U.S. Department of Energy FreedomCAR & Vehicle Technologies Program

Demonstrated Petroleum Reduction Using Oil Bypass Filter Technology on Heavy and Light Vehicles

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Oil Bypass Filter Technology Evaluation

- Funded by the U.S. Department of Energy's FreedomCAR & Vehicle Technologies Program
- Performed by Idaho National Engineering and Environmental Laboratory (INEEL) Fleet Operations
- Goal
  - Support DOE's efforts to reduce petroleum consumption & ensure the energy security of the United States

Oil Bypass Filter Technology Evaluation

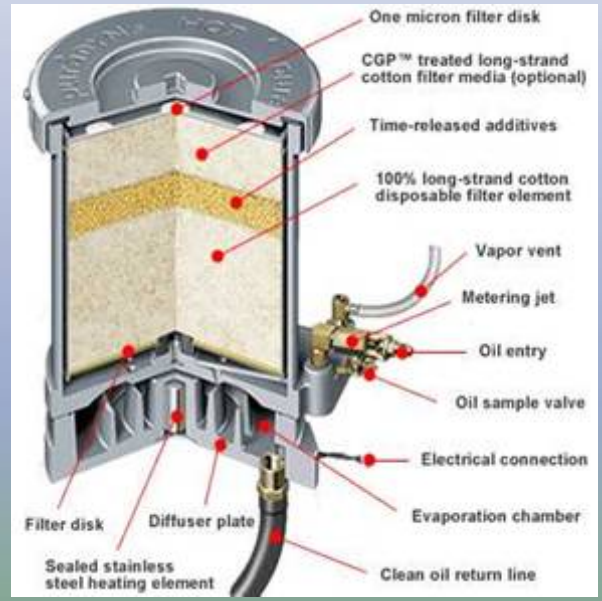
- **Objectives**
  - **Test the concept of using oil bypass filters to minimize engine oil changes & the generation of waste oils**
  - **Demonstration the economics of oil bypass filter systems**
  - **Estimate potential engine oil saving from bypass filter technologies that can be achieved by INEEL, DOE complex, & Federal Fleets**

Full Flow Filter(s)

- Standard to all OEM vehicles
- Filters the full flow of the oil pump (up to 50 gallons per minute)
- Generally filters down to 40 to 60 micron sized particles

Bypass Filter

- Aftermarket filter system
- Operates offline (bypass) of the oil supply system
- Filters a partial flow of oil (6 to 8 gallons per hour)
- Cleans < 1 micron
- Some with additive packages
- Capture / evaporate fluids
- puraDYN bypass filter – test mule



Reported Benefits of Bypass Filters

- Extend oil drain intervals beyond standard 12,000 (diesel buses) or 3,000 miles (gasoline Tahoes)
- ~80% less oil use
- ~80% less waste oil
- Longer engine life (particles in 5 to 20 micron range cause 60% of engine wear)
- Less maintenance time
- Return of investment: varies with vehicle

Testing Method

- Install bypass filters, change full flow filter(s) & new engine oil
- Change full flow & bypass filters at service intervals - not oil
- Obtain oil analysis samples - archive & 2 lab samples
  - CTC Laboratory
  - National Tribology Services Laboratory
- Validate extended oil drain use via oil analysis data
- Track & trend data

INEEL Test Vehicles

- 8 four-cycle INEEL diesel-engine buses initiated October 2002
- 6 INEEL gasoline Chevrolet Tahoes initiated December 2003

INEEL Diesel Buses

- Engines - 7 Detroit Diesel (50s & 60s) & 1 Caterpillar (310)
- Normal 12,000 mile oil change interval
- Evaluation method:
  - Shell Rotello-T oil (15W-40)
  - Change 2 full flow filters & bypass filter
  - 3 oil samples – 2 labs & 1 archive
- Operate in routes to/from INEEL “site”, 100+ miles per round trip

Installed Bus Bypass System

Installed Bus Bypass System

INEEL Diesel Buses (July 2004)

- 498,000 miles traveled & one bus' oil changed (intentionally)
- 473,000 miles without intentional oil change
- 39 oil changes avoided
- 343 gallons engine oil not used & not disposed of

