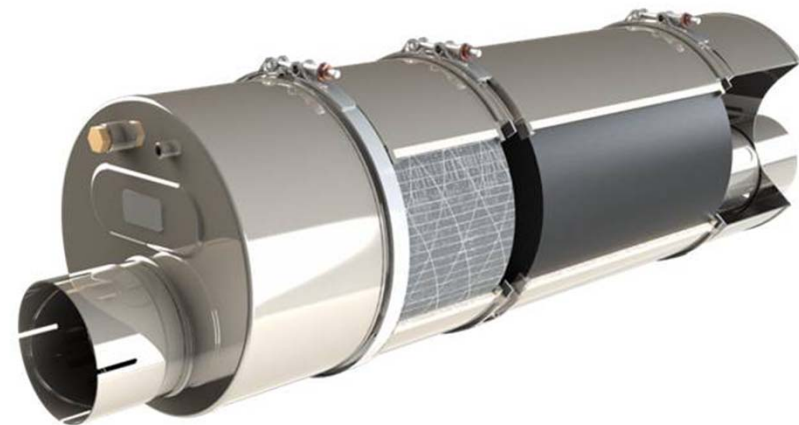


In-use HD Diesel Emissions Reduction Needs: The next ten years

Kevin Brown
Regulatory Affairs Manager



What are the issues today?
What is the potential for further improvement today?
What is the cost of complacency today?
Is retrofit a done deal?

