



EPA 2010

David McKenna

***Director
Powertrain Sales
& Marketing***



EPA 2010

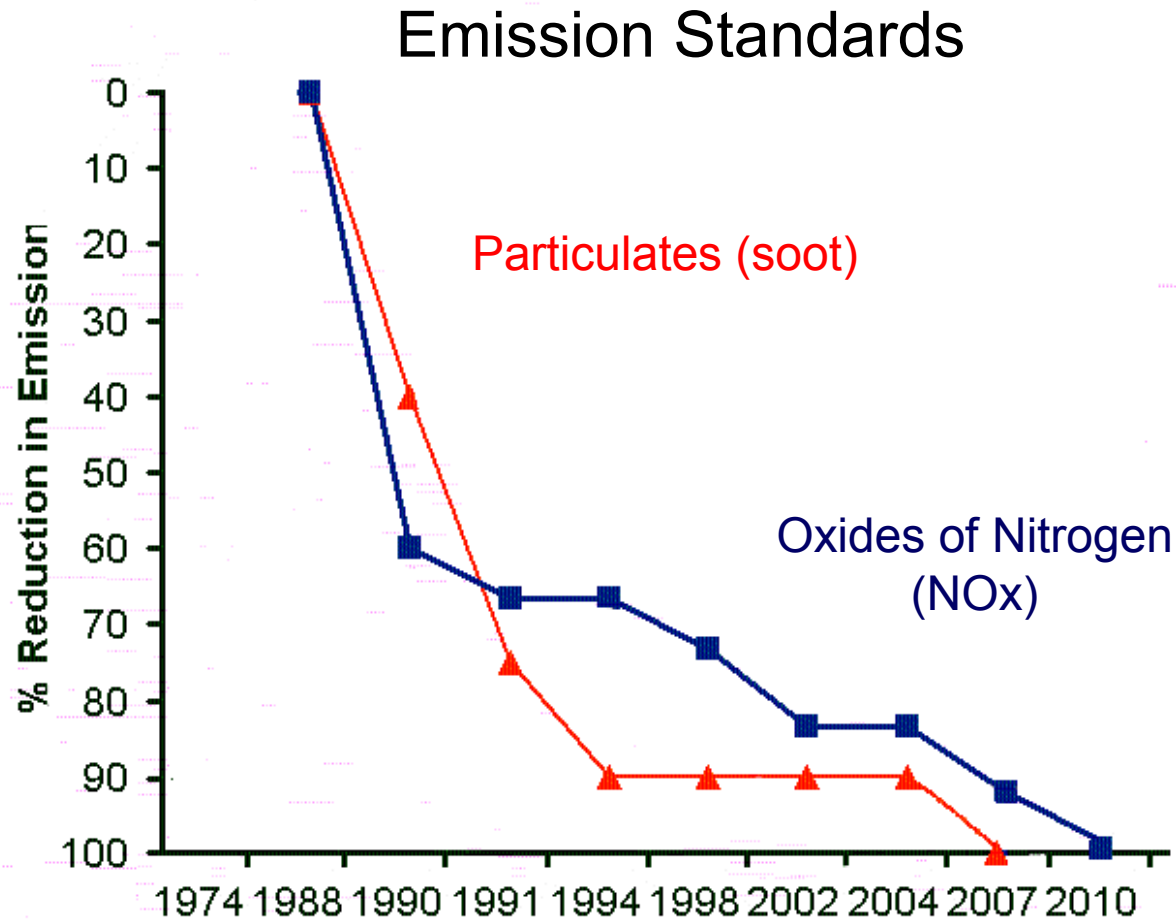
BREAKTHROUGH



PERFORMANCE.



What is Driving EPA'10?



By 2010 diesel truck engines will have near-zero output of all regulated emissions



