

**EVERY  
ALTERNATIVE.**

*The Compelling Case for  
Natural Gas Vehicles: A Fleet  
Seminar*

# 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**

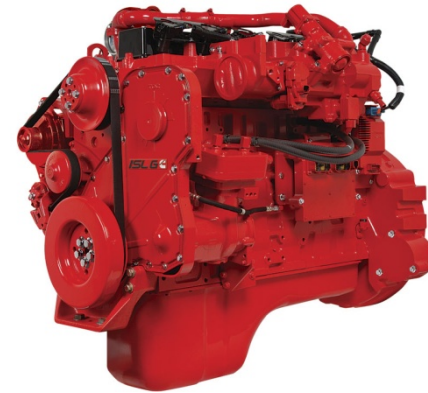
**195–230 hp**

**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**

**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 @ 1600
200	200 @ 2800	465 @ 1600
195	195 @ 2800	420 @ 1600

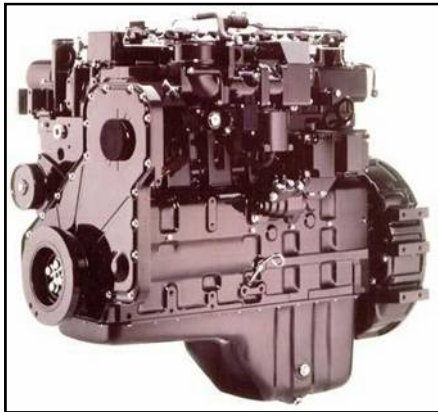


# B Gas Plus - Features

- 4 Cycle, 6 Cylinder, 2800 RPM Engine
- Lean burn, for fuel economy & emissions
- Installation more common to ISB (Retains 2VH)
- CM556 Engine Control
  - Latest Technology Controls
  - Increased speed, memory
  - Diagnostic capabilities of Insite and Quickcheck
  - Electronic throttle (drive-by-wire)
    - faster response and easier installation for bus/truck manufacturers
  - Capable of operating on lower quality natural gas
    - Methane number as low as 65
- Meets US EPA 07 Emissions
- Euro 3, Euro 5, EEV

# Four Generations of Natural Gas Engines

1998



## C8.3G Mechanical

- Introduced in 1998
- Major improvement over 1<sup>st</sup> 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

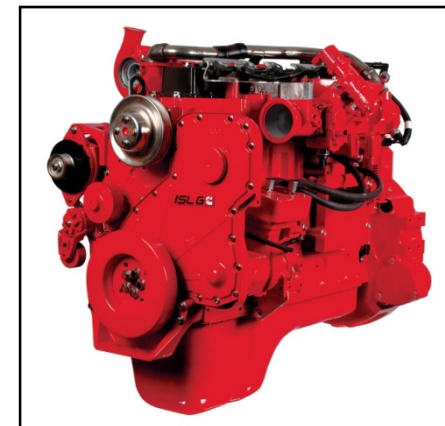
2004



## 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
- Wastegate Turbo
- 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