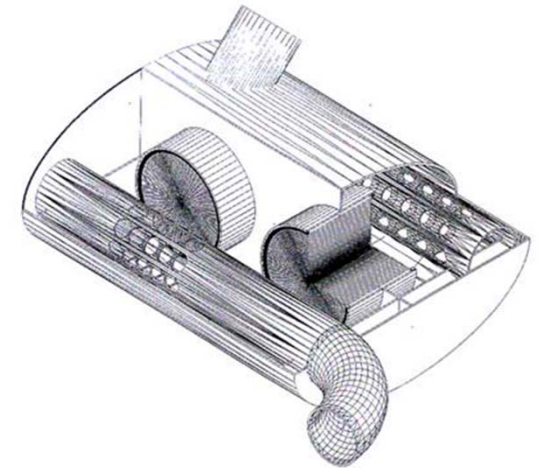


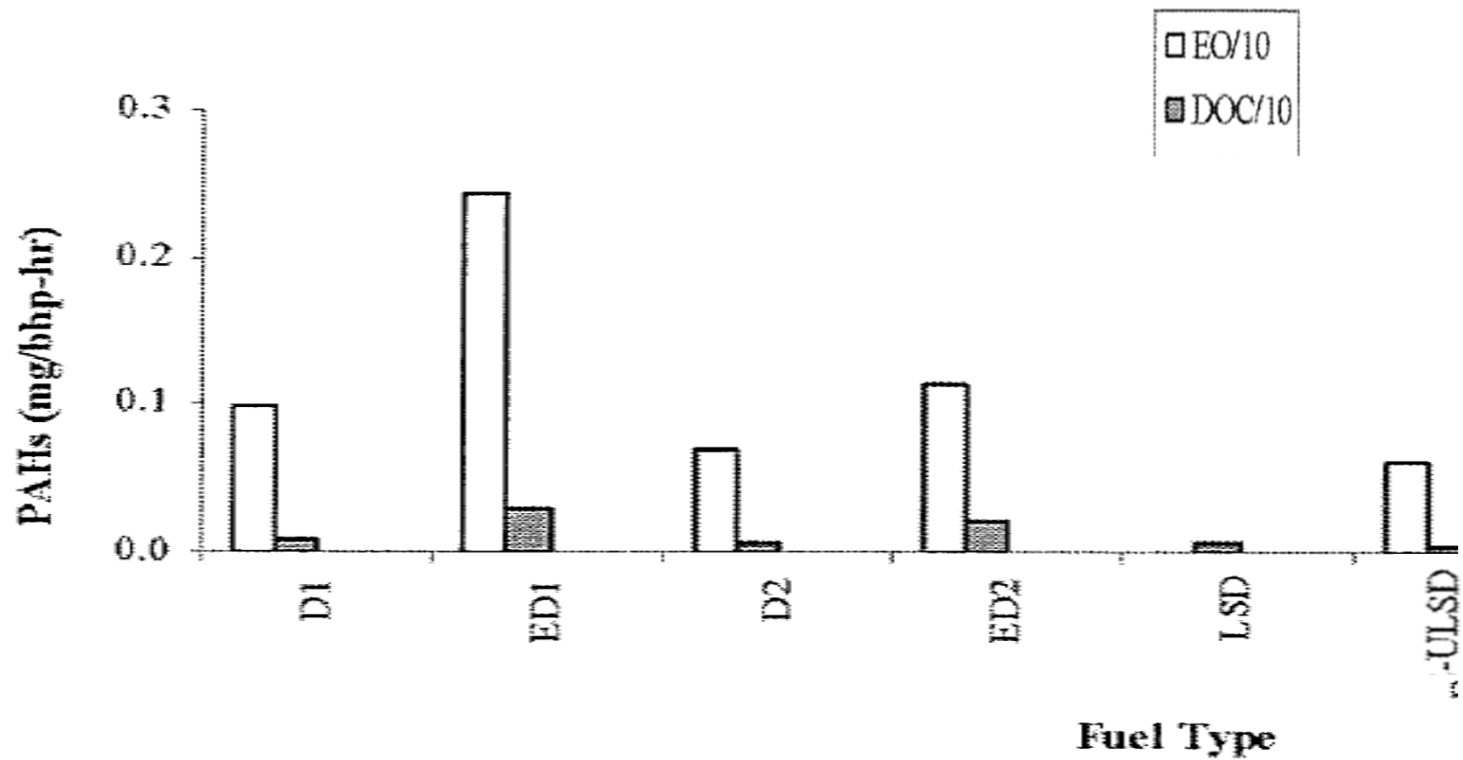
- In 1993, US EPA Urban Bus Retrofit Rebuild Program resulted in first EPA “certified” rebuild & retrofit products
 - DOC’s, DPF’s, engine rebuild kits alone and in combination
- In 1999, NESCAUM managed a project to document the in-use emissions reductions of “urban bus originated retrofit products” on highway and off-road machines
- In March 2000, the **EPA Voluntary Retrofit Program** was launched



Benefits

- Easily adapted and installed on almost any vehicle
- Low cost
- Durable
- Reduces SOF fraction of PM, HC, CO and other organic toxics
- PM reduction varies with SOF content

