Clean Cities
CWI Product Update

Jerry Johnson
CWI Western Regional Manager
May 18, 2017
Cummins Westport Inc. (CWI)

- Cummins Westport is a joint venture company established in 2001
  - 50% - Cummins Inc. - world’s largest builder of commercial diesels,
  - 50% - Westport Innovations Inc. - world leader in gaseous fuel engine technology
- CWI offers 6 to 12 litre alternative fuel automotive engines. (CNG, LNG, RNG)
- Engines are manufactured by Cummins.
- Parts, service and training support through the Cummins Distributor network.
- Over 60,000 engines delivered worldwide
Continued Emission Leading Performance

C Gas Plus

First engine 2004 EPA Certified
1.8 g/bhp-hr. NOx
Lean Burn Combustion

ISL G

First HD engine certified 2010 EPA/ARB
0.2 g/bhp-hr. NOx
SEGR Combustion

ISX12 G

HD Truck engine certified EPA/ARB
0.15 g/bhp-hr. NOx
SEGR Combustion

ISB6.7 G

Mid range engine certified EPA/ARB
0.1 g/bhp-hr. NOx
SEGR Combustion

First engine Certified Near Zero ARB
0.02 g/bhp NOx
SEGR Combustion

Particulate Matter (PM)

All CWI engines have met the 2010 EPA/ARB Particulate Matter (PM) standard (0.01 g/bhp-hr.) with a catalyst since 2001
Natural gas use in vehicles has grown and evolved over the past decade.
Cummins Westport Natural Gas Engines
70,000 engines delivered worldwide

**ISB6.7G**
6.7 Litre
Spark Ignited
SEGR
Three Way Catalyst
33,000 lb. GVW
School bus/MD Truck/Shuttle bus/Sweeper/yard spotter

**ISL G**
8.9 Litre
Spark Ignited
SEGR
Three Way Catalyst
66,000 lb. GVW
Refuse/Transit/Regional P&D Truck/Mixers

**ISX12 G**
11.9 Litre
Spark Ignited
SEGR
Three Way Catalyst
Up to 80,000 lb. GVW
Regional Haul Truck/Tractor/Refuse
Introduction: CWI 2018 NA Products
Move to Zero
Cummins Westport
Next Generation Natural Gas Engines

ISX12N  L9N  B6.7N

CNG  LNG  RNG

Westport
What is regulated Near Zero (NZ) NOx?

California definitions for various vehicle emissions levels / technology

LOW NOx
ARB defines three optional Low NOx standards to certify to:
- 0.1 g/bhp-hr
- 0.05 g/bhp-hr
- 0.02 g/bhp-hr

NEAR ZERO EMISSIONS
- 0.02 g/ bhp-hr NOx (90% reduction from current EPA standard of 0.2 g/bhp-hr)

ZERO EMISSIONS
No tailpipe emissions, regardless of how low. (NOx, PM, GHG etc)

CEC* has defined this certified Near Zero emission level as equivalent to a 100% battery truck using electricity from a modern combined cycle natural gas power plant.

*California Energy Commission
The Move to Zero with Natural Gas

- CWI natural gas engine technology is here today to lower regulated NOx and CO2 emissions levels by up to 90%
- Natural gas is a low carbon fuel, and renewable natural gas is the lowest carbon fuel – even to sub zero levels
- Combining Ultra Low NOx engine technology with RNG is a Move to Zero emissions strategy available for many applications today.
- Move to Zero with natural gas is a lower cost emission reduction pathway for transit, truck and refuse fleets.
CWI Ultra Low NOx Internal Combustion Engines

EPA Emission Standards

<table>
<thead>
<tr>
<th>Year</th>
<th>NOx (g/bhp-hr)</th>
<th>PM (g/bhp-hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>5.0</td>
<td>0.12</td>
</tr>
<tr>
<td>1998</td>
<td>4.0</td>
<td>0.10</td>
</tr>
<tr>
<td>2002</td>
<td>2.0</td>
<td>0.08</td>
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<tr>
<td>2007</td>
<td>1.0</td>
<td>0.06</td>
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</tbody>
</table>

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### Emissions Reduction Impact - NOx

<table>
<thead>
<tr>
<th>Year</th>
<th>NOx (g/hp-hr)</th>
<th>PM (g/hp-hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>10.8</td>
<td>0.59</td>
</tr>
<tr>
<td>1990</td>
<td>6</td>
<td>0.59</td>
</tr>
<tr>
<td>1991</td>
<td>5</td>
<td>0.25</td>
</tr>
<tr>
<td>2000</td>
<td>4</td>
<td>0.05</td>
</tr>
<tr>
<td>2010</td>
<td>0.2</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Cummins Westport Inc. December 2015
Introducing CWI 2018 North American Products

