Diesel Retrofits

Cleaner Diesel to

Help Americans Breathe Easier Today

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Environmental Defense

The Current Rules

2001 Highway

Establishes fuel and engine standards for heavy-duty on-road vehicles

- Requires ultra low sulfur diesel fuel by 2006
- Engine standard phased in between 2007-2010

– Results in NOx and Hydrocarbon standards 50 times lower than 1974, Particulate Matter limits 60 times lower than 1988 standard

– Will save 8,300 lives a year

2004 NonRoad

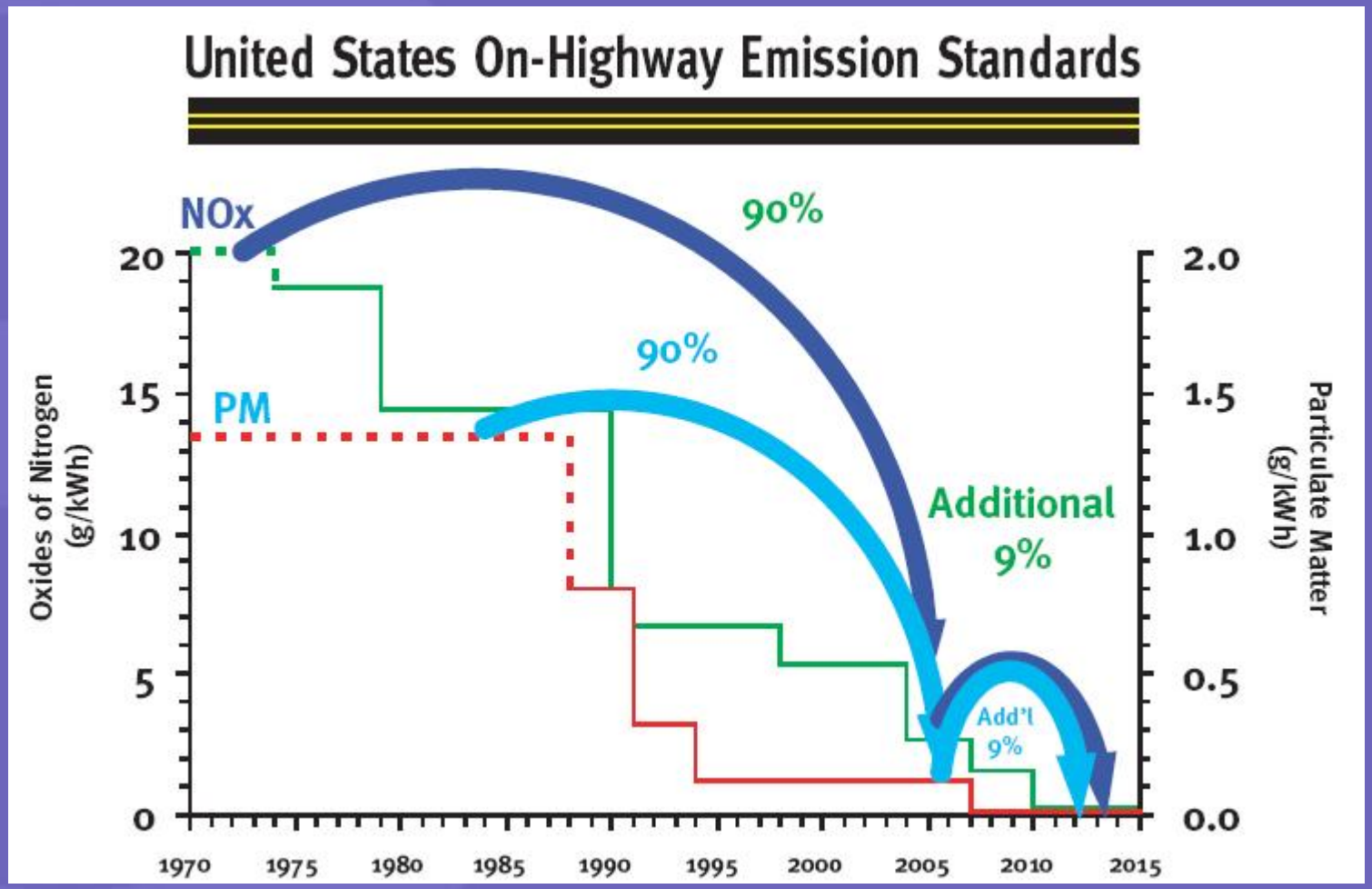
– Applies to diesel engines in construction, agriculture, and industrial equipment

– Also reduces sulfur content of non-road diesel fuel

- from 3400 ppm to 500 ppm in 2007 and 15ppm in 2010

– Reduces PM and NOx emissions levels by 95% and 90%, respectively (from today's engines)

– would annually prevent 9,600 premature deaths, over 8,300 hospitalizations


United States On-Highway Emission Standards
NOx
PM
90%
90%
Additional
9%
Add'l
9%
Oxides of Nitrogen
(g/kWh)
Particulate Matter
(g/kWh)
20
15
10
5
0
2.0
1.5
1.0
0.5
0.0
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

