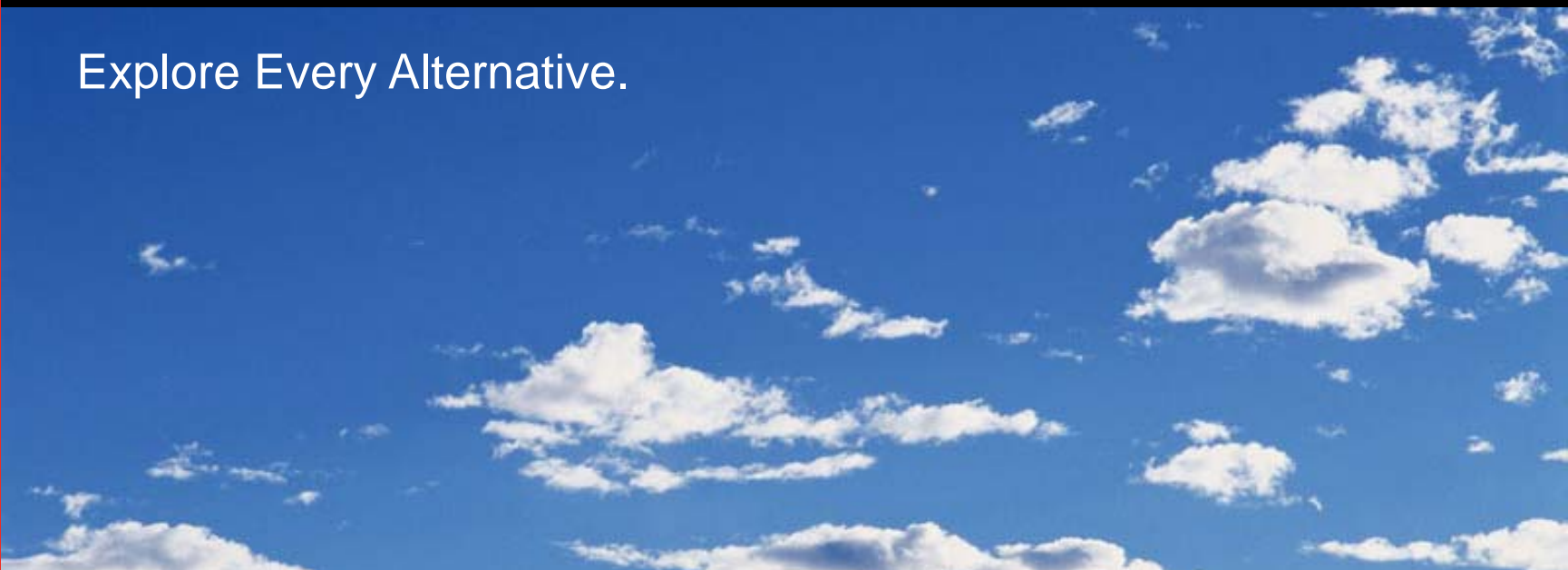




CNG Compelling Case Workshop

October 28, 2009

Explore Every Alternative.



Cummins Westport Inc. (CWI)

A Cummins JV Company

- **CWI is a 50:50 joint venture company based in Vancouver, BC**
 - **Established in 2001**
 - **Cummins Inc. - world's largest builder of commercial diesels,**
 - **Westport Innovations Inc. - world leader in gaseous fuel engine technology**
- **CWI offers 6 to 9 litre spark ignited alternative fuel automotive engines. (CNG, LNG, LPG)**
- **Engines are manufactured by Cummins.**
- **Over 20,000 engines in service worldwide**
- **Local parts and service support through Cummins Distributor network.**



Why Natural Gas Engines for Buses & Trucks?

Emissions Leadership

- ISL G is the only Urban Bus and Truck engine that met 2010 EPA Emissions at launch in 2007
- Low Carbon - Greenhouse Gas advantages



Emerging Economic Benefits

- Continuous reliability improvement
- ISL G improved fuel economy
- Greatest benefits in high fuel use applications

Energy Security

- Reduce reliance on imported oil
- Lower fuel costs
- Pathway to hydrogen



Cummins Westport

Heavy Duty Engines Designed Specifically for Alternative Fuels

- *Based on Reliable Cummins Engine Platforms*
- *Common parts and design provide heavy duty performance*
- *Engineered and Optimized Specifically for Alternative Fuel*
- *Continued improvement in reliability and cost of ownership*
- *Service Support through the Global Cummins Distributor network*



