

# Cummins Westport The Natural Choice

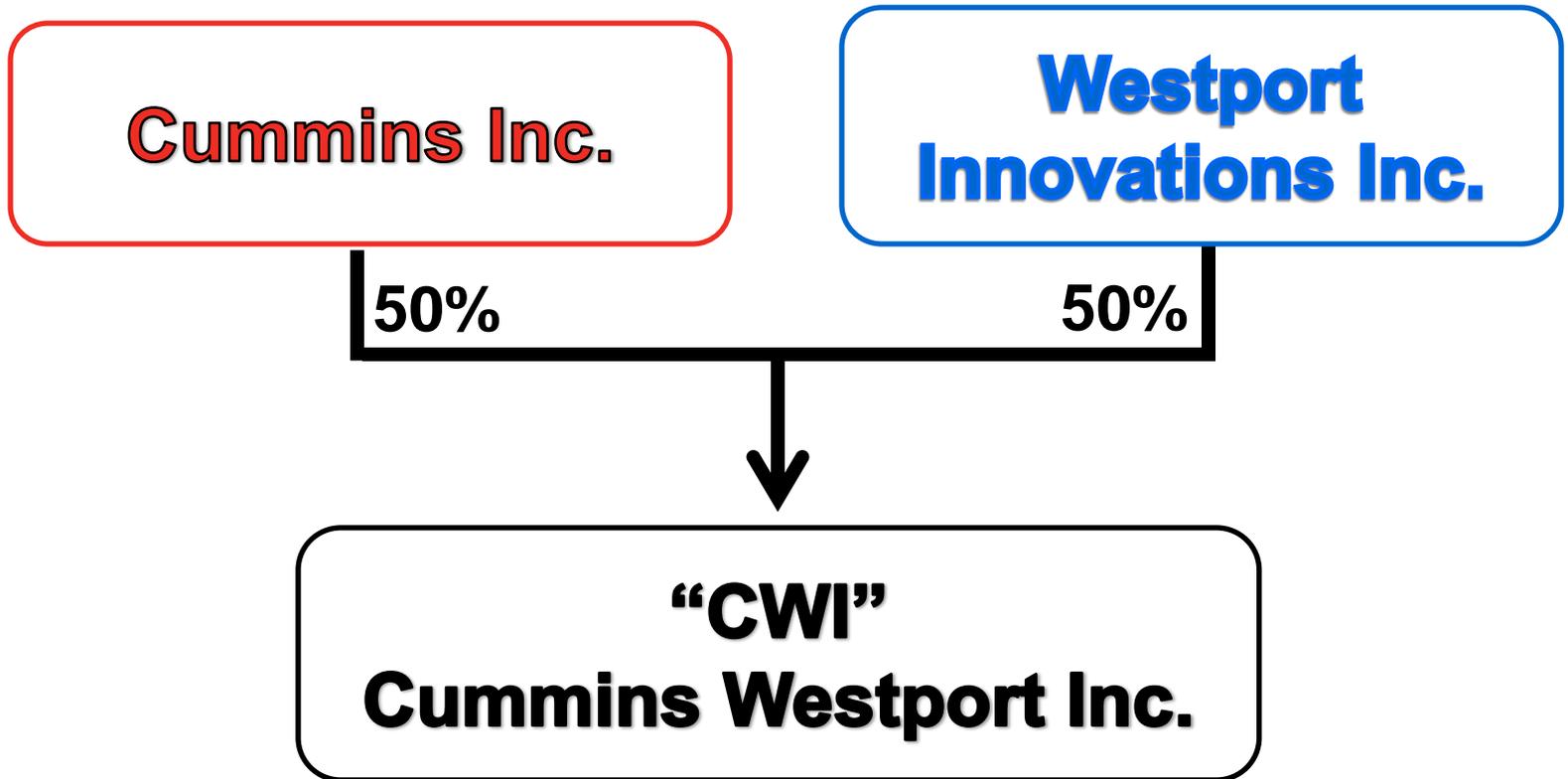
## Natural Gas and Vehicles

July 2012



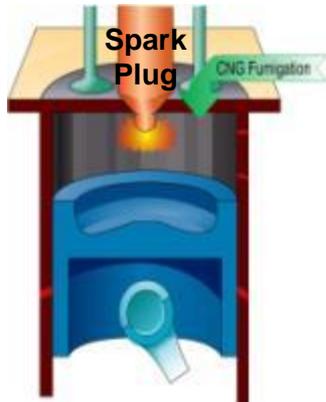
# Cummins Westport Inc. (CWI)