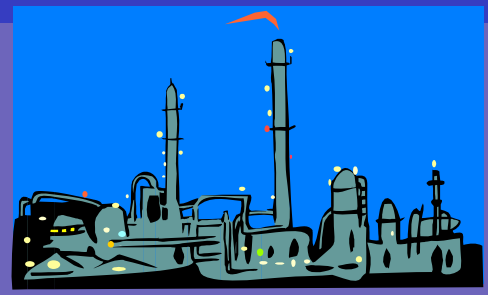
As good as these rules are, there is a gap to be filled

- **Diesel Engines last a long time**
  - Existing engines may last another 20-35 years
  - Diesel powered vehicles may drive a million miles
- **Benefits of regulations occur in the future**
  - Requirements are phased in between 2007 - 2012
  - Full benefits are years away
- **But a Diesel Retrofit Program can improve existing engines today**
  - Benefits from retrofits are immediate
  - Retrofit technology is available now

Diesel Combustion

- **Why are diesel engines used?**
  - More efficient than gasoline engines
    - 20% less energy used
    - 30% less volume of fuel used (diesel fuel more energy dense than gasoline)
- **Engine types vary (compression ratio, direct vs. indirect injection)**
  - High temperatures favor formation of NO_x
    - Excess air favors formation of NO_2
  - Newer engines pre-mix fuel and air, may reduce emissions

Diesel Fuels



- Diesel less refined than gasoline
- Quality measured by cetane (ignitability) not octane (anti-knock)
- Variation in sulfur content, PAH content, density, viscosity

  Makes it difficult to generalize about emissions

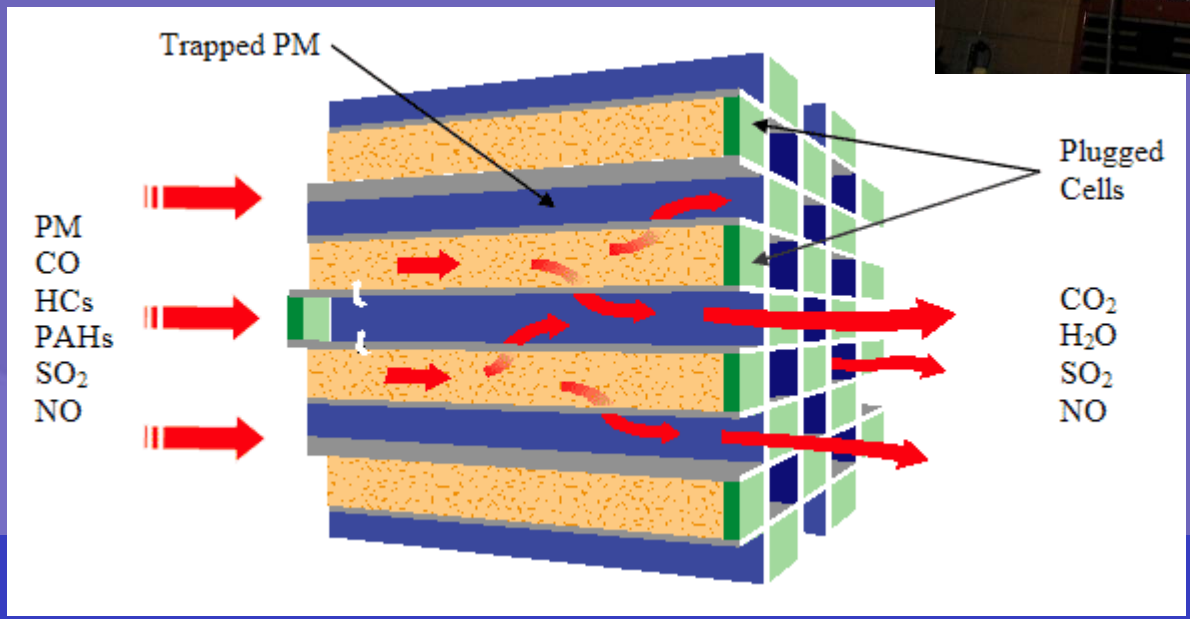
What comes out of the tailpipe?

- Particles
  - Results from fuel-rich combustion (pre-mixing helps reduce)
- NO_x
  - From high peak temperatures; excess air leads to NO_2
- Aldehydes, CO, PAHs, hydrocarbons

