We Have A History Of Building The Future.
Legendary Performance
Dependable Partner
Loyal Customers

Vision, 1919-1944
Innovation, 1945-1952
Scale, 1953-1974
Durability, 1975-2005
Environment, 2006-2015
Agenda

1. Aftertreatment Review & Troubleshooting
2. Redefining the Future – Single Module
3. Diagnostic Tools
4. Expert Diagnostics System
5. Connected Diagnostics
6. Protecting Your Investment
7. Oil Drain Intervals – CK-4
Clean Air – Is Better Air
Cleaning Your Air - Emission Regulations

- 1988 Ignition Timing – Step Timing Control
- 1991 Full Authority Electronic Controls
- 1994 Re-entrant Piston Combustion Bowl
- 2002 Exhaust Gas Recirculation (EGR)
- 2007 Exhaust Aftertreatment
- 2010 Selective Catalytic Reduction
- 2013 OBD On-board Emission Diagnostics
- 2017-2027 Phase 2 CO₂ – Reduce Fuel Consumption
Clean Power Leader

60 = 1988

2017
I heard SCR is going away?

The Right Technology Matters

Cummins Aftertreatment System

Diesel Oxidation Catalyst
Wall-Flow Filter
Cummins Particulate Filter

Diesel Exhaust Fluid (DEF) Dosing Valve
Decomposition Reactor

Sprays a fine mist of DEF into hot exhaust stream

SCR Catalyst
Slip Catalyst
Selective Catalytic Reduction (SCR) Catalyst
Cummins On-Highway Product Plan

- SCR is the foundation for the future
  - Reduces NOx to near-zero levels required
  - Enables greater fuel efficiency
  - Allows for Simple engine design
  - Easy Engine access for servicing
  - Cost Effective.

- No major engine changes, or hardware additions, to meet future EPA Greenhouse Gas Standards; it’s all about reducing fuel consumption.
OEM vs. Engine Components

Mounting Bracket
- Red: Cummins Supplied
- Blue: OEM Supplied

Diagram showing various engine components and their supply sources.
OEM DEF Tank, Supply Lines, Wiring Harnesses, Exhaust Piping & Mounting
DEF System Inspections

- Visually inspect SCR Aftertreatment DEF Supply lines and Connections for signs of leakage (look for white powder residue build-up).
- Visually inspect SCR aftertreatment wiring harnesses and Connectors for signs of chaffing and damaged Connectors.
- For best practice, fill the Diesel Exhaust Fluid (DEF) tank before it gets below 25% of full.
OEM DEF Tank and Supply Lines

- F/C 3574  F/C 3596
- Erratic, Low, DEF Fluid Pressure
- DEF Pump Filter Replace
- DEF Tank Filter Inspect/Replace
- Blockage in the Lines or Fittings
- Debris in the Tank
- Debris in the Sending Unit
- Sucking Air
  - Hole in DEF tank pick-up tube
  - Air Suction from the Sending Unit
  - Air Suction at Quick Connect Fitting
  - Air Suction at Lines
- Run Regen monitoring pump pressure & speed
- Isolate DEF Tank & Supply Lines
Diesel Exhaust Fluid (DEF) Properties

- DEF is a non-toxic, non-polluting, and a non-flammable substance.

- May have slightly pungent odor similar to ammonia.

- Does DEF Freeze?
  - DEF freezes at 11 degrees F.
  - SCR system is designed to provide heating for the DEF tank and supply lines.
  - If DEF freezes, it can be thawed and used.
  - DEF is not damaged or destroyed because it is frozen.
  - System has timed delay while small amount of DEF is thawed for use.
DEF Additives – NO. NO. NO.

- DO NOT be adding anything to the DEF Tank – but DEF!
- No Anti-Freeze Agents
- No HEET
- No Diesel Fuel
- NOTHING but DEF
# Low DEF Warning & Inducement

<table>
<thead>
<tr>
<th>DEF (Urea) Tank Level</th>
<th>Notification*</th>
<th>Inducement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lamp - or - Message</td>
<td></td>
</tr>
<tr>
<td>&gt;10% full</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Stage 1</td>
<td>DEF lamp solid</td>
<td>Warning message</td>
</tr>
<tr>
<td>&lt;10% full</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Stage 2</td>
<td>DEF lamp flashing</td>
<td>Increasing message duration and/or frequency</td>
</tr>
<tr>
<td>&lt;5% full</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Stage 3</td>
<td>DEF lamp flashing, Amber warning lamp solid</td>
<td>Inducement message</td>
</tr>
<tr>
<td>&lt;2.5% full</td>
<td>None</td>
<td>Maintenance derate (25% torque derate)</td>
</tr>
<tr>
<td>Stage 4</td>
<td>DEF lamp flashing, Red lamp solid</td>
<td>-Idle 1-HR -Shut-off Engine -Fill Fuel Tank w/o refilling DEF Tank -Operate for 24-HR</td>
</tr>
<tr>
<td>Empty, after the engine has been shut down</td>
<td>None</td>
<td>Maintenance derate (40% torque derate) Vehicle speed limited to 5 mph</td>
</tr>
</tbody>
</table>
Cummins Emission Solutions has developed an ultra high efficiency aftertreatment system that takes up less space, is easier to install, and simpler to maintain.

