



Virginia Pupil Transportation

Russ Spangler
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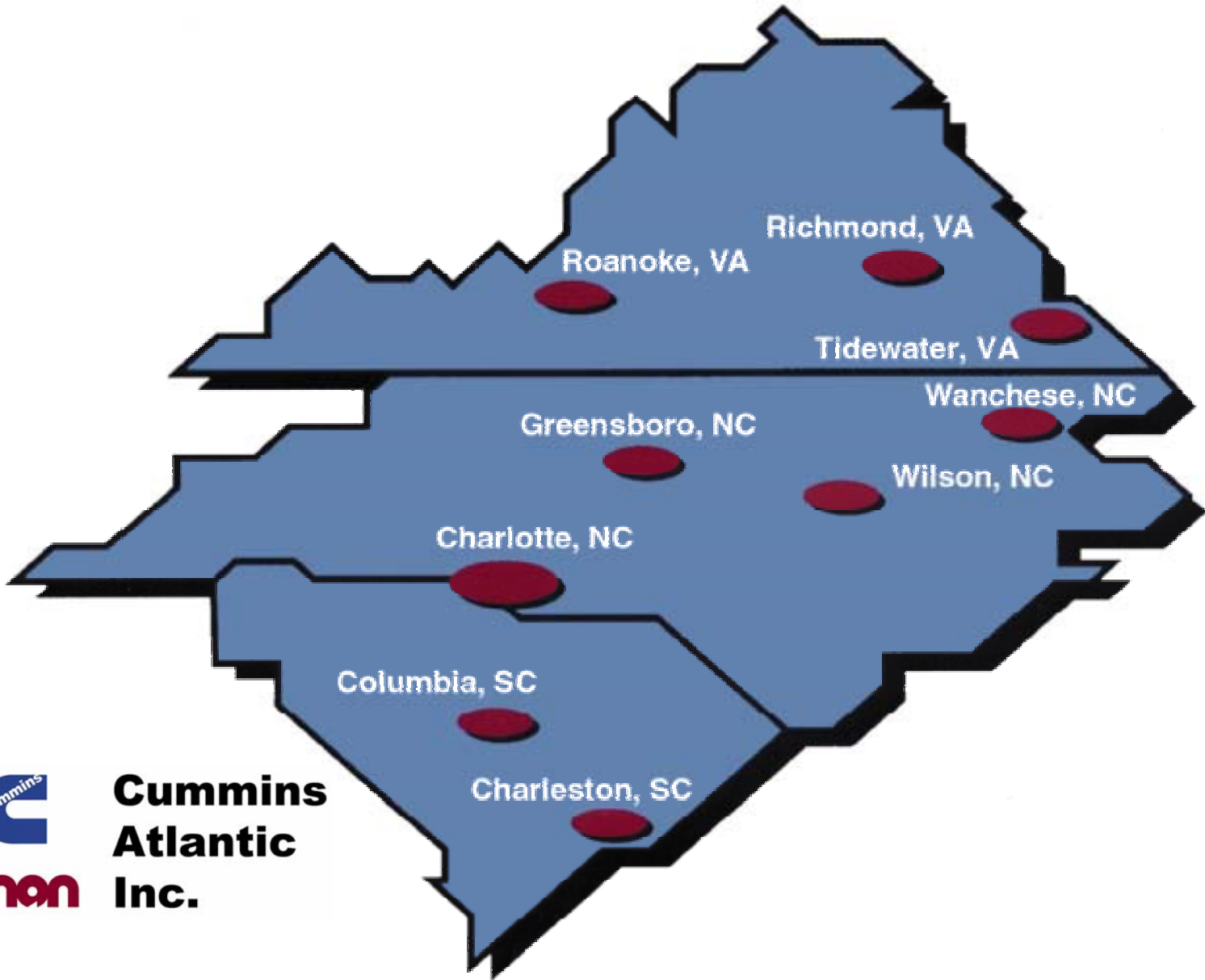
Rick Glover- Technical Support Manager
Cummins Inc.
Southern Division

June 23, 2010

Today's Topics

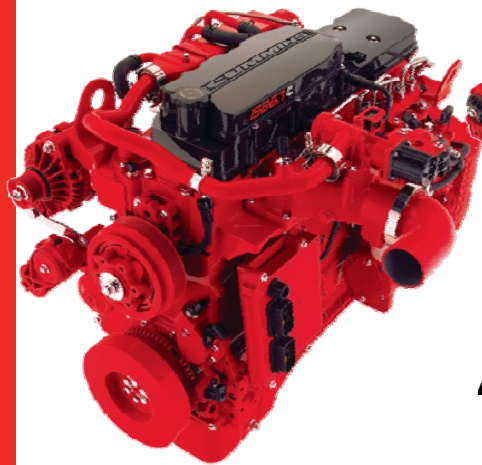
- 2010 EPA Emissions
 - Standards
 - New for 2010
 - Methods
 - SCR - Selective Catalytic Reduction
 - EGR - Exhaust Gas Recirculation
 - Approaches
 - What's next?



