



***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*

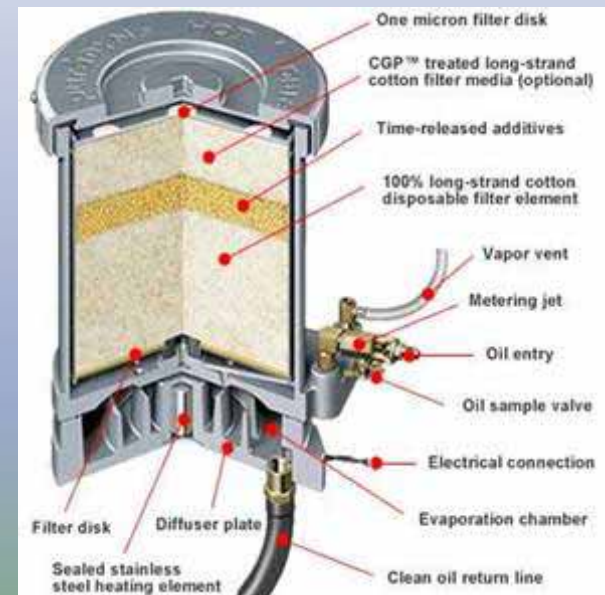
- *Objectives*
  - *Test the concept of using oil bypass filters to minimize engine oil changes & the generation of waste oils*
  - *Demonstration the economics of oil bypass filter systems*
  - *Estimate potential engine oil saving from bypass filter technologies that can be achieved by INEEL, DOE complex,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



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## ***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*

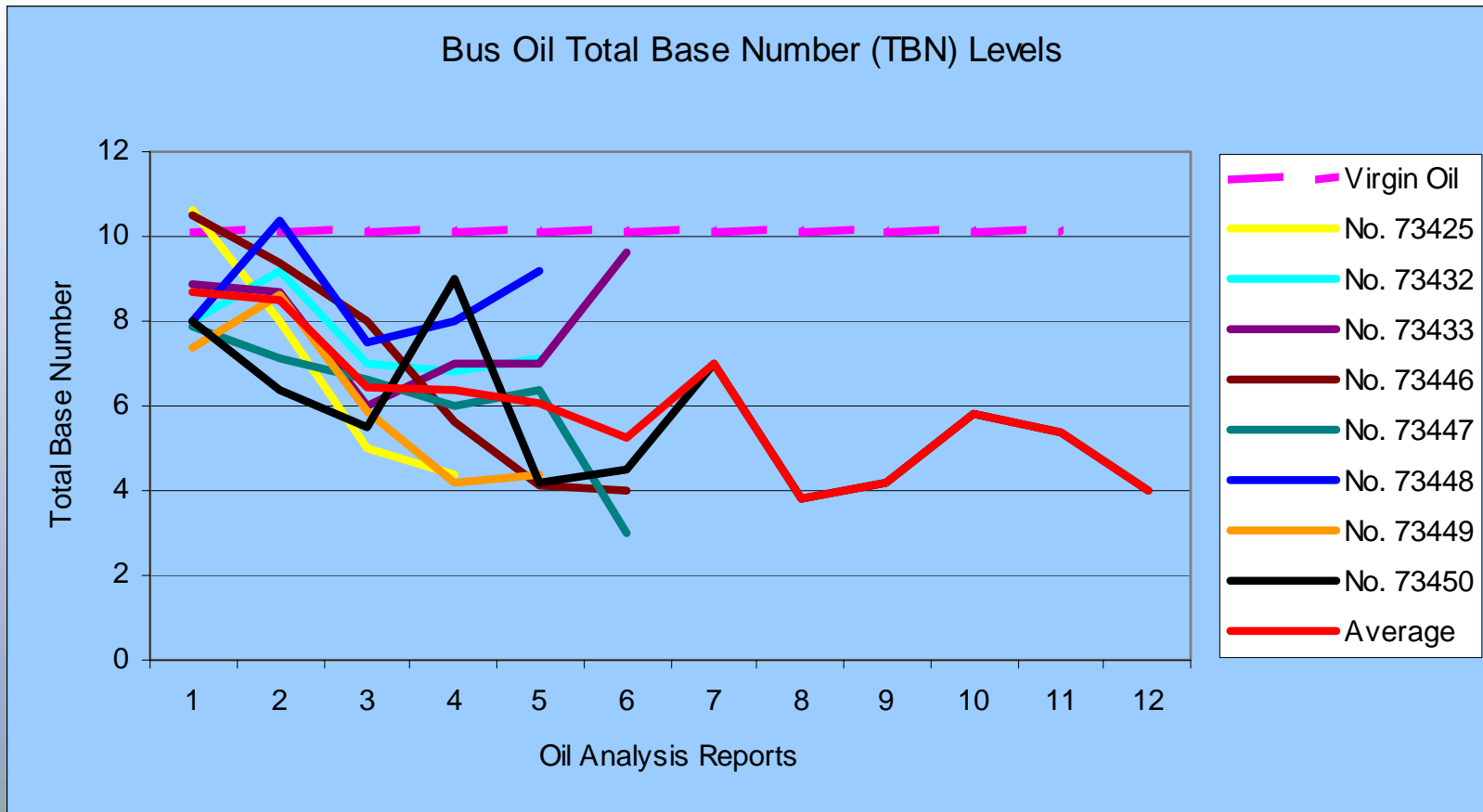
- *Oil quality - contaminates/physical properties:*
  - *Presence of fuel ( $\leq 3\%$ ), water ( $< 0.25\%$ ), and glycol ( $\leq 0.25\%$ )*
  - *Soot content ( $\leq 3\%$ )*
  - *Oxidation and nitration levels ( $\leq 30$  Abs/cm)*
  - *Total base number ( $\geq 3.0$  mgKOH/mL)*
  - *Viscosity (12.50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



