



M.J. BRADLEY & ASSOCIATES LLC
A Climate Change Capital Group Company

ULSD & Emissions Retrofits

Clearing the Air at a
Construction Site Near You

D+Ce

DESIGN + CONSTRUCTION
EXCELLENCE

Continuing Education for NYC Capital Program Staff

LEED AND GREEN CONSTRUCTION
SEPTEMBER 18, 8:30 AM TO 1PM
2 WASHINGTON STREET
CITYWIDE TRAINING CENTER RM 1980

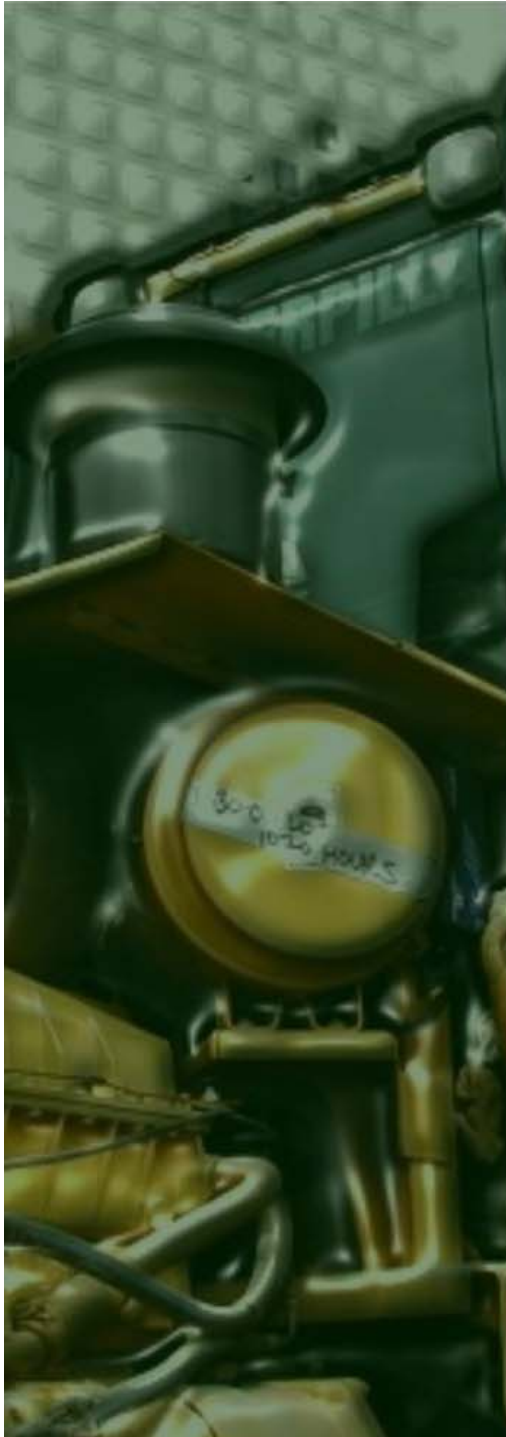


Training Session Outline

- **Background**
 - What Local Law 77 requires and why
- **Technology**
 - What you should be seeing on your Contractor's equipment

Local Law 77

- Intended to reduce emissions from Diesel Construction Equipment
- Applies to City-funded projects
- Requires:
 - The use of **Ultra Low Sulfur Diesel Fuel**
 - The use of “**Best Available Technology**” (**BAT**) to reduce emissions from equipment greater than 50 hp



Schedule

Construction Contracts	Local Law 77 Requirements Contracts Awarded After			
	June 19 2004	Dec 19 2004	June 19 2005	Dec 19 2005
In Lower Manhattan	ULSD & BAT	ULSD & BAT	ULSD & BAT	ULSD & BAT
> \$2 million City-wide	NA	ULSD	ULSD & BAT	ULSD & BAT
< \$2 million City-wide	NA	ULSD	ULSD	ULSD & BAT

Why Local Law 77?