Emissions Comparison

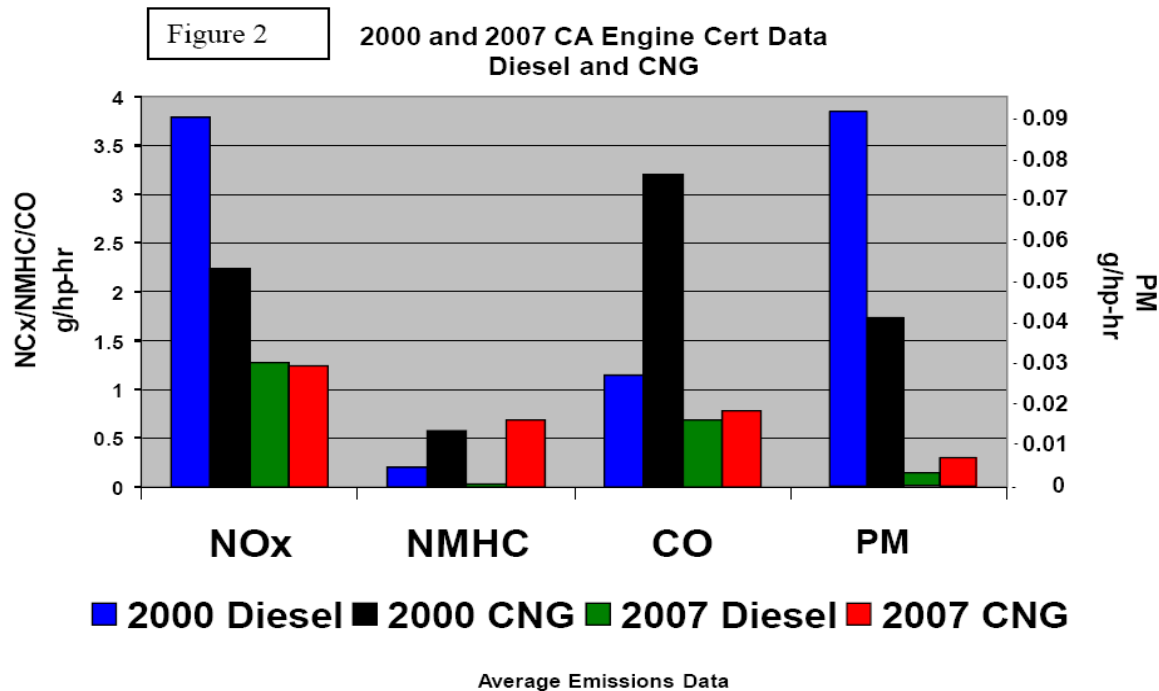


Figure 2: Notes:

1. NOx- oxides of nitrogen emissions;
2. NMHC= Non Methane Hydrocarbon emissions;
3. PM= Particulate matter
4. CO= Carbon Monoxide Emissions
5. Units are grams per brake-horsepower hour
6. Average Emissions Data shown for all certified HD engine families

Source: California Air Resources Board; 2007 Heavy duty engine emissions average certification data
<http://www.arb.ca.gov/msprog/onroad/cert/mdehdhdv/2007/2007.php>



Significant Industrial Upheaval

- 1. Caterpillar as a truck brand HDDE – OE exits the market place.**
- 2. Sterling announces closure.**
- 3. Cummins reevaluates SCR.**
- 4. Rancorous technology debates.**



Technology Paths for EPA'10

- 1. Massive EGR + Emission Credits.**
- 2. Diesel NOx Reduction.**
- 3. Diesel NOx Adsorber.**
- 4. Selective Catalytic Reduction.**



Competitive Positions for EPA'10

Selective Catalytic Reduction

- Mack Trucks
- Volvo Proprietary
- Detroit Diesel (M-B)
- Paccar MX (DAF)
- Cummins

Massive EGR

- International
MaxxForce (MAN)

- *MaxxForce*

Out!



Massive EGR
It's an
accepted
technical
term - Just
Google it....

massive egr - Google Search - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites

Address <http://www.google.com/search?hl=en&q=massive+egr>

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[PDF](#) [Low Emissions Combustion – One Path Forward? Tom Ryan](#)
File Format: PDF/Adobe Acrobat - [View as HTML](#)
Premise. Lowest Possible Emissions and. Highest Efficiency in Diesel Engines.
Achieved Using: Ultra High Injection Pressure and Small. Holes. **Massive EGR** ...
www.erc.wisc.edu/symposiums/2005_Symposium/June%208%20AM/Ryan_SWRI.pdf - [Similar pages](#)

[PDF](#) [Diesel Engine Alternatives](#)
File Format: PDF/Adobe Acrobat - [View as HTML](#)
This represents a 17 percent improvement through the use of **massive EGR**
combined with the use of a. high-energy ignition system. The high-energy ignition
is ...
www.osti.gov/bridge/servlets/purl/829804-lvf6b3/native/829804.pdf - [Similar pages](#)

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Massive EGR. Independent Variables. Table 1. Independent Variables Examined in
the Cycle Simulation Calculations. TestMode ...
www.eere.energy.gov/vehiclesandfuels/pdfs/deer_2003/session7/2003_deer_ryan.pdf - [Similar pages](#)

[Air Induction, EGR, and fuel economy \(John De Armond; Bob Hale\)](#)
Assuming a fly-by-wire system, has there been any consideration to using
massive EGR as a means of throttling the engine? It seems to me that with the
fast ...
yarchive.net/car/air_induction.html - 11k - [Cached](#) - [Similar pages](#)