INEEL Gasoline Tahoes

- Engines – 4.8L V-8s gasoline
- Normal 3,000 mile oil change interval (severe duty)
- Evaluation method:
  - 25% recycled oil used initially
  - Change full flow filter & bypass filter
  - 3 oil samples – 2 labs & 1 archive
- Security vehicles operate within 900 square mile INEEL “site” and to/from site and Idaho Falls with significant idling times

Installed Tahoe Bypass System

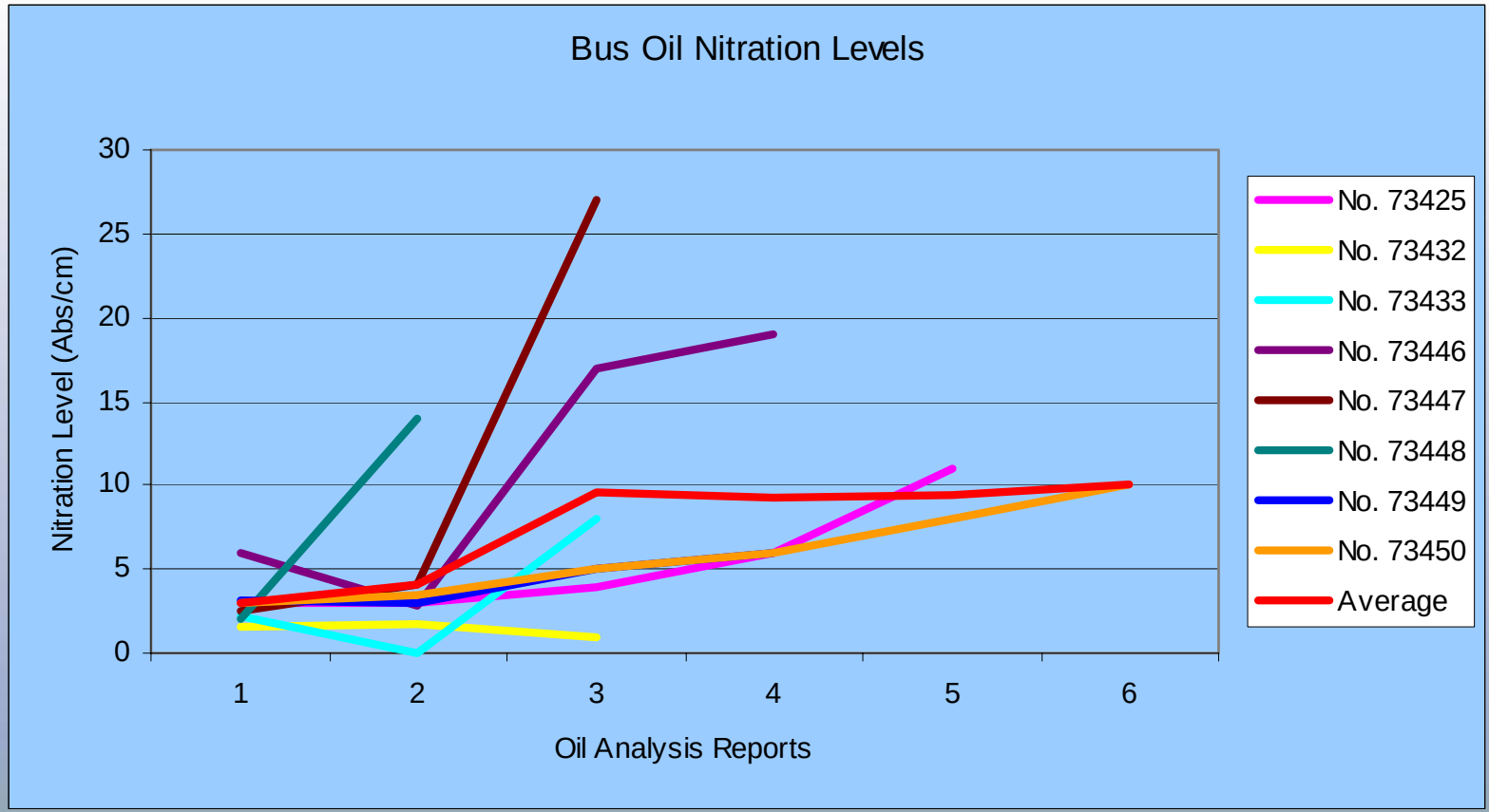
INEEL Gasoline Tahoes (July 2004)