A Joint Venture of Westport & Cummins



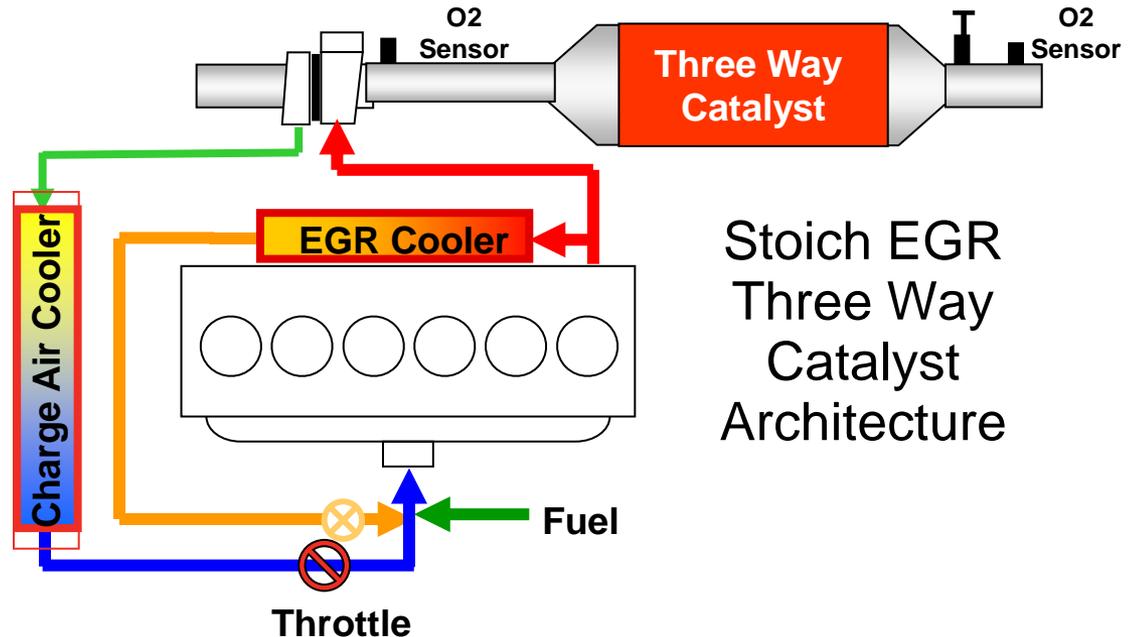
Delivered over 34,000 engines.  
2011 Revenue = \$139M  
New 10 year Agreement 2012

# CWI Technology Path



## Spark Ignited

- Fuel and air are premixed outside the cylinder
- Spark plug ignites the mixture
- Air flow controls fuel flow
- Air/Fuel ratio controls emissions



## Stoich EGR Three Way Catalyst Architecture

# ISL G Product Features and Benefits

- 8.9L Stoichiometric Cooled EGR engine with spark ignition
- In production since mid-2007
- Low emissions
  - 0.20 g/bhp-hr NOx
  - 0.01 g/bhp-hr PM
- Three Way Catalyst Aftertreatment
- Diesel like Performance, Reliability and Durability
  - Same rated speed
  - Similar torque curve
  - Over 30% more torque at idle vs. lean burn
  - Improved fuel economy of 5% vs. lean burn
- Over 80% parts commonality with ISL9
- Compatible with CNG, LNG, or Biomethane (RNG) Renewable Natural Gas



## ISL G

# What is the Same Between ISL9 & ISL G?

- Major Engine Components & Technology
  - Block, crankshaft, main bearing, piston rods
  - Over 80% parts commonality
  - Cooled EGR
- 500 hour Maintenance Interval
- Parts, Service, Training, Warranty
  - Cummins Distributor Network
- 320, 300, 280, 260 and 250 HP rating
- Compatible w/ Cummins Diagnostic Tools
  - Insite
  - QuickServe Online