Particulates

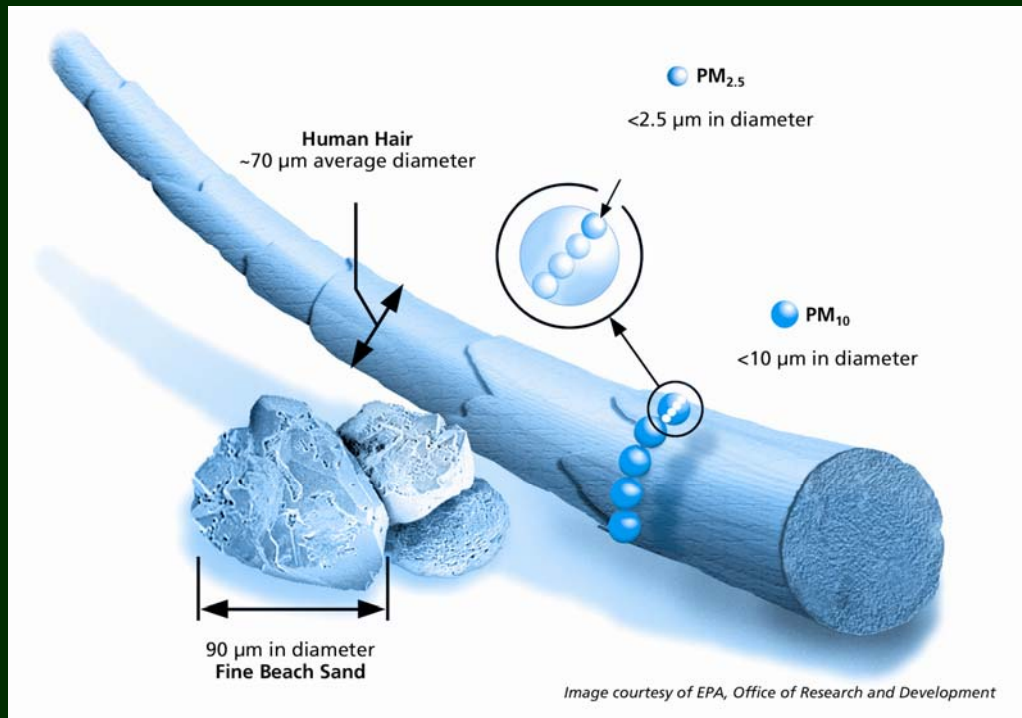
- Carbon particles
- Toxic hydrocarbons
- Sulfur compounds
- Smallest most dangerous