2009 CWI Product Line

B GAS
PLUS

B LPG
PLUS



5.9 liter

Lean Burn

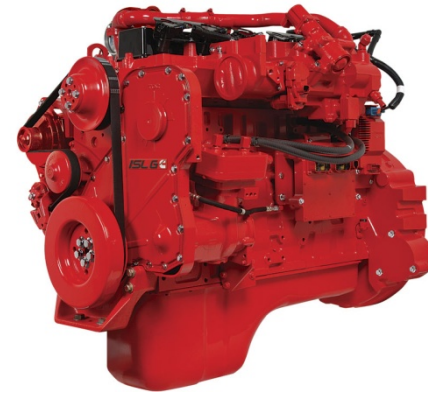
195–230 hp

420–500 lb-ft

Certified 2007-9

Truck and Bus

ISL G



8.9 liter

Stoich EGR

250-320 hp

660-1000 lb-ft

Certified 2010

Truck and Bus

B GAS PLUS

5.9L, LBSI, Full Electronics

Began production in 1994

Available thru 2009

**Over 50 million miles
operational experience**

Applications

Urban/Shuttle Bus

Medium Duty Truck

Specialty Vehicles

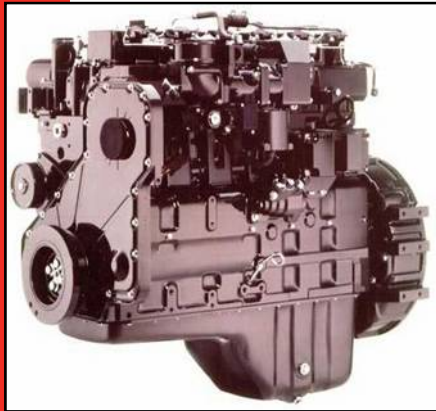
Engine Ratings

<u>Model</u>	<u>Horsepower</u>	<u>Peak Torque</u>
230	230 @ 2800	500 @ 2800
200	200 @ 2800	465 @ 2800
195	195 @ 2800	420 @ 2800



Four Generations of Natural Gas Engines

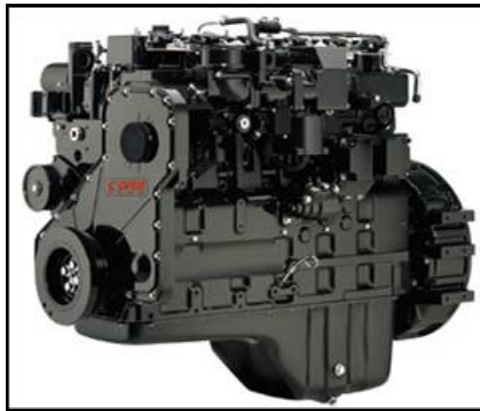
1998



C8.3G Mechanical C Gas Plus

- Introduced in 1998
- Major improvement over 1st generation CNG L10 Series
- Over 4000 still in service
- Improved Reliability

2001



C Gas Plus

- Introduced in 2001
- State of the art spark ignition/control system
- First engine 2004 EPA Certified
- Six fold reliability Increase

2004



L Gas Plus

- Introduced in 2004
- Improved Ignition control system
- VG Turbo
- Based on 8.9 L ISL Block
- 2007 NOx and 2010 PM levels

2007



ISL G

- Introduced in June 2007
- Stoichiometric EGR combustion, three way catalyst
- First HD engine certified 2010 NOx and PM levels



Customer Experience-Diesel vs. NG

Just Like Cell Phones, Natural Gas Engines have Continued to Improve



	L 10 G	C 8.3	C Plus	'07 ISL G
Emissions	Better	Better	Better	Better
Reliability	Worse	Worse	Similar	Similar
Fuel Cost/Mile	Worse	Worse	Similar	Better*
Durability	Worse	Worse	Similar	Similar
LCC	Worse	Worse	Worse	Better*
Timeline	1989	1996	2001	2007