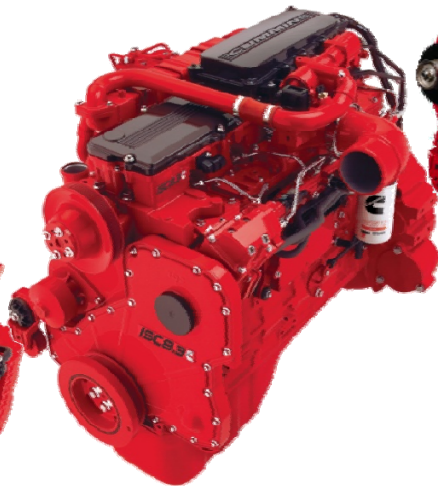


**Cummins
Atlantic
Inc.**

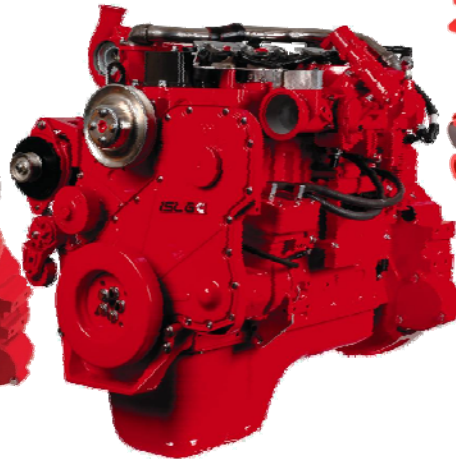




ISB6.7



ISC8.3



ISL G



ISX15



Systems Integration



Filtration



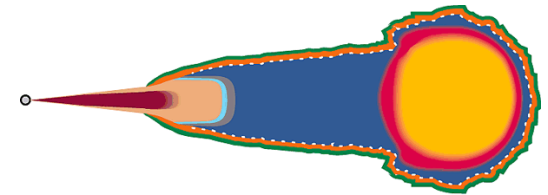
Diesel Exhaust Fluid



Electronic Controls



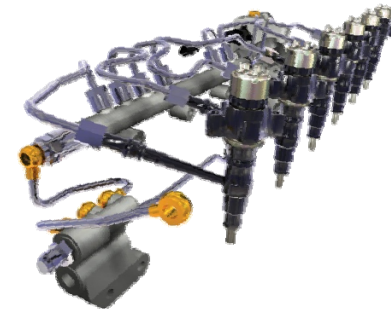
Aftertreatment System



Combustion Technology



Turbochargers



Fuel Systems





One 20 year old truck = 100 New

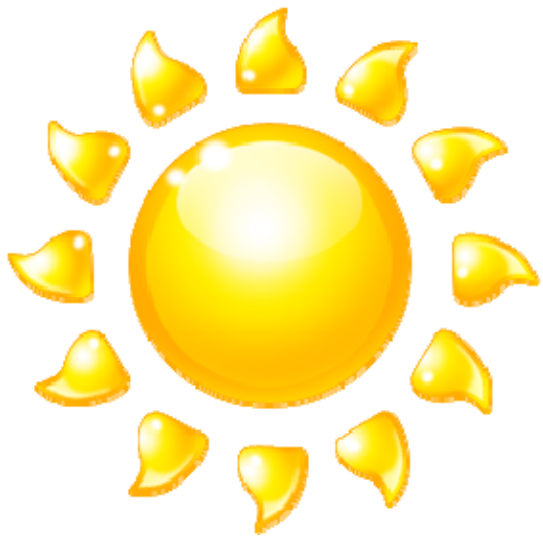


What's in Air We Breathe?