This is the ‘Differentiator’
Single Module Aftertreatment Architecture

- Only TRUE Single Module
- Five sizes to cover engine platforms B6.7 through X15
- Flexible system
  - Inlets and outlets from end or the side
  - Orientation of inlet and sensor table positions
Simple & Optimized DEF Dosing for 2017

- The UL2 system does not require engine coolant lines to and from the diesel exhaust fluid (DEF) injector, reducing installation complexity.
- The system provides a more efficient atomization and minimizes deposit formation.
- This results in fewer regeneration events while optimizing the use of DEF throughout the system.

<table>
<thead>
<tr>
<th>Components Supplied by Cummins</th>
<th>Components Supplied by OEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEF Dosing Valve</td>
<td>DEF Tank</td>
</tr>
<tr>
<td>DEF Dosing Unit</td>
<td>DEF Tank Heater</td>
</tr>
<tr>
<td></td>
<td>DEF Tank Level Sensor</td>
</tr>
<tr>
<td></td>
<td>DEF Tank Temperature Sensor</td>
</tr>
<tr>
<td></td>
<td>DEF Tank Quality Sensor</td>
</tr>
<tr>
<td></td>
<td>DEF Tank Vent</td>
</tr>
<tr>
<td></td>
<td>DEF Tank Fill Connection</td>
</tr>
<tr>
<td></td>
<td>DEF Tank Filter</td>
</tr>
<tr>
<td></td>
<td>DEF Tank Drain</td>
</tr>
<tr>
<td></td>
<td>Heated DEF Suction Line</td>
</tr>
<tr>
<td></td>
<td>Heated DEF Return Line</td>
</tr>
<tr>
<td></td>
<td>Heated DEF Pressure Line</td>
</tr>
<tr>
<td></td>
<td>DEF Heater Control Relay (DEF Lines)</td>
</tr>
<tr>
<td></td>
<td>Coolant Flow Valve</td>
</tr>
<tr>
<td></td>
<td>DEF Tank Heater Coolant Lines</td>
</tr>
<tr>
<td></td>
<td>Coolant Supply Line Tee</td>
</tr>
<tr>
<td></td>
<td>Wiring Harness</td>
</tr>
</tbody>
</table>
2017 Heavy-duty Single Module Aftertreatment

- Customer voice-driven design
- MidRange System features:
  - Up to 60% reduction in size
  - Up to 40% reduction in weight
- Enhanced thermal efficiency
Aftertreatment Problems

Aftertreatment problems, i.e. DOC face plugging, have progressed from upstream exhaust or engine problems:

1.) Leaky Exhaust Connections
   - can’t maintain heat in system for passive regeneration
   - can’t build the heat with dosing during active regeneration
   - Inspect OEM Piping, Flexpipe, Connection Clamps, Mounting Brackets
Aftertreatment Problems

Aftertreatment problems, i.e. DOC face plugging, have progressed from upstream exhaust or engine problems:

1.) Leaky Exhaust Connections
   - can’t maintain heat in system for passive regeneration
   - can’t build the heat with dosing during active regeneration
2.) Plugged or faulty Dosing Injector (HD engines)
3.) Operating Engine with Active Fault Codes
4.) BLACK SMOKE
   - Whatever causes excess black smoke, the aftertreatment cannot keep up with it, resulting in a plugged DPF.
   - Dirty air cleaner, Cracked Charged-Air-Cooler, Intake Leaks
   - Worn/Defective Turbocharger, EGR Valve, Fuel Injectors
   - Test by disconnecting exhaust behind turbo and perform snap-rail test for excess black smoke
5.) Worn DOC from Excess Regens (resulting from idling)
6.) Excess Idle Time – SHUT IT OFF!
DPF Cleaning

ISB, ISC, ISL, PX7, PX9 Mid-range

Maintenance Procedures at 321,500 Kilometers [200,000 Miles], 6,500 Hours (Section 10)

- Aftertreatment Diesel Particulate Filter - Clean
- Aftertreatment Diesel Exhaust Fluid Dosing Unit Filter - Change

ISX, ISM Heavy-duty

Maintenance Procedures at 320,000 Kilometers [200,000 Miles] or 4500 Hours (4) (Section 8)

- Aftertreatment Diesel Particulate Filter – replace or clean
Diesel Particulate Filter Cleaning

- Inspect EXHAUST CONNECTIONS between turbocharger and Aftertreatment assembly (muffler) for LEAKS EVERY CHANCE.