* Must Have Fuel Price Differential to be lower



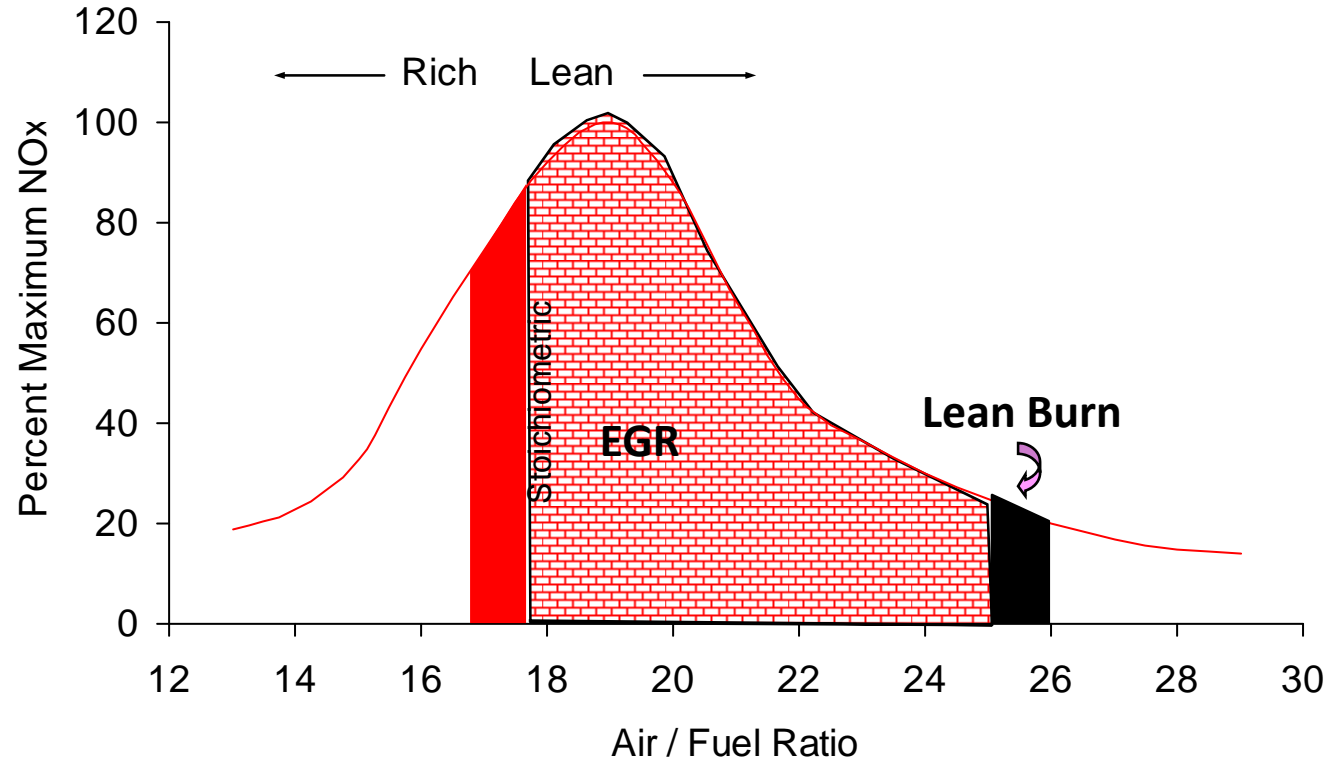
Natural Gas Engine Technology Evolution

1. Stoichiometric

- Low NOx with TWC
- Combustion temperatures limit power density, efficiency and durability
- First technology used in HD natural gas engines

2. Lean Burn

- Introduced in '90s
- NOx control is in-cylinder
- Lean combustion reduces in cylinder temperatures improving power density/efficiency
- Proven reliability/durability in heavy duty applications
- Capable of EPA 07 emissions



3. Stoichiometric with Cooled EGR

- Combines & Improves the best attributes of Stoichiometric & Lean Burn combustion
 - TWC for NOx control - Sub-EPA 2010 emissions with passive aftertreatment
 - Cooled EGR in place of air in Lean Burn reduces in cylinder combustion temperatures
 - Improved low end torque and fuel economy

Three Key Emission Technologies

2010 EPA/Euro EEV Natural Gas Engines

- **Cooled Exhaust Gas Recirculation (CEGR)**
- **Stoichiometric Combustion**
- **Three Way Catalyst (TWC)**