- New Product Names
- EPA/ARB Ultra Low emissions certification
- Lowest Emission MR and HD engines in North America
- On-Board Diagnostics (OBD) applied for optimal emissions system performance
New Engine Names

- The change in product names began in 2017 and is designed to create stronger consistency across the Cummins global product line.
- The new global engine names roll out with all new platforms and significant product or emission changes.
- EPA and California ARB Regulations require all natural gas engines to be OBD compliant for model year 2018, plus all engines certified at Near Zero NOx = significant product and emissions change for all CWI engines.
Key Product Attributes

- 4 cycle, spark ignited, in-line 6 cylinder, turbocharged, CAC
- Displacement – 11.9 litres (726.2 cu in)
- *Certified to CARB Optional Low NOx 0.02g Standard
- Exceeds 2017 EPA GHG requirements
- *2018 On-board Diagnostic (OBD) compliant
- Dedicated 100% natural gas engine
- Engine braking
- Manual/Automatic/AMT Transmissions
- Maintenance free Three Way Catalyst Aftertreatment
- Over 8,500 in service (+700 in Refuse applications)

* Indicates new product attribute for MY2018
– Changes for 2018

- Near Zero Emissions: 0.02 g/bhp-hr NOx emissions level
- 2018 HD OBD for optimal emissions performance
- Improved engine reliability & durability with new fuel system

### Engine Changes

<table>
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<tbody>
<tr>
<td>New fuel system</td>
</tr>
<tr>
<td>On-engine electric CCV filter with 2 CCP sensors</td>
</tr>
<tr>
<td>CM2380 ECM</td>
</tr>
<tr>
<td>500 kbaud datalink</td>
</tr>
<tr>
<td>New wiring harness</td>
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<tr>
<td>New ICM (common with 2018 ISL G)</td>
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### Aftertreatment Changes

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<td>One-piece TWC</td>
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<tr>
<td>Mid-bed O2 sensor</td>
</tr>
<tr>
<td>OEM harnessing</td>
</tr>
<tr>
<td>Size increase for Near Zero</td>
</tr>
</tbody>
</table>
Key Product Attributes

- 4 cycle, spark ignited, in-line 6 cylinder, turbocharged, CAC
- Displacement - 8.9 Litre (540 cu. In.)
- Certified to CARB Optional Low NOx 0.02g Standard (ISL G NZ introduced in 2016)
- Exceeds 2017 EPA GHG requirements
- *2018 On-board Diagnostic (OBD) compliant
- Dedicated 100% natural gas engine
- Peak rating: 320 hp, 1000 lb-ft
- Maintenance free Three Way Catalyst aftertreatment
- Up to 66,000 lb GVW

*Indicates new product attribute for MY2018
Changes for 2018

- 2018 HD OBD for optimal emissions performance
- ISL G NZ (0.02g NOx) introduced in 2016
  - Added CCV and other changes
  - ISL G (0.2g NOx) not available post 2017

### Engine Changes
- Additional crankcase pressure sensor
- CM2380 ECM
- 500 kbaud datalink
- New wiring harness
- New Ignition Control Module

### Aftertreatment Changes
- TWC size similar to 2016 ISL G NZ
- One-piece TWC
- Mid-bed O2 sensor
- OEM harnessing
Key Product Attributes

- 4 cycle, spark ignited, in-line 6 cylinder, turbocharged, CAC
- Displacement – 6.7 litres (408.9 cu in)
- Certified to CARB Optional Low NOx 0.1g Standard
- Exceeds 2017 EPA GHG requirements
- *2018 On-board Diagnostic (OBD) compliant
- Dedicated 100% natural gas engine
- Peak rating: 240 hp, 560 lb-ft
- Maintenance free Three Way Catalyst aftertreatment
- Automatic Transmissions
- Base warranty will be same as ISB6.7 diesel

*Indicates new product attribute for MY2018
B6.7N – Changes for 2018

- 2018 HD OBD for optimal emissions performance
- ISB6.7 G (0.1g NOx) introduced in 2016

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Cummins Westport product plans

<table>
<thead>
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<th>Engine</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
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<tbody>
<tr>
<td>ISB6.7G</td>
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<tr>
<td>ISB6.7G Near Zero</td>
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<td>ISL G</td>
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<td>ISL G Near Zero</td>
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<td>ISX12G Near Zero</td>
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* ISB6.7 G was certified at launch to California ARB optional low NOx standard of 0.1 gram/bhp-hr.

“Near Zero” – A engine certified to ARB’s lowest optional low NOx standard of 0.02 gram/bhp.hr. An emission level ARB defines as ‘equivalent to a 100% battery truck using electricity from a modern combined cycle natural gas power plant’
- Natural Gas Academy: great source of information about NG, technology, vehicles
- Series of instructional videos, including engine walk-around videos and service & driver training videos
- Engine information – specs, features, maintenance intervals
- Product Brochures & Bulletins available for download