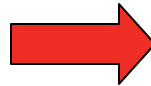
- Nitrogen 78%
- Oxygen 20%
- Carbon Dioxide < 2%
& Trace Elements



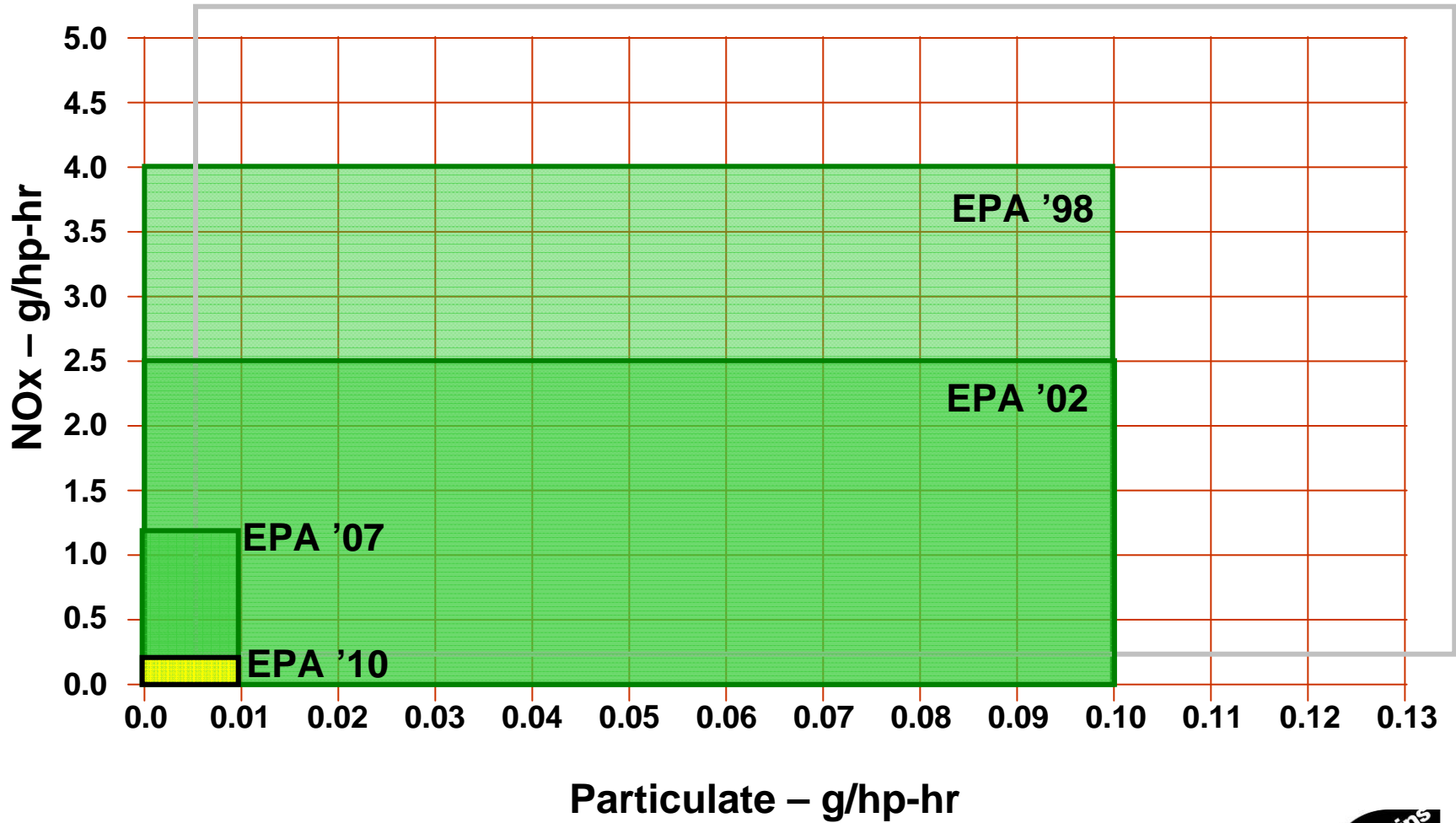
Effect of Oxides of Nitrogen (NOx)



Sun transforms
NOx into SMOG



EPA NA Emission Standards





Methods for 2010 Emissions Compliance

- “Advanced” EGR
- Selective Catalytic Reduction



100% EGR Challenges

- **Fuel Economy** Significantly Compromised
 - ✓ 5-9% loss
 - ✓ Combustion Efficiency degradation:
 - **Lower Combustion Temperatures**
 - **Higher engine pumping losses**
 - **Increase Particulate Filter Regenerations**