Cummins

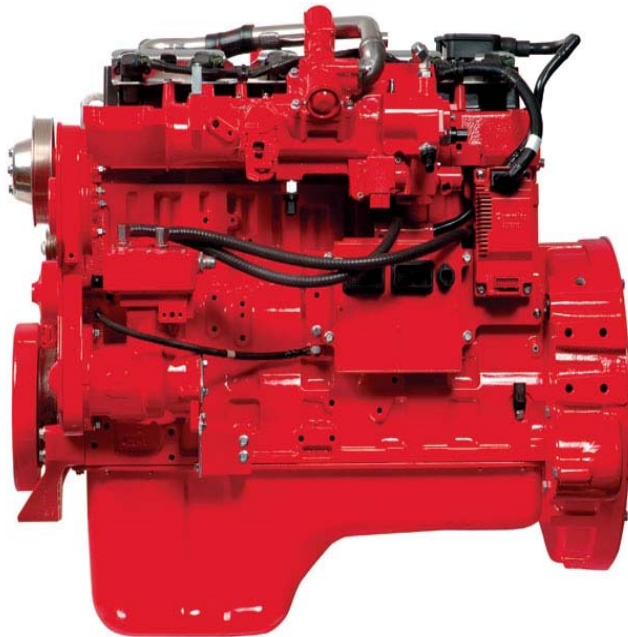
Cummins Westport

**Cummins
Emissions Solutions**



San Diego MTS BRT

2010 Natural Gas Truck and Bus Engine

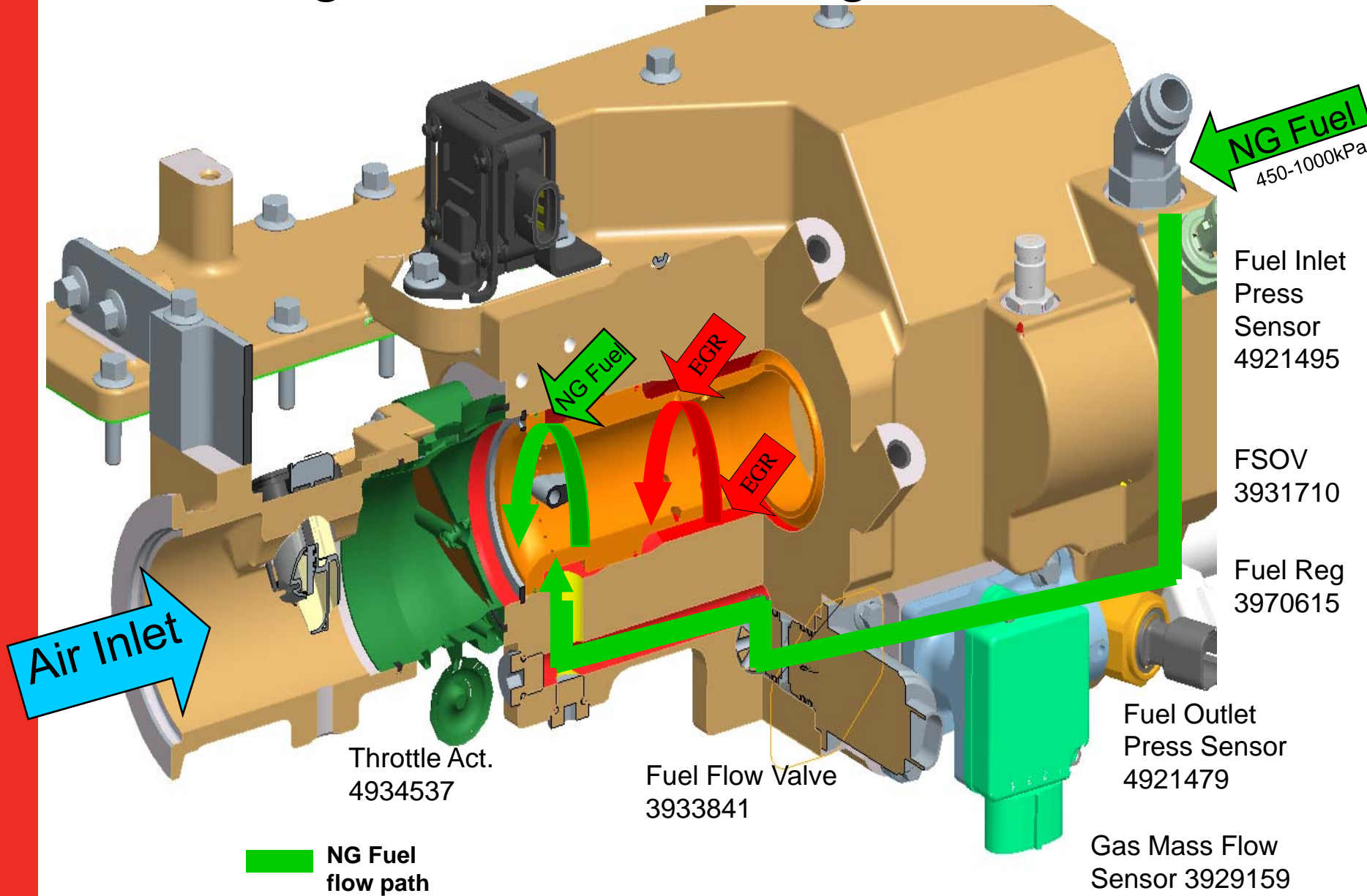


ISL G

- **8.9 litre Stoichiometric Cooled EGR engine**
 - Ratings from 250 to 320 hp
- **Low emissions**
 - 0.20 g/bhp-hr NOx
 - 0.01 g/bhp-hr PM
- **Three Way Catalyst Aftertreatment**
 - Maintenance Free
- **Diesel like Performance, Reliability, Durability**
 - Same rated speed/similar torque curve
 - Over 30% more torque at idle vs. previous engine
 - Improved fuel economy- +5% vs. C Gas Plus
- **Over 80% common Cummins diesel parts**
- **Began production in 2007**
- **CNG or LNG**



ISLG Integrated Fuel Housing



ISL G and ISL Diesel

What is the Same?

- Major Engine Components
 - Block, crankshaft, main bearings, piston rods, EGR
 - Over 80 % parts commonality
- 500 hour Maintenance Interval
- Parts and Service
 - Available from local Cummins Distributor
- Manufactured in Cummins Engine Plant, North Carolina
- 320, 300, and 260 HP truck ratings
- Cummins Base Warranty
 - 2 years, 250,000 miles
- Extended Warranty Option
 - Available
- Compatible with Cummins Diagnostic tools
 - Insite and Quickserve online