NO_x

- Respiratory irritant
- With HC creates OZONE

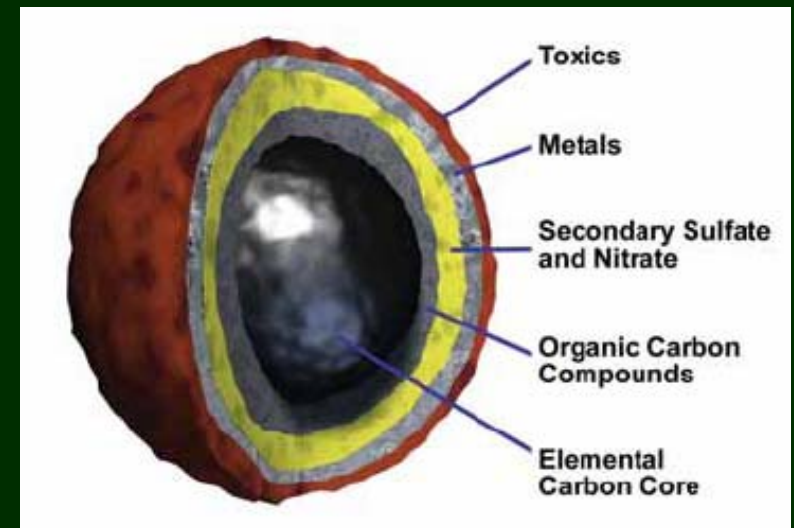


Diesel PM



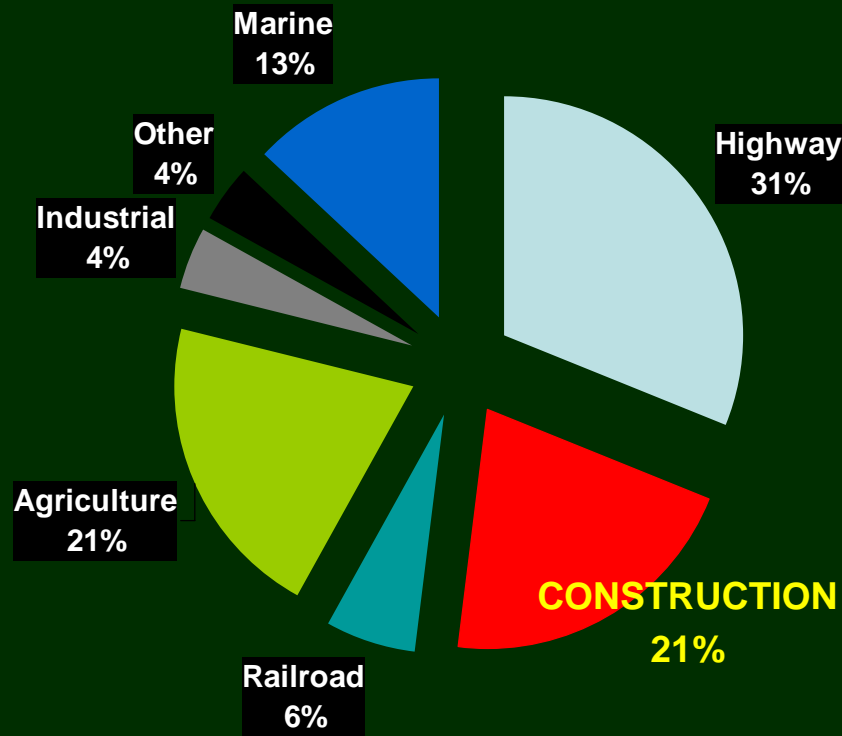
PM is composed of very small particles that remain airborne and can penetrate deep into the lungs.

Diesel PM is primarily composed of a carbon core with organic materials and sulfates adsorbed on the surface
(picture is illustrative only)



Source: Clean Air Task Force

Is Construction the Problem?



US PM Emissions
(US EPA 2004)

NYC PM & NOx Emissions
(USEPA 1999)

	<u>PM %</u>	<u>NOx %</u>
Highway	31.7%	56.8%
Agricultural	0.0%	0.0%
Airport Equipment	1.3%	0.8%
Commercial	9.1%	3.7%
CONSTRUCTION	45.0%	26.2%
Marine & Rail	6.5%	9.2%
Industrial	6.1%	3.1%
Lawn & Garden	0.4%	0.2%
Recreational	0.0%	0.0%


Construction activity is a significant **part** of the problem

Diesel Health Effects

Percent of children
ever having asthma

4-13%
14-19%
20-30%

Pollutant	Health Concern
Particulate Matter (PM)	<ul style="list-style-type: none">• Increased respiratory disease• Lung damage• Cancer• Premature Death
Nitrogen Oxides (NOx)	<ul style="list-style-type: none">• Lung irritation• Respiratory illness• Premature death

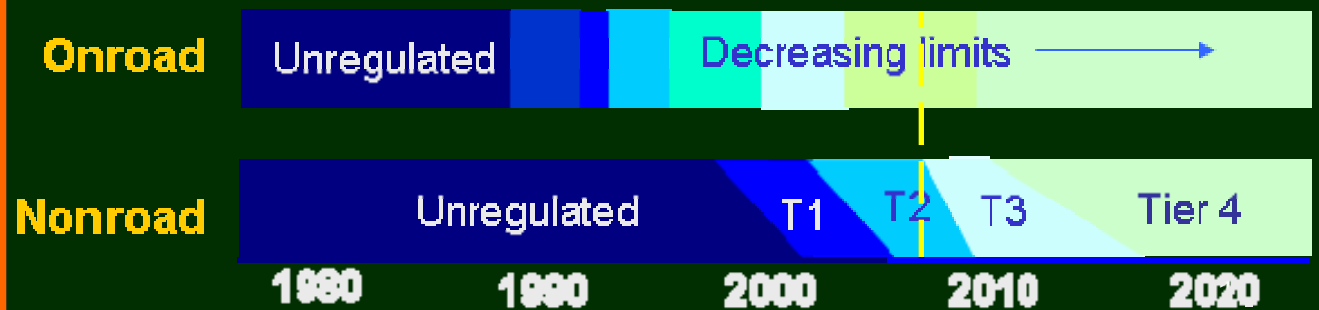


EPA Emissions Regulations

- Emissions from new **cars and light trucks** have been regulated since the 1970's
 - Progressive tightening of rules, culminating in Tier 2 (2004 model year)
- Emissions regulation for new **heavy-duty diesel** engines began in 1988
 - Progressive tightening of rules, but significant lag in regulation of non-road engines
 - Non-road engines will not achieve parity with on-road engines until 2016 or later₉

Non-Road Emissions Regulations

- Differ depending on size of the engine
- Apply to **NEW ENGINES** only
- Focus is on PM and NOx
- Anything built before 1997 is “Tier 0” unregulated
 - Current new engines are Tier 2
 - After 2010, cleaner Tier 3 and Tier 4 engines will be delivered in new equipment





Why ULSD?