# Three Key Emission Technologies

## 2010 EPA/Euro EEV Natural Gas Engines

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

**Cummins**

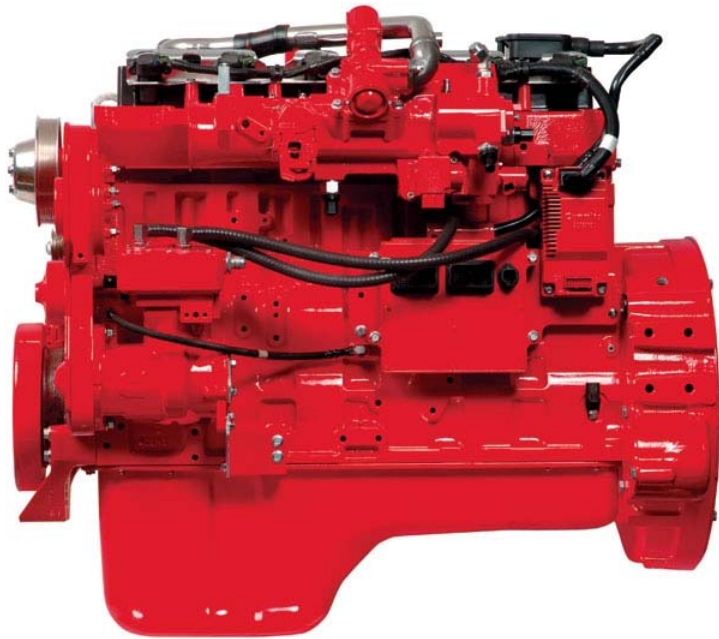
**Cummins Westport**

**Cummins  
Emissions Solutions**



San Diego MTS BRT

# 2010 Natural Gas Truck and Bus Engine

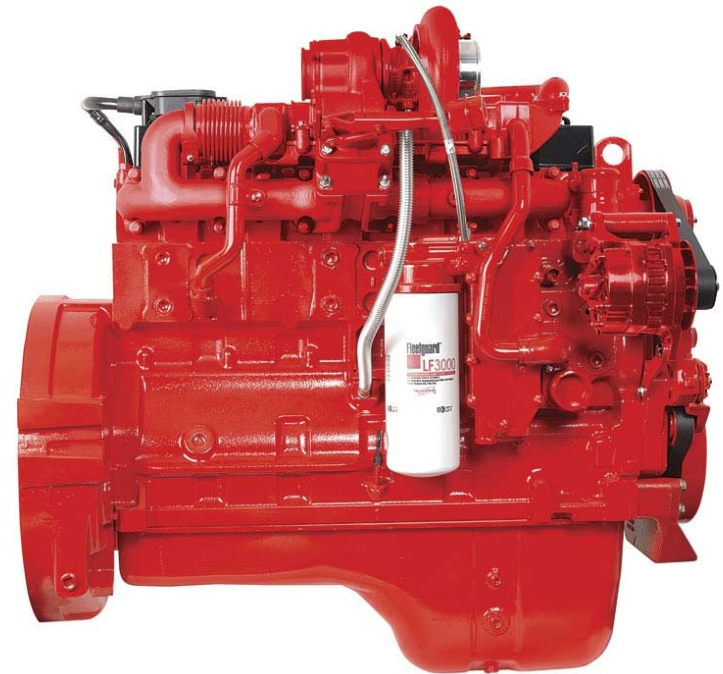


**ISL G**

- **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 June 2007**
- **CNG or LNG**