Retrofits for PM removal

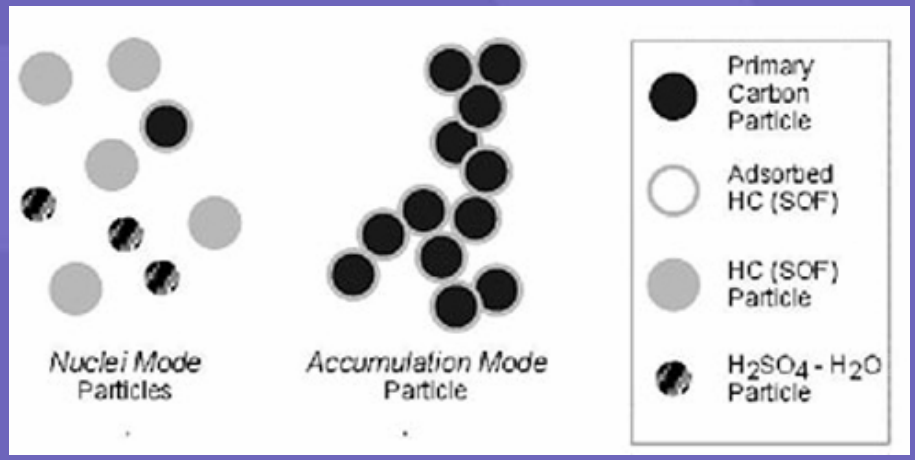
- Close Crankcase Ventilation
- DPF & lean NOx catalyst
- Catalyzed Passive DPFs
- Uncatalyzed DPFs, on-vehicle fuel burner regeneration
- Active DPFs (non-catalyzed), shore power electrical or on-board regeneration
- Flow Through Filters
- DOCs

CCV & DPF – best available



Retrofits and removal

PM, NOx, HC & SOF



DPF in-use reduction numbers

NO_x	0%
PM	Up to 90%
HC	Up to 90%
CO	Up to 90%

Johnson Matthey (SCRT) field-testing reduction numbers (not verified as of February 2005)

NO_x	75–90%
PM	75–90%
HC	Over 90%
CO	Over 90%

CWMF EPA verified reduction numbers (when used with FBC)

NO_x	0–9%
PM	55–76%
HC	75–89%
CO	50–66%

DOC in-use reduction numbers

NO_x	0%
PM	20–30%
HC	50–90%
CO	70–90%

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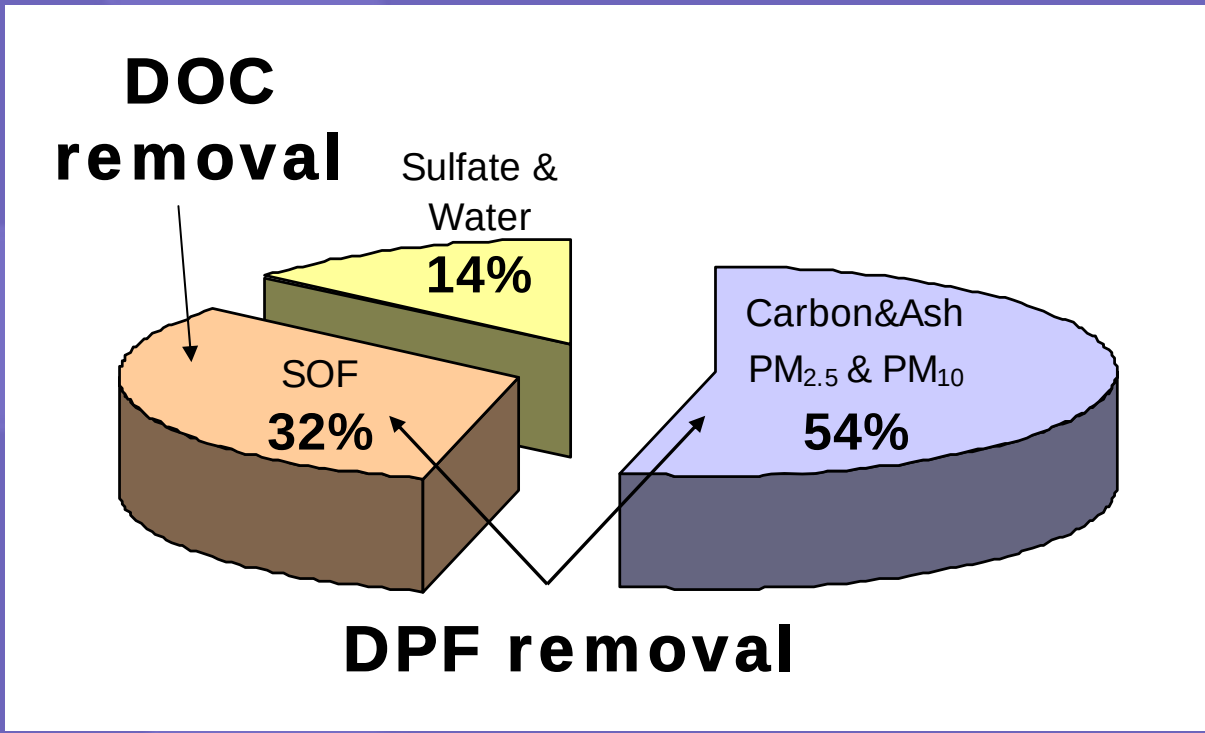
Retrofit type	Emission reductions	Cost installed
Close Crankcase Ventilation	Engine fine PM 60%	$800
DPF & lean NOx catalyst	25% NOx & 85% PM	$20000
Catalyzed Passive DPFs	85% PM	$13-15K
DPF with fuel burn regeneration	85% PM	$20000+
Active DPFs	85% PM	$12-14K
FTF	50% PM	$8-12K
DOC	25% PM = all of SOF	$3-5K

DOCs only remove HC/SOF



Typical PM Composition For Diesel Engines

More information

www.CleanerDieselHandbook.org

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