- Proactively clean DPF’s at:
  - Vocational; Urban; Light-duty; Short-haul; High Idle: 3,000 hours
  - Requires “Maintenance Reset” in ECM using Insite Software
    ALWAYS use new exhaust gaskets in DPF and exhaust connections
  - Remove old gasket materials completely from connections
  - Inspect Aftertreatment Inlet for Oil, Coolant, Fuel Contamination
  - Apply High-Temp rated Anti-seize to innerside of v-bands and all bolts
ReCon DPF Exchange Program

- During normal operation, ash builds up in the Diesel Particulate Filter, eventually the DPF needs to be cleaned or replaced.

- Faster than Cleaning
  - Simply remove the DPF and install the Cummins ReCon DPF
  - No need for DPF regeneration after installation

- Dependable
  - Cummins four-step remanufacturing process restores the DPF to original condition

- Better Value
  - 1 year, unlimited mileage warranty
  - Cummins gives full credit for undamaged cores

- Available for 2010 & 2013 ISX15, ISL engines; Releasing ISB ReCon

- ‘New’ High Efficiency for 2007 ISX
Aftertreatment Diesel Exhaust Fluid Dosing Pump Unit & Filter

DEF Filter Cartridge
Under cap
NOTE: Lubrication of the DEF filter o-rings is not required.

1. Slide the DEF filter equalizing element into the DEF filter cartridge.
2. Insert the assembly into the aftertreatment DEF dosing unit.
3. Install and tighten the cap.

Torque Value: 20 n.m [177 in-lb]
Diagnostic Tools
Fix-it-right – The First Time
InLine 7 DataLink

- Universally Compatible with Engines & Components
- Only WI-FI & Bluetooth
- Industrial Strength
- $1,135 Fleet
- Kit Part #5299899
- 1-Year Warranty
GUIDANZ

- SmartPhone/Tablet Mobile App
- BlueTooth using InLine-Mini or InLine 7
- InLine Mini, #5299909, $312.16
- Fault Code Analysis
- Immediate Assessment
- Integrate and Streamline Repair
- Easy to use!
- It’s FREE!
Insite.Cummins.Com

- Computer Based Diagnostics Software
- Requires In-Line DataLink Translator
- Sold on Annual Subscription, $550/YR
- Required for ‘Tests’
- Required for ‘Reset’ Aftertreatment & Doser
- Required to perform ‘forced’ regeneration
- www.insite.cummins.com
DO NOT USE INSITE FOR TROUBLESHOOTING STEPS! USE EDS.

Cummins Expert Diagnostic System
Insite Functionality

- Viewing Fault Codes
- Run Diagnostic Tests
- ‘Reset’ Aftertreatment Maintenance
- Engine Data Monitor/Logger
- Change/Adjust Engine Feature & Parameters
- Read/Reset Engine Faults & Trip Information

**NOT TO BE USED FOR DIAGNOSTIC FAULT TREES**

Use *QuickServe OnLine* for Diagnostic Fault Trees
- Annual Subscription $50/month (billed $600 annually)
- Identify Engine Campaigns and Temporary Repair Practices
PowerSpec

- Engine Interface Software
- Computer Based Read/Reset Tool
- Requires In-Line DataLink Translator
- Read/Reset Fault Codes
- Read/Reset Trip Information
- Adjust Electronic Feature Parameter Settings
- Downloadable Free www.powerspec.cummins.com
Insite.Cummins.Com

DO NOT USE INSITE FOR TROUBLESHOOTING STEPS! USE EDS.

Cummins Expert Diagnostic System
Troubleshooting the highest likely cause FIRST.

CVC COURSE #1122
# Fault Code Analyzer

Service Information (ISB6.7 CM2350 B101)

## Engine Fault Code Analyzer

Enter all active fault codes. Also enter all inactive fault codes with more than one count logged in the last 25 engine hours.

