2010 CY Diesel Emissions Update
2010 Diesel Emissions

- Production Timing
- Emissions Regulations
- Emission strategy
- DEF tank and fill location
- Operational implications
- Upfitter Impacts
- Cost Impacts
Diesel Emission Regulations Progression

Particulate Emissions (g/bhp-hr)

NOx Emissions (g/bhp-hr)

- 1990
- 1991
- 1994
- 1998
- 2002/2004
- 2010
- 2007
Three different approaches to meet 2010 emissions:

1. **Selective Catalytic Reduction (SCR)**
   - Cummins
   - Detroit Diesel (Freightliner)
   - Dodge chassis cabs
   - Ford
   - Fuso
   - GM
   - Hino
   - Isuzu
   - Paccar (DAF)
   - UD
   - Volvo/Mack

2. **High-rate EGR (Enhanced/Advanced EGR)**
   - International (MaxxForce)

3. **Lean NOx Trap (LNT)**
   - Dodge pickups
Selective Catalytic Reduction (SCR): The best technical solution

- **Engineering assessment:**
  - Proven NOx reduction
  - Cost effective
  - Efficient engine operation
  - Maximizes fuel economy
  - Durable and reliable
  - Global – widely used in Europe
  - Long-term solution

- **Manageable issues:**
  - Packaging of equipment
  - Driver education
  - Vehicle operation

2008 GM Diesel Sales

- Europe 725,000
- North America 150,000
- ASIA 300,000
- S. America 50,000

GM Fleet and Commercial

IT ALL ADDS UP™
What is Selective Catalytic Reduction?

• **An emissions-reduction technology**
  - Provides very low emissions of Nitrogen Oxides (NOx) using exhaust after-treatment downstream of the engine
  - No major re-design of engine required
    - No additional cooling, or heat rejection
    - Optimizes fuel economy, engine reliability, and durability

• **SCR uses Diesel Exhaust Fluid (DEF)**
  - Requires new exhaust system, DEF tank, and sophisticated electronic controls
  - DEF in small amounts is injected into the exhaust where it works with a catalyst to convert NOx into nitrogen and water vapor
    - Two harmless and natural components
Duramax 6.6L Exhaust Concept

Engine

HC (Fuel) Injection

DEF Urea Injection

Combined SCR and DPF

SCR

CDPF

Exhaust Cooler

DOC

Exhaust Cooler

DOC

Exhaust Cooler
Duramax 6.6L Exhaust Concept

**DOC Function:**
Oxidize HC & CO to create heat for DPF regeneration

**SCR Catalyst Function:**
Utilize Ammonia for NOx reduction
\[ \text{NO} + \text{NO}_2 + 2\text{NH}_3 \rightarrow 2\text{N}_2 + 3\text{H}_2\text{O} \]

**HC (Fuel) Injection**

**DEF (UREA) Injection**

**UREA Injection** – Provide \((\text{NH}_2)_2\text{CO}\) for Decomposition to Ammonia

**HC Injector** – Thermal release through chemical reaction

**DPF Function** – Filter and remove particulate matter (soot)
What is Diesel Exhaust Fluid (DEF)?

- **Diesel Exhaust Fluid (DEF)**
  - non-toxic, odorless and safe solution
    - 67.5% purified water
    - 32.5% automotive-grade urea

- **Urea**
  - Produced from natural gas & other sources
  - Commonly used in fertilizer and industrial applications including emissions control at power plants.
  - Certified by the American Petroleum Institute
  - Ample availability to meet 2010 diesel emission requirements.
  - Widely used in Europe where it is known as AdBlue
Diesel Exhaust Fluid in truck operation

- **DEF freezes at approximately 12°F**
  - Thaws with no degradation
  - DEF tank & lines are heated for cold weather operation
  - No impact on cold weather engine operation
- **DEF has a 1 year shelf life**
  - DEF will degrade at temperatures above 86°F or in direct sunlight for an extended period
  - Not an issue if DEF stock is rotated within a year
  - DEF containers will have date stamp
- **On-board warning systems advise driver when DEF level is low or inferior quality**
  - Tank includes filter and screen
How much DEF will be used?