[SwRI: Clean Diesel V Consortium, 5 projects for developing an ...](#)
Massive EGR in Heavy-Duty Diesel Engines (continued from CD IV). Goal—achieve
2010 HD on-road emissions standards using minimum post-combustion NOx ...
www.swri.org/4org/d03/engres/cleandieselv/default.htm - 20k -
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[PDF](#) [CLEAN DIESEL V](#)
File Format: PDF/Adobe Acrobat - [View as HTML](#)
Massive EGR in Heavy-Duty Diesel Engines. This project will be continued from CD
IV. The goal is to achieve 2010 HD on-road ...
www.swiresearch.com/3pubs/brochure/d03/CleanDV/CleanDieselV.pdf -
[Similar pages](#)

[Compression-ignition internal combustion engine - US Patent 6688279](#)
Specifically, since lowering combustion temperature is effective in reducing NOx,
this is done by comparatively **massive EGR**. There is the concern that smoke ...
www.patentstorm.us/patents/6688279-description.html - 63k -
[Cached](#) - [Similar pages](#)

[Ulstd: Encouraging Sign For Diesel Nox/Pm Traps - ultra-low-sulfur ...](#)
The scheme requires multiple fuel injections including post-main injection, allowing
"rich low-temperature exhaust with **massive EGR** ...
findarticles.com/p/articles/mi_m0CYH/s_11_5/ai_75532057 - 34k -
[Cached](#) - [Similar pages](#)

[PDF](#) [Stoichiometric Compression Ignition \(SCI\) Engine Concept](#)
File Format: PDF/Adobe Acrobat - [View as HTML](#)
Massive EGR – high percentages of EGR at. relatively rich A/F ratio to reduce NOx.

Done



History of Exhaust Gas Recirculation

	EGR Flow	Oxygen
Light EGR EPA 2004	10%-20%	18%-20%
Heavy EGR EPA'07	20%-35%	14-16%
Massive EGR EPA '10	35%- <u>>50%!></u>	12-14%
Medium EGR EPA 2010	18%-28%	16%-18%



Comparing Massive EGR vs. SCR

	Massive EGR + DPF	SCR + DPF
Power Density (HP per Liter)	Less (New Engine)	More (Same Engine)
Heat Rejection (Cooling Demand)	MORE	LESS
Fuel Efficiency	LESS (It's a matter of Physics)	MORE (It's still a matter of Physics)



Here are the Numbers

Diesel Cost **\$2.33**
 Urea Cost \$1.75

	Diesel MPG	Diesel cost/mile	Urea MPG (@ 3% rate)	Urea cost/mile	Total Cost/Mile	Cost/100,000 miles	Savings from Today's MP8 (Cost)
2007 MP8	6	\$ 0.388	-	\$ -	\$ 0.388	\$ 38,833	\$0
2010 MP8 + SCR (+3%)	6.18	\$ 0.377	206.00	\$ 0.008	\$ 0.386	\$ 38,551	\$283
Massive EGR (-2%)	5.88	\$ 0.396	-	\$ -	\$ 0.396	\$ 39,626	(\$793)

At \$2.33 gallon diesel and 6.0 mpg, SCR is almost \$1100 less expensive to operate over 100,000 miles than MEGR!

As fuel gets more expensive, the SCR advantage grows.

Diesel Cost **\$3.00**
 Urea Cost \$2.25

	Diesel MPG	Diesel cost/mile	Urea MPG (@ 3% rate)	Urea cost/mile	Total Cost/Mile	Cost/100,000 miles	Savings from Today's MP8 (Cost)
2007 MP8	6	\$ 0.500	-	\$ -	\$ 0.500	\$ 50,000	\$0
2010 MP8 + SCR (+3%)	6.18	\$ 0.485	206.00	\$ 0.011	\$ 0.496	\$ 49,636	\$364
Massive EGR (-2%)	5.88	\$ 0.510	-	\$ -	\$ 0.510	\$ 51,020	(\$1,020)