- 110,000 miles traveled
- 98,000 miles on initial recycled test oil
- 26 oil changes avoided
- 33 gallons of engine oil saved & not disposed of
- Recycled oil changed & replaced with Castrol oil (10W-30)

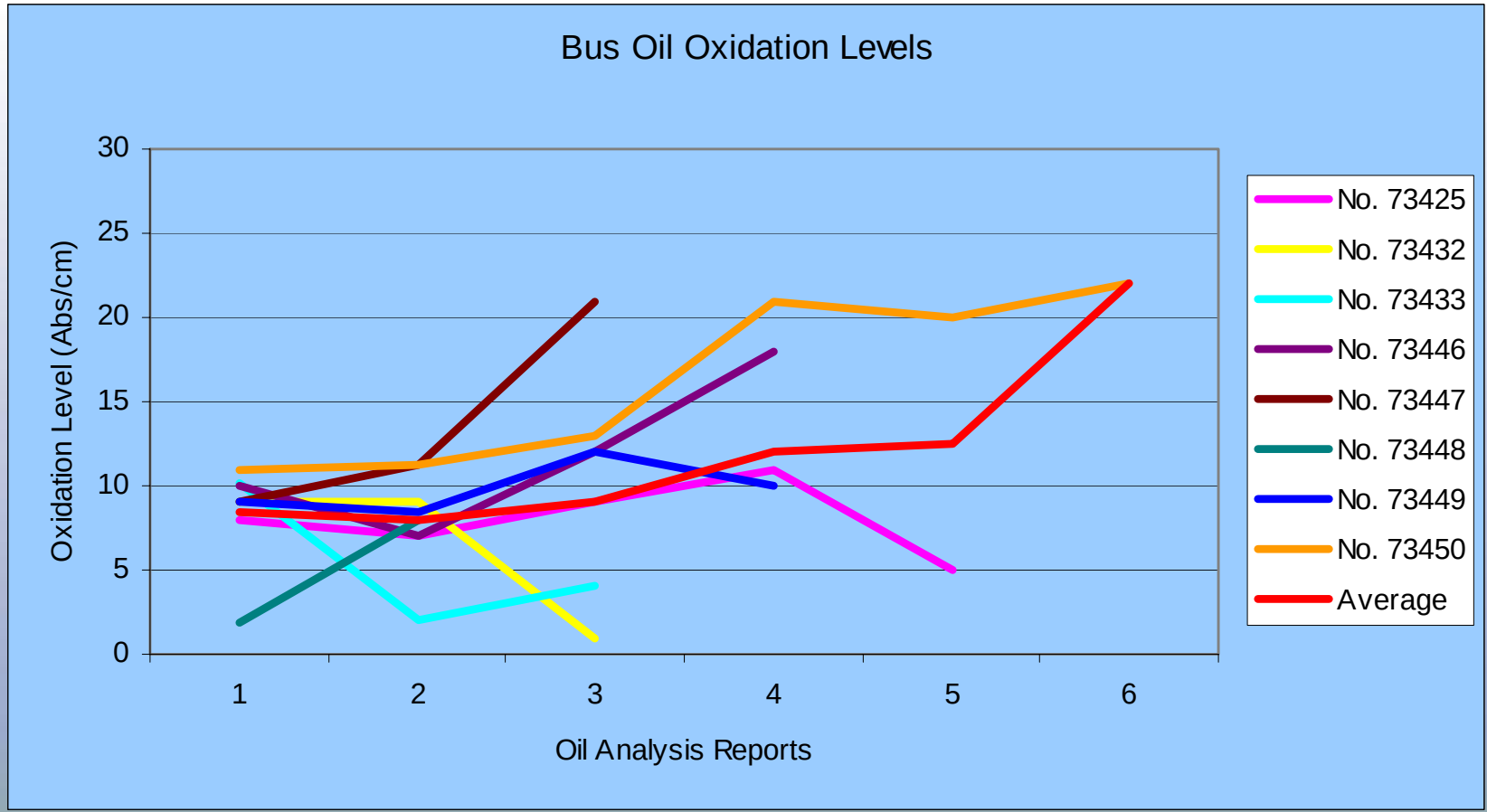
Oil Analysis Reports

- Oil quality - contaminates/physical properties:
  - Presence of fuel (≤3%), water (<0.25%), and glycol (≤0.25%)
  - Soot content (≤3%)
  - Oxidation and nitration levels (≤30 Abs/cm)
  - Total base number (≥3.0 mgKOH/mL)
  - Viscosity (12.50 to 16.39 centistokes)
- Various additives
- Wear metals and other contaminates - (spectrochemical and particle count analyses)
- Trending analysis