- Current diesel fuel sulfur levels
 - On-road fuel: no more than **15 ppm (ULSD)**
 - Non-road fuel: up to **500 ppm**
- **Sulfur IN** (fuel) = **Sulfur OUT** (tailpipe)
- Reducing fuel sulfur reduces emissions
 - Sulfur dioxide
 - Sulfate (PM)
- Sulfur also interferes with the **CATALYSTS** used in many diesel emissions reduction devices
 - **Ultra Low Sulfur Diesel** (<15 ppm) allows the use of the most effective emissions controls

ULSD Availability

- ULSD (<30 ppm sulfur) has been available in NYC since September 2000
- As of mid-2006, ALL fuel sold for on-road use nation-wide has been ULSD (<15 ppm sulfur)



What is BAT?

- **“Best Available Technology”**

.....to reduce emissions

- Determined by NYC Department of Environmental Protection
- Mostly chosen by NYCDEP from lists of “verified” technology, as designated by US EPA or California Air Resources Board
- Can be different for different pieces of equipment

Emissions Reduction

Cleaner Engines

Retrofit Technologies

Diesel Oxidation Catalyst

Wire Mesh Filter

Passive Diesel Particulate Filter

Active Diesel Particulate Filter

Exhaust Gas Recirculation

Lean NOx Catalyst

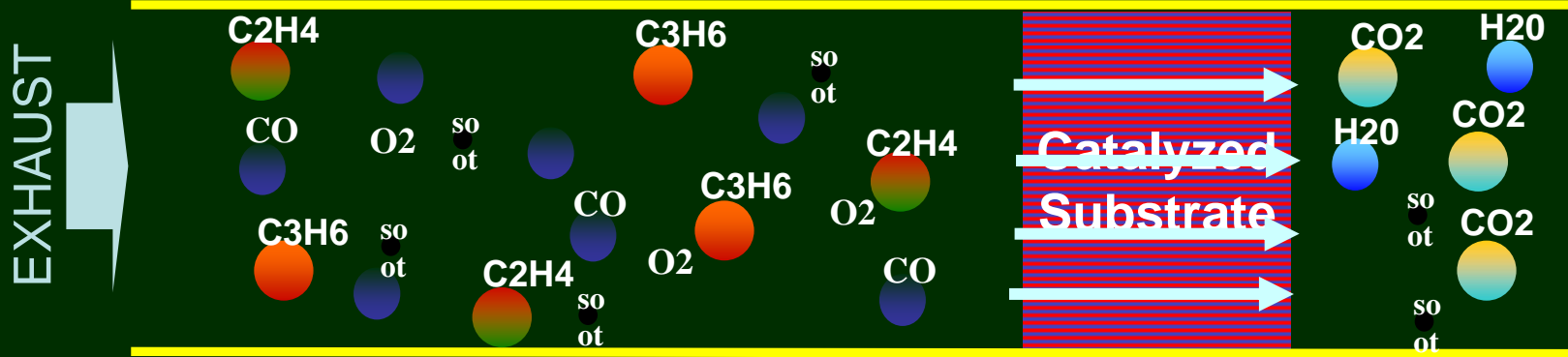
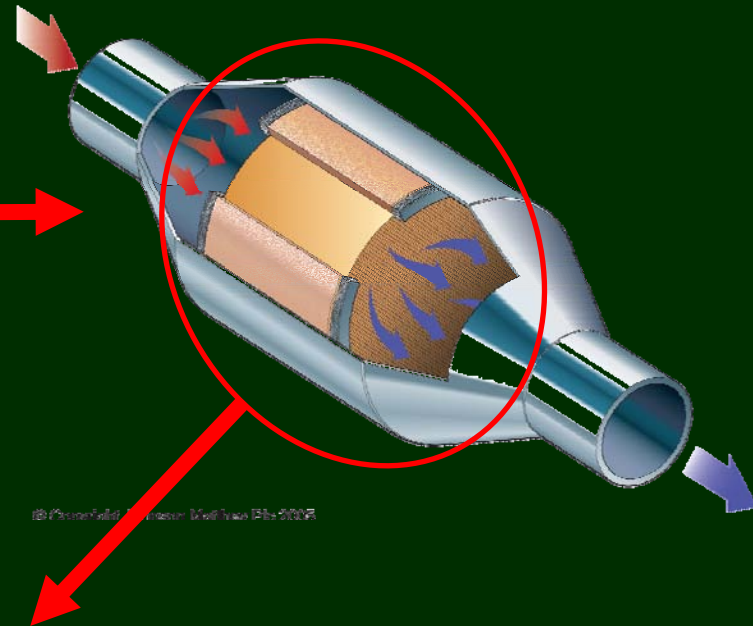
Selective Catalytic Reduction