<table>
<thead>
<tr>
<th>FAULT CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove 1</td>
<td>4769 Aftertreatment Diesel Exhaust Fluid Tank Level Sensor - Abnormal Rate of Change</td>
</tr>
<tr>
<td>Remove 2</td>
<td>4261 Aftertreatment Selective Catalytic Reduction Temperature Sensor Module - Root Cause Not Known</td>
</tr>
<tr>
<td>Remove 3</td>
<td>3232 Aftertreatment 1 Intake NOx Sensor - Abnormal Update Rate</td>
</tr>
<tr>
<td>Remove 4</td>
<td>2556 Engine Intake Air Heater 1 Circuit - Voltage Below Normal or Shorted to Low Source</td>
</tr>
<tr>
<td>Remove 5</td>
<td>2555 Engine Intake Air Heater 1 Circuit - Voltage Above Normal or Shorted to High Source</td>
</tr>
<tr>
<td>Remove 6</td>
<td>559 Injector Metering Rail 1 Pressure - Data Valid But Below Normal Operating Range - Moderately Severe Level</td>
</tr>
<tr>
<td>Remove 7</td>
<td>2638 Aftertreatment Diesel Oxidation Catalyst Conversion Efficiency - Data Valid But Below Normal Operating Range - Least Severe Level</td>
</tr>
<tr>
<td>Remove 8</td>
<td></td>
</tr>
<tr>
<td>Remove 9</td>
<td></td>
</tr>
<tr>
<td>Remove 10</td>
<td></td>
</tr>
</tbody>
</table>

[Add More Fault Codes] [Analyze]
Fault Code Analyzer

Service Information (ISB6.7 CM2350 B101)

Enter all active fault codes. Also enter all inactive fault codes with more than one count logged in the last 25 engine hours.

<table>
<thead>
<tr>
<th>ORDER</th>
<th>PRIMARY FAULT CODES</th>
<th>RELATED FAULT CODES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2556</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3232</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4769</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4261</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>559</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2638</td>
<td></td>
</tr>
</tbody>
</table>

If any additional fault codes are still active after validating the first three primary fault codes, then re-enter the remaining fault codes.
Cummins Virtual College ProMotion Training

- Computer Based
- Access Thru QSOL
- Self-studies by Course or Engine Model
- Assessment Testing Available
- Same training used by Cummins Dealers & Dist.
- Start with EDS #1122
<table>
<thead>
<tr>
<th>Course ID</th>
<th>Course Name</th>
<th>Course Time</th>
<th>Delivery Method</th>
<th>Color</th>
<th>Passed?</th>
<th>Date Passed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1122</td>
<td>EDS Technician Training</td>
<td>0.7 hours</td>
<td>Online</td>
<td>Green</td>
<td>Yes</td>
<td>04/01/2013</td>
</tr>
<tr>
<td>1121</td>
<td>EDS Introduction</td>
<td>0.3 hours</td>
<td>Online</td>
<td>Green</td>
<td>Yes</td>
<td>04/01/2013</td>
</tr>
<tr>
<td>1181</td>
<td>Expert Diagnostics System (EDS) Hands-On Assessment Course</td>
<td>0.0 hours</td>
<td>Instructor-led</td>
<td>Red</td>
<td>No</td>
<td>07/11/2012</td>
</tr>
<tr>
<td>1352</td>
<td>EDS 2015 New Features Update 1</td>
<td>0.2 hours</td>
<td>Online</td>
<td>Red</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>1360</td>
<td>EDS 2015 New Features Update 2</td>
<td>0.1 hours</td>
<td>Online</td>
<td>Red</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

Showing 1 to 5 of 5 entries (filtered from 456 total entries)
Welcome to ProMotion - Jeff Gerdin (A340152) - Cummins Sales and Service - Milwaukee (04896)

<table>
<thead>
<tr>
<th>Program ID</th>
<th>Color</th>
<th>Program Name</th>
<th>Completed Date</th>
<th>Expiration Date</th>
<th>% Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003-23Q+</td>
<td>Red</td>
<td>ISC8.3 CM554, ISC8.3 CM850, ISL8.9 CM554, ISL8.9 CM850 Qualification</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>2003-15Q+</td>
<td>Red</td>
<td>ISC CM554, ISC CM850, ISL CM554, ISL CM850, ISB CM554, ISB CM850 NOW LEO</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>2006-29Q+</td>
<td>Red</td>
<td>ISC/ISL CM2150 Qualification</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>2007-28Q+</td>
<td>Red</td>
<td>ISL G CM2180 Qualification</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>2009-31Q+</td>
<td>Red</td>
<td>ISC8.3 &amp; ISL9 CM2250 Qualification (EPA 2010)</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>2010-31Q+</td>
<td>Red</td>
<td>ISL G CM2180 NOW LEO</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>2010-32Q+</td>
<td>Red</td>
<td>ISC CM2150, ISL CM2130, ISB CM2130 NOW LEO</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>2013-25Q+</td>
<td>Red</td>
<td>ISL9 CM2350 L101 Qualification (EPA 2013)</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>2015-37Q+</td>
<td>Red</td>
<td>ISC8.3 CM2250, ISL9 CM2250, ISB6.7 CM2250 NOW LEO</td>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>
How do I get signed up?

Contact Cummins NPower
Customer Assistance Center
At 1866-831-7620 > #3
For Insite, QSOL, PowerSpec, and all Software Support.

