cup)	D 93	130.0 min	°C
Water and sediment	D 2709	0.050 max	% volume
Kinematic viscosity, 40°C	D 445	1.9–6.0	mm ² /s
Sulfated ash	D 874	0.020 max	% mass
Sulfur	D 5453	0.05 max	% mass
Copper strip corrosion	D 130	No. 3 max	N/A
Cetane number	D 613	47 min	N/A
Cloud point	D 2500	Report to customer	°C
Carbon residue	D 4530	0.050 max	% mass
Acid number	D 664	0.80 max	mg KOH/g
Free glycerin	D 6584	0.020	% mass
Total glycerin	D 6584	0.240	% mass
Phosphorus content	D 4951	0.001 max	% mass
Distillation temperature, atmospheric equiv. temp	D 1160	360 max	°C



- To **promote** the commercial success and public acceptance of biodiesel
- To help **guarantee** that biodiesel fuel is produced and maintained at ASTM D 6751 levels
- To **provide** a mechanism to track biodiesel in the distribution system, identifying biodiesel which meets ASTM standards.

www.BQ-9000.org



Using B20 and Lower Blends

- B20 operates in conventional engines, just like petroleum diesel
- Few or no modifications needed to engine or fuel system
 - Most common measures include initial fuel storage tank cleaning and/or fuel filter replacement
- Higher cetane and lubricity than diesel
- *Similar horsepower, torque and mileage as diesel*



Going over B20 requires caution

!!!

- Cold flow
- Materials compatibility
- Cleaning effect
- Fuel Stability a bigger concern
- Lower BTU content becomes noticeable
- Engine oil may become diluted with fuel
- Not supported by OEM's



OEM Warranty Statements and Use of Biodiesel Blends Above B5

http://www.biodiesel.org/pdf_files/B5_warranty_statement_32206.pdf

NBB Guidance on Use of Biodiesel Blends Above B20

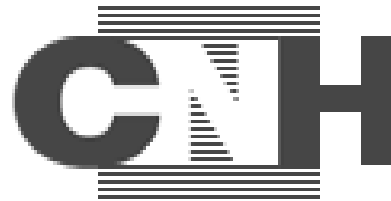
http://www.biodiesel.org/pdf_files/Biodiesel_Blends_Above%20_20_Final.pdf



OEMs:

- ◆ B100 Must Meet ASTM D 6751
- ◆ Most OEM HQs have B20 experience:
 - Won't void warranty, but
 - *Problems caused by the fuel are the responsibility of the fuel supplier*
 - OEMs want to see additional experience in the field
- ◆ Higher blends OK'd based on experience of OEM and their technology

OEM's Don't Make Fuel and
OEM's Don't Warranty Fuel



Manufacturer	Position
Engine Manufacturers Association (EMA)	B5 acceptable if it meets D 6751.
Caterpillar	Many engines approved for B100; for others only B5 is acceptable. Must meet D 6751.
Cummins	All engines approved for B5; must meet D 6751.
DaimlerChrysler	B5 acceptable for all vehicles, but must meet D 6751.
Detroit Diesel	B20 approved for all engines/vehicles, but must meet DDC specific diesel fuel specification.
Ford	B5 acceptable for all vehicles, but must meet both D 6751 and EN 14214.
General Motors	B5 acceptable for all vehicles, but must meet D 6751.
International Truck and Engine	B20 acceptable for all engines, but must meet D 6751.
John Deere	B5 acceptable for all engines, but must meet D 6751.
Volkswagen	B5 acceptable for all engines, but must meet fuel quality standards (D 6751 or EN 14214).
Fuel Injection Equipment Manufacturer	Position
Bosch	B5 acceptable for all vehicles, but must meet EN 14214.
Delphi	B5 acceptable for all vehicles, but must meet D 6751.
Stanadyne	B20 acceptable for all vehicles, but must meet D 6751.

Source: IFQC Biofuels Center. See also, NBB, Fact Sheet: Standards & Warranties, available at http://biodiesel.org/resources/fuelfactsheets/standards_and_warranties.shtm.



Help Needed !

NBB is looking for mining operations that either currently use biodiesel (in any blend level) or are thinking of incorporating biodiesel into their operations

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