Cleaner Fuels

ULSD

Emulsified ULSD

Diesel Oxidation Catalyst (DOC)



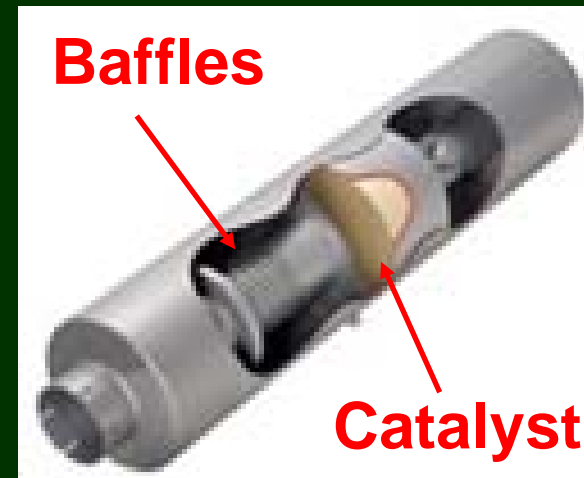
DOC Implementation

- Reduces PM emissions by 20 – 33%
- Can be used on most diesel engines with no trouble
- Completely passive – no maintenance required
- Fits in space of current muffler
- \$500 - \$3,000 and 2-8 hours for installation



Types of DOCs

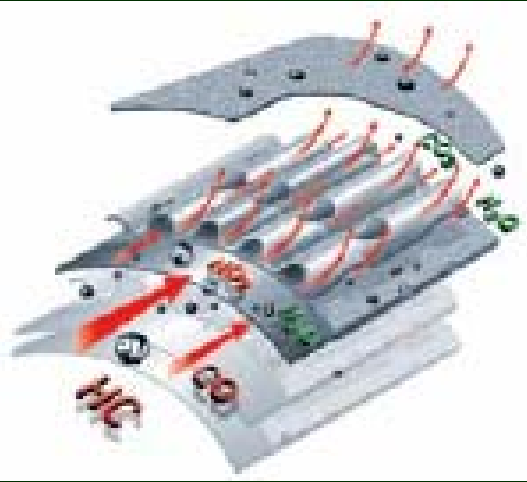
- Direct muffler replacement
- Includes sound attenuation
- Installs in 1-2 hours



Independent Catalytic Converter (ICC)