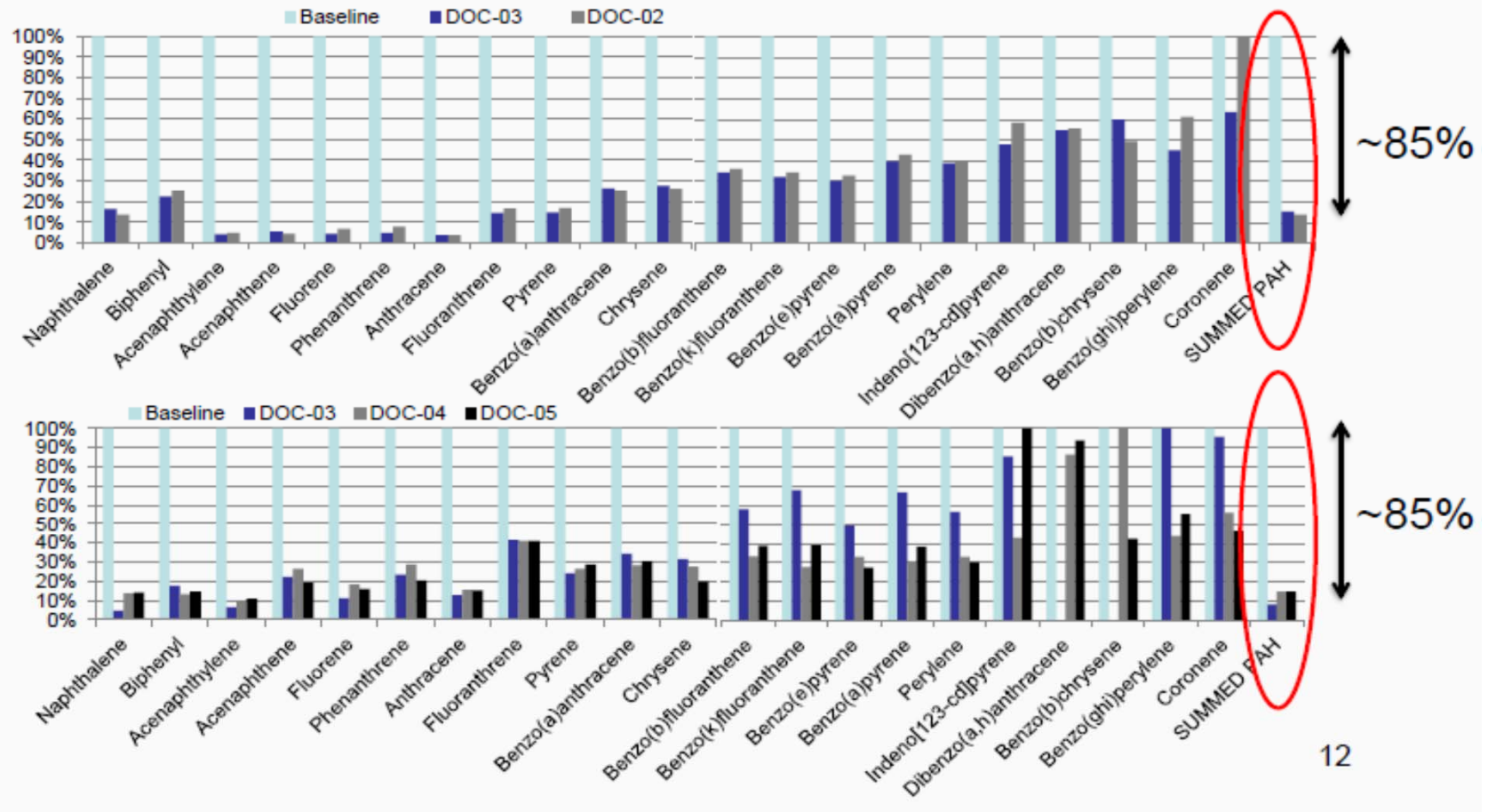




Source: Env. Sci. & Tech., 41, No. 14, 2007, page 5041.