***ISL G***



***ISL9***

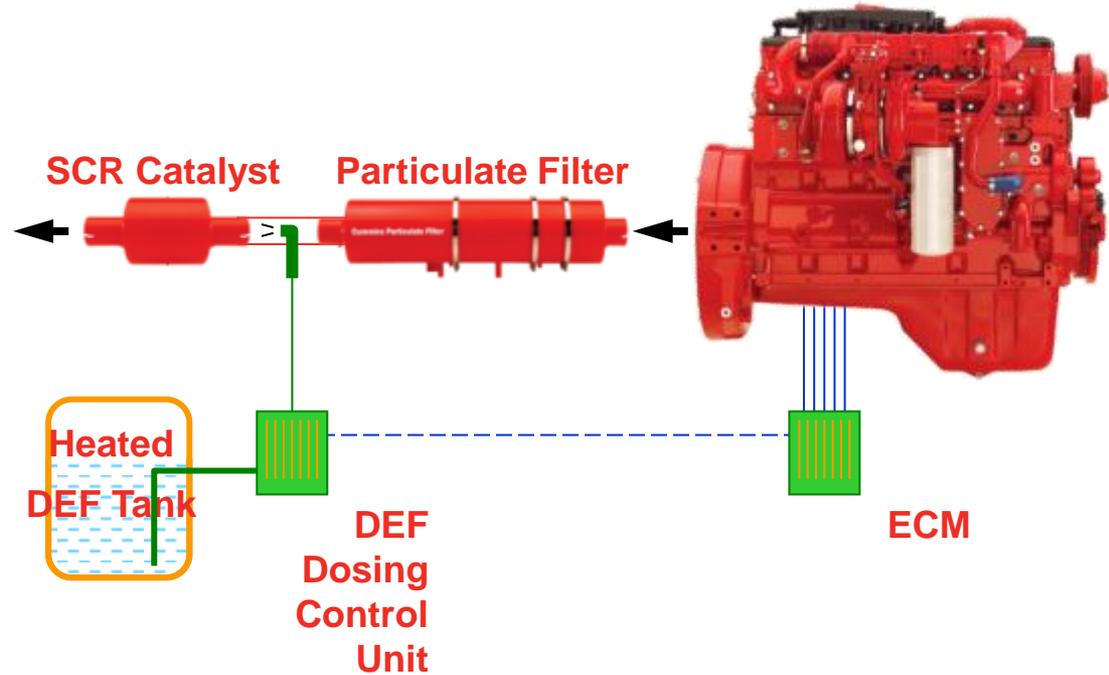


# What is Different Between ISL9 & ISL G?

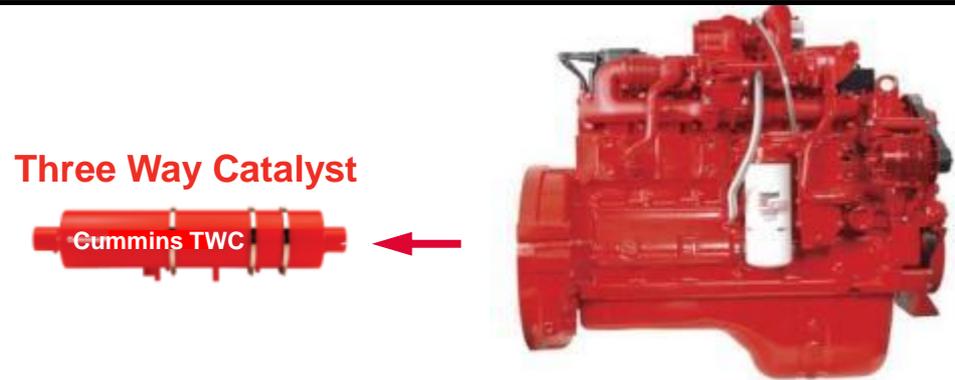
	<i><b>ISL G</b></i>	<i><b>ISL9</b></i>
<b>Cylinder Head</b>	2 Valve	4 Valve
<b>Ignition</b>	Spark Ignition (spark plugs)	Compression Ignition
<b>Fuel System</b>	Intake Manifold	Common Rail
<b>Aftertreatment</b>	Three way catalyst	Particulate Filter + SCR
<b>Compression Ratio</b>	12:1	16.6:1
<b>Maintenance Cost</b>	Cost of maintenance related to ignition and overhead valve adjustments adds incremental maintenance cost for the ISL G versus ISL9. This cost is typically more than offset by fuel cost savings with natural gas.	
<b>Lubricating Oil</b>	Natural gas engines require a specific oil that meets Cummins specification CES 20074	
<b>Noise</b>	Natural gas engines are up to 10db quieter at idle	