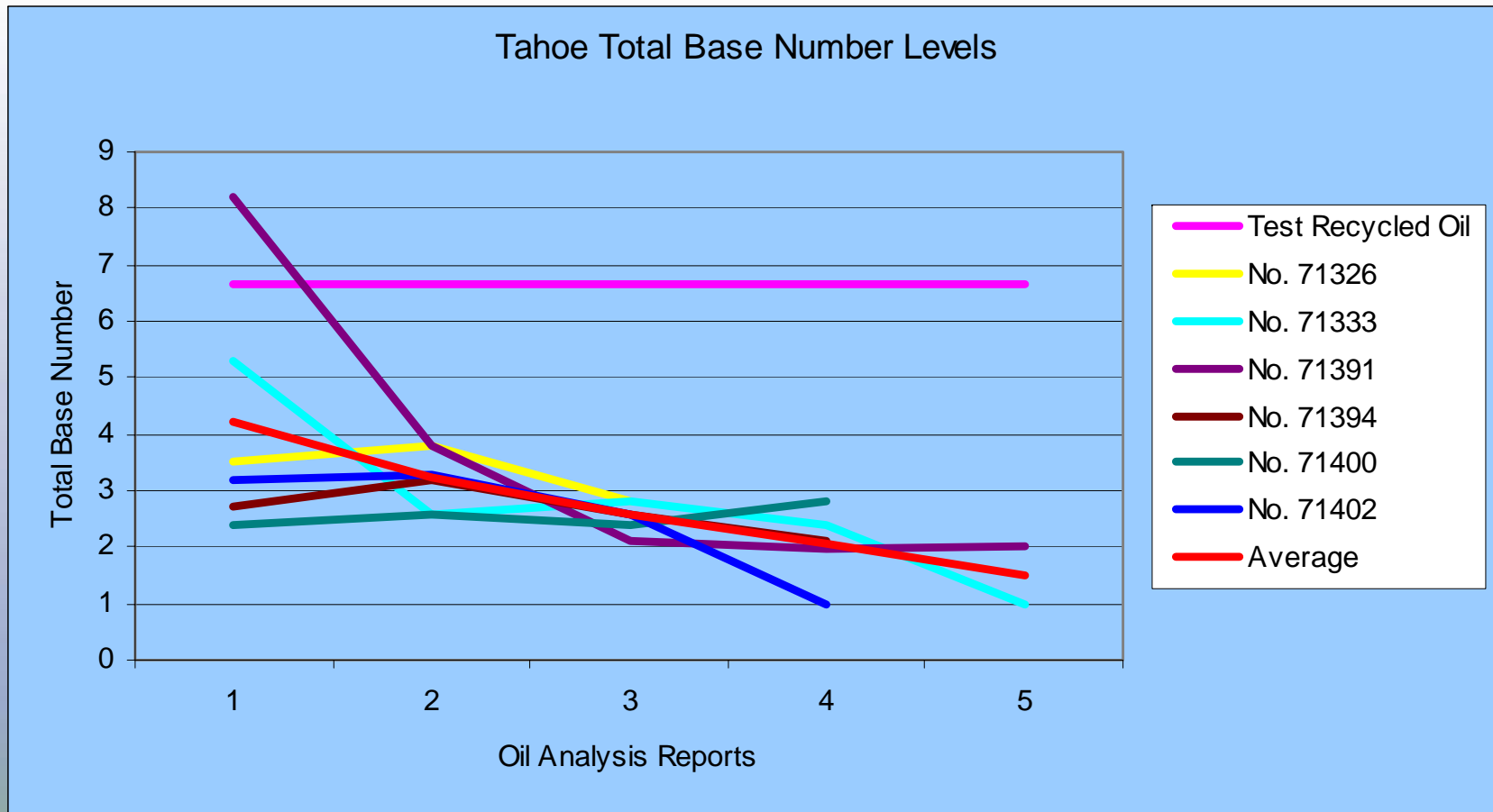




# Bus Oil – Total Base Number (desired $\geq 3.0$ mgKOH/mL )



# Tahoe Oil – Total Base Number (desired $\geq 3.0$ mgKOH/mL )

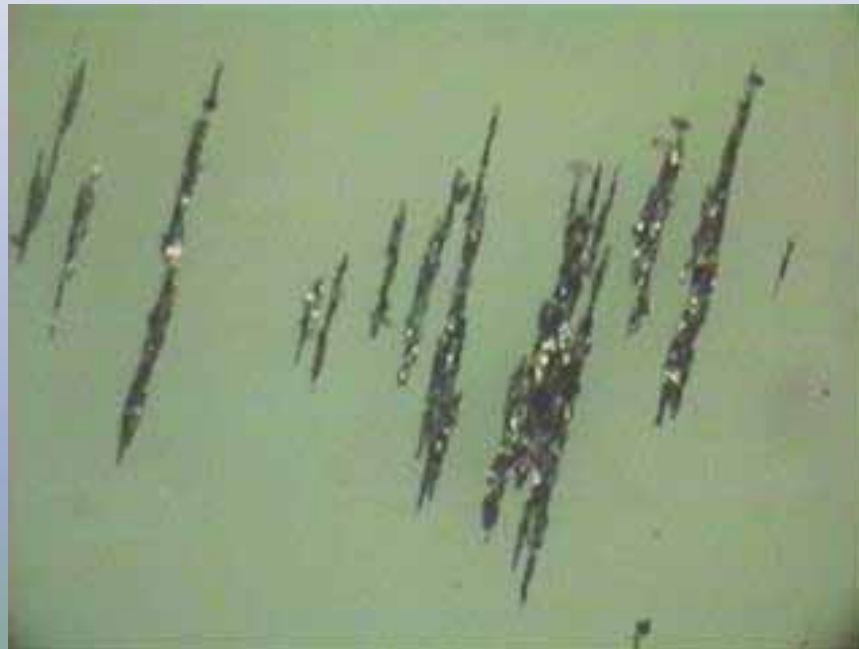


# ***Particulate Tests Evaluate Filter Effectiveness and Engine Wear Metals***

- *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

<sup>1</sup> FAST – INEEL maintained Federal Acquisition Statistical Tool. Fiscal Year 2003 data

## ***Potential Annual Engine Oil Savings***

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

<sup>1</sup> FAST on-road vehicle data for fiscal year 2003.

<sup>2</sup> 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>*