100% EGR Challenges

Horsepower - Power Density / Engine Response Significantly Compromised

- ✓ Deterioration of 50 – 100 hp for same displacement
- ✓ Higher EGR flow & EGR controls compromises engine performance



100% EGR Challenges

- **Engine Life-to-Overhaul** significantly reduced
 - ✓ Higher EGR flow produces excessive acidic condensation:
 - Corrosion of internal engine systems
 - High rate of lube oil contamination
 - ✓ Negative impact on Durability



100% EGR Challenges

- Significant Increase in **Heat Rejection**
 - ✓ 20% increase
 - ✓ Higher EGR flow:
 - Multiple EGR coolers
 - Larger vehicle cooling package
 - Major redesign of radiator / Charge Air Cooler / Fan systems
 - ✓ Increased Heat Load under the hood

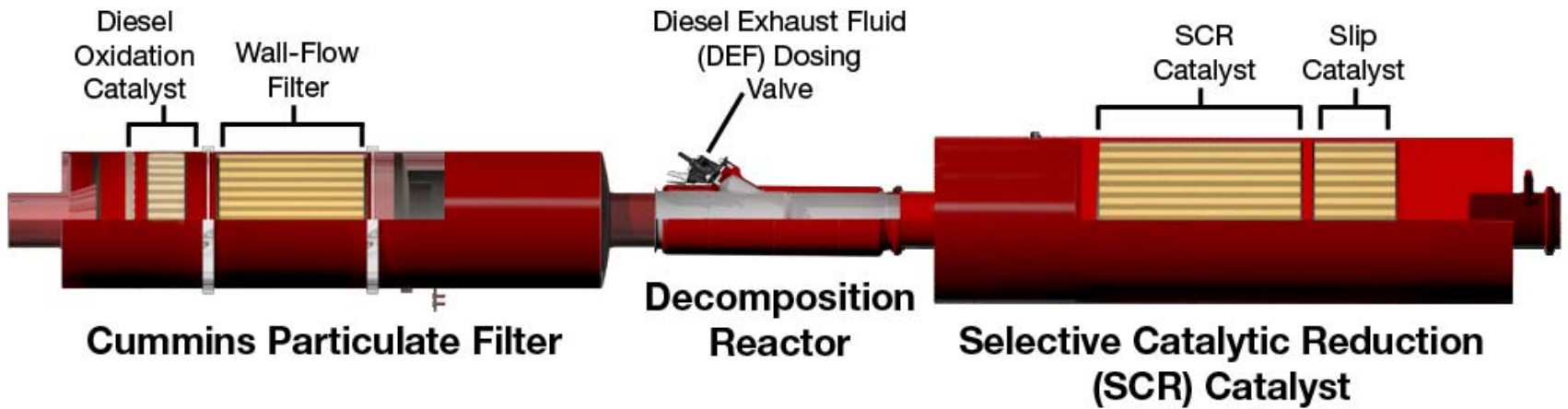


What is Selective Catalytic Reduction (SCR)?

- SCR uses a chemical called Diesel Exhaust Fluid (DEF) and a SCR catalytic converter to significantly reduce nitrogen oxide (NOx) emissions in diesel engines.