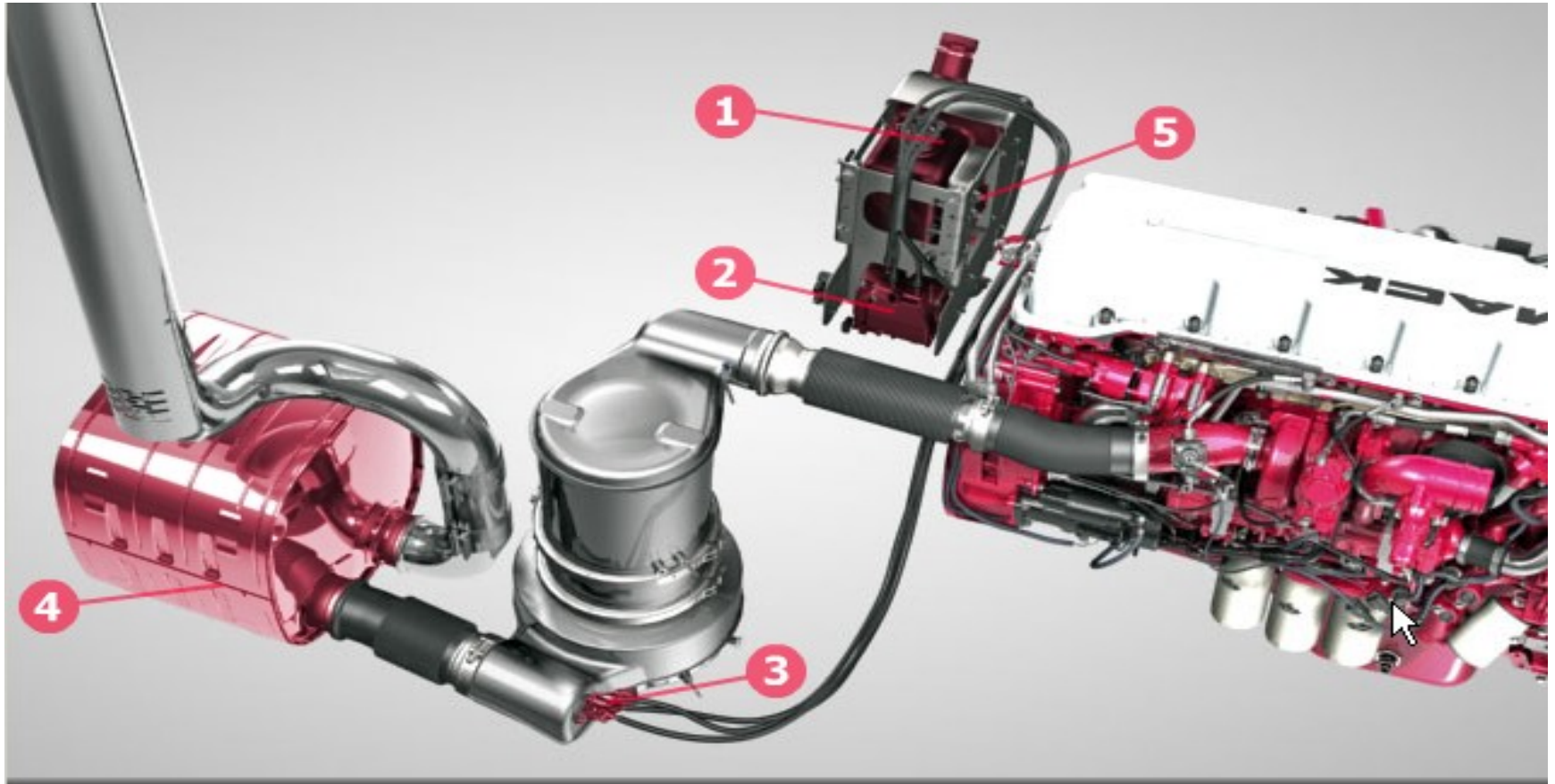
Fuel Economy



Even in 1998 we knew...