# Aftertreatment Comparison

**ISL9  
(diesel)**

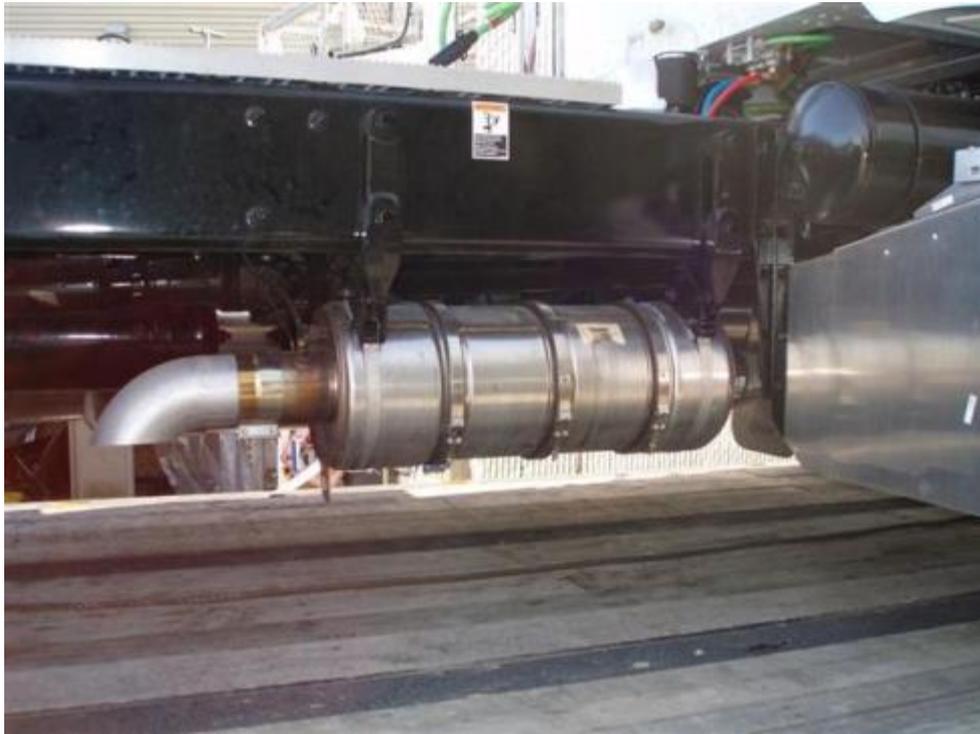


**ISL G  
(natural gas)**



# ISL G Maintenance Free Aftertreatment

- Three Way Catalyst
- Packaged as a muffler-vertical or horizontal mount
- Weighs approx 100 pounds
- Minimizes vehicle impact
- No regeneration or DEF required.



# Maintenance – ISL G

- Maintenance is a key factor in engine life
- ISL G maintenance intervals are established by Cummins Engineering and are based on engine family data.
- Key interval is oil drain, which is duty cycle dependant.
- The ISL G durability target for major engine components (crankshaft, etc.) is the same as ISL
  - B50 of 600K miles / 20,000 hours in typical on-highway applications (30 mph average speed).
- However, not all engine components have the same life expectation. In particular, the ISL G engine 2 valve cylinder head
  - Predicted B50 life of 325K miles (11,000 hours).

# Intended Service Guidelines

- The ISL G operates in a variety of applications. Maintenance intervals as published by Cummins are established based on vehicle applications and average speed.
- *Normal Duty* is described as idle time less than 40%, the vehicle does not operate in dusty areas, and GVW is not more than 65,000 pounds.
- Vehicles exceeding the published weight values as described in Cummins AEB 140.21 require a Cummins application review.

## ***ISL G Severe Duty Application Review***

- *Severe Duty* is described as more than 40% idle time, expected annual mileage in excess of 60,000 miles per year or weights in excess of 65,000 pounds
- *Severe Duty* requires special consideration on a case by case basis
  - Severe duty may increase maintenance costs and engine life
- Each case must be specifically approved by CWI.

# ISL G -Oil Drain Intervals

Table 1, Oil Drain Intervals					
Delivery Truck, School Bus, or Emergency Vehicles					
Type of Use		Kilometers	Miles	Hours	Months
Severe Duty		14,500	9,000	500	6
Normal Duty		24,000	15,000	500	6
Refuse Truck, Mixer, or Dump Truck					
Average Vehicle Speed (mph)		Distance Interval		Time Interval	
Greater than:	to and including:	Kilometers	Miles	Hours	Months
0	10	4,850	3,000	500	6
10	15	9,650	6,000	500	6
15	20	13,700	8,500	500	6
20	25	14,500	9,000	500	6
25		19,000	12,000	500	6
Shuttle or Transit Bus					
Average Vehicle Speed (mph)		Distance Interval		Time Interval	
Greater than:	to and including:	Kilometers	Miles	Hours	Months
2	4	2,400	1,500	500	6
4	6	4,850	3,000	500	6
6	8	6,450	4,000	500	6
8	10	8,050	5,000	500	6
10	15	9,650	6,000	500	6
15		12,000	7,500	500	6

# ISL G Maintenance Intervals - Truck



Eg: Truck application	Hours	Miles	Kilometers	Months
Check CAC cooler, piping and Air Cleaner	250	7500	12,000	3
Oil & Filter*	500	15,000	24,000	6
Coolant Filter**	None <sup>1</sup>	None <sup>1</sup>	None <sup>1</sup>	None <sup>1</sup>
Spin-on Fuel Filter	1,000	30,000	48,000	12
Spark Plugs	1,500	45,000	72,000	18
Standard Coolant	2,000	60,000	96,000	24
Overhead Adjustment***	2,000	60,000	96,000	24
Air Cleaner/Element	Follow vehicle manufacturers published recommendations			



Default interval is the hours stated. Interval is whichever comes first – hours, miles or time. Refer to Owners Manual for complete details on Maintenance Intervals.