tport

ISL G and ISL Diesel

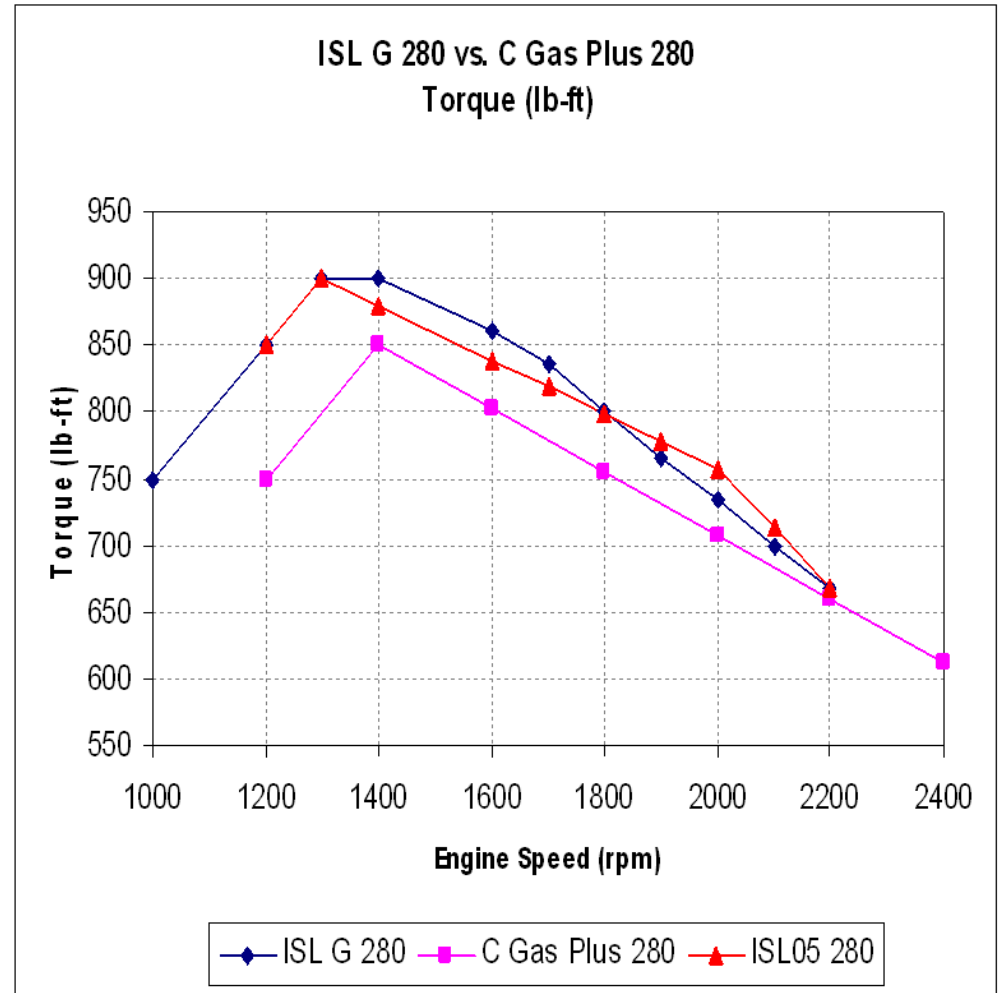
What is Different?

- Cylinder head
 - 4 valve (diesel) vs. 2 valve
- Ignition
 - Compression (diesel) vs. spark ignition
- Fuel System
 - Common rail injection (diesel) vs. intake manifold
- Aftertreatment
 - Particulate Filter + Selective Catalytic reduction (diesel) vs. maintenance free 3 way catalyst
- Noise
 - Natural gas engines are up to 10db quieter at idle
- Crankcase Oil
 - Requires different crankcase oil specification – CES 20074
- Fuel Cost
 - Natural gas total fuel costs (including station) can be less than diesel.
- Fuel Economy
 - Diesel engines typically obtain better fuel economy
- Initial Costs
 - Natural gas trucks typically cost more than diesel trucks



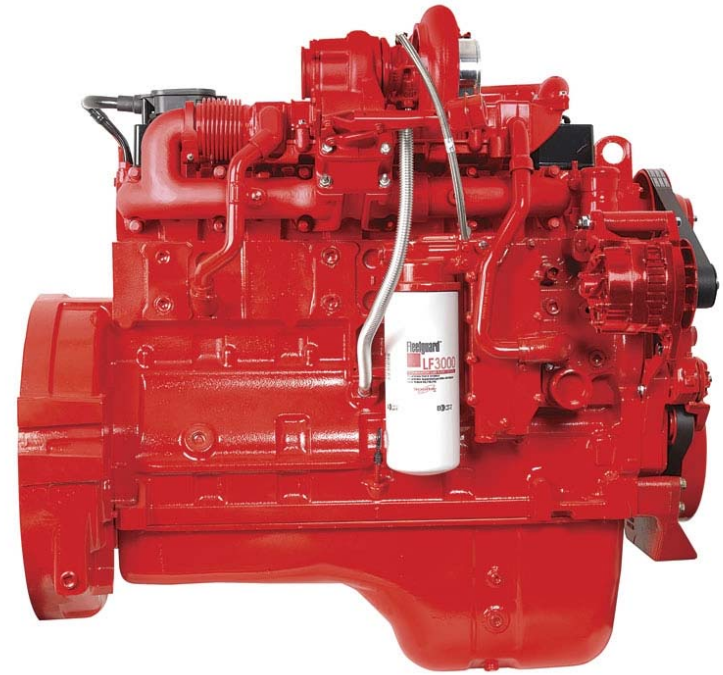
ISL G – Next Generation Natural Gas Engine

- Stoichiometric CEGR Engine
- Improved performance
- Over 34% higher clutch engagement torque
- Diesel-like reliability & durability



2010 ISL G Natural Gas

ISL G



Three Way Catalyst
Aftertreatment

- Passive device
- Packaged as a muffler
- Maintenance Free

Stoichiometric Combustion
Cooled EGR

- Same rated speed as ISL diesel
- 30% more torque at idle
- 5% Better Fuel Economy

Three Way Catalyst

- Reduces three harmful emissions: NO_x , CO, HC
- End products are: N_2 , CO_2 , H_2O
- Simple, passive, maintenance-free