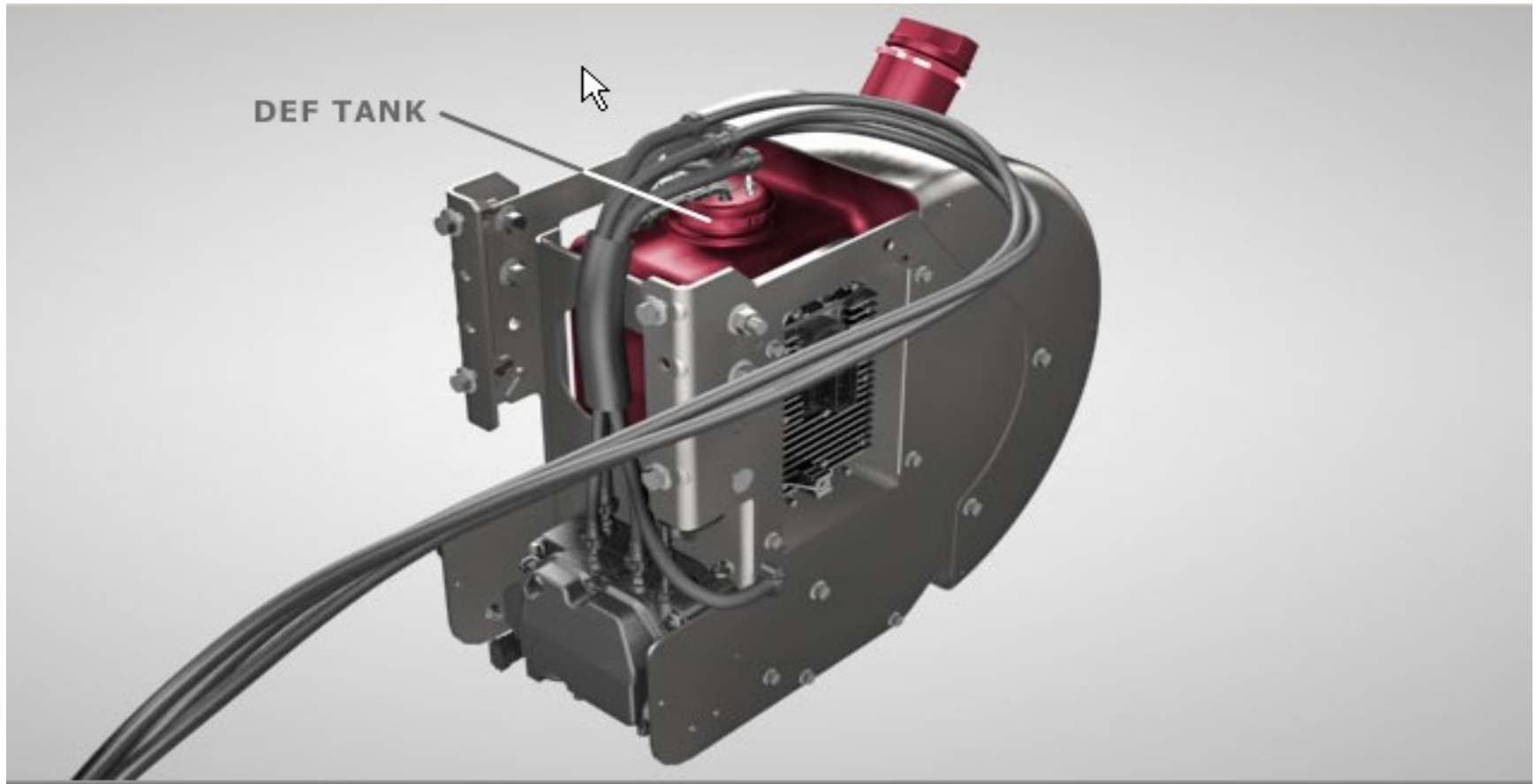
EPA '10 Solution In Action...



SELECTIVE CATALYTIC REDUCTION (SCR) - To meet the strict EPA 2010 emission requirements, MACK trucks are equipped with an SCR system that reduces emissions of nitrogen oxides (NOx) to a near zero level. The system consists of: a small tank for the Diesel Exhaust Fluid (DEF) **1**, a DEF supply pump **2**, an injector **3**, a muffler with built-in catalytic substrates **4**, and an Aftertreatment Control Module (ACM) **5**.