Request a ProMotion Training ID.
Shelly Johnson, Software Administrator
The Lifeline For Your Engine.

Over 200,000 trucks Connected!
Connected Diagnostics

- Previously, the operator relied on lamps and gauges to make operating decisions during an engine system fault.
- Now, Connected Diagnostics provides immediate, expert recommendations in response to urgent faults.

Uptime

Telematics Provider

Fault Code Generated

Fault Code Data Analysis

Urgent Action notification sent

Customer Notified

Process complete in seconds…
Customer Notification – Email Example

---

**Connected Diagnostics**
Notification ID: GS123456789012

Dear Customer,

This is in regard to a recent fault generated on your equipment:

- **Vehicle ID**: 12345
- **Engine Serial Number**: 12345678
- **VIN**: 1A2BCDEFG12345678
- **Engine Model**: ISX15-CF230

**Recommended Action:**
Ensure equipment is in a safe location and shut down your engine. Contact a Cummins certified repair location for immediate repair assistance.

**Fault Code (FC) Information:**

<table>
<thead>
<tr>
<th>Primary FC</th>
<th>SPN</th>
<th>FMI</th>
<th>Timestamp</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>175</td>
<td>3464</td>
<td>3</td>
<td>2014-01-01 22:33:10 UTC/GMT</td>
<td>(Air Handling) Electronic Throttle Control Actuator Driver Circuit - Voltage Above Normal or Shorted to High Source</td>
</tr>
</tbody>
</table>

The following active fault codes may be related to the new primary fault code 175. Recommended action, suggested root cause, and derate information are based on the primary fault code.

<table>
<thead>
<tr>
<th>Related FC</th>
<th>SPN</th>
<th>FMI</th>
<th>Timestamp</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>177</td>
<td>3464</td>
<td>7</td>
<td>2014-01-01 13:41:45 UTC/GMT</td>
<td>(Air Handling) Electronic Throttle Control Actuator - Mechanical System Not Responding or Out of Adjustment</td>
</tr>
</tbody>
</table>

**Suggested Root Causes:**

- **Component or System**: Intake Throttle Actuator
- **Probability**: 95%

This fault code indicates that your engine has entered a situation where performance on road speed will be limited, and you may experience the following:

- 25% torque derate in 8 operating hours

**Equipment and Service Locations:**
Click to see map of nearby Cummins certified service locations.

At the time of service, a Cummins certified service technician will perform standard diagnostics to determine a more detailed root cause and the repairs required.

If you require further assistance, please contact Cummins Care at 1-800-DIESELS (1-800-243-7587) and we will be happy to assist you.

Thank you for being a Cummins customer.

Cummins Care
Connected Diagnostics
cumminsrepairs.com
Benefits of Connected Diagnostics

- Instant Notification
  - Proactive vs. Reactive
  - Allows for alternative optional planning – ‘Plan B’
  - Details on the fault code sent to fleet management allows faults to be addressed before mission is impacted
  - Cummins provides recommendation based upon the primary fault code and probable root cause

- Saves time - Saves money
  - Reduces Tow Charges

- Reduces Late Deliveries and Late Pick-ups

- No Fee Charged from Cummins
Let’s Get Started

- **Geotab**
  - GO7 Device features an integrated cellular antenna and GPS
  - Customer installed “Plug and play” connection to an in-cab 9-pin connector
  - Great for currently unconnected customers
Connected Diagnostics Mobile App

- Brings Connected Diagnostics™ information to the field
  - Full functionality – more than an email
  - Complete information
  - Instant notification
  - Expert recommendations
- Scaled for phones today with tablet version coming soon
- Displays in portrait and landscape
Extended Coverages

- **Fixes Your cost-of-operation** – Customer has peace-of-mind knowing unexpected costly repairs are covered.
- **Repairs follows prescribed troubleshooting** and SRT labor hours - results in less downtime = **UPTIME**!
- **Nationwide Support at 3,500 Authorized Cummins Dealers.**
- Helps plan and maintain Service Department budgets.
- Easy to understand coverages with customized terms based on application and mileage.
- Includes Fuel Pump, Turbo, Injectors, Water Pump, Engine Sensors & HARNESSES, Air Compressor, ECM, EGR Valve, EGR Cooler, and Internally lubricated components.
- **Adds Resale Value in Secondary Market.**
- Extended Warranties **Preserve Relationships.**
Realizing Our Vision

As **One Cummins network** we can deliver **seamless, consistent and excellent** customer support.