Cummins Aftertreatment System



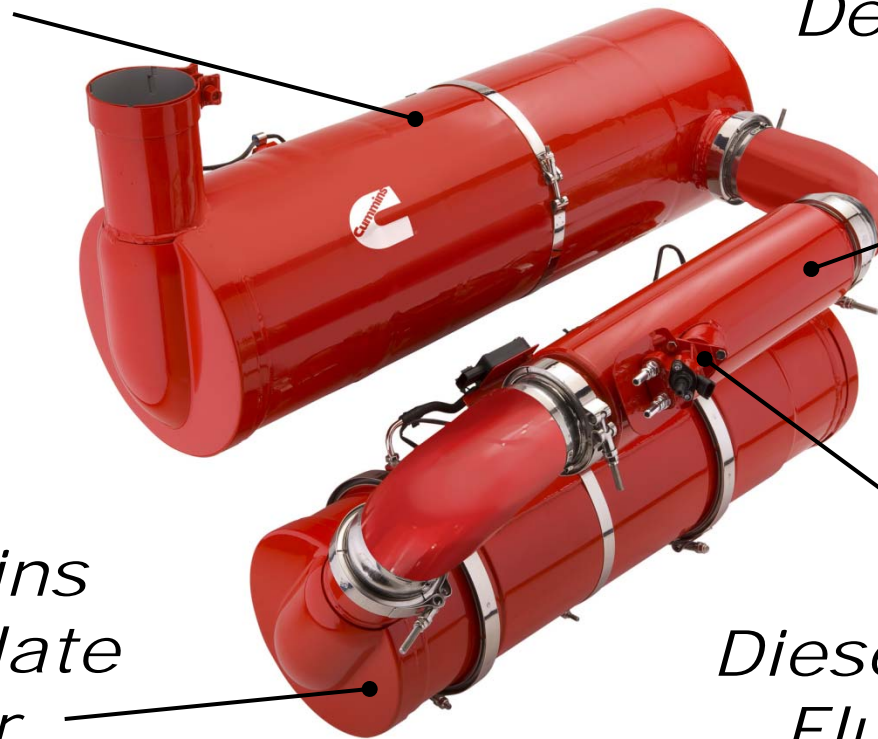
Cummins Aftertreatment System

*Selective
Catalytic
Reduction
(SCR)
Catalyst*

*Decomposition
Reactor*

*Cummins
Particulate
Filter*

*Diesel Exhaust
Fluid (DEF)
Dosing Valve*



The Right Technology Matters

- **Cummins Heavy-Duty engines will add integrated SCR solution to meet 2010 EPA Emission Standards**
 - Significant advancements in SCR technology have been achieved by Cummins Emission Solutions as demonstrated by our 2010 MidRange development program.
 - SCR solution offers up to 5% improvement in fuel economy.



The Right Technology Matters

New SCR catalyst technology allows the engine to operate with optimum fuel efficiency

- NOx conversion efficiency of new Copper Zeolite SCR catalyst allows much better fuel economy
- Fuel (+DEF) consumption better than industry-leading Cummins 2007 ISX
- Approximately 2% DEF consumption
- Maximizes **Passive Regeneration** of the DPF