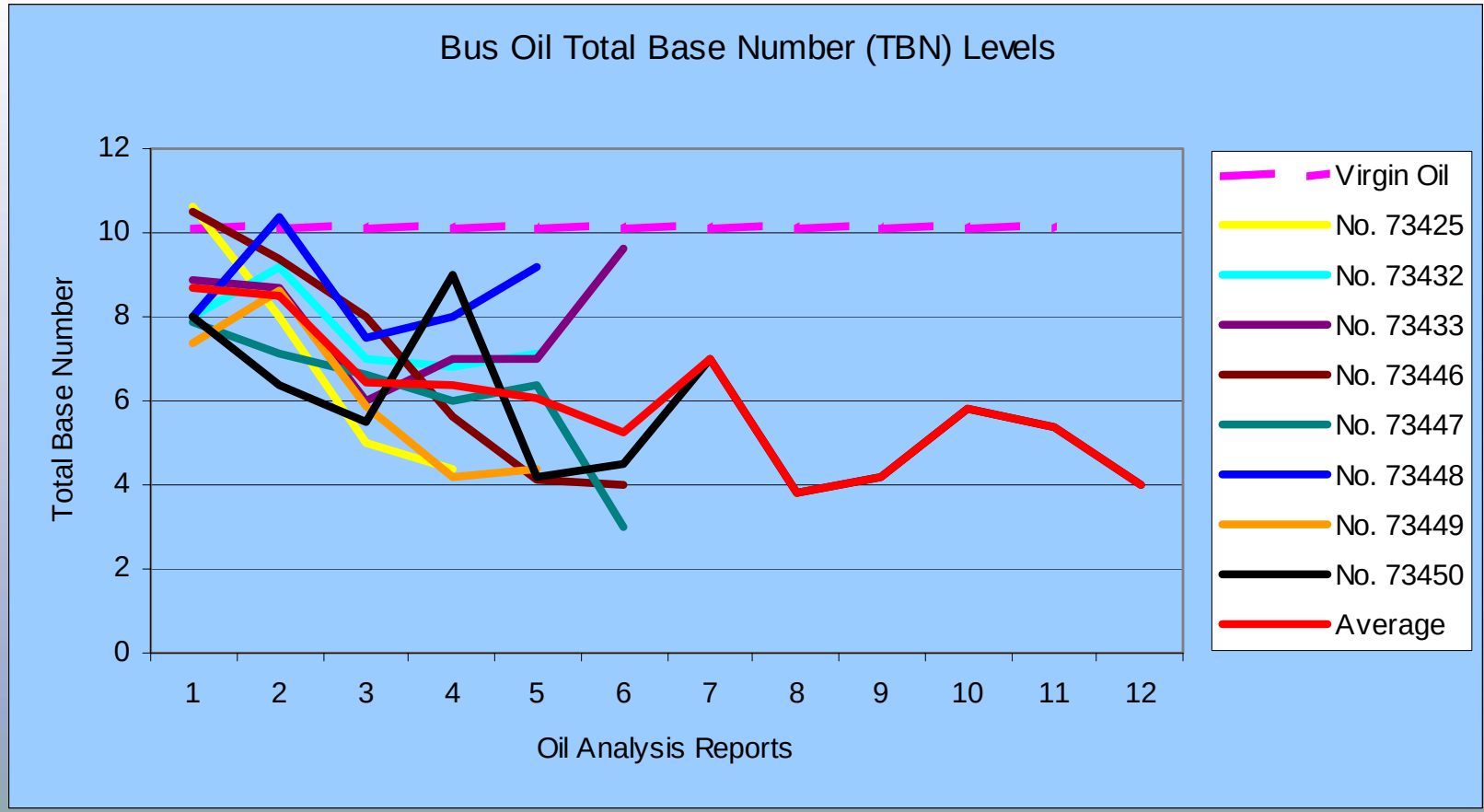
Bus Oil – Nitration (desired ≤30 Abs/cm)