To get there we need to:
- Be a **growth business**
- Support all customers
- Be a **Great Place to Work**
Cummins Authorized Service Locations

3500 Cummins authorized service locations
Incorporated in 1919 by Clessie Cummins and W.G. Irwin
Pioneered the development of diesel engines
Promoted diesels as a reliable source of power
Earned its first profit in 1937
A Common Engine Across Truck Market
One Solution for an Entire Fleet
One Platform for Efficiency or Performance
One Vast Support Network  (The Largest in N.A.)
One One-Stop-Shop for Engine Subsystems
One ‘Power-of-Choice’
One 800-CUMMINS Dealer Locator
One Phone Call Away….
What is Engine Oil?

- Engine oil is made up of 2 main components
  - Base Stock (70-80%)
    - Petroleum based or fully synthesized
      - Group I, II and III are all petroleum based
        (Marketing $\rightarrow$ III = “synthetic”)
      - Group IV and V are fully synthesized
  - Additive Package (20-30%)
    - Chemical compounds that improve the lubricant performance of base stock
What is the Function of Engine Oil?

- Separate moving parts
- Absorb heat
- Prevent corrosion
- Control combustion byproducts
- Clean and remove sludge/soot
What is Engine Oil Viscosity?

- Engine oil is referred to by its viscosity or “weight”
  - Viscosity is a measure of the fluid’s resistance to flow and shear
    - Low viscosity example: water
    - High viscosity example: maple syrup

- Viscosity can be measured in two different ways
  - Kinematic viscosity: a measure of the fluid’s resistance to flow and shear under the forces of gravity
  - Dynamic viscosity: a measure of the fluid’s resistance to flow in the narrow confines between fast moving parts
How Does Engine Oil Degrade?

- Combination of factors → Primary factor is combustion

- HOT Temperatures = Combustion Flame
  - Hot temperatures, combined with Oxygen degrade all components of the oil in a process called Oxidation
    - Base stock → changes the chemical and physical properties
    - Additives → Anti-oxidants are designed to absorb oxygen, others lose function

- Acidic/corrosive gases = NOx & Sulfur (fuel and oil)
  - Acidic/corrosive gases can attack soft metal parts

- Incomplete Combustion = Soot
Why a New Proposed Category (PC-11) for Oils?

Current CJ-4 oils were defined in PC-10. However, a new oil category was created due to several new requirements:

- 2017 EPA Greenhouse Gas (GHG) standards drove lower CO₂ emissions resulting in an increase in fuel economy. This can be accomplished by reducing friction with lower viscosity oils.
- The EMA (Engine Manufacturers Association) requested improved oil oxidation resistance due to:
  - Engines running hotter and higher pressures causing quicker oxidation of current oils.
  - Oil oxidation can lead to shorter oil drain intervals.
- Off-highway markets needed a backward compatible oil for high horsepower type applications.
Oil Analysis Tools

Although multiple oil parameters should be considered when making critical oil decisions, oxidation is the most sensitive and repeatable measure available for oil degradation.

Labs analyze used engine oil based on several parameters including:

- Oxidation
- Nitration
- TBN (Total Base Number)
- TAN (Total Acid Number)

These parameters monitor chemical changes to oil that can precede failures (corrosion, wear, deposits, viscosity increase). All can be useful, but oxidation is key.

These parameters are more reactionary toward wear, deposits, or contamination.

- Additive metals/elements such as magnesium, calcium, zinc, and phosphorus
- Viscosity
- Oil contamination, such as:
  - Certain metals/elements like sodium and potassium, as these may indicate a coolant leak
  - Fuel dilution, which can decrease viscosity and cause more metal to metal contact
  - Water contamination
  - Wear metals, such as iron, copper, and lead
NanoNet Lubricating Oil Filter LF14000NN
Contamination Filter vs. Debris Filter

LF14000NN

Cartridge

NanoNet

Cartridge

StrataPore

Cartridge

Stacked-Disc Cartridge

LF9080

Venturi Nozzle

* Note there is not a venturi Nozzle in LF14000 NN
* LF14000 NN design does not require the venture to pull lube through the NanoNet combo section
Oil – The Life-blood of the Engine

<table>
<thead>
<tr>
<th>Item</th>
<th>Severe &lt; 5.5mpg</th>
<th>Normal 5.5 – 6.5mpg</th>
<th>Light &gt; 6.5mpg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Drain</td>
<td>15,000</td>
<td>25,000</td>
<td>35,000</td>
</tr>
<tr>
<td>Fuel St 1</td>
<td>15,000</td>
<td>25,000</td>
<td>35,000</td>
</tr>
<tr>
<td>Fuel St 2</td>
<td>15,000</td>
<td>25,000</td>
<td>35,000</td>
</tr>
<tr>
<td>Ash Clean</td>
<td>250,000 – 400,000</td>
<td>400,000 – 600,000</td>
<td>600,000 – 800,000</td>
</tr>
<tr>
<td>DEF</td>
<td>250,000</td>
<td>280,000</td>
<td>300,000</td>
</tr>
<tr>
<td>Valvetrain</td>
<td>500,000</td>
<td>500,000</td>
<td>500,000</td>
</tr>
<tr>
<td>Drive Belts</td>
<td>500,000</td>
<td>500,000</td>
<td>500,000</td>
</tr>
<tr>
<td>CCV Filter</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>HC Doser</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