# 2010 ISL G Natural Gas

*ISL G*



Three Way Catalyst  
Aftertreatment

- Passive device
- Packaged as a muffler
- Maintenance Free

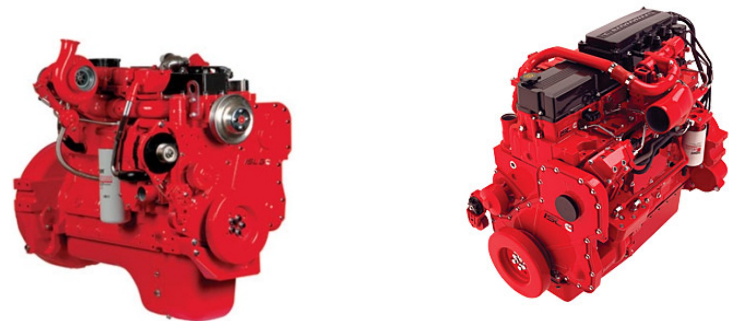
Stoichiometric Combustion  
Cooled EGR

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

# 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



# ISL G and ISL Diesel

## What is Different?

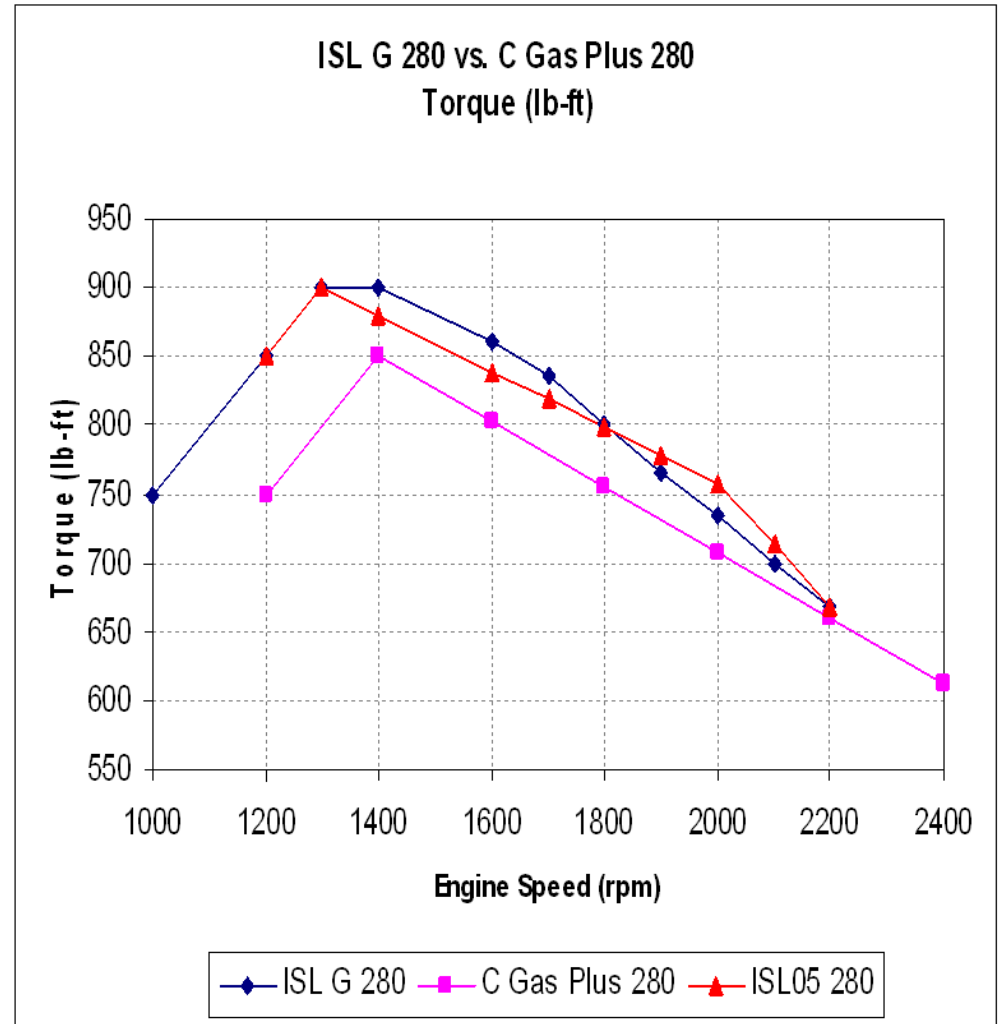
- **Cylinder head**
  - 4 valve (diesel) vs. 2 valve
- **Ignition**
  - Compression (diesel) vs. spark ignition
- **Fuel System**
  - Common rail injection (diesel) vs. intake manifold
- **Aftertreatment**
  - Particulate Filter + Selective Catalytic reduction (diesel) vs. maintenance free 3 way catalyst
- **Noise**
  - Natural gas engines are up to 10db quieter at idle
- **Emissions Certification**
  - ISL G meets 2010 EPA and CARB emission requirements.
- **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

# 2009 ISL G Ratings

ENGINE MODEL	ADVERTISED HP(KW) @ RPM	PEAK TORQUE LB-FT @ RPM	GOVERNED SPEED
ISL G 320	320 (239) @ 2000	1000 (1356) @ 1300	2200 RPM
ISL G 300	300 (224) @ 2100	860 (1166) @ 1300	2200 RPM
ISL G 280	280 (209) @ 2000	900 (1220) @ 1300	2200 RPM
ISL G 260	260 (194) @ 2200	660 (895) @ 1300	2200 RPM
ISL G 250	250 (186) @ 2200	730 (990) @ 1300	2200 RPM

