



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Washington, DC 20460

FEB 14 2019

OFFICE OF
AIR AND RADIATION

Steve Hoke
CEO
Clean Diesel Group LLC
10505 Plaza Drive BLDG C
Whitmore Lake, MI 48189

Dear Mr. Hoke:

The U.S. Environmental Protection Agency (EPA) has reviewed your request for verification of the Clean Diesel Group LLC's (CDG's) Low Oxides of Nitrogen (NO_x) Filter (LXF) System for highway application. The LXF system consists of a metallic flow through pre-filter and a cordierite wall flow diesel particulate filter. Based on the information provided, EPA hereby verifies that this technology reduces emissions of certain criteria pollutants by the percentages described in the table below.

This verification approval is based on the technical information and test data provided along with the in-use compliance test report approved by the California Air Resource Board (CARB). CARB's in-use approval is accepted by EPA through the reciprocity policy.

Technology	Engine Model/Application	Fuel, Max Sulfur (ppm)	Reductions (%)			
			PM	NO _x	HC	CO
Low Oxides of Nitrogen Filter (LXF)	Highway model year 2002 through 2006 and have an engine family name listed in the Attachment A	15	90	0	90	90

The following criteria must be met in order for appropriately retrofitted engines to achieve the aforementioned emission reductions:

- 1 The engine must be used by an on-road motor vehicle with a manufacturer's Gross Vehicle Weight Rating of over 14,000 pounds.
- 2 The engine may or may not have exhaust gas recirculation (EGR).
- 3 The engine may or may not be certified to have an original equipment manufacturer (OEM) diesel oxidation catalyst (DOC).
- 4 The engine must not be certified to have an OEM diesel particulate filter (DPF).
- 5 The engine must be certified to a PM emission level of at most 0.1 grams per brake horsepower hour (g/bhp-hr), and greater than 0.01 g/bhp-hr.

- 6 The NO_x to PM ratio of the engine, calculated using the certified values for NO_x and PM, must be at least 21.
- 7 For engines with NO_x to PM ratio of 23 or greater, other than model year 2004 to 2006 Caterpillar ACERT engines (C7, C9, C11, C13, and C15), the application must have a duty cycle with an exhaust temperature profile that:
 - a. Results in a Weighted Average Temperature (WAT) that is at least 263 degrees Celsius; or
 - b. Is either greater than 245 degrees Celsius for at least 40 percent of the time or, greater than 310 degrees Celsius for at least 10 percent of the time.
- 8 For engines with NO_x to PM ratio of less than 23 and model year 2004 to 2006 Caterpillar ACERT engines (C7, C9, C11, C13, and C15), the application must have a duty cycle with an exhaust temperature profile that:
 - a. Results in a WAT that is at least 270 degrees Celsius; or
 - b. Is greater than 275 degrees Celsius for at least 40 percent of the time
- 9 The engine must be rated to at least 100 horsepower (hp) and no more than 600 hp.
- 10 The engine must remain in its original certified configuration, except that if an OEM oxidation catalyst is present, it may be removed if the LXF system is installed. Should the LXF system be removed, the OEM oxidation catalyst must be re-installed, returning the engine to its original certified configuration.
- 11 The engine must have a four-stroke combustion cycle.
- 12 The engine must be turbocharged.
- 13 The engine may be mechanically or electronically controlled.
- 14 The engine must be well maintained and must not consume lubricating oil at a rate greater than that specified by the engine manufacturer.
- 15 Lube oil, or other oil, must not be mixed with the fuel.
- 16 The engine must be operated on fuel that has a sulfur content of no more than 15 parts per million by weight.
- 17 Each vehicle that is a candidate for installation of the LXF system based on the WAT criterion must first have its exhaust temperature measured and recorded for an appropriate period of time during typical operation. CDG or its authorized representative must maintain these data for each LXF-equipped vehicle and make them available to EPA upon request.

If the LXF system is modified from the application description provided to EPA and representative of products tested, you must notify EPA immediately. This verification does not automatically confer to modified devices or devices that are similar to this original verification. EPA reserves the right to conduct testing of technologies submitted for verification. Verification approval and web listing may be revoked if the technology is modified from the device tested and described in the application or if it fails to meet requirements in EPA testing.

Information on the Clean Diesel Group LLC LXF system, percent reduction, and applicable engines will be posted on the EPA's Verified Technologies List website at: <https://www.epa.gov/verified-diesel-tech/verified-technologies-list-clean-diesel>. EPA reserves the right to review and/or revoke this verification if these operating criteria are not met or if information becomes available regarding the safety, design and/or operation of the technology.

Thank you for participating in EPA's Technology Assessment Center Verification Program. If you have any questions or comments, please contact Kuang Wei, of my staff, at (202) 343-9329.

Sincerely,

A handwritten signature in blue ink, appearing to read 'K. Simon', with a long horizontal flourish extending to the right.

Karl Simon, Director
Transportation and Climate Division
Office of Transportation and Air Quality

Attachment A: Engine Families for Low Oxides of Nitrogen (NO_x) Filter (LXF) System

Notes:

1. Engines have maximum power of more than 600 horsepower (hp) . Not all engines in this family are approved for the LXF System. The LXF System is only verified for engines rated to no more than 600 hp.
2. For engines with NO_x to PM ratio of 23 or greater, other than model year 2004 to 2006 Caterpillar ACERT engines (C7, C9, C11, C13 and C15), the exhaust temperature profile must:
 - (1) Results in a Weighted Average Temperature (WAT) that is at least 263 degrees Celsius; or
 - (2) Is either greater than 245 degrees Celsius for at least 40 percent of the time or, greater than 310 degrees Celsius for at least 10 percent of the time.
3. For engines with NO_x to PM ratio of less than 23 and model year 2004 to 2006 Caterpillar ACERT engines (C7, C9, C11, C13 and C15), the exhaust temperature profile must:
 - (1) Results in a WAT that is at least 270 degrees Celsius; or
 - (2) Is greater than 275 degrees Celsius for at least 40 percent of the time.