²Maintenance Light will illuminate when DPF cleaning is required.
Realistic ISX Oil Drain Intervals

<table>
<thead>
<tr>
<th>SEVERE-Duty</th>
<th>NORMAL-Duty</th>
<th>LIGHT-Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy-Haul over 80,000 lbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Idle Time over 40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dusty Environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPG</td>
<td>Interval/Miles</td>
<td>MPG</td>
</tr>
<tr>
<td>4.5</td>
<td>5,000</td>
<td>5.6</td>
</tr>
<tr>
<td>4.6</td>
<td>6,000</td>
<td>5.7</td>
</tr>
<tr>
<td>4.7</td>
<td>7,000</td>
<td>5.8</td>
</tr>
<tr>
<td>4.8</td>
<td>8,000</td>
<td>5.9</td>
</tr>
<tr>
<td>4.9</td>
<td>9,000</td>
<td>6.0</td>
</tr>
<tr>
<td>5.0</td>
<td>10,000</td>
<td>6.1</td>
</tr>
<tr>
<td>5.1</td>
<td>11,000</td>
<td>6.2</td>
</tr>
<tr>
<td>5.2</td>
<td>12,000</td>
<td>6.3</td>
</tr>
<tr>
<td>5.3</td>
<td>13,000</td>
<td>6.4</td>
</tr>
<tr>
<td>5.4</td>
<td>14,000</td>
<td>6.5</td>
</tr>
<tr>
<td>5.5</td>
<td>15,000</td>
<td>6.6</td>
</tr>
</tbody>
</table>

* Valvoline 5,000 Mile ‘extension' only applies to Normal or Light-Duty Applications
## Maintenance Intervals

Consult your Operation and Maintenance Manual for more information.

<table>
<thead>
<tr>
<th>Maintenance Item</th>
<th>Miles</th>
<th>Kilometers</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil and Filter</td>
<td>15,000</td>
<td>24,000</td>
<td>500</td>
</tr>
<tr>
<td>Fuel Filter</td>
<td>15,000</td>
<td>24,000</td>
<td>500</td>
</tr>
<tr>
<td>Coolant Filter</td>
<td>15,000</td>
<td>24,000</td>
<td>500</td>
</tr>
<tr>
<td>Standard Coolant</td>
<td>60,000</td>
<td>96,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Overhead Adjustment</td>
<td>150,000</td>
<td>240,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Coalescing Filter</td>
<td>Every 3rd to 4th Oil Change Interval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEF Filter</td>
<td>200,000</td>
<td>320,000</td>
<td>6,500</td>
</tr>
<tr>
<td>Particulate Filter Cleaning</td>
<td>200,000</td>
<td>320,000</td>
<td>6,500</td>
</tr>
</tbody>
</table>
## MidRange Engine Vocational Intervals

<table>
<thead>
<tr>
<th>Maintenance Item</th>
<th>Miles</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Filter, CK-4 Oil</td>
<td>9,000</td>
<td>300</td>
</tr>
<tr>
<td>Fuel Filter</td>
<td>9,000</td>
<td>300</td>
</tr>
<tr>
<td>Coolant Filter</td>
<td>9,000</td>
<td>300</td>
</tr>
<tr>
<td>Standard Coolant Change</td>
<td>60,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Overhead Adjustment</td>
<td>150,000</td>
<td>5,000</td>
</tr>
<tr>
<td>DEF Filter</td>
<td>200,000</td>
<td>4,000</td>
</tr>
<tr>
<td>Particulate Filter Cleaning</td>
<td>200,000</td>
<td>4,000</td>
</tr>
<tr>
<td>Coalescing Filter</td>
<td>Every 3rd to 4th oil change interval</td>
<td></td>
</tr>
</tbody>
</table>

* Refer to Operation & Maintenance Manual that is provided with every vehicle

CK-4 category oils were released for 2017, coinciding with higher engine temperatures, to improve oxidation resistance, shear stability, and aeration control.

Under 7 MPG
High Idle 40%
Heavy CGWR Weight
Dusty Environment

Extended Oil Drains **Short-term Gain for Long-term Pain**
EGR Cooler Failures
EGR Cooler Failures
What causes them?

1. Coolant Leaks
2. Defective Radiator Cap
3. Improper Coolant Fill Procedures

Resulting In Progressive Damage?