New SCR catalyst is a **Step Change in Technology**

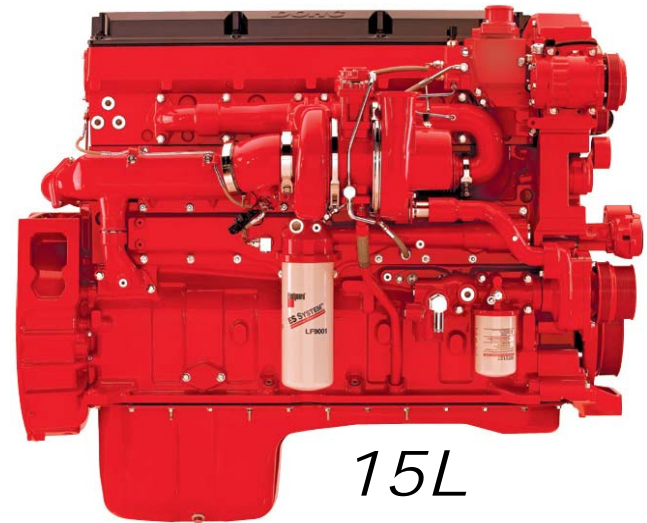


Heavy Duty Solution

2007



*Particulate
Filter*

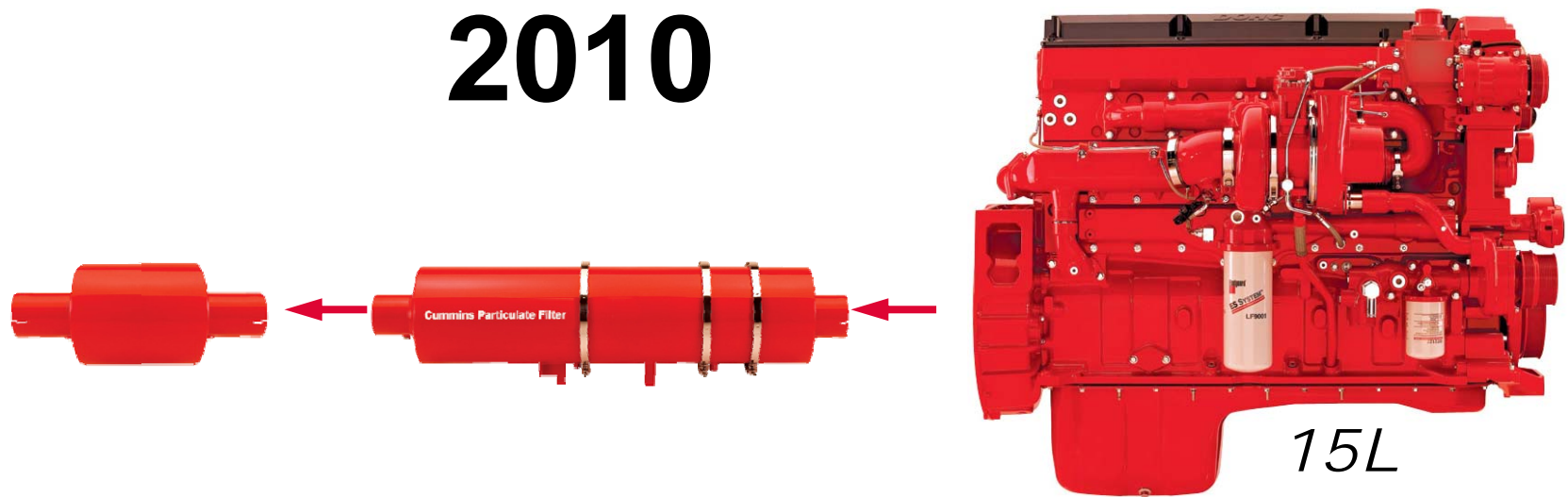


Cooled EGR



Heavy Duty Solution

2010



*Selective
Catalytic
Reduction*

*Particulate
Filter*

Cooled EGR

Same as today



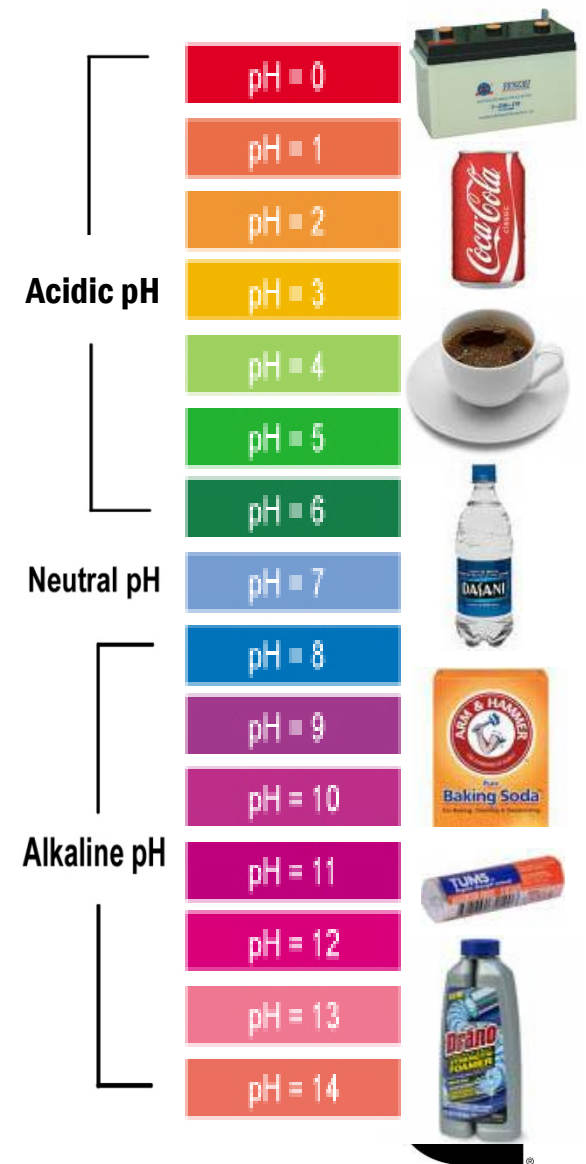
DEF Properties

- Non-
- Safe
- Pose
- anim
- enviro

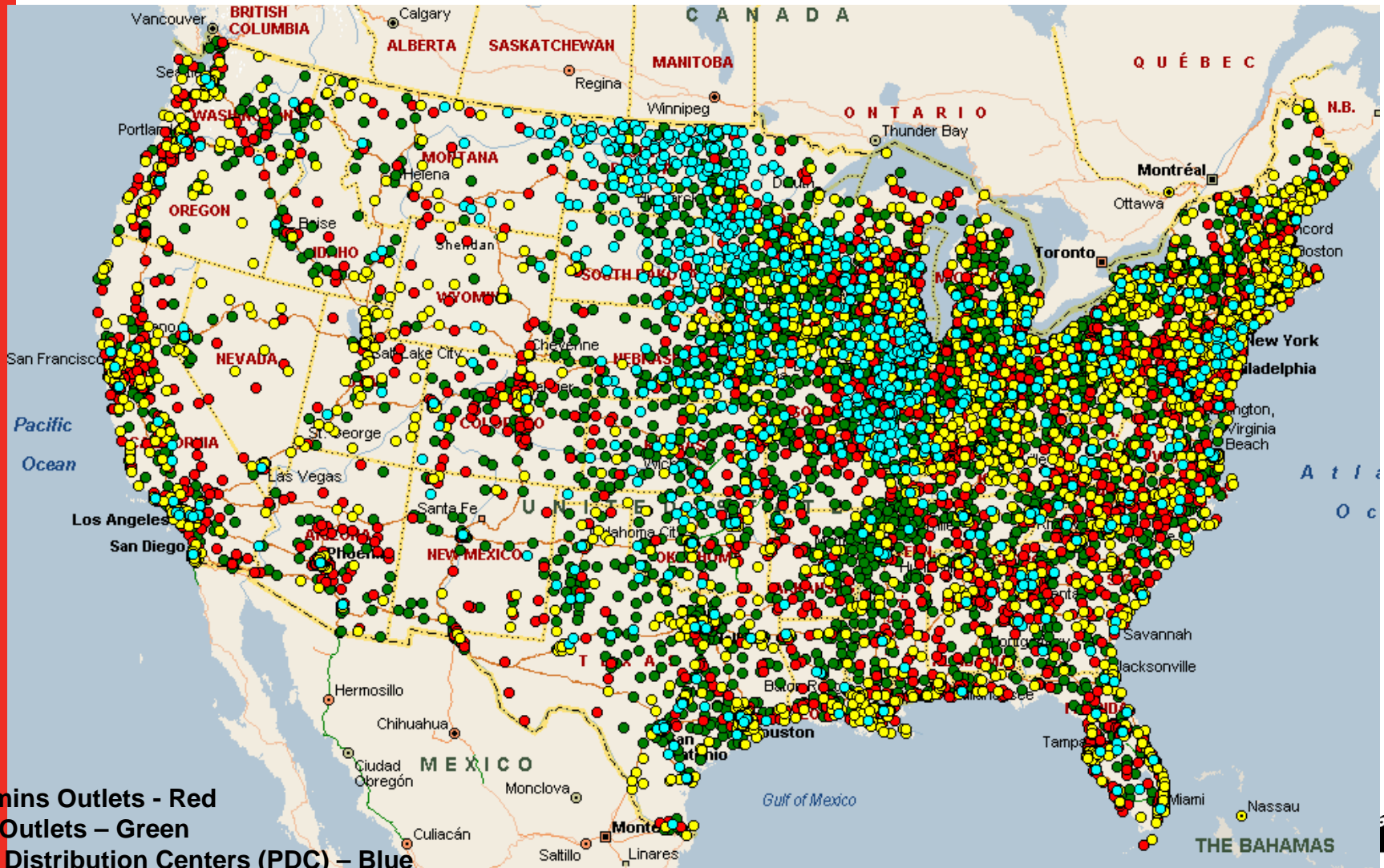


able
e
humans,
re
handled

- The product is slightly alkaline with a pH of approximately 9.0



All Outlets



Cummins Outlets - Red
OEM Outlets - Green
Parts Distribution Centers (PDC) - Blue
Independent Distribution - Yellow

Diesel Exhaust Fluid (DEF)

- Diesel Exhaust Fluid is 32.5% strength urea water solution with high purity requirements.
- The specification of Diesel Exhaust Fluid is currently defined according to the DIN 70700 and the ISO 22241-1 specifications.
- **Water purity:** ISO grade 3, produced for example by single distillation, de-ionization, ultra-filtration or reverse osmosis.



Why 32.5% for DEF?

- The 32.5% wt urea water solution provides the lowest freezing point while also maintaining the solution in constant phase.
 - Urea and water freeze together at 11° F so the frozen solution has the same 32.5% wt.
 - When thawed, it will remain at the same concentration of urea solution feeding the SCR system.
- What happens at different concentrations of Urea:
 - Greater concentrations → Urea freezes before water
 - Reduced concentrations → Water freezes before Urea



DEF Freeze Point

- Freezing of DEF begins at approximately 11°F.
- Once the DEF has melted, it can be used without problem. The first melted drop has the same consistency as defined in the Diesel Exhaust Fluid specification.
- The SCR system is designed to provide heating for the DEF tank and supply lines which will reduce the melting time for frozen DEF.
- If DEF freezes, start up and normal operation of the vehicle is **not inhibited** so the operator is not impacted.