<sup>1</sup> If engine is equipped with an optional coolant filter, it will need to be replaced at the same intervals as the oil filter. Regardless if the engine is or is not equipped with a coolant filter, SCA/DCA additive levels must be checked according to the interval listed in the Owners Manual.

\*Assuming normal duty cycle/based on 30 mph average speed.

\*\*Do not change if SCA above 3

\*\*\*Initial Overhead Adjustment at 1,000 hours



# Value Spec Example – No Funding

1) INITIAL DATA			
<u>*Enter data in the yellow fields*</u>			
<b>Customer Name:</b>	On Highway Truck - United States		
<b>Miles per Year</b>	100,000	<b>Vehicle Average Speed (mph)</b>	30
<b># Years for Calculation</b>	6	<b>Total Hours</b>	20,000
<b>Total Miles for Calculation</b>	600,000	<b>Labor Rate (\$/Hr)</b>	\$90.00
		<b>Comparison Engines</b>	
	<b>Baseline</b>	<b>Engine #1</b>	<b>Engine #2</b>
<b>Labels: Engine Model</b>	ISL G	ISL9	
<b>Fuel Economy</b>			
Fuel Price (\$/Gal) (Diesel or Natural Gas*)	\$2.30	\$3.95	
Engine MPG	5.80	6.50	
<b>Diesel Exhaust Fluid (DEF)</b>			
DEF Cost (\$/Gal)	\$0.00	\$3.00	
DEF Usage	0.00%	2.00%	
<b>Acquisition Costs:</b>			
Quoted Price	\$140,000	\$100,000	
Alternative Fuel Funding	\$0	\$0	
<b>Total Acquisition Costs</b>	<b>\$140,000</b>	<b>\$100,000</b>	<b>\$0</b>
<b>B(W) vs Baseline</b>		<b>\$40,000</b>	<b>\$0</b>

**RESET**

**\*\*This will clear all data in all worksheets\*\***

\* Natural gas fuel cost includes commodity cost, station capital, maintenance, and electricity

4) MAINTENANCE COSTS			
Engine Model	Baseline ISL G	Engine #1 En ISL9	
<b>Oil Change Costs:</b>			
Oil Change Interval (Miles)	15,000	15,000	
Oil Cost (\$/Gal)	\$17.00	\$15.00	
Lube Capacity (Gallons)	7.30	7.30	
Oil Cost per Change	\$124.10	\$109.50	
Oil Filter Cost	\$31.25	\$31.25	
Labor hrs	0.50	0.50	
Oil Change Labor Costs	\$45.00	\$45.00	
Oil Change Costs	\$200.35	\$185.75	
# of Oil Changes	40.0	40.0	
<b>Total Oil Change Costs:</b>	<b>\$8,014</b>	<b>\$7,430</b>	
<b>B(W) vs Baseline</b>		<b>\$584</b>	
<b>Fuel System:</b>			
Fuel Filter Change Interval (Miles)	15,000	15,000	
Fuel Filter Cost	\$37.70	\$37.50	
Labor Hours Required	0.50	0.50	
Fuel Filter Change Labor Costs	\$45.00	\$45.00	
Fuel Filter Cost per Change	\$82.70	\$82.50	
# of Fuel Filter Changes	40.0	40.0	
<b>Total Fuel System Costs</b>	<b>\$3,308</b>	<b>\$3,300</b>	
<b>B(W) vs Baseline</b>		<b>\$8</b>	
<b>Cooling System:</b>			
Coolant Filter Change Interval (Miles)	15,000	15,000	
Coolant Filter Cost	\$16.25	\$16.25	
Labor Hours Required	0.50	0.50	
Coolant Filter Change Labor Costs	\$45.00	\$45.00	
Coolant Cost per Change	\$61.25	\$61.25	
# of Coolant Filter Changes	40.0	40.0	
<b>Total Cooling System Costs</b>	<b>\$2,450</b>	<b>\$2,450</b>	
<b>B(W) vs Baseline</b>		<b>\$0</b>	
<b>Overhead Valve Adjustment</b>			
Valve Adjustment Interval (miles)	60,000	150,000	
Labor Hours Required	2.0	2.0	
Valve Adjustment Labor Cost	\$180.00	\$180.00	
# of Maintenance Sessions	10.0	4.0	
<b>Total Overhead Valve Adjustment</b>	<b>\$1,800</b>	<b>\$720</b>	
<b>B(W) vs Baseline</b>		<b>\$1,080</b>	