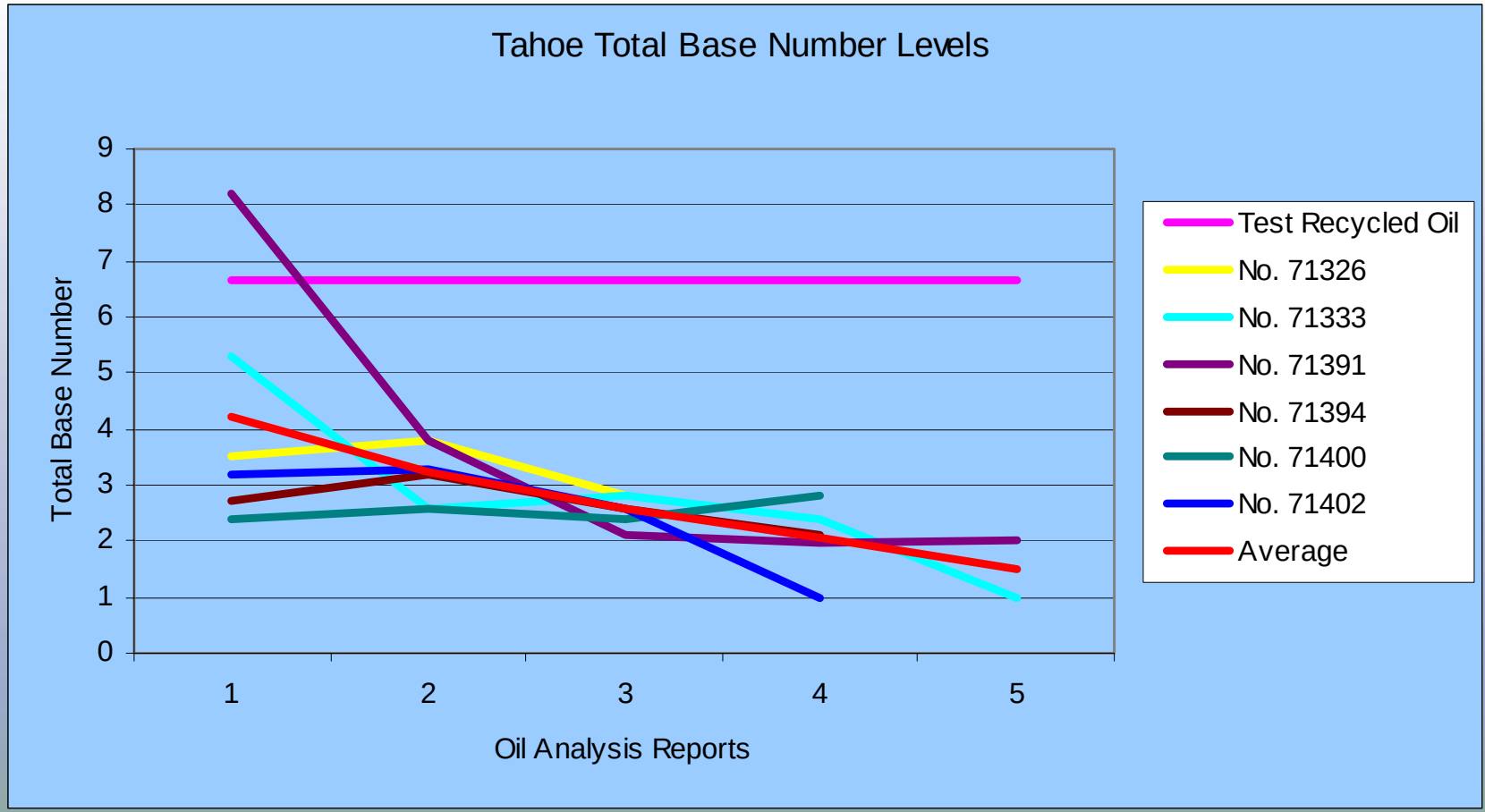
Bus Oil – Oxidation (desired ≤30 Abs/cm)



Bus Oil – Total Base Number (desired (≥3.0 mgKOH/mL)



