



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

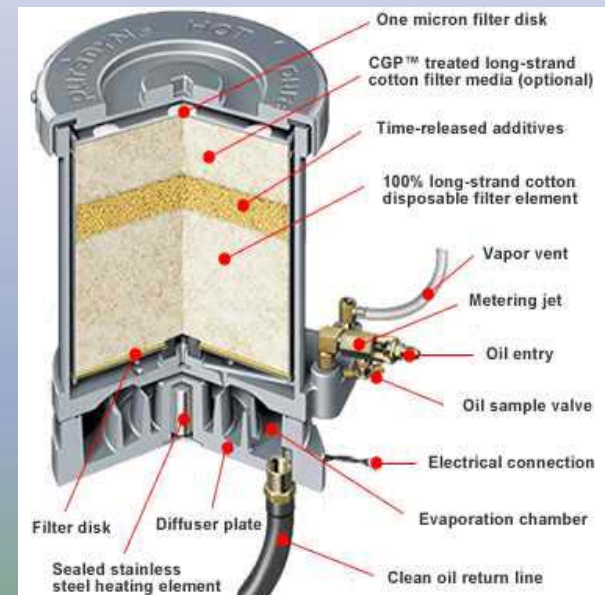
- **Objectives**
 - **Test the concept of using oil bypass filters to minimize engine oil changes & the generation of waste oils**
 - **Demonstration the economics of oil bypass filter systems**
 - **Estimate potential engine oil saving from bypass filter technologies that can be achieved by INEEL, DOE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



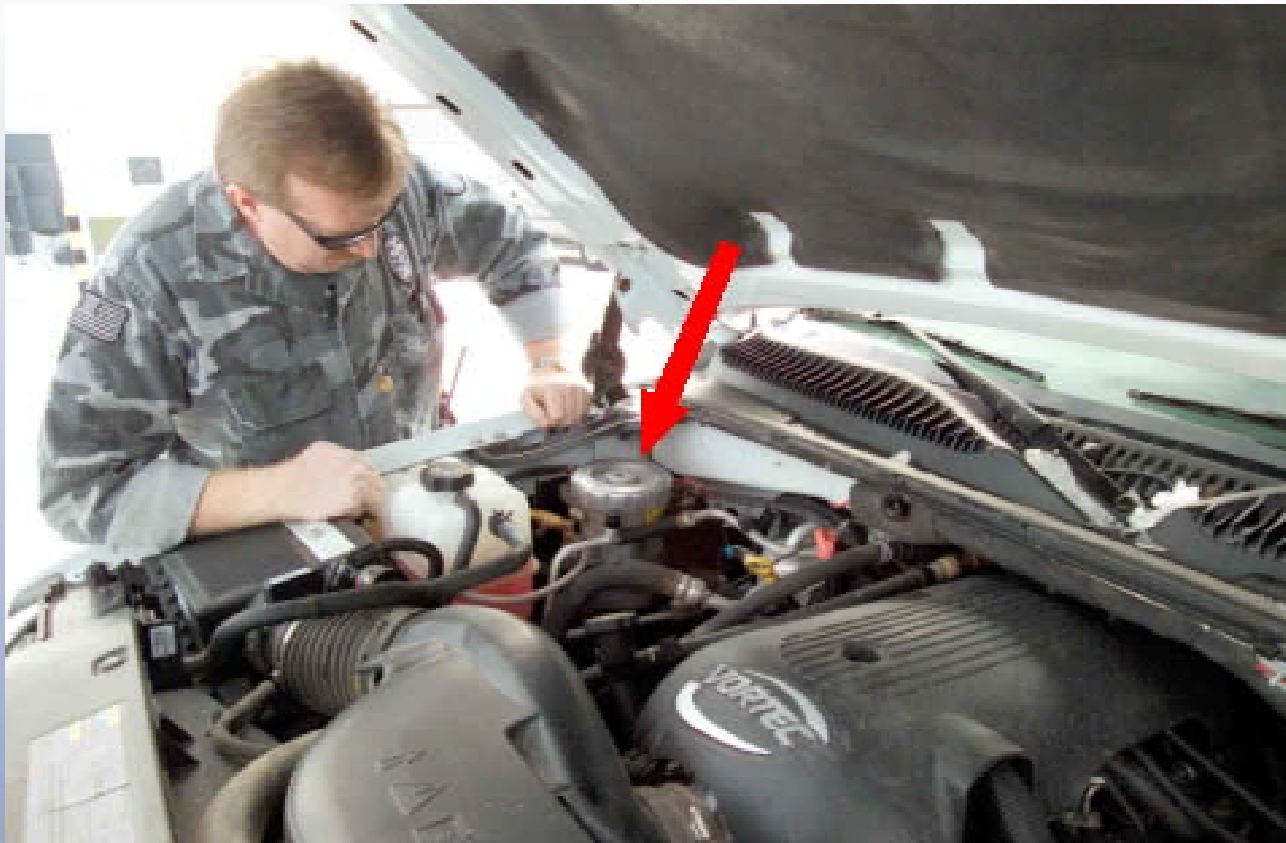
INEEL Diesel Buses (July 2004)