Engine Model	Baseline ISL G	Engine #1 En ISL9	
<b>Natural Gas Engine Only</b>			
<b>Spark Plug Change</b>			
Spark Plug Change Interval (Miles)	45,000		
Spark Plug Cost (6 Plugs)	\$330		
Labor Hours	1.5		N/A
Spark Plug Labor Costs	\$135		
Spark Plug Change Cost	\$465		
# of Spark Plug Changes	13.0		
<b>Total Spark Plug Change</b>	<b>\$6,045</b>		<b>\$0</b>
<b>CNG/LNG Fuel System Inspection</b>			
Storage tank visual inspection interval (miles)	100,000		
Labor hours	1.0		N/A
Labor Cost	\$90.00		
# of Inspections	6		
<b>Total Fuel System Inspection</b>	<b>\$540</b>		<b>\$0</b>
<b>Maintenance Costs</b>	<b>\$6,585.00</b>		
<b>Emission Maintenance:</b>			
<b>DPF Cleaning:</b>			
DPF Filter Cleaning Interval	N/A		195,000
Parts Cost			\$250.00
Labor Hours Required			2.00
DPF Filter Cleaning Labor Costs	\$0.00		\$180.00
DPF Filter Cleaning Costs	\$0.00		\$1,290.00
# DPF Filter Cleanings	0.0		3.0
<b>Coalescing Filter Change:</b>			
Coalescing Filter Change Interval	60,000		60,000
Coalescing Filter Cost	\$56.00		\$56.00
Labor Hours Required	0.60		0.60
Coalescing Filter Change Labor Cost	\$54.00		\$54.00
Coalescing Filter Cleaning Costs	\$1,100.00		\$1,100.00
# Coalescing Filter Cleanings	10.0		10.0
<b>DEF Filter Change:</b>			
DEF Filter Change Interval	N/A		195,000
DEF Filter Cost			\$250.00
Labor Hours Required			2.00
Emission Maintenance Labor Costs	\$0.00		\$180.00
Emission Maintenance Costs	\$0.00		\$1,290.00
# of Events	0.0		3.0
<b>Total Emission Maintenance</b>	<b>\$1,100</b>		<b>\$3,680</b>
<b>B(W) vs Baseline</b>			<b>(\$2,580)</b>

Additional NG Scheduled Maintenance Cost  
 ~\$1,135/year  
 \$0.01.1 per mile  
 (Spark Plugs and Overhead Valves)

<b>Total Maintenance Costs</b>	<b>\$23,257</b>	<b>\$17,580</b>	<b>\$0</b>	<b>\$0</b>
<b>B(W) vs Baseline</b>		<b>\$5,677</b>	<b>\$0</b>	<b>\$0</b>

8) SUMMARY		
	Baseline	Engine #1
Engine Model	ISL G	ISL9
<b>Costs</b>		
Initial Costs	\$140,000	\$100,000
Fuel Summary	\$237,931	\$364,615
DEF Summary	\$0	\$5,538
Maintenance Summary	\$23,257	\$17,580
<b>Total Operating Costs for a Single Unit</b>	<b>\$261,188</b>	<b>\$387,734</b>
<b>B(W) vs Baseline</b>		<b>(\$126,546)</b>
<b>Total Operating Cost per Mile</b>	<b>\$0.435</b>	<b>\$0.646</b>
<b>B(W) vs Baseline</b>		<b>(\$0.211)</b>
<b>Savings per year</b>	<b>\$21,090.97</b>	
<b>Natural Gas Vehicle Incremental Cost</b>	<b>\$40,000.00</b>	
<b>Incremental Initial Cost Payout Time (in years)</b>	<b>1.9</b>	
<b>Units</b>	<b>10</b>	<b>10</b>
<b>Total Operating Costs for 10 Units</b>	<b>\$2,611,880</b>	<b>\$3,877,338</b>
<b>B(W) vs Baseline</b>		<b>(\$1,265,458)</b>
<b>Units</b>	<b>50</b>	<b>50</b>
<b>Total Operating Costs for 50 Units</b>	<b>\$13,059,402</b>	<b>\$19,386,692</b>
<b>B(W) vs Baseline</b>		<b>(\$6,327,291)</b>