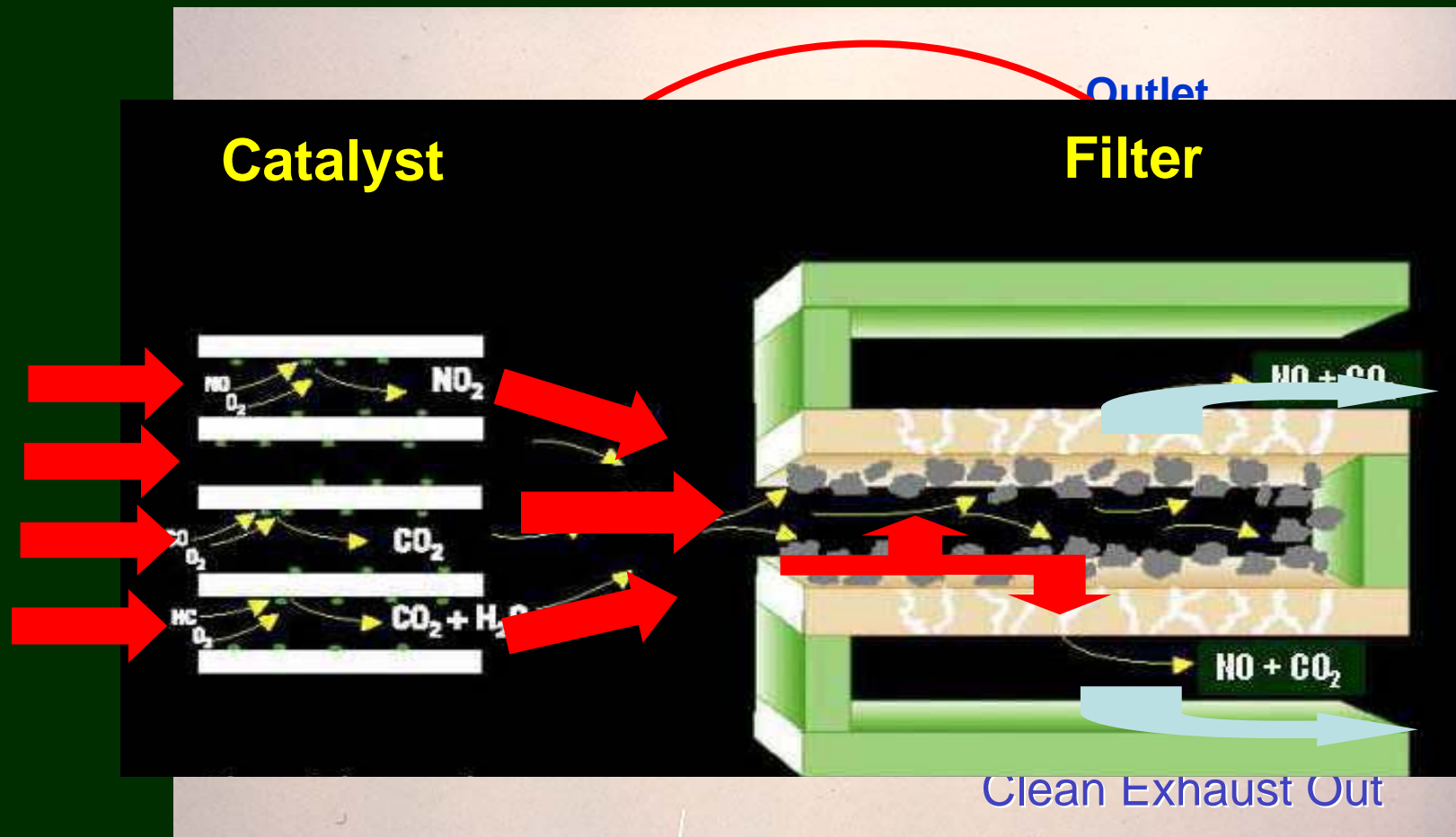
- Reduces PM (same catalyst)
- Does NOT reduce noise
- Muffler still required

Wire Mesh Filter (High Performance DOC)



- Similar to a DOC, but reduces PM emissions by up to 50%
 - Substrate design allows greater opportunity for PM particles to contact a catalyst site
- Passive device – but may require periodic cleaning
- Needs minimum exhaust temperature
- Does not require ULSD
- Applicable to most engines
- \$3,000 - \$5,000 & 2 – 8 hours to install

Passive Diesel Particulate Filter (P-DPF)



P-DPF Installation



Effect of DPF



After 9 months installed on a bus

DPF Implementation

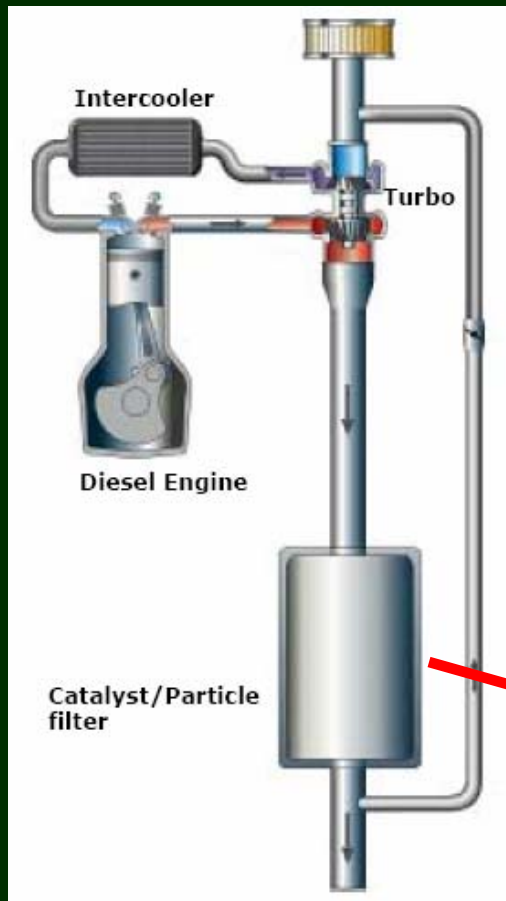
- Reduces PM emissions by 85+%
- Generally can fit into space of existing muffler
- Not applicable to all engines or all duty cycles
 - Increases engine back-pressure
 - The dirtiest engines will overwhelm the filter
 - Engine & duty cycle must produce minimum exhaust temperature
- **MUST** be used with **ULSD**
- Requires approximately annual cleaning to remove accumulated lube oil ash
- \$7,000 - \$15,000 and 4 -12 hours for installation