DEF Service Tool

- A service tool called a refractometer is in development.
- The refractometer measures the concentration of urea in the DEF.
- May provide one quick, simple way for urea quantification.



How Much will DEF Cost?

- Automotive grade DEF is only slightly more expensive to produce compared to Agricultural grade DEF.
 - Requires a higher purity urea base stock and deionized water
- Higher prices of DEF are associated with smaller containers and low volume suppliers.
- DEF prices loosely follow natural gas commodity prices



How Much DEF Will I Use?

- Approximately 2% DEF consumption

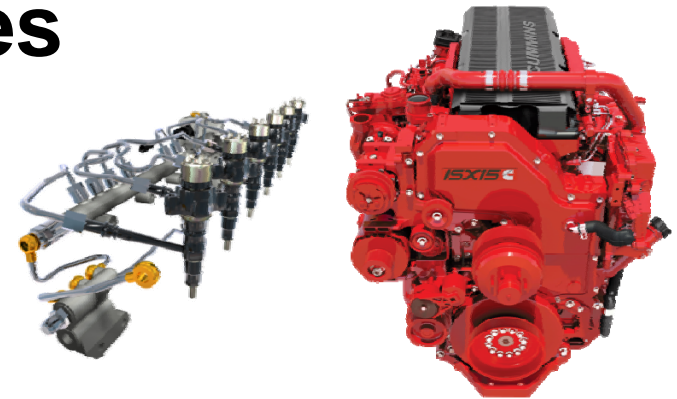
**Every 50 gallons of
fuel =
1 gallon of DEF**



Cummins 2010 Advantages

1. Outstanding Base Engine

- XPI Fuel System



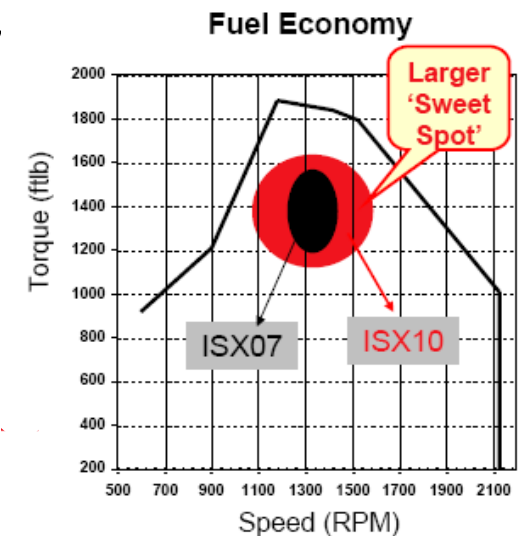
2. Aftertreatment System

- Cummins designed and developed
- Copper Zeolite SCR Catalyst

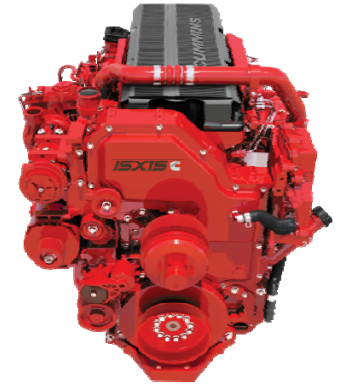


3. Industry Leading Fuel Economy

- 5% better than ISX '07
- Up to 10% better than competition
- Less driver MPG variability across the fleet



ISX15 Readiness



1. Proven base engine

- Built on success of today's industry-leading ISX

2. Cummins designed / developed subsystems

- Only diesel manufacturer with this capability

3. Exceptional product testing results

- Will exceed 5,000,000 field test miles by production launch

4. Service channel is ready for 2010

- Approx. 3500 service locations across North America



Better Every Mile.

- **Better Fuel Economy.**
 - 5% better than '07 ISX / Up to 10% better than competition
- **Better Performance.**
 - Improved driveability and throttle response
- **Better Reliability.**
 - Best-in-class durability and dependability
- **Better for the Environment.**
 - Near zero NOx and PM emissions
 - Improved MPG results in smaller carbon footprint



Get All The Performance
You Expect.



Think Outside
The Cylinder.



Thanks!



Global On-Highway Standards

NOx – g/HP-hr