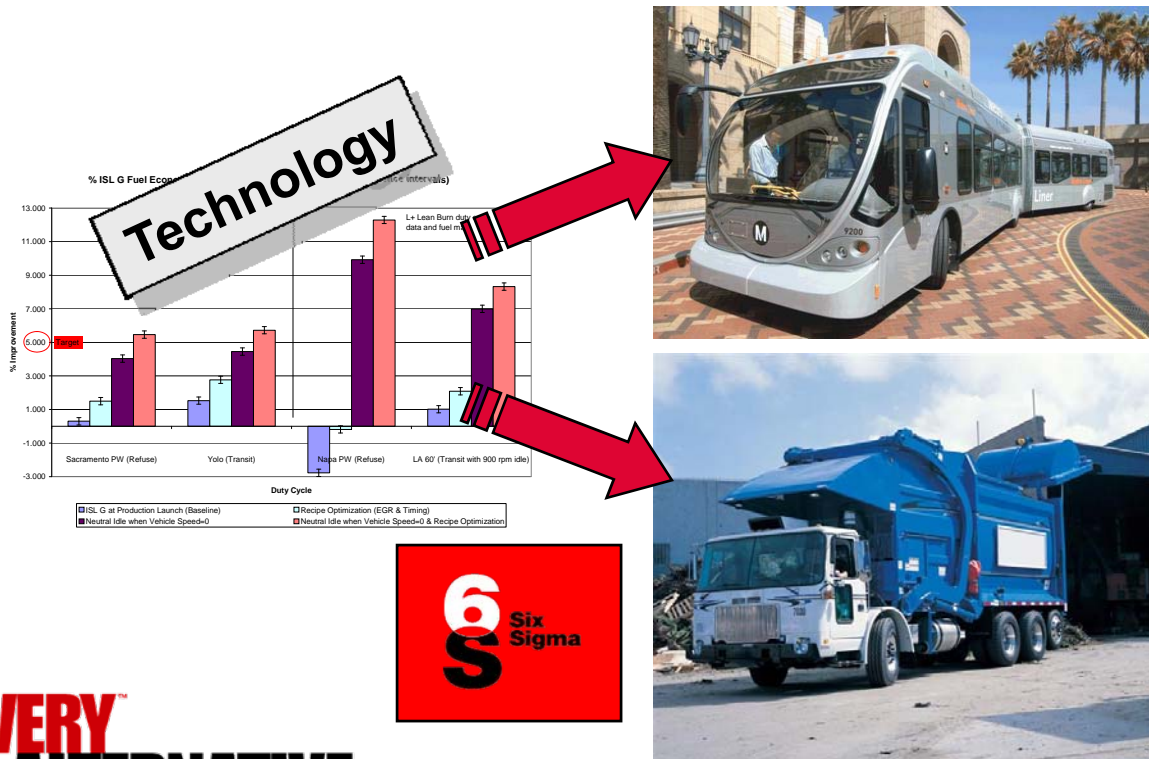
# ISL G – Next Generation Natural Gas Engine

- Stoichiometric Engine
- Lowest emissions
  - **0.20 g/bhp-hr NOx**
  - **0.01 g/bhp-hr PM**
- Higher efficiency
  - Target: 5% fuel economy improvement vs. CWI's current products
- Diesel-like reliability & durability
- Improved performance – 34% Higher clutch engagement torque



# + 5% Fuel Economy Improvement

- 6 Sigma project measured percent fuel economy improvement between ISL G and C Gas Plus products at Orange County Transit Authority (OCTA)
- Demonstrated +5% improvement with measurement method agreed upon by Customer Focused Six Sigma (CFSS) team including customer
- In-use OCTA fleet data supports project findings