- **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



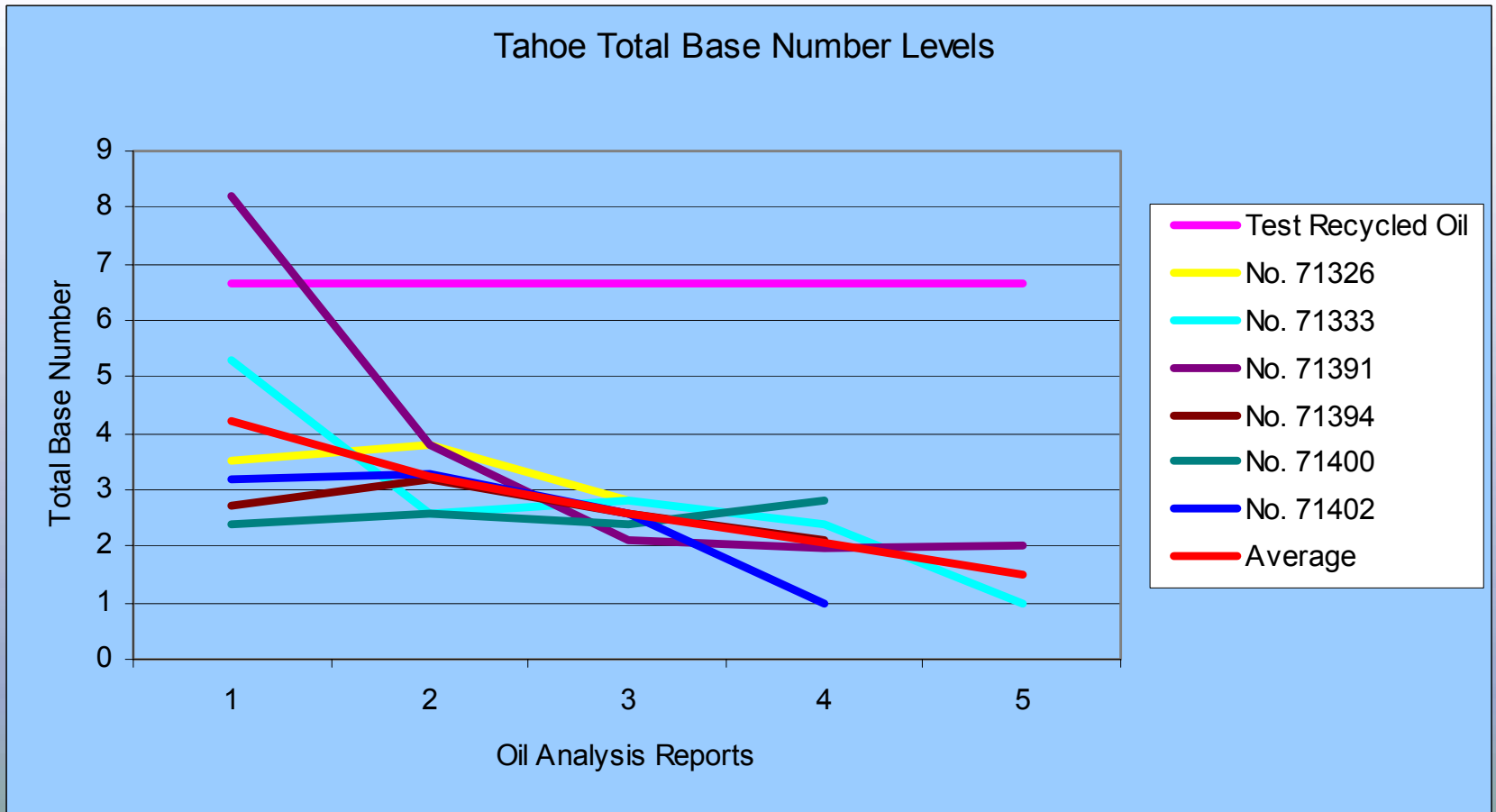
INEEL Gasoline Tahoes (July 2004)

- **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 ($\leq 3\%$), water ($< 0.25\%$), and glycol ($\leq 0.25\%$)**
 - **Soot content ($\leq 3\%$)**
 - **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**

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

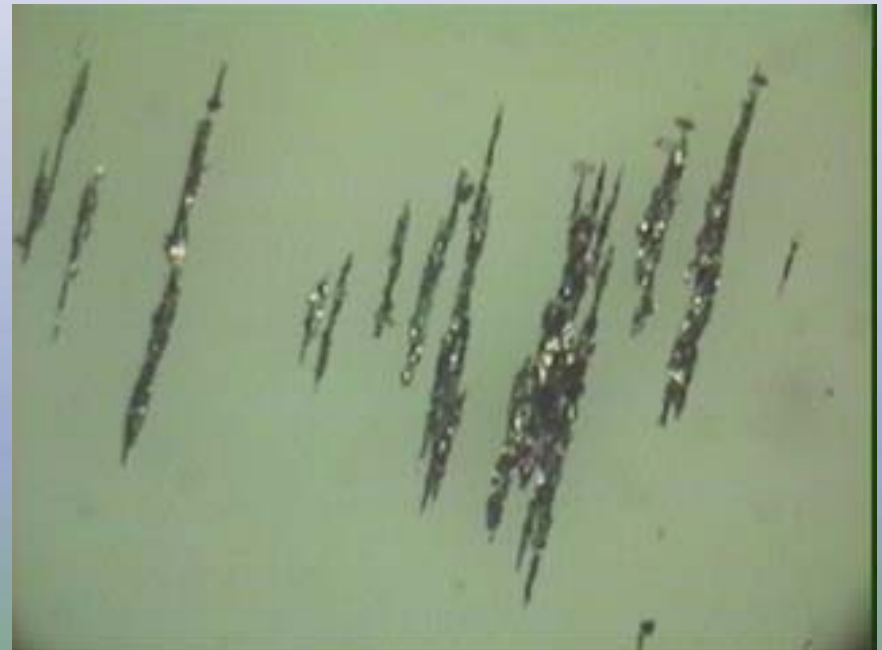


Particulate Tests Evaluate Filter Effectiveness and Engine Wear Metals

- **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 FAST¹ 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 Vehicles¹	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 Fleets²	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>