PAH Reduction Efficiency: DOCs

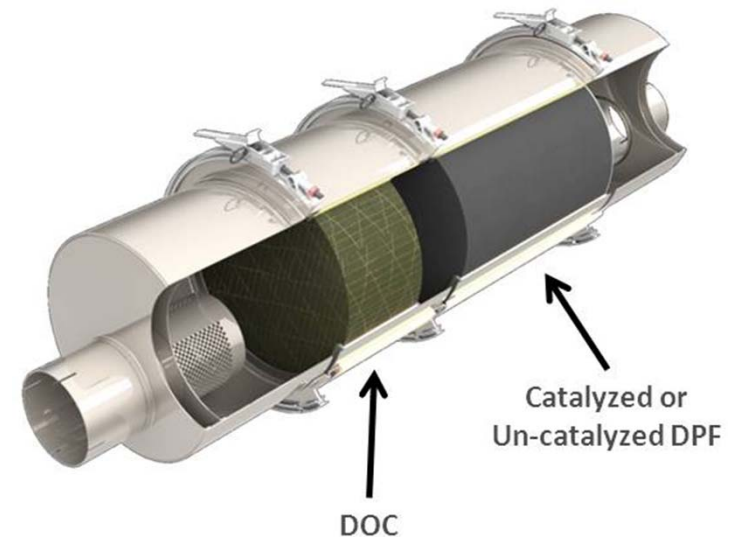
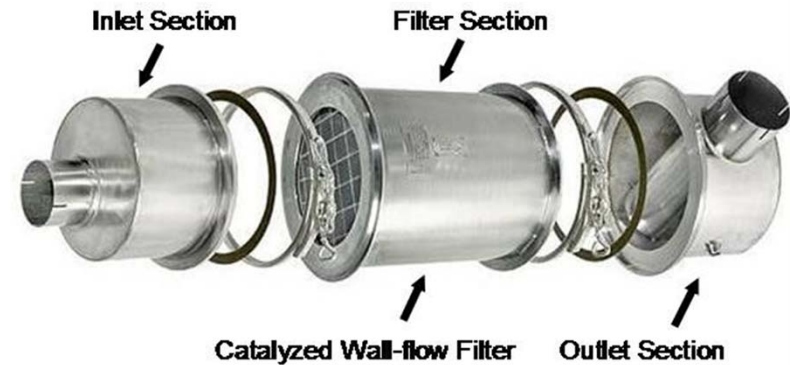


Source: 2012 DEER Conference, Geller et al., Oct 2012

- **In 1964, LD gasoline cars were required to close the engine crankcase**
 - Done via PCV valve which routes crankcase gases to engine intake
- **Today, Diesel engines must factor in crankcase gases to tailpipe emissions**
 - Most engines continue to employ open crankcases but treat/filter the emissions
- **Crankcase emissions vary with age and engine model**
 - Typically 5-10% but can be much higher for certain engines
- **Crankcase emissions are toxic and impact air & aquatic water quality as well as human health**



- **Passive DPF Types**
 - Catalyzed DPF
 - DOC / un-catalyzed DPF
 - DOC / catalyzed DPF
- Rely on sufficient exhaust temperature over vehicle's normal driving cycle
- DPF's provide >85% to >95% reduction in PM emissions and particle number



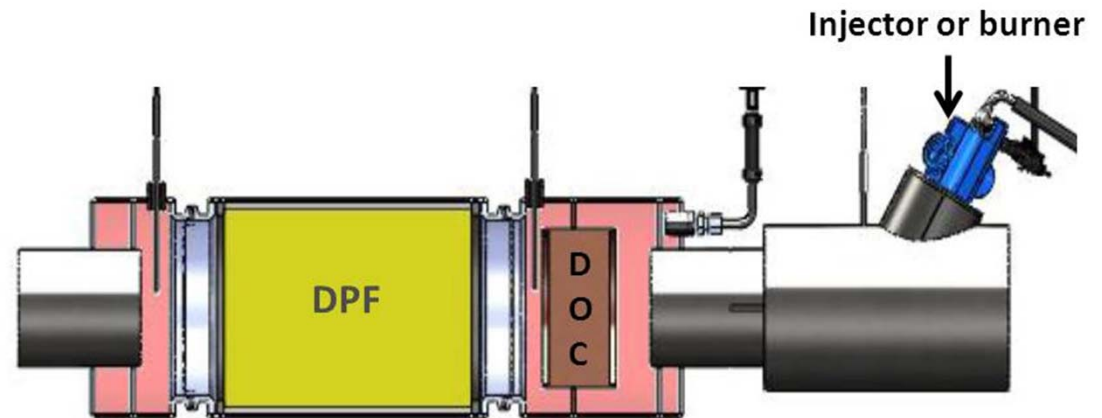
Plug-in Active System

- Can cope with variable duty cycle
- Maintains DPF's in peak readiness



Fuel Injection or Fuel Burner Active System

- Can cope with variable duty cycle
- Maintains DPF's in peak readiness



■ Hwy

- Model Year 04 -06 Class 8 trucks
- Legacy diesel engines will operate in high value specialty Class 8 highway fleets for many more years
 - Construction Trucks
 - Heavy Haul Trucks
 - Specialty Haul Trucks