## ISL G & 2010 Regulated Emissions

### In-Use Results (equipment loaded on bus)

- Sensors Inc tested Sacramento Bus in-service
- Used EPA in-use test procedure
  - Tests full load and speed combinations
  - Tested bus on city and highway routes
- Sensors Inc concluded that emissions were significantly lower than the 2010 EPA Heavy Duty emissions regulations



# ISL G - Conclusions

- Meets 2010 Emission Standards, today.
- No exhaust system related maintenance costs.
- More fuel efficient than previous engines.
- Improved clutch engagement torque (+34%)
- 80% of design based upon diesel engine platform
- Parts and service support from the Cummins Distributor Network
- Uses a renewable fuel found in North America
- Substantial GHG Reductions

# Cummins Westport Applications

## TRUCK



## SPECIALTY



## BUS



## REFUSE



**EVERY  
ALTERNATIVE.**

- OEM Listing at [www.cumminswestport.com](http://www.cumminswestport.com)

# OEM'S

- Trucks
  - AutoCar, Condor, Crane Carrier, Peterbilt, and Mack
  - Freightliner Custom Chassis – MT45/55, MB55
  - Freightliner LLC (Sterling Trucks - L Series - 2008)
  - Freightliner M2
- Buses
  - Transit
    - NABI, New Flyer, and Orion.
  - Shuttle
    - El Dorado and Trolley Enterprises.
  - School
    - Blue Bird and Thomas.

# Similar Maintenance Schedule

## ISL G Maintenance Schedule<sup>(1)</sup>

Daily or Refueling	Every 12,000 km (7,500 Mi), 500 Hrs or 6 Months <sup>(1)(3)</sup> Whichever Comes First	Every 24,000 km (15,000 Mi), 1000 Hrs or 12 Months <sup>(1)(3)</sup> Whichever Comes First	Every 36,000 km (22,500 Mi), 1500 Hrs or 18 Months <sup>(1)(3)</sup> Whichever Comes First	Every 48,000 km (30,000 Mi), 2000 Hrs or 2 Years <sup>(1)(3)</sup> Whichever Comes First
Operator's Report - Check	Catalyst Housing - Check Exterior	Drive Belt - Check	Spark Plugs and Boots- Replace <sup>(6)</sup>	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 Hub, 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 <sup>(4)</sup>	Catalyst - Check		
Air Intake Piping - Check	Lubricating Oil Filter - Change <sup>(4)</sup>	Engine Fuel Filter - Replace		
Fuel Filter - Drain <sup>(2)</sup>	Supplemental Coolant Additives (SCA) and Antifreeze - Check <sup>(5)</sup>	Overhead Valve Lash- Adjust <sup>(7)</sup>		
Throttle Response - Check	Coolant Filter - Change <sup>(5)</sup>			
Crankcase Breather Tube - Check				

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

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

1. Follow the manufacturer's recommended maintenance procedures for the starter, alternator, generator, batteries, electrical components, and fuel filter.
2. Interval period for draining the fuel filter is dependent on the fueling station and varies for each location. The drain interval should be adjusted to the time required to accumulate no more than one ounce of oil in the fuel filter.
3. At each scheduled maintenance interval, perform all previous checks in addition to the ones specified.
4. Refer to Table 1, Oil Drain Intervals for oil and filter change intervals based on average speed.
5. Do **not** change the coolant filter if the SCA is over 3 units. Refer to Section V.
6. 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).
7. Initial valve lash adjustment only - thereafter regular adjustment interval is 2000 hours

# Warranty-Every Coverage

## Bus/Shuttle/Coach

- Standard 2 years Unlimited Mileage/Kilometers with full parts and labor coverage on warrantable failures.
- Major components are covered for 3 years / 300,000 miles (482,804 km.)

## Truck

- Full engine coverage is provided for 2 years / 250,000 miles (402,336 km) whichever comes first

- *Base coverage is same as diesel, extended coverage available!*
- *All warranty programs administered per Cummins Standard Policies*

# More information?

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