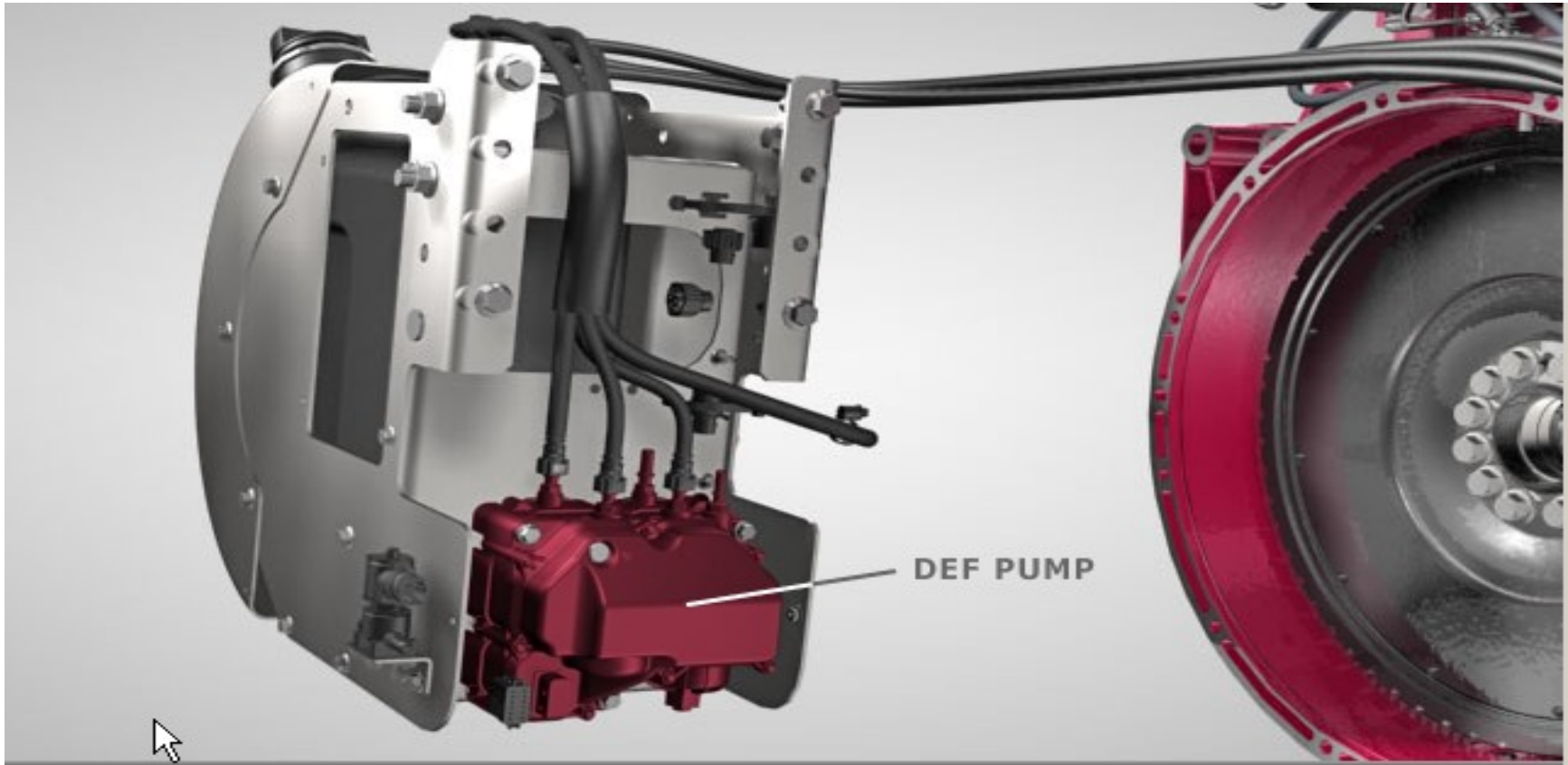
EPA '10 Solution In Action...



1 DIESEL EXHAUST FLUID (DEF) - The tank is filled with liquid urea (DEF), which is a clear, non-hazardous fluid. As DEF freezes at approximately 12°F, the DEF temperature is continuously monitored and, when needed, heated to 60°F by a heater coil located in the tank.



EPA'10 Solution In Action...



2 DEF PUMP - This low-pressure pump supplies the DEF to the SCR injection system. When the engine is turned off, the pump drains the DEF in the system back to tank.



EPA '10 Solution In Action...



3 DEF INJECTOR - The amount of NOx in the engine-out exhaust gas is closely monitored. When needed, a measured amount of DEF is injected directly into the exhaust gas stream. The finely atomized DEF droplets mix with the hot exhaust gases and turns into ammonia (NH₃) and carbon dioxide (CO₂).