- Anticipated DEF usage of 1 – 1.25% of diesel fuel usage

- Vehicle range before requiring DEF tank refill:
  - Can vary significantly based on drive cycle
  - Usage related to diesel consumption
  - Heavy loads, off-road/mountain driving, etc will reduce fuel economy and increase DEF usage
Diesel Exhaust Fluid Availability

- Through all dealers that sell diesel engine trucks
  - Plus truck stops and independent suppliers
- **GM will provide** DEF in:
  - 1 gallon plastic
  - 2.5 gallon plastic
  - 55 gallon drum
  - 250 gallon tote
- **DEF pricing**
  - Estimates around $2.70 - $4.00 per gallon
6.6L Duramax Engine Impacts
Duramax 6.6L 2010 Emissions

• **Builds on product attributes:**
  • High HP and torque
  • Low noise, high refinement
  • Good fuel economy
  • Durability and reliability

• **System changes:**
  • Engine
  • Exhaust system
  • DEF tank and lines
  • Electrical system
Key 6.6L Diesel Engine Features – 2010

- Improved efficiency VNT Turbocharger
- High-efficiency crankcase vent system
- Piezo Common Rail Fuel System
- Increased pressure 2000 bar
- Increased Block NVH improvements
- EGR System with increased capacity
- PS pump mounting improved
- Accessory Drive mounted 5 mm outward
- Oil pump capacity increased
Duramax 6.6L performance

- HP and torque ratings comparable with 2007 emission engines

- Packaged with 6-speed transmissions:
  - FS Pickup: Allison 1000 Series
  - G-van: Hydramatic 6-speed
DEF Tank Locations & Fill points
G-Cutaway DEF Tank w/Rear Fuel Tank

DEF Tank 5.83 Gallons
DEF Tank Flexible Fill Hose
G-Cutaway DEF Tank w/Side Fuel Tank

DEF Tank 5.83 Gallons
DEF Tank Flexible Fill Hose
G-Cutaway DEF Tank in Rear Location

DEF Tank 5.83 Gallons

139” Wheel base

DEF Tank Flexible Fill Hose
G-Van(Cargo) DEF Fuel Tank Location

DEF Fill on Vans located adjacent to Fuel Fill
G-Van DEF & Diesel Fuel Fill

Smaller 19 mm opening – cannot add diesel

DEF Fill Cap is always blue
Silverado/Sierra DEF System

DEF Fill (underhood)  DEF Tank (passenger side)
Silverado/Sierra Underhood DEF Fill
DEF Messaging Strategy
EPA mandates emission compliance

- **EPA Requires:**
  - Tamper resistant design
  - DEF level and quality enforcement
  - Freeze protection
  - Driver warning system using this symbol

- **Driver inducement strategy to replenish DEF**
  1. Warning light and chimes
  2. Speed limitation 55 mph
  3. Speed limitation 4 mph

- **Similar strategies for DEF quality and tampering warnings**
### GM DEF Level Communication

<table>
<thead>
<tr>
<th>Distance to DEF Empty</th>
<th>DIC Message</th>
<th>DEF Indicator</th>
<th>Chime</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 1000 miles</td>
<td>“Exhaust Fluid Range: XXXX”</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>• 400 Miles</td>
<td>“Exhaust Fluid Range: XXX”</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>• 175 Miles</td>
<td>“Exhaust Fluid Range: Low”</td>
<td>None</td>
<td>None</td>
</tr>
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</table>

**Note:** - Driver must acknowledge DIC message, reappears w/ignition cycle

**Notes:** - Driver must acknowledge DIC message, reappears w/ignition cycle
- If equipped w/OnStar, driver will receive call
## GM DEF Level Communication

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<td>• 100 miles</td>
<td>“Exhaust Fluid Empty: Refill Now” (10 seconds then) “55 MPH Max Speed Upon Restart”</td>
<td>Continuous</td>
<td>4 times</td>
</tr>
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**Notes:**
- Speed limiting message cannot be turned off
- DIC messages rerun w/ignition cycles
- After next key cycle, 4 chimes every 3 minutes for each key cycle and DEF indicator flashes continuously
# GM DEF Level Communication