Active DPF



- Uses same filter as P-DPF
 - May also employ a catalyst coating on filter
- Includes system to increase exhaust temperature to oxidize collected carbon
 - Add fuel directly to exhaust
 - Use a separate fuel burner
- Increases fuel use by 3 – 5%
- Requires filter cleaning
- ULSD not required
- Cost \$12,000 - \$20,000

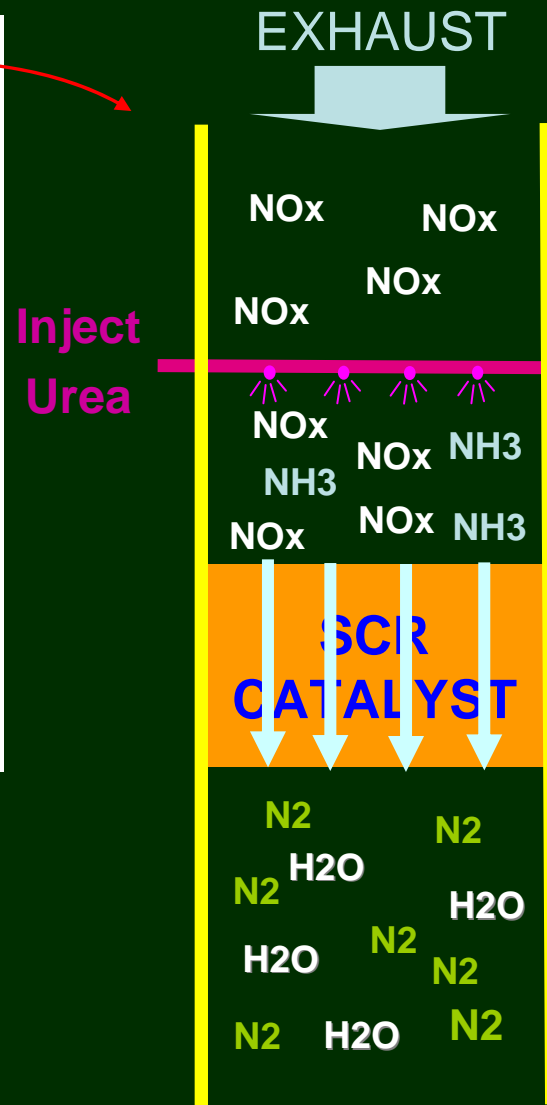
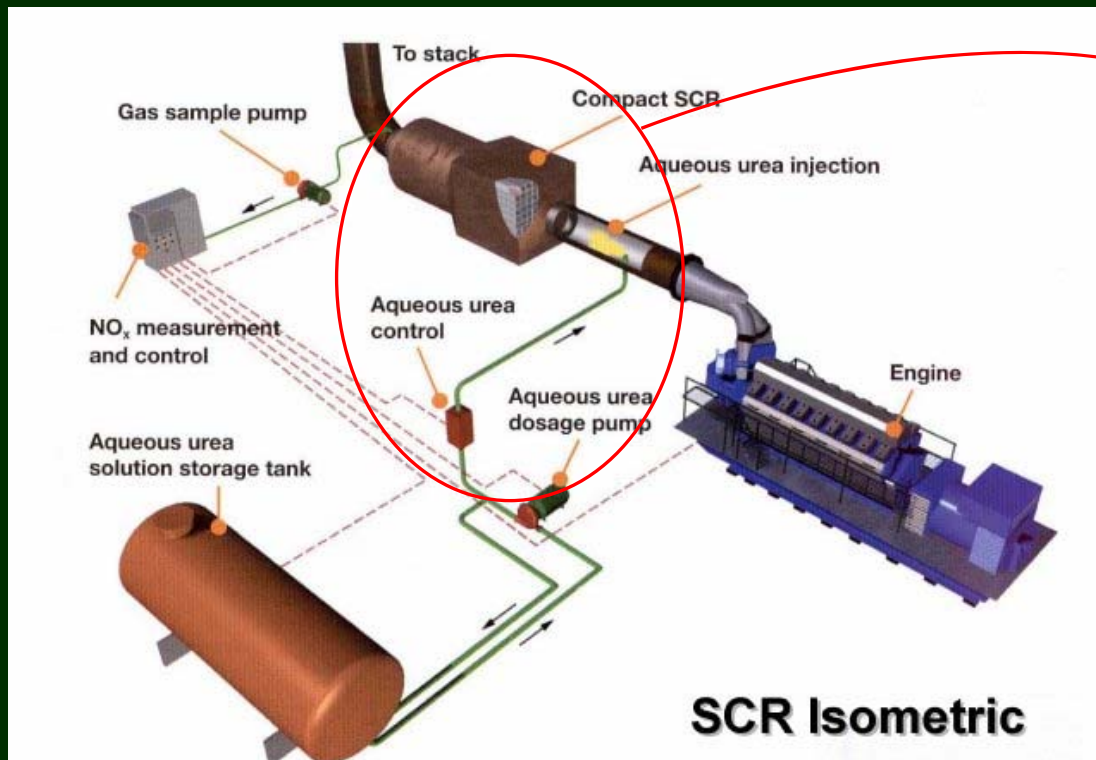
Exhaust Gas Recirculation (EGR)