## Comments

Natural gas (NG) trucks cost more

NG Fuel cost is \$25,337/yr lower

No DEF required on ISL G

ISL G maintenance higher (\$1,135 per year)

Save \$21,090.97 per year, per truck

1.9 year Payback on Incremental Truck cost

# ISL G: The Right Applications

- Medium Duty Market
  - Refuse / Dump / Mixer
  - Transit and School Bus
  - Pickup and Delivery Truck
  - Medium Duty Specialty Vehicles  
(street sweeper, yard spotter, etc...)
- Heavy Duty Market
  - Less Than Truck Load (LTL) applications
  - Regional / Bulk Haul applications



**ISL G**

# ISX12G

## Natural Gas Engine

### ■ Key Product Attributes

- 4 cycle, spark ignited, in-line 6 cylinder, turbocharged, CAC
- Displacement – 11.9 litres (726.2 cu in)
- Peak rating: 400 hp, 1450 lb-ft \*
- EPA/CARB certified at or below EPA10 emission levels
- Dedicated natural gas engine
  - Will operate on CNG or LNG
  - Capable of using up to 100% Biomethane
- Three Way Catalyst after-treatment
- Engine braking
- Manual/Automatic Transmission capable
  - No AMT at launch

### ■ Schedule

- Commercial launch: Early 2013
- Currently in field tests

\* Preliminary Rating Specification – Subject to Change



# ISL G Warranty - Every Coverage

- *Base Warranty for Bus/Shuttle, School Bus and Truck are the same as Cummins ISL9 diesel engines*
- *Extended Coverage options are available for Truck, Transit and School Bus*
  - *5 yr, 200,000 mile or 300,000 mile - Transit*
  - *3 to 7 yr, 100,000 to 300,000 mile - Protection Plan 2 - Truck*
  - *3 to 5 yr, 100,000 to 300,000 mile – Protection Plan 1 –Truck*
  - *5yr to 10 yr, 150,000 to Unlimited miles – School Bus*
  - *6 yr, 300,000 mile Major Component – All applications*
- *All EC warranty programs posted on CIRCUIT*

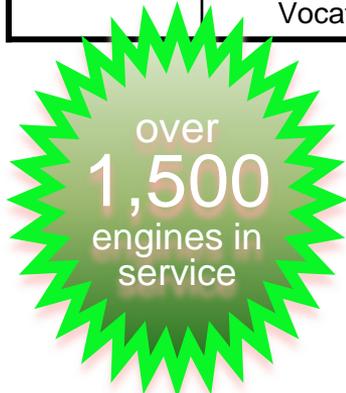


# ISX12 G Warranty

- Base warranty for Cummins Westport natural gas engine is same as Cummins diesel base platform.
  - 2 Years, 250,000 miles (402,336 kilometers)
- Extended Coverage options are yet to be determined, and will be published prior to launch.

# ISL G Availability – Conventional Trucks

OEM	Freightliner	Peterbilt	Kenworth	Volvo	Navistar
					
Model	M2 – 112 SD - 114	320 384 365	T800SH W900S T440 T470	VNM	TranStar
Engine	ISLG 320 ISL G 300	ISL G 320	ISLG 320	ISL G 320	ISL G 320
Application	6x4 Tractor 4x2 Tractor 4x2 Truck 6x2 Truck Vocational	Tractor Vocational Mixer	Tractor Vocational Mixer	Tractor	Tractor



## North America Truck Fleets

Cal Cartage, CA  
Ryder Trucks  
Dillon Transport  
Paper Transport

UPS  
Sysco  
Pepsico  
Coca Cola

Pac 9  
Rush  
Waste Management



# ISL G Availability – COE Trucks

OEM	AutoCar	Mack	Peterbilt	American Lafrance	Crane Carrier
					
Model	Xpeditor	TerraPro LE Terra Pro CO	320	Condor	LET
Fuel	LNG/CNG	LNG/CNG	LNG/CNG	LNG/CNG	LNG/CNG
Engine	ISLG 320	ISLG 320	ISL G 320	ISL G 320	ISLG 320

## North America Refuse Fleets

City of Los Angeles, CA

Republic Service

Specialty Solid Waste

City of New York

Denver, CO

Ogden, Utah

City of Toronto

City of Sacramento, CA

Long Island, NY

Smithtown, NY

Waste Management (USA,  
Canada)