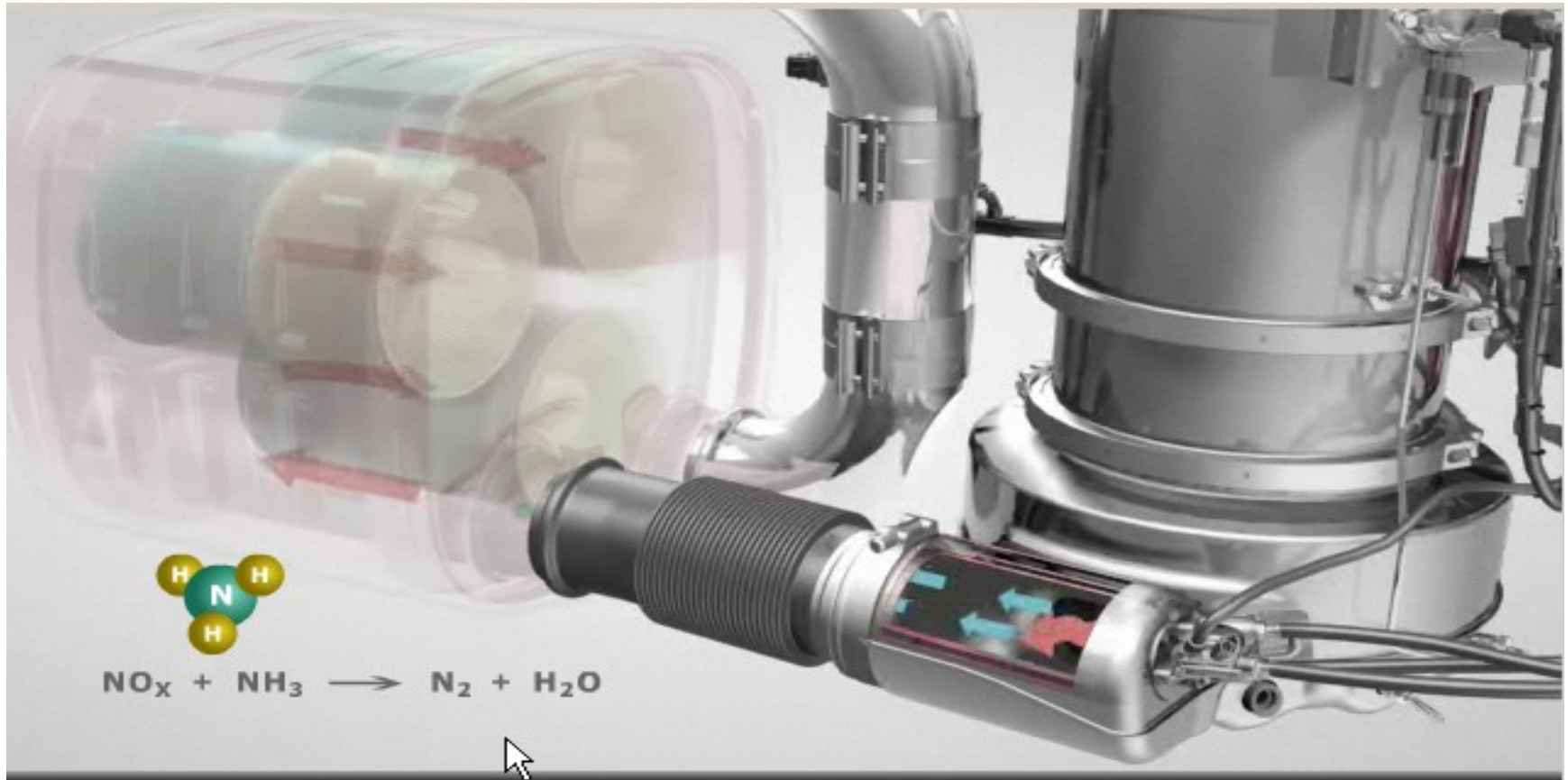
EPA '10 Solution In Action...



3 DEF INJECTOR - The amount of NO_x in the engine-out exhaust gas is closely monitored. When needed, a measured amount of DEF is injected directly into the exhaust gas stream. The finely atomized DEF droplets mix with the hot exhaust gases and turns into ammonia (NH₃) and carbon dioxide (CO₂).



EPA '10 Solution In Action...



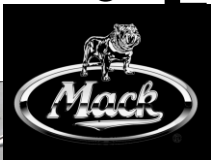
4 CATALYTIC CONVERSION - The ammonia (NH₃) reacts with nitrogen oxides (NO_x) as the exhaust gases pass the catalytic substrates. The catalytic substrates quickly enable the NH₃ and NO_x to chemically react to produce harmless nitrogen (N₂) and water (H₂O) vapor.



EPA'10 So Far...



- **EPA'10 Customer Field Test Trucks**



Is DEF Available?

YES; 'TerraCair' is available today!!



- TERRA's North American manufacturing can supply up to 2.2 million tons or 480 million gallons of AUS 32. This represents only 50% of current capacity.
- Distribution networks are being built to ensure reliable, competitive product supply.



Terra, Brenntag Team up to Supply DEF

12/29/2008

Terra Environmental Technologies and Brenntag North America announced a mutually exclusive, multi-year strategic alliance designed to efficiently supply the United States and Canada with TerraCair ultra pure diesel exhaust fluid.



Diesel Exhaust Fluid (DEF)

DEF infrastructure in good shape

Aug 28, 2008 11:48 AM, By Brian Straight, managing editor

With all the major manufacturers now settled on their engine solutions for 2010 [Environmental Protection Agency \(EPA\)](#) compliance, the focus is shifting to the infrastructure for diesel exhaust fluid (DEF) distribution.

PRESS RELEASE

TA and Petro Reaffirm Diesel Exhaust Fluid (DEF) Distribution Plans To Support 2010 SCR Engines

Last update: 9:41 a.m. EST Nov. 10, 2008



**TravelCenters
of America**

WESTLAKE, Ohio, Nov 10, 2008 (BUSINESS WIRE) -- TravelCenters of America LLC reaffirmed its plans to distribute diesel exhaust fluid (DEF) at all of its TA and Petro branded locations in 2009.

TA makes this announcement in advance of its participation at the Diesel Exhaust Fluid Forum to be held this week in San Diego, CA.