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<td>After Next Fuel Fill</td>
<td>“Exhaust Fluid Empty: Refill Now” <em>(10 seconds then)</em> “Speed Limited to 55 MPH Max” <em>(Alternates every 4 seconds with)</em> “4 MPH Max Speed Next Fuel Fill”</td>
<td>Continuous Flash</td>
<td>4 times</td>
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**Notes:**
- Speed limiting messages cannot be turned off
- DIC messages rerun w/ignition cycles
- 4 chimes every 3 minutes for each key cycle and DEF indicator flashes continuously
GM DEF Level Communication

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<tr>
<td>After 2nd Fuel Fill</td>
<td>“Exhaust Fluid Empty: Refill Now” (10 seconds then) “Speed Limited to 4 MPH”</td>
<td>Continuous Flash</td>
<td>4 times</td>
</tr>
</tbody>
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Notes:  - Speed limiting messages cannot be turned off
- DIC messages rerun w/ignition cycles
- 4 chimes every 3 minutes for each key cycle and DEF indicator flashes continuously
Upfitter Impacts
Vehicle Impacts, Express/Savana

• **Additional weight**
  • DEF tank, lines, engine and exhaust system
    • Adds up to 80 lbs. to Express/Savana

• **No significant changes to:**
  • Frames
  • Axles, suspensions
  • Transmissions
  • Cooling system
  • Fuel tanks
  • Cab
Vehicle Impacts, Silverado/Sierra

• **Additional weight**
  - DEF tank, lines, engine and exhaust system
    - Adds up to 60 lbs. to Silverado/Sierra

• **No significant changes to:**
  - Transmission
  - Cab

• **Improvements to increase chassis capabilities:**
  - Frames
  - Axles / Suspensions
  - Fuel Tanks
Upfitter Modifications

• No modifications recommended: DEF system integral to emissions compliance:
  • DEF lines and hoses:
    • Lines to exhaust system should not be moved, they are heated
    • DEF tank fill hose is flexible to modify position on cutaway chassis; height of fill to be retained to maintain DEF capacity
  • Exhaust system:
    • Exhaust routing modification allowed after DPF within guidelines published by gmupfitter.com

• Measurement Mtg for NTEA members planned
  • September 24, 2009 in Warren, MI
  • After NTEA Fall Product Conference
Cost Impacts

- Additional components and technology will require a significant price increase
- GM cost and pricing are being developed
- No light duty manufacturer has announced pricing to date
- Significant price advantage for 2009/2010 Model Year vehicles ahead of emissions changes
### HD Reg & Crew Cab Timing

<table>
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<th>Product, Engine</th>
<th>2009 CY June &amp; After</th>
<th>2010 CY</th>
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<tbody>
<tr>
<td>Gas</td>
<td>Jun</td>
<td>Jul</td>
</tr>
<tr>
<td>Diesel</td>
<td></td>
<td></td>
</tr>
</tbody>
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- 2010 Start-of-Production (SOP) Mid-Oct 2009
- Diesel order cut-off Nov 2009
- Current emissions diesel build out Jan/Feb 2010
- 3 Month diesel dark period, March – May
- 2011 MY SOP w/new emissions diesel & HD Component Set, May 2010
## Full Size Van Timing

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<tr>
<td>Gas</td>
<td>Jun</td>
<td>Jul</td>
</tr>
<tr>
<td></td>
<td>Downtime</td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>Downtime</td>
<td></td>
</tr>
</tbody>
</table>

- 2010 MY vans in production now
- Diesel order cut-off Nov 2009
- Current emissions diesel build out Jan/Feb 2010
- 3 Month diesel dark period, March – May
- New Emissions diesel SOP late May, 2010 MY vans
# HD Ext & 1500 Ext Cab w/8’ Box Timing

<table>
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<td>Downtime</td>
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</tr>
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<td>Diesel</td>
<td>Downtime</td>
<td></td>
</tr>
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- Pontiac Assembly Center closed by Oct 1, 2009
- Production relocated to new plant with gas SOP Jan 2010
- 9 Month diesel dark period, Oct - July
- 2011 MY SOP w/new emissions diesel & HD Component Set, July 2010
- Extended Cab chassis cab does not return to production
References:

- http://www.factsaboutscr.com
- http://www.truckscr.com/
- http://www.epa.gov
Thank You

Q & A