- Plugs every sensor in the intake and exhaust
- Seizes the EGR Valve
- Takes out the Turbocharger
- Can Damage Aftertreatment
Defective Radiator Caps

- **Procedure 008-047 Radiator Pressure Cap Test**
  - Test with Cap on Radiator, DO NOT REMOVE:
  - Remove Vent Line to top-tank.
  - Install T-fitting and a pressure regulator between the engine and the top tank.
  - Run hose from cap vent to container of water
Defective Radiator Caps
Working harder then ever, reducing life.

- Radiator Caps increase the cooling system pressure raising the boiling point to maximum effectiveness and thermo capacity.
- Protects against air entrainment and component cavitation.

**008-047 Radiator Pressure Cap**
- Test with Cap on Radiator, DO NOT REMOVE:
  - Remove Vent Line to top-tank.
  - Install T-fitting and a pressure regulator between the engine and the top tank.
  - Apply 20 psi air pressure to the cooling system. (NO MORE THEN 20psi)
  - Pressurize the cooling system slowly to the value printed on the radiator pressure cap or until bubbles can be seen in the overflow bottle.
  - Bubbles should start to form at a pressure within -1/+2 psi of the value printed on the radiator pressure cap, or it **must** be replaced.
- Refer to Operation & Maintenance Manual for min. cap requirements.
- This method allows you to check the sealing area on the top tank.
EGR Cooler Failures
What causes them?

1. Coolant Leaks
2. Defective Radiator Cap
3. Improper Coolant Fill Procedures

Resulting In Progressive Damage?
- Plugs every sensor in the intake and exhaust
- Seizes the EGR Valve
- Takes out the Turbocharger
- Requires cleaning the Doser Injector, 7\textsuperscript{th} Injector (EcoFit)
- Can Damage Aftertreatment
- Replace CCV Filter
Defective Radiator Caps

- Working harder than ever, reducing life.
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  - Bubbles should start to form at a pressure within 2 psi of the value printed on the radiator pressure cap, or it **must** be replaced.
  - Refer to Operation & Maintenance Manual for min. cap requirements.
  - This method allows you to check the sealing area on the top tank.
A New Era of Trucking

- Reliability – UPTIME - Top Priority
- Single Module Aftertreatment saving 100 lbs
- Fuel Economy Gains
  - Reduced Internal Parasitic Loads
- Efficiency Series Engines up to 500hp/1850tq
- Engine Braking Improved 50% at low rpm’s
- Maintenance Cost Reduction by 25%
- Removed 7th Dosing Injector
- All Supported by 3,500 Service Dealers throughout North America.
ADEPT – Advanced Dynamic Electronic Features

- Enhances vehicle efficiency by managing torque and leveraging momentum
  - SmartTorque2 (Eaton Neutral Coast)
  - SmartCoast
  - Predictive Cruise
  - Dynamic Torque

- Ordered as ‘OPTIONAL’ Equipment

- Overview Video: [https://www.youtube.com/watch?v=hoOFEHi7YIA](https://www.youtube.com/watch?v=hoOFEHi7YIA)
The American Workhorse

- 30+ years of North American Legacy
- 12-million engines working in-service
- Stable In-line 6 Cylinder Architecture
- Single VGT Turbocharger for all ratings
- 200-325 HP, 520-750 lb-ft Torque
- Proven in various duty cycles and across diverse applications
- New STOP-START Feature to save even more fuel
- American designed and globally embraced
The American Workhorse

- Robust platform with over 5 million units sold
- In-line 6 Cylinder Wet-liner Inframe rebuildable
- Heavy-duty design features
- 260-380 HP, 720-1250 lb-ft Torque
- Class-leading power-to-weight ratio
- Proven in various duty cycles and across diverse applications
Engine Manufacturers Class 6, 7, and 8 Group 1 Market Share* (November, 2016 YTD)

2015 Market Share (EOY)
- Cummins: 78%
- Navistar: 10%
- MB/DD: 4%
- Hino: 8%

2016 Market Share November (YTD)
- Cummins: 75%
- Navistar: 5%
- MB/DD: 4%
- Ford: 7%

* Wards NA Medium Duty Market Share data (Class 6,7,8 Group 1 data) includes natural gas and diesel products, ACT historic build data and Cummins account teams data.
Engine Manufacturers Class 8 Market Share*  
*(December, 2016 YTD)*

2015 Market Share

- Cummins: 33%
- Detroit Diesel: 32%
- Navistar: 3%
- Volvo/Mack: 21%
- PACCAR: 11%

2016 Market Share (December YTD)

- CMI: 31%
- Volvo / Mack: 19%
- Navistar: 3%
- Detroit Diesel: 8%
- PACCAR: 14%

* Wards NAFTA Class 8 Truck Shipments include diesel and natural gas products
Global Diesel Engine Production Volume Leader

Diesel Engines Produced (>3L) in thousands

Source: Power Systems Research, 2008