Model Year	Manufacturer	Engine Family	Displacement (L)	Note
2002	Caterpillar	2CPXH0442HAK	7.2	2
2002	Caterpillar	2CPXH0442HBV	7.2	2
2002	Caterpillar	2CPXH0442HBX	7.2	2
2002	Caterpillar	2CPXH0629EBX	10.0	2
2002	Caterpillar	2CPXH0729EBX	11.9	2
2002	Caterpillar	2CPXH0893EBX	14.6	2
2002	Cummins	2CEXH0912XAG	14.9	2
2002	General Engine Products	2GEPH06.5527	6.5	2
2002	Mack	2MKXH11.9H64	11.9	3
2002	Mack	2MKXH11.9V65	11.9	2
2002	Mack	2MKXH11.9V66	11.9	2
2002	Mack	2MKXH11.9V67	11.9	2
2002	International	2NVXH0365AEA	6.0	2
2003	Caterpillar	3CPXH0442HBV	7.2	2
2003	Caterpillar	3CPXH0442HBX	7.2	2
2003	Caterpillar	3CPXH0629EBV	10.0	2
2003	Caterpillar	3CPXH0629EBX	10.0	2
2003	Caterpillar	3CPXH0729EBV	11.9	2
2003	Caterpillar	3CPXH0729EBX	11.9	2
2003	Caterpillar	3CPXH0893EBV	14.6	2
2003	Cummins	3CEXH0359BAH	5.9	3
2003	Cummins	3CEXH0912XAH	14.9	2
2003	Cummins	3CEXH0912XAJ	14.9	2
2003	Detroit Diesel Corporation	3DDXH12.7EGY	12.7	2
2003	Detroit Diesel Corporation	3DDXH14.0ELY	14.0	2
2003	International	3NVXH0365AEA	6.0	2
2003	General Engine Products	3GEPH06.5527	6.5	2
2003	International	3NVXH06.0AEA	6.0	2

Attachment A: Engine Families for Low Oxides of Nitrogen (NO_x) Filter (LXF) System

Model Year	Manufacturer	Engine Family	Displacement (L)	Note
2005	Caterpillar	5CPXH0763EBK	12.5	3
2005	Caterpillar	5CPXH0928EBK	15.2	1, 3
2005	Cummins	5CEXH0359BAB	5.9	2
2005	Cummins	5CEXH0359BAF	5.9	2
2005	Cummins	5CEXH0359BAH	5.9	3
2005	Cummins	5CEXH0505CAX	8.3	2
2005	Cummins	5CEXH0505CAY	8.3	2
2005	Cummins	5CEXH0540LAH	8.9	2
2005	Cummins	5CEXH0540LAI	8.9	2
2005	Cummins	5CEXH0661MAX	10.8	2
2005	Cummins	5CEXH0912XAH	14.9	2
2005	Cummins	5CEXH0912XAJ	14.9	3
2005	DaimlerChrysler	5MBXH12.8DJA	12.8	2
2005	DaimlerChrysler	5MBXH4.25DJA	4.3	2
2005	DaimlerChrysler	5MBXH6.37DJA	6.4	2
2005	DaimlerChrysler	5MBXH7.20DJA	7.2	2
2005	General Motors	5GMXH06.6592	6.6	2
2005	General Motors	5GMXH06.6593	6.6	2
2005	Hino	5HMXH04.7JTA	4.7	2
2005	Hino	5HMXH07.7JTA	7.7	2
2005	Hino	5HMXH07.7JTB	7.7	2
2005	International	5NVXH0275AEA	4.5	2
2005	International	5NVXH0365AEC	6.0	2
2005	International	5NVXH0466AEA	7.6	2
2005	International	5NVXH0570AEA	9.3	2
2005	International	5NVXH06.0AEC	6.0	3
2005	Isuzu	5SZXH05.23AB	5.2	2
2005	Isuzu	5SZXH07.84RA	7.8	2
2005	Isuzu	5SZXH07.84RB	7.8	2
2005	Isuzu	5SZXH07.84RW	7.8	2
2005	Mack	5MKXH11.9H70	11.9	2
2005	Mack	5MKXH11.9H73	11.9	2
2005	Mack	5MKXH11.9V65	11.9	2
2005	Mack	5MKXH11.9V67	11.9	2
2005	Mack	5MKXH11.9V71	11.9	2
2005	Mack	5MKXH11.9V74	11.9	2
2005	Mitsubishi	5MFTH04.9M5A	4.9	2
2005	Mitsubishi	5MFTH07.5M6A	7.5	2
2005	Volvo	5VTXH12.150S	12.1	2
2006	Caterpillar	6CPXH0537HBK	8.8	3
2006	Caterpillar	6CPXH0680EBK	11.1	3
2006	Caterpillar	6CPXH0763EBK	12.5	3
2006	Caterpillar	6CPXH0928EBK	15.2	1, 3

Attachment A: Engine Families for Low Oxides of Nitrogen (NO_x) Filter (LXF) System

Model Year	Manufacturer	Engine Family	Displacement (L)
2004	Cummins	4CEXH0359BAD	5.9
2005	Cummins	5CEXH0359BAD	5.9
2005	Cummins	5CEXH0505CAW	8.3
2006	Cummins	6CEXH0505CAW	8.3
2006	Cummins	6CEXH0359BAD	5.9