■ Off-road

- Legacy diesel engines are still overwhelmingly in operation and will be for many years

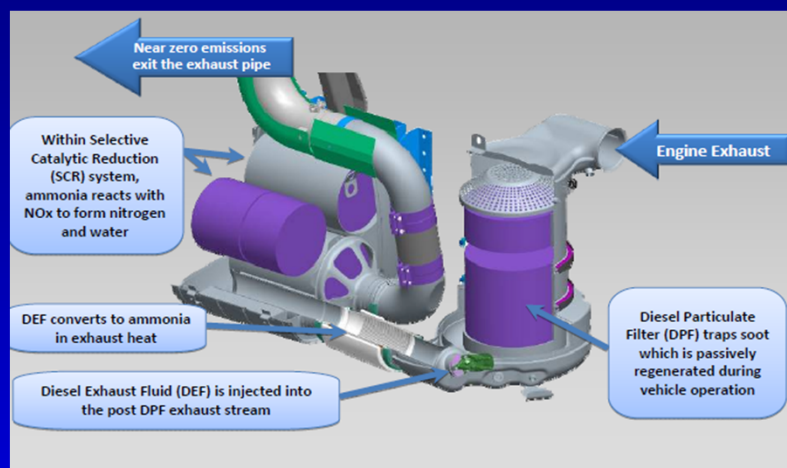


Dual DPF Install on 500hp truck

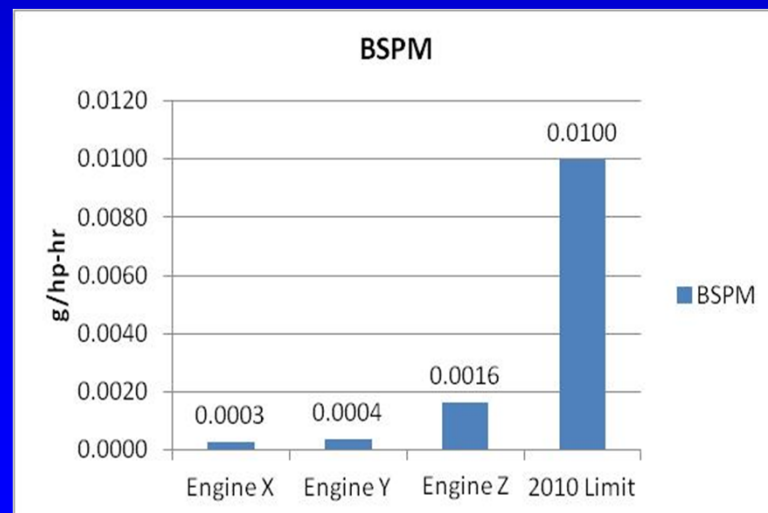
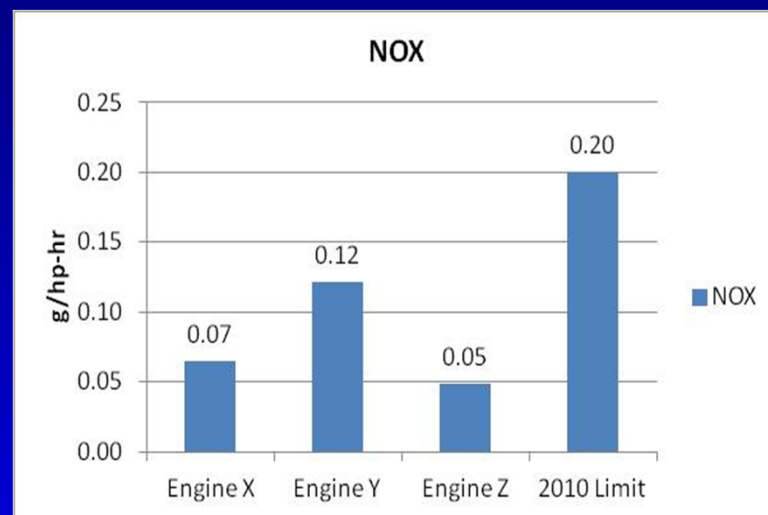
- From 1994 to 2009, 380 engines certified in the US have used **DOC's** to comply to emissions limits
 - Engines up to 15.2L and 625hp
- In 2007, **DPF's** were incorporated on new diesel engines and most employ DOC's
- In 2010, **SCR** technology was introduced
 - 2010 engines are equipped with DOC's, DPF's and SCR units
- New 2010 HD engines emit 90% less PM and 96% less NOx
- Emission Controls now on every new HD Hwy diesel
- In 2012, UN WHO IARC declare that diesel exhaust is a known human carcinogen