- Returns a portion of exhaust to air intake
- Reduces combustion temperature, reducing NOx by 30-40%
- Retrofit low pressure systems must be used with DPF
- Adds equipment to engine, and requires precise electronic control; retrofits can be costly



Selective Catalytic Reduction (SCR)





SCR Implementation

- Reduces NOx emissions by 70 - 90% and PM emissions by 10 – 25%
- Not applicable to all engines or all duty cycles
- Requires approximately 1 gallon of urea for each 20 gallons of diesel fuel.
- Adds significant equipment to the vehicle, and requires precise electronic control
- \$20,000 - \$40,000 and 30 – 50 hours for installation on a vehicle
- Best suited for temporary electric generators

Lean NOx Catalyst



- Similar to SCR, but uses diesel fuel instead of urea
- 25 – 35% NOx reduction
- Typically deployed with a DOC or DPF for PM reduction
- Similar in cost and complexity to SCR
- “Fuel Penalty” of 5 -10%

Emulsified Diesel Fuel



- Up to 20% water blended with ULSD and a proprietary additive to keep water in suspension
- Evaporation of water during combustion reduces temperature and lowers NOx by up to 30%
- Also reduces PM by up to 20%
- 10-30% power reduction at the same throttle setting
- Emulsion is very stable, but fuel sitting in tanks for months without use can stratify
- Cost can be as high as +\$0.10/gallon compared to ULSD – because water has no energy content, vehicles will typically use 10-30% more gallons of emulsified fuel to do the same amount of work

Summary of Reduction Potential

Option	Reduction	
	PM	NOx
DOC	20 – 33%	No Effect
WMF	30 – 50%	No Effect
DPF	60 – 95%	No Effect
Lean NOx Catalyst	No Effect ¹	25 – 35%
EGR	No Effect ²	30 – 50%
SCR	10 – 25%	70 -90%
Emulsified ULSD	17 - 23%	9 - 20%

¹ Typically used with a DOC or DPF

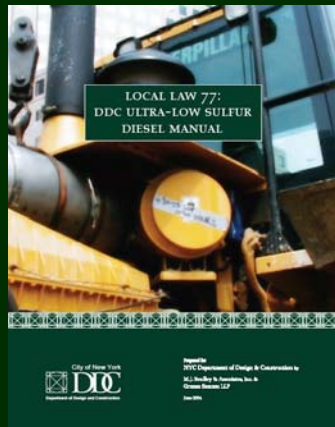
² Must be used with a DPF



Retrofits vs Fuel Options

- Retrofits cost more up front, but generally are less expensive in the long run than fuel options
- Fuel options can be easier to implement – they generally do not require any changes to the vehicle
- Fuel options could allow contractor to use BAT on city projects but not use BAT on private projects (therefore saving \$\$\$)
- NYCDEP clearly **prefers retrofit options** over fuel options
 - they are more “permanent” and can provide much greater reductions

Resources



Local Law 77 Manual & Reporting Forms

<http://www.ci.nyc.ny.us/html/ddc/html/ddcgreen/>



Lists of EPA & ARB verified technologies

<http://www.epa.gov/otaq/retrofit/verif-list.htm>



<http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm>

MassDEP Construction Retrofit Manual

<http://www.mass.gov/dep/air/transport.htm>