Catalyst Inlet

NO_x

CO

HC



Catalyst Outlet

N_2

CO_2

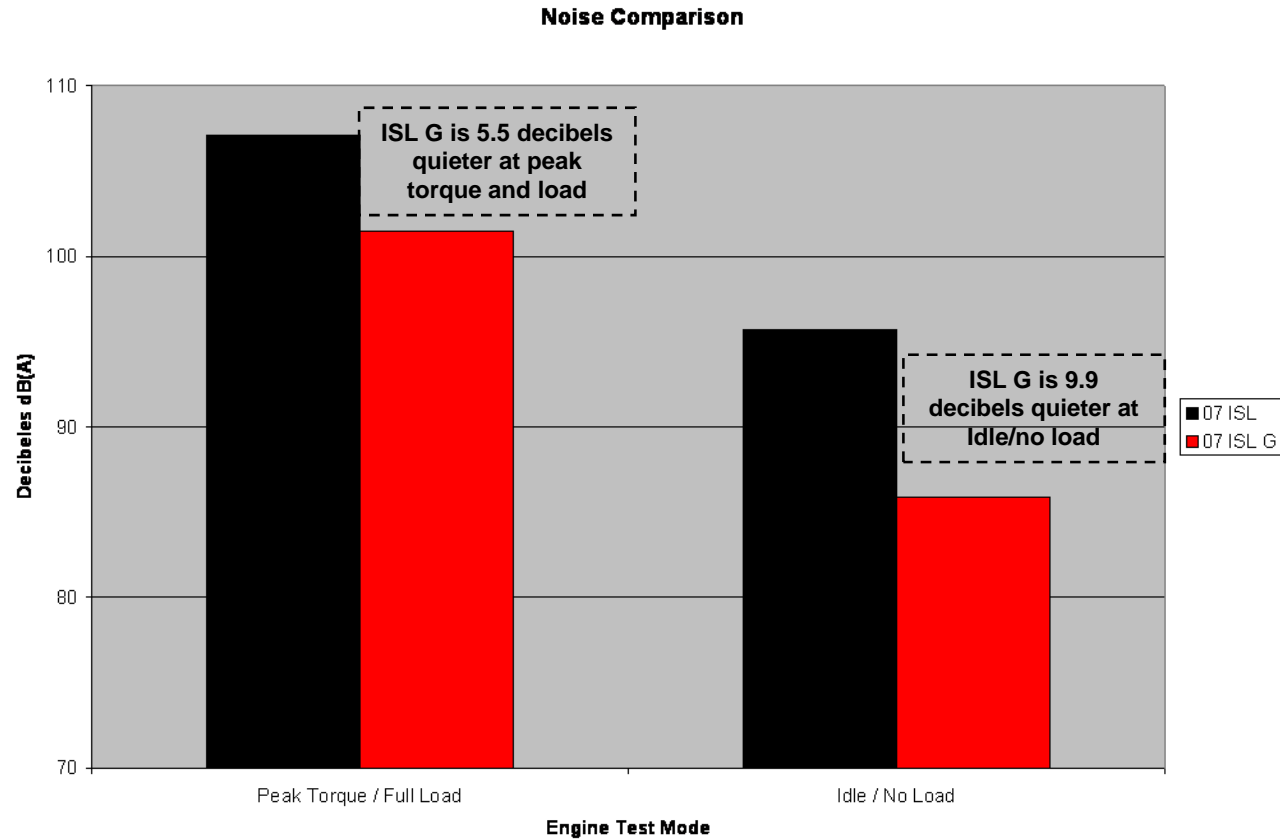
H_2O

ISL G TWC - similar package size to current mufflers

CNG Engines Reduce Noise

Communities notice the natural gas noise advantage.

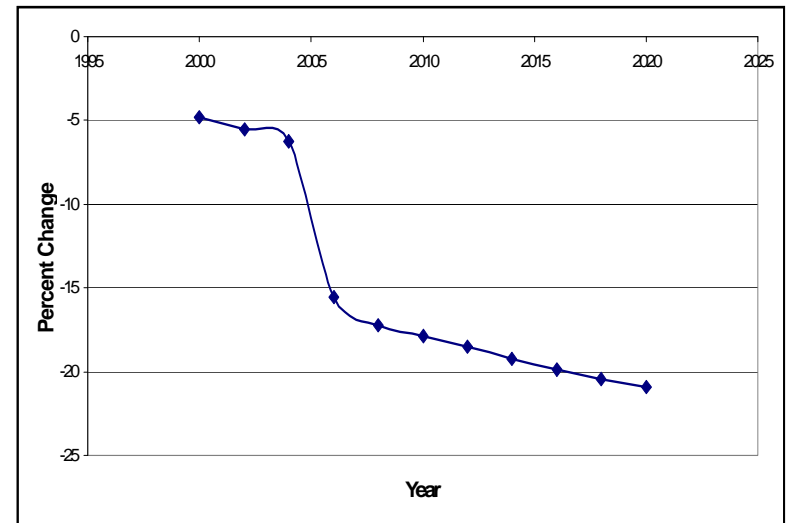
ONE Diesel engine idling is louder than TEN natural gas engines idling together



Up to 20% Lower Greenhouse Gas Emissions

- As natural gas fuel economy improves, CO₂ emissions are reduced
- CH₄ emissions, adjusted to consider GHG impact are less than 10% of total GHG emissions.
- Well to Wheel analysis with GHGenius modeling tool predicts up to 20% WTW GHG emissions for natural gas vs. diesel.
- Using landfill gas or anaerobic gas as a biomethane fuel increases GHG difference to ~90%.
- Cummins Westport approves the use of biomethane that meets fuel specifications.