Violia Environmental

Miller Waste, Ontario

EMI, Quebec

BFI / City of Surrey, BC



# ISL G Availability – Transit Buses

OEM	New Flyer	NABI	Orion	EIDorado	Gillig
					
Model	30/35/40 Low Floor	35/40 Low Floor 60 BRT	Orion V HF Orion VII LF	EZ Rider II	30/35/40 Low Floor
Fuel	CNG	CNG	CNG	LNG/CNG	CNG
Engine	ISLG 280	ISLG 280 ISL G 320	ISL G 280	ISLG 280	ISLG 280

## Top North American CNG Transit Fleets



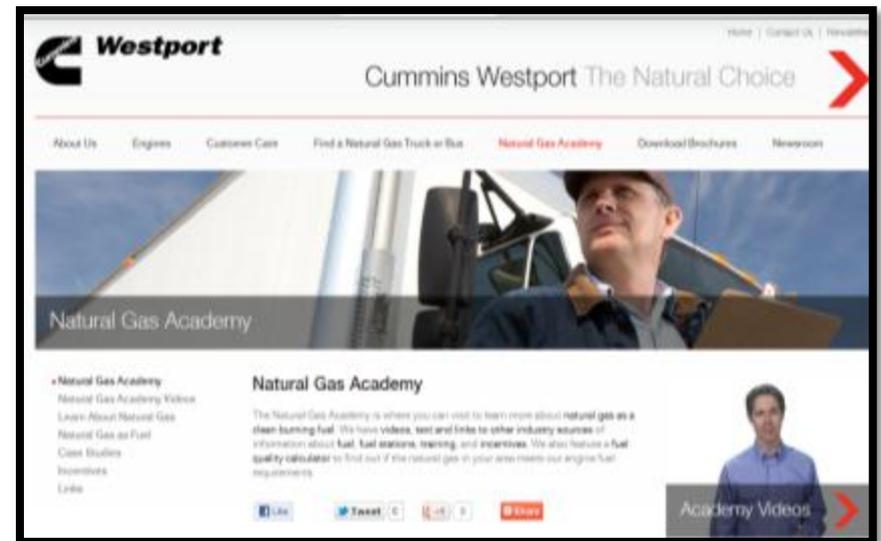
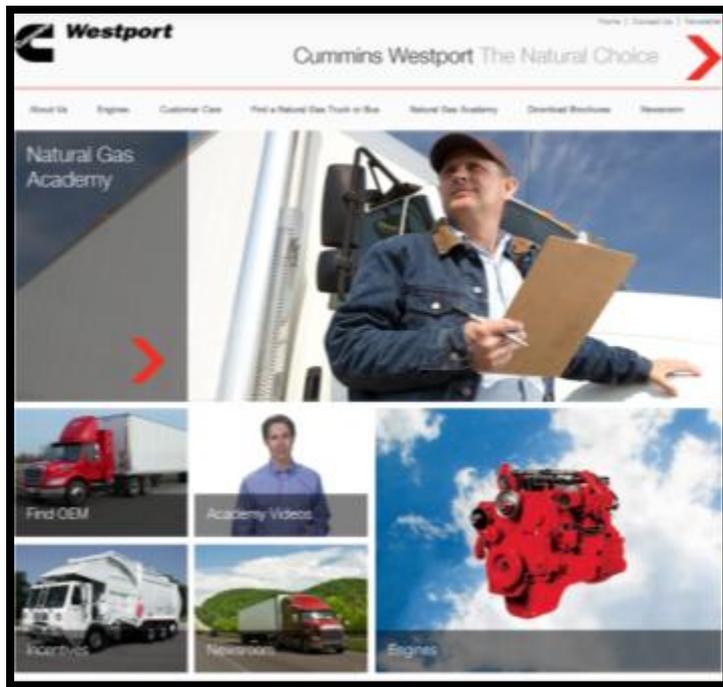
LAMTA, Los Angeles, CA  
Boston, MA  
TransLink, Vancouver, Canada  
Foothills Transit, CA  
Fort Worth, TX  
Tacoma, WA

OCTA, Orange County, CA  
Washington DC  
NY / Long Island Transit, NY  
RTC Transit, Las Vegas, NV  
Santa Clara, CA  
St. Louis, MO

Big Blue Bus, Santa Monica, CA  
Dallas, TX  
San Diego Transit, CA  
HSR, Hamilton, Canada



# www.cumminswestport.com



- New Website launched May 1, 2012
- Great source of information about natural gas engines and vehicles.
- Features the *Natural Gas Academy*, a series of instructional videos
  - Designed to provide a general overview of natural gas as a fuel whether it is compressed (CNG) or liquefied (LNG), and how it is used with vehicles.



# Thank You

