

2015 BMW 3.0L N57 Engine Tested with Diesel Fuel – NCAT Test Report

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**Test:** 2015 BMW 3.0L xDrive35d Engine Tested with Diesel Fuel – NCAT Test Report

**Program:** Light-Duty Greenhouse Gas Test Program

**Project:** Mid Term Evaluation (MTE) Engine Benchmarking

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# Purpose of Test

The purpose of this test was to perform a benchmarking study on a 2015 BMW X5 xDrive35d vehicle equipped with a 3.0L N57 diesel engine. This vehicle was considered to have a state of the art diesel engine with a uniquely configured exhaust after treatment system. This vehicle is certified as a Tier II Bin 5. Results of this study may also be used in the ALPHA (Advanced Light-Duty Powertrain & Hybrid Analysis) model.

# Definitions

|  |  |
| --- | --- |
| Fuel Map | Engine operating map that displays contours of brake specific fuel consumption (in g/kWh) on a grid of engine speeds (in RPM) and engine torques (in Nm). |

# Test Article

The engine used in this project was a 3.0L N57 diesel engine (turbocharged, intercooled, DOHC, 24-valve, inline, 6 cylinder) from a 2015 BMW X5 xDrive35d SUV. This engine was tested using its state of the art exhaust after treatment system which utilizes a Lean NOx Trap (LNT), urea dosing Selective Catalytic Reduction (SCR) system for NOx control and a Catalyzed Diesel Particulate Filter (CDPF). The CDPF regeneration frequency was investigated and combustion analysis was performed to understand the influences of Low Pressure (LP) and High Pressure Exhaust Gas Recirculation (EGR) on the combustion process. Table 1 summarizes information that identifies the system used in this test program.

**Table 1: Summary of Vehicle and Engine Identification Information**

|  |  |
| --- | --- |
| Vehicle (MY, Make, Model) | 2015 BMW X5 xDrive35d |
| Engine (name, displacement) | 3.0L DOHC 24-Valve I-6 Diesel Engine; 2993 cc |
| Certification Level | Tier II Bin 5 |
| Rated Power | 255 hp @ 4000 RPM (190 kW) |
| Rated Torque | 413 lb-ft @ 1500 RPM (560 Nm) |
| Recommended Fuel | Diesel |
| Engine Features of Interest for MTE | Single Variable Geometry Turbocharger (VGT), Intercooled, Lean NOx Trap (LNT), Diesel Particulate Filter (DPF), Selective Catalytic Reduction (SCR) and Start/Stop Technology |

# Test Fuel

This test program used ultra-low sulfur diesel fuel obtained from Corrigan Oil Company. The properties of the fuel used to test the engine are listed in Table 2. A detailed summary of the fuel analysis measurements performed by Paragon Laboratories can be found in the file: *5- ULS Diesel Fuel Analysis Report (FEV).pdf*.

**Table 2: Engine Test Fuel Properties**

|  |  |
| --- | --- |
| Fuel Type | Ultra-Low Sulfur Diesel Fuel |
| Fuel Density @ 15 °C | 0.848 g/ml |
| Fuel Density @ 20 °C | 0.8444 g/ml |
| Heating Value NET | 42.874 MJ/kg |
| Heating Value GROSS | 45.72 MJ/kg |
| Cetane Number | 43.4 |
| Sulfur | 2.8 ppm wt. |

# Test Methodology

The engine was installed in a test cell operated by FEV Engine Technologies at their facility in Farmington Hills, MI under contract EP-C-12-014 WA 3-11. A schematic of the overall testing configuration and a photograph of the actual test cell setup including the complete engine installation in the test cell and are provided in Figures 1 and 2 below. Additional descriptions are also provided in *3b- 2015 BMW 3.0L N57 Engine Diesel Fuel – FEV Final Presentation.pdf.*



**Figure 1: Schematic of FEV’s Engine Testing Setup Configuration**



**Figure 2: Schematic of FEV’s Engine Test Cell Setup**

# Data Set

After installation, data were collected at stable engine operation conditions over a range of steady state torque and speed operating points, as shown in Figure 3 below. These mapping points include a series of regularly spaced points. The lower speed mapping points, those at 2250 rpm and below, were taken at 1 bar BMEP increments. The higher speed mapping points, those above 2500 rpm, were taken at 2 bar BMEP increments. In addition, a WOT curve was generated from this map and an idle point was collected as well.

The data obtained are given in the accompanying test data file, *4– 2015 BMW 3.0L N57 Engine Diesel Fuel – Test Data.xlsx.* There are separate sheets in the data file for the specific tests conducted which include:

* *1500rpm 2BMEP Continuous*
* *Cold Start Warm Up*
* *DPF Interval*
* *Engine Mapping*
* *Engine Mapping v2*
* *Engine Mapping EGR*
* *Engine Mapping Urea*
* *Engine Mapping Simulation*

# Results

The fuel map demonstrating the engine mapping BSFC results is shown in Figure 3. Additional contour maps for engine test data measurements are provided in FEV’s final presentation, *3b- 2015 BMW 3.0L N57 Engine Diesel Fuel – FEV Final Presentation.pdf*.



Figure 3: 2015 BMW 3.0L xDrive35d Diesel Engine – BSFC (g/kWh)

# Discussion and Data Usage

In general, the engine operation and fuel consumption data produced in this testing are robust and can be used for any purpose. The intent of this testing was to determine the emissions performance of a state of the art diesel engine equipped with a modern after treatment system. Results of this study may also be used in the ALPHA (Advanced Light-Duty Powertrain & Hybrid Analysis) model.