HD NGV GHG Performance



GHGENIUS

A Model for Life Cycle Assessment of Transportation Fuels



Natural Gas Applications

TRUCK



SPECIALTY



BUS



REFUSE



New ISL G Availability 08-09



Freightliner M2 – 112
May 2009



Peterbilt
August 2009



Kenworth
Sept 2009



Mack
June 2009



McNeilus
May 2009



Capacity
September 2008



Mack Australia
April 2009



OEM Availability – North America

North America						
OEM	Model	Segment	B Gas Plus	B LPG Plus	ISL G	Comments
Freightliner Truck	Business Class M2 112 (Class 7/8)	MD/HD Truck			X	6X4 Tractor (LNG, CNG), CNG - 4X2 Tractor, 6X2, 4X2 Truck. Vocational
Kenworth	T800SH, W900S, (2010 - add T470),	MD/HD Truck			X	W900S - Mixer T800SH - Tractor T470 - Vocational (2010)
Peterbilt	Model 384, Model 365	MD/HD Truck			X	Model 384 - Tractor model 365 - Vocational
American LaFrance	Condor	Refuse			X	
AutoCar	WX / WXLL	Refuse			X	
Crane Carrier	LCF	Refuse			X	
Peterbilt	320	Refuse			X	
Mack	TerraPro Low Entry	Refuse			X	TerraPro Cab Over TBA
NABI	35 LFW/40 LFW/60 BRT	Urban Bus			X	
New Flyer	30 LF/35 LF/40 LF	Urban Bus			X	
Orion	Orion V HF/Orion VII LF	Urban Bus			X	
Foton	City - L40 CNG	Urban Bus			X	
El Dorado National	Axess/E-Z Rider II/Transmark RE/XHF	Shuttle	X	X	X	
Blue Bird	All American	School Bus			X	
Thomas Bus	Saf-T Liner	School Bus			X	
Capacity	TJ9000 (LNG/CNG), TJ5000	Yard Spotter	X	X	X	
Ottawa		Yard Spotter	X	X		
Elgin	Eagle/Broom Bear/Crosswind	Sweeper	X	X		
Allianz Sweeper	4000	Sweeper	X	X		
Schwarze	A7000	Sweeper	X	X		
Tymco	Model 600	Sweeper	X	X		
Freightliner Custom Chassis	MB-55	Various	X	X		
Optima Bus	AH-28 (CNG + Propane)	Shuttle	X	X		
Blue Bird	Ultra LF	Shuttle	X			
Re-Power						
Complete Coach Works	Freightliner M2 106 Business Class	MD/HD Truck			X	ISL G Re-Power
Fontaine Modification Company	Freightliner M2 106 Business Class	MD/HD Truck			X	ISL G Re-Power

Similar Maintenance Schedule

ISL G Maintenance Schedule⁽¹⁾

Daily or Refueling	Every 12,000 km (7,500 Mi), 500 Hrs or 6 Months ⁽¹⁾⁽³⁾ Whichever Comes First	Every 24,000 km (15,000 Mi), 1000 Hrs or 12 Months ⁽¹⁾⁽³⁾ Whichever Comes First	Every 36,000 km (22,500 Mi), 1500 Hrs or 18 Months ⁽¹⁾⁽³⁾ Whichever Comes First	Every 48,000 km (30,000 Mi), 2000 Hrs or 2 Years ⁽¹⁾⁽³⁾ Whichever Comes First
Operator's Report - Check	Catalyst Housing - Check Exterior	Drive Belt - Check	Spark Plugs and Boots - Replace ⁽⁶⁾	Vibration Damper - Check
Engine Oil - Check, add if required	Air Cleaner - Check	Automatic Belt Tensioner - Check	Ignition Coils - Check	Turbocharger - Check
Engine Coolant - Check, add if required	Charge Air Cooler - Check	Fan H.b., Belt Driven - Check		Engine Coolant - Flush and Replace
Cooling Fan - Check	Charge Air Piping - Check	Water Pump - Check		Air Compressor - Check
Radiator Hose - Check	Lubricating Oil - Change ⁽⁴⁾	Catalyst - Check		
Air Intake Piping - Check	Lubricating Oil Filter - Change ⁽⁴⁾	Engine Fuel Filter - Replace		
Fuel Filter - Drain ⁽²⁾	Supplemental Coolant Additives (SCA) and Antifreeze - Check ⁽⁵⁾	Overhead Valve Lash - Adjust ⁽⁷⁾		
Throttle Response - Check	Coolant Filter - Change ⁽⁵⁾			
Crankcase Breather Tube - Check				

**Same Schedule
as Diesel – Some
Different
Maintenance
Items**

Note: Refer to the appropriate manual for complete inspection and maintenance procedures.