2010 Technologies Deliver Surplus Health Benefits



- 2010 on-highway emission controls employing SCR catalysts have evolved into 2nd generation technologies.
- ACES study shows that 2010 DPF & SCR equipped Hwy engines have emissions significantly lower than the standards, esp. on PM.
- **Steps need to be taken to preserve these benefits!**





- **DOC's are commonly removed**
- **Tampering of LD & HD diesel engines is becoming more widespread**
 - Google search of “DPF Delete” results in 1,930,000 results in 0.19 seconds. “SCR delete” results in 3,670,000 results in 0.33 seconds
 - Also services & kits available to
 - convert 2004 & newer Caterpillar ACERT compound turbocharging systems to older single turbo configuration,
 - Convert 2010 and newer Hwy Truck engines to non-road engine configuration
- **Widespread advertising of services & parts to remove emissions controls from LD and HD trucks**
- **Increasing number of instructional videos showing how to defeat diesel emissions controls**

- **Over 380 certified engine families manufactured between 1994 and 2009 included DOC's to meet emissions limits**
 - Engines up to 15.2L in displacement and over 600hp
 - Engine emissions typically increase with age
- **DOC's are simple, straightforward, low cost devices that are easily installed as distinct converters or integrated converter mufflers**
- **CARB, WHO IARC and others classify diesel exhaust as a known human carcinogen**
- **Lack of action on DOC's conveys strong precedent that there will be no action if DPF & SCR emissions controls are removed**

- **Older trucks emit higher levels of emissions**
- **Older trucks are typically found in high population areas**
 - Populations living adjacent to major transportation corridors are at higher risk
- **Taking action immediately puts truck owners on notice that the removal of all emissions control devices is illegal and that existing devices should be retained and maintained**
- **Readily implemented strategies exist for DOC's**
- **Taking action encourages fleet turnover**

- **Reduce highway opacity limits from 40%**
 - CDTi experience in California shows 85% of 1994 and newer trucks have peak opacities below 10%; 95% are below 15%
 - Very few engines have peak opacities higher than 15%- those that do typically present values 25% and above
 - Recommendation: 20% maximum for 1994 and newer highway trucks;
2% for 2007 and newer trucks
- **Transition to mandatory requirements for older trucks**
 - For engine & vehicle labeling
 - Mandatory annual opacity testing for fleets / bi-annual for owner / operators
 - Schedule mandatory retrofit of all pre 2007 trucks with DOC's
 - Similar to Province of British Columbia program
 - Will provide incentive to turn over fleet
 - Will provide precedent that 2007 & newer trucks will be monitored



- Retrofit will continue to be needed for the legacy fleet
- As DOC's were carried over from Urban Bus Rebuild / Retrofit Program, request EPA carry over current EPA Verified DOC's as first HD Aftermarket Replacement DOC's
- Focus resources to develop state I/M strategies for 2007 and newer trucks and Tier 4 off-road engines