Pilot Travel Centers to carry DEF "at the pump"

Sep 30, 2008 2:02 PM

Pilot Travel Centers will carry diesel exhaust fluid (DEF) in bulk "at the pump" for selective catalytic reduction- (SCR) equipped trucks at over 100 locations nationwide beginning in mid-to-late 2009, the company announced.



Diesel Exhaust Fluid (DEF)

- DEF will be available at your Mack Dealer
- Typically available volumes:
 - 10L emergency jug
 - 55 gal drum
 - 275 gal bulk container

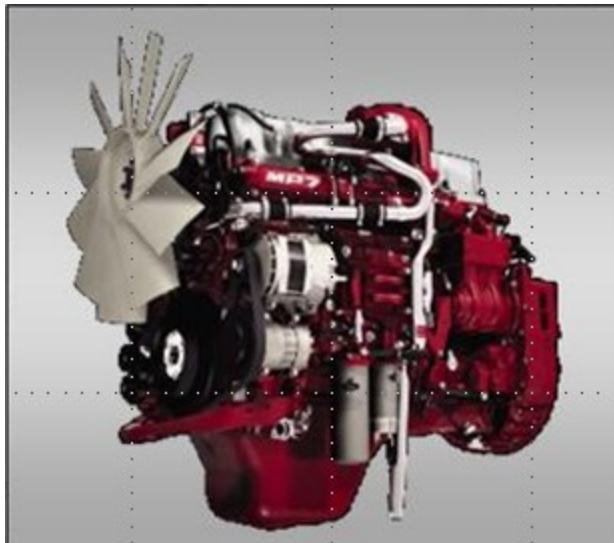


- All heavy duty OEM's will be offering trucks with SCR technology and therefore should have DEF available at their dealerships as well

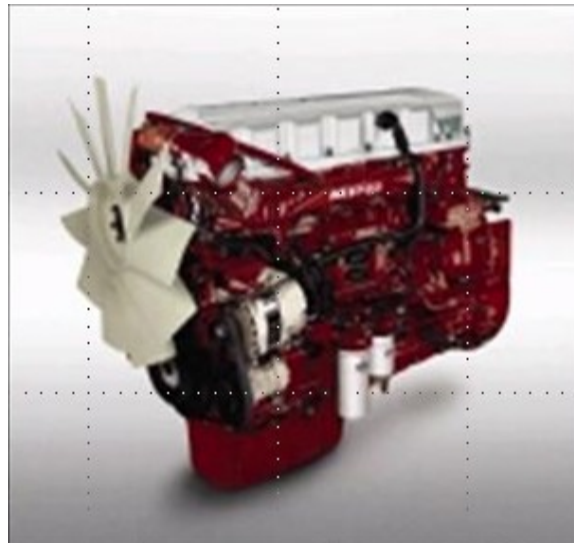


Mack Trucks

- Reduced EGR + Catalyzed DPF + SCR.



MP7 325 / 405 HP



MP8 415 / 505



MP10 525 / 605



Mack Trucks

- Strengths
- Strong Brand
- Known engines.
- 3 platforms.
- Small modification for 2010.
- Weaknesses
- Weight SCR



The Mack SCR Blog

[Dealer & Service Locations](#) - [Truck Locator](#) - [Site Map](#) - [Site Search](#) - [Contact Us](#)



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Construction Series Highway Series Refuse Series Titan Series Powertrain

Durable Trucks for the refuse industry.



Mack Refuse



Driving the New Mack Trucks

Mack and the Environment
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Mack in the Military

ELECTIVE CATALYTIC EDUCATION MACK'S 2010 SOLUTION

Recent Press Releases

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- ▶ [Ports of Los Angeles and Long Beach Order 100 Mack® Pinnacle™ DayCab Models](#)
- ▶ [Mack's McKenna Talks SCR Via The Web](#)

MACK
PERFORMANCE TOUR

Talking SCR 



New and Noteworthy



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- ▶ [Mack and the Environment](#)
- ▶ [President Bush Sees CO2-Neutral Mack](#)
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- ▶ [The 2008 Mack Driving Skills Safety Challenge](#)

Customer Success Stories

Bulldog Magazine

Mack Shop

SHARE THE ROAD

 Employment Opportunities
 Mack Worldwide



New Stuff...

- **B20 Biodiesel Fuel Approval Jan. 2009**

B-20 Biodiesel Blend

**contains biomass-based diesel
or biodiesel in quantities
between 5 percent and
20 percent**



To summarize...

- Mack will use the same engine as today.
- Add on is EATS only.
- Significantly improved FE.
- Significantly reduced CO₂ foot print.
- Known reliability of an integrated system.
- Certified and Compliant to EPA 2010.
- Driver and shop acceptance of Mack demos is very good.





We are the tough, Period.

Thank you

Q & A