- Follow the manufacturer's recommended maintenance procedures for the starter, alternator, generator, batteries, electrical control system, and fuel filter.
- Interval period for draining the fuel filter is dependent on the fueling station and varies for each location. The drain interval should be based on the amount of oil in the fuel filter.
- At each scheduled maintenance interval, perform all previous checks in addition to the ones specified.
- Refer to Table 1, Oil Drain Intervals for oil and filter change intervals based on average speed.
- Do not change the coolant filter if the SCA is over 3 units. Refer to Section V.
- Use only Cummins authorized spark plugs for scheduled maintenance or repairs. The use of unauthorized parts can affect performance and emission control system. The recommended 36,000 km [22,500 mile] interval is based on an average vehicle speed of 24 kph [15 mph] and must be derated accordingly for slower speed applications (i.e. 1500 hr times average kph [mph] = distance maintenance interval).
- Initial valve lash adjustment only - thereafter regular adjustment interval is 2000 hours

Warranty - Every Coverage

- *Base Warranty for Bus/Shuttle, School Bus and Truck are the same as diesel*
- *2 yr / 250,000 mile Basic Warranty - Truck*
- *Extended Coverage options are available for Truck Customers*
 - *4 yr / 150,000 miles*
 - *5 yr / 150,000, 200,000, 250,000, or 300,000 miles*
 - *6 yr / 250,000 miles*
 - *7 yr / 250,000 miles*
 - *6 yr / 300,000 Major Component Warranty*
- *All warranty programs administered per Cummins Standard Policies*

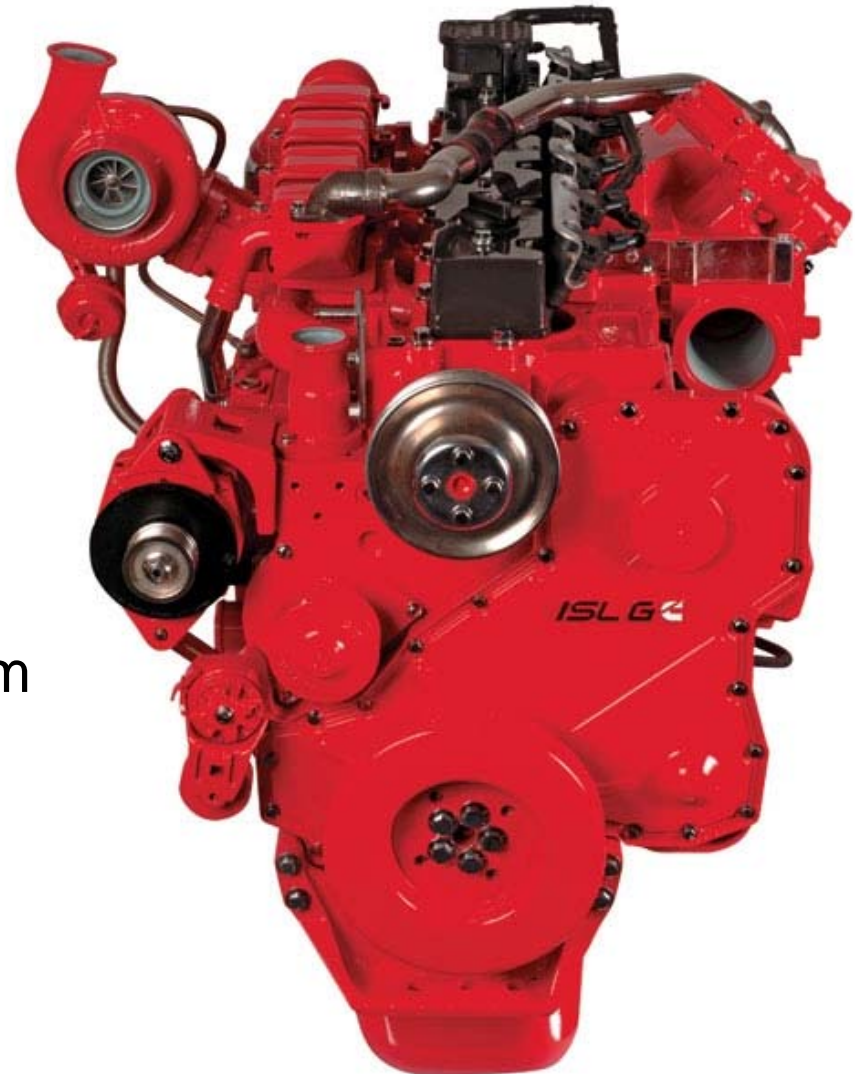
Summary

- Proven technology – Cummins support
- Maintenance free exhaust system
- Lower emissions- tailpipe and community noise.
- Lower Well to Wheel Greenhouse Gas
- Biomethane low carbon option
- Potential lower total costs with natural gas

More information?

Questions?

- For more information:
Bill Boyce
East Regional Manager
(330) 720-9785
- Or visit
www.cumminswestport.com



ort