Tahoe Oil – Total Base Number (desired (≥3.0 mgKOH/mL)

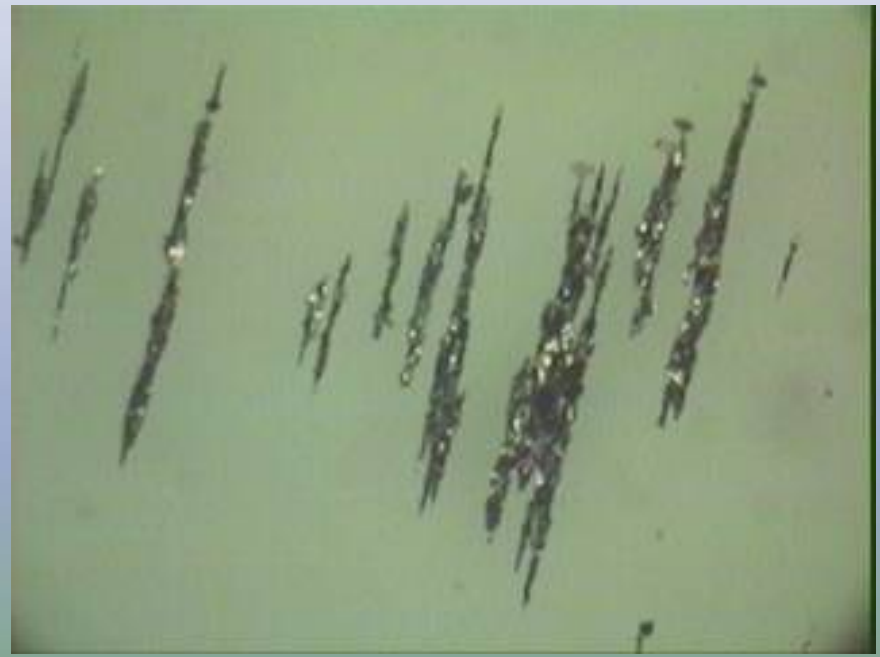


Particulate Tests Evaluate Filter Effectiveness and Engine Wear Metals

- Spectrometric/elemental analysis: < 4 micron
- Rotrode Filter Spectroscopy: 4 to 20 microns - wear trend
- Particle Count: 4 to 70 micron - particle binning
- Analytical Ferrography - traps larger debris

Analytical Ferrography—bus 73450

- 107,000 miles on oil (120,000 miles before oil change)
- Wear particle types - fine irons
- Lab's interpretive comments - trace amounts
- Ferrogram - shows photo of rubbing wear particles (100x)



Potential Fleet Engine Oil Savings

- Assumed 80% oil changes avoided
- Used FAST[1] database for on-road fleet vehicles
- Assumed oil capacities and service intervals

Vehicle Type	Oil Capacity (Qts)	Service Interval (Miles)
Ambulance	5	3,000
Sedan/Station Wgn	5	3,000
LD truck 4 X 2	5	3,000
LD truck 4 X 4	5	3,000
MD truck 8.5k – 16k lb	6	4,000
HD truck >16k lb	15	6,000
Bus	35	12,000

[1] FAST – INEEL maintained Federal Acquisition Statistical Tool. Fiscal Year 2003 data

Potential Annual Engine Oil Savings

Fleet	Number of Vehicles[1]	Total Miles (millions)[1]	Est. Oil Changes	Est. Oil Used (gals.)	Est. Oil Savings (gals.)
INEEL	871	8.3	2,077	4,286	3,428
DOE Complex (92 fleets)	15,464	91.7	26,433	39,635	31,707
All Federal Fleets[2]	607,630	4,838.1	1,492,895	2,073,456	1,658,764

[1] FAST on-road vehicle data for fiscal year 2003.
[2] 61 administrations, agencies, authorities, boards, branches, corps, commissions, corporations, departments, institutions, offices and other Federal entities.

INEEL Bypass Oil Filter Evaluation Status

- Testing continues with puraDYN filters
- Adding Refined Global Solutions' OilRig bypass filters to 3 diesel buses
- Idling 2 INEEL diesel buses for 1,000 hours each while evaluating oil quality and engine wear metals
- Quarterly reports:

http://avt.inel.gov